SGT University, Chandu-Budhera, Gurugram
Faculty of Engineering & Technology
Department of Mechanical Engineering

- B. Tech. Mechanical Engineering with specialization in (Robotics, Machine Design, Thermal Engineering, Computer Enable Manufacturing, Automotive Design and Development, Mechatronics, and Electric Vehicles) (Honours)
- B. Tech. Mechanical Engineering with Minor Degree in Computer Science Engineering
- B. Tech. Mechanical Engineering with Minor Degree in Artificial Intelligence and Machine Learning.

Scheme & Syllabus (2021-22)

Vision of SGT University

"Driven by Research & Innovation, we aspire to be amongst the top ten Universities in the Country by 2022"

Vision of the Department

Department endeavors to be recognized globally through outstanding education & research that produces qualified engineers who are ready to cater the everchanging industrial and social demands.

Mission of the department

- To create environment conducive for the quality teaching-learning interdisciplinary research and innovation.
- To establish academic system facilitating real learning in Mechanical Engineering.
- To prepare the graduates be leader in the profession.
- To inculcate universal human values, professional ethics and life-long learning attitude.
- To empower the learners to device their own unique path of education for acquiring multi specializations and skills.

Program Specific Outcomes (PSOs)

Mechanical Engineering Graduates will be able to:

PSO1 Apply viable aptitudes, learning in significant streams, for example, Thermal, Design, Mechatronics, Manufacturing, Production and Industrial Engineering.

PSO2 Design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

PSO3 Improve team building, team working and leadership skills of the students with high regard for ethical values and social responsibilities. Communicate effectively and demonstrate the knowledge of project management and independent research.

Program Educational Objectives (PEOs)

PEO1 To impart to the students' knowledge of contemporary science and mechanical engineering related subjects.

PEO2 To enhance analytical skills of the students for decision making.

PEO3 To provide opportunity to the students to expand their horizon beyond mechanical engineering.

PEO 4 To prepare the students to take-up career in different industries or to pursue higher studies in mechanical and interdisciplinary programs

PEO 5 To create awareness amongst the students towards social, environmental and energy related issues.

Program Outcomes (POs)

At the end of the Bachelor of Technology in Mechanical Engineering program graduates will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization in mechanical engineering for the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyze complex mechanical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3: Design / Development of Solutions: Design solutions for complex mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and the cultural, societal, and environmental considerations.

PO4: Conduct Investigations of Complex Problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5: Modern Tools Usage: Create, select, and apply proper procedure, resources, and current engineering and mechanical tools including prediction and modelling to complex engineering activities in mechanical engineering with an understanding of the limitations.

PO6: The Engineer and Society: Apply reasoning inferred by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PO9: Individual and Team work: Function effectively as an individual, and as a member or leader in diverse teams, and multidisciplinary settings.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

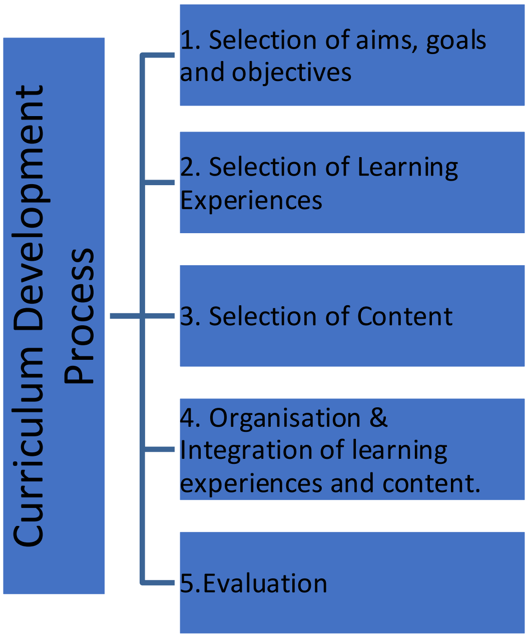
PO11: Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12: Lifelong Learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Curriculum Design & Development Process

Engineering Science is a new concept of multidisciplinary program that emphasizes enhanced understanding and integrated application of engineering, science and mathematics. B. Tech. in Mechanical Engineering gaining greater acceptance from the employers, as student are industry ready possessing greater skills. The B.Tech. courses are being carefully crafted after integrating inputs from leading national and international experts both from industries as well as academia. Here are some of the highlights of the program.

- Departmental subjects are introduced from 3rd semester onwards. The curriculum is based on a unique mix of basic sciences, humanities, core engineering, and discipline-specific subjects.
- There are many choices of elective subjects, which may or may not be related to the parent discipline comes under open elective.
- The Choice based credit system is introduced. CBCS provides a "cafeteria" type approach in which the students can take courses of their choice, learn as per interest, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.
- Huge emphasis is given on the industrial projects to address real-life issues and problems faced by the industries. Students are encouraged and facilitated to undergo training and internship during summer vacation to industries and/or national and international universities/research laboratories



List of programs being offered by the Department (with broad credit distribution)

A. B. Tech. Program

1. B. Tech. Mechanical Engineering with specialization in (Robotics, Machine Design, Thermal Engineering, Computer Enable Manufacturing, Automotive Design and Development, Mechatronics, and Electric Vehicles)

2. B. Tech. Mechanical Engineering with Minor Degree in Computer Science Engineering

3. B. Tech. Mechanical Engineering with Minor Degree in Artificial Intelligence and Machine Learning.

Note:

1. A student will be eligible to get Under Graduate degree with **Honours**, if he/she completes an additional 18-20 credits. These can be acquired through SWAYAM MOOCs. The list of MOOC courses will be provided by the Departement to the students before commencement of the semester.
2. Student can opt for any of the Open Elective, Value Added Course and Ability Enhancement Courses subject outside from the Parent Institute leading to Holistic Development of student. It may include Yoga, Dance, Fashion, Agriculture, Medicine, etc. These courses as mentioned in the curriculum can be opted from the University Pool which is circulated before the commencement of semester classes.
3. Students entring directly in 2nd and 3rd year with Certifciate Course and Dipoma will be given Undergradute Diploma considering their credits of previous courses after successfully completion of 3rd year but the student need to submit his original previous certificate.
4. Students can opt for B.Tech. Mechanical Engineering with Specialization (As stated above) before commencement of the Course with prior information the Department in accordance with the eligibility criteria defined by the Academic council from time to time. As per the current criteria, a student can get B. Tech. Mechanical Engineering with Specialization Degree if she/he has 18-20 more credits of a same specialization throughout his/her program.
5. Students can opt for B.Tech. Mechanical Engineering with Minor Degree in Computer Science Engineering/ Artificial Intelligence and Machine Learning before commencement of the Course with prior information the Department in accordance with the eligibility criteria defined by the Academic council from time to time. As per the current criteria, a student can get B. Tech. Mechanical Engineering with Minor Degree in Computer Science Engineering/ Artificial Intelligence and Machine Learning if she/he has 18-20 more credits of a same specialization throughout his/her program.

DETAILED COURSE CONTENT & SYLLABUS
B.Tech. Mechanical Engineering
2021-22

Scheme of Examination for B.Tech. (Mechanical Engineering) Program, 1st year

SEMESTER WISE COURSE STRUCTURE 2021-2022

First Semester

S. No.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
1		Applied Mathematics	3	0	0	3	40	60	100
2		Design Thinking	3	0	0	3	40	60	100
3		Basics of Mechanical Engineering	3	0	0	3	40	60	100
4		Biology for Engineers	3	0	0	3	40	60	100
5		Material Engineering and Technology	3	0	0	3	40	60	100
6		Value Addition Course-I	2	0	0	2	40	60	100
7		Ability Enhancement Course-I	2	0	0	2	40	60	100
8		Metrology and Material Engineering Lab	0	0	2	1	60	40	100
9		Workshop Technology Lab	0	0	2	1	60	40	100
10		Engineering Graphics and Design Lab	0	0	2	1	60	40	100
		Total	**19**	**0**	**06**	**22**	**460**	**540**	**1000**

Second Semester

S. No.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
1		Applied Physics	3	0	0	3	40	60	100
2		Engineering Thermodynamics	3	0	0	3	40	60	100
3		Advance Graphics and Design	2	0	0	2	40	60	100
4		Basics of Automobile Engineering	3	0	0	3	40	60	100
5		Probability and Statistics	3	0	0	3	40	60	100
6		Ability Enhancement Course-II	2	0	0	2	40	60	100
7		Engineering Thermodynamics Lab	0	0	2	1	60	40	100
8		Advance Graphics and Design Lab	0	0	2	1	60	40	100
9		Basics of Automobile Engineering Lab	0	0	2	1	60	40	100
10		Object Oriented Programming Lab	0	0	2	1	60	40	100
		Total	**16**	**0**	**08**	**20**	**500**	**500**	**1000**

Note:-

1. 4 weeks mandatory Industrial Internship of 2 credits after completetion of 1st year.

Exit Point

Certification Course in Mechanical Engineering.

Entry Point

Three years Diploma or One year Certification Course in Mechanical Engineering and in lieu of Industrial Internship of 4 weeks student has to complete MOOC Course of 4 weeks (2 Credits) in 3rd semester.

Scheme of Examination for B.Tech. (Mechanical Engineering) Program 2nd year

SEMESTER WISE COURSE STRUCTURE 2021-2022

Third Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
1.		Strength of Materials	3	0	0	3	40	60	100
2.		Engineering Mechanics	3	0	0	3	40	60	100
3.		Department Electives-I	3	0	0	3	40	60	100
4.		Department Electives-II	3	0	0	3	40	60	100
5.		Open Elective-I	4	0	0	4	40	60	100
6.		Value Addition Course-II	2	0	0	2	40	60	100
7.		Strength of Materials Lab	0	0	2	1	60	40	100
8.		Engineering Mechanics Lab	0	0	2	1	60	40	100
9.		Department Electives-I Lab	0	0	2	1	60	40	100
10.		Department Electives-II Lab	0	0	2	1	60	40	100
11.		Industrial Internship	0	0	4w	2	60	40	100
		Total	**18**	**0**	**08**	**24**	**540**	**560**	**1100**

Fourth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
1.		Mechanical Machine Design	3	0	0	3	40	60	100
2.		Manufacturing Processes and Technology	3	0	0	3	40	60	100
3.		Research Methodology	3	0	0	3	40	60	100
4.		Department Electives-III	3	0	0	3	40	60	100
5.		Department Electives-IV	3	0	0	3	40	60	100
6.		Open Elective-II	4	0	0	4	40	60	100
7.		Mechanical Machine Design Lab	0	0	2	1	60	40	100
8.		Manufacturing Processes Lab	0	0	2	1	60	40	100
9.		Department Electives-III Lab	0	0	2	1	60	40	100
10.		Department Electives-IV Lab	0	0	2	1	60	40	100
		Total	**19**	**0**	**08**	**23**	**480**	**520**	**1000**

Note: -

1. 4 weeks mandatory Industrial Training-I of 2 credits after completetion of 2nd year.

Specialization Stream for Department Electives	Department Electives-I	Department Electives-II	Department Electives-III	Department Electives-IV
Thermal	Refrigeration & Air Conditioning 3-0-2 (4)	Steam Power Generation 3-0-2 (4)	Cryogenic Engineering 3-0-2 (4)	Fluid Power System 3-0-2 (4)
Manufacturing	Advanced Machining Processes 3-0-2 (4)	Production Planning & Control 3-0-2 (4)	Computer Aided Manufacturing 3-0-2 (4)	CNC Programming 3-0-2 (4)
Automotive Technology	Advance Automobile Engineering 3-0-2 (4)	Fuel & Combustion 3-0-2 (4)	Hydrogen and Fuel Cells 3-0-2 (4)	Chassis Design 3-0-2 (4)
Industrial Engineering & Management	Industrial Engineering 3-0-2 (4)	Estimation & Costing / Total Quality Management 3-0-2 (4)	Plant Layout and Material Handling / Lean enterprise & Advanced Manufacturing Technologies 3-0-2 (4)	Work Study/Supply Chain and Logistic Managements 3-0-2 (4)
Machine Design	Product Design for Manufacturing 3-0-2 (4)	Tool Design 3-0-2 (4)	Mechanical Vibration 3-0-2 (4)	Finite Element Methods 3-0-2 (4)
Material & Metallurgy	Advance Materials 3-0-2 (4)	Composite Materials 3-0-2 (4)	Nanomaterials 3-0-2 (4)	Biomaterials 3-0-2 (4)

Exit Point

Diploma in Mechanical Engineering with specialization in_____________.

Entry Point

Certification Course in Mechanical Engineering and in lieu of Industrial Training-I of 6 weeks student has to complete MOOC Course of atleast 6 weeks (3 Credits) in 5th semester.

Scheme of Examination for B.Tech. (Mechanical Engineering) Program

SEMESTER WISE COURSE STRUCTURE 2021-2022

Fifth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	**Ext.**	
1.		Fluid Mechanics and Machines	3	0	0	3	40	60	100
2.		Kinematics of Machines	3	0	0	3	40	60	100
3.		Department Electives-V	3	0	0	3	40	60	100
4.		Department Electives-VI	3	0	0	3	40	60	100
5.		Open Elective-III	4	0	0	4	40	60	100
6.		Ability Enhancement Course-III	2	0	0	2	40	60	100
7.		Fluid Mechanics and Machines Lab	0	0	4	2	60	40	100
8.		Kinematics of Machines Lab	0	0	2	1	60	40	100
9.		Department Electives-V Lab	0	0	2	1	60	40	100
10.		Department Electives-VI Lab	0	0	2	1	60	40	100
11.		Industrial Training-I	0	0	4w	2	60	40	100
		Total	**18**	**0**	**10**	**25**	**500**	**500**	**1000**

Sixth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	**Ext.**	
1.		Heat and Mass Transfer	3	0	0	3	40	60	100
2.		Dynamics of Machines	3	0	0	3	40	60	100
3.		Department Electives-VII	3	0	0	3	40	60	100
4.		Department Electives-VIII	3	0	0	3	40	60	100
5.		Open Elective-IV	4	0	0	4	40	60	100
6.		Value Addition Course-III	2	0	0	2	40	60	100
7.		Heat and Mass Transfer Lab	0	0	2	1	60	40	100
8.		Dynamics of Machines Lab	0	0	2	1	60	40	100
9.		Department Electives-VII Lab	0	0	2	1	60	40	100
10.		Department Electives-VIII Lab	0	0	2	1	60	40	100
		Total	**18**	**0**	**08**	**22**	**480**	**520**	**1000**

Note:-

1. 4 weeks mandatory Industrial Training-II of 2 credits after completetion of 3rd year.

Department Electives Specialization Streams	Department Electives-V	Department Electives -VI	Department Electives- VII	Department Electives-VIII
Robotics	Robotics Engineering & Applications 3-0-2 (4)	Sensors & Actuators 3-0-2 (4)	Pneumatics & Control 3-0-2 (4)	Mobile Robots 3-0-2 (4)
Thermal Engineering	Solar & Nuclear Power Engineering 3-0-2 (4)	Design of Thermal Systems 3-0-2 (4)	Power Plant Engineering 3-0-2 (4)	Computational Fluid Dynamics 3-0-2 (4)
Computer Enable Manufacturing	Rapid Manufacturing Technologies 3-0-2 (4)	Non-Conventional Machining 3-0-2 (4)	Non-Destructive Evaluation & Testing 3-0-2 (4)	Press Tools & Dies 3-0-2 (4)
Machine Design	Design for Manufacturing & Assembly 3-0-2 (4)	Mechanism & Manipulator Design 3-0-2 (4)	Advance Tribology 3-0-2 (4)	Finite Element Analysis 3-0-2 (4)
Automotive Design & Development	Advance Automotive Electronics 3-0-2 (4)	Engine Design 3-0-2 (4)	Design of Transmission System 3-0-2 (4)	Vehicle Body Dynamics 3-0-2 (4)
Mechatronics	Mechatronics Systems and its Applications 3-0-2 (4)	Sensors & Actuators 3-0-2 (4)	Pneumatics & Control 3-0-2 (4)	MEMS & Micro-Systems 3-0-2 (4)
Electric Vehicles	Introduction to Hybrid and Electric Vehicles 3-0-2 (4)	Battery Management System 3-0-2 (4)	Plug-in Electric Vehicles in Smart Grid 3-0-2 (4)	EV Charging Infrastructure Technology 3-0-2 (4)

Exit Point

Undergraduate Diploma in Mechanical Engineering with specialization in_____________.

Entry Point

Diploma in Mechanical Engineering and in lieu of Industrial Training of 6 weeks student has to complete MOOC Course of atleast 6 weeks (3 Credits) in 7th semester.

Scheme of Examination for B.Tech. (Mechanical Engineering) Program 4th year

SEMESTER WISE COURSE STRUCTURE 2021-2022

Seventh Semester

S. NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
1.		Automation in Manufacturing	3	0	0	3	40	60	100
2.		Department Electives-IX	3	0	0	3	40	60	100
3.		Department Electives-X	3	0	0	3	40	60	100
4.		Value Addition Course-IV	2	0	0	2	40	60	100
5.		Ability Enhancement Course-IV	2	0	0	2	40	60	100
6.		Automation in Manufacturing Lab	0	0	2	1	60	40	100
7.		Department Electives Lab-IX	0	0	2	1	60	40	100
8.		Department Electives Lab-X	0	0	2	1	60	40	100
9.		Capstone Project	0	0	4	2	60	40	100
10.		Industrial Training-II	0	0	4w	2	60	40	100
		Total	**13**	**0**	**10**	**20**	**500**	**500**	**1000**

Eighth Semester

S.NO.	Subject Code	Course Title	L	T	P	C	Examination marks		Subject Total
							Int.	Ext.	
1.		Industrial Internship with Project (Industrial oriented/Research oriented)	-	-	20 W	**10**	100	100	**200**
	Total Credits = 10								
	Overall Total Credits = I to VIII= 166								

Department Electives	Department Electives-IX	Department Electives-X
Thermal	Nuclear Power Engineering 3-0-2 (4)	Advance Heat Transfer 3-0-2 (4)
Computer Enable Manufacturing	Machine Tool Technology 3-0-2 (4)	Modelling and Simulation of Manufacturing System 3-0-2 (4)
Automotive Technology	Recent Trends in Automotive Technology 3-0-2 (4)	Gas Dynamics & Jet Propulsion 3-0-2 (4)
Industrial Engineering & Management	Maintenance Engineering / Operation Research 3-0-2 (4)	Industrial Safety Engineering / Sales & Marketing 3-0-2 (4)
Mechatronics	Instrumentation & Control Engineering 3-0-2 (4)	Neural Networks and Fuzzy Systems 3-0-2 (4)
Material & Metallurgy	Nano-Technology and Surface Engineering 3-0-2 (4)	Aerospace Materials 3-0-2 (4)
Robotics	Robot Operating Systems 3-0-2 (4)	Cognitive Robotics 3-0-2 (4)
Electric Vehicles	Modelling and Simulation of EHV 3-0-2 (4)	Autonomous Vehicles 3-0-2 (4)

Exit Point

Degree in Mechanical Engineering with specialization in_____________.

1st Semester

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Applied Mathematics**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE ()**	**BSC (✓)**	**OE ()**	**EAS ()**
5. Pre-requisite (if any)	+2 Math	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
Introduction to applied mathematics and their applications like differential equations, matrix and set theory, recursive programming, multiple integrations and Laplace transform be the tool for solving the real-life problems in engineering & sciences. Enhance and develop the ability of using the language of mathematics in analyzing the real-world problems of sciences and engineering.						
9. Learning Objectives: **i)** To provide basic and theoretical competencies that is majorly used in Computer Science. To help students understand and appreciate the basic mathematical knowledge which is fundamental to Computer Science. **ii)** To aware students about computer, its functions and utilities. **iii)** To promote the development of computer-related skills for immediate application to other curricular areas. **iv)** To provide a foundation for post-secondary education.						
10. Course Outcomes (COs):						
The students will be able to: - **i)** Derive mathematical models of physical systems. **ii)** Solve differential equations using appropriate methods. **iii)** Present mathematical solutions in a concise and informative manner. **iv)** Solve linear system of equations by direct, iterative methods and determine eigen values and eigen vectors of given square matrix also inverse of the matrix using Cayley Hamilton theorem.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Matrices**				
Matrices, additions and scalar multiplication, matrix multiplication; Linear system of equations, rank of a matrix, determinants, inverse of matrix, Gauss elimination and Gauss Jordan Methods, E-row methods. Caley Hamilton Theorem, Eigen value & eigen vector.						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Laplace Transforms & application**				
Laplace transform & inverse Laplace transform: Solution based on Definition, change of scale property, 1^{st} & 2^{nd} shifting Theorem, LT division by t, LT of the derivative, LT by multiplication by t, Convolution theorem and application on LT & Inverse LT.						
Unit – 3	**Number of lectures = 11**	**Title of the unit: Calculus**				
Taylor & Maclaurin series for one and two variables (without proof), Partial derivative, Multiple integral: change of order of integration, Double integration in Cartesian & polar form. Triple integration & Beta and Gamma function.						
Unit – 4	**Number of lectures = 11**	**Title of the unit: Differential equation & its application**				

Exact differentia equation, Application of DE of first order and first degree to simple electric circuits, Linear differential equation of 2nd and higher order., Method of variation, Cauchy's and Lagrendre's linear equations, Application of linear differential equations to electric circuits.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

i)	N. P. Bali and Manish Goyal, A text book of engineering mathematics, Laxmi publication, 2010

Reference Books

i)	H.K.Dass, A text book of engineering mathematics, S.Chand & Company LTD
ii)	B.S.Grewal, A text book of engineering mathematics, Khanna publication.
iii)	Elements of Engineering Mathematics, Liu, Tata Mac Graw Hills.
iv)	Kolman B, Busby R.C. and Ross S., Engineering Mathematical Structures for Computer Science, Fifth Edition, Prentice Hall of India, New Delhi, 2006.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Design Thinking**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE ()**	**BSC ()**	**OE ()**	**EAS (✓)**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Course Description

Design thinking is a systematic method of solving problems. This method is unique that it starts and ends with humans. The design thinkers start by observing, interviewing or just plain experiencing a situation. Then, they proceed to improve the situation of the humans by solving problems for them. This course familiarizes you with the concept of "innovation" and the journey of a design idea from the identification of a problem to a final solution that has a positive impact on a large community of users.

9. Learning Objectives:

i) To expose the student with state-of-the-art perspectives, ideas, concepts, and solutions related to the design and execution of innovation driven projects using design thinking principles.

ii) To develop an advance innovation and growth mindset form of problem identification and reframing, foresight, hindsight and insight generation.

iii) To prepare the mindset and discipline of systemic inspiration driven by an educated curiosity aimed find new sources of ideas, new connections and new models specially outside their regular operating atmosphere.

iv) To propose a concrete, feasible, viable and relevant innovation project/challenge.

10. Course Outcomes (COs): The students will be able to: -

i) Understand the concepts of design thinking approaches.

ii) Create design thinking teams and conduct design thinking sessions.

iii) Apply both critical thinking and design thinking in parallel to solve problems.

iv) Apply some design thinking concepts to their daily work.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to Design Thinking**

What Is Design Thinking? Preparing Your Mind for Innovation, Empathize Phase: Customer Journey Mapping, Analyze Phase: 5-Whys and How might we..., Idea Generation, Free Brainstorming & Make/Test Phase: Prototype, Experimentation.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Innovation by Design**

The Seven Concerns, Design Thinking and Collaboration, Challenges to Innovation, Understanding Users, Arriving at Design Insights, Prototyping for User Feedback, The First C: The Cause, Crossing the first Pitfall, Trial and Error, User Feedback for Development, New users, New needs to meet, Knowing the Context.

Unit – 3	**Number of lectures = 11**	**Title of the unit: Context, Comprehension, Check and Cause**

The Second C: The Context, The Basic Need, Ingenious Attempt, Further Insights, The Working Rig, Concepts Generation, Experiencing the Product, Refinements.

The Third C: The Comprehension, Understanding Constraints, Positioning the Product, Exploring Possibilities, More Experiment, Understanding the Technology, At the 2^{nd} Valley of Death, Finishing Touches.

The Fourth C: The Check and Cause, the product, the Users and the Context, The Prototyping, User Needs, The Crucial Step Missed.

Unit – 4	Number of lectures = 11	Title of the unit: Conception, Crafting and Connection
The Fifth C: The Conception, Synchronic Studies, One Product, many problems, Concept Clusters, From Idea to Product, Prototyping, Material and Technologies, Collaborative Efforts. The Sixth C: The Crafting, Recap, The Manufacturing Challenge, The User Feedback, The Iterative Process. The Seventh C: The Connection, The Seed for Innovation, Pinnacle for Innovation, The Innovation Timeline, The Innovation Champions, The Innovation Domain, The Innovation Template, The Serial Innovation.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
i)	Innovation By Design by Chakravarthy, Battula Kalyana, and Janaki Krishnamoorthy, Springer India, 2013, ISBN 978-81-322-0901-0	
Reference Books		
i)	Innovation by Design: How Any Organization Can Leverage Design Thinking to Produce Change, Drive New Ideas, and Deliver Meaningful Solutions by Thomas Lockwood, New Page Books, US; 1st edition (28 November 2017), ISBN: 1632651165.	
ii)	Innovation by Design by Gerard Gaynor, Amacom, A Division of American Management Associ135 West 50th Street New York, NY, United States, ISBN:978-0-8144-0696-0	

<table>
<tr><td colspan="7">1. Name of the Department: Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Basic of Mechanical Engineering</td><td>L
3</td><td colspan="2">T
0</td><td colspan="2">P
0</td></tr>
<tr><td>3. Course Code</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>PE ()</td><td>OE ()</td><td>EAS ()</td><td>BSC (✓)</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Physics at +2 Level</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Brief Syllabus
This introductory course covers the fundamentals of technical drawing and an introduction to computer-aided design (CAD) with a focus on mechanical applications. Topics include the development of visualization and technical sketching skills in conjunction with orthographic projections; dimensioning and tolerance practices, including an introduction to geometric dimensioning and tolerance (GD&T); and descriptive geometry with applications to engineering</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The course aims to deal with the concept of thermodynamics and steam generator.
ii) The course aims to deal with the concept of RAC and hydraulic pump and turbines.
iii) The course aims to deal with the concept of Power Transmission and Internal Combustion Engine.
iv) The course aims to deal with the concept of stress and strain</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
Upon successful completion of this course students can:
i) Understanding the concept of thermodynamics and steam generator.
ii) Understanding the concept of RAC and hydraulic pump and turbines.
iii) Understanding the concept of Power Transmission and Internal Combustion Engine.
iv) Understanding the concept of stress and strain</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Thermodynamics, and Steam</td></tr>
<tr><td colspan="7">Basic concept of thermodynamics: Introduction, States, Work, Heat, Temperature, Zeroth, 1st, 2nd and 3rd law of thermodynamics, Concept of internal energy, enthalpy and entropy. Analysis of free expansion and throttling processes, flow processes for an ideal gas under constant volume (Isochoric), constant pressure (Isobaric), constant temperature (Isothermal, adiabatic and polytrophic conditions), Problems
Properties of Steam & Steam Generator: Formation of steam at constant pressure, Thermodynamic properties of Steam, Use of steam tables, Measurement of dryness fraction by throttling calorimeter.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Refrigeration & Air-Conditioning and Hydraulic Turbines and Pumps</td></tr>
<tr><td colspan="7">Refrigeration & Air-Conditioning: Introduction to refrigeration and air -conditioning, Rating of refrigeration machines, Coefficient of performance, Simple refrigeration vapor compression cycle, Psychometric charts and its use, working of a domestic refrigerator, Human comforts</td></tr>
</table>

Hydraulic Turbines & Pumps: Introduction, Classification, Construction details and working of Pelton, Francis and Kaplan turbines, Specific speed and selection of turbines, characteristics curve of hydraulic turbines, draft tube, Classification of water pumps and their working.

Unit – 3	Number of lectures = 10	Title of the unit: Power Transmission and Internal Combustion Engine
Power Transmission Methods and Devices: Introduction to Power transmission, Belt, types of belt, slip of the belt, creep of the belt, tension ratios of belts, minimum and maximum tension in belt, rope drive-ratio of driving tensions, chain drive and its terminology, pulley drive, gear drive, gear train Types and functioning of clutches, single and multi-plate clutch, cone clutch, centrifugal clutch, diaphragm clutch, dog clutch. **Internal Combustion Engines:** Introduction of engines & their classification, basic engine components, basic engine terminology nomenclature, four stroke and two stroke diesel and petrol cycle, comparison of S.I. and C.I. engines, lubricating system, cooling system.		

Unit – 4	Number of lectures = 10	Title of the unit: Stresses and Strain
Stresses and Strains: Introduction, Concept & types of Stresses and strains, Poison's ratio, stresses and strains in simple and compound bars under axial, flexure & torsional loading, Stress- strain diagrams, Hooks law, Elastic constants & their relationships, factor of safety, torsional loading, torque, torsion equation, shear force and bending moment diagrams for cantilevers, simply supported.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

i) R. K. Rajput, Elements of Mechanical Engineering Lakshmi Publication,2019 Delhi, ISBN 9788126518784

ii) D. S. Kumar, Elements of Mechanical Engineering, S.K. Kataria and Sons, 2021, ISBN:9350147289

Reference Books

i) P. K. Nag Engineering Thermodynamics- TMH, New Delhi ,2017, ISBN: 9789352606429

ii) Arora & Domkundwar, Refrigeration &Air conditioning, Dhanpat Rai & Co. Pvt. Ltd., 2021, ISBN: 9390385849

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Biology for Engineers**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE ()**	**BSC (✓)**	**OE ()**	**EAS ()**
5. Pre-requisite (if any)	**NA**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Course Description

It is well known that this is the century of biology in which significant advances in the understanding and application of biological systems are expected. The significant impact on the world is expected in terms of better healthcare, better processes, better products and an overall better quality of life. Thus, any person can be interested in knowing the fundamentals of biology to be able to understand, or participate in the biological revolution. For example, any engineer, irrespective of the parent discipline (mechanical, electrical, civil, chemical, metallurgical, etc.,) has a high probability of using the disciplinary skills toward designing/improving biological systems in the future. This course is designed to convey the essentials of cell and molecular biology to provide a frame-work for more specific understanding, and contribution by any interested person.

9. Learning Objectives:

- **i)** To understand biological concepts from an engineering perspective.
- **ii)** To understand the inter-connection between biology and future technologies.
- **iii)** To motivate technology application for biological and life science challenges.
- **iv)** To understand the Physiological Assist Device.

10. Course Outcomes (COs): The students will be able to: -

- **i)** Understand the biological concepts from an engineering perspective
- **ii)** Understand the concepts of biological sensing and its challenges
- **iii)** Understand development of artificial systems mimicking human action
- **iv)** Integrate biological principles for developing next generation technologies

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Need to study Biology**

Life Science Studies Significance, Bio Inspired Inventions, Role of Biology in Next Generation Technology Development, Cell Structure, Cell Potential, Action Potential, ECG and other common signals – Sodium.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Nervous Systems**

Potassium channels, Neuron function, Central Nervous Systems, Evolution of Artificial Neural Networks, Machine Learning techniques.

Unit – 3	**Number of lectures = 11**	**Title of the unit: Sensing Techniques**

Understanding of Sense organs working, Sensing mechanisms, Sensor Development issues, Digital Camera, Eye Comparison, electronic nose, electronic tongue, electronic skin.

Unit – 4	**Number of lectures = 11**	**Title of the unit: Physiological Assist Device**

Physiological Assist Device: Artificial Organ Development: Kidney, Liver, Pancreas, heart valves – Design Challenges and Technological Developments
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) Biology for Engineers by Thyagarajan S., Selvamurugan N., Rajesh M.P., Nazeer R.A., Thilagaraj W., Barathi S., and Jaganthan M.K., Tata McGraw-Hill, New Delhi, ISBN: 1121439934
Reference Books
i) Biology for Engineers, by Wiley Editorial (Author), January 2018, ISBN: 8126576340.
ii) Biology for Engineers by G. K. Suraishkumar, Oxford University Press; First edition, May 2019, ISBN: 0199498741

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Material Engineering and Technology**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	Chemistry at +2 Level	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**
8. Course Description		

This introductory course combines the academic disciplines of chemistry, physics, and engineering to create a MST curriculum. The course covers the fundamentals of ceramics, glass, metals, polymers, and composites. Designed to appeal to a broad range of students, the course combines hands-on activities, demonstrations and long-term student project descriptions. The basic philosophy of the course is for students to observe, experiment, record, question, seek additional information, and, through creative and insightful thinking.

9. Learning objectives:

- **i)** The main objective of this course is to provide the basic knowledge needed to explore the discipline of materials science and engineering.
- **ii)** To develop the knowledge of how the structure of materials is described technically.
- **iii)** To develop the knowledge of how the properties of materials are described and how material failure is analyzed.
- **iv)** To introduce the concepts of structure-property.
- **v)** To develop knowledge in various class of materials and their applications.

10. Course Outcomes (COs):

- **i)** Understand how materials are formed and their classification based on atomic arrangement.
- **ii)** Describe the mechanical behaviour of metallic systems and its importance.
- **iii)** Evaluate system for fatigue failures.
- **iv)** Gain knowledge on different classes of materials and their applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Crystal Structure and their Imperfections**

Introduction to materials science – Primary and Secondary bonding in materials- Crystalline and amorphous materials –Single crystal and polycrystalline materials – Space Lattice-Module cell –Crystal systems – Bravais Lattice- Miller indices – Closed packed structures- Principal Metallic crystal structures, stacking sequence and stacking faults, classification of crystal defects- Point, Line, surface and volume, Edge & Screw dislocation, Effect of imperfection on material properties, Numerical Problems on crystallography.

Unit – 2	**Number of lectures = 11**	**Title of the unit: Phase Diagram**

Basics of Solidification mechanism – Cooling curve of pure metal and alloy – Phase –Phase Diagram–Gibbs's Phase rule – Interpretation of mass fractions using Lever's rule, Binary Iso-morphous system, Binary Eutectic alloy system (Lead-Tin System) –Binary Peritectic alloy system (Iron-Nickel System) – Invariant reactions – Iron-Iron carbide phase diagram- Slow cooling of Hypo and hyper eutectoid steels – Temperature-Time-Transformation (TTT) and Continuous Cooling Transformation(CCT) Diagrams – Effect of alloying elements in steel – types of stainless steel and cast iron		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Heat Treatment**
Heat Treatment, Annealing and its types, Normalizing, Hardening tempering, Aus-tempering and Mar- tempering, Microstructure observation, Surface Heat treatment processes, Carburizing, Nitriding, cyaniding, carbonitriding, flame and induction hardening. Composites, Fiber reinforced, Metal Matrix, Ceramic Matrix, properties and applications; Ceramics, Alumina, Zirconia, Silicon Carbide, Sialons, Reaction Bonded Silicon Nitride (RBSN), Glasses, properties and applications, Magnetic materials.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Mechanical Properties of Materials and Testing**
Mechanical properties of materials, Strengthening mechanism, Plastic deformation of single and poly-crystalline materials, Effect of Slip and twinning, Stress-strain curves of various ferrous and non-ferrous metals, Engineering stress strain, true stress strain relations, problems, Tensile test of ductile material, properties evaluation- Hardness measurement tests, Fracture of metals, Ductile and Brittle fracture; Fatigue, Endurance limit of ferrous and non-ferrous metals, Fatigue test ; Creep and stress rupture, mechanism of creep, stages of creep and creep test, SEM, XRD.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

- **i)** O.P. Khanna, Material Science, Dhanpat Rai Publication House, New Delhi, 2012, ISBN: 8189928392

Reference Books

- **i)** V. Raghavan. Materials Science and Engineering, PHI; Fifth edition (30 July 2011), ASIN: B00K7YGKWQ
- **ii)** William D. Callister, David G. Rethwisch, Fundamentals Of Materials Science And Engineering: An Integrated Approach, John Wiley & Sons; 4th Edition edition (8 December 2011), ISBN: 1118061608
- **iii)** William F. Smith and Javad Hashemi (2004), Foundations of materials science and engineering 5th Edition, Mc Graw Hill, 2009, ISBN: 9780073529240

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Basic of Mechanical Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>PE ()</td><td>BSC</td><td>OE ()</td><td>EAS ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Physics at +2 Level</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">Basic of mechanical engineering Lab work includes hand sketching and the use of two- and three-dimensional CAD systems. Students use one or more CAD software packages to draft and model various objects. The use of CAD software is an integral part of the course.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The course aims to deal with the concept of boilers and accessories.
ii) The course aims to deal with the concept of engines.
iii) The course aims to deal with the concept refrigeration system, air conditioning system and turbines
iv) The course aims to deal with the concept of velocity Ratio and Efficiency of wheels and screw jack</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Acquire knowledge of boilers and accessories.
ii) Acquire knowledge of engines.
iii) Acquire knowledge refrigeration system, air conditioning system and turbines
iv) Acquire knowledge of velocity Ratio and Efficiency of wheels and screw jack</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	**Title**	**CO covered**
1	To Study the Cochran and Babcock & Wilcox boilers.	i)
2	To Study the working and function of mountings and accessories in boilers.	i)
3	To study Two-Stroke & Four-Stroke Diesel Engines.	ii)
4	To Study Two-Stroke & Four-Stroke Petrol Engines.	ii)
5	To Study the vapor compression Refrigeration System and determination of its C.O.P.	iii)
6	To study the functioning of Window Room Air Conditioner.	iii)

7	To study the constructional features and working of Pelton wheel Turbine, Francis Turbine and Kaplan Turbine.	iii)
8	To calculate the Mechanical Advantage, Velocity Ratio and Efficiency of Single Start, Double Start and Triple Start Worm & Worm Wheel.	iv)
9	To study simple screw jack and compound screw jack and determine their efficiency.	iv)
10	To find the Mechanical Advantage, Velocity Ratio and Efficiency of a Differential Wheel & Axle.	iv)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Metrology and Material Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>PE ()</td><td>BSC ()</td><td>OE ()</td><td>EAS ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Physics at +2 Level</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">This introductory course combines the academic disciplines of chemistry, physics, and engineering to create a MST curriculum. The course covers the fundamentals of ceramics, glass, metals, polymers, and composites. Designed to appeal to a broad range of students, the course combines hands-on activities, demonstrations and long-term student project descriptions. The basic philosophy of the course is for students to observe, experiment, record, question, seek additional information, and, through creative and insightful thinking.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The main objective of this course is to provide the basic knowledge needed to explore the discipline of materials science and engineering.
ii) To develop the knowledge of how the structure of materials is described technically.
iii) Inspection of engineering parts with various precision instruments.
iv) Design of part, tolerances and fits. To know the principles of measuring instruments and gauges and their uses. Evaluation and inspection of surface roughness.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Understand how materials are formed and their classification based on atomic arrangement.
ii) Describe the mechanical behaviour of metallic systems and its importance.
iii) Students will be able to design tolerances and fits for selected product quality. They can understand the standards of length, angles, they can understand the evaluation of surface finish and measure the parts with various comparators.
iv) The quality of the machine tool with alignment test can also be evaluated by them</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	**Title**	**CO covered**
1	Preparation of a plastic mould for small metallic specimen.	i)
2	Preparation of specimen for micro structural examination-cutting, grinding, polishing, etching.	ii)
3	Comparative study of microstructures of different specimens of different materials (mild steel, gray C.I., brass, copper etc.)	i), ii)

4	Experiments on heat treatment such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after heat treatment.	ii)
5	Study of corrosion and its effects.	ii)
6	Determination of grain size for a given specimen.	ii)
7	Study the working of simple measuring instruments- Vernier calipers, micrometer, tachometer.	iii), iv)
8	Measurement of effective diameter of a screw thread using 3 wire method.	iii), iv)
9	Study & angular measurement using level protector.	iii), iv)
10	Measurement of angle using sine bar & slip gauges.	iii), iv)
11	Study of limit gauges.	iii), iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Workshop Technology Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>PE ()</td><td>EAS ()</td><td>OE ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">Workshop technology deals with different processes by which component of a machine or equipment's are made. The subject aims at imparting knowledge and skill components in the field of basic workshop technology. It deals with different hand and machine tools required for manufacturing simple metal components and articles.</td></tr>
</table>

9. Learning objectives:

i) The course aims to deal with the concept of Lathe, Shaper, and Milling machine.
ii) The course aims to deal with the concept of surface grinder and drilling machine.
iii) The course aims to deal with the concept of joints
iv) The course aims to deal with the concept of joint using Electric Arc Welding.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

i) Acquire knowledge of Lathe, Shaper, and Milling machine.
ii) Acquire knowledge of surface grinder and drilling machine.
iii) Acquire knowledge of joints
iv) Acquire knowledge of joint using Electric Arc Welding

11. Lab Content

Sr. No.	**Title**	**CO covered**
1	To perform machining operations like turning, step turning, threading etc. on the Lathe.	i)
2	To make slot on work piece by using Milling Machine.	i)
3	To prepare groves on work piece by using Shaper Machine.	i)
4	To perform surface finishing operation on Surface Grinder.	ii)
5	To perform drilling operations.	ii)
6	To make cross lap joint.	iii)

7	To make butt joint	iii)
8	To make male and female joint.	iii)
9	To make Lap joint by using Electric Arc Welding.	iv)
10	To make butt joint by using Electric Arc Welding	iv)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Engineering Graphics and Design Lab**	**L**	**T**		**P**		
3. Course Code		0	0		2		
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**	**EAS ()**	**OE ()**	**BSC ()**	
5. Pre-requisite (if any)	**Geometry and Drawing at +2 Level**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures =0		**Tutorials = 0**	**Practical = 28**				
8. Course Description							

Engineering Graphics and design is considered as language of engineers. This course is introduced to provide basic understanding of importance of designing aspects in engineering applications. The topics are covered in a sequence and starts from the basic concepts of introduction to computer aided design and then designing of planes and solids. Towards the end of the course, it is expected that students would be matured to visualize the engineering components from any drawing sheet, followed by the projection techniques. A number of chosen problems will be solved to illustrate the concepts clearly.

9. Learning objectives:

i) To understand the basic concepts of Graphics.
ii) To develop the skills of reading & interpretation of Engineering Drawing.
iii) To construct the basic and intermediate geometry.
iv) To develop the skills of preparing the engineering drawing.

10. Course Outcomes (COs):

i) Understand the use of drawing instruments and dimensioning of given drawing.
ii) Acquire the visualization skills and use of projection methods.
iii) Able to draw the different views using projection of lines, planes and solids.
iv) Use of edges, vertices and curves to construct the drawing.

11. Lab Content

Sr. No.	Title	CO Covered
1	Different types of lines with illustration and application.	i), ii)
2	Use of Drawing instruments and understand the design sheet layout with dimensioning and lettering.	i)
3	Applications of drawing commands in AutoCAD.	i)
4	Projection of points in all the four quadrants.	ii)
5	Projection of straight lines parallel, perpendicular, inclined to projection planes and traces of lines.	ii), iii)
6	Projection of plane in perpendicular and inclined positions.	iii)

7	Projection of cones and solid cylinders with axes parallel, perpendicular and inclined to both the reference planes.	iii), iv).
8	Projection of prisms and pyramids with axes parallel, perpendicular, inclined to both the reference planes.	iii), iv).
10	Design Orthographic projection of simple machine elements and engineering drawings.	iv)
11	Design Isometric projection of simple machine elements and engineering drawings.	iv)
12	Design Sectional views of simple machine elements and engineering drawings.	iv)

2^{nd} Semester

<table>
<tr><td colspan="7">1. Name of the Department: Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Applied Physics</td><td>L
3</td><td colspan="2">T
0</td><td colspan="2">P
0</td></tr>
<tr><td>3. Course Code</td><td></td><td></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>PE ()</td><td>EAS ()</td><td>OE ()</td><td>BSC (✓)</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Physics at +2 Level</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Brief Syllabus
Engineering physics course provide an opportunity to students to learn fundamental concepts of physics and apply these concepts in today's rapidly changing and highly technical/engineering environment. This course also emphasizes the solid foundations of modern scientific principles.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) An ability to apply profound understanding of Quantum Mechanics and its applications.
ii) An understanding of Optics, Dielectric and Super conductivity.
iii) An ability to design a Laser system and its component, or process to meet desired needs within realistic constraints such as health and safety, manufacturability
iv) The broad education necessary to understand special theory of relativity.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): At the completion of this course, students will be able to:
i) Students would be able to describe the Quantum Mechanics and its applications.
ii) Students would be able to write down the band theory of Solids.
iii) To enable student to learn and to apply concepts learnt in Quantum optics in Industry and in real life.
iv) To identify the applications of Dielectric and Super Conductors.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Interference and Diffraction</td></tr>
<tr><td colspan="7">Interference: Coherent sources, conditions for sustained interference. Division of Wave-Front - Fresnel’s Biprism, Division of Amplitude- Wedge-shaped film, Newton’s Rings, Michelson Interferometer, applications (Resolution of closely spaced spectral lines, determination of wavelengths, determination of refractive indices of the medium).

Diffraction: Difference between interference and diffraction, Fraunhofer and Fresnel diffraction. Fraunhofer diffraction through a single slit, Plane transmission diffraction grating, absent spectra, Rayleigh criterion of resolution, dispersive power and resolving power of grating.</td></tr>
<tr><td>Unit - 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Polarization and Special Theory of Relativity</td></tr>
<tr><td colspan="7">Polarization: Polarized and unpolarized light, uniaxial crystal, double refraction, Nicol prism, Quarter and Half wave plates, Detection and production of different types of polarized light, polarimetry, optical and specific rotation, Biquartz& Laurent’s half shade polarimeter.</td></tr>
</table>

Special Theory of Relativity: Michelson's Morley Experiment, Postulates of special theory of relativity, Lorentz transformations. Consequences of LT (length contraction and time dilation). Addition of velocities, variation of mass with velocity, Mass energy equivalence.

Unit - 3	**Number of lectures = 10**	**Title of the unit: Laser and Fiber Optics**

LASER: Spontaneous and Stimulated emission, Laser action, characteristics of laser beam-concept of coherence, spatial and temporal coherence, He-Ne, Ruby Laser and semiconductor lasers (simple ideas), applications.

Fiber Optics: Propagation of light in optical fibers, numerical aperture, V-number, single and multimode fibers, attenuation, dispersion, applications.

Unit - 4	**Number of lectures = 11**	**Title of the unit: Dielectrics and Superconductivity**

Dielectrics: Molecular theory, polarization, displacement vector, electric**,** Susceptibility, dielectric coefficient, permittivity & various relations between them, Gauss's law in the presence of a dielectric, Energy stored in a uniform electric field, concept of local molecular fields and Classius-Mossotti relation.

Superconductivity: Introduction (Experimental survey), Meissner effect, London equations, Hard and Soft superconductors, Elements of BCS Theory.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i)	Modern Physics for Engineers – S.P.Taneja (R. Chand)

Reference Books

i)	Engineering Physics – Satya Prakash (PragatiPrakashan)
ii)	Modern Engineering Physics – A. S. Vasudeva (S. Chand)
iii)	Perspectives of Modern Physics - Arthur Beiser (TMH)
iv)	Optics – Ajoy Ghatak (TMH)
v)	Fundamentals of Physics – Resnick & Halliday (Asian Book)

1. Name of the Department- Mechanical Engineering

2. Course Name	**Engineering Thermodynamics**	**L**	**T**	**P**
3. Course Code		**3**	**0**	**0**
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**	**OE ()**

5. Pre-requisite (if any)	**+2 Level Physics and Chemistry**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Brief Syllabus

This course provides a basic grounding in the principles and methods of classical thermodynamics. It concentrates on: understanding the thermodynamic laws in relation to familiar experience; phase change, ideal gas and flow processes; using sources of data like thermodynamic tables and charts; application of the basic principles to the operation of various vapour and gas power cycles; and fuels and combustion.

9. Learning objectives:

i) To learn the basic principles of classical thermodynamics.
ii) To apply the laws of thermodynamics to various systems and analyze the significance of the results.
iii) To analyze the performance of thermodynamic gas and vapour power cycles.
iv) To understand the ideal gas mixtures.

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Differentiate between closed and open systems and analyze related problems.
ii) Apply the concept of second law to design thermodynamic systems.
iii) Analyze the performance of gas and vapour power cycles and identify methods to improve thermodynamic performance.
iv) Solve problems of combustion

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: First Law of Thermodynamics**

Basic concepts of Thermodynamics, Thermodynamics and Energy, Closed and open systems, Properties of a system - State and equilibrium, Processes and cycles, Forms of energy, Work and heat transfer, Temperature and Zeroth law of thermodynamics, first law of thermodynamics, Energy balance for closed systems, first law applied to steady, flow engineering devices

Unit – 2	**Number of lectures = 11**	**Title of the unit: Second Law of Thermodynamics**

Limitations of the first law of Thermodynamics, Thermal energy reservoirs, Kelvin-Planck statement of the second law of thermodynamics, Clausius statement, Equivalence of Kelvin-Planck and Clausius statements - Refrigerators, Heat Pump and Air-Conditioners, COP, Perpetual Motion Machines, Reversible and Irreversible process, Carnot cycle, Entropy, The Clausius inequality, Availability and irreversibility

Unit – 3	**Number of lectures = 11**	**Title of the unit: Vapour and Gas Power Cycles**
Properties of pure substance, Property diagram for phase, change processes, Carnot vapour cycle, Rankine cycle, Combined gas, vapour power cycles, Analysis of power cycles, Carnot cycle, Conditions for exact differentials. Maxwell relations, Clapeyron equation, Joule-Thompson coefficient and Inversion curve		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Ideal Gas Mixtures**
Ideal and real gases, Vander Waals equation, Principle of corresponding states, Ideal gas equation of state - Other equations of state, Compressibility factor, Evaluating internal energy, enthalpy, entropy and specific heats.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) P. K. Nag, Basic and Applied Thermodynamics, Tata McGraw-Hill Publishing Company Ltd., ISBN 978-0-070-15131-4

Reference Books

i) Yunus A. Cengel, Thermodynamics: An Engineering Approach, Tata McGraw- Hill Publishing Company Ltd., ISBN 978-0-073-30537-0

ii) C. P. Arora, Thermodynamics, Tata McGraw- Hill Publishing Company Ltd., ISBN 978-0-074-62014-4.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advance Graphics and Design</td><td colspan="2">L</td><td colspan="2">T</td><td>P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">2</td><td colspan="2">0</td><td>0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>EAS ()</td><td colspan="2">PE ()</td><td>OE () | BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Geometry and Drawing at +2 Level</td><td colspan="2">6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem () | Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures =28</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
</table>

8. Brief Syllabus

Engineering Drawing is considered the language of engineers. This course is thus introduced to provide advanced understanding of fundamentals of engineering drawing, visualization, standards and conventions of drawing, the tools of drawing and use of drawing in engineering applications with design. For an engineer to work efficiently he must have a very sound knowledge of drawing. This course covers all aspects of engineering drawing to make the student well trained in drafting and understanding it. So that he may be able to work in different fields such as in manufacturing industry, construction industry etc.

9. Learning objectives:

- **i)** To develop primary knowledge of working drawing.
- **ii)** To produce orthographic drawing of different machine parts using Solid works software.
- **iii)** To develop skill to produce assembly drawings on Solid Works.
- **iv)** To develop skill to produce detailed drawings of machines parts from assembly drawing.

10. Course Outcomes (COs):

- **i)** Can perform conventional representation of materials: common machine elements and parts such as screws, nuts, bolts, webs etc.
- **ii)** Knowledge of types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned.
- **iii)** Knowledge of methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features
- **iv)** Knowledge of types of Drawings – working drawings for machine parts.

11. Unit wise detailed content

Unit	Number of lectures	Title of the unit
Unit-1	**Number of lectures = 7**	**Title of the unit: Introduction to Solid Works and projection of views**
Introduction to Solid Works software and drafting on it. Representation of different materials, like - ferrous, non-ferrous, atone, bricks, wood. Limits and Fits; Conversion of Isometric Views into Orthographic Projection. Selection of Views, additional views for the following machine elements and parts with every drawing proportion: popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screw; Keys, Cotter joints and knuckle joint; Riveted joints for plates; shaft coupling, spigot and socket pipe joint		
Unit – 2	**Number of lectures = 7**	**Title of the unit: Drawing different shapes**
Introduction of shapes of rivet heads. Caulking and Fullering pitch, Diagonal pitch, Margin, Back pitch, etc. Types of riveting (lap and butt joint, zigzag and chain structure, Boiler joint. (All drawings to be completed using Solid Works software).		
Unit – 3	**Number of lectures = 7**	**Title of the unit: Drawing Nuts & Bolts**
Classification of nuts, terminology used in the drawing of nuts and bolts. Drawing of orthographic projections (top view, front view and side view) of a bolt, Imperical relations of dimensions of nut and bolt with respect to bolt head diameter.		

Unit – 4	Number of lectures = 7	Title of the unit: Joints, Bearing and Engine parts.
Principles of Isometric Projection – Isometric Scale – Isometric Knuckle joint, coupling, (any one coupling) bearing (any one bearing), Internal Combustion Engine parts.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book	
i)	Machine Drawing by Bhattacharya, Oxford University Press; Illustrated edition. ISBN : 978-0198070771
Reference Books	
i)	Drawing and Detailing with SolidWorks by David Planchard, SDC Publications; 1st edition. ISBN: 78-1585038459
ii)	Machine Drawing by Ajeet Singh, McGraw Hill Education; 2nd edition. ISBN: 978-0071072946
iii)	Engineering Drawing – M.B. Shah and B.C. Rana, Pearson, 2005, ISBN: 9788129712301

1. Name of the Department- Mechanical Engineering

2. Course Name	**Basics of Automobile Engineering**	**L**	**T**	**P**
3. Course Code		**3**	**0**	**0**

4. Type of Course (use tick mark)	**Core (✓)**	**PE ()**	**OE ()**

5. Pre-requisite (if any)	**NA**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Brief Syllabus

The Automobile Engineering provides in depth knowledge of vehicle engineering, incorporating elements of mechanical, electrical, electronics, software and safety engineering it is applied to the design, manufacture and operation of motorcycle, automobile, buses and trunks and their respective engineering subsystem.

9. Learning objectives:

- **i)** To develop knowledge on basic concepts of Automotive Chassis.
- **ii)** To develop knowledge on Automobile systems concerning control of vehicles.
- **iii)** To develop knowledge on understanding and improving the performance of Automobile chassis system.
- **iv)** To develop knowledge on understanding the Steering mechanism and power steering.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Understand construction, working and functions of Automobile body & chassis.
- **ii)** Understand construction, working and functions of Automobile control systems such as steering.
- **iii)** Understand the modern trend of technological developments of chassis frame, body engineering & steering systems.
- **iv)** Understand the concept of body engineering.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Vehicle Layout and Frames**

Vehicle layout, Definition of an automobile, layout of a vehicle. Layout of the front engine rear wheel driven vehicle, and explain location and function of major vehicle components and systems in brief. Classification & comparison of vehicle layout with respect to i) Location of engine, ii) No of live axles, iii) Arrangement of Engine, Passenger and Luggage section, iv) Application. & Comparison. Chassis Frames: Introduction – Necessity of frame and its functions. Loads acting on frame. Types of frames- conventional (ladder and x-member type), semi-integral and integral types. Frame sections-channel, box and tubular sections, back bone type Chassis frame, Materials of frames. Sub frame, Defects in frames.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Body Engineering**

Types of bodies and materials used in body construction. Protective and anticorrosive treatments, painting and repainting procedure. Effect of stream lining [aerodynamic shape] on vehicles' performance. Comparison between Integral body and Framed Construction		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Steering system**
Steering linkages& Steering column. Steering geometry and its effects – Caster, camber, king pin inclination, toe in– toe out, Correct Steering angle, suspension height & it's effects on stability, steering effort & vehicle control etc. Understeering and oversteering, Turning radius & it's effects. Tilt & Telescoping steering wheels, Collapsible steering column, construction & working Principle. Construction, working and application of Steering gear box – Rack and Pinion type, Recirculating ball type, Worm and Roller type. Ackerman Principle and linkage. Defects & Troubleshooting.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Power Steering**
Principles of Power Steering. Comparison between Conventional Steering System and Power Steering System. Power Steering System Types (Hydraulic and electrical) Construction and working principle of different power steering system, Power Steering Pumps, Four Wheeled Steering. Power Steering System – Troubleshooting.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
ii) Dr. Kirpal Singh, Automobile Engg. Vol.-1, Standard Publishers		
Reference Books		
iii) R.B. Gupta Automobile Engineering Satya Prakashan		
iv) Crouse & Angline Automotive Mechanics Tata McGraw Hill		
v) Joseph Heitner Automotive Mechanics East West Press, New Delhi		

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Probability and Statistics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE ()</td><td>OE ()</td><td>EAS ()</td><td>BSC (✓)</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Maths at +2 Level</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">The course begins with the theoretical study of probability distributions which is widely used in all engineering applications. The student is then introduced to the logic as well as the technical side of the main forms of inference: point estimation, interval estimation and hypothesis testing. Special tests of significance and ANOVA are also dealt with. Lastly, the course emphasizes on the concepts of Correlation and Regression and different types of curve fitting by the method of least squares are discussed.</td></tr>
<tr><td colspan="7">9. Learning Objectives:
i) To give an exposure to the students the basic concepts of Probability and Statistical methods and their application.
ii) To serve as a foundation to analyze problems in Science and Engineering applications through Statistical testing Method.
iii) To understand the Tests of Hypothesis and Significance.
iv) Expose students to Correlation and Regression</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students are expected to learn
i) Basics of Probability distributions.
ii) Sampling theory and Theory of Estimation.
iii) Various tests of Hypothesis and Significance
iv) Correlation and Regression and fitting of different types of curves</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Probability Distributions</td></tr>
<tr><td colspan="7">Review of basic probability, Random variables, Probability Distribution, Mathematical Expectation and Variance of Probability distribution, Standard discrete distributions: Binomial, Poisson and Geometric distributions, Probability density function, Cumulative distribution function, Expectation and Variance, Standard continuous distributions - Uniform, Normal, Exponential, Joint distribution and Joint density functions.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Sampling and Estimation Theory</td></tr>
<tr><td colspan="7">Population and Sample, Statistical inference, Sampling with and without replacement, Random samples, Population parameters, Sample statics, Sampling distributions, Sample mean, Sampling distribution of means, Sample variances, Sampling distribution of variances, Case where population variances is unknown, Unbiased estimates and efficient estimates, point estimate and Interval Estimates, Confidence Interval estimates of</td></tr>
</table>

<table>
<tr><td colspan="3">population parameters, Confidence intervals for variance of a Normal distribution, Maximum likelihood estimates.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 11</td><td>Title of the unit: Tests of Hypothesis and Significance</td></tr>
<tr><td colspan="3">Statistical hypothesis, Null and Alternate hypothesis, test of hypothesis and significance, Type I and Type II errors, Level of Significance, Tests involving the Normal distribution, One-Tailed and Two-Tailed tests, P value. Special tests of significance for large samples and small samples (F, chi- square, z, t- test), ANOVA.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td>Title of the unit: Correlation and Regression</td></tr>
<tr><td colspan="3">Correlation, Rank correlation, Regression Analysis, Linear and Nonlinear Regression, Multiple regression, Curve fitting by method of least squares, fitting of straight lines, polynomials, exponential curves.</td></tr>
<tr><td colspan="3">12. Brief Description of self-learning / E-learning component
The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.</td></tr>
<tr><td colspan="3">13. Books Recommended</td></tr>
<tr><td colspan="3">Text Books</td></tr>
<tr><td colspan="3">i) Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 4th Edition, Academic Foundation, ISBN: 978-8-190-93568-5.
ii) C.R. Kothari, Research Methodology, New Age Publications, ISBN: 9386649225</td></tr>
<tr><td colspan="3">Reference Books</td></tr>
<tr><td colspan="3">i) 1. Douglas C. Montgomery, Applied Statistics and Probability for Engineers, 5th Edition, Wiley India, ISBN: 978-8-126-53719-8.</td></tr>
<tr><td colspan="3">ii) 2. Spiegel, M. R., Schiller, J. and Srinivasan, R. A., Probability & Statistics, 3rdEdition, Tata McGraw Hill, ISBN: 978-0-070-15154-3.</td></tr>
<tr><td colspan="3">iii) R. E. Walpole, R. H. Mayers, S. L. Mayers and K. Ye, Probability and Statistics for Engineers and Scientists,8th Edition, Pearson Education, ISBN: 978-8-131-71552-9.</td></tr>
</table>

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Engineering Thermodynamics Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	**Engineering Physics**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Brief Syllabus

This course provides a basic grounding in the principles and methods of classical thermodynamics. It concentrates on: understanding the thermodynamic laws in relation to familiar experience; phase change, ideal gas and flow processes; using sources of data like thermodynamic tables and charts; application of the basic principles to the operation of various vapour and gas power cycles; and fuels and combustion.

9. Learning objectives:

i) To learn the basic principles of classical thermodynamics.
ii) To apply the laws of thermodynamics to various systems and analyze the significance of the results.
iii) To analyze the performance of thermodynamic gas and vapour power cycles.
iv) To understand the ideal gas mixtures.

10.Course Outcomes (Cos):

i) Understand the working principle of Engine and Gas Turbines.
ii) Differentiate between different types of boilers.
iii) Differentiate combustion process.
iv) Analyze the performance of gas and vapour power cycles and identify methods to improve thermodynamic performance.

11. Unit wise detailed content

Sr. No.	Title	COs Covered
1	Study of Fire Tube boiler.	ii)
2	Study of Water Tube boiler.	ii)
3	Study and working of Two stroke petrol Engine.	i), iii)
4	Study of Gas Turbine Model.	i), iv)
5	Study and working of Four stroke petrol Engine	i), iii)

6	Study of steam Engine model.	i), ii), iii)
7	Study of Impulse & Reaction turbine.	i)
8	Study and working of two stroke Diesel Engine.	i), iii)
9	Study and working of four stroke Diesel Engine.	i), iii)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Advance Graphics and Design Lab**	**L**	**T**		**P**		
3. Course Code		0	0		2		
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**	**EAS ()**	**OE ()**	**BSC ()**	
5. Pre-requisite (if any)	**Geometry and Drawing at +2 Level**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures =0	Tutorials = 0	Practical = 28

8. Course Description

Engineering Graphics and design is considered as language of engineers. This course is introduced to provide basic understanding of importance of designing aspects in engineering applications. The topics are covered in a sequence and starts from the review of basic concepts of introduction to computer aided design and introduction to working on Solid Works software. Towards the end of the course, it is expected that students would be matured to visualize the engineering components from any drawing sheet, followed by the projection techniques. A number of chosen problems will be solved to illustrate the concepts clearly.

9. Learning objectives:

- **i)** To understand the basic concepts of drafting in Solid Works software.
- **ii)** To develop the skills of reading & interpretation of component Drawings.
- **iii)** To construct basic mechanical components using different views.
- **iv)** To develop the skills of preparing complete engineering drawings for different parts.

10. Course Outcomes (COs):

- **i)** Understand the basics of Solid Work software and drafting using it.
- **ii)** Acquire the visualization skills and use of projection methods.
- **iii)** Able to draw the different views using the basic concepts projection of lines, planes and solids.
- **iv)** Be able to draw complete industrial components using Solid Works software

11. Lab Content

Sr. No.	Title	CO Covered
1	Introduction to Solid Works software	i)
2	Working on Solid Works commands and user interface.	i)
3	Projection of lines on Solid Works.	i)
4	Projection of planes using Solid Works	i), ii)
5	Projection of cones and other solids on Solid Works - I	i), ii)
6	Projection of Prisms and other solids on Solid Works - II	i), ii)
7	Drafting Orthographic projection of simple machine elements (Nuts & Bolts)- I	i), ii), iii)
8	Drafting Orthographic projection of simple machine elements (Mechanical Joints)- II	i), ii), iv)

9	Design Isometric projection of simple machine elements and engineering drawings.	i), ii), iv)
10	Design Sectional views of simple machine elements and engineering drawings.	i), ii), iv)

1. **Name of the Department- Mechanical Engineering**						
2. **Course Name**	**Basics of Automobile Engineering Lab**	**L**	**T**		**P**	
3. **Course Code**		0	0		2	
4. **Type of Course (use tick mark)**		**Core (✓)**	**PE ()**	**EAS ()**	**OE ()**	**BSC ()**
5. **Pre**-requisite **(if any)**	**NA**	6. **Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. **Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)**

Lectures =0	**Tutorials = 0**	**Practical = 28**

8. **Course Description**

The Automobile Engineering provides in depth knowledge of vehicle engineering, incorporating elements of mechanical, electrical, electronics, software and safety engineering it is applied to the design, manufacture and operation of motorcycle, automobile, buses and trunks and their respective engineering subsystem.

9. **Learning objectives:**

i) To develop knowledge on basic concepts of Automotive Chassis.
ii) To develop knowledge on Automobile systems concerning control of vehicles.
iii) To develop knowledge on understanding and improving the performance of Automobile chassis system.
iv) To develop knowledge on understanding the Steering mechanism and power steering.

10. Course **Outcomes (COs):** On completion of this course, the students will be able to

i) Understand construction, working and functions of Automobile Engine.
ii) Understand construction, working and functions of Automobile control systems such as steering, Suspension, Gear Box, Fuel injection system, Clutches.
iii) Understand the modern trend of technological developments of chassis frame, body engineering, drive lines & steering systems.
iv) Understand the concept of brakes, tyres and wheels.

11. **11. Lab Content**

Sr. No.	**Title**	**CO Covered**
1	To study and prepare report on the constructional details, working principles and operation of the following Automotive Engine Systems & Sub Systems. (a) Multi-cylinder : Diesel and Petrol Engines. (b) Engine cooling & lubricating Systems. (c) Engine starting Systems. (d) Contact Point & Electronic Ignition Systems	i)
2	To study and prepare report on the constructional details, working principles and operation of the following Fuels supply systems: (a) Carburetors (b) Diesel Fuel Injection Systems (c) Gasoline Fuel Injection Systems.	i)
3	To study and prepare report on the constructional details, working principles and operation of the following Automotive Clutches. (a) Coil-Spring Clutch (b) Diaphragm – Spring Clutch. (c) Double Disk Clutch.	ii)

4	To study and prepare report on the constructional details, working principles and operation of the following Automotive Transmission systems. (a) Synchromesh – Four speed Range. (b) Transaxle with Dual Speed Range. (c) Four Wheel Drive and Transfer Case. (d) Steering Column and Floor – Shift levers.	ii)
5	To study and prepare report on the constructional details, working principles and operation of the following Automotive Drive Lines & Differentials. (a) Rear Wheel Drive Line. (b) Front Wheel Drive Line. (c) Differentials, Drive Axles and Four-Wheel Drive Line.	iii)
6	To study and prepare report on the constructional details, working principles and operation of the following Automotive Suspension Systems. (a) Front Suspension System. (b) Rear Suspension System.	ii)
7	To study and prepare report on the constructional details, working principles and operation of the following Automotive Steering Systems. (a) Manual Steering Systems, e.g. Pitman –arm steering, Rack & Pinion steering. (b) Power steering Systems, e.g. Rack and Pinion Power Steering System. (c) Steering Wheels and Columns e.g. Tilt & Telescopic steering Wheels, Collapsible Steering Columns	ii)
8	To study and prepare report on the constructional details, working principles and operation of the following Automotive Tyres & wheels. (a) Various Types of Bias & Radial Tyres. (b) Various Types of wheels.	iv)
9	To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems. (a) Hydraulic & Pneumatic Brake systems. (b) Drum Brake System. (c) Disk Brake System. (d) Antilock Brake System. (e) System Packing & Other Brakes.	iv)

1. Name of the Department- Computer Science & Engineering						
2. Course Name	**Object Oriented Programming Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even	Odd (□)	Either Sem()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

9. Learning objectives:

- To understand fundamentals of programming such as variables, conditional and iterative execution, methods, etc.
- To understand fundamentals of object-oriented programming in Java, including defining classes, invoking methods, using class libraries ,etc
- To have the ability to write a computer program to solve specified problems

10. Course Outcomes (COs):

- Understand the features of C++ supporting object-oriented programming
- Understand the relatives merits of C++ as an object oriented programming language

11. List of Experiments

1. Simple C++ programs to implement various control structures.
a. if statement b. switch case statement and do while loop
c. for loopd. while loop
2. Programs to understand structure &unions.
a. structure b. union
3. Programs to understand pointer arithmetic.
5. Inline functions.
6. Programs to understand different function call mechanism.
a. call by reference b. call by value
7. Programs to understand storage specifies.
8. Constructors &destructors.
9. Use of –this pointer using class
10. Programs to implement inheritance and function overriding.
a. multiple inheritance –access Specifies
b. hierarchical inheritance – function overriding /virtual Function
11. Programs to overload unary & binary operators as member function &non member function.
a. unary operator as member function
b. binary operator as non-member function
12. Programs to understand friend function & friend Class.
a. friend Function b. friend class
13. Programs on class templates
14. Using a C++ program check whether a student passed the exam or not based on total mark which shall be above40%
15. Create a C++ program which takes two distances in inch-feet system and stores in data members of two structure variables. Then, this program calculates the sum of two distances and displays it.

3rd Semester

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Strength of Materials</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Basic Engg. I and Mathematics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials =0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">Strength of Materials (also known as Mechanics of Materials) is the study of the internal effect of external forces applied to structural member. Stress, strain, deformation deflection, torsion, flexure, shear diagram, and moment diagram are some of the topics covered by this subject.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the basic concepts of the stresses and strains in materials and understand the elastic behavior of the materials.
ii) To analyze and understand different internal forces, stresses and deflection induced in a loaded member.
iii) To analyze and understand principal stresses due to the combination of two-dimensional stresses on an element and failure mechanisms in materials.
iv) To evaluate the behavior of torsional members, columns and struts.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able:</td></tr>
<tr><td colspan="7">i) To suggest suitable material with the help of relationship between elastic constants and thermal consideration of a material.
ii) To evaluate the strength of materials subjected to various internal forces such as compression, tension, shear and bending loads.
iii) To apply the concept of Principal stress and strain in order to prevent the failures in materials subjected to two-dimensional loading condition.
iv) To Apply the basic concepts in designing the machine elements subjected to torsion and axial loading condition.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Stresses and Strains</td></tr>
<tr><td colspan="7">Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress-strain diagram- Elastic constants – Poisson’s ratio – relationship between elastic constants and Poisson’s ratio – Generalized Hook’s law – Strain energy – Deformation of simple and compound bars – thermal stresses.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Simple Bending & Deflection of Beams</td></tr>
</table>

Types of beams: Cantilever, simply supported, Over hanging: Shear Force and Bending Moment Diagrams. Theory of simple bending – bending stress and shear stress in beams, Deflection of beams by Double integration method – Macaulay's method.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Bi-axial Stress system**
Biaxial state of stress – Stress at a point – stresses on inclined planes – Principal stresses and Principal strains and Mohr's circle of stress, Theories of failure Thin cylinders and shells – deformation of thin cylinders and shells; Thick Cylinders,		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Torsion and columns**
Introduction to Torsion – derivation of shear strain – Torsion formula – stresses and deformations in circular and hollow shafts – Stepped shafts – shafts fixed at the both ends. Columns and Struts: Buckling and stability, slenderness ratio, combined bending and direct stress, struts with different end conditions, Euler's theory for pin ended columns.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Khurmi, R.S., (2019) "A Text Book of Strength of Materials", S. Chand Publishing India, ISBN: 9789352833979, 935283397X

Reference Books

i) B.S. Basavarajaiah, P.Mahadevappa (2010) "Strength of Materials" CRC Press Publication India, 3rd Edition, ISBN-13 : 978-1439854198.

ii) Rattan S.S. (2011) "Strength of Materials" McGraw-Hill Education (India) Pvt Limited, ISBN: 9780071072564, 007107256X.

iii) Bansal R.K. (2010) "A Text book of Strength of Materials" 5th Edition (In Si Units), Laxmi Publication, India, ISBN: 9788131808146, 8131808149.

iv) DeWolf, John T.. "Mechanics of Materials" (In Si Units), Tata McGraw-Hill, Third Edition, ISBN: 9780070535107, 0070535108.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Engineering Mechanics**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	**Engg. Physics & Mathematics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						

Engineering Mechanics course is to expose students to problems in mechanics as applied to real-world scenarios. In this subject student learn the how to apply laws of mechanics to actual engineering problems. By this subject student develop analytical skill of splitting the larger practical problems into a number of small problems like make free body diagrams and solve them easily.

9. Learning objectives:

- **i)** To familiarize students with the basic principles of physics applied in real life situations.
- **ii)** To calculate the reactive forces and analyze the structures.
- **iii)** To familiarize students with the concept of friction and virtual work.
- **iv)** To know the concepts of kinematics and to learn energy and momentum methods.

10. Course Outcomes (COs): After successful completion of this course students will be able to

- **i)** Solve the engineering problems in case of equilibrium conditions and calculate the reaction forces of various supports of different structures.
- **ii)** Solve the problems involving dry friction and virtual work. Apply concepts of conservation of energy and momentum to solve real life problems
- **iii)** Determine the centroid, center of gravity and moment of inertia of various surfaces and solids.
- **iv)** Calculate the outcome of applied forces acting on a rigid body using principle of kinematics.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Equilibrium of Particle and Rigid body, Trusses & Virtual work**

Introduction to Mechanics – Fundamental Principles – Coplanar forces – Equilibrium of particles – Free body diagram – Equilibrium of particle in space – Single equivalent force, Equilibrium of rigid bodies in two dimensions. Analysis of plane trusses –Method of joints – Method of sections – Zero-force member. Definition of virtual work – Principle of virtual work

Unit – 2	**Number of lectures = 10**	**Title of the unit: Friction, conservation of energy, centroid & moment of inertia**

Characteristics of dry friction – Problems involving dry friction – Ladder – Wedges. – System of connected rigid bodies – Conservative forces – Potential energy – Potential energy criteria for equilibrium. Centroid – First moment of area – Theorems of Pappus and Guldinus – Second moment of

area – Moment and Product of inertia of plane areas – Transfer Theorems – Polar moment of inertia – Principal axes – Mass moment of inertia.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Kinematic and Kinetics**
Position, Velocity and Acceleration – Rectilinear motion – Curvilinear motion of a particle – Tangential and Normal components –Radial and Transverse components – Rotation of rigid bodies about a fixed axis – General plane motion – Absolute and relative motion method – Instantaneous centre of rotation in plane motion. Linear momentum – Equation of motion – Angular momentum of a particle and rigid body in plane motion – D'Alembert's principle.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Energy and Momentum Methods**
Principle of work and energy for a particle and a rigid body in plane motion – Conservation of energy Principle of impulse and momentum for a particle and a rigid body in plane motion – Conservation of momentum – System of rigid bodies– Impact -direct and central impact – coefficient of restitution. Introduction of Advanced and recent methods of analyzing a structure for equilibrium		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book:		
i) Engineering Mechanics by R S Khurmi, S Chand & Co Ltd, Revised Edition, ISBN: 9788121926164		
Reference Books:		
i) J. V. Rao, D. H. Young, S. Timoshenko, Sukumar Pati (2013), Engineering Mechanics, Tata McGraw Hill Education. ISBN: 978-1-259-06266-7		
ii) Irving H. Shames (2012), Engineering Mechanics – Statics and Dynamics, 4th Edition, Prentice-Hall of India Private limited. ISBN: 978-8-131-72883-3		
iii) P. Ferdinand, E. Beer and J. Russell (2010), Vector Mechanics for Engineers, 9th Edition, McGraw-Hill International Edition. ISBN: 978-0-079-12637-5		

Department Electives-I

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Refrigeration and Air Conditioning**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	Engineering Thermodynamics	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

8. Course Description

Refrigeration and air conditioning are used to cool products or a building environment. The refrigeration or air conditioning system(R) transfers heat from a cooler low-energy reservoir to a warmer high-energy reservoir.

9. Learning objectives:

i) To understand the principles of refrigeration and air conditioning.
ii) To calculate the cooling load for different applications of Refrigeration and Air conditioning.
iii) To learn the principles of psychrometry.
iv) To develop the knowledge of selecting the right equipment for a particular application of Refrigeration and Air-conditioning.

10. Course Outcomes (COs):

i)	Possess the knowledge of system components of refrigeration and air conditioning.
ii)	Design and implement refrigeration and air conditioning systems using standards.
iii)	Apply the knowledge of psychrometry in calculating cooling load and heating load calculations.
iv)	Possess the knowledge of system components of refrigeration and air conditioning.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Refrigeration Cycles**
Vapour compression refrigeration cycles-Air refrigeration cycles-Simple saturated vapour compression refrigeration cycle-P-H charts - Multi stage compression –Multi evaporator system-cascade system-Vapour absorption systems.		
Unit – 2	**Number of lectures = 09**	**Title of the unit: System Components**
Refrigeration classification –Designation-Alternate refrigerants –Global warming and Ozone depleting aspects. Refrigerant compressors Reciprocating –Rotary - Condensers - Evaporators - Expansion devices - Cooling towers.		
Unit – 3	**Number of lectures = 9**	**Title of the unit: Psychrometry System**
Moist air properties - Psychrometric chart - Different Psychrometric process analysis.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Air Conditioning**
Air conditioning systems – classification - Cooling load calculations - different types of loads - GRSHF - ERSHF - Estimation of total load - Air distribution patterns - Dynamic and frictional losses in air ducts - Equal friction method - Fan characteristics of duct system.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Arora, C. P., (2008), Refrigeration and Air Conditioning, Tata McGraw-Hill Publishing Company Ltd. ISBN: 978-0-070-08390-5.

Reference Books

i) Manohar Prasad, (2003), Refrigeration and Air conditioning, New Age International, ISBN: 978-8122414295.

ii) W. F. Stocker and J. W. Jones, Refrigeration and Air conditioning, McGraw Hill, (2014), 2nd Edition ISBN: 9789332902954

iii) R. S. Khurmi, A Text Book for Refrigeration and Air conditioning, (2020)Edition, ISBN: 978-81-219-2781-9

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advanced Machining Processes</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Today’s stringent design requirements and difficult-to-machine materials such as tough super alloys, ceramics, and composites, have made traditional machining processes costly and obsolete. As a result, manufacturers and machine design engineers are turning to advance machining processes. These machining processes utilizes electrical, chemical and optimal sources of energy to machine the given job. Going through this subject student will get insight of various advanced machining processes and their system components, process variables and industrial applications. This is a perfect course for anyone designing, researching or converting to a more advance machining process.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To teach the principles of Mechanical Advanced Machining Processes.
ii) To understand the concept of EDM.
iii) To understand the concept of IBM, EBM, PAM etc.
iv) To understand the concept of advance finishing process</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Acquire Knowledge of manufacturing process for advanced materials and critical finishing.
ii) Acquire Knowledge of concept of EDM.
iii) Acquire Knowledge of concept of IBM, EBM, PAM etc.
iv) Acquire Knowledge of concept of advance finishing process</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Mechanical Advanced Machining Processes</td></tr>
<tr><td colspan="7">Need and classification of nontraditional machining processes – Material removal in traditional and nontraditional machining processes - considerations in process selection. Ultrasonic machining – Working principle, mechanism of metal removal – Theory of Shaw, elements of the processes, tool feed mechanism, effect of parameters, applications and numerical. Abrasive jet machining, Water jet machining and abrasive water jet machine - Basic principles, equipment’s process variables, mechanics of metal removal, MRR, application and limitations.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures =10</td><td colspan="5">Title of the unit: Electric Discharge Machining</td></tr>
<tr><td colspan="7">Working principle of EDM, Power circuits for EDM - RC pulse generator and controlled pulse generator– Analysis of R-C Circuits – Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, surface finish and machining accuracy, characteristics of spark eroded surface and recent</td></tr>
</table>

development in EDM. Wire EDM – Working principle, process variables, process characteristics and applications. Electric discharge grinding and electric discharge diamond grinding - working principle, process capabilities and applications.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Laser, Electron Beam, Ion Beam and Plasma Arc Machining**
General working principle of laser beam machining – Generation of Laser, types of Lasers, process characteristics and applications. Electron Beam Machining - Equipment for production of Electron Beam, theory of EBM, thermal and non-thermal type, process characteristics and applications. Ion Beam Machining - Mechanism of metal removal and associated equipments, process characteristics and applications. Plasma Arc Machining - Metal removal mechanism, process parameters, process characteristics, types of torches, applications.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Advanced Finishing Processes**
Abrasive flow Machining (AFM) - working principle, AFM system, process variables, process performance and applications. Magnetic abrasive finishing (MAF) - working principle, MAF system, material removal and surface finish, process variables and applications. Chemo mechanical polishing, working principle, material removal and surface finish and applications		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) V. K. Jain (2004), Advanced Machining Processes, 1st Edition, Affiliated Allied Publishers. ISBN: 978-8-177-64294-0.

Reference Books

i) Hassan El-Hofy (2005), Advanced Machining Processes, 1st edition Affiliated McGraw-Hill. ISBN: 978-0-071-45334-9.

ii) Gary F. Benedict (1987), Nontraditional Machining Processes, 1st Edition, Affiliated CRC press. ISBN 082-4-773-527.

iii) M. Adithan (2008), Modern Machining Methods, 1st Edition, Affiliated Khanna Publishers New Delhi. ISBN: 978-8-174-09225-0.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advance Automobile Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Basics of Automobile Engineering</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Automobile engineering is the one of the streams of mechanical engineering. It deals with the various types of automobiles, their mechanism of transmission systems and its applications. Automobiles are the different types of vehicles used for transportation of passengers, goods, etc. Basically, all the types of vehicles work on the principle of internal combustion processes or sometimes the engines are called as internal combustion engines. Different types of fuels are burnt inside the cylinder at higher temperature to get the transmission motion in the vehicles. Most of the automobiles are internal combustion engines vehicles only.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To broaden the understanding of students in the structure of vehicle chassis and engines.
ii) To introduce students to Transmission system.
iii) To introduce students to steering, suspension, braking and transmission systems.
iv) To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning and also the importance of alternate fuels.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Develop chassis and identify suitable engine for different applications.
ii) Able to select a suitable conventional and automatic transmission system for the Vehicle.
iii) Formulate steering, braking and suspension systems.
iv) Identify the usage of Electrical vehicles / Hybrid vehicles and power plants.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 08</td><td colspan="5">Title of the unit: Introduction to Vehicle Structure</td></tr>
<tr><td colspan="7">Vehicle construction, Chassis and body, Specifications, Engine, Types, Construction, Location of engine, Cylinder arrangement, Construction details, Cylinder block, Cylinder head, Cylinder liners, Piston, piston rings, Piston pin, Connecting rod, Crankshaft, Valves.
Lubrication system, Types, Oil pumps, Filters, Cooling system, Types, Water pumps, Radiators, Thermostats, Anti-freezing compounds.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Ignition, Fuel Supply and Emission Control System</td></tr>
<tr><td colspan="7">Coil and Magneto - Spark plug - Distributor – Electronic ignition system - Fuel system - Carburetor - Fuel pumps - Fuel injection systems– Module injector – Nozzle types - Electronic Fuel Injection system (EFI) -Dash board instrumentation – Passenger comfort – Safety and security – HVAC – Seat belts – Air bags – Automotive Electronics - Electronic Control Module (ECU) - Common-Rail Diesel Injection (CRDI) – Multipoint fuel injection system(MPFI) - Gasoline Direct Injection (GDI) - Variable Valve Timing (VVT) - Active Suspension</td></tr>
</table>

System (ASS) - Anti-lock Braking System (ABS) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP) Traction Control System (TCS) - Global Positioning System (GPS) - X-by-wire - Electric - Hybrid vehicle. Automobile Emissions - Source of formation – Effects on human health and environment - Control techniques - Exhaust Gas Recirculation (EGR) - Catalytic converter -		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Transmission System**
Clutches - Function - Types - Single plate, Multiple plate and Diaphragm Clutch - Fluid coupling - Gearbox - Manual - Sliding - Constant - Synchromesh - Overdrive - Automatic transmission - Torque converter - Continuously variable transmission - Universal joint - Propeller shaft - Hotchkiss drive – Final drive - Rear axle assembly - Types -Differential - Need - Construction — Differential locks - Four wheel drive.		
Unit – 4	**Number of lectures = 08**	**Title of the unit: Steering, Suspension and Braking System**
Principle of steering - Steering Geometry and wheel alignment - Steering linkages – Steering gearboxes - Power steering - front axle - Suspension system - Independent and Solid axle – coil, leaf spring and air suspensions - torsion bar - shock absorbers-Wheels and Tires - Construction - Type and specification - Tire wear and causes - Brakes - Needs – Classification –Drum and Disc Mechanical - Hydraulic and pneumatic - Vacuum assist – Retarders.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Kirpal Singh (2011), Automobile Engineering, 12th edition, Standard Publications, ISBN: 9788180141775

Reference Books

i) William H. Crouse (2006), Automotive Mechanics, 10th Edition, McGraw Hill/ ISBN: 9780070634350

ii) Joseph Heitner (1999), Automotive Mechanics: Principles and Practices, 2nd edition, Affiliated East West Pvt. Ltd, D. Van Nostrand Company publisher, ISBN:978-0442033026.

iii) Bosch Automotive Hand Book (2007), 9thedition, Robert Bosch GmbH; Publications, ISBN: 978-0837617329

iv) K. Newton and W. Steeds (2001), The motor vehicle, 13th Edition, Iliffe Books Ltd publisher, ISBN 13: 9780408011181.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Industrial Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Manufacturing systems and Statistics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the concepts of manufacturing economics and its critical parameters. Introducing thoroughly the concepts of Productivity, Fixed and Variable costs, Materials management, EOQ, Inventory management, Quality management, Production planning and control and Management Information systems.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) Learn basic concept of productivities in industrial manufacturing.
ii) Learn basic concept of cost analysis for a manufacturing system.
iii) Learn basic concept of Inventory control and its application.
iv) Learn basic concept of Industrial and Quality Management.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to:
i) Define and measure various productivities in industrial manufacturing.
ii) Perform full cost analysis for a manufacturing system.
iii) Understand the concept of Inventory control and its application.
iv) Explain key features of Industrial and Quality Management.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction</td></tr>
<tr><td colspan="7">Definition of Industrial Engineering: Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, time study PMTS, determining time, Work sampling, Numerical.
Productivity & Workforce Management: Productivity - Definition, Various methods of measurement,
Factors effecting productivity, Strategies for improving productivity, Various methods of Job evaluation & merit rating, Various incentive payment schemes, Behavioral aspects, Financial incentives.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Manufacturing Cost Analysis and Production Planning</td></tr>
<tr><td colspan="7">Manufacturing Cost Analysis: Fixed & variable costs, Direct, indirect & overhead costs, & Job costing,
Recovery of overheads, Standard costing, Cost control, Cost variance Analysis - Labor, material, overhead in volume, rate & efficiency, Break even Analysis, Marginal costing & contribution, Numerical. Materials Management: Strategic importance of materials in manufacturing industries, Relevant costs.
Introduction to Forecasting - Simple & Weighted moving average methods, Objectives & variables of PPC, Aggregate planning - Basic Concept, its relations with other decision areas, Decision options - Basic & mixed strategies, Master production schedule (MPS), Scheduling Operations Various methods for line & intermittent production systems, Gantt chart, Introduction to JIT, Numerical.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Inventory Control</td></tr>
<tr><td colspan="7">Purchase discounts, Sensitivity analysis, Inventory control systems - P, Q, S’s Systems, Service level, Stock out</td></tr>
</table>

risk, determination of order point & safety stock, Selective inventory control - ABC, FSN, SDE, VED and three dimensional, Numericals.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Product Quality Management**
Product Design and Development: Various Approaches, Product life cycle, Role 3S's – Standardization, Simplification, Specialization, Introduction to value engineering and analysis, Role of Ergonomics in Product Design. Definition of quality, Various approaches, Concept of quality assurance systems, Costs of quality, Statistical quality Control (SQC), Variables & Attributes, X, R, P & C - charts, Acceptance sampling, OC - curve, Concept of AOQL, Sampling plan - Single, Double & sequential, Introduction to TQM & ISO - 9000.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Industrial Engineering and organization management by S K Sharma and Swati Sharma (2013) SK Kataria & Sons Publishing House ISBN-13:978-8185749136

Reference Books

i) Industrial Engineering and production management by Martand Telsang (2006) S Chand; 2nd Revised Edition 2018 edition ISBN-13: 978-8121917735

ii) Industrial Engineering and Management by O P Khanna Dhanpat Rai Publications (2018) ISBN-13: 978-8189928353.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Product Design for Manufacturing</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Product design for manufacturing is the general engineering art of designing products in such a way that they are easy to manufacture. This design practice not only focuses on the design aspect of a part but also on the product ability. In simple language it means relative ease to manufacture a product, part or assembly. DFM describes the process of designing or engineering a product in order to facilitate the manufacturing process in order to reduce its manufacturing costs. This course will impart knowledge of various methods and approaches used in design of manufacturing. Moreover, students will get familiar to DFMA software through case studies. In the end of course, student will be able to utilize the knowledge gained through coursework for the development of new product.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To expose with basics of product design and manufacturing.
ii) To introduce principles and evaluation methods of various aspects of designing components.
iii) To teach about the manufacturability requirements
iv) To expose with basics of assembly processes and DFMA software for case studies.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Apply customer-oriented, manufacturing and life cycle sensitive approach to product design and development with product design principles and structured design methodologies.
ii) Possess methods and approaches for principles and evaluation methods of various aspects of designing components
iii) Develop a manufacturability of new product as per the requirement.
iv) Demonstrate the knowledge of DFMA software for case studies</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to Product design</td></tr>
<tr><td colspan="7">Introduction to Product design: Asimow's Model - Product design practice in Industry - Strength consideration in product design- Design for stiffness and rigidity.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Principles and evaluation methods</td></tr>
<tr><td colspan="7">Principles and evaluation methods of various aspects of Design for X (machining - sheet metal working - injection molding - environment- service and repair - etc.).</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Manufacturability requirements</td></tr>
<tr><td colspan="7">Manufacturability requirements - Forging design - Pressed component design - Casting design - Die Casting and special castings.</td></tr>
</table>

Unit – 4	Number of lectures = 12	Title of the unit: Assembly and assembly process and Other supporting techniques
Assembly and assembly process - principles of Design for assembly and applications (Boothroyd/Dewhurst Method – case studies using DFMA software). Other supporting techniques for new product development processes such as quality function deployment - and quality engineering and Taguchi Method		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Geoffrey Boothroyd, Peter Dewhurst and Winston Anthony Knight (2009), Product Design for Manufacture and Assembly, Taylor & Francis e-Library. ISBN: 978-1-420-08927-1.

Reference Books

i) A.K. Chitale and R.C. Gupta, (2005), Product Design and Manufacturing, 6th Edition, Printice Hall of India, ISBN: 9788120342828

ii) Karl T. Ulrich and Steven D. Eppinger (2011), Product Design and Development, 7th Edition, Tata McGraw, ISBN: 9789390113231

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advance Materials</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3.Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Material Engineering and Technology</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
</table>

8. Course Description

Introduction to the materials science and engineering of ceramics, electronic materials, metals and polymers. Bonding; crystallography; imperfections; processing and properties of semiconductors, polymers, metals, ceramics and composites; and phase diagrams. The course is intended to give the student a broad scope preparation in selecting and using materials for applications in engineering.

9. Learning objectives:

- **i)** To provide the knowledge of advanced materials and production technology.
- **ii)** Characterization of materials structure and properties and different types of advance materials.
- **iii)** Development and application of advanced materials.
- **iv)** To give the understanding of Nanomaterials

10. Course Outcomes (COs): At the end of this course the student will be able to:

- **i)** Select materials for specific applications.
- **ii)** Learn materials by properties and application-based selection, with special attentions to applications in engineering
- **iii)** Extend their in-depth knowledge of one of the following specializations: - Metals and Ceramics; - Semiconductor Processing and Nanotechnology, or - Biobased Materials
- **iv)** Apply the knowledge of Nanomaterials in Industry.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Introduction

Introduction, classification: Polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon–carbon composites, fiber- reinforced composites and nature-made composites, and applications.
Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and born carbide fibres.
Polymer composites, thermoplastics, thermosetting plastics, manufacturing of PMC, MMC & CCC and their applications.

Unit – 2	Number of lectures =10	Title of the unit: Manufacturing Methods

Autoclave, tape production, moulding methods, filament winding, man layup, pultrusion, RTM.

Unit – 3	Number of lectures = 8	Title of the unit: Functionally Graded Materials

Types of functionally graded materials-classification-different systems-preparation-properties and applications of functionally graded materials. Introduction-shape memory effect- classification of shape memory alloys-composition-properties and applications of shape memory alloys.

Unit – 4	Number of lectures = 8	Title of the unit: Nano Materials

Introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) Material science and Technology- Cahan.
Reference Books
i) B. Frank L. Matthews and Rees D. Rawlings (1999), Composite Materials: Engineering and Science, Woodhead Publishing.
ii) Ning Hu (2012), Composites and Their Applications, in Tech Publisher
iii) Nano material by A.K. Bandyopadyay, New age Publishers.

Department Electives-II

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Steam Power Generation</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">To teach students about the working of various power generation units and steam cycles. To introduce students to steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities of the country. To enable students, understand functioning of boilers, turbines and pumps used in power generation.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To calculate the efficiency of thermal power plant.
ii) To know the working of boilers and turbines.
iii) To learn various sources of energy.
iv) Possess the knowledge of global energy resources.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Involve in optimizing and selecting an alternate source of energy.
ii) Know about the kind of boilers being used in various industries and their applicability.
iii) Distinguish between various power generation units and choose one that meets desired economic, environmental and social requirements.
iv) Understand basic power generation types and steam cycles.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Description of Boiler</td></tr>
<tr><td colspan="7">Classification and types of boilers, arrangements of main boiler, fundamentals of boiler design, location of various pressure parts.
Boiler Circulation Theory: Water walls, boiling phenomena, nucleate / film boiling, natural / controlled / forced circulation. Construction Details of Super Heaters, Re-heaters, and Economizers, De-super heaters. Steam Separation Theory: Boiler Drum & its internals.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Steam turbine and condenser</td></tr>
<tr><td colspan="7">Water Supply System: Soft water, Circulated Water, Cooling Water, and D.M. Water.
Steam Cycle Theory: Carnot Cycle, Rankine Cycle, with reference to a specific unit 500/210 MW, steam properties.
Steam Turbines: Classification of Turbines, Metallurgical considerations, working principles.
Description of main components i.e. Turbine casing, Steam Condensation and Condensers: Film wide / drop wise condensation, direct/indirect condensation and vacuum creation</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 09</td><td colspan="5">Title of the unit: Power Station Pumps</td></tr>
<tr><td colspan="7">Classification of pumps, centrifugal pumps, and positive displacement pumps.
Boiler Feed Pump: Function of BFP, Constructional details.
Circulating Water System: Open / closed system, CW Pumps, Cooling Towers, CT Pumps, CT Fans.</td></tr>
</table>

Unit – 4	Number of lectures = 12	Title of the unit: Various Fans and their salient features
Construction details / lubricating oil system for PA Fan, FD Fan, ID Fan. Air Pre-heaters: Types and functions, constructional details, SCAPH, soot blowers. Fuel Firing Arrangements and Burners: Corner, front and rear wall firing, Direct and indirect firing, details of coal and oil burners		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i)	R. K. Rajput, (2007), A Text Book of Power Plant Engineering, Laxmi Publications (P) Ltd. 5th Edition. ISBN 13: 9788131802557

Reference Books

i)	P. K. Nag, (2014), Power Plant Engineering: Steam and Nuclear, Tata McGraw-Hill Publishing Company Ltd., 4th EditionISBN13 9789339204044.
ii)	Wood, A.J. and Wollen Berg, B.F. (2013), Power Generation and Control, John Wiley, 3rd Edition, ISBN: 978-0-471-79055-6

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Production Planning and Control</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>IE</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">PPC, is the process of production planning sets the objectives, goals, targets on the basis of available resources with their given constraints. Control is the integral part of effective planning. Similarly control involves assessment of the performance; such assessment can be made effectively only when some standards are set in advance. Planning involves setting up to such standard. The controlling is made by comparing the actual performance with these present standard and deviations are ascertained and analyzed.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) Identify and suggest correct type of production planning technique
ii) Analyze the concepts of production planning.
iii) Control and implement PPC methods in crucial areas of the industry.
iv) Implement the knowledge of ERP systems and shop floor scheduling.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Acquire Knowledge of type of production planning technique
ii) Acquire Knowledge of of production planning.
iii) Acquire Knowledge of Control and implement PPC methods in crucial areas of the industry.
iv) Acquire Knowledge of Implement the knowledge of ERP systems and shop floor scheduling.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: MPC Performance</td></tr>
<tr><td colspan="8">Factors influencing MPC performance - Review of fundamental features of Material Requirements Planning systems - MRP systems dynamics and system nervousness.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Sales and Operations Planning</td></tr>
<tr><td colspan="8">Sales and operations planning - Production Planning - Master scheduling and order promising - Distribution Resource Planning - Bills of material structuring, master scheduling - and final assembly scheduling.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Capacity Management</td></tr>
<tr><td colspan="8">Capacity management using planning factors - bills of capacity - and capacity requirements planning – CRP and I/O Control - Shop floor control/operations scheduling – Inventory models.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Shop Floor Control and ERP Systems</td></tr>
</table>

Shop floor control/scheduling - Kanban/pull systems - Alternative pull systems; parameter settings - Pull systems for suppliers.
ERP systems - Technical aspects of SAP - Focus on implementation and system's fit - ERP implementation - Beyond ERP Software for manufacturing firms - Supply Chain Management.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

- **i)** D.W. Fogarty, J.H. Blackstone and T. Hoffmann. (2009), Production and Inventory Management, 3rd Edition, South-Western Publishing. ISBN: 978-0-324-31137-2

Reference Books

- **i)** S. K Mukhopadhyay (2009), Production Planning and Control: Text and Cases, 2nd Edition, Phi Learning. ISBN: 978-8-120-33118-1
- **ii)** Stephen N. Chapman (2005), Fundamentals of Production Planning and Control, Prentice Hall. ISBN: 978-0-130-17615-8.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Fuel and Combustion</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engg. Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Two and four stroke engines, air standard cycles, fuels and combustion, fundamental of ignition systems, performance and rating of engines, combustion characteristics and combustion chamber for S.I and C.I engines, supercharging.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To learn about various types of fuels, their composition and properties
ii) To acquire depth knowledge of solid, liquid and gaseous fuels.
iii) To understand the thermodynamics of combustion.
iv) To learn about the types of pollution and its control.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Analyze the composition of various types of fuels and their properties.
ii) Estimate the composition of various types of fuels and their properties.
iii) Demonstrate the knowledge of combustion thermodynamics.
iv) Acquire the knowledge of Stoichiometry of Fuel and Kinematics of Combustion.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Fuel Characteristics & Air Pollution</td></tr>
<tr><td colspan="7">Fuels – Types and Characteristics of Fuels – Determination of Properties of Fuels - Fuels Analysis - Proximate and Ultimate Analysis - Moisture Determination – Calorific Value - Gross and Net Calorific Values - Calorimetry - DuLong’s Formula for CV Estimation - Flue gas Analysis - Orssat Apparatus - Fuel and Ash Storage and Handling – Spontaneous Ignition Temperatures.
Types of pollution - Combustion-Generated air pollution - Effects of air pollution - Pollution of fossil fuels and its control – Pollution from automobiles and its control.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Solid and Liquid Fuels</td></tr>
<tr><td colspan="7">Solid Fuels: Wood and Wood Charcoal-Origin of coal-Composition of coal –Analysis and properties of different grades of coal preparation and storage of coal-coal washing –Briquetting. Liquid coals: Origin of petroleum fuels-Production –Composition-Petroleum Refining-Various grades of petro-Products-Properties and testing –Alcohol shale oil-Gasification of liquid fuels –Synthetic fuels -Storage and handling of liquid fuels.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Gaseous Fuels</td></tr>
<tr><td colspan="7">Classification - Composition and Properties – Estimation of Calorific Value - Gas Calorimeter. Rich and Lean Gas - Wobbe Index - Natural Gas - Dry and Wet Natural Gas - Stripped NG - Foul and Sweet NG -</td></tr>
</table>

LPG - LNG - CNG - Methane – Producer Gas - Gasifies - Water Gas – Town Gas - Coal Gasification – Gasification Efficiency - Non - Thermal Route - Biogas - Digesters -Reactions – Viability - Economics.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Stoichiometry and Kinematics**
Stoichiometry - Mass Basis and Volume Basis – Excess Air Calculation - Fuel and Flue Gas Compositions – Calculations – Rapid Methods - Combustion Processes - Stationary Flame – Surface or Flameless Combustion – Submerged Combustion – Pulsating and Slow Combustion Explosive Combustion. Mechanism of Combustion – Ignition and Ignition Energy - Spontaneous Combustion - Flame Propagation - Solid - Liquid and Gaseous Fuels Combustion - Flame Temperature - Theoretical - Adiabatic and Actual - Ignition Limits – Limits of inflammability.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

i) Stephen Turns, (2011), an Introduction to Combustion: Concepts and Applications, McGraw Hill. McGraw-Hill Education; 3 Edition, ISBN: 978-0073380193

ii) SS Thipse (2010) Alternative Fuels. Jaico Publishers, 1st Edition, ISBN: 9788184950786

Reference Books

i) John B. Heywood (2017)– Internal Combustion Engine, McGraw Hill. 1 edition, ISBN-13: 978-1259002076

ii) Mishra, D. P, (2007), Fundamentals of Combustion, Prentice Hall of India. Revised Edition ISBN 13: 9788120333482

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Estimation & Costing</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Nil</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This is a course in Estimation & Costing is a new approach for product cost estimating in mechanical production is proposed within the framework of integrated product engineering. The approach introduces the new concept of Cost Entity. It is made necessary due to the current context of growth of indirect costs, especially in manufacturing. The objective, i.e., establishing a tight link between technical variables (or manufacturing features) and economic variables (modeled as Cost Entities), requires to model the reasoning procedure and associated knowledge related to cost estimating.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The student can identify different areas of Engineering Costing & Estimating.
ii) To address the underlying concepts, methods and application of Engineering Costing & Estimating.
iii) Understanding the concept of Depreciation & Break-Even Analysis and Estimating
iv) The student can identify different areas of Budgetary control, securing flexibilities of budgeting.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) To present a problem oriented in depth knowledge of Engineering Costing & Estimating.
ii) To address the underlying concepts, methods and application of Engineering Costing & Estimating.
iii) Understanding the concept of Depreciation & Break-Even Analysis and Estimating
iv) Understanding the concept of Budget, Budgetary Control and Engineering Contracts.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction</td></tr>
<tr><td colspan="7">Related terminology, Estimating, Importance and aim, objectives, functions, organization of Estimating department, Estimating Procedure, Constituents of Estimation, Costing- Definition, aims, procedure for Costing, types of costs, Costing controls, Difference between Estimating and Costing, Control of Costs, Elements of PPC and Time & Motion Studies, Allowance, Overheads, Profit and Pricing Policy.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Costing and Labour Costing</td></tr>
<tr><td colspan="7">Elements of Costs, Costing methodology for raw materials, Products and Services, Nature of Costs Direct, Traceable and Non traceable, Wastage. Determining of Cost of raw materials, manufactured products, labor, indirect expenses, and methods of overhead allocation. Introduction, factors influencing wage rate, methods of wage payments for direct and indirect labor time wage system, piece rate system, Wage incentives: different plans.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Depreciation & Break-Even Analysis and Estimating</td></tr>
<tr><td colspan="7">Introduction, purpose, methods for calculating depreciation-straight line method, Diminishing balance method, sum of year digit method, machine hour basis method, Break even analysis: Introduction, assumptions in break-even analysis, important terms and definitions, calculation of breakeven point, advantages and limitations.</td></tr>
</table>

Definition, Different types, Methods adopted for estimation, Use of Standard data, parameter estimating, statistical estimating, feedback systems, importance, purpose and functions of estimating, Menstruation.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Budget, Budgetary Control And Engineering Contracts**
Budget, objectives, classification of budgeting, Budgetary control, securing flexibilities of budgeting, limitation of budget. Operational and capital budgets, Cash flow schedules, estimating cost, Preparing an annual budget for the Engineering Department. Introduction, Types of contracts and similarities. Terms of payments, firm price contracts, cost reimbursable contracts, Target of cost contracts		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

- **i)** Mechanical Estimating and Costing By B.P. Sinha. Tata McGraw Hill Publishing Co. Ltd. N. Delhi ISBN: 0133800202

Reference Books

- **i)** Mechanical Estimating and Costing T.R. Banga and S.C.Sharma, Khanna Publishers, Delhi-6
- **ii)** Industrial Engineering & Operations management by S.K.Sharma & Savita Sharma,Kataria publishers ISBN: 1412918057
- **iii)** Handbook of Engineering Management- Edited by Dennis Lock, Butterwork & Heinemanky Ltd., ISBN: 0470942185

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Total Quality Management</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Industrial Engineering, Probability & Statistics.</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">To give the students an overview of quality and TQM and explaining the salient contributions of Quality Gurus like Deming, Juran and Crosby. General barriers in implementing TQM.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To learn the basic concepts of quality and quality from organizational point of view.
ii) To learn the concept of total quality management from different philosophical approach.
iii) To learn the internal politics, quality culture, education and training of the organization.
iv) To be aware of international/national Quality standards.</td></tr>
<tr><td colspan="7">10. Course Outcomes (Cos): Students should be able to understand
i) Need and steps of maintaining Quality environment of the organization.
ii) The TQM approach for manufacturing/service organization at length.
iii) Quality terms like Tolerance and Variability PDCA cycle, Crosby’s 10 points and Deming’s 14 Points etc.
iv) The international/national Quality Standards.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Introduction and TQM Principles</td></tr>
<tr><td colspan="7">Introduction – Need for quality – Evolution of quality – Definitions of quality – Dimensions of product and service quality – Basic concepts of TQM – TQM Framework — Barriers to TQM – Quality statements – Customer focus – Customer orientation, Customer satisfaction, Customer complaints, and Customer retention – Costs of quality.
TQM, Leadership, Lean and JIT Quality Philosophy, Strategic quality planning, Quality Councils, PDCA cycle, 5s, Kaizen, Contributions of Deming, Juran and Crosby</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Tools & Techniques for Quality management-I</td></tr>
<tr><td colspan="7">Introduction to Process Quality, Graphical and statistical techniques for Process Quality Improvement, Graphical tools for data representation, Sampling, sampling distribution, and hypothesis Testing, Regression, Control charts, Process capability analysis, Measurement system analysis, Analysis of Variance (ANOVA), Design and Analysis of Experiment (DOE)</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Tools & Techniques for Quality management-II</td></tr>
<tr><td colspan="7">Six-sigma for Process Improvement, Quality functions development (QFD), QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process and documentation. Seven old (statistical) tools. Seven new management tools. Bench marking and POKA YOKE.</td></tr>
</table>

Unit – 4	Number of lectures = 10	Title of the unit: Quality Systems
Introduction to IS/ISO 9004:2000 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition and reward- Introduction to software quality.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) D. C. Montgomery, Introduction to Statistical Quality Control, John Wiley & Sons, 3rd Edition, ISBN-978-0470169926.

Reference Books

i) Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education, ISBN-9789332534452.

ii) Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, ISBN-978-8178662527.

1. Name of the Department- Mechanical Engineering				
2. Course Name	**Tool Design**	**L**	**T**	**P**
3. Course Code		**3**	**0**	**0**
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**

5. Pre-requisite (if any)	**Workshop Technology, Manufacturing Process**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Course Description

Tool design is a specialized area of manufacturing engineering comprising the analysis, planning, design, construction, and application of tools, methods, and procedures necessary to increase the manufacturing productivity.

9. Learning objectives:

- **i)** The main objective of this course is to provide the basic knowledge needed to explore the discipline of tool design and engineering.
- **ii)** Implement the tool design process when designing tooling for the manufacturing of a product
- **iii)** Design, develop, and evaluate cutting tools and work holders for a manufactured product
- **iv)** Use CAD and conventional techniques in creating tooling drawings.

10. Course Outcomes (COs): At the end of the course, the student will be able to,

- **i)** Understand introduction, regulation of speed and feeds.
- **ii)** Learn the designing of machine tool structures and its constructional features.
- **iii)** Understand mechanical properties of materials and testing.
- **iv)** Learn about advance materials and its applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Introduction, Regulation of Speed and Feeds**
Introduction to Machine Tool Drives and Mechanisms: Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission. Regulation of Speeds and Feeds: Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Machine tool structures**
Design of Machine Tool Structures: Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Mechanical Properties of Materials and Testing**
Design of Guideways, Power Screws and Spindles: Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power		

Screws. Design of Spindles and Spindle Supports: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Advance Material and Application**
Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness Acceptance Tests, Current industry trends.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
i) Machine Tool Design and Numerical Control/ N.K. Mehta / McGraw Hill Education; 3rd edition, ISBN: 9781259004575		
Reference Books		
i) Principles of Machine Tools/ G. C. Sen and A. Bhattacharyya / New Central Book Agency/ASIN- B01FIX1MKA.		
ii) Design of Machine Tools / D. K Pal, S. K. Basu / Oxford /ISBN: 9788120417779/Product Code- EBK0013309.		

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Composite Materials**	**L**	**T**	**P**		
3.Course Code		3	0	0		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**MET**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	Tutorials = 0	Practical = 0

8. Course Description

Composites are a unique class of materials made from two or more distinct materials that when combined are better than each would be separately. They are non-corroding, non-magnetic, radar transparent and they are designed to provide strength and stiffness where it is needed. This course will describe different types of composites. Student will also get the idea about design and manufacturing methods involved in making of composites. Joining method and failure theories for composites are also discussed in this course. Since composites are affordable high-performance material and expanded commercial as well as industrial utilization, hence this course is quite useful.

9. Learning objectives:

i) To understand the properties and design of composite materials.
ii) To familiarize with the manufacturing methods for composites.
iii) Demonstrate the ability to use appropriate design and analysis tools and techniques.
iv) To get acquainted with practical requirements associated with joining and manufacturing.

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Analyze economic aspects of using composites.
ii) Conduct mechanical testing of composite structures and analyse failure modes.
iii) Design and manufacture composite materials for various applications.
iv) Explain the relevance and limitations of the destructive and non-destructive test methods used for composites.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**

Definitions: Composites, Reinforcements and matrices, Types of reinforcements, Types of matrices, Types of composites, Carbon Fibre composites, Properties of composites in comparison with standard materials, Applications of metal, ceramic and polymer matrix composites.

Unit – 2	**Number of lectures =11**	**Title of the unit: Manufacturing Methods**

Hand and spray lay-up, press moulding, injection moulding, resin injection, RRIM, filament winding, pultrusion, centrifugal casting and prepress. Fibre/Matrix Interface, Theories of adhesion; absorption and wetting, Inter diffusion, electrostatic, chemical, and mechanical. Measurement of interface strength. Characterization of systems; carbon fibre/epoxy, glass fibre/polyester, etc. Influence of interface on mechanical properties of composite.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Mechanical Properties**

Stiffness and Strength: Geometrical aspects – volume and weight fraction. Unidirectional continuous fibre, discontinuous fibres, Short fibre systems, woven reinforcements – length and orientation distributions. Mechanical Testing: Determination of stiffness and strengths of unidirectional composites; tension, compression, flexure and shear. Fracture: Typical fracture processes; effect of transverse ply. Review of fracture mechanics methods and application to composites. Impact: Typical impact damage; role of fibre, matrix and interface. Low and high-speed impact test methods. Fatigue: Behaviour of notched and unnotched specimens. Tension testing of composites. Fatigue damage – Effect of matrix and fibre properties. Implications for component design. Environmental Effects: Influence of moisture and other contaminants on fibre, matrix, interface and effect on mechanical properties. Stress corrosion cracking. Influence of high and low temperatures.

Unit – 4	Number of lectures= 11	Title of the unit: Joining Methods and Failure Theories
Joining –Advantages and disadvantages of adhesive and mechanically fastened joints. Typical bond strengths and test procedures. Design philosophy and procedures (systems approach). Simple design studies (pressure vessels, torsion bar); factors of safety. Case studies for failure design process, materials selection, manufacturing method. Economic aspects of using composites. Stress Analysis: Free edge stresses; typical distributions, significance of stacking sequence, significance of ply blocking, effect on failure modes, experimental evidence. Development of engineer's theory of bending for thin walled beams comprising several different materials and analysis of the shear flow distribution. Buckling; strut buckling, buckling of especially orthotropic plates, significance of bending-twisting coupling.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) K.K. Chawla, (2007), Composite Materials, Springer-Verlag, New York.

Reference Books:

i) B. Frank L. Matthews and Rees D. Rawlings (1999), Composite Materials: Engineering and Science, Woodhead Publishing.

ii) Ning Hu (2012), Composites and Their Applications, in Tech Publisher

iii) Pavla Tesinova (2011) Advances in Composite Materials: Analysis of Natural and Man-Made Materials, in Tech Publisher.

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Engineering Mechanics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Practical hours (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Brief Syllabus
This practical lab work will give students an insight about the basics of applied engineering mechanics.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the concepts of forces.
ii) To understand the conditions of static and dynamic equilibrium.
iii) To understand the basic principles of physics applied to Engineering Mechanics.
iv) To know the geometric properties of the different shapes.</td></tr>
<tr><td colspan="7">10. Course Outcomes (Cos):</td></tr>
<tr><td colspan="7">i) Students will be able to work with forces acting on a body.</td></tr>
<tr><td colspan="7">ii) Solve for equilibrium conditions of a rigid body.</td></tr>
<tr><td colspan="7">iii) Implementation of different laws in real life problems.</td></tr>
<tr><td colspan="7">iv) Determine the centroid, center of gravity and moment of inertia of various surfaces and solids.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
</table>

Sr. No.	**Title**	**CO Covered**
1	Verification of triangle law & parallelogram law of forces	i)
2	Verification of polygon law of forces	i), ii)
3	Verification of the principle of moments using the bell crank lever apparatus	i), ii)
4	Verification of support reactions of a simply supported beam	i), ii)
5	Verification of condition of equilibrium of a system of forces	i), ii)
6	Verification of axial forces in the members of a truss	i), ii)
7	Verification of equilibrium of three-dimensional forces	i), iii)
8	Determination of coefficient of friction between two surfaces	iii)
9	Verification of centroid of different laminae	iv)
10	Determination of moment of inertia of a flywheel	iv)

Department Electives-I Lab

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Refrigeration and Air Conditioning Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engg. Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Brief Syllabus

Refrigeration and air conditioning are used to cool products or a building environment. The refrigeration or air conditioning system transfers heat from a cooler low-energy reservoir to a warmer high-energy reservoir.

9. Learning objectives:

- **i)** To understand the principles of refrigeration and air conditioning.
- **ii)** To calculate the cooling load for different applications of Refrigeration and Air conditioning.
- **iii)** To learn the principles of psychrometry.
- **iv)** To develop the knowledge of selecting the right equipment for a particular application of Refrigeration and Air-conditioning.

10. Course Outcomes (COs):

- **i)** Possess the knowledge of system components of refrigeration and air conditioning.
- **ii)** Design and implement refrigeration and air conditioning systems using standards.
- **iii)** Apply the knowledge of psychrometry in calculating cooling load and heating load calculations.
- **iv)** Possess the knowledge of system components of refrigeration and air conditioning.

11. Unit wise detailed content

Sr. No.	**Title**	**COs Covered**
1	To study the vapour compression Refrigeration System and determine its C.O.P. and draw P-H and T-S diagrams.	i), iv)
2	To Study the Mechanical heat pump and find its C.O.P.	i)
3	To study the Air and Water heat pump and find its C.O.P.	i)

4	To study the cut- sectional models of Reciprocating and Rotary Refrigerant compressor.	iv)
5	To study the various controls used in Refrigerating & Air Conditioning systems.	ii)
6	To study the Ice- plant, its working cycle and determine its C.O.P and capacity.	i), ii), iv)
7	To study the humidification, heating, cooling and dehumidification processes and plot them on Psychrometric charts.	iii)
8	To determine the By-pass factor of Heating & Cooling coils and plot them on Psychrometric charts on different inlet conditions.	iii)
9	To determine sensible heat factor of Air on re-circulated air-conditioning set up.	iii)
10	To study the chilling plant and its working cycle.	iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advanced Machining Processes Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✔)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 0</td><td colspan="4">Practical = 56</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Today's stringent design requirements and difficult-to-machine materials such as tough super alloys, ceramics, and composites, have made traditional machining processes costly and obsolete. As a result, manufacturers and machine design engineers are turning to advance machining processes. These machining processes utilizes electrical, chemical and optimal sources of energy to machine the given job. Going through this subject student will get insight of various advanced machining processes and their system components, process variables and industrial applications. This is a perfect course for anyone designing, researching or converting to a more advance machining process.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To teach the principles of Mechanical Advanced Machining Processes.
ii) To understand the concept of EDM.
iii) To understand the concept of IBM, EBM, PAM etc.
iv) To understand the concept of advance finishing process</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): The curriculum of the Department is designed to satisfy the diverse needs of students.
i) Acquire Knowledge of manufacturing process for advanced materials and critical finishing.
ii) Acquire Knowledge of concept of EDM.
iii) Acquire Knowledge of concept of IBM, EBM, PAM etc.
iv) Acquire Knowledge of advance finishing process</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	Title	COs covered
1	To study the MRR of USM	i)
2	To study the MRR of Abrasive jet machining	i)
3	To study the MRR of water jet machining	i)
4	To study the MRR of EDM	ii)
5	To study the Analysis of R-C Circuits in EDM	ii)
6	To study the MRR of Wire EDM	ii)
7	To study the MRR of Laser, and Electron Beam Machining	iii)
8	To study the MRR of Ion Beam Machining	iii)

9	To study the MRR of Plasma Arc Machining	iii)
10	To study the MRR of MAF	iv)
11	To study the MRR of AFM	iv)
12	To study the MRR of Chemo mechanical polishing	iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advance Automobile Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>IC Engines</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Automobile engineering is the one of the streams of mechanical engineering. It deals with the various types of automobiles, their mechanism of transmission systems and its applications. Automobiles are the different types of vehicles used for transportation of passengers, goods, etc. Basically, all the types of vehicles work on the principle of internal combustion processes or sometimes the engines are called as internal combustion engines. Different types of fuels are burnt inside the cylinder at higher temperature to get the transmission motion in the vehicles. Most of the automobiles are internal combustion engines vehicles only.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To broaden the understanding of students in the structure of vehicle chassis and engines.
ii) To introduce students to Transmission system.
iii) To introduce students to steering, suspension, braking and transmission systems.
iv) To introduce students to engine auxiliary systems like heating, ventilation and air-conditioning, and also the importance of alternate fuels.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
i) Develop chassis and identify suitable engine for different applications.
ii) Able to select a suitable conventional and automatic transmission system for the Vehicle.
iii) Formulate Steering, Pollution Control, Braking and Suspension Systems.
iv) Identify the usage of Electrical vehicles / Hybrid vehicles and power plants.</td></tr>
<tr><td colspan="8">11. Lab Content</td></tr>
</table>

Sr. No.	Title	COs covered
1	To study and prepare report on the constructional details, working principles and operation of the following Automotive Engine Systems & Sub Systems. (a) Multi-cylinder : Diesel and Petrol Engines.	i)
2	To study and prepare report on the constructional details, working principles and operation of the following Fuels supply systems: (a) Carburetors (b) Diesel Fuel Injection Systems (c) Gasoline Fuel Injection Systems.	i)
3	To study and prepare report on the constructional details, working principles and operation of the following Automotive Transmission systems. (a) Synchromesh – Four speed Range. (b) Transaxle with Dual Speed Range.	ii)
4	To study and prepare report on the constructional details, working principles and operation of the following Automotive Drive Lines & Differentials.	ii)

	(a) Rear Wheel Drive Line. (b) Front Wheel Drive Line. (c) Differentials, Drive Axles and Four Wheel Drive Line.	
5	To study and prepare report on the constructional details, working principles and operation of the following Automotive Steering Systems. (a) Manual Steering Systems, e.g. Pitman –arm steering, Rack & Pinion steering. (b) Power steering Systems, e.g. Rack and Pinion Power Steering System. (c) Steering Wheels and Columns	iii)
6	To study and prepare report on the constructional details, working principles and operation of Automotive Emission / Pollution control systems.	iii)
7	To study and prepare report on the constructional details, working principles and operation of the following Automotive Tyres & wheels. (a) Various Types of Bias & Radial Tyres. (b) Various Types of wheels.	iii)
8	To study and prepare report on the constructional details, working principles and operation of the Automotive Brake systems. (a) Hydraulic & Pneumatic Brake systems. (b) Drum Brake System. (c) Disk Brake System. (d) Antilock Brake System. (e) System Packing & Other Brakes	iii)
9	To study and prepare report on the constructional details, working principles and operation of the cooling system. (a) Engine cooling & Lubricating Systems.	iv)
10	To study and prepare report on the constructional details, working principles and operation of effect on health of emissions from diesel engine & petrol engine	iii)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Industrial Engineering Lab**	**L**		**T**		**P**	
3. Course Code		**0**		**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			
8. Course Description							

This course introduces the concepts of manufacturing economics and its critical parameters. Introducing thoroughly the concepts of Productivity, Fixed and Variable costs, Materials management, EOQ, Inventory management, Quality management, Production planning and control and Management Information systems.

9. Learning objectives:

To know the structure, operation and applications of the concepts of Industrial production and Management.

- **i)** Learn basic concept of productivities in industrial manufacturing.
- **ii)** Learn basic concept of cost analysis for a manufacturing system.
- **iii)** Learn basic concept of Inventory control and its application.
- **iv)** Learn basic concept of Industrial and Quality Management.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Define and measure various productivities in industrial manufacturing.
- **ii)** Perform full cost analysis for a manufacturing system.
- **iii)** Understand the concept of Inventory control and its application.
- **iv)** Explain key features of Industrial and Quality Management.

11. Lab Content

Sr. No.	**Title**	**Cos covered**
1	To Study the THERBLIGS work measurement using case study.	i)
2	To Study the time study PMTS using case study.	i)
3	To study the factors effecting productivity.	i)
4	To Study the Manufacturing Cost Analysis using case study.	ii)
5	To Study the Master production schedule system.	ii)
6	To study the Gantt chart in manufacturing using case study.	ii)
7	To study the P, Q, S's Systems	iii)
8	To study the ABC and FSN system.	iii)
9	To study the VED and three-dimensional system.	iii)
10	To study the role of 3 S in the system.	iv)
11	To study the concept of Statistical quality Control.	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Product Design for Manufacturing Lab**	**L**		**T**		**P**
3. Course Code		**0**		**0**		**2**
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem () / Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**		**Practical = 28**		

8. Course Description

Product design for manufacturing is the general engineering art of designing products in such a way that they are easy to manufacture. This design practice not only focuses on the design aspect of a part but also on the product ability. In simple language it means relative ease to manufacture a product, part or assembly. DFM describes the process of designing or engineering a product in order to facilitate the manufacturing process in order to reduce its manufacturing costs. This course will impart knowledge of various methods and approaches used in design of manufacturing. Moreover, students will get familiar to DFMA software through case studies. In the end of course, student will be able to utilize the knowledge gained through coursework for the development of new product.

9. Learning objectives:

- **i)** To expose with basics of product design and manufacturing.
- **ii)** To introduce principles and evaluation methods of various aspects of designing components.
- **iii)** To teach about the manufacturability requirements
- **iv)** To expose with basics of assembly processes and DFMA software for case studies.

10. Course Outcomes (COs):

- **i)** Apply customer-oriented, manufacturing and life cycle sensitive approach to product design and development with product design principles and structured design methodologies.
- **ii)** Possess methods and approaches for principles and evaluation methods of various aspects of designing components
- **iii)** Develop a manufacturability of new product as per the requirement.
- **iv)** Demonstrate the knowledge of DFMA software for case studies

11. Lab Content

Sr. No.	**Title**	**COs covered**
1	To Study the Asimow's Model.	i)
2	To Study the Product design practice in Industry.	i)
3	To study evaluation methods of various aspects of Design for sheet metal working.	ii)

4	To Study the evaluation methods of various aspects of Design for injection molding.	ii)
5	To Study the Casting design Manufacturability requirements.	iii)
6	To study the Forging design Manufacturability requirements	iii)
7	To study the Pressed component design Manufacturability requirements.	iii)
8	To study the techniques for new product development processes	iv)
9	To study the Dewhurst Method- case studies using DFMA software	iv)
10	To study the Boothroyd method– case studies using DFMA software	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Advance Materials Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

This subject covers practical knowledge about the advance materials, their development, Characterization and properties. Fabrication of different composite materials and nano materials and analysis of their properties and strength.

9. Learning objectives: After the completion of the course, the student shall be able to

- **i)** To provide practical knowledge about materials.
- **ii)** To develop new materials by studying characterization process.
- **iii)** Development and application of advanced materials.
- **iv)** To give the understanding of material characterisation properties.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Understand advance material and their properties.
- **ii)** Select constituent materials glass, carbon, aramid, ceramic fibres and resins.
- **iii)** Understand engineering mechanics, analysis and design, macro and micro mechanics of composites.
- **iv)** Develop and processing of metal- matrix, ceramic -matrix and carbon- carbon composites.

11. Lab Content

Sr. No.	Title	COs covered
1	To study advance Material properties and characteristics.	i)
2	To study different Crystallographic method.	iii)
3	Synthesis of Ni-SiO2 nanocomposites by Sol-Gel technique.	iv)
4	Characterization of nano-composites by XRD analysis.	i), ii)
5	Measurement of magnetic properties using PPMS of NSMs.	i), iii)
6	Characterization of ZnO Nanostructured materials using AFM.	i), ii)
7	True & apparent porosity measurement of refractory bricks.	ii), iii)
8	Thermal Analysis of dissociation reaction of hydrated copper sulphate and magnesium carbonate (DTATGA-DTG) True & apparent porosity measurement of refractory bricks.	ii), iii)

9	Electrical property measurement of dielectric materials ($BaTiO_3$)using P-E loop technique.	iii)
10	Characterization of materials by SAXS analysis.	i), ii)

Department Electives-II Lab

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Steam Power Generation Lab**	**L**	**T**		**P**		
3. Course Code		**0**	**0**		**2**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite (if any)	**Engineering Thermodynamics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

8. Brief Syllabus

To teach students about the working of various power generation units and steam cycles. To introduce students to steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities of the country. To enable students, understand functioning of boilers, turbines and pumps used in power generation.

9. Learning objectives:

i) This course will describe the fundamental principles of power plant.
ii) Discuss the fundamental principles of generators & Combustion
iii) The understanding of various thermal power plants.
iv) The understanding of various gas power plants

10. Course Outcomes (COs):

i) Describe sources of energy and types of power plants.
ii) Analyze the performance of diesel powered thermal power plant.
iii) Describe basic working principles of gas turbine, cooling towers and condensers.
iv) Estimate different efficiencies associated with power plant systems and Analyze economics of power generation.

11. Lab Content

Sr. No.	Title	CO Covered
1	To study of modern steam power plant.	i), ii)
2	To Study about the Various Types of Fuel & Ash Handling Systems	ii)
3	To study about different types of dust collectors and pulverized fuel burners.	ii)
4	To study about nuclear power plant.	i), ii)
5	To study of different types of steam turbines.	i), ii)
6	To study about different types of condensers and cooling towers.	iii)
7	To study about economics of power generation systems.	iv)
8	To study of gas power plant.	i), iii)
9	To study of combined steam & gas turbine power plant.	iii)

10	Testing of diesel fired water tube boiler-based steam power plant.	ii)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Production Planning and Control Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 0</td><td colspan="4">Practical = 56</td></tr>
</table>

8. Course Description

PPC, is the process of production planning sets the objectives, goals, targets on the basis of available resources with their given constraints. Control is the integral part of effective planning. Similarly control involves assessment of the performance; such assessment can be made effectively only when some standards are set in advance. Planning involves setting up to such standard. The controlling is made by comparing the actual performance with these present standard and deviations are ascertained and analyzed.

9. Learning objectives:

i) Identify and suggest correct type of production planning technique.
ii) Analyze the concepts of production planning.
iii) Control and implement PPC methods in crucial areas of the industry.
iv) Implement the knowledge of ERP systems and shop floor scheduling.

10. Course Outcomes (COs): The curriculum of the Department is designed to satisfy the diverse needs of students.

i) Acquire Knowledge of type of production planning technique
ii) Acquire Knowledge of production planning.
iii) Acquire Knowledge of Control and implement PPC methods in crucial areas of the industry.
iv) Acquire Knowledge of Implement the knowledge of ERP systems and shop floor scheduling.

11. Lab Content

Sr. No.	Title	COs covered
1	To study the Factors influencing MPC performance	i)
2	To study the MRP system	i)
3	To study the Planning system	i)
4	To study the Sales and operations planning.	ii)
5	To study the Production Planning - Master scheduling and order promising	ii)
6	To study the Distribution Resource Planning	ii)
7	To study the capacity management using planning factory	iii)
8	To study the CRP and I/O Control system.	iii)
9	To study the Inventory model	iii)
10	To study the Shop floor control/scheduling	iv)
11	To Study the Kanban/pull systems	iv)
12	To study the ERP system	iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Fuel and Combustion Lab</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="3">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="3">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engg. Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="5">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Two and four stroke engines, air standard cycles, fuels and combustion, fundamental of ignition systems, performance and rating of engines, combustion characteristics and combustion chamber for S.I and C.I engines, supercharging.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To learn about various types of fuels, their composition and properties
ii) To acquire depth knowledge of solid, liquid and gaseous fuels.
iii) To understand the thermodynamics of combustion.
iv) To learn about the types of pollution and its control.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Analyze the composition of various types of fuels and their properties.
ii) Estimate the composition of various types of fuels and their properties.
iii) Demonstrate the knowledge of combustion thermodynamics.
iv) Acquire the knowledge of Stoichiometry of Fuel and Kinematics of Combustion.</td></tr>
<tr><td colspan="8">11. Lab Content</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	Temperature dependence of viscosity of lubrication oil by Redwood Viscometer.	i), ii)
2	Flash and Fire points of Diesel, K-Oil, Bio Diesel.	i), ii)
3	Flash and Fire points of lubricants.	i), ii)
4	Drop point of grease and mechanical penetration in grease	i), ii)
5	Calorific value of liquid fuel.	i), ii)
6	Calorific value of gaseous fuel temperatures	iv)
7	Study of semi solid lubrication in various Automobile Unit & Joints	ii)
8	Study of lubrication in transmission, final drive, steering gearbox.	ii)
9	Study of analytical equipment for oil analysis.	iv)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Estimation & Costing Lab**	**L**		**T**		**P**	
3. Course Code		**0**		**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			
8. Course Description							

This is a course in Estimation & Costing is a new approach for product cost estimating in mechanical production is proposed within the framework of integrated product engineering. The approach introduces the new concept of Cost Entity. It is made necessary due to the current context of growth of indirect costs, especially in manufacturing. The objective, i.e. establishing a tight link between technical variables (or manufacturing features) and economic variables (modeled as Cost Entities), requires to model the reasoning procedure and associated knowledge related to cost estimating.

9. Learning objectives:

- **i)** The student can identify different areas of Engineering Costing & Estimating.
- **ii)** To address the underlying concepts, methods and application of Engineering Costing & Estimating.
- **iii)** Understanding the concept of Depreciation & Break-Even Analysis and Estimating.
- **iv)** The student can identify different areas of Budgetary control, securing flexibilities of budgeting.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** To present a problem oriented in depth knowledge of Engineering Costing & Estimating.
- **ii)** To address the underlying concepts, methods and application of Engineering Costing & Estimating.
- **iii)** Understanding the concept of Depreciation & Break-Even Analysis and Estimating.
- **iv)** Understanding the concept of Budget, Budgetary Control and Engineering Contracts.

11. Lab Content

Sr. No.	Title	COs covered
1	To Study the Difference between Estimating and Costing.	i)
2	To Study the Elements of PPC and Time & Motion Studies.	i)
3	To study how to find out the Cost of raw materials.	ii)
4	To Study the methods of wage payments for direct and indirect labor time wage system.	ii)
5	To Study the factors influencing wage rate.	ii)
6	To study the calculation of breakeven point.	iii)
7	To study the statistical estimation.	iii)

8	To study the machine hour basis method	iii)
9	To study the Preparing an annual budget for the Engineering Department	iv)
10	To study the Cash flow schedules.	iv)
11	To study the Operational and capital budgets.	iv)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Total Quality Management Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>EAS ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td colspan="2"></td><td colspan="4"></td></tr>
<tr><td colspan="8">To give the students an overview of quality and TQM and explaining the salient contributions of Quality Gurus like Deming, Juran and Crosby. General barriers in implementing TQM.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To learn the basic concepts of quality and quality from organizational point of view.
ii) To learn the concept of total quality management from different philosophical approach.
iii) To learn the internal politics, quality culture, education and training of the organization.
iv) To be aware of international/national Quality standards.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Understanding the concept of TQM principle.
ii) To address the underlying concepts of Tools & Techniques for Quality management-I
iii) Understanding the concept of Tools & Techniques for Quality management-II
iv) Understanding the concept of Quality Systems</td></tr>
<tr><td colspan="8">11. Lab Content</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	To Study the PDCA cycle in TQM using case study	i)
2	To Study the Contributions of Deming in TQM using case study.	i)
3	To study the Juran and Crosby in TQM using case study	i)
4	To Study the sampling distribution, and hypothesis Testing of Quality	ii)
5	To Study the Measurement system analysis, Analysis of Variance (ANOVA) using Design and Analysis of Experiment (DOE)	ii)
6	To study the Measurement system analysis using Analysis of Variance (ANOVA)	ii)
7	To study the Quality functions development process	iii)
8	To study the Failure mode effect analysis process	iii)

9	To study the quality management systems using case study	iv)
10	To study the software quality.	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Tool Design lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ( )**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	**Even ()**	**Odd (✓)**	**Either Sem ()**	**Every Sem ()**
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 00**	**Practical = 28**			
8. Course Description						

Tool design is a specialized area of manufacturing engineering comprising the analysis, planning, design, construction, and application of tools, methods, and procedures necessary to increase the manufacturing productivity.

9. Learning objectives:

i) The main objective of this course is to provide the basic knowledge needed to explore the discipline of tool design and engineering.
ii) Implement the tool design process when designing tooling for the manufacturing of a product
iii) Design, develop, and evaluate cutting tools and work holders for a manufactured product
iv) Use CAD and conventional techniques in creating tooling drawings.

10. Course Outcomes (COs):

i) To understand introduction, regulation of speed and feeds.
ii) To learn the designing of machine tool structures and its constructional features.
iii) To understand mechanical properties of materials and testing.
iv) To learn about advance materials and its applications.

11. Lab Content

Sr. No.	**Title**	**COs covered**
1	To study of functional requirements of machine tools.	i), ii), iii), iv)
2	Study of working and auxiliary motion of machine tools	i)
3	Design criterion for machine tool structure, Static & dynamic stiffness.	i)
4	Function & important requirements of spindle unit.	i)
5	Importance of machine tool compliance with respect to machine tool accuracy	ii), iii)

6	Study of different mechanism used for transforming rotary motion into translatory motion. (Application and sketching of Slider-crank mechanism, Cam mechanism, Rack & pinion mechanism, Nut & screw mechanism.	v)
7	Discuss various device for intermittent motion and draw the schematic diagram for various application. (Application and sketching of Ratchet gear mechanism, Geneva mechanism, Reversing mechanism, Differential mechanism, Norton mechanism, Mender's mechanism.).	i), ii), iii), iv)
8	Step turning and taper turning on lathe	i), ii), iii), iv)
9	Thread cutting and knurling on lathe	i), ii), iii), iv)
10	To machine flat surface using shaper machine	i), ii), iii), iv)
11	To perform drilling, taping and grinding operation.	i), ii), iii), iv)
12	Lathe tool and drill tool dynamometers	i), ii), iii), iv)
13	Grinding of single point cutting tool	i), ii), iii), iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Composite Materials Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Course Description

Composites are a unique class of materials made from two or more distinct materials that when combined are better than each would be separately. They are non-corroding, non-magnetic, radar transparent and they are designed to provide strength and stiffness where it is needed. This course will describe different types of composites. Student will also get the idea about design and manufacturing methods involved in making of composites. Joining method and failure theories for composites are also discussed in this course. Since composites are affordable high-performance material and expanded commercial as well as industrial utilization, hence this course is quite useful.

9. Learning objectives:

- **i)** To understand the properties and design of composite materials.
- **ii)** To familiarize with the manufacturing methods for composites.
- **iii)** To Conduct mechanical testing of composite structures and analyze failure modes.
- **iv)** To get acquainted with practical requirements associated with joining and manufacturing.

Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Design and manufacture composite materials for various applications.
- **ii)** Identify and explain the stress-strain relationship of composite materials
- **iii)** prepare and characterise different components materials
- **iv)** Identify and explain the fundamental properties of composite materials

10. Lab Content

Sr. No.	Title	COs covered
1	Preparation of Continuous Fiber reinforced Polymer Composites	i), iii)
2	Preparation of Dis-Continuous Fiber reinforced Polymer Composites	i)
3	Study of Tensile strength and young's modulus of FRP composites	i), ii)
4	Study of Tensile strength of Al-SiC composites	i), ii)
5	Study of microstructure, hardness and density of Al-SiC composite	i), iii)
6	Environmental Testing (Humidity and temperature)	i), ii)
7	Study of Hardness of FRP composites	ii), iii)
8	Study of Flexural strength of FRP composites	ii), iii)

9	Study of drop weight impact testing	ii) ,iii)
10	Preparation of Al-SiC composites by stir casting method	i), ii)

4^{th} Semester

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Mechanical Machine Design**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	**Machine Drawing & SOM**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

8. Brief Syllabus

Design of Machine Elements is a required course for mechanical engineering students. This course is an introduction to the basic principles of modern engineering. It provides the students with fundamental skills of engineering and the ability to apply the theories of science to practice and understand the factors; such as stresses, deformations, and failure criteria, influencing the machine elements like shafts, springs, belts, bearings, gears etc. The main objective of design of machine element is that the machine should function properly to satisfy the needs of the customer and it should be safe against the predicted modes of failure.

9. Learning objectives:

- **i)** To understand the design methodology for machine elements.
- **ii)** To analyze the forces acting on a machine element and apply the suitable design methodology.
- **iii)** To understand the various standards and methods of standardization.
- **iv)** To apply the concept of parametric design and validation by strength analysis.

10. Course Outcomes (COs): After successful completion of the course, student will be able to

- **i)** understand the basic of mechanical design process and design of simple machine components like shaft, key, coupling, lever power screw etc.
- **ii)** select various flexible power transmitting device such as belt drives such as belt drive and chain drive from manufacture's catalogue.
- **iii)** apply the knowledge of computer aided drafting tools to prepare production drawings of machine components.
- **iv)** determine tolerances for proper fit to achieve functional requirements of assembly

11. Unit wise detailed content

Unit-1	Number of lectures = 12	Title of the unit: Design Consideration of Machine Parts

Loads, different types, factor of safety, stress, design stress factors affecting its selection, determination of factor of safety, tensile, compressive, shear, bending, bearing, crushing stresses, bending and torsional shear stress, transverse shear, principal stress determination, eccentric loading, bearing pressure.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Keys and Couplings**
Design of sunk keys, design of a muff, clamp, flange (protected type) and bushed pin type of flexible coupling. Power Screws: Types of threads, design of screw with different types of threads used in practice.		
Unit – 3	**Number of lectures = 08**	**Title of the unit: Shafts**
Design stress, design of axles, spindles and shafts on the basis of strength, based on Rankine's and Guests' theory, design of shafts on the basis of rigidity. Design of Joints, Flat and V Belt drives, design of pulleys for these drives		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Design of Springs and Engine parts**
Wahls' factor and its use in design of spring, effect of end connections on design of compression spring, design of helical tensile spring and compression spring for circular wire. Buckling of compression spring. Length and number of turns calculation, design of leaf spring. Design of Parts		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) V B Bhandari, "Design of Machine Elements", TMH Publications, Fourth Edition, 2017, ISBN: 9789339221126

Reference Books

i) V B Bhandari, Introduction to Machine Design, TMH Publications
ii) 7P. Kannaiah, Machine design by, Scitech Publication
iii) J E Sighley, Mechanical Engineering Design, TMH Publications
iv) Norton. R. L, Design of Machinery, TMH Publications

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Manufacturing Processes and Technology</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (Name use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">In this syllabus to introduce about manufacturing process, theory of metal cutting, metrology, metal forming operations, machine tool, plastic processing and other important things which are very needful to a mechanical engineer. The fundamental idea of manufacturing or production is to create that has a useful form. This form is most likely predetermined, calculated, with a certain physical geometry. Usually this geometry has certain tolerances that it must meet in order to be considered acceptable. A tolerance outlines the geometric accuracy that must be achieved in the manufacturing process.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the principles of manufacturing processes.
ii) To learn the principles of metal forming processes and metrology.
iii) To develop the knowledge of selecting the right equipment for a particular application of manufacturing and production.
iv) To acquire basic knowledge about the behavior and manufacturing properties of engineering materials and concepts of machine tools.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) To understand the basics and theory of metal cutting.
ii) To study the metrology and measurement methods used in manufacturing processes.
iii) Explain the various metal forming and sheet metal operations.
iv) Explain in detail about machine tools.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Basics and Theory of Metal Cutting</td></tr>
<tr><td colspan="7">Introduction to Manufacturing Processes and their Classification, Metal Cutting & Tool Life: Introduction, basic tool geometry, single point tool nomenclature, chips types and their characteristics, mechanics of chips formation, theoretical and experimental determination of shear angle, orthogonal and oblique metal cutting, metal cutting theories, relationship of velocity, forces, and power consumption, cutting speed, feed and depth of cut, cutting fluids, coolants, lubricants,</td></tr>
</table>

temperature profile in cutting, tool life relationship, tailor equation of tool life, tool material and mechanism, machinability.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Metrology and measurements**
Metrology: Standards of Measurements, Linear and angular instruments; slip gauges, comparator-mechanical, electrical, optical, sine bar, angle gauges, tape gauge, screw thread measurements limit gauging, Gauge design; surface finish and its measurements, micro and macro deviation, factors Influencing surface finish and evaluation of surface finish. Limits, fits and tolerances, types of limits, types of fits, types of tolerances, hole basis system, shaft basis system.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Metal Forming and Sheet Metal Operations**
Forming Processes: Basic Principle of Hot & Cold Working, Hot & Cold Working Processes, classifications of forming processes, Bulk forming processes: Rolling, Extrusion, Forging. Sheet metal forming processes, basics of sheet metal working, sheet material selection, sheet thickness selection, sheet temperature: cold, warm, hot forming, sheet metal forming operations, shearing operations: cutting, punching, blanking, notching, lancing. Forming operations: bending, beading, embossing, drawing, deep-drawing, spinning. Dieless forming processes- Incremental Sheet Forming (ISF), types of ISF, process parameters of ISF, working principle and applications of ISF		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Machine Tools**
Introduction, constructional features, specialization, operations and devices of basic machine tools such as lathe, shaper, planner, drilling machining, and milling machine, indexing in milling operation, working principle of lathe, milling, drilling, shaper, planer machine tools, feed, spindle speed, depth of cut, cutting speed, calculation of machining time, Current industry trends.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
i) P N Rao, Vol. 1, Foundry, Forming and Welding, McGraw Hill, 5th Edition, ISBN-13: 978-93-5316-050-0.		
Reference Books		
i) Workshop Technology (Manufacturing Process) – S K Garg, Laxmi Publications; Fourth edition (2018), ISBN-10: 8131806979		
ii) Ajay, R.K. Mittal, Incremental Sheet Forming Technologies: Principles, merits, limitations, and applications, CRC Press, Taylor and Francis, ISBN: 978-0-367-27674-4.		

iii) Raghuvanshi; Workshop Technology, Dhanpat Rai & Co. (P) Ltd., 2016, ASIN: B01N11V21D

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Research Methodology**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE ()**		**OE ()**	EAS (✓)
5. Pre-requisite (if any)	**None**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials =0**	**Practical = 0**			
8. Course Description						
This course is designed to help students to identify research problems in various fields. It aims at giving potential researchers the knowledge of effectively analysing and interpreting results and presenting the findings to the scientific and technological community of the world. This course also aims at motivating students to bring about their creative ideas for innovation and establishing research impact in the global foray through intellectual ownership.						
9. Learning objectives: Students undergoing this course are expected to **i)** Develop the ability to perform research related activities. **ii)** Analyze the available research data for given research problem. **iii)** Understand the role of computers in available data analysis considering the research ethical values. **iv)** Develop technical writing and presentation skills.						
10. Course Outcomes (COs): On completion of this course, the students will be able: **i)** Identify and solve the research problem in conjunction with literature. **ii)** Analyze the available data effectively and apply the relevant test of hypothesis in their research problems. **iii)** Understand the soft computing, plagiarism and follow research ethics. **iv)** Structure and present the research findings with the conventions of scholarly writing.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 11**	**Title of the unit: Introduction to Research Problem Formulation and Design**				
Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review-primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.						
Unit – 2	**Number of lectures = 11**	**Title of the unit: – Data Collection and Analysis**				
Effective literature review approaches, literature analysis, avoiding Plagiarism, methods of data collection, aspects of method validation, observation and collection of data, sampling methods, data processing and analysis strategies and tools, data analysis with statical packages, hypothesis testing.						
Unit – 3	**Number of lectures = 10**	**Title of the unit: Soft Computing & Research Ethics**				
Computer and its role in research, Use of statistical software in research. Introduction to evolutionary algorithms - Fundamentals of Genetic Algorithms, Optimization of fuzzy systems.						

Ethics-ethical issues, design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Interpretation and Report Writing**
Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:	
i)	Kumar, R. (2010), "Research Methodology: A Step-by-Step Guide for Beginners", United Kingdom: SAGE Publications, ISBN: 9781446244777, 1446244776.
ii)	Kothari, C. R. (2004), "Research Methodology: Methods and Techniques", India: New Age International (P) Limited, ISBN: 9788122415223, 8122415229
Reference Books:	
i)	Sinha, S.C. and Dhiman, A.K., (2002), "Research Methodology (set of Two Vol.)", India: Ess Ess Publications, ISBN: 9788170003243, 8170003245.
ii)	Trochim, W. M. K. (2001), "Research Methods Knowledge Base", Germany: Atomic Dog Publication, ISBN: 9780970138590, 0970138598.
iii)	Wadehra, B. L. (2004), "Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications", India: Universal Law Publication, ISBN: 9788175343825, 8175343826.

Department Electives-III

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Cryogenic Engineering</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td colspan="2">Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Refrigeration & Air conditioning, Applied Thermodynamics</td><td colspan="2">6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical =0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Introduction to Cryogenics and its applications, Properties of cryogenic fluids, Properties of materials at cryogenic temperature, Cryogenic Refrigeration Systems, Gas-liquefaction systems, Cryocoolers, Cryogenic Insulations, Vacuum Technology, Instrumentation in Cryogenics, Liquid storage and transfer systems, heat exchangers used in cryogenic systems.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To provide in-depth knowledge of low temperature science.
ii) To provide knowledge on the properties of materials at low temperature.
iii) To familiarize with Cryogenic refrigeration systems.
iv) To familiarize with various gas liquefaction systems.
v) Cryogenic storage and transfer lines</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): The students will be able to
i) Understand the science of cryogenic temperatures.
ii) Know about Cryogenic refrigeration systems.
iii) Get ideas on cryogenic fluids.
iv) Understand the working of cryogenic instrumentation and cryogenic heat exchangers.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Introduction</td></tr>
<tr><td colspan="8">Introduction to Cryogenics, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen. Properties of material at cryogenic temperature- mechanical, thermal, magnetic and electrical-Super conductivity, application of cryogenic systems in space, medical, industries, biological etc.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="6">Title of the unit: Cryogenic Refrigeration</td></tr>
<tr><td colspan="8">Principle and Methods of production of low temperature and their analysis: Joule Thomson expansion, Adiabatic expansion, Linde Hampson Cycle, Claude & Cascaded System, Magnetic Cooling, Stirling Cycle Cryo Coolers. Gas liquefaction & separation systems: Liquefaction systems for Neon. Hydrogen and Helium. Cryogenic Refrigeration systems: Ideal Refrigeration systems. Refrigeration using liquids and gases as refrigerant-Refrigerators using solids as working media.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 09</td><td colspan="6">Title of the unit: Cryogenic System and instrumentation</td></tr>
<tr><td colspan="8">Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations (expanded foams, gas filled, fibrous, vacuum, multi-layer etc.) and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids. Properties and characteristics</td></tr>
</table>

of instrumentation, strain displacement, pressure, flow, liquid level, density and temperature measurement in cryogenic range.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Safety in Cryogenics & its applications**
Safety in cryogenic fluid handling, storage and use. Safety against cryogen hazards: Physical hazards, Chemical hazards, Physiological hazards, combustion hazards, oxygen hazards, accidents in cryogenic plants & prevention. Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) Randall F. Barron, "Cryogenics Systems", Second Edition, Oxford University Press, New York (1985). (ISBN-10: 0070038201, ISBN-13: 978-0070038202)

Reference Books:

i) Timmerhaus, Flynn, "Cryogenic Process Engineering", Plenum Press, New York (1989). ISBN:978-1-4684-8758-9)

ii) Thomas M. Flynn, "Cryogenic Engineering", second edition, CRC press, New York (2005), ISBN: 9780824753672)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Computer Aided Manufacturing</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Workshop Technology</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials =</td><td colspan="4">Practical = 00</td></tr>
</table>

8. Brief Syllabus

CAD is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. Students learn the importance of CAD/CAM principles in the Product development, programs related to manufacturing using codes and analyze the importance of networking in manufacturing environment.

9. Learning objectives:

i) To understand the basics of CAD/CAM and concepts of computer graphics.
ii) To learn about the geometric issues concerned to the manufacturing and its related areas.
iii) To understand the latest advances in the manufacturing perspectives and their applications.
iv) To learn about the concept of group technology and computer integrated manufacturing.

10. Course Outcomes (COs):

i) To understand the importance of CAD/CAM principles and computer hardware in the Product development.
ii) To understand the principles of computer graphics.
iii) To develop programs related to manufacturing using codes.
iv) To learn the concepts of group technology, flexible manufacturing system and computer integrated manufacturing system.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Computer Hardware**
Product Development Cycle – Introduction to CAD/CAM – Graphics input devices- cursor control devices, Digitizers, Scanners, speech oriented devices and touch panels, Graphics display devices – CRT, color CRT monitors, DVST, Flat- panel display, Graphics output Devices – Printers and Plotters – Graphics Standards – Neutral File formats –IGES, STEP.		

Unit – 2	Number of lectures = 10	Title of the unit: Principles of Computer Graphics
Geometric Modeling – Wireframe, Surface and Solid – CSG and B-Rep- World/device co-ordinate representations, 2D and 3Dn geometric transformations, Matrix representation-translation, scaling, shearing, rotation and reflection, composite transformations, concatenation – Graphics software, Graphics functions, output primitives- Bresenham's Algorithm and DDA.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: CNC Machine Tools**
Introduction to NC, CNC, DNC- Manual part Programming – Computer Assisted Part Programming – Examples using NC codes- Adaptive Control – Canned cycles and subroutines – CAD / CAM approach to NC part programming – APT language, machining from 3D models.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Group Technology, CAPP, FMS, and CIM**
Introduction to part families-parts classification and cooling – group technology machine cells-benefits of group technology – Process Planning – CAPP & types of CAPP – Flexible manufacturing systems (FMS) – the FMS concept-transfer systems – head changing FMS – Introduction to Rapid prototyping, Knowledge Based Engineering. CIM wheel – CIM Database- CIM-OSI Model– Networking Standards in CIM Environment – Network structure – Network architecture –TCP/IP, MAP – Virtual Reality, Augmented Reality- Artificial Intelligence and Expert system in CIM, Current industry trends.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Mikell P. Groover (2016), Automation, Production Systems and Computer Integrated Manufacturing, 4th Edition, Pearson Education. ISBN: 978-9332572492.

Reference Books

i) Ibrahim Zeid (2009), Mastering CAD/CAM, 2nd Edition, Tata McGraw Hill International Edition, ISBN: 9780070634343.

ii) P N Rao (2010), CAD/CAM Principles and Applications, 3rd Edition, Tata McGraw-Hill Education, ISBN: 9780070681934.

iii) James A. Rehg and Henry W. Kraebber (2004), Computer Integrated Manufacturing, 3rd Edition, Pearson Education, ISBN: 978-0131134133.

iv) Mikell P. Groover and Emory W. Zimmers (2003), CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall Edition, ISBN: 978-8-177-58416-5.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Hydrogen and Fuel Cells</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>IC Engines, Automobile Engineering</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course provides students a brief overview on Hydrogen and Fuel cells. This includes understanding the newest energy variants. Also give overview how to store and utilize these energies.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The objective of the course is to provide comprehensive and logical knowledge of hydrogen production.
ii) Knowledge of storage and utilization of Hydrogen.
iii) To provide an understanding of various fuel cell technologies
iv) To know the application of Fuel cells.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Evaluate the performance of fuel cells under different operating conditions.
ii) Select and defend appropriate fuel cell technology for a given application.
iii) Design and develop suitable hydrogen storage system to be used along with fuel cell system.
iv) Minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction of hydrogen energy systems</td></tr>
<tr><td colspan="7">Properties of hydrogen as fuel, Hydrogen pathways introduction-current uses, general introduction to infrastructure requirement for hydrogen production, storage, dispensing and utilization, and hydrogen production plants.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Hydrogen production processes</td></tr>
<tr><td colspan="7">Thermal-Steam reformation, thermo chemical water splitting, gasification-pyrolysis, nuclear thermal catalytic and partial oxidation methods. Electrochemical-Electrolysis, photo electro chemical, Biological-Anaerobic digestion, fermentation micro-organism, PM based electrolyzer.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Hydrogen Storage and utilization</td></tr>
<tr><td colspan="7">Physical and chemical properties, general storage methods, compressed storage-composite cylinders, glass micro sphere storage, zeolites, metal hydride storage, chemical hydride storage and cryogenic storage, carbon-based materials for hydrogen storage.
Overview of hydrogen utilization, IC Engines, gas turbines, hydrogen burners, power plant, domestic cooking gas, marine applications, hydrogen dual fuel engines.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Fuel cells and Its applications.</td></tr>
<tr><td colspan="7">History – principle - working - thermodynamics and kinetics of fuel cell process – performance evaluation of fuel cell – comparison on battery Vs fuel cell, Types of fuel cells – AFC, PAFC, SOFC, MCFC, DMFC, PEMFC, microbial fuel cells, relative merits and demerits.</td></tr>
</table>

Fuel cell usage for domestic power systems, large scale power generation, Automobile, Space, economic and environmental analysis on usage of hydrogen and fuel cell. Future trends in fuel cells, portable fuel cells, laptops, mobiles, submarines.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Sorenson B, Hydrogen and Fuel Cells: Emerging Technologies and Applications, Bent Sorenson, Academic Press (2005), ISBN:0126552819.

Reference Books

i) Hordeski MF, Alternative Fuels: The Future of Hydrogen, CRC Press, 3rd Edition, 2013, ISBN: 9781466580244.

ii) Busby RL, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Books, American Edition, (2005), ISBN: 1593700431.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Plant Layout and Material Handling</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
</table>

8. Course Description

Introduction to Plant Layout and Material Handling Objectives and Functions of Plant Layout and Material Handling Introduction to Layout and its Importance Types of layouts Selection and specifications of layouts Implementation and follow up of layouts Introduction to CORELAP, ALDEP and CRAFT, CORELAP and ALDEP concepts Introduction to Group Layout and Fixed Position Layout Quadratic assignment model. Branch and bound method Introduction to Material Handling Relationship of material handling to plant layout Methods to minimize cost of material handling Ergonomics of Material Handling equipment.

9. Learning objectives

- **i)** Learn the basic concept of Workstations
- **ii)** Learn the basic concept Layout construction techniques
- **iii)** Learn the basic concept Computerized Layout and Analytical Methods
- **iv)** Learn the basic concept Assessment and Evaluation

10. Course Outcomes (COs):

- **i)** Understanding the concept of Workstations
- **ii)** To address the underlying concepts of Layout construction techniques
- **iii)** Understanding the concept of Computerized Layout and Analytical Methods
- **iv)** Understanding the concept of Assessment and Evaluation

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Introduction and Workstations**

Introduction Criteria, Strategies/Tactics, Sustainability and Eco-Efficiency in Facility Design, Basic Planning, Alternative Machine Arrangements, Flow Lines, Location Models, Act/Building Details, Aisles and Security, Storage, Shipping and Receiving, Offices, Specialized Areas.

Workstations, Unit Loads & Containers, Conveyors, Vehicles, Lifting Devices, Workstation Material Handling, Ethics in Facility Design Facilities design procedure and planning strategies, Production, activity and materials flow analysis, Space requirements and personnel services design considerations.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Layout construction techniques**

Systematic layout planning; activity relationship analysis, pair wise exchange, graph-based construction algorithmic. Material Handling: Material handling principles; material handling equipment and material handling systems.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Computerized Layout and Analytical Methods**

ALDEP, CORELAP, CRAFT, BLOCPLAN, etc. Warehouse operations: function, storage operations. Manufacturing operation: JIT, TQM, AM, CIM, SCM, Facility systems, Quantitative models: Layout model, waiting line, AS/RS, simulation model, etc.

Unit – 4	Number of lectures = 11	Title of the unit: Assessment and Evaluation
Assessment and evaluation of layout alternatives Projects, Use Spiral software to practice plant layout design, apply mathematical and engineering techniques such as systematic layout planning approach, quantitative model, cost estimate to solve practical facility layout problem.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book:		
i) Plant Layout and Material Handling, by- S. C. Sharma, Jain Brothers, Khanna Publishers; Third edition, 2000, ISBN: 8174093192		
Reference Books:		
i) Plant Layout and Material Handling, by- James M. Apple, John Wiley & Sons, 3rd Edition, ISBN: 0471071714.		
ii) Plant Layout and Material Handling, by- Fred E. Meyers, Prentice Hall. Latest Edition, ISBN: 0130134759		
iii) Facility Layout and Location: An Analytical Approach, by Richard L, Francis, Pearson India, 2nd Edition, ISBN: 0132992310		
iv) Plant Layout and Material Handling, by- B. K. Aggarwal, Jain Brothers, Latest Edition, 2017, ISBN: 8186321780		

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Lean Enterprise & Advanced Manufacturing Technologies</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures =42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This is a course based on lean thinking, enterprise process re-engineering, and digital manufacturing are becoming more prevalent in the work place, engineering and science professionals need to be prepared to address the enterprise as a holistic system of technologies, decision-making processes, and cultural components. The objective of this course to graduates with experience in manufacturing, engineering, design, or business who wish to develop their manufacturing expertise. This course is deal for wishing to transfer smoothly and effectively to a career in the manufacturing sector and of industry.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To Learn the basic concept of lean thinking and, enterprise process re-engineering concept.
ii) To Learn the basic concept of advanced production techniques methods.
iii) To Learn the basic concept of Plastic Processing methods.
iv) To Learn the basic concept of Press tools used in various engineering applications.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) To develop lean thinking and, enterprise process re-engineering concept.
ii) To explain advanced production techniques methods for different applications.
iii) To Explain Plastic Processing methods for different applications.
iv) To Classify Press tools and apply it in various engineering applications.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction & Jidoka Concept (Automation with A Human Touch)</td></tr>
<tr><td colspan="7">The mass production system – Origin of lean production system, Necessity, Lean revolution in Toyota – Systems and systems thinking – Basic image of lean.
Production Customer focuses Muda (waste). Poka concept – Poka-Yoke (mistake proofing) systems – Inspection systems and zone control – Types and use of Poke-Yoke systems – Implementation of Jidoka.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Stability of Lean System & Just In Time</td></tr>
<tr><td colspan="7">Standards in the lean system, 5S system, Total Productive Maintenance standardized work, Elements of standardized work, Charts to define standardized work, Man power reduction, Overall efficiency, and standardized work and Kaizen &layouts. Principles of JIT – JIT system – Kanban – Kanban rules – Expanded role of conveyance – Production leveling – Pull systems – Value stream mapping.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to Plastics Processing</td></tr>
<tr><td colspan="7">Plastics Processing Introduction, Processing of plastics, Injection moulding, Compression moulding, Transfer</td></tr>
</table>

moulding, Extruding, Casting, Calendaring, machining and welding, fabrication methods. Applications of Plastics. Shear action in die cutting operation, punch and die clearance and angular clearance, centre of pressure, cutting forces. Press working operations: blanking, piercing and forming, lancing, cutting-off and parting, notching, shaving, trimming, embossing, beading and curling, bulging, twisting, coining, swaging, hole flanging or extruding, line sketches and meaning of terms.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Press Tools Introduction**
Press Tools Introduction, Types of Presses, hand, power, gap, inclinable, adjustable, horn, straight side, and pillar presses. Constructional details of a power press, Press size. Press Tools, Punch and die, Die Accessories, Stops, Pilots, strippers, Knockouts, pressure pads. Shear action in die cutting operation punch and die clearance and angular clearance, centre of pressure, cutting forces.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) Manufacturing Technology - Vol.1 Paperback by P.N Rae, ISBN-10: 9353160502, Publisher McGraw Hill Education (24 July 2018)

Reference Books:

i) Lean Manufacturing: Tools, Techniques, and How to Use Them (Resource Management) Hardcover – 28 September 2000 by William M Feld, ISBN-13: 978-1574442977.

ii) Industrial Engineering & Operations management by S. K. Sharma & Savita Sharma, Kataria publishers ISBN: 1412918057

iii) Handbook of Engineering Management- Edited by Dennis Lock, Butterwork & Heinemanky Ltd., ISBN: 0470942185

iv) Lean Manufacturing and Tools Paperback by Shorya Sharma, ISBN-13: 978-1647831806, Publisher: Notion Press (18 December 2019)

1. Name of the Department- Mechanical Engineering

2. Course Name	**Mechanical Vibration**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**KOM & DOM**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 00**

8. Course Description

A structure or a body is said to vibrate if it has a to and fro motion. A greater proportion of human activities involve vibration in one form or the other. We hear because our eardrums vibrate. The cause and effects of vibration must be clearly understood. The structures designed to support the high speed machines are subjected to inherent unbalance which causes problems. The unbalance may be due to faulty design or poor manufacture. Because of cyclic vibration, the material of the structure or the machine component may undergo fatigue failure. Vibration causes fasteners such as nuts of the machine to become loose. In metal machining processes, vibration may cause chatter, which results in poor surface finish. If the natural frequency of vibration of a machine or structure equals the forced frequency caused by external excitation, resonance occurs which causes dangerously large oscillations and the structure fails. A bridge can collapse due to wind-induced vibration. Critical instruments mounted on machines may loose their accuracy due to excessive vibrations. Vibrations can be used for useful works such as vibration testing equipments, vibratory conveyors, hoppers, sieves, compactors, washing machines.

9. Learning objectives:

i) To learn the basics of vibrations including causes and effects of vibrations.
ii) To study the undamped and damped free vibration.
iii) To study the forced vibrations.
iv) To study multi degrees of freedom system and vibration measuring instruments..

10. Course Outcomes (COs):

i) Understanding the fundamentals concepts of vibration.
ii) To understand the free and forced vibrations with two-degree freedom system.
iii) To learn the methods to solve vibration problems with multi-degree freedom system.
iv) To understand the basics of vibration of continuous systems and experimental methods in vibration analysis and the working of vibration measuring instruments.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Fundamentals of Vibrations**

Terminology, Single degree freedom systems – Response to arbitrary periodic excitations – Duhamel`s integral

– Impulse response function – Virtual work – Lagrange`s equation – Single degree freedom forced vibration with elastically coupled viscous dampers – System identification from frequency response – Transient vibration – Laplace transformation formulation.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Two Degree Freedom System**
Free vibration of spring-coupled system – Mass coupled system – Bending vibrations of two degree freedom system – Forced vibration – Vibration Absorber - Vibration Isolation. Force Transmissibility and Support Motion.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Multi Degree Freedom System**
Normal mode of vibration – Flexibility matrix and Stiffness matrix – Eigen value and Eigen vector – Orthogonal properties – Modal matrix – Modal analysis – Forced vibration by matrix inversion – Modal damping in forced vibration – Numerical methods for fundamental frequencies.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Vibration of continuous Systems and Experimental Methods in Vibration Analysis**
System governed by wave equations – Vibration of strings – Vibration of rods – Euler`s equation for beams – Effects of Rotary Inertia and shear deformation – Vibration of plates. Vibration Measuring Instruments – Vibration Exciters – Vibration Tests – Free and Forced Vibration Tests. Examples of Vibration Tests – Industrial Case Studies, Current industry trends		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Textbook Book

i) William T. Thomson (2005), Theory of vibration with applications, 5th Edition, Pearson Education India. ISBN: 978-8-131-70482-0.

Reference Books

i) R V Dukkipati (2008), Advanced Mechanical Vibrations, Alpha Science. ISBN: 978-1-842-65222-0.

ii) V.P. Singh (2016), Mechanical vibrations, Dhanpat Rai Publications, ISBN: 978-8177004014.

iii) G K Grover (2009), Mechanical Vibrations, Nem Chand & Bros. Roorkee, ISBN 978-8185240565

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Nano Materials**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**BSC ()**	**EAS ()**
5. Pre-requisite (if any)	**MET**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Course Description

Nano and micro electromechanical machines (NEM and MEM) are manufactured in the billions annually for sensing, ink jet printing, automotive applications, communications, and medicine. In medicine, bio-MEMS promise to revolutionize biotechnology and biomedical engineering through fabrication of devices under 100 micrometers using novel micro and Nano-fabrication techniques. Nanofabrication is the group of techniques that allows scientists and engineers to build structures and devices at the atomic scale. Traditional top-down nanofabrication consists of carving nanoscale materials from a bulk structure through chemical means or by using beams of electrons or ions to strip away layers of material. Bottom-up methods create structures by adding atomic layers one at a time by deposition or by molecular or nanoparticle self-assembly.

9. Learning objectives:

- **i)** To understand the basic concepts of Nanotechnology.
- **ii)** To enhance the knowledge of nonmaterial.
- **iii)** To familiarize with the properties of nanomaterial and their applications.
- **iv)** To understand the mechanical properties of Nanostructures.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Use Nanomaterials for various industrial applications.
- **ii)** Understand MEMS / NEMS devices for various applications.
- **iii)** Explain approaches for Nanomaterial fabrication.
- **iv)** Differentiate Nanostructures on the basis of mechanical properties.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to Nanotechnology**
Nanotechnology, Background and definition of nanotechnology, Types of Nano materials Microstructure, Properties, Application in different fields, Reliability issues of MEMS/NEMS		
Unit – 2	**Number of lectures = 11**	**Title of the unit: Synthesis of Nano materials**
Chemical methods, Gas phase synthesis, Liquid phase synthesis, Plasma vapor deposition, Spray synthesis, Extrusion forging, ECAP, Characterization, Description of AFM/FFM and various measurement techniques, TEM.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Types of Nano materials**
Metallic Nano particles, Metallic alloys, Nano wires and rods, thin films, Carbon Nanotubes, Structure, Synthesis, Growth mechanisms, Properties, Applications, Nano wires, Synthesis, Characterization and physical properties, Applications, Polymer ceramic Nano composites, Biological based Nano materials-Importance of hierarchy and third dimension of bone, Self-assembly, Applications.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Mechanical Properties of Nanostructures**
Melting and solidification of Nano phase materials- Creep in Nano materials, Experimental techniques for measurement of mechanical properties of Nano structures, Self assembled mono layers for controlling adhesion, Friction and Wear.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Textbook:
i) Charles P. Poole and Frank J. Owens (2007), Introduction to Nanotechnology, John Wiley & Sons. ISBN: 978-8-126-51099-3.
Reference Books:
i) Jin Zhang, Zhong-lin Wang, Jun Liu, Shaowei Chen and Gang-yu Liu, (2003), Self Assembled Nanostructures, Kluwer Academic/Plenum Publishers. ISBN: 978-0-306-47299-2.
ii) Bharat Bhushan (2007), Hand book of Nanotechnology, Springer Hand Book. ISBN: 978-3-540-29855-7.
iii) Mark Ratner and Daniel Ratner (2009), Nanotechnology: A Gentle Introduction to the Next Big Idea, 5th Edition, Pearson Education India. ISBN: 978-8-177-58743-2.

Department Electives-IV

1. Name of the Department: Mechanical Engineering							
2. Course Name	**Fluid Power System**	**L**	**T**		**P**		
3. Course Code		**3**	**0**		**0**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite	**Fluid Mechanics and Fluid Machinery**	**6. Frequency (Use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Course Description:

A fluid power system has a pump driven by a prime mover (such as an electric motor or IC engine) that converts mechanical energy into fluid energy. This fluid flow is used to actuate a device such as: A Hydraulic cylinder or Pneumatic cylinder, A Hydraulic motor or Pneumatic motor, A Rotary actuator etc.

9. Learning Objectives:

i) Understanding of basics of hydraulics and pneumatics (pumps and various power supply sources).
ii) To learn students about the utilization of cylinders, accumulators, valves and various control components.
iii) Understand the control of Hydraulic and Pneumatic systems.
iv) To learn about fluid power maintenance and troubleshooting.

10. Course Outcomes (COs): At the end of this course, the learner will be:

i) Find the importance of fluid power technology in industries and to obtain knowledge on hydraulic and pneumatic components.
ii) Gets exposure to the basics of fluid flow including the physical laws affecting fluid standards and symbols used in industrial applications.
iii) Gain knowledge of that how to control the Hydraulic and Pneumatic Systems.
iv) Gain knowledge of the various components in fluid power industry and solve problems related to pumps.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Introduction to Fluid Power**
Definition- Hydraulics Vs Pneumatics – Standards- Application – Basic Principle of Hydraulics-Pascal's Law-Transmission and multiplication of force-Basic properties of hydraulic fluids- liquid flow- static head pressure-pressure loss – Power-Basic principle of pneumatics: absolute pressure and Temperature- gas laws- vacuum.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Hydraulic and Pneumatic Power Supply Source**
Hydraulic Pump- graphic symbol- pump types -pump flow and pressure- pump drive torque and Power- pump efficiency –air compressor- graphic symbol-compressor types-compressor sizing- vacuum pumps.		
Unit – 3	**Number of lectures = 9**	**Title of the unit: Hydraulic and Pneumatic Control Components**
Cylinders-accumulators –FRL-Directional control Valves- Pressure control valves-Flow control Valves-electronic control components- symbols.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Basic Circuits, Fluid Power System Maintenance**
Introduction, Sealing Devices - Reservoir System - Filters and Strainers - Beta Ratio of Filters - Wear of Moving Parts - Gases in Hydraulic Fluids - Temperature Control - Troubleshooting.		

12. Brief Description of self learning / E-learning component
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book:
i) lango and Sundararajan (2017), Introduction to Hydraulics and Pneumatics, 3rd Edition, Prentice hall, ISBN: 978-81-203-4406-8.
Reference Books:
i) M. Rabie (2009), Fluid power Engineering, McGraw-Hill, NY, ISBN: 978-0-071-62246-2.
ii) Espositho (2009), Fluid power with application, 6th edition, Prentice Hall, ISBN: 978- 81-7758- 580-3.
iii) Robert P. Kokernak (1999), Fluid power technology, 2nd edition, Prentice Hall, ISBN: 978-0-139-12487-7.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>CNC Programming</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>EAS ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Advance Machining Process</td><td colspan="2">6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description:
The course of introductory Learn Standard terminologies, conventions, and types of standard CNC machine tools. The theoretical concepts of Automatic/ Computer Assisted NC Tool Path Planning for multi-axis machines as well as virtual CAM environment using professional software for complicated machining applications. Learn constructional details of NC machine tools, selection of standard components used for NC machine tools for accuracy and productivity enhancement.</td></tr>
<tr><td colspan="8">9. Learning objective
i) To understand the concept of CNC Programming effectively.
ii) To understand the concept of CNC machine tools & application.
iii) To understand the concept of CNC technology using part programming.
iv) To understand the concept of computer aided part programming.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Practice CNC Programming effectively.
ii) Acquire knowledge and use simple CNC machine tools & application.
iii) To understand fundamentals of the CNC technology using part programming.
iv) To understand the computer aided part programming.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Introduction</td></tr>
<tr><td colspan="8">Basics and need of CNC machines, NC, CNC and DNC systems, Structure of NC systems, Applications of CNC machines in manufacturing, Advantages of CNC machines.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="6">Title of the unit: CNC Machine & tooling</td></tr>
<tr><td colspan="8">Machine structure, Slide –ways, Motion transmission elements, Swarf removal and safety considerations, Automatic tool changers and multiple pallet systems, Sensors and feedback devices in CNC machines, Constructional detail of CNC turning center and CNC machining center, Classification of CNC control systems. Tooling requirements of CNC machines, Pre-set and qualified tools, Work and tool holding devices in CNC machines.</td></tr>
</table>

Unit – 3	Number of lectures = 10	Title of the unit: Part Programming
Axis identification and coordinate systems, Structure of CNC part program, Programming codes ,Programming for 2 and 3 axis control systems ,Manual part programming for a turning center ,Programming using tool nose radius compensation ,Tools offsets ,Do loops, sub routines and fixed cycles.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Computer Aided CNC Part Programming**
Need for computer aided part programming, Tools for computer aided part programming, APT, COMPACT II, CAD/CAM based part programming.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Kundra, Rao and Tewari, "Numerical Control and Computer Aided Manufacturing" Tata McGraw-Hill, New Delhi, ISBN-9780074517345, 0074517341

Reference Books

i) Ploywka, John & Gabrel, Stanley, "Programming of Computer Numerically Controlled Machines" Industrial Press Inc., New York, 1992, ISBN: **0831130350**

ii) Rapello. Ralph. "Essentials of Numerical Control", Prentice Hall, NJ, 1986, ISBN: **978-0132865685**

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Chassis Design**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**MS ()**	
5. Pre-requisite (if any)	**Advance Graphics Design**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
This course is intended to allow you the opportunity to explore engine design fundamentals and learn what you can do to help during the machining process. You will also learn about clutch, gear box, suspension, steering, and frame systems.						

9. Learning objectives:

- **i)** The student will be able to understand the fundamental principles involved in design of components of automotive chassis,
- **ii)** Understand the complete design exercise and arrive at important dimensions of chassis components.
- **iii)** Understand the Clutch Design.
- **iv)** Understand the Gear Box Design.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** The student can identify different areas of automobile chassis component design.
- **ii)** Design the front axle and Steering system of an automobile.
- **iii)** Design the clutch for flawless power transmission.
- **iv)** Analyze the assembly and maintenance of Gear box of an automobile.

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Vehicle Frame and Suspension**
Study of loads-moments and stresses on frame members. Design of frame for passenger and commercial vehicle – Design of leaf Springs-Coil springs and torsion bar springs.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Front Axle and Steering Systems**
Analysis of loads-moments and stresses at different sections of front axle. Determination of bearing loads at Kingpin bearings. Wheel spindle bearings. Choice of Bearings. Determination of optimum dimensions and proportions for steering linkages, ensuring minimum error in steering. Design of front axle beam.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Clutch design**
Design of single plate clutch, multi plate clutch, design of centrifugal clutch, cone clutch, energy dissipated, torque capacity of clutch.		

Unit – 4	Number of lectures = 10	Title of the Unit: Gearbox design
Basic consideration in design, determination of speed range, concept of structure diagram, graphical representation of Ray and speed diagram, gearbox layout.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) Machine Design by R. S. Khurmi & J.K.Gupta, S.Chand & Co

Reference Books:

i) Dean Averns, "Automobile Chassis Design", Illife Book Co., 2001.

ii) Design of machine Elements by Bhandari , Tata McGraw-Hill Publishing Company Ltd

iii) Machine Design by Sharma-Agarwal, S.K.Kataria & Sons

iv) Machine Design by Sadhusingh, Khanna Publishers,

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Work Study</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Industrial Engineering</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This is a course based on Work study and industrial engineering play important role in job simplification, job design, job enrichment, value analysis/engineering, method analysis, operational analysis, etc. Work study has been utilized by companies to job productivity. Industrial engineering is the latest method employed to improve productivity. It deals with design, enhancement and setting up of engineering systems encompassing plants, machinery, workers, etc.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) Learn the basic concept of various productivities and work study in industrial manufacturing.
ii) Learn the basic concept of Micro and Memo Motion Study.
iii) Learn the basic concept of Work Measurement.
iv) Learn the basic concept of different Ratings and Incentives.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Understanding of various productivities and work study in industrial manufacturing.
ii) Understanding of Micro and Memo Motion Study.
iii) Understanding of the concept of Work Measurement.
iv) Understanding of different Ratings and Incentives.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Introduction to Work-study</td></tr>
<tr><td colspan="7">Productivity: Definition of productivity, individual enterprises, task of management Productivity of materials, and, building, machine and power. Measurement of productivity, factors affecting the productivity, productivity improvement programs. Work Study: Definition, objective and scope of work study. Human factor in work study, Work study and management, work study and supervision, work study and worker.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to Method Study</td></tr>
<tr><td colspan="7">Introduction to Method Study: Definition, objective and scope of method study, activity recording and exam aids. Charts to record moments in shop operation – process charts, flow process charts, travel chart and multiple activity charts. (With simple problems), Micro and Memo Motion Study :Charts to record moment at work place – principles of motion economy, classification of movements, two handed process chart, SIMO chart, and micro motion study. Development, definition and installation of the improved method.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to Work Measurement and Ergonomics</td></tr>
<tr><td colspan="7">Introduction to Work Measurement: Definition, objective and benefit of work measurement. Work measurement techniques. Work sampling: need, confidence levels, sample size determinations, with simple problems. Time Study: Time Study, Definition, time study equipment, selection of job, steps in time study. breaking jobs into elements, recording information. Rating, Systems of rating. Ergonomics: Introduction, areas of study under ergonomics, man-machine system. Components of man-machine system and their functions –, study of</td></tr>
</table>

development of stress in human body and their consequences. Computer based ergonomics. Usability Engineering and Human Computer interface.

Unit – 4	**Number of lectures = 11**	**Title of the unit: Ratings and Incentives**
Scales of rating, factors affecting rate of working, allowances and standard time, determination. Predetermined motion time study – Method time measurement (MTM), Wages and Incentives: introduction, definition, wage differentials, methods of wage payment, Advantages, disadvantages, Financial incentives, non-financial incentives.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) M S Sanders and E J McCormic -Human Factors in Engineering Design, ISBN:13: 9780070549012, Mc Graw Hill, 7th Edition,1992.

Reference Books

i) ILO -Introduction to work study, ISBN 13:9788120406025 Publisher: India Book House Pvt. Ltd, 4th Revised Edition,2008.

ii) Ralph M Barnes -Motion and Time study, ISBN:13:978981426182 Publisher: John Wiley, 7th edition 2009.

iii) R. S. Bridger -Introduction to Ergonomics, ISBN:13:9780849373060, Publisher Taylor and Francis dated 20th Aug 2008, 3rdEdition

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Supply Chain and Logistic Management</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Industrial Engineering</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This is a course in supply chain management (SCM), a term which denotes the integration of key business processes from end user through original suppliers for the purpose of adding value for the firm, its key supply chain members, to include customers and other stakeholders. This course presents a framework for SCM that requires cross-functional integration of key business processes within the firm and across the network of firms that comprise the supply chain.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) An understanding of the primary differences between logistics and supply chain management.
ii) An understanding of the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain.
iii) An understanding of the management components of supply chain management.
iv) An understanding of the tools and techniques useful in implementing supply chain management.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Understanding the concept of Logistic Managements.
ii) Understanding the concept of Supply Chain Management
iii) Understanding the concept Matching supply and demand
iv) Understanding the concept of Strategic Management</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Logistic Managements</td></tr>
<tr><td colspan="7">Introduction, Logistics system design, Demand planning, Multiple channel distribution, Multi-echelon system, Model development, Concept of warehousing, Methods of storage, Primary and secondary transportation, Logistics information system, Logistics costing</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Supply Chain Management</td></tr>
<tr><td colspan="7">Understanding the Supply Chain, Process view, Decision phases and importance of supply chain, Supply chain management and logistics, supply chain and the value chain, Competitive advantage, supply chain and competitive performance, changing competitive environment, Supply Chain drivers and obstacle</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Matching supply and demand</td></tr>
<tr><td colspan="7">The lead-time gap, Improving the visibility of demand, supply chain fulcrum, forecast for capacity, execute against demand, Demand management and aggregate planning, Collaborative planning, forecasting and replenishment.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Strategic Management</td></tr>
</table>

Creating the responsive supply chain Product 'push' versus demand 'pull' The Japanese philosophy, Foundations of agility, Route map to responsiveness. Strategic lead-time management: Time-based competition, Lead-time concepts, Logistics pipeline management. Planning and managing inventories in a supply chain: managing economies of scale in supply chain cycle inventory, managing uncertainty in supply chain, determining optimal level of product availability.
12. Brief Description of self-learning / E-learning component
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) Chopra, S. and Meindl, P. "Supply Chain Management", Prentice Hall, 6th Edition, 2016, ISBN: 0133800202
Reference Books
i) Christopher, M. Logistics & Supply Chain Management, FT Prentice Hall, 5th Edition, 2016, ISBN: 1292083794.
ii) John T. Mentzer, J. T. Supply Chain Management, illustrated edition, SAGE Publications (2001), 1st Edition, ISBN: 1412918057
iii) Michael H. Hugos, M. H. Essentials of Supply Chain Management, John Wiley, (2011), 3rd Edition, ISBN: 0470942185

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Finite Element Methods</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ( )</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Mechanical Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 00</td><td colspan="4">Practical = 42</td></tr>
<tr><td colspan="7">8. Brief Syllabus

The finite element method (FEM) is among one of the most powerful tool for the numeric solution of wide range of engineering problems. The application ranges from deformation and stress analysis of civil and mechanical structures, automotive components, aircraft designs, heat flux analysis, fluid flow problems, electrical magnetic flux problem. Upon completion, students should be able to solve the problems in solid mechanics and heat transfer using FEM..</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To enable the students, understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis.
ii) To understand the characteristics of various finite elements.
iii) To develop finite element equations for simple and complex domains.
iv) To understand ANSYS and CAD tools.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Apply the knowledge of mathematics and engineering to solve problems in structural and thermal engineering by approximate and numerical methods.
ii) Design a new component or improve the existing components using FEA.
iii) Solve the problems in solid mechanics and heat transfer using FEM.
iv) Use commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life problems.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction</td></tr>
<tr><td colspan="7">Introduction to FEM. Method of weighted residuals and variational approach for solving differential equations.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Discretization</td></tr>
<tr><td colspan="7">Element types and properties. Boundary conditions. Stress-strain determination. Solution techniques. Mesh refinement. Convergence criterion. Frames, beams and axial element. Plane stress. Plane strain. of shape function equations.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: FEM Formulation</td></tr>
</table>

Finite element formulation for linear elastic continuum and extended Laplace equation including inertia and dissipative terms. Plate bending and 'C' elements. Non-conforming elements and patch test. FEM analysis of plates and shells.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Problems**
Dynamic and nonlinear problems, Material and geometric non-linearity. Axisymmetric problems-classical solution. Finite Element solution of free vibration problems. Principles of transient dynamic analysis. Laboratory work for the solution of solid mechanics problems using FE packages, Current industry trends.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Textbook

- **i)** Tirupathi R. Chandrupatla (2009), Finite Element Analysis for Engineering and Technology, 1st Edition, University Press. ISBN: 978-8-173-71427-6.

Reference Books

- **i)** P. Seshu (2010), Text book of Finite Element Analysis, Prentice Hall of india. ISBN: 978-8-120-32315-5.
- **ii)** J.N. Reddy (2005), An Introduction to the Finite Element Method, McGraw-Hill, Third Edition. ISBN: 978-0-070-60741-5.
- **iii)** S. S. Rao (2012), The Finite Element Method in Engineering, 5th Edition, Elsevier. ISBN: 978-9-380-93155-5.
- **iv)** O.C. Zienkiewicz, R.L. Taylor and J. Z. Zhu (2005), The Finite Element Method: Its Basis and Fundamentals, 6th Edi-tion, Butterworth-Heinemann. ISBN: 978-0-750-66320-5.

1. Name of the Department: Mechanical Engineering							
2. Course Name	**Biomaterials**	**L**	**T**		**P**		
3. Course Code		**3**	**0**		**0**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite	**Material Engineering & Technology**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Course Description:

A biomaterial is any matter, surface, or construct that interacts with biological systems. This course covers basic synthesis, analysis and design of biomaterials used for bioengineering, including biotechnology, tissue engineering, medical imaging and clinical applications. Topics include interactions between bio- and synthetic molecules and surfaces; design, synthesis, and processing approaches for materials that control cell functions; and application of state-of-the-art biomaterial approaches to problems in tissue engineering.

9. Learning Objectives:

- **i)** To learn about Biomaterials.
- **ii)** Understand common use biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology.
- **iii)** To learn about different types of implants.
- **iv)** To learn new concepts in the interface of biology and materials science.

10. Course Outcomes (COs): On completion of this course, the students will

- **i)** Understand common use biomaterials as metals, ceramics and polymers and its chemical structure, properties and morphology.
- **ii)** Understand the various applications of biomaterials as an implant.
- **iii)** Understand and account for methods for categorization of biomaterials.
- **iv)** Apply and account for methods to characterize interactions between materials and tissue.

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Introduction**

Definition of biomaterials, requirements & classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra-vascular system). Surface properties of materials, physical properties of materials, mechanical properties.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Metallic implant materials**

Stainless steel, Co-based alloys, Ti and Ti-based alloys. Importance of stress-corrosion cracking. Host tissue reaction with bio metal, corrosion behavior and the importance of passive films for tissue adhesion. Hard tissue replacement implant: Orthopedic implants, Dental implants. Soft tissue replacement implants: Percutaneous and skin implants, Vascular implants, Heart valve implants-Tailor made composite in medium.

Unit – 3	**Number of lectures = 11**	**Title of the unit: Ceramic and composite implant materials:**

Definition of bio ceramics. Common types of bio ceramics: Aluminum oxides, Glass ceramics, Carbons. Bio resorbable and bioactive ceramics. Importance of wear resistance and low fracture toughness. Host tissue reactions: importance of interfacial tissue reaction (e.g. ceramic/bone tissue reaction).
Composite implant materials: Mechanics of improvement of properties by incorporating different elements. Composite theory of fiber reinforcement (short and long fibers, fibers pull out). Polymers filled with osteogenic fillers (e.g. hydroxyapatite). Host tissue reactions.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Polymeric implant materials**

Polyolefin's, polyamides, acrylic polymers, fluorocarbon polymers, silicon rubbers, acetyls. (Classification according to thermo sets, thermoplastics and elastomers). Viscoelastic behavior: creep-recovery, stress-relaxation, strain rate sensitivity. Importance of molecular structure, hydrophilic and hydrophobic surface properties, migration of additives (processing aids), aging and environmental stress cracking. Physiochemical characteristics of biopolymers. Biodegradable polymers for medical purposes, Biopolymers in controlled release systems. Synthetic polymeric membranes and their biological applications.
12. Brief Description of self-learning / E-learning component
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) Sujata V. Bhat, Biomaterials, Narosa Publishing House, 2002.
Reference Books
i) Biomaterials Science: An Introduction to Materials in Medicine, By Buddy D. Ratner, et. al. Academic Press, San Diego, 1996.
ii) Amar K. Mohanty, Manjusri Misra and Lawrence T. Drzal (2005), Natural Fibers, Biopolymers, and Bio composites, First Edition, CRC Press. ISBN: 978-0-849-31741-5.
iii) JB Park and RS Lakes (2010), Biomaterials - An Introduction, Springer. ISBN: 978-1-441-92281-6.

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mechanical Machine Design Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td>EAS ()</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Graphics and Deign</td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Brief Syllabus:

Design of Machine Elements is a required course for mechanical engineering students. This course is an introduction to the basic principles of modern engineering. It provides the students with fundamental skills of engineering and the ability to apply the theories of science to practice and understand the factors; such as stresses, deformations, and failure criteria, influencing the machine elements like shafts, springs, belts, bearings, gears etc. The main objective of design of machine elements is that the machine should function properly to satisfy the needs of the customer and it should be safe against the predicted modes of failure.

9. Learning objectives:

- **i)** To understand the design methodology for machine elements.
- **ii)** To analyze the forces acting on a machine element and apply the suitable design methodology.
- **iii)** To understand the various standards and methods of standardization.
- **iv)** To apply the concept of parametric design and validation by strength analysis.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Apply modern tools and skills in design and manufacturing to solve real world problems
- **ii)** Acquire knowledge and study effects of static stress concentrations in machine component
- **iii)** Acquire knowledge and design of Shafts, Springs and Drives.
- **iv)** Acquire knowledge and design of keys & coupling

11. Unit wise detailed content

Sr. No.	Title	COs covered
1	Study of selection of materials for given applications	i), ii)
2	Study of effect of different alloying elements on the properties of materials and comparison of it with properties of steel and ci.	ii)
3	Study of design of mechanical components subjected to fluctuating loads	ii), iii)
4	Study of selection of mechanical springs for various applications and design of springs subjected to different loads.	ii), iii)
5	Study of selection and design procedure for belt drives and ropes drives	iii)
6	Study of selection and design procedure for chain drives	iii)
7	To understand the design process for a sunk shaft system	iv)
8	To understand the design process for a power screw system.	i)

9	To understand the design process for a leaf spring	iii)
10	To understand the design process for a flat belt drive	iii)
11	To understand the design process for Keys and Coupling	iv)
12	To understand the design process for a v-Belt drive	iii)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Strength of Materials Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	**Materials Engineering and Technology**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials =0**	**Practical = 28**			
8. Course Description						

Strength of Materials (also known as Mechanics of Materials) is the study of the internal effect of external forces applied to structural member. Stress, strain, deformation deflection, torsion, flexure, shear diagram, and moment diagram are some of the topics covered by this subject.

9. Learning objectives:

i) To determine experimental data, including universal testing machines.

ii) To determine experimental data for spring testing machine, compression testing machine, impact tester, hardness tester.

iii) To determine stress analysis and design of beams subjected to bending and shearing loads using several methods.

iv) To determine mechanical properties of the mild steel.

10. Course Outcomes (COs): On completion of this course, the students will be able:

i) To estimate and compare the strength of solid materials using Tension, shear and torsion test.

ii) To determine and compare the Toughness of the materials using CHARPY and IZOD Test.

iii) To determine and compare the Brinnell and Rockwell hardness number of the given specimens.

iv) To determine the bending strength and fatigue strength of specimen using bending test.

11. Lab Content

Sr. No.	Title	COs covered
1	Evaluation of engineering stress-strain diagram on mild steel and cast-iron rods under tension.	**i)**
2	Determine the mechanical Properties of material by bending test on mild steel using universal testing machine.	**iv)**
3	Comparison of hardness values of steel, copper and aluminium using Brinell hardness testing machine.	**iii)**
4	Comparison of hardness values of steel, copper and aluminium using Rockwell hardness testing machine.	**iii)**
5	Determination of spring constant under tension and compression.	**i)**

6	Determination of impact strength for the given specimen using Charpy test	**ii)**
7	Determination of impact strength for the given specimen using Izod test	**ii)**
8	Determination of fatigue strength for the given specimen using Fatigue test.	**iv)**
9	Determination of shear stress for the given specimen using Torsion test	**i)**
10	Determination of shear strength for the given specimen using double shear test.	**i)**

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Manufacturing Process Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ( )</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">In this syllabus to introduce about manufacturing process, welding process and other important things which are very needful to a mechanical engineer. Students learn metal cutting operations like turning, milling, drilling, shaping, etc., Joining Processes, Metal Forming Processes, methods of measurements, Super Finishing Processes, Sheet Metal Developments.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the principles of manufacturing process.
ii) To learn the principles of welding process.
iii) To develop the knowledge of selecting the right equipment for a particular application of manufacturing and production.
iv) To acquire basic knowledge about the behaviour and manufacturing properties of engineering materials and concepts of different machining processes and various methods of measurements..</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Explain the mechanism of chip formation in machining.
ii) Explain the various machining processes such as turning, drilling, boring, shaping, slotting, milling and grinding.
iii) Use the principles of machine tools.
iv) Choose materials in a manufacturing process based on their properties and conduct experiments on various manufacturing processes.</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	Title	COs covered
1	Study and Practice of Orthogonal & Oblique Cutting on a Lathe.	i), iv)

2	Machining time calculation and comparison with actual machining time while cylindrical turning on a Lathe and finding out cutting efficiency.	i), iv)
3	Study of Tool Life while Milling a component on the Milling Machine.	i), iv)
4	To establish the relationship between cutting speed, feed rate and depth of cut during forces generated in oblique cutting.	ii), iii), iv)
5	Study of Tool Wear of a cutting tool while Drilling on a Drilling Machine.	iv)
6	Preparation of joint using spot welding.	iv)
7	Preparation of butt joint using arc welding.	iv)
8	Welding of stainless-steel specimen using MIG welding.	iii), iv)
9	Experiment on sheet metal development: Preparation of models – tray, funnel, truncated cone, pyramid, transition piece	iv)
10	Study of various super finishing operations-Lapping, honing, burnishing.	iv)
11	Study of divided head and generation of gear profile on milling machine.	iii)
12	To perform taper turning and thread cutting by different methods on lathe machine.	vi)
13	To select an appropriate grinding wheel to perform cylindrical & surface grinding operation.	iv)
14	Study and practice of Linear and angular measurement instruments	iv)

Department Electives-III Lab

<table>
<tr><td colspan="9">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Cryogenic Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="4">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="4">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✔)</td><td colspan="2">PE ()</td><td colspan="4">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Refrigeration & Air Conditioning</td><td>6. Frequency (use tick marks)</td><td>Even (✔)</td><td>Odd ()</td><td colspan="2">Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="9">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="6">Practical = 28</td></tr>
<tr><td colspan="9">8. Brief Syllabus
Introduction to Cryogenics and its applications, Properties of cryogenic fluids, Properties of materials at cryogenic temperature, Cryogenic Refrigeration Systems, Gas-liquefaction systems, Cryocoolers, Cryogenic Insulations, Vacuum Technology, Instrumentation in Cryogenics, Liquid storage and transfer systems, heat exchangers used in cryogenic systems.</td></tr>
<tr><td colspan="9">9. Learning objectives:
i) This course will describe the fundamental principles of cryogenic substances
ii) It'll discuss the fundamental principles cryogenics & its usage
iii) The understanding of cryogenic refrigeration systems.
iv) The understanding of various heat exchanges & cryogenic systems</td></tr>
<tr><td colspan="9">10. Course Outcomes (COs):
i) It'll help us in basic concepts of cryogenic substances.
ii) Analyses the effects & properties associates with cryogenics.
iii) Describe basic working principles of cryogenics & how it can be stored.
iv) Estimate the thermal conductivity associated with cryogenics.</td></tr>
<tr><td colspan="9">11. Unit wise detailed content</td></tr>
</table>

Sr. No.	Title	CO Covered
1	To study Properties of Cryogenic Fluids & its effects on Materials.	i), ii)
2	To compute the thermal conductivity at very low temperature	i)
3	To compare different insulating materials used in cryogenic applications	iii)
4	To compare different insulating materials used in cryogenic applications based on heat transferred through insulation.	ii) , iv)
5	To study cryogenic storage vessels.	ii), iii)
6	To study various applications of cryogenic substances.	i), ii)

7	To study cryo - refrigeration system, isothermal source system, isobaric source system.	iii)
8	To study working of magnetic refrigerator & thermal valves.	i), iii)
9	To study liquefaction system – ideal liquefaction system, simple Linde Hampson model	ii), iii)
10	To study liquefaction system – pre cooled Linde Hampson model	ii)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Computer Aided Manufacturing Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Machining Processes and Technology</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
<tr><td colspan="7">CAD is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. Students learn the importance of CAD/CAM principles in the Product development, programs related to manufacturing using codes and analyze the importance of networking in manufacturing environment.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the basics of CAD/CAM and concepts of computer graphics.
ii) To learn about the geometric issues concerned to the manufacturing and its related areas.
iii) To understand the latest advances in the manufacturing perspectives and their applications.
iv) To understand the working of G and M codes.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) To understand the importance of CAD/CAM principles and computer hardware in the Product development.
ii) To understand the principles of computer graphics.
iii) To develop programs related to manufacturing using codes.
iv) To learn the concepts of group technology, flexible manufacturing system and computer integrated manufacturing system.</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	Use and learn import/export techniques and customization of software.	i)

2	Construction of simple machine parts and components like Coupling, Crankshaft, Pulley, Piston, Connecting rod, nuts, bolts, gears and helical springs.	i)
3	Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies: Lathe Tail stock, Machine vice, Pedestal bearing, Drill jigs and Milling fixture.	i)
4	Make the part family/family table of a bolt	i)
5	Tool path generation	i)
6	Part programming	ii)
7	G & M codes development for machining operations	ii), iv)
8	Physical interpretation of machining features and tool geometries	iii)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Hydrogen and Fuel Cells Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Automobile Engineering</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course provides students a brief overview on Hydrogen and Fuel cells. This includes understanding the newest energy variants. Also give overview how to store and utilize these energies.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The objective of the course is to provide comprehensive and logical knowledge of hydrogen production.
ii) Knowledge of storage and utilization of Hydrogen.
iii) To provide an understanding of various fuel cell technologies
iv) To know the application of Fuel cells.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Evaluate the performance of fuel cells under different operating conditions.
ii) Select and defend appropriate fuel cell technology for a given application.
iii) Design and develop suitable hydrogen storage system to be used along with fuel cell system.
iv) Minimize environmental hazards associated with the use of hydrogen storage and fuel cell technology.</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	Title	COs covered
1	To Study the hydrogen energy systems	iv)
2	To Study the various Hydrogen production processes	iii), iv)
3	To study the various Hydrogen Storage systems.	iii), iv)
4	To Study the Hydrogen Utilization	iii), iv)
5	To study the evaluation process of fuel cells	i), ii)
6	To study the Fuel cells performance.	i), ii)
7	To study the application of Hydrogen and Fuel Cell	i), ii), iii), iv)
8	To design and develop the Hydrogen storage in combination with fuel cell technology.	iii)

1. Name of the Department- Mechanical Engineering

2. Course Name	Plant Layout and Material Handling Lab	L	T	P
3. Course Code		0	0	2

4. Type of Course (use tick mark)	Core ()	EAS ()	PE (✓)	OE ()

5. Pre-requisite (if any)		6. Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 0	Tutorials = 0	Practical = 28

8. Course Description

Introduction to Plant Layout and Material Handling Objectives and Functions of Plant Layout and Material Handling Introduction to Layout and its Importance Types of layouts Selection and specifications of layouts Implementation and follow up of layouts Introduction to CORELAP, ALDEP and CRAFT, CORELAP and ALDEP concepts Introduction to Group Layout and Fixed Position Layout Quadratic assignment model. Branch and bound method Introduction to Material Handling Relationship of material handling to plant layout Methods to minimize cost of material handling Ergonomics of Material Handling equipment.

9. Learning objectives:

- **i)** Learn the basic concept of Workstations
- **ii)** Learn the basic concept Layout construction techniques
- **iii)** Learn the basic concept Computerized Layout and Analytical Methods
- **iv)** Learn the basic concept Assessment and Evaluation

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Understanding the concept of Workstations
- **ii)** To address the underlying concepts of Layout construction techniques
- **iii)** Understanding the concept of Computerized Layout and Analytical Methods
- **iv)** Understanding the concept of Assessment and Evaluation

11. Lab Content

Sr. No.	Title	Cos covered
1	To Study the Production, activity and materials flow analysis using case study	i)
2	To Study the Facilities design procedure and planning strategies using case study.	i)
3	To study the graph-based construction algorithmic using case study	i)
4	To Study the Material Handling using case study	ii)

5	To Study the Systematic layout planning using case study	ii)
6	To study the Manufacturing operation using case study	ii)
7	To study the Warehouse operations using case study	iii)
8	To study the AS/RS and simulation model using case study	iii)
9	To study the Assessment and evaluation of layout alternatives Projects using case study	iii)
10	To study the Use Spiral software to practice plant layout design using case study	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Lean enterprise & Advanced Manufacturing Technologies Lab**	**L**		**T**		**P**
3. Course Code		**0**		**0**		**2**
4. Type of Course (use tick mark)		**Core ()**	**BSC ()**	**PE (✓)**		**OE ()**
5. Pre-requisite (if any)	**Industrial Engineering**	**6. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem () / Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**		**Practical = 28**		
8. Course Description						

This is a course based on lean thinking, enterprise process re-engineering, and digital manufacturing are becoming more prevalent in the work place, engineering and science professionals need to be prepared to address the enterprise as a holistic system of technologies, decision-making processes, and cultural components. The objective of this course to graduates with experience in manufacturing, engineering, design, or business who wish to develop their manufacturing expertise. This course is deal for wishing to transfer smoothly and effectively to a career in the manufacturing sector and of industry.

9. **Learning objectives:**

i) To develop lean thinking and, enterprise process re-engineering concept, & Jidoka Concept
ii) To explain advanced production techniques for Stability of Lean System & Just In Time
iii) To Explain Plastic Processing methods for different applications.
iv) To Classify Press tools and apply it in various engineering applications.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to
On completion of this course, the students will be able to:

i) Understanding the Introduction & Jidoka Concept (Automation with A Human Touch)
ii) Understanding the Stability of Lean System & Just in Time
iii) Understanding the concept and Introduction to Plastics Processing
iv) Understanding the concept of Press Tools Introduction

11.Lab Content

Sr. No.	**Title**	**CO covered**
1	To Study the Poke-Yoke systems.	i)
2	To Study the Implementation of Jidoka.	i)
3	To study the 5S system using case study.	i)
4	To Study the Value stream mapping using case study.	ii)
5	To Study the Injection moulding operation.	ii)
6	To study the hole flanging or extruding process.	iii)

7	To study the blanking, and piercing operation.	iii)
8	To study the Die Accessories using case study.	iii)
9	To study the Shear action in die cutting operation using case study.	iv)
10	To study the Constructional details of a power press using case study.	iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mechanical Vibration Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Basics of Mechanical Engineering</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td></td><td colspan="4"></td></tr>
</table>

A structure or a body is said to vibrate if it has a to and fro motion. A greater proportion of human activities involve vibration in one form or the other. We hear because our eardrums vibrate. The cause and effects of vibration must be clearly understood. The structures designed to support the high speed machines are subjected to inherent unbalance which causes problems. The unbalance may be due to faulty design or poor manufacture. Because of cyclic vibration, the material of the structure or the machine component may undergo fatigue failure. Vibration causes fasteners such as nuts of the machine to become loose. In metal machining processes, vibration may cause chatter, which results in poor surface finish. If the natural frequency of vibration of a machine or structure equals the forced frequency caused by external excitation, resonance occurs which causes dangerously large oscillations and the structure fails. A bridge can collapse due to wind-induced vibration. Critical instruments mounted on machines may lose their accuracy due to excessive vibrations. Vibrations can be used for useful works such as vibration testing equipment's, vibratory conveyors, hoppers, sieves, compactors, washing machines.

9. Learning objectives:

- **i)** To learn the basics of vibrations including causes and effects of vibrations.
- **ii)** To study the undamped and damped free vibration.
- **iii)** To study the forced vibrations.
- **iv)** To study multi degrees of freedom system and vibration measuring instruments.

10. Course Outcomes (COs):

- **i)** Understanding the fundamentals concepts of vibration.
- **ii)** To understand the free and forced vibrations with two-degree freedom system
- **iii)** To learn the methods to solve vibration problems with multi-degree freedom system.
- **iv)** To understand the basics of vibration of continuous systems and experimental methods in vibration analysis and working of vibration measuring instruments.

11. Lab Content

Sr. No.	Title	CO covered
1	To study the forced vibration of the beam for different damping.	i), ii), iii), iv)
2	To determine the radius of gyration ‘k’ of a given compound pendulum.	i)
3	To determine the radius of gyration of trifilar suspension.	i)
4	To determine the radius of gyration of given bar using bi-filler suspension.	i)
5	To verify the dunker lay’s rule viz.	ii), iii)
6	To study the pressure profile of lubricating conditions of load and speed.	v)
7	To determine the natural frequency of undamped torsional vibration of a single rotor shaft system.	i), ii), iii), iv)
8	To determine the frequency of undamped free vibration of an equivalent spring mass system.	i), ii), iii), iv)
9	To determine the frequency of damped force vibration of a spring mass system.	i), ii), iii), iv)
10	To determine the frequency of undamped free vibration of an equivalent spring mass system.	i), ii), iii), iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Nano Materials Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			
8. Course Description						

The course should give a basic introduction to chemical and physical principles in the synthesis of inorganic nanostructured materials. In addition, basic principles of finite size effects will be covered. The course will also cover different methods for synthesis and characterization of different nanostructures and nanostructured bulk materials.

9. Learning objectives:

i) To understand the basic concepts of surface engineering

ii) To understand the basic concepts of Nano-coating.

iii) To enhance the knowledge of Nano material.

iv) To allowing students to get familiarized with Microencapsulation

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Use of Nanomaterials for various industrial applications.

ii) To understand the basic concepts of properties of Nano materials

iii) Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.

iv) Describe Microencapsulation and their application in industry

11. Lab Component

Sr. No.	Title	COs covered
1	To study the process of synthesis of Nano materials	i)
2	To study the effect of reinforcement on properties of Nano materials	i)
3	To study the Physical routes for preparation of Nano materials	i)
4	To study the nano-structured coatings developed using CVD and PVD	ii)
5	To study the Functional coatings developed using CVD and PVD.	ii)
6	To study the effect in electrochemical properties of nanostructured coatings.	iii)

7	To study the effect in mechanical properties of nanostructured coatings.	iii)
8	To study the effect in physical and other properties of Nanostructured coatings.	iii)
9	To study the Current trends in the Nanomaterials.	iv)
10	To study amorphization and crystallization by Milling Process.	iv)
11	To study the Main problems in synthesis of Nanomaterials	iv)

Department Electives-IV Lab

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Fluid Power System Lab**	**L**	**T**		**P**		
3. Course Code		**0**	**0**		**2**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite (if any)	**Fluid Mechanics and Fluid Machinery**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

8. Brief Syllabus

A fluid power system has a pump driven by a prime mover (such as an electric motor or IC engine) that converts mechanical energy into fluid energy. This fluid flow is used to actuate a device such as: A Hydraulic cylinder or Pneumatic cylinder, A Hydraulic motor or Pneumatic motor, A Rotary actuator etc.

9. Learning Objectives:

i) Understanding of basics of hydraulics and pneumatics (pumps and various power supply sources).
ii) To learn students about the utilization of cylinders, accumulators, valves and various control components.
iii) Understand the control of Hydraulic and Pneumatic systems.
iv) To learn about fluid power maintenance and troubleshooting.

10. Course Outcomes (COs): At the end of this course, the learner will be:

i) Find the importance of fluid power technology in industries and to obtain knowledge on hydraulic and pneumatic components.
ii) Gets exposure to the basics of fluid flow including the physical laws affecting fluid standards and symbols used in industrial applications.
iii) Gain knowledge of that how to control the Hydraulic and Pneumatic Systems.
iv) Gain knowledge of the various components in fluid power industry and solve problems related to pumps.

11. Unit wise detailed content

Sr. No.	**Title**	**CO Covered**
1	Design and Testing of Pneumatic Single- and Double-Cylinder actuating system	i), ii)

2	Design and Testing of Two Hand operated Pneumatic Double Acting Cylinder (Direct Method).	i)
3	Design and Testing of Two Hand operated Pneumatic Double Acting Cylinder (Indirect Method).	i)
4	Design and Testing of PneumaticSingle Acting Cylinder by two DCV's – Shuttle (OR) and Dual Pressure (AND) valve	iv)
5	Design and Testing of Pneumatic Metering-In and Metering-Out circuit.	ii), iii)
6	Design and Testing of Pneumatic two Double Acting Cylinder Synchronization circuits (Cylinders connected in Series and Parallel)	i), ii)
7	Design and Testing of Single Cycle operation of Pneumatic Double Acting Cylinder.	iii)
8	Design and Testing of Multi Cycle operation of Pneumatic Double Acting Cylinder.	i), iii)
9	Design and Testing of two Pneumatic Double Acting Cylinder Sequencing circuit (A+ B+ B- A-)	iii)
10	Design and Testing of Single acting cylinder reciprocating system using Electro-Pneumatics	ii)

1. Name of the Department- Mechanical Engineering

2. Course Name	**CNC Programming Lab**	**L**		**T**		**P**	
3. Course Code		**0**		**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**	
1. Pre-requisite (if any)		**2. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()

3. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 0	**Tutorials = 0**	**Practical = 28**

4. Course Description

The course of introductory Learn Standard terminologies, conventions, and types of standard CNC machine tools. The theoretical concepts of Automatic/ Computer Assisted NC Tool Path Planning for multi-axis machines as well as virtual CAM environment using professional software for complicated machining applications. Learn constructional details of NC machine tools, selection of standard components used for NC machine tools for accuracy and productivity enhancement.

5. Learning objectives:

i) To understand the concept of CNC Programming effectively.
ii) To understand the concept of CNC machine tools & application.
iii) To understand the concept of CNC technology using part programming.
iv) To understand the concept of computer aided part programming.

6. Course Outcomes (COs): On completion of this course, the students will be able to:

i) Practice CNC Programming effectively.
ii) Acquire knowledge and use simple CNC machine tools & application.
iii) To understand fundamentals of the CNC technology using part programming.
iv) To understand the computer aided part programming.

7. Lab Content

Sr. No.	**Title**	**CO covered**
1	To study the NC machine	i)
2	To study the CNC machine	i)
3	To study the DNC machine	i)
4	To study the Constructional detail of CNC turning center and CNC machining center.	ii)
5.	To study the Tooling requirements of CNC machines	ii)
6	To study the Pre-set and qualified tools, Work and tool holding devices in CNC machines.	ii)

7	To study the R Manual part programming for a turning center	iii)
8	To study the Programming using tool nose radius compensation	iii)
9	To study the Tools offsets, Do loops, sub routines and fixed cycles.	iii)
10	To study the CAD based part programming.	iv)
11	To study the CAM based part programming.	iv)
12	To study the APT, COMPACT II, CAD/CAM based part programming.	iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Chassis Design Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td colspan="2">MS ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Advance Graphics Design</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Course Description

This course is intended to allow you the opportunity to explore engine design fundamentals and learn what you can do to help during the machining process. You will also learn about clutch, gear box, suspension, steering, and frame systems.

9. Learning objectives:

- **i)** The student will be able to understand the fundamental principles involved in design of components of automotive chassis,
- **ii)** Understand the complete design exercise and arrive at important dimensions of chassis components.
- **iii)** Understand the Clutch Design.
- **iv)** Understand the Gear Box Design.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** The student can identify different areas of automobile chassis component design.
- **ii)** Design the front axle and Steering system of an automobile.
- **iii)** Design the clutch for flawless power transmission.
- **iv)** Analyze the assembly and maintenance of Transmission line of an automobile.

11. Lab Content

Sr. No.	**Title (All Experiment should be performed on Software)**	**COs covered**
1	Complete design of clutch components.	i), iii)
2	Assembly drawing of clutch using drafting software.	i), iii)
3	Gear train calculations.	i), iv)
4	Layout of gear box.	i), iv)
5	Calculation of bearing loads	i), iv)
6	Selection of bearings.	i), iv)
7	Assembly drawing of gear box using drafting software.	i), iv)
8	Design of propeller shaft.	i), iv)
9	Design details of final drive gearing.	i), iv)
10	Design details of full floating, semi-floating and three-quarter floating rear shafts and rear axle housings	i), ii)
11	Design aspects of final drive.	i), ii)

1. Name of the Department- Mechanical Engineering							
3. Course Name	**Work Study Lab**	**L**		**T**		**P**	
4. Course Code		**0**		**0**		**2**	
5. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**	
6. Pre-requisite (if any)		**7. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()
8. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			

9. Course Description

This is a course based on Work study and industrial engineering play important role in job simplification, job design, job enrichment, value analysis/engineering, method analysis, operational analysis, etc. Work study has been utilized by companies to job productivity. Industrial engineering is the latest method employed to improve productivity. It deals with design, enhancement and setting up of engineering systems encompassing plants, machinery, workers, etc.

10. Learning objectives:

- **i)** Learn the basic concept of various productivities and work study in industrial manufacturing.
- **ii)** Learn the basic concept of Micro and Memo Motion Study.
- **iii)** Learn the basic concept of Work Measurement.
- **iv)** Learn the basic concept of different Ratings and Incentives.

11. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Understanding of various productivities and work study in industrial manufacturing.
- **ii)** Understanding of Micro and Memo Motion Study.
- **iii)** Understanding of the concept of Work Measurement.
- **iv)** Understanding of different Ratings and Incentives.

12. Lab Content

Sr. No.	**Title**	**COs covered**
1	To Study the factors affecting the productivity using case study	i)
2	To Study the human factor in work study using case study.	i)
3	To study the Charts to record moments in shop operation using case study	ii)
4	To Study the SIMO chart, and micro motion study using case study	ii)
5	To Study the principles of motion economy using case study	ii)
6	To study the areas of study under ergonomics using case study	iii)
7	To study the Work measurement techniques using case study	iii)

8	To study the Usability Engineering and Human Computer interface using case study	iii)
9	To study the Method time measurement using case study	iv)
10	To study the Predetermined motion time study using case study	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Supply Chain and Logistic Management Lab**	**L**		**T**	**P**	
3. Course Code		**0**		**0**	**2**	
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**	**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 0	**Tutorials = 0**	**Practical = 28**

8. Course Description

This is a course in supply chain management (SCM), a term which denotes the integration of key business processes from end user through original suppliers for the purpose of adding value for the firm, its key supply chain members, to include customers and other stakeholders. This course presents a framework for SCM that requires cross-functional integration of key business processes within the firm and across the network of firms that comprise the supply chain.

9. Learning objectives:

i) An understanding of the primary differences between logistics and supply chain management.

ii) An understanding of the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain.

iii) An understanding of the management components of supply chain management.

iv) An understanding of the tools and techniques useful in implementing supply chain management.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

i) Understanding the concept of Logistic Managements.

ii) Understanding the concept of Supply Chain Management

iii) Understanding the concept Matching supply and demand

iv) Understanding the concept of Strategic Management

11. Lab Content

Sr. No.	Title	COs covered
1	To Study the Multi-echelon system.	i)
2	To Study the Logistics information system using case study.	i)
3	To study the Supply chain management and logistics using case study.	ii)
4	To Study the Supply Chain drivers and obstacle using case study.	ii)
5	To Study the Demand management and aggregate planning using case study.	iii)
6	To study the forecasting and replenishment - using case study.	iii)

7	To study the Collaborative planning using case study	iii)
8	To study the uncertainty in supply chain using case study.	iv)
9	To study the Strategic lead-time management -using case study.	iv)
10	To study the economies of scale in supply chain cycle inventory using case study.	iv)

1. Name of the Department- Mechanical Engineering				
2. Course Name	**Finite Element Methods Lab**	**L**	**T**	**P**
3. Course Code		**0**	**0**	**2**
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**

5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	**Even (✓)**	**Odd ()**	**Either Sem ()**	**Every Sem ()**

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 00	**Tutorials = 00**	**Practical = 28**

8. Course Description

The finite element method (FEM) is among one of the most powerful tool for the numeric solution of wide range of engineering problems. The application ranges from deformation and stress analysis of civil and mechanical structures, automotive components, aircraft designs, heat flux analysis, fluid flow problems, electrical magnetic flux problem. Upon completion, students should be able to solve the problems in solid mechanics and heat transfer using FEM..

9. Learning objectives:

i) To enable the students, understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis.
ii) To understand the characteristics of various finite elements.
iii) To develop finite element equations for simple and complex domains.
iv) To understand ANSYS and CAD tools.

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Apply the knowledge of mathematics and engineering to solve problems in structural and thermal engineering by approximate and numerical methods.
ii) Design a new component or improve the existing components using FEA.
iii) Solve the problems in solid mechanics and heat transfer using FEM.
iv) Use commercial FEA packages like ANSYS and modern CAD/CAE tools for solving real life problems.

11. Lab Content

Sr. No.	**Title**	**COs covered**
1	Force and stress analysis using link elements in Trusses, cables etc.	i), ii), iii), iv)

2	Stress and deflection analysis in beams with different support conditions.	i), ii), iii), iv)
3	Stress analysis of flat plates and simple shells.	i), ii), iii), iv)
4	Stress analysis of axi-symmetric components.	i), ii), iii), iv)
5	Thermal stress and heat transfer analysis of plate.	i), ii), iii), iv)
6	Thermal stress analysis of cylindrical shells.	i), ii), iii), iv)
7	Vibration analysis of spring-mass systems.	i), ii), iii), iv)
8	Model analysis of beams.	i), ii), iii), iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Biomaterials Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ( )	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

A biomaterial is any matter, surface, or construct that interacts with biological systems. The course biomaterials laboratory covers practical synthesis, analysis and design of biomaterials used for bioengineering, including biotechnology, tissue engineering, medical imaging and clinical applications.

9. Learning Objectives:

v) To learn about structure of Biomaterials.
vi) Understand applications, chemical structure, properties and morphology of biomaterials.
vii) To learn about different types of implants and their characteristic.
viii) To analyze interface of biology and materials science with vast applications.

10. Course Outcomes (COs): On completion of this course, the students will

v) Able to investigate the properties of biomaterials.
vi) Understand the various analyzing processes for characterization of materials.
vii) Understand the vast applications of these material in the industries and prepare new materials.
viii) Apply and account for methods to characterize interactions between materials and tissue.

11. Lab Content

Sr. No.	**Title**	**COs covered**
1	To study surface properties, physical properties, mechanical properties of materials.	i)
2	To investigate the structure, properties, and applications of metal.	i)
3	To investigate the structure, properties, and applications of polymer, and ceramic based biomaterials.	i), ii)
4	To understand the structure property-performance in design and function of biomaterial devices.	i)
5	To study techniques for Cell Culture and Cell-Material Interactions.	i), iii)
6	To learn about histological staining and examination of cells and tissues.	i), ii)
7	To investigate how polymeric chemical structure can be used to control the degradation properties of the crosslinked network.	ii), iii)
8	To investigate how molecular precursors can be used to alter end-stage mechanical properties of hydrogel networks.	ii), iii)

9	To investigate how polymeric chemical structure can be used to control the degradation properties of the crosslinked network.	iii)

5^{th} Semester

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Fluid Mechanics and Machines</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>Engg. Maths & Engineering Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td colspan="2">Tutorials = 00</td><td colspan="3">Practical = 00</td></tr>
<tr><td colspan="7">8. Course Description:</td></tr>
<tr><td colspan="7">Fluid mechanics and machinery is a branch of continuum mechanics that deals with the behavior of fluids (gases or liquids) either in motion or at rest and the subsequent effects of fluids upon boundaries, which may be either solid surfaces or interfaces with other fluids. This course deals fluids and their properties, and the kinematics and dynamics of fluid flow. After that students learn the fundamentals of flow through pipes, turbulent flow, dimensional analysis and boundary layers and their applications in engineering.</td></tr>
<tr><td colspan="7">9. Learning Objectives:
i) Understand fluid behavior for engineering design and control of fluid systems.
ii) Develop competence with mass, energy and momentum balances.
iii) Study the development of boundary layers and model similitude.
iv) Study about various turbines and pumps designed on above concepts</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Understand the fundamental models for analyzing a fluid flow and fluid at rest both.
ii) Find the dependent and independent parameters for a fluid flow.
iii) Explain various methods available for boundary layer separation and analyze the model and prototype.
iv) Understand the working principles of turbines and pumps</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td colspan="2">Number of lectures = 12</td><td colspan="4">Title of the unit: Fluid Properties and Hydrostatics</td></tr>
<tr><td colspan="7">Introduction to fluid mechanics, Fluid types and properties: Density, Viscosity, Surface tension, compressibility, capillarity, Fluid statics, Hydrostatic forces on plane, inclined and curved surfaces, buoyancy – centre of buoyancy, metacenter. Fluid Kinematics, Streamline and Velocity potential lines, stream function and potential function, Types of flows; Steady flow, Unsteady flow, Uniform and Non-Uniform flow, Rotational flow, Irrotational flow, 1-D, 2-D, 3-D flows</td></tr>
<tr><td>Unit - 2</td><td colspan="2">Number of lectures = 10</td><td colspan="4">Title of the unit: Fluid Dynamics</td></tr>
</table>

Surface and Body forces-Euler and Bernoulli's equations and their applications, Momentum equation, Navier-Stokes Equations, Applications, force on pipe bend Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and parallel- total energy line- hydraulic gradient line Measurement of flow- Venturi meter, orifice meter and Pitot tube		
Unit - 3	**Number of lectures = 09**	**Title of the unit: Boundary layers & Dimensional analysis**
Boundary layers, Laminar flow and Turbulent flow, Boundary layer thickness, momentum, Integral equation, Drag and lift, Separation of boundary layer, Methods of separation of boundary layer. Dimensional homogeneity, Raleigh and Buckingham pi theorems, Non-dimensional numbers, Model laws and distorted models, Module quantities, Specific quantities		
Unit - 4	**Number of lectures = 11**	**Title of the unit: Turbo machines**
Basics of Turbo machinery: Impact of jets on stationary and moving flat and curved plates, concept of velocity diagram Hydraulic turbines: Types and classification: Pelton, Francis and Kaplan turbines- work done, efficiency, work proportions and performance characteristic curves, draft tube design. Pumps- Centrifugal and reciprocating pumps: work done, efficiency, work proportions and performance characteristic curves, pumps in series and parallel, Water hammer, NPSH. Current Industrial applications of fluid flow analysis and fluid Machinery.		
12. Brief Description of self learning / E-learning component		
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book:		
i) R. K. Bansal (2010), A Textbook of Fluid Mechanics and Hydraulic Machines, 9th Edition, Laxmi Publication (P) Ltd. New Delhi. ISBN- 978-8-131-80815-3.		
Reference Books:		
i) Yunus A. Çengel (2010), Fluid Mechanics, Tata McGraw Hill, ISBN: 978-0-070-70034-5.		
ii) Frank M. White (2011), Fluid Mechanics, 7th edition, Tata McGraw-Hill Education, ISBN-978-0-071-33312-2.		

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Kinematics of Machines**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	**+2 Level Physics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Brief Syllabus

The analysis of a machine requires the determination of the movement or kinematics of its component parts, known as kinematic analysis. The assumption that the system is an assembly of rigid components allows rotational and translational movement to be modelled mathematically. This allows the position, velocity and acceleration of all points in a component to determine from these properties for a reference point and the angular position, angular velocity and angular acceleration of the component. Students learn Basics of Mechanisms, kinematic analysis of simple mechanisms, synthesis of simple mechanisms, kinematics of CAMS and kinematics of gears and gear trains.

9. Learning objectives:

- **i)** To familiarize students with basic types of mechanisms, joints and degrees of freedom to perform position, velocity and acceleration analysis using graphical and analytical methods.
- **ii)** To provide students an understanding of different types of mechanisms.
- **iii)** To teach the basics of synthesis of simple mechanisms.
- **iv)** To teach students the kinematic analysis of cam-follower motion and gears.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Demonstrate an understanding of the concepts of various mechanisms and pairs.
- **ii)** Conduct velocity and acceleration analysis of simple mechanisms.
- **iii)** Synthesize simple mechanisms for function, path generation and body guidance.
- **iv)** Design a layout of cam for specified motion and demonstrate an understanding of principles of operation of gears.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Basics of Mechanisms**
Introduction to Kinematics, Kinematic Link, Kinematic Pairs, Kinematic Chain, Mechanism vs Machine, Degree of Freedom Mobility, Kutzbach criterion, Grubler's criterion for planar mechanisms mechanism and Grashoff's law, Kinematic Inversions of 4-bar chain, Single slider and double slider crank chains, Quick return and its terminologies, Limiting positions, Mechanical advantage, Transmission angle.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Kinematic Analysis of Simple Mechanisms**
Displacement, velocity and acceleration analysis in simple mechanisms having turning, sliding and rolling pair, Coriolis acceleration using graphical relative motion method, Instantaneous center method, Four bar and slider crank mechanisms, Analytical method for four bar and slider crank mechanisms.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Synthesis of Simple Mechanisms**

Classification of kinematic synthesis problems, two position synthesis of slider crank and crank rocker mechanisms, three position synthesis of double rocker mechanism, Chebychev spacing, Freudenstein analytical method, synthesis of function genera-tor using three precision positions, Graphical and analytical design of a four-bar linkage for body guidance, path generation by graphical method.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Kinematics of CAMS and Gears**
Types of cams and followers, Definitions related cam profile, Simple harmonic motion, Constant acceleration and deceleration, constant velocity, Cycloidal motion for knife edge and roller (in-line and offset). Spur gear terminology and definitions, Law of toothed and involute gearing, Interchangeable gears, Gear tooth action, Interference and undercutting, Basics of nonstandard gear teeth, Helical, Bevel, Worm, Rack and pinion gears, cycloidal tooth properties, Comparison of involute and cycloidal tooth forms.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i)	S.S. Rattan (2009), “Theory of Machines”, 3rd Edition, Tata McGraw-Hill. ISBN: 978-0-070-14477-4.

Reference Books:

i)	A.Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.
ii)	Thomas Bevan (2009), Theory of Machines, 3rd Edition, Pearson Education, ISBN: 978-8-131-72965-6.
iii)	Kenneth J Waldron and Gary L. Kinzel (2007), Kinematics, Dynamics, and Design of Machinery, 2nd Edition, John-Wiley and Sons Inc., New York, ISBN: 978-8-126-51255-3.
iv)	J. Uicker John, Gordon R. Pennock Jr. and Joseph E. Shigly (2011), Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, ISBN: 978-0-199-77781-5.

Department Electives-V

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Robotics Engineering and Applications**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite	**NA**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	Tutorials = 0	Practical = 0

8. Course Description:

Introduction to Robotics, Components, Types and classification, control, sensing, static and dynamic properties. Grippers, types, mechanisms for actuation & design. Industrial robots' specifications. Selection based on the Application. Kinematics: Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots. Trajectory planning: Introduction Cartesian space scheme, adaptive control, and Servo system for robot control. Programming of Robots and Vision System.

9. Learning Objectives:

- **i)** To familiarize the students with the concepts and techniques in robotic engineering and control, manipulator kinematics & dynamics, application and selection of robotic system for various industrial scenarios.
- **ii)** Make the students acquainted with the theoretical aspects of Robotics
- **iii)** Enable the students to acquire practical experience in the field of Robotics through case studies.
- **iv)** Make the students understand the importance of robots in various fields of engineering and expose them to various robots and their operational details.

10. Course Outcomes (COs): At the end of this course, the learner will be:

- **i)** Understand the basic components of robots.
- **ii)** Differentiate types of robots and robot grippers.
- **iii)** Model forward and inverse kinematics of robot manipulators.
- **iv)** Analyze forces in links and joints of a robot.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Fundamentals of Robotic Systems

Introduction to Robotics, Components of a robotic system, Types and classification of Robots, applications Drives and actuators, control components (Serial manipulator & Parallel Manipulator),

Unit - 2	Number of lectures = 10	Title of the unit: Robotic actuation and specification

Grippers, Mechanical Gripper, Grasping force, Engelberger-g-factors-mechanisms for actuation, Magnetic gripper, vacuum cup gripper, considerations in gripper selection & design. Industrial robots' specifications. Selection based on the Application.

Unit - 3	Number of lectures = 10	Title of the unit: Kinematics in Robots

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogeneous Transformation Matrix, D-H transformation matrix, D-H method of assignment of frames. Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots		
Unit - 4	**Number of lectures = 12**	**Title of the unit: Robotic Navigation**
Trajectory planning: Joint space scheme- Cubic polynomial fit-Obstacle avoidance in operation space-cubic polynomial fit with via point, bleeding scheme. Introduction Cartesian space scheme. Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity, and force control systems, computed torque control, adaptive control, and Servo system for robot control.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

- **i)** Industrial Robotics / Groover M P /McGraw Hill. (ISBN-10: 0071004424, ISBN-13: 978-0071004428)

Reference Books:

- **i)** John J. Craig (2008), Introduction to Robotics: Mechanics and Control, 3rd Edition, Pearson Education. ISBN: 978-8-131-71836-0.
- **ii)** Theory of Applied Robotics /Jazar/Springer. (ISBN- 978-1-4419-1750-8)
- **i)** Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, (2010), Robotic Engineering an Integrated Approach, 1st Edition, Prentice-hall of India. ISBN: 978-8-120-30842-8.
- **ii)** S. R. Deb and Sankha Deb (2009), Robotics Technology and Flexible Automation, 2nd Edition, Tata McGraw-Hill Edu-cation. ISBN: 978-0-070-07791-1.
- **iii)** Robert Joseph Schilling (2007), Fundamentals of Robotics: Analysis and Control, Prentice Hall India. ISBN: 978-8-120-31047-6.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Solar and Nuclear Power Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 00</td></tr>
</table>

8. Brief Syllabus

The combination of continual nuclear power with solar energy stored in the salts allows the reactor to generate super-heated steam to run electricity even at night. Studies predict solar-nuclear hybrid power plants to be far more efficient in power generation compared to nuclear or solar power plants alone. Solar energy systems include collectors to convert solar radiation to heat in a fluid, energy storage units which are designed to accumulate energy when it is available and deliver it when needed, means to deliver the energy from the storage to a load, and necessary pumps, controls, etc. On the other hand Nuclear Power Engineering concentrates on the principles, techniques and processes involved in generation of power from nuclear fuels. This involves studying and exploring various aspects of science ranging from processing of nuclear fuel to merits and demerits of various nuclear reactors and from reprocessing of nuclear waste to their safely disposal. Upon completion of this course students will be able to have better understanding of nuclear processes involved in nuclear power generation, know working and pros & cons of various reactors and also have understanding of nuclear power generation and safety rules implemented during power generation from nuclear fuels and nuclear waste disposal.

9. Learning objectives:

- **i)** The student will be exposed to the basic physics of solar energy system and applications of solar based energy equipment.
- **ii)** The student will be exposed to the basic physics of nuclear reactions and operation of nuclear reactors.
- **iii)** To learn the working and various type of Reprocessing
- **iv)** To learn various types of power generation methods, safety and its impact on environment.

10. Course Outcomes (COs):

- **i)** Know the fundamentals of solar energy systems operations.
- **ii)** Aware to the concept of solar thermal and photovoltaic operating systems and to Know the nuclear fission and fusion processes.
- **iii)** Understand the working of Reprocessing
- **iv)** Understand the working of nuclear reactors and understand power generation and safety aspects.

11. Unit wise detailed content

Unit-1	Number of lectures = 12	Title of the unit: Fundamentals of Solar energy system

Introduction, Energy science and Technology, Forms of Energy, Importance of Energy Consumption as Measure of Prosperity, Per Capita Energy Consumption, Roles and responsibility of Ministry of New and Renewable Energy Sources, Needs of renewable energy, Classification of Energy Resources, Conventional Energy Resources, Nonconventional Energy Resources, World Energy Scenario, Indian Energy Scenario.

Introduction to Solar Radiation, Sun path diagram, Basic Sun-Earth Angles, Solar Radiation Geometry and its relation, Measurement of Solar Radiation on horizontal and tilted surfaces, Principle of Conversion of Solar Radiation into Heat, Collectors, Collector efficiency, Selective surfaces, Solar Water Heating system, Solar Cookers, Solar driers, Solar Still, Solar Furnaces, Solar Green Houses. Solar Photovoltaic, Solar Cell fundamentals, Characteristics, Classification, Construction of module, panel and array. Solar PV Systems (stand-alone and grid connected), Solar PV Applications. Government schemes and policies.

Unit – 2	Number of lectures = 08	Title of the unit: Nuclear Reactors and Reactor Materials

Mechanism of nuclear fission – Nuclides - Radioactivity – Decay chains - Neutron reactions - Fission process – Reactors - Types of reactors – Design and construction of nuclear reactors - Heat transfer techniques in nuclear reactors - Reactor shielding.

Nuclear fuel cycles – Characteristics of nuclear fuels – Uranium – Production and purification of uranium – Conversion to UF4 and UF6 – Other fuels like Zirconium, Thorium, Berylium.

Unit – 3	Number of lectures = 08	Title of the unit: Reprocessing

Nuclear fuel cycles - Spent fuel characteristics - Role of solvent extraction in reprocessing - Solvent extraction equipment.

Unit – 4	Number of lectures = 14	Title of the unit: Separation of Reactor Products and Waste Disposal and Radiation Protection

Processes to be considered - Fuel element dissolution - Precipitation process – Ion exchange - Redox - Purex - TTA – Chelation -U235 -Hexone - TBP and Thorax processes - Oxidative slagging and electro-refining - Isotopes – Principles of isotope separation.

Types of nuclear wastes – Safety control and pollution control and abatement - International convention on safety aspects – Radiation hazards prevention. Unit of Nuclear Radiation, Effects of Nuclear Radiation, Radioactive Waste Disposal System, Gas Disposal System.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

i) Janet Wood (2007), Nuclear Power, Institution of Engineering and Technology. ISBN: 978-0-863-41668-2.

ii) Samuel Glasstone, Alexander Sesonske (2012), Nuclear Reactor Engineering: Reactor Systems Engineering, 4th Edition, CBS Publisher. ISBN: 978-1-461-35866-4.

iii) J. Kenneth Shultis, Richard E. Faw, Marcel Dekker (2002), Fundamentals of Nuclear Science and Engineering, Marcel Dekker. ISBN: 978-0-824-70834-4.

Reference Books

i) Samuel Glasstone (1994), Nuclear Reactor Engineering: Reactor Design Basics, Volume-1, 4th Edition, Kluwer Academic Publishers. ISBN: 9780412985218

ii) A.E. Walter and A.B. Reynolds (1981), Fast Breeder Reactor, Pergamon Press, ISBN: 978-0-080-25982-6.

iii) D. Y. Goswami, Principles of Solar Engineering, Third Edition, CRC Press, Taylor and Francis, 2015. ISBN- 13: 978-1-4665-6379-7.

iv) Garg and Prakash, Solar Energy, Fundamentals and Applications, Tata McGraw Hill, 2017. ISBN-13: 978-0074631416.

v) Solar energy : principles of thermal collection and storage, Sukhatme. S.P., Tata McGraw Hill Publishing Company Ltd., 1997. ISBN- 0074624539 9780074624531.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Rapid Manufacturing Technologies</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Material Engineering & Technology</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">The syllabus includes importance of rapid additive manufacturing in advance manufacturing process and technology used in Rapid manufacturing. Data formats to acquire knowledge, techniques and skills to select relevant additive and rapid manufacturing process. It also includes case studies to explore the potential of rapid manufacturing in different industrial sectors.</td></tr>
<tr><td colspan="7">9. Learning objectives: Students undergoing this course are expected to:
i) To Learn the Rapid Manufacturing Technologies.
ii) To Design, Development and Manufacturing using Rapid Manufacturing Technologies
iii) To Acquaint the Concept of Additive Manufacturing Technologies and Material selection for AM.
iv) To familiarize with the Rapid Manufacturing Technologies in various fields through case studies.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On course completion students will be able to
i) To understand various Rapid manufacturing technologies.
ii) To understand the use of techniques for processing of CAD models for rapid prototyping.
iii) To understand the use of rapid manufacturing technology in reverse engineering.
iv) Understand and apply fundamentals of rapid prototyping techniques.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to rapid manufacturing</td></tr>
<tr><td colspan="7">Introduction to Rapid Manufacturing, Customization and Mass Customization, Classification of Rapid Manufacturing Processes (Additive/Subtractive/Formative, Process Chain for Additive and Other Rapid Manufacturing Processes, Advantages and limitations of rapid manufacturing, challenges in rapid manufacturing.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Pre and post processing in additive manufacturing</td></tr>
<tr><td colspan="7">Preprocessing: Preparation of CAD Model, Conversion to STL file, Diagnosis of STL file Error, Part orientation, Generation/Design of Support, Slicing, Generation of Tool Path Pattern and Internal Hatching Pattern, Post processing: Removal of Support Material, Improvement in Surface Finish, Improvement in Accuracy, Aesthetic Improvement of AM products, Modifying Property of AM products.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 14</td><td colspan="5">Title of the unit: Additive manufacturing processes</td></tr>
</table>

Vat photopolymerization based, powder bed fusion based, extrusion based, material jetting based, binder jetting based, direct energy deposition based and sheet lamination based additive manufacturing processes, Process parameters, Advantages, disadvantages, and materials for different additive manufacturing processes.		
Unit – 4	**Number of lectures = 8**	**Title of the unit: Additive and other Rapid manufacturing case study**
Case study of additive manufacturing processes: In medical, in automobile sector, in defense, in aerospace and in other fields like arts, fashion and jewelry. Rapid Manufacturing Processes: Subtractive, Rapid Manufacturing Processes: Formative, Process selection, Applications and Case studies		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
i) Gibson, I., Rosen, D., Stucker, B. (2016), "Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing", Germany: Springer New York, ISBN: 9781493944552, 149394455X		
Reference Books		
i) Gebhardt, A. (2012). Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing. Germany: Hanser Publications, ISBN: 9783446425521, 3446425527		
ii) Hötter, J., Gebhardt, A. (2016), "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Germany: Hanser Publications, ISBN: 9781569905821, 1569905827		
iii) Cooper, K. (2001), "Rapid Prototyping Technology: Selection and Application", United States: Taylor & Francis, ISBN: 9780824745240, 0824745248		

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Design for Manufacture & Assembly</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td colspan="2">Specialization ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Design for Mechanical Elements</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">The Design for Manufacturing & assembly is challenging subject that includes design principles for manufacturability and Influencing factors on Design. To learn about the machining, casting and environmental consideration while design. The aim of present course is to introduce and aware students about the basic design process with general design principles which based on different aspects of manufacturing as well assembly.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To study various factors influencing the manufacturability of components.
ii) To impart knowledge about factors that influence changes in product design.
iii) To study applications of various casting, forging and welding processes
iv) To study life cycle assessment of the product.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On course completion students will be able to
i) Get to know about various internal and external characteristic of material affecting design.
ii) To know general design principles for manufacturability.
iii) Introduction of basic design process based on different aspects of different manufacturing processes like machining, drilling etc.
iv) Student will have idea about various phases in the life of a product.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Introduction</td></tr>
<tr><td colspan="7">Strength and mechanical factors, mechanisms selection, evaluation method, Process capability: Feature tolerances, Geometric tolerances, Assembly limits, Datum features, and Tolerance stacks.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Factors Influencing Design</td></tr>
<tr><td colspan="7">Working principle, Material, Manufacture, Design- Possible solutions, Materials choice, Influence of materials on form design, form design of Welded members, forgings and castings.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Component Design-I</td></tr>
<tr><td colspan="7">Machining Consideration: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by</td></tr>
</table>

amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Component Design-II**
Casting Consideration: Redesign of castings based on parting line considerations, minimizing core requirements, machined holes, re-design of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA. Recent trends and some promising techniques for designing a component for manufacturing.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) Kevien Otto and Kristin Wood, Product Design. Pearson Publication, 2004, ISBN-13 978-: 0130212719

Reference Books:

i) Product design and development, by K.T. Ulrich and S.D. Eppinger, Tata McGraw Hill, ISBN 9780070146792

ii) Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994, ISBN 978-0824791766

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Advanced Automotive Electronics**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Basics of Automobile Engineering**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
Automotive electronics are electronic systems used in vehicles, including engine management, ignition, radio, carputers, telematics, in-car entertainment systems and others. Ignition, engine, and transmission electronics are also found in trucks, motorcycles, off-road vehicles, and other internal combustion-powered machinery such as forklifts, tractors, and excavators. Related elements for control of relevant electrical systems are found on hybrid vehicles and electric cars as well.						
9. Learning objectives: **i)** To understand the concepts of Automotive Electronics and its evolution and trends, Automotive systems & subsystems overview. **ii)** To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms. **iii)** To understand, design and model various automotive control systems using Model based development technique. **iv)** To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software.						
10. Course Outcomes (COs): On course completion students will be able to **i)** Develop, simulate and integrate control algorithms for ECUs with hardware **ii)** Interface automotive sensors and actuators with microcontrollers. **iii)** Obtain an overview of automotive components, subsystems, design cycles, communication protocols and safety systems employed in today's automotive industry **iv)** Describe various communication systems, wired and wireless protocols used in vehicle networking.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 12**	**Title of the unit: Engine/Vehicle Sensors & Digital Engine Control System**				
Introduction, basic sensor arrangement, types of sensors, oxygen sensors, fuel metering/vehicle speed sensors, detonation sensor. Flow sensor. Throttle position sensors. Solenoids, stepper motors, and relays.Open loop and close loop control system, Engine Control Module (ECM), engine cooling and warm up control, Acceleration, detonation and idle speed control-integrated engine system, exhaust emission control engineering, on-board diagnostics, diagnostics, future automotive electronic systems						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Electronic Fuel Injection and Ignition system**				
Introduction, feedback carburettor system (FBC), types of gasoline fuel injection system, Throttle body injection and multi-port of point fuel injection, injection system control. Robert Bosch gasoline fuel injection system controls. Fuel air ration sensing. Turbo charged engine fuel system. Advantages of electronic ignition system, principle of operation, high energy ignition distributors operation, simplified operational diagram for a distributor less ignition system, Electronic spark timing /control.						

Unit – 3	Number of lectures = 10	Title of the unit: Warning and alarm instruments
Brake actuation warning system, traficators, flash system, oil pressure warning system, engine over heat warning system, air pressure warning system, speed warning system, door lock indicators, gear neutral indicator, horn design, permanent magnet horn, air & music horns.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Dash board amenities, Comfort and Safety**
Car radio and stereo, courtesy lamp, time piece, cigar lamp, car fan, wind shield wiper, window washer, instrument wiring system and electromagnetic interference suppression, wiring circuits for instruments, electronic instruments, dash board illumination. seats, mirrors and sun-roofs, central locking and electronic windows, cruise control, in-car multimedia, security, airbag and belt tensioners, other safety and comfort systems, advanced comfort and safety systems, new developments in comfort and safety, the system approach to control & instrumentation, Antilock braking system (ABS). Electronic Ride Microprocessor control.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Robert N. Brandy, "Automotive Computers & Digital Instrumentation", Prentice Hall Eaglewood, Cliffs, Reston Pub Co, ISBN: 0835902633

Reference Books

i) Wiliam B. Ribbens- Understanding Automotive Electronics, Allied Publishers Pvt. Ltd., 5th Revised Edition, ISBN: 0750670088.

ii) Tom Denton- Automobile Electrical & Electronic Systems, Allied Publishers Pvt. Ltd., 3rd Edition, 2004, ISBN: 0768014972

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mechatronics Systems and Its Applications</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="3">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td colspan="2">EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Applied Physics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td colspan="2">Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="5">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Mechatronics is a design process that includes a combination of mechanical engineering, electrical engineering, control engineering and computer engineering. Mechatronics is a multidisciplinary field of engineering, that is to say, it rejects splitting engineering into separate disciplines. Originally, mechatronics just included the combination of mechanics and electronics, hence the word is a combination of mechanics and electronics; however, as technical systems have become more and more complex the word has been “updated” during recent years to include more technical areas.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To introduce integrated approach to the design of complex engineering systems.
ii) To provide knowledge of sensors, actuators and their selection for an application.
iii) To expose interfacing of devices with controllers.
iv) To understand the Intelligent Mechatronics.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On course completion students will be able to
i) Identify the elements of mechatronics system.
ii) Select suitable sensors and actuators to meet specific requirements.
iii) Select the controllers according to the need.
iv) Demonstrate intelligent mechatronics system for engineering applications.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Introduction to Mechatronics</td></tr>
<tr><td colspan="8">Introduction to Mechatronics – Conventional and Mechatronics approach in designing products – Mechatronics design process –Mechatronics in manufacturing – Adaptive and distributed control systems – Modeling and simulation of Mechatronics Systems.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Microprocessor</td></tr>
<tr><td colspan="8">Architecture of microprocessor and microcontroller – System interfacing for a sensor, keyboard, display and motors – Application cases for temperature control, warning and process control systems.</td></tr>
</table>

Unit – 3	Number of lectures = 12	Title of the unit: Programmable Logic Controllers
Architecture of Programmable Logic Controllers – Input/Output modules – Programming methods – Timers and counters – Master controls – Branching – Data handling – Analog input/output – Selection of PLC and troubleshooting.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Intelligent Mechatronics and Case Studies**
Fuzzy logic control and Artificial Neural Networks in mechatronics – Algorithms – Computer-based instrumentation – Real-time Data Acquisition and Control – Software integration – Man-Machine Interface – Vision system – Mechatronics system case studies.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) W. Bolton (2008), Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, 4th Edition, Prentice Hall. ISBN: 978-0-273-74286-9.

Reference Books:

i) Devdas Shetty and Richard A. Kolk (2012), Mechatronics System Design, 2nd Edition, C. L. Engineering, ISBN: 978-8-131-51828-1.

ii) Michael B. Histand and David G. Alciatore (2005), Introduction to Mechatronics and Measurement systems, McGraw- Hill. ISBN: 978-0-070-64814-2

iii) B.P. Singh (2006), Advanced Microprocessor and Microcontrollers, New Age International Publisher.ISBN: 978-8-122-41956-6.

iv) A. Smaili and F. Mrad (2008), Mechatronics: Integrated Technologies for Intelligent Machines, 1st Edition, Oxford University Press. ISBN: 978-0-198-06016-1.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Introduction to Electric and Hybrid Vehicles</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Basics of Automobile Engineering</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know the structure, operation and applications of the concepts of Hybrid electric vehicles.
ii) Understand the working principle of Electric Vehicle motors
iii) Learn about the control in Electric Vehicles.
iv) Know about the Hybrid Vehicles.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to:
i) Describe about working principle of electric vehicles.
ii) Explain the construction and working principle of various motors used in electric vehicles.
iii) Understand about working principle of electronics and sensor less control in electric vehicles
iv) Describe the different types and working principle of hybrid vehicles.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to Electric Vehicles</td></tr>
<tr><td colspan="7">Electric Vehicle – Need - Types – Cost and Emissions – End of life. Electric Vehicle Technology – layouts, cables, components, Controls. Batteries – overview and its types. Battery plug-in and life. Ultra-capacitor, Charging – Methods and Standards. Alternate charging sources – Wireless & Solar</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Electric Vehicle Motors</td></tr>
<tr><td colspan="7">Motors (DC, Induction, BLDC) – Types, Principle, Construction, Control. Electric Drive Trains (EDT) – Series HEDT (Electrical Coupling) – Power Rating Design, Peak Power Source (PPS); Parallel HEDT (Mechanical Coupling) – Torque Coupling and Speed Coupling. Switched Reluctance Motors (SRM) Drives – Basic structure, Drive Convertor, Design.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Electronics and Sensor-less control in EV</td></tr>
<tr><td colspan="7">Basic Electronics Devices – Diodes, Thyristors, BJTs, MOSFETs, IGBTs, Convertors, Inverters. Safety – Risks and Guidance, Precautions, High Voltage safety, Hazard management. Sensors - Autonomous EV cars, Self Drive Cars.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Hybrid Vehicles</td></tr>
<tr><td colspan="7">Hybrid Electric vehicles – Classification – Micro, Mild, Full, Plug-in, EV. Layout and Architecture – Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System – Analysis and its Types, Controls.</td></tr>
</table>

12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://elearning.sgtuniversity.ac.in/
13. Books Recommended
Text Books:
ii) 1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
Reference Books:
iii) Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
ii) James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

Department Electives-VI

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Sensors & Actuators**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**NIL**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	Tutorials = 0	Practical = 0

8. Course Description

One of the key elements in the implementation of mechatronic systems is the integration of computational intelligence with sensing (measurement of environmental conditions) and actuation (affecting the surrounding environment through a controlled response). In this course, students are introduced to advanced concepts in sensing and actuation for mechatronic systems, including both traditional sensors and actuators an introduction to advanced topics in micro electromechanical system (MEMS) sensing, and smart materials.

9. Learning objectives:

i) To develop understanding of different sensors and their applications.
ii) To develop understanding of mathematical analysis of sensors
iii) To develop understanding of different types of actuating devises and their suitability.
iv) To understand the design of various sensors and actuators.

10. Course Outcomes (COs):

i) Ability to identify and analyze various sensing system, their classification and characteristics.
ii) Capability to carryout mathematical analysis of various sensors, like piezoelectric sensors and strain gauge.
iii) Ability to understand the suitability and applications of different types of actuators.
iv) Propensity to identify, model and design of various sensing and actuation devices.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Introduction

Sensors - Basic requirements of sensors, Classification of sensors, Static and Dynamic characteristics of sensors, Displacement Sensors- Linear and Rotary displacement sensors-Potentiometer, Capacitive and Inductive type displacement sensor- position sensors- Optical encoder.

Unit – 2	Number of lectures = 10	Title of the unit: Types of sensors

Eddy current proximity sensor, Inductive Proximity sensor, Capacitive Proximity sensor, Pneumatic Proximity sensors, Contact and Noncontact type – Strain Gauge – Diaphragm Pressure Sensor- Capsule Pressure sensors- Bellows Pressure Sensor Bourdon tube pressure sensor, Piezoelectric Sensor, Tactile sensor.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Types of sensors cont..**
Pyroelectric sensors, Ultrasonic sensor, Resistive sensor, Orifice plate, flow nozzle, Electromagnetic flow meter. Thermocouples, Thermistors, Thermo-diodes, Thermotransistors, Bimetallic Strip, Resistance Temperature Detector, Infrared Thermography. Vibrometer and accelerometer- seismic accelerometer. Photo-resistors, Photodiodes, Phototransistors, Photo-conductors.		
Unit – 4	**Number of lectures = 11**	**Title of the Unit: Actuators**
Actuators: Actuation principle, shape memory effects-one way, two way and pseudo elasticity. Types of micro actuators- Electrostatic, Magnetic, Fluidic, Inverse piezo effect, stepper motor.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Clarence W. de Silva, Sensors and Actuators: Control System Instrumentation, CRC Press 2007, ISBN-13: 978-1420044836.

Reference Books

i) Histand, M. B. & Alciatore, D. G., Introduction to Mechatronics & Measurement Systems, McGraw-Hill, 2003.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Design of Thermal System</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Thermodynamics, Heat Transfer & Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 00</td></tr>
<tr><td colspan="7">8. Brief Syllabus

The design of thermal systems requires an integrated approach that treats thermodynamics, fluid mechanics, and heat transfer as parts of one interconnected area, in which appropriate solutions to real-life design and analysis problems can be obtained only when all these aspects are considered simultaneously (after familiarity with these three topics is achieved in previous dedicated courses.) This approach must be implemented through open-ended problems and design project oriented teaching. Topics related to thermal systems include fluid flow networks, heat exchanger design, design and selection of pumps, fans and compressors, heat recovery systems, psychometrics, air-conditioning systems, electronic cooling systems, fuels and combustion, solar thermal systems, and power plant design. This course is specifically designed to allay the fear of ill-defined problems by teaching the skills to model and translate a physical situation into the relevant equations. The use of equation-solving software facilitates the implementation of this focus by reducing the effort involved in solving equations and affording the opportunity for more discourse on the approach toward modeling of thermal systems. The students will learn the effect of individual component design on overall systems through parametric optimization studies. Topics common to the design of all thermal systems will be taught briefly in an interactive lecture format, but the main emphasis will be on open-ended design problems to be formulated and solved in discussion format. The course will begin with the development of skills for the modeling and parametric investigation of individual thermal system components. As proficiency is gained in these exercises, the students will develop the capability to design overall thermal systems in projects of larger scope. The methodology of translating a problem statement into design tasks and executing them will be illustrated. The understanding of thermal component and system design will be encouraged by requiring the students to view the “solution” to the problem as the beginning rather than the end of a design. Discussion of the effects of changes in design conditions (flow rates, inlet temperatures, etc.) and component geometry (diameter, length, other features) on performance will be emphasized.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To learn overall design requirement and methodology of a thermal system.
ii) To learn tools and techniques of analysis of a thermal system.
iii) How to do modeling of a thermal system.</td></tr>
</table>

iv) To techniques of economic analysis of thermal system and how to do optimization of a thermal system.		
10. Course Outcomes (COs): **i)** Students should be able to have knowledge of different aspects of designing of a thermal system. **ii)** Students should be able to identify and examine a design problem associated to a thermal system, **iii)** Students should be able to understand basics of modeling and their associated techniques, **iv)** Students should be able to explain economic aspect of designing and able to apply different techniques of optimization applicable to thermal system.		
11. Unit wise detailed content		
Unit-1	**Number of lectures = 10**	**Title of the unit: Fundamentals of Design**
Requirement of engineering design, Other similar terms: Analysis, Synthesis, Selection and Optimization. Characteristics of a thermal system, types and analysis. Formulation of the Design Problem, Conceptual Design, Steps in the Design Process, Computer-Aided Design, Material Selection		
Unit – 2	**Number of lectures = 11**	**Title of the unit: Modelling**
Modelling Basics: Importance of Modelling in Design, basic features of modelling, Types of Models-Analogue, Mathematical, Physical and Numerical. Mathematical modelling – general procedure, final model and validation. Modelling Techniques: Physical modelling and dimensional analysis, Curve fitting – exact and best fit. Synthesis of Different Design Steps – Initial design, Design strategies- commonly used design approach and Iterative design procedure.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Economic considerations**
Economic Considerations: Calculation of interest- simple, compound, continuous compounding and effective. Worth of money as function of time. Types of payments. Bonds and stocks, Taxes and depreciations. Cost comparison and rate of return. Application to thermal system.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Optimization**
Optimization- Introduction: Need of optimization, Basic concepts- Objective function, constraints, mathematical formulation for optimization. Methods of Optimization: Calculus method, Search method and Geometrical programming Practical aspect of Optimal design – choice of variables, sensitivity analysis, dependence on objective function, multi-objective optimization.		
12. Brief Description of self-learning / E-learning component		

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended:

Text Books

i)	Jaluria, Yogesh. Design and optimization of thermal systems. CRC press, 2007.Stoecker, W.F. Design of Thermal Systems, McGraw-Hill, New York. ISBN-13: 978-0849337536.
ii)	Dieter, G.E., Engineering Design: A Materials and Processing Approach, McGraw-Hill, 2008. ISBN-13: 978-0071263412.

Reference Books

i)	Janna, William S. Design of Fluid Thermal Systems-SI Version. Cengage learning, 2010. ISBN-13: 978-1305076075.
ii)	Rieder, W.G. and Busby, H.R. Introductory Engineering Modelling Emphasizing differential Models and Computer Simulation, Wiley, 1986. ISBN-13: 978-0471895374.
iii)	Collier, Courtland A., and William Burl Ledbetter. Engineering economic and cost analysis. Harpercollins College Division, 1988. ISBN-13: 978-0060413330.
iv)	Fox, R.L. Optimization Methods for Engineering Design, Addison-Wesley, 1971. ISBN-13: 978-0201020786.
v)	Rao, Singiresu S., and S. S. Rao. Engineering optimization: theory and practice. John Wiley & Sons, 2009. ISBN: 978-1-119-45479-3.

1. Name of the Department- Mechanical Engineering

2. Course Name	**Non-Conventional Machining**	**L**	**T**	**P**
3. Course Code		**3**	**0**	**0**

4. Type of Course (use tick mark)	**Core ()**	**PE (✓)**	**OE ()**	**Specialization ()**

5. Pre-requisite (if any)	**Manufacturing Process and Technology**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Course Description

This course is designed to understand advance manufacturing process within the Mechanical Engineering curriculum. Students will explore advance manufacturing process over conventional manufacturing process known as non-conventional manufacturing. The nonconventional manufacturing is designed to prepare interested students for future careers manufacturing industry where non-conventional machines are used.

9. Learning objectives: Students undergoing this course are expected to**:**

- **i)** To compare traditional and non-traditional machining process and recognize the need for Non-traditional machining process.
- **ii)** To Learn the numerical control and thermal energy in non-conventional Machining process.
- **iii)** To understand the role of process parameters in metal removal rate.
- **iv)** Learning about different types of non-conventional machining process and advance machines.

10. Course Outcomes (COs): On course completion students will be able to:

- **i)** To understand the need of Non-Traditional Machining Processes and able to Classify various processes.
- **ii)** To recognize the CNC and thermal energy based nontraditional machining processes.
- **iii)** To apply the knowledge of process parameters to calculate the performance of non-traditional machining processes.
- **iv)** To understand the concept of machining the hard material using chemical energy and electrochemical energy.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Non-Conventional machining methods and Mechanical energy-based process**

Non-Conventional Machining Methods: Classification of non-traditional machining methods, their comparative study with traditional machines, economic considerations, applications and limitations.

Principle, process parameter and classifications of AJM, determination and evaluation of MRR and applications and limitations.

Unit – 2	Number of lectures = 12	Title of the unit: Numerical control and Thermal based Process

Concepts and types, position and motion control constructional features of NC machines CNC and DNC. Ultrasonic Machining, Principle, applications and process parameters, purpose of slurry selection, analysis of process parameters. Plasma Arc Machining: Principles and applications.

Electron Beam Machining Principle, advantages and limitations.

Unit – 3	Number of lectures = 10	Title of the unit: Electrical energy Based Process

Electric Discharge Machining, Principle and applications, mechanism of metal removal, basic EDM circuits, evaluation of metal removal, calculation of metal removal rate and optimization of MRR, selection of tool material and dielectrics

Unit – 4	Number of lectures = 10	Title of the unit: Electro chemical energy-based process

Principle and classification of ECM, Chemical machining and electro chemical machining, etchants maskant, techniques of applying maskant, process parameters, surface finish and MRR applications principles of ECM Equipment, surface roughness. Determination and evaluation of MRR, Electrochemistry of ECM, selection of electrolytes and analysis of ECM, Electro Chemical Grinding.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) El-Hofy, H. A. (2005), "Advanced Machining Processes: Nontraditional and Hybrid Machining Processes" United Kingdom: McGraw-Hill Education, ISBN: 9780071466943, 0071466940.

Reference Books:

i) Pandey, P. C., Shan, H. S. (1980), "Modern Machining Processes", India: McGraw-Hill, ISBN: 9780070965539, 0070965536

ii) Paulo Davim J. (2013), "Nontraditional Machining Processes: Research Advances", Netherlands: Springer London, ISBN: 9781447151791, 1447151798

iii) Mishra, P. K. (2007), “Nonconventional Machining”, India: Narosa Publishing House, ISBN: 9788173191923, 8173191921

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mechanism & Manipulator Design</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course includes basically kinematics of Robots consists of DH notations & parameters, links, pairs, chains. It covers synthesis of Robot. It consists Actuation and transmission systems and dynamics of robot.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The course aims to study different types of mechanism.
ii) To understand the basics of manipulator.
iii) To understand the Kinematics of Robots.
iv) To understand the motion planning of the robot.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Understand the links, pairs and chains.
ii) Understand the different mechanisms uses in machines.
iii) Understand the anatomy of manipulators.
iv) Understand the basic design and dynamics of manipulators.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Mechanism Design</td></tr>
<tr><td colspan="7">Kinematics and Dynamics, Mechanisms and Machines, Plane and Space Mechanisms, Kinematic Pairs, Kinematic Chains, Kinematic Diagrams, Kinematic Inversion, Mobility and range of movement.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Mechanism Synthesis</td></tr>
<tr><td colspan="7">Dimensional synthesis of mechanism; motion, path and function generation, precision point approach, Chebyshev spacing, Three position synthesis, graphical approach for four link mechanisms, Advanced synthesis solutions, branch and order defects, Analytical methods, straight line mechanisms</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Manipulator Kinematics</td></tr>
<tr><td colspan="7">Classification, Actuation and transmission systems, Homogeneous Coordinate transformations, DH notations, Inverse and forward kinematics, Rigid body dynamics, Manipulator dynamics by Newtonian and Lagrangian approach.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Motion planning and control</td></tr>
</table>

Joint and Cartesian space trajectory planning and generation, Classical control concepts using the example of control of a single link, Independent joint PID control, Control of a multi-link manipulator, Non-linear model based control schemes, Simulation and experimental case studies on serial and parallel manipulators, Control of constrained manipulators, Cartesian control, Force control and hybrid position/force control, Advanced topics in non-linear control of manipulators.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) A. Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.

ii) Robotics and Control by R K Mittal and I J Nagrath, Mcgraw Hill,2003, ISBN: 9780070482937

Reference Books

i) Richard D. Klafter, Thomas A. Chmielewski and Michael Negin, (2010), Robotic Engineering an Integrated Approach, 1st Edition, Prentice-hall of India. ISBN: 978-8-120-30842-8.

ii) S. R. Deb and Sankha Deb (2009), Robotics Technology and Flexible Automation, 2nd Edition, Tata McGraw-Hill Edu-cation. ISBN: 978-0-070-07791-1.

iii) Robert Joseph Schilling (2007), Fundamentals of Robotics: Analysis and Control, Prentice Hall India. ISBN: 978-8-120-31047-6.

iv) John J. Craig (2008), Introduction to Robotics: Mechanics and Control, 3rd Edition, Pearson Education. ISBN: 978-8-131-71836-0.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Engine Design**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**NIL**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course develops competence in IC Engine Systems and Systems Modeling, and is oriented to graduate students who are interested in designing, testing, analyzing, or controlling next generation IC engine systems.

9. Learning objectives:

i) To make students familiar with the design and operating characteristics of modern internal combustion engines.

ii) To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines.

iii) To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emission.

iv) To introduce students to the environmental and fuel economy challenges facing the internal combustion engine.

10. Course Outcomes (COs): The curriculum of the Department is designed to satisfy the diverse needs of students.

i) Differentiate among different internal combustion engine designs.

ii) Recognize and understand reasons for differences among operating characteristics of different engine types and designs

iii) Learn to compare and contrast experimental results with theoretical trends, and to attribute observed discrepancies to either measurement error or modelling limitations.

iv) Develop an ability to optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions)

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**
Design procedure of theoretical analysis, design considerations, material selection & actual design of components - cylinder block deign, cylinder head design, piston & piston pin design, piston ring design, connecting rod design, crankshaft design, flywheel design, design of valve mechanism		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Fundamentals of Engine Modelling & Design Parameters**
Governing equations, Equilibrium charts of combustion chemistry, Chemical reaction rates, Approaches of modeling, Model building and integration methods. Gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves. Engine balancing, firing order, longitudinal forces, transverse forces, pitching moments, yawing moments, Engine layout, major critical speed & minor critical speed, design of engine mounting, design of cooling system, design principles of exhaust & inlet system		

Unit – 3	Number of lectures = 11	Title of the unit: Thermodynamic Combustion Models of Engines
Single zone models, premixed and diffusive combustion models, combustion heat release using Wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two-zone model, applications of heat release analysis. for drawing die.		
Unit – 4	**Number of lectures = 11**	**Title of the Unit: Mathematical Models of SI Engines**
Simulation of Otto cycle at full throttle, part throttle and supercharged conditions, progressive combustion, Autoignition Modeling, single zone models, multi-zone models and mass burning rate estimation, SI engine with stratified charge. Friction in pumping, in piston assembly, bearings and valve train etc. Friction estimation for warm and the warm-up engines.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book:		
i) William Harry Crouse- Engine Design, Tata McGraw Publication, Delhi, 2017, ISBN: 9780070634350		
Reference Books:		
i) Internal Combustion Engine Modeling, J.I. Ramos, Hemisphere Publishing Corporation, 1989.		
ii) Modeling Engine Spray and Combustion Processes, G. Stiesch, Springer Verlag, 2003, ISBN: 9783662087909		
iii) Giles J. G.- Engine Design, Lliffe Book Ltd., London, Latest Edition, ASIN: B0000COABL		
iv) William Harry Crouse- Engine Design, Tata McGraw Publication, Delhi, 2017, ISBN: 9780070634350		
v) Internal Combustion Engine Fundamentals, John B Heywood, McGraw-Hill, 1988, ISBN: 007028637X		

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Battery Management System</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Introduction to Electric and Hybrid Vehicles</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.</td></tr>
<tr><td colspan="7">9. Learning objectives: The objective of this course is to
i) Identify the requirements of Battery Management System
ii) Introduce learner to batteries, its parameters and modelling.
iii) Introduce learner to batteries charging requirements
iv) The course will help learner to develop battery management algorithms for batteries.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to
i) Interpret the role of battery management system
ii) Interpret the concept associated with battery charging / discharging process
iii) Calculate the various parameters of battery and battery pack
iv) Design the model of battery pack</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction</td></tr>
<tr><td colspan="7">Introduction to Battery Management System, Cells & Batteries, Nominal voltage and capacity, C rate, Energy and power, Cells connected in series, Cells connected in parallel, Electrochemical and lithium-ion cells, Rechargeable cell, Charging and Discharging Process, Overcharge and Undercharge, Modes of Charging.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Battery Management System Requirement</td></tr>
<tr><td colspan="7">Introduction and BMS functionality, Battery pack topology, BMS Functionality, Voltage Sensing, Temperature Sensing, Current Sensing, BMS Functionality, High-voltage contactor control, Isolation sensing, Thermal control, Protection, Communication Interface, Range estimation, State-of charge estimation, Cell total energy and cell total power.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Battery State of Charge and State of Health Estimation, Cell Balancing</td></tr>
<tr><td colspan="7">Battery state of charge estimation (SOC), voltage-based methods to estimate SOC, Model-based state estimation, Battery Health Estimation, Lithium-ion aging: Negative electrode, Lithium ion aging: Positive electrode, Cell Balancing, Causes of imbalance, Circuits for balancing</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Design of battery BMS</td></tr>
<tr><td colspan="7">Design principles of battery BMS, Effect of distance, load, and force on battery life and BMS, energy balancing with multi-battery system</td></tr>
</table>

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Ibrahim Dinçer, Halil S. Hamut and Nader Javani, "Thermal Management of Electric Vehicle Battery Systems", JohnWiley& Sons Ltd., 2016

Reference Books

i) James Larminie, John Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd, 2003

ii) Chris Mi, Abul Masrur& David Wenzhong Gao, "Hybrid electric Vehicle- Principles & Applications with Practical Properties", Wiley, 2011.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Fluid Mechanics and Machines Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">4</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>Engg. Maths & Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td colspan="2">Tutorials = 00</td><td colspan="3">Practical = 56</td></tr>
</table>

8. Course Description:

Fluid mechanics and machinery is a branch of continuum mechanics that deals with the behavior of fluids (gases or liquids) either in motion or at rest and the subsequent effects of fluids upon boundaries, which may be either solid surfaces or interfaces with other fluids. This course deals fluids and their properties, and the kinematics and dynamics of fluid flow. After that student learn the fundamentals of flow through pipes, turbulent flow, dimensional analysis and boundary layers and their applications in engineering.

9. Learning Objectives:

- **i)** Understand fluid behavior for engineering design and control of fluid systems.
- **ii)** Develop competence with mass, energy and momentum balances.
- **iii)** Study the development of boundary layers and model similitude.
- **iv)** Study about various turbines and pumps designed on above concepts

10. Course Outcomes (Cos):

- **i)** Understand the fundamental models for analyzing a fluid flow and fluid at rest both.
- **ii)** Find the dependent and independent parameters for a fluid flow.
- **iii)** Explain various methods available for boundary layer separation and analyze the model and prototype.
- **iv)** Understand the working principles of turbines and pumps

11. Lab component

Sr. No.	**Title**	**CO covered**
1	Conducting experiments to verify Bernoulli's theorem.	i)
2	Determination of the Coefficient of discharge and coefficient of velocity for the given Orifice meter.	i), iii)
3	Determination of the Coefficient of discharge of given Venturi-meter.	i), iii)
4	Determination of the Coefficient of discharge of given of Notch (V and Rectangular types)	iii)
5	Comparative study of head loss in pipes connected series and parallel.	ii)
6	Study of fluid flow types using Reynolds apparatus.	ii)
8	To determine the coefficient of impact for vanes.	iv)
10	To determine the meta-centric height of a floating body.	i)
11	To study the constructional details of a Pelton turbine and draw its fluid flow circuit.	iv)

12	To draw the following performance characteristics of Pelton turbine-constant head, constant speed and constant efficiency curves.	iv)
13	To study the constructional details of a Francis turbine and draw its fluid flow circuit.	iv)
14	To draw the constant head, constant speed and constant efficiency performance characteristics of Francis turbine.	iv)
15	To study the construction details of a Kaplan turbine and draw its fluid flow circuit.	iv)
16	To draw the constant head, speed and efficiency curves for a Kaplan turbine.	iv)
17	To study the constructional details of a Centrifugal Pump and Reciprocating Pump.	iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Kinematics of Machines Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>+2 Level Physics</td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Brief Syllabus

The analysis of a machine requires the determination of the movement or kinematics of its component parts, known as kinematic analysis. The assumption that the system is an assembly of rigid components allows rotational and translational movement to be modelled mathematically. This allows the position, velocity and acceleration of all points in a component to determine from these properties for a reference point and the angular position, angular velocity and angular acceleration of the component. Students learn Basics of Mechanisms, kinematic analysis of simple mechanisms, synthesis of simple mechanisms, kinematics of CAMS and kinematics of gears and gear trains.

9. Learning objectives:

i) To familiarize students with basic types of mechanisms, joints and degrees of freedom to perform position, velocity and acceleration analysis using graphical and analytical methods.
ii) To provide students an understanding of different types of mechanisms.
iii) To teach the basics of synthesis of simple mechanisms.
iv) To teach students the kinematic analysis of cam-follower motion and gears.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

i) Demonstrate an understanding of the concepts of various mechanisms and pairs.
ii) Conduct velocity and acceleration analysis of simple mechanisms.
iii) Synthesize simple mechanisms for function, path generation and body guidance.
iv) Design a layout of cam for specified motion and demonstrate an understanding of principles of operation of gears. Also, demonstrate an understanding of various drives.

11. Lab Component

Sr. No.	**Title**	**COs covered**
1	To study various types of Kinematic links, pairs, chains and Mechanisms.	i)
2	To study inversions of 4 Bar Mechanisms, Single and double slider crank mechanisms.	i)
3	To plot slider displacement, velocity and acceleration against crank rotation for a single slider crank mechanism.	ii)
4	To find coefficient of friction between belt and pulley.	iv)
5	To study various types of cam and follower arrangements.	iv)

6	To plot follower displacement vs cam rotation for various Cam Follower systems.	iv)
7	To generate spur gear involute a tooth profile using a simulated gear shaping process.	iv)
8	To study various types of gears – Helical, cross helical worm, bevel gear.	iv)
9	To study various types of gear trains – simple, compound, reverted, epicyclic and differential	iv)
10	To plot slider displacement, velocity and acceleration against crank rotation for different mechanisms using the software.	i), ii)
11	To study nomenclature of cam and plotting the cam profile.	iv)

Department Electives-V Lab

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Robotics Engineering and Applications Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite	**NA**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 0	**Tutorials = 0**	**Practical = 28**

8. Course Description:

Introduction to Robotics, Components, Types and classification, control, sensing, static and dynamic properties. Grippers, types, mechanisms for actuation & design. Industrial robots' specifications. Selection based on the Application. Kinematics: Direct and Inverse Kinematics for industrial robots. Differential Kinematics for planar serial robots. Trajectory planning: Introduction Cartesian space scheme, adaptive control, and Servo system for robot control. Programming of Robots and Vision System.

9. Learning Objectives:

- **i)** To familiarize the students with the concepts and techniques in robotic engineering and control, manipulator kinematics & dynamics, application and selection of robotic system for various industrial scenarios.
- **ii)** Make the students acquainted with the theoretical aspects of Robotics
- **iii)** Enable the students to acquire practical experience in the field of Robotics through case studies.
- **iv)** Make the students understand the importance of robots in various fields of engineering and expose them to various robots and their operational details.

10. Course Outcomes (COs): At the end of this course, the learner will be:

- **i)** Understand the basic components of robots.
- **ii)** Differentiate types of robots and robot grippers.
- **iii)** Analyze forces in links and joints of a robot.
- **iv)** Programme a robot to perform tasks in industrial applications.

11. Lab Component

Sr. No.	**Title**	**COs covered**
1	Study of robotic arm and its configuration	i), ii), iv)
2	Study the robotic end effectors	i), ii), iv)
3	Study of different types of hydraulic and pneumatic valves	ii)
4	Robot programming and simulation for pick and place	ii), iv)
5	Robot programming and simulation for Shape identification	i), iv)

6	Robot programming and simulation for machining (cutting, welding)	i), iv)
7	Robot programming and simulation for writing practice	i), iv)
8	Robot programming and simulation for any industrial process (Packaging, Assembly).	i), iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td colspan="2">Solar and Nuclear Power Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td colspan="2"></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="3">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td colspan="2">5. Pre-requisite (if any)</td><td>Engineering Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures =0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Brief Syllabus

The combination of continual nuclear power with solar energy stored in the salts allows the reactor to generate super-heated steam to run electricity even at night. Studies predict solar-nuclear hybrid power plants to be far more efficient in power generation compared to nuclear or solar power plants alone. Solar energy systems include collectors to convert solar radiation to heat in a fluid, energy storage units which are designed to accumulate energy when it is available and deliver it when needed, means to deliver the energy from the storage to a load, and necessary pumps, controls, etc. On the other hand Nuclear Power Engineering concentrates on the principles, techniques and processes involved in generation of power from nuclear fuels. This involves studying and exploring various aspects of science ranging from processing of nuclear fuel to merits and demerits of various nuclear reactors and from reprocessing of nuclear waste to their safely disposal. Upon completion of this course students will be able to have better understanding of nuclear processes involved in nuclear power generation, know working and pros & cons of various reactors and also have understanding of nuclear power generation and safety rules implemented during power generation from nuclear fuels and nuclear waste disposal.

9. Learning Objectives: The student will be exposed to the basic physics of solar energy system

- **i)** The student will be exposed to the basic physics of solar energy system.
- **ii)** The student will be exposed to the basic physics of applications of solar based energy equipment.

- **iii)** The student will be exposed to the basic physics of nuclear reactions and operation of nuclear reactors.
- **iv)** To learn various types of Nuclear power generation methods, safety and its impact on environment.

10. Course Outcomes (COs): On completion of this course, the student will be able to:

- **i)** Know the fundamentals of solar energy systems operations.
- **ii)** Aware to the concept of solar thermal and photovoltaic operating systems.
- **iii)** Know the nuclear fission and fusion processes.
- **iv)** Understand the working of nuclear reactors and understand power generation and safety aspects.

11. Lab Components

Sr. No.	Title	COs Covered
1	Understand the working of nuclear reactors and understand power generation and safety aspects.	i), ii)
2	Determination of parameters of Flat Plate Collector – Thermo siphon Mode	ii), iii)
3	Determination of parameters of Flat Plate Collector for different mass flow rate	ii),
4	Determination of parameters of Flat Plate Collector for different radiation	ii), i)
5	To illustrate the determination of trace impurities by neutron activation.	ii), iv)
6	To determine the critical mass of an unknown configuration of fuel and reflector elements by performing a critical experiment on the Ford Nuclear Reactor.	ii), iv)
7	To study the operation, calibration, and uses of scintillation counters in gamma ray spectroscopy	iv)
8	To impart an understanding and an appreciation of the problems of reactor startup, operation at power level, and shutdown.	iv)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Rapid Manufacturing Technologies Lab**	**L**		**T**		**P**	
3. Course Code		**0**		**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**	**BSC ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			

8. Brief Syllabus:

The syllabus includes importance of rapid additive manufacturing in advance manufacturing process and technology used in Rapid manufacturing. Data formats to acquire knowledge, techniques and skills to select relevant additive and rapid manufacturing process. It also includes case studies to explore the potential of rapid manufacturing in different industrial sectors.

9. Learning objectives: Students undergoing this course are expected to**:**

- **i)** To know the Principles of Rapid Manufacturing Processes.
- **ii)** To understand with various methods of Rapid Manufacturing Technologies.
- **iii)** To familiarize with the characteristics of various materials used in Additive Manufacturing.
- **iv)** To Understand possibilities and limitations of Additive Manufacturing Technologies.

10. Course Outcomes (COs): After the completion of the course, the student shall be able:

- **i)** To Describe the applications of Rapid manufacturing Technologies.
- **ii)** To select suitable method for Rapid Manufacturing.
- **iii)** To select suitable material for Rapid Manufacturing.
- **iv)** To apply the reverse engineering using Additive Manufacturing Technology.

11. Lab Components

Sr. No.	**Title**	**CO covered**
1	To perform the experiment with methods involved in Rapid Manufacturing Processes	i), ii)
2	To perform the experiment with methods involved in Customization and Mass Customization manufacturing.	i), ii)
3	To perform the experiment with methods involved in Process Chain for Additive manufacturing.	i), ii)
4	To perform the experiment with methods involved in hatching pattern	i), ii)

5	To perform the experiment with methods involved in Diagnosis of STL file Error.	i), ii)
6	To perform the experiment with methods involved in Part orientation, Generation/Design of Support in manufacturing	i), ii)
7	To perform the experiment with methods involved in material jetting based manufacturing	i), ii), iii)
8	To perform the experiment with methods involved in powder bed fusion-based manufacturing	i), ii), iii)
9	To perform the experiment with methods involved in Vat photo polymerization	i), ii), iii)
10	To perform the experiment with methods involved in case study of rapid manufacturing	i), ii), iii)
11	To perform the experiment with methods involved in rapid manufacturing in subtractive case	iii), iv)
12	To perform the experiment with methods involved rapid manufacturing in additives case	iii), iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Design for Manufacture & Assembly Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Design for Mechanical Elements**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

The Design for Manufacturing and assembly is challenging subject that includes design principles for manufacturability and Influencing factors on Design. To learn about the machining, casting and environmental consideration while design. The aim of present course is to introduce and aware students about the basic design process with general design principles which based on different aspects of manufacturing as well assembly.

9. Learning objectives:

- **i)** To study various factors influencing the manufacturability of components.
- **ii)** To impart knowledge about factors that influence changes in product design.
- **iii)** To study applications of various casting, forging and welding processes
- **iv)** To study life cycle assessment of the product.

10. Course Outcomes (COs):

- **i)** Get to know about various internal and external characteristic of material affecting design.
- **ii)** To know general design principles for manufacturability.
- **iii)** Introduction of basic design process based on different aspects of different manufacturing processes like machining, drilling etc.
- **iv)** Student will have idea about various phases in the life of a product.

11. Lab Component

Sr. No.	Title	COs covered
1	To study different types of **Factors Influencing Design**	i), ii)
2	To study the working principle, Material, Manufacture for welding process	i), ii)
3	To study the working principle, Material, Manufacture for forging process	i), ii)
4	To study and design features to facilitate drills	i), ii)
5	To study and design features to facilitate milling cutters	ii), iii), iv)
6	To study and design for machinability	ii), iii), iv)
7	To study the Computer Applications for DFMA	ii), iii), iv)
8	To study the Identification of uneconomical design	ii), iii), iv)
9	To study the redesign of castings based on parting line considerations	ii), iii), iv)
10	To study the Global issues, Regional and local issues, Basic DFE methods	iii), iv)

11	To study and Design for recyclability	iii), iv)
12	To study and Design for energy efficiency, Design to regulations and standards.	iii), iv)

<table>
<tr><td colspan="9">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Advanced Automotive Electronics Lab</td><td>L</td><td colspan="2">T</td><td colspan="4">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="4">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td colspan="3">BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Fluid Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td colspan="3">Every Sem ()</td></tr>
<tr><td colspan="9">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="6">Practical = 28</td></tr>
<tr><td colspan="9">8. Course Description</td></tr>
<tr><td colspan="9">To provide broad based understanding of the electronics function and its technological significance, syllabus includes the types of sensors, safety systems. To learn about fuel injection system, antilock brakes function and also learn about function used in dash board of car.</td></tr>
<tr><td colspan="9">9. Learning objectives:
i) To understand the concepts of Automotive Electronics and its evolution and trends, Automotive systems & subsystems overview.
ii) To understand sensors and sensor monitoring mechanisms aligned to automotive systems, different signal conditioning techniques, interfacing techniques and actuator mechanisms.
iii) To understand, design and model various automotive control systems using Model based development technique.
iv) To understand role of Microcontrollers in ECU design and choice of appropriate Hardware and Software.</td></tr>
<tr><td colspan="9">10. Course Outcomes (COs): On course completion students will be able to:
i) Develop, simulate and integrate control algorithms for ECUs with hardware
ii) Interface automotive sensors and actuators with microcontrollers.
iii) Obtain an overview of automotive components, subsystems, design cycles, communication protocols and safety systems employed in today’s automotive industry.
iv) Describe various communication systems, wired and wireless protocols used in vehicle networking.</td></tr>
<tr><td colspan="9">11. Lab Component</td></tr>
</table>

Sr. No.	Title	CO covered
1	Study of different types of sensors used in automobile.	i), ii)
2	Study of electronic control module.	i), ii)
3	Study of electronic fuel injection system and multipoint fuel injection system.	i), ii), iii)
4	Study of carburetor system.	i), iii)

5	Study of antilock braking system.	i), iii), iv)
6	Study of battery and their types which are used in automobile.	i), ii), iii)
7	Study of different types of warning system used in automobile.	i), ii), iii)
8	Study about car dashboard amenities.	i), iii), iv)
9	Study about comfort & safety in a car.	i), iv)
10	Study of various technology used in a car dashboard.	i), iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mechatronics Systems and Its Applications Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Applied Physics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Mechatronics is a design process that includes a combination of mechanical engineering, electrical engineering, control engineering and computer engineering. Mechatronics is a multidisciplinary field of engineering, that is to say, it rejects splitting engineering into separate disciplines. Originally, mechatronics just included the combination of mechanics and electronics, hence the word is a combination of mechanics and electronics; however, as technical systems have become more and more complex the word has been “updated” during recent years to include more technical areas.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To introduce integrated approach to the design of complex engineering systems.
ii) To provide knowledge of sensors, actuators and their selection for an application.
iii) To expose interfacing of devices with controllers.
iv) To understand the Intelligent Mechatronics.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Identify the elements of mechatronics system.
ii) Select suitable sensors and actuators to meet specific requirements.
iii) Select the controllers according to the need.
iv) Demonstrate intelligent mechatronics system for engineering applications.</td></tr>
<tr><td colspan="7">11. Lab Component</td></tr>
</table>

Sr. No.	Title	COs covered
1	Assembly language programming of 8085 – Addition – Subtraction – Multiplication – Division – Sorting – Code Conversion.	i), ii), iii), iv)
2	Stepper motor interface.	i), ii), iii), iv)
3	Traffic light interface.	i), ii), iii), iv)
4	Speed control of DC motor.	i), ii), iii), iv)

5	Study of various types of transducers.	i), ii), iii), iv)
6	Study of hydraulic, pneumatic and electro-pneumatic circuits.	i), ii), iii), iv)
7	Modelling and analysis of basic hydraulic, pneumatic and electrical circuits using Software.	i), ii), iii), iv)
8	Study of PLC and its applications.	i), ii), iii), iv)
9	Study of image processing technique temperature control	i), ii), iii), iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	Introduction to Electric and Hybrid Vehicles Lab	L	T		P	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		Core ()	PE (✓)		OE ()	
5. Pre-requisite (if any)	Basics of Automobile Engineering	6. Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		Tutorials = 0	Practical = 28			

8. Course Description

This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.

9. Learning objectives:

- **i)** To know the structure, operation and applications of the concepts of Hybrid electric vehicles.
- **ii)** Understand the working principle of Electric Vehicle motors
- **iii)** Learn about the control in Electric Vehicles.
- **iv)** Know about the Hybrid Vehicles.

10. Course Outcomes (COs): On successful completion of this course, the student will be able to:

- **i)** Describe about working principle of electric vehicles.
- **ii)** Explain the construction and working principle of various motors used in electric vehicles.
- **iii)** Understand about working principle of electronics and sensor less control in electric vehicles
- **iv)** Describe the different types and working principle of hybrid vehicles.

11. Lab Content

Sr. No.	Title	CO covered
1	To Study of various components of electric car.	i)
2	To Study of wiring layout of electric vehicle.	i)
3	To study the V/f control of three-phase induction motor.	i)
4	To Study the Speed control of BLDC motor in two-wheeler.	ii)
5	To Study the Speed control of SRM motor in three-wheeler.	ii)
6	To study the Simulation of Four quadrant operation of three-phase induction motor.	ii)
7	To study the Sensor & Actuators in an Electric Vehicle.	iii)
8	To Control Circuit of induction motor.	iii)
9	To study of DC series motor in an electric vehicle.	iii)
10	To study the of charging circuit in an electric vehicle.	iv)

Department Electives-VI Lab

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Sensors & Actuators Lab</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="3">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td colspan="2">BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>NIL</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="5">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">This course deals with the basic principles on which sensors and actuators work. Different types of sensors that are used for different applications are used for practical hands-on training. Classification and characteristics of sensors and actuators are also covered so that student may easily identify and analyze various sensing system.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) Be able to determine the required sensor and actuator criteria for a mechatronic system.
ii) Understand the operation of commonly employed sensors and actuators.
iii) Be able to analyze and select the most appropriate sensors or actuator for an application.
iv) To understand the design of various sensors and actuators.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs):
i) Analyze various premises, approaches, procedures and results related to sensors and actuators.
ii) Conduct experiments and measurements in laboratory and on real components, sensors and actuators.
iii) Interpret the acquired data and measured results.
iv) Take part in team work and be able to independently present various professional materials</td></tr>
<tr><td colspan="8">11. Lab Component</td></tr>
</table>

Sr. No.	Title	COs covered
1	Closed loop temperature control	i), ii), iii), iv)
2	LVDT, encoder and tachometer interface and performance	i), ii), iii), iv)
3	Pneumatic components and closed loop system.	i), ii), iii), iv)
4	Stepper motor drive construction and closed loop linear positioning.	i), ii), iii), iv)

5	Brushless DC motor drive construction and closed loop linear positioning.	i), ii), iii), iv)
6	Shape memory alloy actuator closed loop linear positioning.	i), ii), iii), iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Design of Thermal System Lab</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="3">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="3">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Thermodynamics & Mechanical Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 0</td><td colspan="5">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">The design of thermal systems requires an integrated approach that treats thermodynamics, fluid mechanics, and heat transfer as parts of one interconnected area, in which appropriate solutions to real-life design and analysis problems can be obtained only when all these aspects are considered simultaneously (after familiarity with these three topics is achieved in previous dedicated courses.) This approach must be implemented through open-ended problems and design project-oriented teaching. Topics related to thermal systems include fluid flow networks, heat exchanger design, design and selection of pumps, fans and compressors, heat recovery systems, psychometrics, air-conditioning systems, electronic cooling systems, fuels and combustion, solar thermal systems, and power plant design. This course is specifically designed to allay the fear of ill-defined problems by teaching the skills to model and translate a physical situation into the relevant equations. The use of equation-solving software facilitates the implementation of this focus by reducing the effort involved in solving equations and affording the opportunity for more discourse on the approach toward modeling of thermal systems. The students will learn the effect of individual component design on overall systems through parametric optimization studies. Topics common to the design of all thermal systems will be taught briefly in an interactive lecture format, but the main emphasis will be on open-ended design problems to be formulated and solved in discussion format. The course will begin with the development of skills for the modeling and parametric investigation of individual thermal system components. As proficiency is gained in these exercises, the students will develop the capability to design overall thermal systems in projects of larger scope. The methodology of translating a problem statement into design tasks and executing them will be illustrated. The understanding of thermal component and system design will be encouraged by requiring the students to view the “solution” to the problem as the beginning rather than the end of a design. Discussion of the effects of changes in design conditions (flow rates, inlet temperatures, etc.) and component geometry (diameter, length, other features) on performance will be emphasized.</td></tr>
</table>

9. Learning objectives:

- **i)** To learn overall design requirement and methodology of a thermal system.
- **ii)** To learn tools and techniques of analysis of a thermal system.
- **iii)** How to do modeling of a thermal system.
- **iv)** To techniques of economic analysis of thermal system.
- **v)** How to do optimization of a thermal system.

10. Course Outcomes (COs):

- **i)** Students should be able to have knowledge of different aspects of designing of a thermal system.
- **ii)** Students should be able to identify and examine a design problem associated to a thermal system.
- **iii)** Students should be able to understand basics of modeling and their associated techniques.
- **iv)** Students should be able to explain economic aspect of designing and able to apply different techniques of optimization applicable to thermal system.
- **v)** Students should be able to explain the most optimal solution for thermal performance of such systems.

11. Lab Content

Sr. No.	Title	COs Covered
1.	2-D Thermal analysis on a rectangular plate.	i)
2.	Thermal analysis on a furnace wall consists of two layers.	i), ii)
3.	Thermal analysis on a mild steel tank which contain water.	ii), iii)
4.	Thermal analysis on wall which contain brick, foam and wood.	i), ii)
5.	Laminar pipe flow.	iii)
6.	Turbulent pipe flow.	iii), iv), v)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Non-Conventional Machining Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Fundamentals of Machining Processes**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 0**	**Practical = 28**			

8. Course Description

This course is designed to understand advance manufacturing process within the Mechanical Engineering curriculum. Students will explore advance manufacturing process over conventional manufacturing process known as non-conventional manufacturing. The nonconventional manufacturing is designed to prepare interested students for future careers manufacturing industry where non-conventional machines are used.

9. Learning objectives: Students undergoing this course are expected to**:**

i) To Acquire a functional understanding of Electrical Energy based non-traditional manufacturing equipment.
ii) To Acquire a functional understanding of Electro-Chemical Energy based non-traditional manufacturing equipment.
iii) To Acquire a functional understanding of Thermal Energy based non-traditional manufacturing equipment.
iv) To Acquire a functional understanding of Mechanical Energy based non-traditional manufacturing equipment.

10. Course Outcomes (COs): On course completion students will be able to:

i) To perform the machining operation using Electric discharge and Electron Beam machining process.
ii) To perform the machining operation using Electro-Chemical and Chemical machining process.
iii) To perform the machining operation using ultrasonic machining and laser beam machining process.
iv) To perform the machining operation using water jet and abrasive jet machining process.

11. Lab Component

Sr. No.	Title	COs covered
1	Electric Discharge Machining	i)
2	Electro-Chemical Machining	ii)
3	Laser Beam Machining	iii)

4	Electron Beam machining	i)
5	Abrasive Jet Machining	iv)
6	Water Jet Machining	iv)
7	Ultra-Sonic Machining	iii)
8	Chemical Machining	ii)
9	Abrasive Water Jet Machining	iv)
10	Photo Chemical Milling	ii)
11	Electro Jet Drilling	i)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mechanism & Manipulator Design Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course includes basically kinematics of Robots consists of DH notations & parameters, links, pairs, chains. It covers synthesis of Robot. It consists Actuation and transmission systems and dynamics of robot.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The course aims to study different types of mechanism.
ii) To understand the basics of manipulator.
iii) To understand the Kinematics of Robots.
iv) To understand the motion planning of the robot.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Understand the links, pairs and chains.
ii) Understand the different mechanisms uses in machines.
iii) Understand the anatomy of manipulators.
iv) Understand the basic design and dynamics of manipulators.</td></tr>
<tr><td colspan="7">11. Lab Component</td></tr>
</table>

Sr. No.	Title	COs covered
1	Create various types of linkage mechanism in CAD and simulate for motion outputs and study the relevant effects.	i), ii)
2	Creation of various joints like revolute, planes, spherical, cam follower and study the degree of freedom and motion patterns available.	i), ii)
3	To design a cam profile by using the requirement graph using on-line engineering handbook and verify the same using a 3D mechanism on CAD.	i), ii)
4	Simulations of Gears and Gear trains in Solidworks	i), ii)
5	Modeling and analysis of four bar mechanism and its inversions.	i), ii)
6	Modeling and analysis of single slider crank mechanism and its inversions.	i), ii)
7	Modeling and analysis of double slider crank mechanism and its inversions.	i), ii)

8	Acceleration and velocity analysis of single slider crank mechanism	i), ii)
9	Acceleration and velocity analysis of double slider crank mechanism	i), ii)
10	To study of robot anatomy.	iii), iv)
11	To study different types of robots.	iii)
12	To study Denavit- Hartenberg parameters of Robotics.	iii), iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	Engine Design Lab	L	T		P	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		Core ()	PE (✓)	OE ()	EAS ()	BSC ()
5. Pre-requisite (if any)	IC Engines	6. Frequency (use tick marks)	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		Tutorials = 0	Practical = 28			
8. Course Description						
This course develops competence in IC Engine Systems and Systems Modeling, and is oriented to graduate students who are interested in designing, testing, analyzing, or controlling next generation IC engine systems.						

9. Learning objectives:

- **i)** To make students familiar with the design and operating characteristics of modern internal combustion engines.
- **ii)** To apply analytical techniques to the engineering problems and performance analysis of internal combustion engines.
- **iii)** To study the thermodynamics, combustion, heat transfer, friction and other factors affecting engine power, efficiency and emission.
- **iv)** To introduce students to the environmental and fuel economy challenges facing the internal combustion engine.

10. Course Outcomes (COs): The curriculum of the Department is designed to satisfy the diverse needs of students.

- **i)** Differentiate among different internal combustion engine designs.
- **ii)** Recognize and understand reasons for differences among operating characteristics of different engine types and designs
- **iii)** Learn to compare and contrast experimental results with theoretical trends, and to attribute observed discrepancies to either measurement error or modelling limitations.
- **iv)** Develop an ability to optimize future engine designs for specific sets of constraints (fuel economy, performance, emissions)

11. Lab Content

Sr. No.	Title	COs covered
1	Performance test on Gasoline engine	i), iv)
2	Performance & emission test on Genset diesel engine	i), iv)
3	Performance & emission test on CNG engine	i), iv)
4	Swirl & Flow tests of ports on steady state flow-bench.	i), ii), iii)
5	Designing automobile parts and assemblies using Softwares.	i), ii), iii)
6	Stress Analysis of automobile parts and assemblies using software	i), ii), iii)
7	Manufacturing Simulation using software like DELMIA.	i), ii), iii)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Battery Management System Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**Introduction to Electric and Hybrid Vehicles**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.

9. Learning objectives: The objective of this course is to

- **i)** Identify the requirements of Battery Management System
- **ii)** Introduce learner to batteries, its parameters and modelling.
- **iii)** Introduce learner to batteries charging requirements
- **iv)** The course will help learner to develop battery management algorithms for batteries.

10. Course Outcomes (COs): On successful completion of this course, the student will be able to

- **i)** Interpret the role of battery management system
- **ii)** Interpret the concept associated with battery charging / discharging process
- **iii)** Calculate the various parameters of battery and battery pack
- **iv)** Design the model of battery pack

11. Lab Content

Sr. No.	Title	COs covered
1	To Study of different types of batteries.	i)
2	To Study Battery monitoring System for Lead acid battery.	i)
3	To study for passive cell balancing for Li-Ion battery.	i)
4	Analysis of Electric vehicle power system.	ii)
5	To Perform Short Circuit Test for traction batteries (Lead-Acid/Li-ion) as per AIS 048 standard.	ii)
6	To Perform Overcharge Test for traction batteries (Lead-Acid/Li-ion) as per AIS 048 standard.	ii)
7	To study Coulomb counting method for Lead-Acid battery and Li-ion battery.	iii)
8	To Study of different types of batteries with their characteristics & detailed specifications.	iv)

6^{th} Semester

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Heat and Mass Transfer**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		Core (✓)	PE ()		OE ()	
5. Pre-requisite (if any)	Engineering Thermodynamics	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						

An introductory course in heat and mass transfer covering conduction, convection and radiation heat transfer, principles of heat exchanger and mass transfer. Heat transfer and mass transfer are kinetic processes that may occur and be studied separately or jointly. Studying them apart is simpler, but both processes are modeled by similar mathematical equations in the case of diffusion and convection (there is no mass-transfer similarity to heat radiation), and it is thus more efficient to consider them jointly

9. Learning objectives:

i) To comprehend and evaluate various modes of heat and mass transfer
ii) To design fin enhanced systems, evaporators, condensers and heat exchangers.
iii) To understand boundary layer theory, condensation and boiling.
iv) To determine effectiveness of heat exchangers using LMTD and NTU.

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Apply basic principles of fluid mechanics, thermodynamics, heat transfer for designing heat and mass transfer systems.
ii) Model heat, mass and momentum transport systems and develop predictive correlation.
iii) Assess and evaluate various designs for heat and mass transfer and optimize the solution.
iv) Apply the basic principles of heat exchanger applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Conduction – I**
Basic concepts – conduction - convection and radiation – Laws – General equation of heat conduction – Derivation in Cartesian and cylindrical - One dimensional steady state heat conduction in simple geometries – plane wall – cylinder and sphere – Heat transfer composite walls - composite cylinders and composite spheres – Critical thickness of insulation –Thermal contact resistance – Overall heat transfer coefficient – Electrical analogy – Heat generation in plane wall - cylinder and sphere – Extended surfaces – general equations		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Conduction – II**
Two- and Three-dimensional steady state heat conduction – Analytical - Graphical and Numerical methods – Unsteady state heat conduction – Lumped parameter system – Non-dimensional numbers in conduction – Significance of Biot and Fourier numbers -Types and applications of fins – Fin efficiency and effectiveness – Fin performance.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Convection**

Boundary layer theory – Conservation equations of mass - momentum and energy for laminar flow over a flat plate – Turbulent flow over a flat plate –Internal flow through pipes – annular spaces – Analogy between momentum and heat transfer – Natural convection in vertical Dimensional analysis.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Condensation, Boiling and Radiation and Heat Exchanger**
Condensation and Boiling – Film wise and Drop wise condensation – Film condensation on a vertical plate – Regimes of Boiling –Forced convection boiling – Radiation heat transfer – Thermal radiation –Laws of radiation – Black body concept – Emissive power – Radiation shape factor – Gray bodies – Radiation shields. Heat Exchangers – Types and practical applications – Use of LMTD – Effectiveness – NTU method – Compact heat exchangers– Plate heat exchangers – Fouling factor – Heat pipes – Types and applications.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books	
i)	R. C. Sachdeva (2005), Fundamentals of Heat and Mass Transfer, New Age International (P) Ltd. ISBN: 978-8-122-40076-2.
ii)	P. K. Nag (2005), Heat Transfer, Tata McGraw Hill Publishing Company Limited. ISBN: 978-0-070-60653-1.
Reference Books:-	
i)	J. P. Holman (2005), Heat Transfer, 9th Edition, McGraw-Hill Publishing Company Limited. ISBN: 978-0-070-29618-3.
ii)	Dewitt Lavine, Bergmann and Incropera (2010), Fundamentals of Heat and Mass Transfer, 6th Edition, John Wiley & Sons, ISBN: 978-8-126-52764-9.
iii)	M. Necat Ozisik, Helcio R.B. Orlande (2021), Inverse Heat Transfer: Fundamentals and Applications, 2nd Edition, CRC Press, Taylor & Francis, ISBN 9780367820671.
iv)	Abram S. Dorfman, (2010), Conjugate Problems in Convective Heat Transfer, 1st Edition, CRC Press, Taylor & Francis, ISBN 9781138372719.
v)	S. Mostafa Ghiaasiaan, (2018), Convective Heat and Mass Transfer, 2nd Edition, CRC Press, Taylor & Francis, ISBN 9780815361411.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Dynamics of Machines</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Kinematics of Machines</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Dynamic loads and undesired oscillations increase with higher speed of machines. At the same time, industrial safety standards require better vibration reduction. This course covers parameter identification, balancing of mechanisms, torsional and bending vibrations, vibration isolation, and the dynamic behavior of drives and machine frames as complex systems. Typical dynamic effects, such as the gyroscopic effect, damping and absorption, shocks, nonlinear and self-excited vibrations are covered in dynamics of machinery. Upon completion, students should be able to analyze the effect of dynamic forces on systems and try to minimize the negative impact of such effects.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocating engines.
ii) To understand the balancing procedures for rotating and reciprocating masses, rotors and engines.
iii) To understand the fundamentals of free and forced vibrations.
iv) To understand the mechanisms for control.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Demonstrate skills to design flywheel for an IC engine and punching press with the consideration of geometrical and economical constraints.
ii) Perform static and dynamic balancing of high-speed rotary and reciprocating machines.
iii) Analyze free and forced vibrations of machines, engines and structures.
iv) Apply the concept of governors for speed control.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Dynamic Force Analysis</td></tr>
<tr><td colspan="7">D'Alembert's principle, Equivalent offset inertia force, Dynamic analysis of four bar mechanism, Dynamic Analysis of reciprocating engines, Piston effort, Crank effort, turning moment on crankshaft, Inertia of connecting rod, Inertia force in reciprocating engines (Graphical method). Turning moment diagrams, Single and multi-cylinder engines, Fluctuation of energy, Flywheels, Applications in engines and punching presses.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Balancing</td></tr>
<tr><td colspan="7">Static and Dynamic balancing of rotating masses, balancing of reciprocating masses, Balancing of locomotives, Partial balancing of reciprocating masses, Multi cylinder Inline and radial engines.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Vibration – Singh Degree of Freedom Systems</td></tr>
<tr><td colspan="7">Introduction to vibration, Terminology, Classification of vibrations, Undamped and Damped free vibration of single degree of freedom systems, Viscous damping, Introduction to coulomb damping. Forced vibration,</td></tr>
</table>

harmonic excitation, Magnification factor, Vibration isolation and Transmissibility.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Mechanism for Control**
Functions of Governors, Gravity controlled and Spring controlled governor characteristics. Stability, Hunting and Isochronisms. Effect of friction, Calculation of equilibrium speeds and ranges of speed of governors.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) S.S. Rattan (2009), "Theory of Machines", 3rd Edition, Tata McGraw-Hill. ISBN: 978-0-070-14477-4.

Reference Books

i) A.Ghosh (2009), Theory of Mechanisms and Machines, 3rd Edition, East-West Press Pvt. Ltd., New Delhi, ISBN: 978-8-185-93893-6.

ii) Thomas Bevan (2009), Theory of Machines, 3rd Edition, Pearson Education, ISBN: 978-8-131-72965-6.

iii) Kenneth J Waldron and Gary L. Kinzel (2007), Kinematics, Dynamics, and Design of Machinery, 2nd Edition, John-Wiley and Sons Inc., New York, ISBN: 978-8-126-51255-3.

iv) J. Uicker John, Gordon R. Pennock Jr. and Joseph E. Shigly (2011), Theory of Machines and Mechanisms, 4th Edition, Oxford University Press, ISBN: 978-0-199-77781-5.

Department Electives-VII

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Pneumatics & Control**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**NIL**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						

Robotics has stimulated a growing interest among a wide range of scholars, researchers and students due to its interdisciplinary characteristics. Through this course the participants will acquire the ability to conduct research, develop innovative designs in the field of systems engineering and control of robots and to direct the development of engineering solutions in new or unfamiliar environments by linking creativity, innovation and transfer of technology.

9. Learning objectives:

i) Study about use of Pneumatics in robotic control systems
ii) To understand the various Robot configurations.
iii) To study the Robot path and speed control systems.
iv) To understand the mechanical designing and control of robot through various case studies.

10. Course Outcomes (COs):

i) Able to use the concept of pneumatics in robots while having knowledge of Pneumatic systems.
ii) Optimize the robot path and apply speed and adaptive control systems.
iii) Students will acquire the ability to conduct research, develop innovative designs in the field of systems engineering and control of robots.
iv) Get a practical exposure to real life problems in robotic control.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Pneumatics**
Introduction, Air Control Valves, Pneumatic Actuators, Pneumatic Circuit Design Considerations, Basic Pneumatic Circuit: Operation of Single & Double Acting Cylinder, Air Pilot Control of Double Acting Cylinder. Pneumatic actuators and its control: case studies.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Mechanical designing of robots**
Introduction to Robotic Exoskeletons, Optimal Design of a Three Finger Exoskeleton for Rehabilitation Purpose, Differential transformation and velocity of a frame: Derivative of a frame, Velocity, Jacobian, Inverse Jacobian, Trajectory Planning: Polynomial trajectory, Biped trajectory.		

Unit – 3	**Number of lectures = 11**	**Title of the unit: Robotic control**
Lagrangian method, Robot dynamics equation, Control: Robot dynamics equation as a control system, Trajectory tracking control, PD controller, Neural network control design. Redundancy Resolution of Human Fingers using Robotic Principles, Manipulability Analysis of Human Fingers during Coordinated Object Rotation, Kinematics of Flexible Link Robots		
Unit – 4	**Number of lectures = 11**	**Title of the Unit: Case study**
Robot Assisted Needling System for Percutaneous Intervention-An Introduction, Smart Robotic Needles for Percutaneous Cancerous Interventions, Robust Force Control of a Two Finger Exoskeleton during Grasping, Neural Control of an Index Finger Exoskeleton		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Introduction to Robotics: Analysis, Control, Applications by Saeed Benjamin Niku, John Wiley & Sons, Inc. ISBN: 978-1-119-52760-2

Reference Books

i) Introduction to Robotics: Mechanics and Control by John J. Craig, Pearson Education International, ISBN 978-0201543612

ii) Richard Paul, Robot Manipulators: Mathematics, Programming and Control, MIT Press, 1981, ISBN 9780262160827

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Power Plant Engineering</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="3">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="3">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>Engineering Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td colspan="2">Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 42</td><td colspan="2">Tutorials = 0</td><td colspan="3">Practical = 0</td></tr>
</table>

8. Course Description:

Power Plant engineering course is concerned with the types, construction, working principles and performance of various conventional and non-conventional power plants. This course covers the design, construction, operations and performance of various components of steam, gas turbine, nuclear, hydra and diesel power plants. The course also focusses on various sub components of power plants, such as steam generators, condensers, cooling towers, fuel and air handling system, super-heaters, inter-coolers, re-heaters and waste handling systems; to have a proper understanding. This course also discusses the Steam power plant in detail as 60% of total energy produced in world are generated by thermal power plants. The syllabus also covers nuclear power plant in detail which is a need of current scenario.

9. Learning Objectives:

- **i)** To teach students about the working of various power generation Modules and steam cycles.
- **ii)** To introduce students to steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities of the country.
- **iii)** To enable students, understand in detail about nuclear and gas turbine power plants.
- **iv)** To enable students, understand in detail about hydro and diesel power plants which play an important role in power generation.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Understand basic power generation types and steam cycles.
- **ii)** Know about the kind of boilers being used in various industries and their applicability.
- **iii)** Solve problems related to gas turbines and Rankine cycles.
- **iv)** Distinguish between various power generation Modules and choose one that meets desired economic, environmental and social requirements.

11. Unit wise detailed content

Unit-1	Number of lectures = 10	Title of the unit: Introduction to Power Plant

Power plants-Features - Components and layouts-Working principle of Steam - Hydro - Nuclear - Gas Turbine and Diesel power plants-Selection of site-Analysis of steam cycles-Rankine cycle-Reheating and Regenerative cycles.

Unit – 2	Number of lectures = 11	Title of the unit: Steam Generators, Combustion and Firing Methods

Boiler classification-Types of Boiler-Fire tube and Water tube boilers-High pressure and Supercritical boilers-Positive circulation boilers-Fluidized bed boiler-Waste heat recovery boiler-Feed water heaters-Superheaters-Reheaters-Economizer-Condenser-Cooling tower-Feed water treatment-Air heaters.

Coal handling and preparation-Combustion equipment and firing methods-Mechanical Stokers-Pulverized coal firing systems-Cyclone Furnace-Ash handling systems-Electrostatic Precipitator-Fabric filter and Bag house-Forced draft and Induced draft fans-Chimney.

Unit – 3	Number of lectures = 10	Title of the unit: Nuclear and Gas Turbine Power Plants
Boiling water reactor-Pressurized water reactor-Pressurized Heavy Water Reactor-Gas cooled reactor-High temperature gas cooled reactor-Pebble bed reactor-Fast breeder reactor-Liquid metal fast breeder reactor-reactor materials-Radiation Shielding-Waste Disposal-Gas turbine power plant-Open and closed cycles-Intercooling - Reheating and Regenerating-Combined cycle power plant.		
Unit –4	**Number of lectures = 11**	**Title of the unit: Hydro and Diesel Power Plants**
Classification of Hydro-electric power plants and their applications-Selection of prime movers-Governing of turbine-Diesel power plant- Subsystems-Starting and stopping-Heat Balance-Supercharging of Diesel engines.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books:

i)	R. K. Rajput, (2007), A Text Book of Power Plant Engineering, Laxmi Publications (P) Ltd. 5th Edition. ISBN 13: 9788131802557

Reference Books:

i)	P. K. Nag, (2014), Power Plant Engineering: Steam and Nuclear, Tata McGraw-Hill Publishing Company Ltd., 4th EditionISBN13 9789339204044.
ii)	M.M. El- Wakil, (2010), Power Plant Technology, Tata McGraw-Hill Education, 1st Edition, ISBN 13: 9780072871029
iii)	P C Sharma (2013), Power Plant Engineering, S.K. Kataria & Sons; 2013 edition, **ISBN-13:** 978-9350143841

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Non-Destructive Evaluation and Testing**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course provides students a synopsis of non-destructive evaluation and testing methods used in evaluation of welds. This includes understanding the basic principles of various NDT methods with importance, applications and limitations.

9. Learning objectives:

- **i)** To learn non-destructive and destructive evaluation methods that are used in evaluation of welds.
- **ii)** To understand the basic principle of non-destructive testing and fundamentals.
- **iii)** To understand the inspection methods used in non-destructive testing and their limitations.
- **iv)** To explore the various factors influences the non-destructive testing performance

10. Course Outcomes (COs): On course completion Students will be able to:

- **i)** To identify different welding defects through non-destructive examination/testing.
- **ii)** To identify and use of each non-destructive testing equipment with their applications.
- **iii)** To select the specific Code, Standard, or Specification related to each testing method.
- **iv)** Have the knowledge and essential skills to identify strengths and weaknesses in materials used in fabrication.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction of Non-Destructive testing.**

Introduction to non-destructive testing, Non-destructive methods for testing weld jobs and general stages of weld inspection and testing, visual inspection, leak test, dye test, x ray test, particle inspections, fluorescent penetrate inspection, ultrasonic inspection.

Unit – 2	**Number of lectures =10**	**Title of the unit: Surface and Methods**

Liquid Penetrate Testing – Principles, types and properties of liquid penetrates developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials Magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Thermography and eddy current testing**

Thermography- Principles, Contact and non-contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation, infrared radiation and infrared detectors, Instrumentations and methods, applications.

Unit – 4	**Number of lectures = 12**	**Title of the unit: Eddy Current Testing & Radiography**

Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors. Pentameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xerox-Radiography, Computed Radiography, Computed Tomography.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Baldev Raj, T. Jayakumar, M. Thavasimuthu (2009), "Practical Non-Destructive Testing", Wood Head Publishing, ISBN: 1855736004

Reference Books

i) Ravi Prakash (2010), "Non-Destructive Testing Techniques", New Age International Private Limited; 1st edition, ISBN: 8122425887

ii) Chuck Hellier (2012), "Handbook of Non-Destructive Evaluation" Second Edition, Mc Graw Hill Education, ISBN: 0071777148.

iii) J Prasad, C G Krishnadas Nair (2007), "Non-Destructive Test and Evaluation of Materials", Mc Graw Hill Education, 2007, ISBN: 0070620849.

1. Name of the Department- Mechanical Engineering					
2. Course Name	**Advance Tribology**	**L**	**T**		**P**
3. Course Code		**3**	**0**		**0**
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Basics of Lubrication & Bearing**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	Tutorials = 0	Practical = 0

8. Course Description

This course includes basically different types of wear mechanism. It covers the properties and testing of lubricants and surface properties of target material. It deals with the different types of bearings.

9. Learning objectives: Students undergoing this course are expected to**:**

- **i)** To provide broad based understanding of the subject "Tribology" and its technological significance.
- **ii)** To make the students understand the principles of lubrication, lubrication regimes, theories of hydrodynamic and the advanced lubrication techniques.
- **iii)** To understand the principle of Hydrostatic and gas lubrication and their applications.
- **iv)** To understand the principle and applications of Elasto-hydrodynamic lubrication.

10. Course Outcomes (COs): On course completion students will be able to

- **i)** To Apply the concepts of tribology for the performance analysis and to get basic idea on consequences of wear, wear mechanisms, wear theories and analysis of wear problems.
- **ii)** To understand the theories of hydrodynamic lubrication and different factors affecting the effectiveness of hydrodynamic lubrication.
- **iii)** To apply the knowledge for finding the performance of hydrostatic and gas lubrication with the consideration of various factors.
- **iv)** To understand the theories of rolling friction in rolling elements and significance if Elasto-hydrodynamic lubrication.

11. Unit wise detailed content

Unit-1	Number of lectures = 11	Title of the unit: Introduction

Tribology, Historical background; Properties and testing of lubricants, Viscosity, Viscometry, Effect of temperature and pressure on viscosity

Surface Roughness, Friction and Wear

Surface topography, surface characterization, apparent & real area of contract, laws of friction, friction theories with criticism, frictional heating, classification of wear, mechanism of wear, laws of wear: Qualitative & quantitative, wear resistance materials.

Unit – 2	Number of lectures = 11	Title of the unit: Hydrodynamic Bearings

The generalized Reynold s equation, fundamentals of lubrication and lubrication regims, mechanism of pressure development, Plane slider bearing, Step bearing, Idealized journal bearing: infinitely long & short journal bearing; Petroff equation, oil film thickness: approx. relation, film shape, accurate expression; finite journal bearings, boundary conditions: Sommerfeld condition, Half Sommerfeld condition, Reynold s condition; load carrying capacity and attitude angle, oil flow, friction in journal bearings; Cavitation, oil whirl in journal bearings and methods of cure; bearing materials

Unit – 3	**Number of lectures = 10**	**Title of the unit: Hydrostatic Bearings**

System of hydrostatic lubrication, restrictors, circular step bearings, Rectangular thrust bearings, opposed pad bearings; multi recess journal bearings, hydrostatic lift, hybrid bearings.

Gas Lubricated Bearings
Governing equations, limiting solutions, infinitely long plane slider &journal bearings, externally pressurized gas bearings.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Elasto-hydrodynamic Lubrication & Rolling Element Bearings**

Theoretical consideration, Grubin type solution, film-thickness equation, different regimes in EHL contacts, Geometry and kinematics of ball bearings, stress & deformations, load capacity, prediction of fatigue life of ball bearings and lubrication of ball bearings.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Halling J. (1978), "Principles of Tribology", United Kingdom: Macmillan Education UK, ISBN: 9781349041381, 1349041386

Reference Books

i) Huang, P., Wen, S. (2017), "Principles of Tribology", Germany: Wiley, ISBN: 9781119214915, 1119214912

ii) Bhushan, B. (2013), "Principles and Applications of Tribology", Germany: Wiley, ISBN: 9781118403013, 1118403010

iii) Batchelor, A. W., Stachowiak, G. (2013). Engineering Tribology. United Kingdom: Elsevier Science, ISBN: 9780123977762, 0123977762

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Design of Transmission System</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Mechanical Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Transmission system is most important part of any automotive vehicle. Often transmission refers simply to the gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device. But in broad understanding transmission also refers to refers to the whole drive train, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts. In design of transmission system course, student learns to design various components of transmission such as gears, bearings, clutches, brakes, cams etc. After going through the course, students will be able to understand the design aspects of a transmission system and the materials which are used to make them.</td></tr>
<tr><td colspan="7">9. Learning Objectives:
i) To understand the various elements involved in a transmission system.
ii) To design the system based on input and output parameters.
iii) To produce working drawings of the system involving pulleys, gears, clutches and brakes.
iv) Know the applications of the various systems, materials used to make Transmission System, and methods used.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On course completion students will be able to
i) Design pulleys, chain drives, rope drives and belt drives.
ii) Determine performance requirements in the selection of commercially available transmission drives.
iii) Design Brakes and Clutches.
iv) Design various types of gear boxes.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Design of bearing and flexible power transmission systems</td></tr>
<tr><td colspan="7">Design of sliding contact bearing using Sommer field number – Design using Mckee's equation – Selection of rolling contact bearings. Design of Belts – Flat Belts and Pulleys – V Belts and Pulleys – Design of chain drives – Wire ropes.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Spur Gear</td></tr>
<tr><td colspan="7">Gear geometry – Kinematics – Forces on gear tooth – Stresses in Gear tooth – Selection of gear material based on bending stress and contact stress – Design of Spur gear – Power transmitting capacity. Computer – Aided Spur gear Design and Analysis.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Helical, Bevel and Worm Gears</td></tr>
</table>

Parallel Helical Gears – Kinematics – Tooth proportions – Force analysis – Stresses in Helical gear – Design of helical gear – Crossed Helical gears – Straight Bevel gears – Kinematics – Force analysis – Stresses in straight bevel gear tooth – Design of bevel gear – Worm gearing – Kinematics – Forces - Friction and Efficiencies – Stresses in worm gear tooth.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Motion control: clutches, brakes and cams**
Internal – Expanding Rim clutches and Brakes, External- Contracting Rim clutches and Brakes – Band type Clutches – Core clutches and Brakes – Energy considerations – Temperature rise – Friction materials.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book:		
i) P. Kanniah, 'Design of Transmission Elements', SciTech Pvt. Ltd., 2015, ISBN 978-81-8-963-8733.		
Reference Books:		
i) Joseph Edward Shigley and Charles, R. Mischke (2011), Mechanical Engineering Design, 9th Edition, McGraw –Hill International Editions, ISBN: 978-0-071-07783.		
ii) V B Bhandari, "Design of Machine Elements", TMH Publications, Fourth Edition, 2017, ISBN: 9789339221126.		
iii) Sundaraja Moorthy T.V. and Shanmugam, 'Machine Design', Nandhini Publications, 2017, Third Edition, ISBN: 8192549364		

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Plug-in Electric Vehicles in Smart Grid</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Manufacturing systems and Statistics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know the Vehicle Electrification & Impact of Charging Strategies.
ii) Understand the influence of EVs on power system.
iii) To know about the ICT Solutions to Support EV Deployment.
iv) Learn about the EV Charging Facility Planning</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to
i) Describe about vehicle electrification and impact of charging strategies
ii) Describe the influence of EVs on power system.
iii) Describe the ICT solutions to support EV deployment.
iv) Describe the EV charging and facility planning.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Vehicle Electrification & Impact of Charging Strategies</td></tr>
<tr><td colspan="7">Introduction, Impact of charging strategies, EV charging options and infrastructure, energy, economic and environmental considerations, Impact of EV charging on power grid, effect of EV charging on generation and load profile, Smart charging technologies, Impact on investment.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Influence of EVs On Power System</td></tr>
<tr><td colspan="7">Introduction, identification of EV demand, EV penetration level for different scenarios, classification based on penetration level, EV impacts on system demand: dumb charging, multiple tariff charging, smart charging, case studies.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: ICT Solutions to Support EV Deployment</td></tr>
<tr><td colspan="7">Introduction, Architecture and model for smart grid & EV, ICT players in smart grid, smart metering, information & communication models, functional and logical models, technology and solution for smart grid: interoperability, communication technologies.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: EV Charging Facility Planning</td></tr>
<tr><td colspan="7">Energy generation scheduling, different power sources, fluctuant electricity, centralized charging schemes, decentralized charging schemes, energy storage integration into Microgrid, Design of V2G Aggregator.</td></tr>
</table>

12. Brief Description of self-learning / E-learning component	
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.	
13. Books Recommended	
Text Books	
i)	SumedhaRajakaruna, FarhadShahnia and Arindam Ghosh, “Plug In Electric Vehicles in Smart Grids-Integration Techniques”, Springer Science + Business Media Singapore Pte Ltd., 2015
Reference Books	
i)	Canbing Li, Yijia Cao, YonghongKuang and Bin Zhou, “Influences of Electric Vehicles on Power System and Key Technologies of Vehicle-to-Grid”, Springer-Verlag Berlin Heidelberg, 2016
ii)	Qiuwei Wu, “GRID INTEGRATION OF ELECTRIC VEHICLES IN OPEN ELECTRICITY MARKETS”, John Wiley & Sons, Ltd, 2013.

Department Electives-VIII

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Mobile Robots</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>NIL</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamentals of robotics with an emphasis on mobile robots, which are integrated mechanical, electrical and computational systems functioning in the physical world. Topics include state-of-the-art technologies in mobile robotics, such as locomotion, sensing, communication, localization and mapping, navigation, etc. Advanced topics such as coordination of multiple mobile robots will also be discussed. The course aims to provide both theoretical and practical experience to students through lectures and hands-on experiments with real robots and simulation software.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) Demonstrate a basic understanding of the fundamental concepts and applications of mobile robotics.
ii) Demonstrate a basic understanding of the fundamental technologies in mobile robot hardware including locomotion and sensors.
iii) Demonstrate a basic understanding of mobile robot control systems including hardware and software.
iv) Demonstrate a basic understanding of mobile robot navigation, which includes localization, mapping and motion planning.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Students will be able to define mobile robots and their fundamental technologies.
ii) Develop a basic understanding of mobile robot control systems.
iii) Understand the localization of Robots.
iv) Understand basics of image processing and its use in the designing of mobile robots.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction of Mobile Robotics, Mechanics and Locomotion</td></tr>
<tr><td colspan="7">A brief history of mobile robotics, applications and market. Recent advances in the mobile robotics for RISE (Risky Intervention and Surveillance Environment) applications, Locomotion, Key issues in locomotion, legged, wheeled and aerial mobile robots. Mobile Robot Kinematics: Introduction, kinematic models and constrains, mobile robot workspace, beyond basic kinematics, motion control (kinematic control).</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Perception, robotics Architectures and Robot Learning</td></tr>
</table>

Sensors Classification, sensor characterization, wheel/motor encoders, heading/orientation sensors, ground based beacons, active ranging, motion/speed sensors, vision based sensors. Low level control, Control architectures, software frameworks, Robot Learning, case studies of learning robots.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Mobile Robot Localization**
Introduction, the challenge of localization: Noise and aliasing, to localize or not to localize: localization-based navigation versus programmed solutions, map representation, probabilistic map, map based localization, autonomous map building. Planning and navigation: Planning and reaction, obstacle avoidance, D* algorithm, Navigation architecture, case studies.		
Unit – 4	**Number of lectures = 11**	**Title of the Unit: Introduction to image processing**
Introduction to computer vision, Image processing: Point operators, Linear Filters, More neighborhood operators, Fourier transforms, Pyramids and wavelets, Geometric transformations. Camera Systems in Machine: Camera Technology, History in Brief, Machine Vision versus closed Circuit Television (CCTV), Sensor Technologies, spatial Differentiation: 1D and 2D, CCD Technology, Full Frame Principle, Frame Transfer Principle, Interline Transfer, Interlaced Scan Interline Transfer, Frame Readout.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Embedded Robotics: Mobile Robot Design and Applications with Embedded Systems. T. Braunl. Springer-Verlag 2003.

Reference Books

i) Roland Siegwart & Illah R. Nourbakhsh, “Introduction to autonomous mobile robots”, Prentice Hall of India, 2004.

ii) George A. Bekey “Autonomous Robots” MIT Press.

iii) Howie Choset, Kevin M. Lynch, Seth Hutchinson, George A. Kantor, Wolfram Burgard, Lydia E. Kavrakiand Sebastian Thrun, "Principles of Robot motion: Theory, Algorithm and Implementations", MIT Press.

<table>
<tr><td colspan="7">1. Name of the Department: Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Computational Fluid Dynamics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>Fluid Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 42</td><td colspan="2">Tutorials = 0</td><td colspan="2">Practical = 00</td></tr>
</table>

8. Course Description:

Computational Fluid Dynamics is one of the fast-evolving fields engineering which takes essential concepts from continuum mechanics, numerical analysis, computer programming and data structures and applies to almost all engineering problems where fluid flow occurs. This course enables a thorough understanding of the basics of CFD like the governing equations, meshing issues, heat transfer applications and the method of finite differences.

9. Course Objectives:

- **i)** To understand the mathematical basis and evolution of the governing equations of fluid flow and heat transfer.
- **ii)** To solve one and two-dimensional partial differential equations using traditional CFD tools.
- **iii)** To learn meshing methods and intricacies and techniques of discretization.
- **iv)** To apply the various finite differencing schemes to CFD problems.

10. Course Outcomes (COs): At the end of this course, the learner will be:

- **i)** Use the knowledge of CFD techniques, basic aspects of discretization and grid generation.
- **ii)** Solve fluid flow fields using CFD methods.
- **iii)** Model fluid flow problems and heat transfer.
- **iv)** Able to verify the different finite schemes to CFD approach.

11. Unit wise detailed content

Unit-1	Number of lectures = 11	Title of the unit: Introduction and Governing Equations

Introduction - Impact and applications of CFD in diverse fields - Governing equations of fluid dynamics – Continuity – Momentum and energy - Generic integral form for governing equations - Initial and Boundary conditions - Classification of partial differential equations – Hyperbolic - Parabolic - Elliptic and Mixed types - Applications and relevance.

Unit - 2	Number of lectures = 10	Title of the unit: Discretization

Basic aspects of discretization - Discretization techniques – Finite difference - Finite volume and Finite Element Method– Comparison of discretization by the three methods - Introduction to Finite differences - Difference equations - Uniform and non-uniform grids - Numerical errors - Grid independence test - Optimum step size.

Unit - 3	Number of lectures = 10	Title of the unit: Grid Generation and Transformation

Grid generation – Transformation of non-uniform grids to uniform grids - General transformation of the equations - Form of the governing equations suitable for CFD - Compressed grids - Boundary fitted co-ordinate systems – Elliptic grid generation -Adaptive grids - Modern developments in grid generation.

Unit - 4	Number of lectures = 11	Title of the unit: Numerical Heat Transfer
Steady one-dimensional, two and three-dimensional conduction - Steady one-dimensional convection and diffusion – Transient one-dimensional and two-dimensional conduction – Explicit - Implicit - Crank-Nicolson - ADI scheme – Stability criterion. Discretization of convection - Diffusion – Central difference, upwind, hybrid and power law schemes - Representation of the pressure - Gradient term and continuity equation – Staggered grid.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book	
i)	J.D. Anderson, Jr., (2012), Computational Fluid Dynamics – The basics with applications, McGraw-Hill, ISBN: 978-1-259-02596-9.
References Books	
i)	John D. Ramshaw (2011), Elements of Computational Fluid Dynamics, Imperial College Press. ISBN: 978-1-848-16695-0.
ii)	Oleg Zikanov (2010), Essential Computational Fluid Dynamics, John Wiley & Sons. ISBN: 978-0-470-42329-5.
iii)	Valter Bruno Reis e Silva João Cardoso (2020), Computational Fluid Dynamics Applied to Waste-to-Energy Processes: A Hands-On Approach, Butterworth-Heinemann Inc, ISBN-13: 978-0128175408.

1. Name of the Department- Mechanical Engineering

2. Course Name	**Press Tools & Dies**	**L**	**T**		**P**		
3. Course Code		**3**	**0**		**0**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**	
5. Pre-requisite (if any)	**Manufacturing Processes and Technology**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Course Description

Press tools and dies subject is designed to acquire theoretical and practical knowledge of different types of tools and dies used in manufacturing processes.

9. Learning objectives: Students undergoing this course are expected to**:**

i) To understand the fundamentals of press working, to be familiar with the various press working operations and machines.
ii) To understand and compare different types of Die construction.
iii) To understand the construction and operating principle of forging dies.
iv) To understand the principles of jigs and fixtures design, locating principles, locating elements and clamping Devices.

10. Course Outcomes (COs): On course completion students will be able to

i) To explain the various press working and press tool accessories.
ii) To demonstrate the various bending, forming and other miscellaneous press working operations.
iii) To apply the concepts by considering various factors in forging die design.
iv) To select and design suitable jigs and fixtures for press working operations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Press Tool Design**

Introduction, Press operations – Blanking, piercing, Fine Blanking, Notching, Perforating, Trimming, Shaving, Slitting, Lancing, Nibbling, Bending, Drawing, Squeezing. Press working equipment – Classification, Rating of a press, Press working Terminology, Working of a cutting die, Types of dies – Simple dies, Inverted dies, Compound dies, Combination dies, Progressive dies, Transfer dies, Multiple dies. Principle of metal cutting, strip layout, clearance, angular clearance, clearance after considering elastic recovery, cutting forces, method of reducing cutting forces, Die block, die block thickness, Die opening, Fastening of die block, back up plate, Punch, Methods of holding punches, Strippers. Stoppers, Stock stop, Stock guide, Knock outs, Pilots. Blanking & Piercing die design-single & progressive dies.

Unit – 2	**Number of lectures = 11**	**Title of the unit: Bending, Forming and Drawing Dies**

Bending methods – Bending Terminology, V – Bending, Air bending, bottoming Dies, Wiping dies, spring back & its prevention, channel dies. Design Principles- Bend radius, Bend allowance, Spanking, width of die opening, Bending pressure.
Forming Dies – Introduction, Types – solid form dies, pad type form dies, curling Dies, Embossing dies, coining dies, Bulging dies, Assembly dies.
Drawing Dies – Introduction, Difference between blending, forming & drawing, Metal flow during drawing, Design, Design consideration – Radius of draw die, Punch Radius, Draw clearance, Drawing speed, Calculating blank size, Number of draws, Drawing pressure, Blank holding pressure.

Unit – 3	Number of lectures = 10	Title of the unit: Forging Die Design
Introduction, Classification of forging dies, Single impression dies, Multiple Impression dies, Forging design factors – Draft, fillet & Corner radius, parting line, shrinkage & die wear, mismatch, finish allowances, webs & ribs Preliminary forging operation- fullering, edging, bending, drawing, flattering, blacking finishing, cutoff. Die design for machine forging – determination of stock size in closed & open die forging. Tools for flash trimming & hole piercing, materials & manufacture of forging dies.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Design of Jigs & Fixtures**
Introduction, locating & clamping – principle of location, principle of pin location, locating devices, radial or angular location, V –location, bush location design principle for location purpose, principle for clamping purposes, clamping devices, design principles common to jigs & fixtures. Drilling Jigs: Design principles, drill bushes, design principles for drill bushings, Types of drilling jigs – Template jig, plate type jig, open type jig, swinging leaf jig, Box type jig, channel type jig. Jig feet. Milling Fixtures: Essential features of milling fixtures, Milling machine vice, Design principles for milling fixtures, Indexing jig & fixtures, Automatic clamping devices.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Venkataraman, K. (2015), "Design of Jigs, Fixtures and Press Tools", United Kingdom: Wiley, ISBN: 9781119155676, 1119155673

Reference Books

i) Boljanovic, V. (2004), "Sheet Metal Forming Processes and Die Design", United States: Industrial Press, ISBN: 9780831131821, 0831131829

ii) Joshi P.H. (1998), "Jigs and Fixtures", India: Tata McGraw-Hill Education, ISBN: 9780070680739, 0070680736

iii) John G. Nee (2010), "Fundamentals of Tool Design", United States: Society of Manufacturing Engineers, ISBN: 9780872638679, 0872638677

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Finite Element Analysis**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite	**Mechanics, Strength of Materials & Engineering Maths**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)		
Lectures = 42	**Tutorials = 00**	**Practical = 00**

8. Course Description:

The finite element analysis (FEA) is among one of the most powerful tools for the numeric solution of wide range of engineering problems. The application ranges from deformation and stress analysis of civil and mechanical structures, automotive components, aircraft designs, heat flux analysis, fluid flow problems, electrical magnetic flux problem. Upon completion, students should be able to solve the problems in solid mechanics and heat transfer using FEA.

9. Learning Objectives:

- **i)** To enable the students, understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis.
- **ii)** To understand the process of creating finite elements.
- **iii)** To develop finite element equations for simple and complex domains.
- **iv)** To familiarize students with variety of problem-solving techniques used in various domains.

10. Course Outcomes (COs):

- **i)** Will be introduced to the concepts of Mathematical Modeling of Engineering Problems.
- **ii)** Will get to know various Discretization techniques.
- **iii)** Will appreciate the use of FEM to a range of Engineering Problems.
- **iv)** Will learn different problem-solving techniques applied in different situations.

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Introduction**

Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

Unit - 2	**Number of lectures = 10**	**Title of the unit: Discretization of the problem**

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes. Fourth Order Beam Equation –Transverse deflections and Natural frequencies of beams.

Unit - 3	**Number of lectures = 09**	**Title of the unit: FEM Analysis**

Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements. Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

Unit - 4	**Number of lectures = 12**	**Title of the unit: FEM problems**

Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software. Current trends in Finite element analysis applied to various industrial applications.

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Reddy. J.N., "An Introduction to the Finite Element Method", 3rd Edition, Tata McGraw-Hill, 2005, ISBN 13: 9780070607415.

Reference Books

i) Seshu, P, "Text Book of Finite Element Analysis", Prentice-Hall of India Pvt. Ltd., New Delhi, 2007, ISBN-10: 8120323157.

ii) Robert D. Cook, David S. Malkus, Michael E. Plesha, Robert J. Witt, "Concepts and Applications of Finite Element Analysis", 4th Edition, Wiley Student Edition, 2002, ISBN-13: 978-0471356059.

iii) Chandrupatla & Belagundu, "Introduction to Finite Elements in Engineering", 3rd Edition, Prentice Hall College Div, 4th Edition, 2015, ISBN-10: 9332551820.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Vehicle Body Dynamics</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td></td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Graphics and Design</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Vehicle body dynamics is a very important part of automobile field, In this course we have study about types of car body details, safety features, vehicle aerodynamics, about the drag force, different types of bus body details and commercial vehicle body.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To make students familiar with the vehicle body parameters and different types of car body.
ii) Students can understand the vehicle aerodynamics.
iii) Students can learn the objective of car speed.
iv) Student can learn the safety measures of vehicle body</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Understand the principles of Vehicle Body Dynamics
ii) Analyze the dynamics of road vehicles.
iii) Familiar with the terminology of road vehicle dynamics, stability and handling.
iv) Know the detailing of the Bus Body.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Car Body Details</td></tr>
<tr><td colspan="7">Types: Saloon, Convertibles, Limousine, Estate van, racing and sports car. Visibility: regulations, driver's visibility, test for visibility, Methods of improving visibility and space in cars. Safety: safety design, safety equipments for car. Car body construction.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Vehicle Aerodynamics</td></tr>
<tr><td colspan="7">Objectives, Vehicle drag and types, various types of forces and moments, Effects of forces and moments, side wind effects on forces and moments, various body optimization techniques for minimum drag. Wind tunnel testing: Flow visualization techniques, scale model testing. Component balance to measure forces and moments.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Bus Body Details</td></tr>
<tr><td colspan="7">Types, mini bus, single decker, double decker, two level, split level and articulated bus. Bus Body Lay Out: Floor height, engine location, entrance and exit location, seating dimensions. Constructional details: Frame construction, Double skin construction- Types of metal section used-Regulations-Conventional and Integral type construction.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Commercial Vehicle Details</td></tr>
</table>

Types of body, Flat platform, drop side, fixed side, tipper body, tanker body. Light commercial vehicle body types, Dimensions of driver's seat in relation to controls, driver's cabin design. Body Materials, Trim and Mechanism: Steel sheet, timber, plastics, GRP, properties of materials-Corrosion anticorrosion methods, escalation of paint and painting process, body trim items. Body mechanisms.
12. Brief Description of self-learning / E-learning component
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book:
i) Thomas D.Gillespie, Vehicle body dynamics, SAE International (15 February 1992), ISBN-10 : 1560911999.
Reference Books:
i) Powloski. J. Vehicle Body Engineering
ii) Massimo Guiggiani , The Science of Vehicle Dynamics, ISBN-10: 9401785325, Springer Nature (22 January 2014)
iii) Giles. J.C., Body Construction and Design

1. Name of the Department- Mechanical Engineering						
2. Course Name	**MEMS & Micro-Systems**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Mechatronics Systems and Its Applications**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.						
9. Learning objectives: **i)** To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices **ii)** To educate on the rudiments of Micro fabrication techniques. **iii)** To introduce the working principle of Sensors and Actuators. **iv)** To introduce various sensors & actuators their applications.						
10. Course Outcomes (COs): **i)** Know the basic concepts of MEMS structures under different modes of operation and characteristics. **ii)** Understand the fundamentals on solving the problem based on MEMS structure. **iii)** Gain the expertise on fundamentals of MEMS design and operation. **iv)** Understand the design concepts of MEMS sensors and actuator for practical applications						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Basics of MEMS & Introduction**				
Intrinsic Characteristics of MEMS – Energy Domains and Transducers- Sensors and Actuators – Introduction to Micro fabrication – Silicon based MEMS processes – New Materials						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Reactor Materials, Reprocessing**				
Review of Electrical and Mechanical concepts in MEMS – Semiconductor devices – Stress and strain analysis – Flexural beam bending- Torsional deflection.						
Unit – 3	**Number of lectures = 11**	**Title of the unit: Sensors and Actuators-I**				

Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Sensors and Actuators-II**
Piezo Resistive sensors – Piezoresistive sensor materials – Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Chang Liu, 'Foundations of MEMS', Pearson Education Inc., 2012.

Reference Books

i) Nadim Maluf,“ An Introduction to Micro Electro Mechanical System Design”, Artech House, 2000.

ii) Mohamed Gad-el-Hak, editor, “ The MEMS Handbook”, CRC press Baco Raton, 2001.

iii) James J.Allen, Micro Electro Mechanical System Design, CRC Press Publisher, 2005

iv) Thomas M.Adams and Richard A.Layton, “Introduction MEMS, Fabrication and Application,” Springer, 2010.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>EV Charging Infrastructure Technology</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Introduction to Electric and Hybrid Vehicle</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know the Battery Parameters for better performance.
ii) Understand the EV charging concept.
iii) Learn about the Batteries used in EV.
iv) Understand the infrastructure of Charging stations of EV.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to
i) Elaborate various technical parameters of batteries.
ii) Distinguish between various types of batteries used for EV applications.
iii) Develop battery charger for an EV
iv) Develop and Design the Charging Infrastructure.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Battery parameters</td></tr>
<tr><td colspan="7">Cell and battery voltages, Charge (or Amphour) capacity, Energy stored, Energy density, Specific power, Amphour (or charge) efficiency, Energy efficiency, Self-discharge rates, Battery geometry, Battery temperature, heating and cooling needs, Battery life and number of deep cycles.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: EV Charging</td></tr>
<tr><td colspan="7">Battery Chargers: Charge equalization, Conductive (Basic charger circuits, Microprocessor based charger circuit. Arrangement of an off-board conductive charger, Standard power levels of conductive chargers, Inductive (Principle of inductive charging, Soft-switching power converter for inductive charging), Battery indication methods.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: EV Batteries</td></tr>
<tr><td colspan="7">Lead Acid Batteries- Lead acid battery basics, Special characteristics of lead acid batteries, Battery life and maintenance, Battery charging, Summary Nickel-based Batteries Introduction, Nickel cadmium, Nickel metal hydride batteries
Sodium, Lithium and Metal air batteries - Sodium-based Batteries Introduction, Sodium sulphur batteries, Sodium metal chloride (Zebra) batteries Lithium Batteries Introduction, The lithium polymer battery, The lithium-ion battery Metal Air Batteries Introduction, The aluminum air battery, The zinc air battery.</td></tr>
</table>

Unit – 4	Number of lectures = 8	Title of the unit: Charging Infrastructure
Domestic Charging Infrastructure, Public Charging Infrastructure, Normal Charging Station, Occasional Charging Station, Fast Charging Station, Battery Swapping Station, Move-and-charge zone.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E- Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

http://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

iv)	Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
v)	C.C Chan, K.T Chau: Modern Electric Vehicle Technology, Oxford University Press Inc., New York 2001.

Reference Books

v)	Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
vi)	James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003.

1. Name of the Department- Mechanical Engineering				
2. Course Name	**Heat and Mass Transfer Laboratory**	**L**	**T**	**P**
3. Course Code		**0**	**0**	**2**
4. Type of Course (use tick mark)		Core (✓)	PE ()	OE ()
5. Pre-requisite (if any)	**Engineering Thermodynamics**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)				
Lectures =0	**Tutorials = 0**	**Practical = 28**		
8. Course Description				

An introductory course in heat and mass transfer covering conduction, convection and radiation heat transfer, principles of heat exchanger and mass transfer. Heat transfer and mass transfer are kinetic processes that may occur and be studied separately or jointly. Studying them apart is simpler, but both processes are modeled by similar mathematical equations in the case of diffusion and convection (there is no mass-transfer similarity to heat radiation), and it is thus more efficient to consider them jointly

9. Learning Objectives:

i) To comprehend and evaluate various modes of heat and mass transfer.
ii) To design fin enhanced systems, evaporators, condensers and heat exchangers.
iii) To understand boundary layer theory, condensation and boiling.
iv) To determine effectiveness of heat exchangers using LMTD and NTU.

10. Course Outcomes (COs): On completion of this course, the student will be able to:

i) Apply basic principles of fluid mechanics, thermodynamics, heat transfer for designing heat and mass transfer systems.
ii) Model heat, mass and momentum transport systems and develop predictive correlation.
iii) Assess and evaluate various designs for heat and mass transfer and optimize the solution.
iv) Apply the basic principles of heat exchanger applications.

11. Lab Content

Sr. No.	**Title**	**COs Covered**
1	To calculate thermal conductivity of insulating material in the form of slab.	i), ii)
2	To calculate total thermal resistance and thermal conductivity of composite wall.	ii), iii)
3	To calculate the thermal conductivity of insulating powder.	ii), iv)

4	To calculate the thermal conductivity of given liquid (glycerin).	ii), i)
5	To calculate the average heat transfer co-efficient of vertical cylinder under natural convection.	ii), iii)
6	To calculate surface heat transfer coefficient for a pipe by forced convection and compare heat transfer coefficient for different air flow rates and heat flow rates.	ii)
7	To calculate the heat transfer coefficient experimentally and theoretically for free and forced convection and compare the theoretical temperature distribution with experimentally obtained distribution.	ii)
8	To study the Boiling Heat Transfer phenomenon for pool boiling of water.	ii)
9	To conduct test on a heat pipe and compare the temperature distribution and rate of heat transfer with geometrically similar copper and stainless-steel tubes.	i), ii)
10	To determine the value of Stefan-Boltzmann constant for radiation heat transfer.	i), ii)
11	To measure the property of emissivity of the test plate surface at various temperatures.	ii)
12	To study and compare temperature distribution, heat transfer rate, overall heat transfers co-efficient in parallel flow and counter flow heat-exchanger.	ii), iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Dynamics of Machines Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td colspan="2">Core (✓)</td><td colspan="2">PE ()</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Kinematics of Machines</td><td colspan="2">6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Brief Syllabus

Dynamic loads and undesired oscillations increase with higher speed of machines. At the same time, industrial safety standards require better vibration reduction. This course covers parameter identification, balancing of mechanisms, torsional and bending vibrations, vibration isolation, and the dynamic behavior of drives and machine frames as complex systems. Typical dynamic effects, such as the gyroscopic effect, damping and absorption, shocks, nonlinear and self-excited vibrations are covered in dynamics of machinery. Upon completion, students should be able to analyze the effect of dynamic forces on systems and try to minimize the negative impact of such effects.

9. Learning objectives:

i) To understand the concepts of turning moment diagrams, flywheel design and the dynamics of reciprocating engines.
ii) To understand the balancing procedures for rotating and reciprocating masses, rotors and engines.
iii) To understand the fundamentals of free and forced vibrations.
iv) To understand the mechanisms for control.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

i) Demonstrate skills to design flywheel for an IC engine and punching press with the consideration of geometrical and economical constraints.
ii) Perform static and dynamic balancing of high-speed rotary and reciprocating machines.
iii) Analyze free and forced vibrations of machines, engines and structures.
iv) Apply the concept of governors for speed control.

11. Lab Component

Sr. No.	Title	COs covered
1	To determine the Moment of Inertia of Flywheel.	i)
2	Comparative study of static and dynamic balancing in rotors.	ii)
3	To determine natural frequency of longitudinal vibration in spring mass system.	iii)
4	Determination of torsional frequency of a single rotor system.	iii)
5	To determine the frequency of undamped free vibration of an equivalent spring mass system.	iii)
6	To determine the radius of gyration ‘k’ of the given compound pendulum.	iii)
7	To find out critical speed and to compare the whirling speed of a shaft.	iii)
8	To study TRI –FILAR / BI-FILAR System.	iii)
9	To perform experiment on Proell governor to determine performance characteristic curves, and to find stability & sensitivity.	iv)
10	To perform experiment on Hartnell governor to determine performance characteristic curves, and to find stability & sensitivity.	iv)
11	To determine gyroscopic couple on motorized gyroscope.	iv)

12	To perform experiment on Watt and Porter governors to determine performance characteristic curves, and to find stability & sensitivity.	iv)

Department Electives-VII Lab

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Pneumatics & Control Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**NIL**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

Introduction to Pneumatic circuits, basic principles, components, accessories, basic circuit design via a practical hand on training approach. Self-paced collaborative lab projects will complement the weekly lectures of Robotic control. Whereas the lectures emphasize the underlying math and algorithms of each sub-discipline of robotics, the projects will emphasize the pragmatic facets of implementing robotic and mechatronic devices.

9. Learning objectives:

- **i)** To learn the basic principles of Pneumatics.
- **ii)** To be able to design a Pneumatic circuit for a specified problem at hand.
- **iii)** To present an overview of robotics in practice and research with topics including vision, motion planning, control mechanisms etc.
- **iv)** To understand the various Robot configurations.

10. Course Outcomes (COs):

- **i)** Design an appropriate pneumatic circuit for a given application.
- **ii)** Visualize how a pneumatic circuit will work to accomplish the function.
- **iii)** The labs give students an education that go well beyond robotics into fields like control, embedded systems, programming, signal processing, interfacing, and electronics
- **iv)** Able to differentiate between the configuration and identify the actual application of Robot.

11. Lab Component

Sr. No.	**Title**	**COs covered**
1	To demonstrate the motion of a single acting cylinder and double acting cylinder.	i), ii)
2	To perform AND & OR logic for forward stroke of a double acting cylinder using two manual controls.	i), ii)
3	To perform single and multi-cycle operation of a double acting cylinder using roller lever valve and memory valve.	i), ii)
4	Using feedback control, make a marker that is attached to a robot to follow a trajectory	iii), iv)
5	Find a way around a known map from an unknown start position to an unknown end position without touching any obstacle	iii), iv)
6	Build a robot arm with a pneumatic gripper that can perform inverse kinematics.	i), ii), iii)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Power Plant Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>Engineering Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="2">Practical = 28</td></tr>
</table>

8. Course Description:

Power Plant engineering course is concerned with the types, construction, working principles and performance of various conventional and non-conventional power plants. This course covers the design, construction, operations and performance of various components of steam, gas turbine, nuclear, hydra and diesel power plants. The course also focusses on various sub components of power plants, such as steam generators, condensers, cooling towers, fuel and air handling system, super-heaters, inter-coolers, re-heaters and waste handling systems; to have a proper understanding. This course also discusses the Steam power plant in detail as 60% of total energy produced in world are generated by thermal power plants. The syllabus also covers nuclear power plant in detail which is a need of current scenario.

9. Learning Objectives:

- **i)** To teach students about the working of various power generation Modules and steam cycles.
- **ii)** To introduce students to steam generators, combustion and firing methods in order to make the fullest use of thermal power potentialities of the country.
- **iii)** To enable students, understand in detail about nuclear and gas turbine power plants.
- **iv)** To enable students, understand in detail about hydro and diesel power plants which play an important role in power generation.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Understand basic power generation types and steam cycles.
- **ii)** Know about the kind of boilers being used in various industries and their applicability.
- **iii)** Solve problems related to gas turbines and Rankine cycles.
- **iv)** Distinguish between various power generation Modules and choose one that meets desired economic, environmental and social requirements.

11. Lab Content

Sr. No.	**Title**	**COs covered**
1	To study of modern steam power plant.	i)
2	To Study about the Various Types of Fuel & Ash Handling Systems.	i)
3	To study about different types of dust collectors and pulverized fuel burners.	i)
4	To study about nuclear power plant.	i)
5	To study of different types of steam turbines.	i), iii)
6	To study about different types of condensers and cooling towers.	i), ii), iii)
7	To study about economics of power generation systems.	iv)

8	To study of gas power plant.	iii)
9	To study of combined steam & gas turbine power plant.	iii)
10	Testing of diesel fired water tube boiler-based steam power plant.	ii)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Non-Destructive Evaluation and Testing Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**Specialization ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 12 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 24**			

8. Course Description

This course provides students a synopsis of non-destructive evaluation and testing methods used in evaluation of welds. This includes understanding the basic principles of various NDT methods with importance, applications and limitations.

9. Learning objectives:

i) To learn the use of non-destructive examination of welding defects.
ii) To understand the various inspection methods for non-destructive evaluation.
iii) To understand the use of thermography in the non-destructive testing.
iv) To understand the use of radiography in the non-destructive testing.

10. Course Outcomes (COs): On course completion Students will be able to:

i) Identify the types of equipment used for each Non-Destructive evaluation and testing
ii) Check different metals and alloys by visual inspection method.
iii) Explain and perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test.
iv) X-ray and Gamma ray radiography, Leak Test, Eddy current test and Identify defects by using relevant NDT methods.

11. Lab Content

Sr. No.	Title	COs covered
1	Dye penetration inspection	ii), iii)
2	Eddy current testing	i), iv)
3	Magnetic particle inspection	i), iii)
4	Ultra-sonic testing (Acoustic resonance technology)	i), iii)
5	Visual inspection	i), ii)
6	Electromagnetic testing	i), iii)

7	Magnetic Flux Leakage testing	i), iii)
8	Infra-red and Thermal Testing	i), iii)
9	LASER testing	i), iii)
10	Scanning electron Microscopy	i), iv),
11	X-ray Diffraction testing	i), iv)
12	Transmission Electron Microscopy	i), iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Advance Tribology Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Fluid Mechanics**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

To provide broad based understanding of the subject "Tribology" and its technological significance, syllabus includes the genesis of friction, the theories/laws of sliding and rolling friction and the effect of viscosity. To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems and to get knowledge about different bearing materials.

9. Learning objectives: Students undergoing this course are expected to**:**

- **i)** To understand the fundamentals of tribology and associated parameters.
- **ii)** To expose the students to the factors influencing the selection of bearing materials for different sliding applications.
- **iii)** To analyze the performance characteristics of hydrodynamic journal bearing.
- **iv)** To understand the theories/laws of sliding and rolling friction and the effect of viscosity.

10. Course Outcomes (COs): On course completion students will be able to:

- **i)** To apply concepts of tribology for the performance analysis and design of components experiencing relative motion.
- **ii)** To analyze the requirements and design hydrodynamic journal and plane slider bearings for a given application.
- **iii)** To perform tests in order to find the factors affecting the fluid film thickness in hydrodynamic lubrication.
- **iv)** To understand the nature of engineering surfaces, their topography and friction characteristics and their effects.

11. Lab Content

Sr. No.	Title	COs covered
1	To perform experiment on the journal bearing test rig for the measurement of Pressure and Temperature distribution in the fluid film of hydrodynamic journal bearings at different loads and speeds. To analyze the real time results obtained through data acquisition system for predicting the performance characteristics of bearing.	i), ii)

2	To perform experiment on the journal bearing test rig for investigating the fluid film thickness of hydrodynamic journal bearings at different loads and speeds. To analyze the real time results obtained through data acquisition system for predicting the performance characteristics of bearing.	i), iii)
3	To measure the frictional torque in hydrodynamic journal bearings at different loads and speeds on journal bearing test rig. To analyze the real time results obtained through data acquisition system for predicting the performance of bearing.	i), iii)
4	To determine wear preventive (WP) and extreme pressure (EP) behavior of lubricants on four ball tester and to measure viscosity of lubricants with the help of viscometer. To analyze the real time results obtained through data acquisition system for predicting behavior of lubricants.	i), iv)
5	To determine the friction and wear characteristics in sliding contacts under various normal loads and speeds on wear and friction monitor. To analyze the real time results obtained through data acquisition system for predicting tribological characteristics.	ii), iv)
6	The modeling and analysis hydrodynamic/hydrostatic bearings using software (ARMD).	ii), iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Design of Transmission Systems Lab</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="3">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td colspan="2">BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Mechanical Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="5">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Transmission system is most important part of any automotive vehicle. Often transmission refers simply to the gearbox that uses gears and gear trains to provide speed and torque conversions from a rotating power source to another device. But in broad understanding transmission also refers to refers to the whole drive train, including clutch, gearbox, prop shaft (for rear-wheel drive), differential, and final drive shafts. In design of transmission system course, student learns to design various components of transmission such as gears, bearings, clutches, brakes, cams etc. After going through the course, students will be able to understand the design aspects of a transmission system and the materials which are used to make them.</td></tr>
<tr><td colspan="8">9. Learning Objectives:
i) To understand the various elements involved in a transmission system.
ii) To design the system based on input and output parameters.
iii) To produce working drawings of the system involving pulleys, gears, clutches and brakes.
iv) To Know the applications of the various systems, materials used to make Transmission System, and methods used.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On course completion students will be able to
i) Design pulleys, chain drives, rope drives and belt drives.
ii) Determine performance requirements in the selection of commercially available transmission drives.
iii) Design Brakes and Clutches.
iv) Design various types of gear boxes.</td></tr>
<tr><td colspan="8">11. Lab Content</td></tr>
</table>

Sr. No.	Title	CO covered
1	Study on Gear Box	iv)
2	Study of manual steering Mechanism	iv)
3	Study of power steering Mechanism.	iv)
4	Study of suspension System.	i)
5	Study of braking system.	ii), iii)
6	Study of clutches (Centrifugal, Claw, Single and multiple, Conical).	iii)
7	Study on Differential Gear Mechanism of Rear Axle.	ii)
8	Study of Car Chassis.	i)
9	Visit of an Automobile factory.	i), ii), iii), iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Plug-in Electric Vehicles in Smart Grid Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Manufacturing systems and Statistics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know the Vehicle Electrification & Impact of Charging Strategies.
ii) Understand the influence of EVs on power system.
iii) To know about the ICT Solutions to Support EV Deployment.
iv) Learn about the EV Charging Facility Planning</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to
i) Describe about vehicle electrification and impact of charging strategies
ii) Describe the influence of EVs on power system.
iii) Describe the ICT solutions to support EV deployment.
iv) Describe the EV charging and facility planning.</td></tr>
<tr><td colspan="7">11. Lab Content</td></tr>
</table>

Sr. No.	Title	COs covered
1	To study about the Electric vehicle charging system.	i)
2	To study about the frequency regulation of EVs.	i)
3	To study the voltage regulation of EVs.	i)
4	To study about the smart grid system of EVs. .	ii)
5	To study about the Smart charging system of EVs.	ii)
6	To study about the Penetration level of EVs for different scenarios.	ii)
7	To study about the Energy generation scheduling.	iii)
8	To study about smart charger of EVs.	iv)

Department Electives-VIII Lab

1. Name of the Department- Mechanical Engineering						
2. Course Name	Mobile Robots Lab	L	T		P	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		Core ()	PE (✓)	OE ()	EAS ()	BSC ()
5. Pre-requisite (if any)	NIL	6. Frequency (use tick marks)	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		Tutorials = 0	Practical = 28			

8. Course Description

Labs are meant to provide drill practice opportunities for better understanding of the concepts learnt in class and enhance critical thinking in some difficult problems. This course includes a practical approach to understand the working of Mobile robots. Different aspects of Mobile robots like Hardware, software, sensors used, navigation, control etc. are taught through a practical approach.

9. Learning objectives:

- **i)** Demonstrate a basic understanding of the wireless communication technologies for mobile robots.
- **ii)** Design and implement mobile robot functions using the iRobot platform and its program development tool.
- **iii)** Design, develop, debug and document control software of mobile robots
- **iv)** Use the basic skills required to conduct research in an engineering area.

10. Course Outcomes (COs):

- **i)** Students will start analyzing, developing and presenting control & navigation systems for applications that span multiple disciplines through laboratory exercises.
- **ii)** Develop an understanding of factors that affect system performance and stability.
- **iii)** Students will be able to define sensing and controller requirements for unmanned vehicles that operate in different conditions.
- **iv)** Understand the localization of Robots.

11. Lab Component

Sr. No.	Title	COs covered
1	Introduction to mobile robots	iii)
2	Mobile robot hardware: locomotion	i), ii), iii), iv)
3	Mobile robot hardware: sensors	ii), iii)
4	Mobile robot control system: hardware and software.	i), ii), iii)
5	Navigation I: localization and mapping	iv)
6	Navigation II: reasoning and motion planning	iv)
7	Wireless communication for mobile robots	iii)
8	Advanced topics: multiple robots' coordination	ii)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Computational Fluid Dynamics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Fluid Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Course Description

Computational Fluid Dynamics is one of the fast-evolving fields engineering which takes essential concepts from continuum mechanics, numerical analysis, computer programming and data structures and applies to almost all engineering problems where fluid flow occurs. This course enables a thorough understanding of the basics of CFD like the governing equations, meshing issues, heat transfer applications and the method of finite differences.

9. Learning Objectives:

i) To understand the mathematical basis and evolution of the governing equations of fluid flow and heat transfer.
ii) To solve one and two-dimensional partial differential equations using traditional CFD tools.
iii) To learn meshing methods and intricacies and techniques of discretization.
iv) To apply the various finite differencing schemes to CFD problems.
v) To learn the algorithms for standard CFD problems.

10. Course Outcomes (COs): At the end of this course, the learner will be:

i) Use the knowledge of CFD techniques, basic aspects of discretization and grid generation.
ii) Solve fluid flow fields using CFD methods.
iii) Model fluid flow problems and heat transfer.
iv) Will be able to verify the different finite schemes to CFD approach.
v) Algorithm for standard CFD practices.

11. Lab Content

Sr. No.	**Title**	**COs Covered**
1.	Three-dimensional analysis of flow in the spiral casing of a reaction turbine using a differently weighted Petrov-Galerkin method.	i)
2.	Computation of flow structure and heat transfer due to longitudinal vortices in heat exchanger applications.	i), ii)
3.	CFD in food processing in single-screw extruders.	ii), iii)

4.	Numerical study of double-diffusive natural convection in anisotropic porous enclosures.	iii)
5.	Mixed convective flow in vertical channel with a built-in circular cylinder.	iii), iv)
6.	Understanding hinge through CFD.	iv), v)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Press Tools & Dies Lab**	**L**		**T**		**P**	
3. Course Code		**0**		**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**EAS ()**	**PE (✓)**		**Specialization ()**	
5. Pre-requisite (if any)	**Manufacturing Processes**	**6. Frequency (use tick marks)**		Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			
8. Course Description							
Press tools and dies subject is designed to acquire theoretical and practical knowledge of different types of tools and dies used in manufacturing processes.							

9. Learning objectives: Students undergoing this course are expected to**:**

i) To acquaint the methods and technologies involved in the various press working operations.
ii) To understand the construction and operation of the different types dies.
iii) To acquire the knowledge of various factors affecting the die design for press working.
iv) To understand the principles, functions and design practices of Jigs, Fixtures and dies for press working.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

i) To explain with the various press and press tool accessories
ii) To design the press tools and dies in press working operations.
iii) To perform press working operations using different dies.
iv) To select and design the jigs and fixture for different dies in press working operations.

11. Lab Content

Sr. No.	**Title**	**CO covered**
1	To perform the experiment with methods involved in design of press tool	i), iii)
2	To perform the experiment with methods involved in metal cutting.	i), iii)
3	To perform the experiment with methods involved in open die and punch.	i), ii)
4	To perform the experiment with methods involved in drawing die.	i), ii)
5	To perform the experiment with methods involved in bending die.	ii), iii)
6	To perform the experiment with methods involved in forming die.	ii), iii)
7	To perform the experiment with methods involved in forging die.	ii), iii)
8	To perform the experiment with methods involved in multiple forging die.	iii)
9	To perform the experiment with methods involved in Tools for flash trimming & hole piercing	iii)

10	To perform the experiment with methods involved in locating & clamping	iv)
11	To perform the experiment with methods involved in drilling jigs	iv)
12	To perform the experiment with methods involved in milling fixture	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Finite Element Analysis Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
5. Pre-requisite (if any)	**Engineering Mechanics, SOM**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			
8. Course Description						
The finite element analysis (FEA) is among one of the most powerful tools for the numeric solution of wide range of engineering problems. The application ranges from deformation and stress analysis of civil and mechanical structures, automotive components, aircraft designs, heat flux analysis, fluid flow problems, electrical magnetic flux problem. Upon completion, students should be able to solve the problems in solid mechanics and heat transfer using FEA.						
9. Learning Objectives: **i)** Introduce students to MATLAB software to work on. **ii)** To enable the students, understand the mathematical and physical principles underlying the Finite Element Method (FEM) as applied to solid mechanics and thermal analysis. **iii)** To understand the characteristics of various finite elements. **iv)** To develop finite element equations for simple and complex domains.						
10. Course Outcomes (COs): After the completion of the course, the student shall be able to **i)** Get comfortable in working on MATLAB software. **ii)** Get to know the concepts of Mathematical Modeling of Engineering Problems. **iii)** Get comfortable in deciding the geometry of finite element for different cases. **iv)** To appreciate the use of FEM to a range of Engineering Problems.						
11. Unit wise detailed content						

Sr. No.	Title	CO covered
1	Introduction to MATLAB	i)
2	MATLAB code for analysis of spring systems	i)
3	MATLAB code for One-Dimensional elasticity problems	i)
4	MATLAB code for plane truss analysis	i), ii), iii)
5	MATLAB code for beam analysis	i), ii), iii)
6	MATLAB code for 2-D frame analysis	i), ii), iii)
7	MATLAB code for plane stress analysis using CST element	i), ii), iii)
8	MATLAB code for one-dimensional heat conduction considering convection	i), ii), iii), iv)
9	Bars of constant cross section area, tapered cross section area and stepped bar in ANSYS	ii), iii), iv)
10	Trusses in ANSYS	ii), iii), iv)
11	Beams – Simply supported, cantilever, beams with point load, UDL, beams with varying load etc. in ANSYS	ii), iii), iv)
12	Stress analysis of a rectangular plate with a circular hole in ANSYS	ii), iii), iv)

13	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions in ANSYS	ii), iii), iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Vehicle Body Dynamics Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td>OE ()</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Fluid Mechanics</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">In this course we learn about the different type of car & bus body, safety equipment’s of car and also learn about the different types of force acting on a vehicle. By this course students can learn about construction of vehicle body, space in the car.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know about vehicle body arrangement.
ii) To learn about the safety features of vehicle body.
iii) To learn about understand the vehicle aerodynamics.
iv) To know the details of various types of automobiles.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): After the completion of the course, the student shall be able to
i) Understand the subject and its technological significance.
ii) Differentiate the types of vehicle body which are used in automobile.
iii) Identify the various types of forces.
iv) Get basic idea on safety and comfort of vehicle</td></tr>
<tr><td colspan="7">11. Lab Component</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	Study of different types of car and Bus body.	i), ii)
2	Study of driver’s visibility & space in the car.	i), ii)
3	Study about safety equipment’s of vehicle.	i), ii), iii)
4	Study about the various painting process on the car.	i), iii)
5	To Study the different vehicle crash conditions.	i), ii), iii)
6	Study of different types of tool used in body shop. .	i), ii), iii)
7	Study of various joining processes (welding, riveting) in the body material.	i), ii), iii)

8	Study about the different types of commercial vehicle body.	i), ii), iii)
9	Study and perform wind tunnel test on models like aero foil & cylinder.	i), iii)
10	Study about different types of material used in vehicle body construction.	i), ii), iii)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>MEMS & Micro-Systems Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td>EAS ()</td><td>BSC ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Mechatronics Systems and Its Applications</td><td>6. Frequency (use tick marks)</td><td>Even (✓)</td><td>Odd ()</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">MEMS and Microsystem, Typical MEMS and Microsystems Products, Evolution of Microfabrication, Microsystems and Microelectronics, Multidisciplinary Nature of Microsystems, Miniaturization. Applications and Markets.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To provide knowledge of semiconductors and solid mechanics to fabricate MEMS devices
ii) To educate on the rudiments of Micro fabrication techniques.
iii) To introduce the working principle of Sensors and Actuators.
iv) To introduce various sensors & actuators their applications.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs):
i) Know the basic concepts of MEMS structures under different modes of operation and characteristics.
ii) Understand the fundamentals on solving the problem based on MEMS structure.
iii) Gain the expertise on fundamentals of MEMS design and operation.
iv) Understand the design concepts of MEMS sensors and actuator for practical applications</td></tr>
<tr><td colspan="7">11. Lab Component</td></tr>
</table>

Sr. No.	Title	COs Covered
1	Study of IntelliSuite Software for the design and fabrication process of MEMS devices.	i), ii), iii), iv)
2	Deflection Response of SOI (Silicon –On –Insulator) Pressure Sensor	i), ii), iii), iv)
3	Construction and Simulation of RF Switch	i), ii), iii), iv)
4	Determination of Capacitance change in Capacitive Pressure Sensor	i), ii), iii), iv)
5	Studies on effect of Air Gap on Pull –in Voltage of Cantilever beam employed RF Switch	i), ii), iii), iv)
6	Estimation of Resistance change in SOI Piezo –resistive Pressure Sensor	i), ii), iii), iv)
7	Studies on effect of Air Gap on Pull –in voltage of fixed beam employed in RF Switch.	i), ii), iii), iv)
8	Design and Construction of different types of Accelerometers and determination of its natural frequency	i), ii), iii), iv)
9	Design and Analysis of Piezoresistive Accelerometer using Coventor Ware software.	i), ii), iii), iv)
10	Design and Analysis of Comb drive type Capacitive Accelerometer using IntelliSuite software.	i), ii), iii), iv)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**EV Charging Infrastructure Technology Lab**	**L**	**T**		**P**		
3. Course Code		**0**	**0**		**2**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite (if any)	**Introduction to Electric and Hybrid Vehicle**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				
8. Course Description							
This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles. The material for this course will be prepared in such a manner that it will be useful for post-graduate students, teachers, practitioners and final year undergraduate students.							
9. Learning objectives: **i)** To know the Battery Parameters for better performance. **ii)** Understand the EV charging concept. **iii)** Learn about the Batteries used in EV. **iv)** Understand the infrastructure of Charging stations of EV.							
10. Course Outcomes (COs): On successful completion of this course, the student will be able to **i)** Elaborate various technical parameters of batteries. **ii)** Distinguish between various types of batteries used for EV applications. **iii)** Develop battery charger for an EV **iv)** Develop and Design the Charging Infrastructure.							
11. Lab Content							

Sr. No.	**Title**	**COs covered**
1	To Study about charging system of EV.	i)
2	To Study about different types of chargers used in EV.	i)
3	To study about Lead-acid battery system	i)
4	To study about the performance of Lead-acid battery.	ii)
5	To study about sodium-based battery system.	ii)
6	To study about domestic charging system.	iv)
7	To study about the charging station of batteries.	iv)
8	To Study of battery swapping system.	iii)

7th Semester

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Automation in Manufacturing**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**	
5. Pre-requisite (if any)	**Manufacturing Processes and Technology & Engineering Graphics and Design**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 00**	**Practical = 00**			

8. Course Description

Automation in manufacturing is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. Students learn the importance of CAD/CAM principles in the Product development, programs related to manufacturing using codes and analyse the importance of networking in the manufacturing environment.

9. Learning objectives:

- **i)** To understand the basics of CAD/CAM and concepts of computer graphics.
- **ii)** To learn about the geometric issues concerned with manufacturing and its related areas.
- **iii)** To understand the latest advances in the manufacturing perspectives and their applications.
- **iv)** To have an idea of Computer Integrated Manufacturing.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** To understand the importance of CAD/CAM principles in Product development.
- **ii)** To develop programs related to manufacturing using codes.
- **iii)** To understand the concept of group technology and flexible manufacturing system.
- **iv)** To understand in details about computer integrated manufacturing.

11. Unit wise detailed content

Unit-1	**Number of lectures = 12**	**Title of the unit: Computer Hardware & Principles of Computer Graphics**
Product Development Cycle – Graphics display devices – CRT, colour CRT monitors, DVST, Flat- panel display, Graphics output Devices – Printers and Plotters – Graphics Standards – Neutral File formats –IGES, STEP.2D and 3Dn geometric transformations, Matrix representation-translation, scaling, shearing, rotation and reflection, composite transformations, concatenation – Graphics software, Graphics functions, output primitives-Bresenham's Algorithm and DDA		
Unit – 2	**Number of lectures = 10**	**Title of the unit: CNC Machine Tools**
Introduction to NC, CNC, DNC- Manual part Programming – Computer Assisted Part Programming – Examples using NC codes- Adaptive Control – Canned cycles and subroutines – CAD / CAM approach to NC part programming – APT language, machining from 3D models.		
Unit – 3	**Number of lectures = 10**	**Title of the unit: Group Technology, CAPP and FMS**
Introduction to part families-parts classification and cooling – group technology machine cells-benefits of group technology – Process Planning – CAPP & types of CAPP – Flexible manufacturing systems (FMS) – the FMS		

concept-transfer systems – head changing FMS – Introduction to Rapid prototyping, Knowledge Based Engineering.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Computer Integrated Manufacturing**
CIM wheel – CIM Database- CIM-OSI Model– Networking Standards in CIM Environment – Network structure – Network architecture –TCP/IP, MAP – Virtual Reality, Augmented Reality- Artificial Intelligence and Expert system in CIM, Current industry trends.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Mikell P. Groover (2008), Automation, Production Systems and Computer Integrated Manufacturing, 3rd Edition, Pearson Education. ISBN: 978-8-120-33418-2.

Reference Books

i) Ibrahim Zeid (2009), Mastering CAD/CAM, 2nd Edition, Tata McGraw Hill International Edition, ISBN: 978-0-070- 15134-5.

ii) P N Rao (2010), CAD/CAM Principles and Applications, 3rd Edition, Tata McGraw-Hill Education, ISBN: 978-0-070- 68193-4.

iii) James A. Rehg and Henry W. Kraebber (2004), Computer Integrated Manufacturing, 3rd Edition, Pearson Education, ISBN: 978-0-131-13413-3

Department Electives-IX

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Nuclear Power Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engg. Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Nuclear Power Engineering concentrate on the principles, techniques and processes involved in generation of power from nuclear fuels. This involves studying and exploring various aspects of science ranging from processing of nuclear fuel to merits and demerits of various nuclear reactors and from reprocessing of nuclear waste to their safely disposal. Upon completion of this course students will be able to have better understanding of nuclear processes involved in nuclear power generation, know working and pros & cons of various reactors and also have understanding of nuclear power generation and safety rules implemented during power generation from nuclear fuels and nuclear waste disposal.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) The student will be exposed to the basic physics of nuclear reactions and operation of nuclear reactors.
ii) To learn various types of power generation methods, safety and its impact on environment.
iii) Give understanding of Separators used in reactors.
iv) Learn about how to dispose the waste and get protected from radiations.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Know the nuclear fission and fusion processes.
ii) Understand the working of a nuclear reactors
iii) Understand power generation and safety aspects.
iv) Able to apply the concepts of waste disposal and radiation protection.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Nuclear Reactors</td></tr>
<tr><td colspan="7">Mechanism of nuclear fission – Nuclides - Radioactivity – Decay chains - Neutron reactions - Fission process – Reactors - Types of reactors – Design and construction of nuclear reactors - Heat transfer techniques in nuclear reactors - Reactor shielding.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Reactor Materials, Reprocessing</td></tr>
<tr><td colspan="7">Nuclear fuel cycles – Characteristics of nuclear fuels – Uranium – Production and purification of uranium – Conversion to UF4 and UF6 – Other fuels like Zirconium, Thorium, Berylium.
Nuclear fuel cycles - Spent fuel characteristics - Role of solvent extraction in reprocessing-Solvent extraction equipment.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Separation of Reactor Products</td></tr>
<tr><td colspan="7">Processes to be considered - Fuel element dissolution - Precipitation process – Ion exchange - Redox - Purex - TTA – Chelation -U235 -Hexone - TBP and Thorax processes - Oxidative slagging and electro-refining - Isotopes – Principles of isotope separation.</td></tr>
</table>

<table>
<tr><td>Unit – 4</td><td>Number of lectures = 11</td><td>Title of the unit: Waste Disposal and Radiation Protection</td></tr>
<tr><td colspan="3">Types of nuclear wastes – Safety control and pollution control and abatement - International convention on safety aspects – Radiation hazards prevention.</td></tr>
<tr><td colspan="3">12. Brief Description of self-learning / E-learning component</td></tr>
<tr><td colspan="3">The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.</td></tr>
<tr><td colspan="3">13. Books Recommended</td></tr>
<tr><td colspan="3">Text Book</td></tr>
<tr><td colspan="3">i) Janet Wood (2007), Nuclear Power, Institution of Engineering and Technology. ISBN: 978-0-863-41668-2.</td></tr>
<tr><td colspan="3">Reference Books</td></tr>
<tr><td colspan="3">i) Samuel Glasstone, Alexander Sesonske (2012), Nuclear Reactor Engineering: Reactor Systems Engineering, 4th Edition, CBS Publisher. ISBN: 978-1-461-35866-4.</td></tr>
<tr><td colspan="3">ii) J. Kenneth Shultis, Richard E. Faw, Marcel Dekker (2002), Fundamentals of Nuclear Science and Engineering, Marcel Dekker. ISBN: 978-0-824-70834-4.</td></tr>
<tr><td colspan="3">iii) Samuel Glasstone (1994), Nuclear Reactor Engineering: Reactor Design Basics, Volume-1, 4th Edition, Kluwer Academic Publishers. ISBN: 9780412985218</td></tr>
<tr><td colspan="3">iv) A.E. Walter and A.B. Reynolds (1981), Fast Breeder Reactor, Pergamon Press, ISBN: 978-0-080-25982-6.</td></tr>
</table>

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Machine Tool Technology**	**L**	**T**		**P**		
3. Course Code		**3**	**0**		**0**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 42		**Tutorials = 0**	**Practical = 0**				

8. Course Description

Study of different machine tools and hence educates the students about the scope of the subject. To train the students in the metal cutting domain so as to equip them with adequate knowledge about the various processes. To emphasize upon the prominent theories, concepts and constructional features of machines related to them. To provide an insight about the super finishing operations of gear generating. To lay groundwork for further studies in manufacturing stream.

9. Learning objectives:

i) The course provides students with fundamental knowledge and principles of tool design.
ii) To demonstrate the fundamentals of machining tool guide ways.
iii) To develop fundamental knowledge of gear generating processes.
iv) Understand the basics of press tool engineering and jigs- fixtures.

10. Course Outcomes (COs): The curriculum of the Department is designed to satisfy the diverse needs of students.

i) Understand the cutting tool geometry, mechanism of machine tool design.
ii) Understand the machining tool guide ways to produce a component.
iii) Acquire knowledge of gear generation process with applications, advantages and disadvantages
iv) Acquire knowledge of the basics of press tool engineering and jigs- fixtures.

11. Unit wise detailed content

Unit-1	**Number of lectures = 11**	**Title of the unit: Introduction Machine Tools Design**
General requirement of machine tool design, engineering design process applied to machine tool, Desisn of machine tool structure, bed column, housing, materials and profile of machine tool requirement.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Design of Machine Tool Guide ways.**
Functions, requirement, types of slide ways, plastic slideways, functions, requirements, types, aerostatic sideways.		

Unit – 3	Number of lectures = 10	Title of the unit: Gear Generating Process
Introduction to Gear generating process, gear shaping, gear hobbling, Gear shaving, copying machine.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Press Tool Engineering and Jigs & Fixture**
Design of punches and dies. Classification based on operation classification based on constructional and operation. Design of drawing dies, factors affecting drawing, design procedure for drawing die, Introduction to jigs and mixture, types of Jigs and fixtures locations, Design of jigs, design of fixture.		

12. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) PC Sharma, A text book of Production Engineering, S. Chand, 2009, ISBN: 8121901111.

Reference Books

i) Rao PN; Manufacturing Technologies, 2017, Fourth Edition, McGraw Hill Education, ISBN:1259062570.

ii) Victor Repp and Williard McCarthy, Machine Tool Technology, Career Education, ISBN: 0026715708.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Recent Trends in Automotive Technology**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**IC Engines, Automobile Engineering**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
This course provides students a synopsis of latest trends in automotive industry used in evaluation of world. This includes understanding the basic principles of various hybrid and electric vehicles with importance, applications and limitations.						
9. Learning objectives: **i)** Understand the suspension, brakes and safety. **ii)** Understand the vehicle operation and control. **iii)** Understand the Electric and Hybrid Vehicles. **iv)** Understand the Latest Engine Technology Features and 42 Volt Systems.						
10. Course Outcomes (COs): On completion of this course, the students will be able to **i)** Know the Hybrid, Battery and Magnetic track Vehicle. **ii)** Describe the computer control in automotive. **iii)** Describe the working of vehicle for safe ad fast travel. **iv)** Know the latest trend in Automotive Industry.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 11**	**Title of the unit: Future of Automotive Industry**				
Challenges and Concepts for the 21st century, crucial issues facing the industry and approaches to meet these challenges. Fuel Cell Technology for Vehicles: What is fuel cell, Type of fuel cell, Advantages of fuel cell? current state of the technology, potential and challenges, advantages and disadvantages of hydrogen fuel.						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Electrical and Hybrid Vehicles**				
Types of hybrid systems, Objective and Advantages of hybrid systems. Current status, Future developments and Prospects of Hybrid Vehicles. Starts stop operation, Power Assist, Regenerative Braking, Advanced lead acid batteries, alkaline batteries, and Lithium batteries, Development of new energy storage systems, Deep discharge and rapid charging ultra-capacitors.						
Unit – 3	**Number of lectures = 10**	**Title of the unit: Safety Equipment & Collision Warning and Avoidance, Comfort and Convenience Systems**				
Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety. EBD, ABS, Electronic Braking, Traction and Stability control. Collision warning system, causes of rear end collision, frontal object detection, rear vehicle object detection system, object detection system with braking system interactions. Steering and mirror adjustment, central locking system, Garage door opening system, tyre pressure control						

system, rain sensor system, environment information system		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Latest Engine Technology Features and 42 Volt Systems**
Advances in diesel engine technology. Direct fuel injection Gasoline engine, Diesel particulate emission control, Throttling by wire. Variable Valve Timing, Method used to affect variable Valve Timing, Electromagnetic Valves, and Cam less engine actuation. 42 VOLT SYSTEM: Need, benefits, potentials and challenges, Technology Implications for the Automotive Industry, Technological revolution that will occur as a result of the adoption of 42-volt systems.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
i) Advanced Vehicle Technologies by Heinz Heisler-SAE International Publication, Butterworth-Heinemann, 2nd Edition, 2002, ISBN: 0750651318.		
Reference Books		
i) Electric and Hybrid Electric vehicles by Ronald K. Jurgen - SAE International Publication with a Product Code of PT-85, 2002, ISBN: 9780768008333.		
ii) Electronic Braking, Traction and Stability control, SAE International, 2006, ISBN: 0768017866		
iii) 42-Volt system by Daniel J. Holt, Society of Automotive Engineers, U.S., ISBN: 076801297X		

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Maintenance Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the concepts of Maintenance categories Comparative merits of each category, Preventive maintenance, maintenance schedules, repair cycle and Principles and methods of lubrication with TPM.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know the structure, operation and applications of the concepts of Industrial maintenance and its Management.
ii) To enable the students, apply mathematical, computational and communication skills to learn full cost analysis for maintenance a system.
iii) To introduce students' concept of Condition Monitoring, Cost comparison with and without CM.
iv) To introduce students' concept of key features of Industrial and Total Quality Management.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to:
i) Define and measure various Basic Principles of maintenance planning.
ii) Perform full cost analysis for maintenance a system.
iii) Apply the concept of Condition Monitoring Cost comparison with and without CM
iv) Explain key features of Industrial and Total Quality Management.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Principles and practices of maintenance planning</td></tr>
<tr><td colspan="7">Basic Principles of maintenance planning – Objectives and principles of planned maintenance activity – Importance and benefits of sound Maintenance systems – Reliability and machine availability – MTBF, MTTR and MWT – Factors of availability – Maintenance organization – Maintenance economics.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Maintenance policies –preventive maintenance</td></tr>
<tr><td colspan="7">Maintenance categories – Comparative merits of each category – Preventive maintenance, maintenance schedules, repair cycle - Principles and methods of lubrication – TPM.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Condition monitoring</td></tr>
<tr><td colspan="7">Condition Monitoring – Cost comparison with and without CM – On-load testing and offload testing – Methods and instruments for CM – Temperature sensitive tapes – Pistol thermometers – wear-debris analysis</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Repair methods for basic machine elements and for material handling equipment</td></tr>
<tr><td colspan="7">Repair methods for beds, slide ways, spindles, gears, lead screws and bearings – Failure analysis – Failures and their development – Logical fault location methods – Sequential fault location. Repair methods for Material handling equipment - Equipment records –Job order systems -Use of computers in maintenance.</td></tr>
<tr><td colspan="7">12. Brief Description of self-learning / E-learning component</td></tr>
</table>

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) "Maintenance Engineering Hand Book" by L T Higgins and L C Marrow, ISBN-13:978-81785749136
Reference Books:
i) **"**Maintenance Engineering and Management" by Venkataraman (2006) S Chand; 2nd Revised Edition 2006 edition ISBN-13: 978-8121917465

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Operation Research</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="3">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="3">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Industrial Engineering</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="5">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Operation research is having many powerful tools to optimize the real-life problems. The study of this subject will give knowledge to the students regarding transportation and inventory related problems. This also describes the method of sequencing of jobs through different number of machines. Focus is also given to most common problems of waiting of either job/machines/peoples. Emphasis is given to decision models and replacement problems. So, the study of this subject will develop the capability among students to solve effectively many problems arising during their career.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To provide students the knowledge of Linear model.
ii) To enable the students, apply mathematical, computational and communication skills to learn Sequencing and Networks needed for the practical utility of Operations Research.
iii) To introduce students concept of inventory model in Operations Research.
iv) To introduce students concept of Queuing Models and decision models</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Apply the concept of Linear model to solve various transportation problems.
ii) Apply the concept of Sequencing and Networks to optimize the production
iii) Apply the concept of inventory model to maximize the profit.
iv) Apply the concept of Queuing Models and decision models to forecast the demand in the industry.</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Linear Models</td></tr>
<tr><td colspan="8">Introduction to Operations Research – Linear Programming - Mathematical Formulation – Graphical method – Simplex method – Duality two phase simplex method – Transportation problems – Northwest Corner method – Vogel’s Approximation method – MODI method – Transshipment problems - Assignment problems – Applications Introduction to dynamic programming and nonlinear programming- Goal programming.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Sequencing and Networks</td></tr>
<tr><td colspan="8">Sequencing –Problem with N jobs and 2 machines using Johnson’s method, Problems with N jobs - 3 machines and ‘M’ machines using modified Johnson’s method.
Network models – Basic Concepts – Construction of Networks – Project Network – CPM and PERT - Critical Path Scheduling – Crashing of Network.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Inventory Models</td></tr>
</table>

<table>
<tr><td colspan="3">Inventory models – Various Costs and Concepts–EOQ–Deterministic inventory models – Production models – Stochastic Inventory models – Buffer stock.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 12</td><td>Title of the unit: Queuing Models and decision models</td></tr>
<tr><td colspan="3">Queuing models – Poisson arrivals and Exponential service times – Single channel models and Multi channel models. Simulation – Basic concepts – Advantages and Disadvantages – Random number generation – Monte-Carlo Simulation models. Decision models – Game theory – Two person zero sum game – Graphic solution - Property of dominance – Algebraic solution. Replacement models, Items that deteriorate with time - When money value changes – Items that fail completely – Individual replacement and Group replacement.</td></tr>
<tr><td colspan="3">12. Brief Description of self-learning / E-learning component
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.</td></tr>
<tr><td colspan="3">13. Books Recommended</td></tr>
<tr><td colspan="3">Text Book</td></tr>
<tr><td colspan="3">i) DS GUPTA ,PK HIRA(2015), Operation Research, S.CHAND PUBLISHER; 2011 edition (2015)ISBN-10: 121212184 ISBN-13: 978-1212121844, ISBN: 978-8-120- 30162-7.</td></tr>
<tr><td colspan="3">Reference Books</td></tr>
<tr><td colspan="3">i) Hamdy Taha, (2008), Operations Research-An Introduction, 8th Edition, Pearson Education, ISBN: 978-8-131-71104-0.</td></tr>
<tr><td colspan="3">ii) R. Panneerselvan (2006), Operation Research, 2nd Edition, Prentice Hall of India Pvt Ltd ISBN: 978-8-120-31743-7.</td></tr>
<tr><td colspan="3">iii) J. K. Sharma (2013), Operation Research, 5th Edition, Macmillan Publications, ISBN: 978-9-350-59336-3.</td></tr>
<tr><td colspan="3">iv) Kanti Swarup, P.K. Gupta and Manmohan Lal (2010), Operations Research, 15th Edition, S. Chand & Sons, ISBN: 978- 8-180-54771-3.</td></tr>
</table>

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Instrumentation and Control Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>NIL</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">The objective of this course is to present sufficient background in different instruments and sensors and their use in control system design. This course combines knowledge, techniques, and methodologies from various sources, using techniques from transform theory and basic principle of classical physics based upon which different instruments and sensors are built.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To introduce a variety of sensors and instruments commonly used in Mechanical Engineering practice.
ii) To instill a fundamental understanding of various instrumentation and control detection circuits as they relate to temperature, pressure, flow, and level monitoring using concept of transfer function.
iii) To enable students, apply control engineering techniques to the automatic control systems found in modern manufacturing, processing and transportation environments.
iv) Identify, formulate, and solve engineering problems</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Understand fundamental elements of instrumentation, measurement and control systems.
ii) Build mathematical models of simple physical systems using transfer functions.
iii) Will be able to design a control system for any required objective by using the theory of control system and implementing it with various sensors and transducers.
iv) Can easily identify, formulate, and solve engineering problems</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Fundamentals of Measuring Systems</td></tr>
<tr><td colspan="7">General concepts of Mechanical measuring instruments – Elements of a measuring system – Requirements of measuring instruments – Static and dynamic characteristics of measuring instruments – Errors in measurements – Introduction to Transducers and Sensors – Classification and types.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 09</td><td colspan="5">Title of the unit: Measuring Devices - I</td></tr>
<tr><td colspan="7">Measurement of vibrations – Accelerometer – Measurement of Low, Medium, and High pressures- Measurement of temperature: bi-metallic thermometer, thermocouple, RTD, thermistor, pyrometer – Measurement of flow- hot wire anemometer – magnetic flow meter – ultrasonic meter.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 09</td><td colspan="5">Title of the unit: Measuring Devices - II</td></tr>
<tr><td colspan="7">Measurement of displacement – Measurement of Force – Proving Ring, Strain gauge, Load cells- Measurement of torque – Measurement of Speed – Case study assignments.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 13</td><td colspan="5">Title of the unit: Fundamentals of Control System & response analysis</td></tr>
</table>

Introduction to Control systems – Open and Closed loop systems – servomechanisms. Transfer function: Block diagram reduction algebra, signal flow graphs – Basics of Controllers – Problems. Time response of First and Second order systems –Frequency domain analysis – Polar and Bode plots – Concept of Stability-Routh-Hurwitz Criterion– Problems. Exposure to applications based on current industrial trends.
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) Instrumentation And Control Systems Paperback – 1 Jan 2015 by V. Sugumaran, ISBN-10: 9383828501, ISBN-13: 978-9383828500)
Reference Books
i) Instrumentation and Control Paperback – 2011by Patranabis D. (ISBN-10: 8120342461, ISBN-13: 978-8120342460)
ii) Instrumentation and Process Control Paperback – 2019 by D. C. Sikdar. (ISBN-10: 9789382609049, ISBN-13: 978-9382609049)
iii) J.P. Holman (2004), Experimental Methods for Engineers, Tata McGraw-Hill (ISBN-10: 0070586748, ISBN-13: 978-0070586741)
iv) I.J. Nagrath and M. Gopal (1999), Control Systems Engineering, New Age Int. Pub (ISBN-10: 9789386070111, ISBN-13: 978-9386070111)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Nano-Technology and Surface Engineering</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Prerequisite (if any)</td><td>Materials Engineering and Technology</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures =42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">Surface engineering is a sub-discipline of Materials Science and Materials Engineering which deals with the surface of a solid and its modifications. The primary goal of Surface Engineering of nanomaterials is to modify the properties of surface to improve its electrical and thermal properties, and to improve the compatibility of nanomaterials with some matrix when they are used as reinforcing fillers in composites for high performance applications. The course should give a basic introduction to chemical and physical principles in the synthesis of inorganic nanostructured materials. In addition, basic principles of finite size effects will be covered. The course will also cover different methods for synthesis and characterization of different nanostructures and nanostructured bulk materials.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To understand the basic concepts of surface engineering
ii) To understand the basic concepts of Nano-coating.
iii) To enhance the knowledge of Nano material.
iv) To allowing students to get familiarized with Microencapsulation</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Use of surface engineering and Nanomaterials for various industrial applications.
ii) To understand the basic concepts of Surface Engineering of Nano materials
iii) Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.
iv) Describe Microencapsulation and their application in industry</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Introduction to Surface Engineering</td></tr>
</table>

Tribology & its classification, Friction tribology, Wear & corrosion, Lubrication, Effect of tribology on surface of nanomaterials. Conventional surface engineering, Types of surface modifications, Physical modifications, Chemical modifications, Applications of surface engineering towards nanomaterials.		
Unit – 2	**Number of lectures = 10**	**Title of the unit: Nano coatings**
Deposition and surface modification methods, Physical vapor deposition, Chemical vapor deposition, Advanced surface, modification practices, Advantages of deposition for surface modification. Synthesis, processing and characterization of nano-structured coatings, Functional coatings, Advanced coating practices, Characterization of nano-coatings, Applications of nano-coatings.		
Unit – 3	**Number of lectures = 12**	**Title of the unit: Surface Engineering of Nano materials**
Need of advanced methods for surface and coating testing's, Size dependency in nanostructures of nano-coatings, Size effect in electrochemical properties of nanostructured coatings, Size effect in mechanical properties of nanostructured coatings, Size effect in physical and other properties of nanostructured coatings. Thin films for surface engineering of nanomaterials, Sputtering techniques, Evaporation processes, Thin film deposition through gas phase techniques, Liquid phase techniques.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Microencapsulation**
Processes, Microencapsulation: Kinetics of release, Plating of nanocomposite coatings, Advantages of microencapsulation over other conventional methods. Current trends in surface modification of nanomaterials, Modified Nanomaterials: In-use for consumer products, Main problems in synthesis of modified nanomaterials		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.		
13. Books Recommended		
Text Book		
i) Jamal Takadou,Nanomaterials and Surface Engineering, Edited by m, John Wiley & Sons, Inc,2019, USA.ISBN: 978-9814774598		
Reference Books:		
i) Bharat Bhusan ,Introduction to Tribology , John Wiley & Sons, USA.ISBN: 978-111994453,2013,		
ii) Mahmood Aliofkhazrae ,Nanocoatings: Size Effect in Nanostructured Films , Springer-Verlag, USA.2021,ISBN: 978-0444632371		

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Robot Operating Systems</td><td>L</td><td colspan="2">T</td><td colspan="3">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="3">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="3">OE ()</td></tr>
<tr><td>5. Prerequisite (if any)</td><td>Materials Engineering and Technology</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td colspan="2">Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures =42</td><td>Tutorials = 0</td><td colspan="5">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">The main aim of this course is to introduce the Robot Operating system. This course gives a brief understanding of the UNIX, architecture of operating system, computation graph level, debugging and Visualization. To give a practical exposure various case studies will be introduced.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) Introduce the basics of Robot Operating Systems.
ii) Understand the Architecture of Operating System.
iii) Provide knowledge on the hardware interfacing aspects.
iv) Understand the applications of ROS in real world complex applications</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Describe the need for ROS and its significance. Summarize the Linux commands used in robotics.
ii) Discuss about the concepts behind navigation through file system.
iii) Explain the concepts of Node debugging
iv) Analyze the issues in hardware interfacing and discuss about the applications of ROS</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Introduction to ROS and UNIX</td></tr>
<tr><td colspan="8">Introduction –The ROS Equation - History - distributions -difference from other meta-operating systems–services - ROS framework – operating system – releases.
UNIX commands - file system – redirection of input and output - File system security - Changing access rights – process commands – compiling, building and running commands – handling variables.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Architecture of Operating System and Computation Graph Level</td></tr>
</table>

File system - packages – stacks – messages – services – catkin workspace – working with catkin workspace – working with ROS navigation and listing commands. Navigation through file system -Understanding of Nodes – topics – services – messages – bags – master – parameter server.		
Unit – 3	**Number of lectures = 12**	**Title of the unit: Debugging and Visualization**
Debugging of Nodes – topics – services – messages – bags – master – parameter – visualization using Gazebo – Rviz – URDF modeling – Xacro – launch files. Hardware Interface: Sensor Interfacing – Sensor Drivers for ROS – Actuator Interfacing – Motor Drivers for ROS.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Case Studies: Using ROS in Real World Applications**
Navigation stack-creating transforms -odometer – imu – laser scan – base controller – robot configuration – cost map – base local planner – global planner – localization – sending goals – TurtleBot – the low cost mobile robot.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

i) Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, Apress, 2018 2.

ii) Aaron Martinez, Enrique Fernández, "Learning ROS for Robotics Programming", Packt Publishing Ltd, 2013

Reference Books:

i) Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2013.

ii) Anis Koubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.

iii) Kumar Bipin, "Robot Operating System Cookbook", Packt Publishing, 2018.

iv) Wyatt Newman, "A Systematic Approach to learning Robot Programming with ROS", CRC Press, 2017.

v) Patrick Gabriel, "ROS by Example: A do it yourself guide to Robot Operating System", Lulu, 2012

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Modelling and Simulation of EHV</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Introduction to Electric and Hybrid Vehicles</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles using the Modelling and Simulation. The material for this course will be prepared in such a manner that it will be useful for graduate students, teachers, practitioners and final year undergraduate students.</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To know the basics of Modelling in performance parameters.
ii) Learn about the Modelling of Batteries
iii) To know the Drivetrain characteristics using Modelling of it.
iv) Understand the concept of Energy Management.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On successful completion of this course, the student will be able to
i) Understand the modeling of vehicle performance parameters.
ii) Model battery electric vehicles.
iii) Describe the drive train characteristics.
iv) Apply the concepts of energy management system.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Modelling in Performance Parameter</td></tr>
<tr><td colspan="7">Modelling Vehicle Acceleration - Acceleration performance parameters, modelling the acceleration of an electric scooter, modelling the acceleration of a small car.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="5">Title of the unit: Modelling of Electric Vehicles Battery</td></tr>
<tr><td colspan="7">Electric Vehicle Modelling - Tractive Effort, Rolling resistance force, Aerodynamic drag, Hill climbing force, Acceleration force, Total tractive effort, Modelling Electric Vehicle Range - Driving cycles, Range modelling of battery electric vehicles, Constant velocity range modelling, Range modelling of fuel cell vehicles, Range modelling of hybrid electric vehicles</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Drivetrain Characteristics</td></tr>
<tr><td colspan="7">Modelling and Characteristics of EV/HEV Powertrains Components- ICE Performance Characteristics, Electric Motor Performance Characteristics - Battery Performance, Characteristics-Transmission and Drivetrain Characteristics-Regenerative Braking Characteristics-Driving Cycles Modelling and Analysis of Electric and Hybrid Electric Vehicles Propulsion and Braking.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Energy Management</td></tr>
<tr><td colspan="7">Analysis of Electric and Hybrid Electric Vehicles - Simplified Handling Models Energy/Power Allocation and Management - Power/Energy Management Controllers - RuleBased Control Strategies - Optimization-Based Control Strategies</td></tr>
</table>

12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.
13. Books Recommended
Text Book
i) James Larminie, John Lowry, “Electric Vehicle Technology Explained”, John Wiley & Sons Ltd, 2003.
Reference Books
i) Amir Khajepour, Saber Fallah and AvestaGoodarzi, “Electric and Hybrid VehiclesTechnologies, Modelling and Control: A Mechatronic Approach”, John Wiley & Sons Ltd, 2014.
ii) Mehrdad Ehsani, Yimin Gao, Ali Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles_ Fundamentals, Theory, and Design, Second Edition”, CRC Press, 2010.

Department Electives-X

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Advanced Heat Transfer**	**L**	**T**		**P**	
3. Course Code		**3**	**0**		**0**	
4. Type of Course (use tick mark)		Core ()	PE (✓)		OE ()	
5. Pre-requisite (if any)	**Heat and Mass Transfer**	**6. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						

An introductory course in heat and mass transfer covering conduction, convection and radiation heat transfer, principals of heat exchanger and mass transfer. Heat transfer and mass transfer are kinetic processes that may occur and be studied separately or jointly. Studying them apart is simpler, but both processes are modelled by similar mathematical equations in the case of diffusion and convection (there is no mass-transfer similarity to heat radiation), and it is thus more efficient to consider them jointly. Besides, heat and mass transfer must be jointly considered in some cases like evaporative cooling and ablation.

9. Learning objectives:

i) To comprehend and evaluate various modes of heat and mass transfer.
ii) To design fin enhanced systems, evaporators, condensers and heat exchangers.
iii) To understand boundary layer theory, condensation and boiling.
iv) To determine effectiveness of heat exchangers using LMTD and NTU.

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Apply basic principles of fluid mechanics, thermodynamics, heat transfer for designing heat and mass transfer systems.
ii) Model heat, mass and momentum transport systems and develop predictive correlation.
iii) Assess and evaluate various designs for heat and mass transfer and optimize the solution.
iv) Apply the basic principles of heat exchanger applications.

11. Unit wise detailed content

Unit-1	**Number of lectures = 9**	**Title of the unit: Conduction**

Introduction
Reviews of basic laws of Conduction, Convection and Radiation
Steady State Heat Conduction
Thermal insulation problem, Extended surfaces- Fins with uniform cross-sectional area, Fins variable cross-sectional area- circumferential, triangular and parabolic shape, Fin effectiveness and efficiency, thermal contact resistance. Methods for the solution of the Multi-Dimensional heat conduction problem: Analytical Method, Graphical Method, Electrical Analogy, Numerical Methods, Numerical.

Unit – 2	Number of lectures = 11	Title of the unit: External Flow and Forced Convection
External Flow and Forced Convection Introduction, Exact and approximate integral solutions for the flow over flat plate, hydrodynamic & thermal boundary layer, boundary layer thickness, drag coefficient, mean drag coefficient, The local & average heat transfer coefficient, mass flow through the boundary, Turbulent flow over flat plate, Reynolds analogy, Reynolds-Colburn analogy, Drag & heat transfer in mixed boundary layer, Flow over curved surfaces, Cylinder, Sphere, Cross flow over banks of tubes, Numericals.		
Unit – 3	**Number of lectures = 11**	**Title of the unit: Convection and Phase Heat Transfer**
Internal Flow and Forced Convection Introduction, Entrance region, Fully developed region, Mean velocity, Mean temperature, Governing differential equation and velocity profile for fully developed laminar tube flow, Hagen-Poiseuille equation, Fanning friction coefficient, Heat transfer for fully developed laminar tube flow: Governing differential equation, heat transfer coefficient for constant wall temperature and constant wall heat flux boundary conditions, Velocity distribution in turbulent flow through pipe, Fluid friction, Convection Correlations for turbulent flow in tubes: Reynolds Analogy, Reynolds-Colburn analogy, Dittus-Boelter equation, Sieder and Tate equation, Petukhov expression, Numerical. Two Phase Heat Transfer Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling regimes, Nucleate and film boiling, Heat pipe.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Radiation and Heat Exchanger**
Heat Exchangers Classification and selection of heat exchangers, Some important definitions, Heat Exchanger Analysis: Use of LMTD, Multipass heat exchangers, Effectiveness NTU Method, Plate heat exchanger, evaporative tubular heat exchanger, Evaporative Effectiveness, Dryout heat flux, Design of Shell and Tube Heat Exchanger, Simulation of heat exchangers, Pressure drop and Pumping power, Optimization of heat exchanger size, Numerical. Thermal Radiation Review of basic laws for radiation-, Black body concept, gray body radiation, Solar radiations, Radiation between surfaces- Shape factor and correlations, Radiation exchange between surfaces in black enclosure, Network representation, Radiation exchange in gray enclosure, apparent emissivity of a cavity, Radiation shields, Radiations in emitting and absorbing media.		
12. Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. http://sgtlms.org Journal papers; Patents in the respective field.		

13. Books Recommended	
Text Books:-	
i)	R. C. Sachdeva (2005), Fundamentals of Heat and Mass Transfer, New Age International (P) Ltd. ISBN: 978-8-122-40076-2.
ii)	P. K. Nag (2005), Heat Transfer, Tata McGraw Hill Publishing Company Limited. ISBN: 978-0-070-60653-1.
Reference Books:-	
i)	J. P. Holman (2005), Heat Transfer, 9th Edition, McGraw-Hill Publishing Company Limited. ISBN: 978-0-070-29618-3.
ii)	Dewitt Lavine, Bergmann and Incropera (2010), Fundamentals of Heat and Mass Transfer, 6th Edition, John Wiley & Sons, ISBN: 978-8-126-52764-9.
iii)	M. Necat Ozisik, Helcio R.B. Orlande (2021), Inverse Heat Transfer: Fundamentals and Applications, 2nd Edition, CRC Press, Taylor & Francis, ISBN 9780367820671.
iv)	Abram S. Dorfman, (2010), Conjugate Problems in Convective Heat Transfer, 1st Edition, CRC Press, Taylor & Francis, ISBN 9781138372719.
v)	S. Mostafa Ghiaasiaan, (2018), Convective Heat and Mass Transfer, 2nd Edition, CRC Press, Taylor & Francis, ISBN 9780815361411.

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Modeling and Simulation of Manufacturing System</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Computer Aided Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td>Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="7">8. Course Description</td></tr>
<tr><td colspan="7">The objective of this course is to give a sound knowledge of the fundamental aspects of system simulation, which is used in the analysis of complex system and finds applications in a wide range of real-life situations. Modeling and Simulation of Manufacturing Systems course is concerned with the concepts of system, system modeling and simulation, has been expanded to include the details of types of models and simulation software. This course covers the mathematical and statistical models. This course provides the knowledge of random number generation and inverse transform techniques. This course also discusses the analysis of simulation data and application of simulation system in manufacturing and material handling systems</td></tr>
<tr><td colspan="7">9. Learning objectives:
i) To learn about discrete event simulation basics.
ii) To introduce modeling, simulation and optimization as it applies to the study and analysis of manufacturing systems for decision support.
iii) To expose with a wide range of applications for simulation methods and models and to integrate them with their introduction to operations management.
iv) To familiarize students with the process of analyzing different types of simulation data.</td></tr>
<tr><td colspan="7">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Develop the practical skills necessary to design, implement and analyze discrete-event simulation systems.
ii) Cover the basic theory underlying discrete-event simulation methodologies in order to enable a critical understanding of simulation output in managerial environments.
iii) Get comfortable in applying and analyzing the process of operations management. Build the foundations necessary to quickly adapt for future advances in simulation technology.
iv) Build the foundations necessary to quickly adapt for future advances in simulation technology.</td></tr>
<tr><td colspan="7">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 11</td><td colspan="5">Title of the unit: Introduction to System Simulation</td></tr>
<tr><td colspan="7">Introduction to system simulation – Applications – Discrete and Continuous simulation – Simulation models – Simulation procedure– Simulation Examples – General Principles -Simulation software.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 10</td><td colspan="5">Title of the unit: Mathematical and Statistical Models & Applications</td></tr>
<tr><td colspan="7">Review of basic probability and Statistics – Statistical models in simulation - Selecting input probability distributions. Simulation of Manufacturing and Material Handling systems – Simulation of Computer Systems – Simulation of Computer Networks</td></tr>
</table>

Unit – 3	Number of lectures = 10	Title of the unit: Random Numbers
Random number generation-Testing of Random numbers – Techniques for generating random numbers-Random Variate Generation– Inverse transform techniques-Acceptance-Rejection techniques- Special properties.		
Unit – 4	**Number of lectures = 11**	**Title of the unit: Analysis of Simulation Data**
Input modeling – Data collection – Identifying the distribution with data- Parameter estimation - Goodness of fit tests – Fitting a non-stationery Poisson`s process- Selecting input models without data-Multi Variate and Time Series Input Models- Model Building – Verification, Validation and Calibration of Simulation Models – Output analysis – Comparison and Evaluation of Alternative System designs. Exposure to applications based on current industrial trends.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book:

i) Stephen Jerry banks, John S Carson, Barry L Nelson and David M Nicol (2006), Discrete Event System Simulation, 4th Edition, Pearson Education Asia. ISBN: 978-8-177-58591-9

Reference Books:

i) Manufacturing Systems Modeling and Analysis 2nd ed. 2011 Edition by Guy L. Curry, Richard M. Feldman (ISBN-13: 978-3642166174, ISBN-10: 9783642166174)

ii) Averill M. Law and W David Kelton (2000), Simulation Modeling and Analysis, 3rd Edition, McGraw Hill. ISBN: 978-0-071-16537-2.

iii) W David Kelton, Randoll P Sadowski and Debroah A Sasowski (2003), Simulation with ARENA, 3rd Edition, McGraw Hill. ISBN: 978-0-072-91981-3.

iv) Geoffrey Gordon “System simulation” – Prentice Hall of India, 1992 (ISBN - 10 : 8120301404)

1. Name of the Department- Mechanical Engineering

2. Course Name	**Gas Dynamics and Jet Propulsion**	**L**	**T**	**P**
3. Course Code		3	0	0
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**

5. Pre-requisite (if any)	**Engineering Thermodynamics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 42	**Tutorials = 0**	**Practical = 0**

8. Course Description

The principles of jet propulsion are of prime significance in designing and constructing aircraft engines. The primary focus of this course is on the teaching of thermodynamics and gas dynamics in aircraft engines. This course provides information that will enable the engineering analysis of ramjets and turbine engines and its separate components including inlets, nozzles, combustion chambers, compressors.

9. Learning objectives:

- **i)** To learn about various types of fuels, their composition and properties
- **ii)** To provide an insight into applications of compressible flows and the fundamentals of jet propulsion systems.
- **iii)** To formulate and solve problems in one-dimensional steady compressible flow.
- **iv)** To solve problems in two-dimensional compressible flows.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Demonstrate the knowledge of major elements in a jet engine and calculate the overall performance of a jet engine.
- **ii)** Apply the concepts of gas dynamics for applications related to compressible flows and jet propulsion.
- **iii)** Possess the knowledge of combustion in Jets.
- **iv)** Possess the knowledge of jet engines and aircraft propulsion theories.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Gas Dynamics**

Conservation laws for mass - Momentum and energy in steady flow - Velocity of sound - Bulk modulus of elasticity – Coefficient of Compressibility - Stagnation state - Critical state - Various regions of flow - Physical significance of Mach number – Crocco Number - Characteristic Mach number - Critical Mach number - Mach cone - Von – Karma's rules for supersonic flow – Differences between Incompressible and Compressible flows. Properties of atmosphere - Effect of Mach number on compressibility: T-S and H-S diagrams showing Nozzle and Diff user process.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Isentropic Flow**

Isentropic flow through a constant area duct – Absence of any of the factors which can trigger a change in fluid flow behavior like area change - Heat transfer - Friction and work transfer – Non variation of properties. Isentropic flow through a variable area duct – Mach number variation - Area ratio as a function of Mach

number - Impulse function - Mass flow rate through nozzles and diff users. Phenomenon of choking – subsonic and supersonic designs - Pressure values for nozzles - Diffusers.		
Unit – 3	**Number of lectures = 12**	**Title of the unit: Flow Through Constant Area Duct and Combustion**
Fanno flow - Fanno curves - Equation and its solution - Variation of flow properties with duct length - Applications. Isothermal flow with friction – Variation of flow properties – Applications Rayleigh flow - Rayleigh flow equation - Rayleigh line – Variation of flow properties - Maximum heat transfer applications. on Isothermal flow with heat transfer and friction - Basic formulation– Elementary treatment only. Flow with normal shock waves - Governing equations - Prandtl–Meyer equation - Impossibility of rarefaction shock – Mach number downstream of shock - Property variation across shock - Strength of shock wave - entropy change. Characteristics of flow through a C-D nozzle at various back pressures. Normal shocks in Fanno and Rayligh flow. Flow with oblique shock waves (Qualitative treatment)		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Jet Propulsion**
Air craft propulsion – Types of jet engines - Energy flow through jet engines - Thrust - Thrust power and Propulsive efficiency - Turbojet components - Diff user compressor - Combustion chamber - Turbines - Exhaust system - Performance of jet engines – Thrust augmentation - Pulse jet and Ram jet engines. Rocket propulsion – Rocket engines - Basic theory of equation – Thrust effective jet velocity - Specific impulse - Rocket engine performance - Solid and Liquid propellant rockets - Comparison of various propulsion systems - Principle and Working of Helicopter.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Stephen Turns, (2011), an Introduction to Combustion: Concepts and Applications, McGraw Hill.

Reference Books

i) John B. Heywood – Internal Combustion Engine, McGraw Hill.

ii) Mishra, D. P, (2000), Fundamentals of Combustion, Prentice Hall of India.

1.Name of the Department- Mechanical Engineering							
2.Course Name	**Industrial Safety Engineering**	**L**	**T**		**P**		
3.Course Code		**3**	**0**		**0**		
4.Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5.Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 42		**Tutorials = 0**	**Practical = 0**				

8.Course Description

This course provides students a brief overview on Industrial Safety. This includes understanding the safety precautions in various manufacturing processes. Also give overview on safety in finishing and testing.

9.Learning objectives:

- **i)** Possess a mastery of Health safety and environment knowledge and safety management skills, to reach higher levels in their profession, Safety in metal working and wood working machines.
- **ii)** Design, Establish, Implement maintain and continually improve an occupation health and management system to improve safety.
- **iii)** Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.
- **iv)** Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

10. Course Outcomes (COs): On completion of the course,

- **i)** Apply operations research techniques in industrial Safety in metal working and wood working machines.
- **ii)** Understanding the concept of Principles of Machine Guarding
- **iii)** Understanding the concept of Safety in Welding and Gas Cutting
- **iv)** Understanding the concept of Safety in Finishing, Inspection and Testing

11.Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Safety in metal working and wood working machines**

General safety rules-turning machines-boring machines-milling, planning and grinding machines-general safety principles-safety in the use of sawing machines-wood working equipment's. CNC machines-need for selection and care of cutting tools – preventive maintenance, periodical checks for safe operation – associated hazards and prevention.

Unit – 2	**Number of lectures = 10**	**Title of the unit: Principles of Machine Guarding**

Guarding during maintenance-Zero Mechanical State (ZMS) – Definition – Policy for ZMS – guarding of hazards point of operation, protective devices-machine guarding-types-fixed guard-interlock guard-automatic guard-trip guard-electron eye-positional control guard-fixed guard fencing. Selection and suitability: lathe-drilling-boring-milling-grinding-shaping-sawing-shearing- presses-forge hammer-flywheels-shafts-couplings-gears sprockets wheels and chains- pulleys and belts-authorized entry to hazardous installations-benefits of good guarding systems.

Unit – 3	**Number of lectures = 10**	**Title of the unit: Safety in Welding and Gas Cutting**

Gas welding and oxygen cutting-resistances welding, arc welding and cutting-common hazards-personal protective equipment-training-safety precautions in brazing, soldering and metalizing – explosive welding – selection, care and maintenance of the associated equipment and instruments – safety in generation, distribution

and handling of industrial gases-colour coding – flashback arrestor – leak detection-pipe line safety-storage and handling of gas cylinders.		
Unit – 4	**Number of lectures = 12**	**Title of the unit: Safety in Finishing, Inspection and Testing**
Safety in grinding-heat treatment operations-electro plating-paint shops-sand and shot blasting-safety in inspection and testing-dynamic balancing- hydro testing -valves- boiler drums and headers- pressure vessels, air leak test- steam testing-safety in radiography- personal monitoring devices-radiation hazards – engineering and administrative controls, Indian Boilers Regulation. Health and welfare measures in engineering industry-pollution control in engineering industry-industrial waste disposal.		
12.Brief Description of self-learning / E-learning component The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.		
13.Books Recommended		
Text Book		
i) Safety Management by John V. Grimaldi and Rollin H. Simonds, All India Travelers Book seller, New Delhi, 5th Edition. ISBN: 0939874989		
Reference Book		
i) Health and Safety in welding and Allied Processes, welding Institute, UK, High Tech. Publishing Ltd., London, 2002 5th Edition. ISBN: 9781855735385		

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Sales & Marketing</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">3</td><td colspan="2">0</td><td colspan="2">0</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td colspan="2">Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 42</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 0</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">This is a course based on practical introduction to marketing and sale management, students improve their ability to make effective sales and marketing decisions, including assessing marketing opportunities and developing marketing strategies and implementation plans</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) Develop effective marketing strategies and sales strategies to achieve organizational objectives.
ii) Design a strategy implementation program to Developing Sales Training
iii) To develop practical concept of Principles of Management
iv) To develop practical concept of Marketing Management and Financial Management</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Understanding the Nature and Scope of Sales Management.
ii) Understanding the Developing Sales Training
iii) Understanding the concept and Principles of Management
iv) Understanding the concept of Marketing Management and Financial Management</td></tr>
<tr><td colspan="8">11. Unit wise detailed content</td></tr>
<tr><td>Unit-1</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Nature and Scope of Sales Management</td></tr>
<tr><td colspan="8">Nature and Scope of Sales Management; Objectives and functions of Sales management; Prospecting for customers; Modes of sales presentation, Designing and delivering of sales presentation; Recruiting and selecting Sales Personnel – Methods and administering selection procedures.</td></tr>
<tr><td>Unit – 2</td><td>Number of lectures = 12</td><td colspan="6">Title of the unit: Developing Sales Training</td></tr>
<tr><td colspan="8">Developing Sales Training: Programmes, Executing and Evaluating sales training programmes; Motivating Sales Personnel; Compensating sales personnel, Designing and Administering various Compensation Plans; Controlling Sales personnel and managing sales evaluation programmes, Comparing standards with actual performances of sales personnel.</td></tr>
<tr><td>Unit – 3</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Principles of Management</td></tr>
<tr><td colspan="8">Introduction, Planning, Organizing, Staffing, Motivating and Leading, Controlling, introduction to business economics and fundamental concepts, consumer behavior and demand analysis, Theory of production cost analysis and price output decisions.</td></tr>
<tr><td>Unit – 4</td><td>Number of lectures = 10</td><td colspan="6">Title of the unit: Marketing Management and Financial Management</td></tr>
<tr><td colspan="8">Product, Pricing Decisions, Place, Promotion, Types of channels, promotion mix, product innovation and diffusion, pricing techniques, marketing logistics and supply chain management. Meaning and scope of accounting, accounting principles and standards, Journal sizing transactions, capital and revenue, deprecation provisions and reverse, company final accounts.</td></tr>
</table>

12. Brief Description of self-learning / E-learning component	
The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University. The link to the E-Learning portal. https://sgtlms.org Journal papers; Patents in the respective field.	
13. Books Recommended	
Text Book	
i)	Tanner, J; Honeycutt ED; Erffmeyer Robert C.; Sales management: Pearson Education, 2009, ISBN-13: 978-8131727379
Reference Books	
i)	Dalrymple, D J. Sales Management: Concepts and cases. New York, John Wiley, 1989, ISBN no.045089186
ii)	Still, R R. & Cundiff; Sales Management, Englewood Cliff, New Jersey, Printice Hall Inc ISBN: 0470452185

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Neural Networks and Fuzzy Systems**	**L**	**T**		**P**	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5.Pre-requisite (if any)		**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures =42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
Basic introduction to neural networks & fuzzy logic, development and implementation. It includes; Neural versus conventional computing. Learning processes. The MLP NN, backpropagation learning algorithm. Recurrent networks. Self-organization Feature maps. Applications. Introduction to Fuzzy theory. Fuzzy Logic. Neuro-Fuzzy system in engineering						
9. Learning objectives: **i)** Introduce the fundamentals of Neural Networks and its applications. **ii)** Provide an overview of deep learning and convolutional neural networks. **iii)** Gain understanding about the fundamentals of Fuzzy Logic and its applications **iv)** To understand membership functions and applications.						
10. Course Outcomes (COs): On completion of this course, the students will be able to **i)** Classify the types of neural networks. **ii)** Discuss about the applications of neural networks. **iii)** Describe the concepts of deep learning and convolutional neural networks **iv)** Compare fundamentals of classical logic and fuzzy logic concepts. **v)** Characterize the fuzzy membership functions. **vi)** Summarize the applications of fuzzy logic controllers.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction to Neural Networks**				
Differences between Biological and Artificial Neural Networks - Typical Architecture, Common Activation Functions, McCulloch - Pitts Neuron, Simple Neural Nets for Pattern Classification, Linear Separability - Hebb Net, Perceptron, Adaline, Madaline - Architecture, algorithm, and Simple Applications.						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Neural Network Applications**				
Training Algorithms for Pattern Association - Hebb rule and Delta rule, Heteroassociative, Autoassociative and Iterative Auto associative Net, Bidirectional Associative Memory - Introduction to Neural Network Controllers						

Unit – 3	Number of lectures = 12	Title of the unit: Deep Learning and Convolution Neural Networks, Classical and Fuzzy Sets and Relations
Evolution of deep learning – Impact of deep learning – Motivation for deep architecture – Applications – Deep Learning in Computer Vision – Convolutional Neural Networks – Popular CNN Architecture – Simple Applications. Properties and Operations on Classical and Fuzzy Sets, Crisp and Fuzzy Relations - Cardinality, Properties and Operations, Composition, Tolerance and Equivalence Relations, Simple Problems.		
Unit – 4	**Number of lectures = 10**	**Title of the unit: Membership Functions and Applications**
Features of membership function, Standard forms and Boundaries, fuzzification, membership value assignments, Fuzzy to Crisp Conversions, Defuzzification methods, Neural Networks: Case Studies: Inverted Pendulum, CMAC, Robotics, Image compression, and Control systems - Fuzzy Logic: Mobile robot navigation, Autotuning a PID Controller.		

12. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Jacek M. Zurada, ‘Introduction to Artificial Neural Systems’, Jaico Publishing home, 2002

ii) Timothy J. Ross, ‘Fuzzy Logic with Engineering Applications’, Tata McGraw Hill, 2009.

Reference Books

i) LaureneFausett, Englewood cliffs, N.J., ‘Fundamentals of Neural Networks’, Pearson Education, 2008.

ii) Simon Haykin, ‘Neural Networks’, Pearson Education, 2003.

iii) George.J.Klir, ‘Fuzzy Sets and Fuzzy Logic – Theory and Applications’, Pearson, 2015.

iv) Rajasekaran, VijayalakshmiPai, “Neural Networks, Fuzzy Systems and Evolutionary Algorithms”, PHI Learning, 2017.

v) Shigeo Abe, “Neural Networks and Fuzzy Systems”, Springer, 2012.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Aerospace Materials**	**L**	**T**		**P**	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5.Pre-requisite (if any)	**MET**	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. Course Description

This course teaches the fundamentals for the analysis of materials and structures in engineering with a specific focus on aircraft and space structures. This course provides an introduction about the different types of materials used for aerospace applications. The course gives a detailed knowledge of the material used in aircrafts and also the mechanical behavior of materials.

9. Learning objectives: Students undergoing this course are expected to**:**

- **i)** To enumerate the mechanical properties of aerospace materials.
- **ii)** To study the importance of non-ferrous metals in aerospace equipment.
- **iii)** To study the role of ferrous metals in aerospace equipment.
- **iv)** To study the thermal properties and the behavior of materials at high temperature.

10. Course Outcomes (COs): On course completion students will be able to:

- **i)** To apply the knowledge about the mechanical behaviour of different aircraft & aerospace materials.
- **ii)** To explain the applications of aluminum alloys, ceramics and composites materials.
- **iii)** To explain the applications of alloy steel, corrosion and heat resistant steel materials.
- **iv)** To appreciate the importance of high temperature materials and their characterization.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Mechanical Behaviour of Materials**

Linear and non-linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect –Knowledge of Various types of hardness testing machines- Notch effect testing and flaw detection of materials and components – creep and fatigue.

Unit – 2	**Number of lectures = 11**	**Title of the unit: Non-ferrous materials in aircraft construction**

Aluminium and its alloys: Types and identification. Properties – Castings – Heat treatment processes – Surface treatments. Magnesium and its alloys: Cast and Wrought alloys – Aircraft application, features specification, fabrication problems, Special treatments. Titanium and its alloys: Applications, machining, forming, welding and heat treatment, Copper Alloys. Wood and fabric in aircraft construction and specifications -Glues Use of glass, plastics & rubber in aircraft, Introduction to glass & carbon composite.

Unit – 3	Number of lectures = 11	Title of the unit: Ferrous materials in aircraft construction
Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications. Maraging Steels: Properties and Applications. Super Alloys: Use – Nickel base – Cobalt base – Iron base -Forging and Casting of Super alloys – Welding, Heat treatment		
Unit – 4	**Number of lectures = 10**	**Title of the unit: High Temperature Materials Characterization**
Classification, production and characteristics, Methods and testing, Determination of mechanical and thermal properties of materials at elevated temperatures, Application of these materials in Thermal protection systems of Aerospace vehicles, High temperature material characterization.		

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Pantelakis, S., Tserpes, K. (2020), "Revolutionizing Aircraft Materials and Processes", Germany: Springer International Publishing, ISBN: 9783030353469, 303035346X

Reference Books

i) Mouritz, A. P. (2012), "Introduction to Aerospace Materials", United Kingdom: Elsevier Science, ISBN: 9780857095152, 0857095153

ii) Gupta Balram (2002), "Aerospace Materials V" India: S. Chand Limited, ISBN: 9788121922272, 8121922275

iii) Siddiqui, T. (2014), "Aircraft Materials and Analysis", United States: McGraw-Hill Education, ISBN: 9780071831147, 0071831142

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Cognitive Robotics**	**L**	**T**		**P**	
3. Course Code		3	0		0	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**Robotics Engineering and Its Application**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. 8. Course Description

This course teaches the fundamentals for the Cognitive Robots. This course provides an introduction about the Cybernetic View of Robot Cognition and Perception, Map Building. materials used for aerospace applications. The course gives a detailed knowledge of the Randomized Path Planning and Simultaneous Localization and Mapping (SLAM). Also provide the detailing of Robot Programming Packages and Imaging Geometry.

9. Learning objectives: Students undergoing this course are expected to

i) Provide an overview of tele-robotics.
ii) Understand the concept of networked telerobotic systems.
iii) Provide knowledge on the functions of online robots
iv) Explain the fundamentals of robot manipulation and teleoperation.

10. Course Outcomes (COs): On course completion students will be able to

i) Discuss about the basic principles of telerobotic
ii) Describe the concepts of wired and wireless communication for networked telerobotic systems.
iii) Design and fabricate the software architecture and interface for networked robot systems on the web.
iv) Analyze the performance of mobile robots controlled through the web.

11. Unit wise detailed content

Unit-1	**Number of lectures = 10**	**Title of the unit: Cybernetic View of Robot Cognition and Perception, Map Building**

Introduction to the Model of Cognition, Visual Perception, Visual Recognition, Machine Learning, Soft Computing Tools and Robot Cognition.
Introduction, Constructing a 2D World Map, Data Structure for Map Building, Explanation of the Algorithm, An Illustration of Procedure Traverse Boundary, An Illustration of Procedure Map Building, Robot Simulation, Execution of the Map Building Program.

Unit – 2	**Number of lectures = 11**	**Title of the unit: Randomized Path Planning**

Introduction, Representation of the Robot's Environment, Review of configuration spaces, Visibility Graphs, Voronoi diagrams, Potential Fields and Cell Decomposition, planning with moving obstacles, Probabilistic Roadmaps, rapidly exploring random trees, Execution of the Quad tree-Based Path Planner Program.

Unit – 3	**Number of lectures = 11**	**Title of the unit: Simultaneous Localization and Mapping (SLAM)**

Problem Definition, Mathematical Basis, Examples: SLAM in Landmark Worlds, Taxonomy of the SLAM Problem, Extended Kalman filter, Graph-Based Optimization Techniques, Particle Methods Relation of Paradigms. Module 5: R

Unit – 4	**Number of lectures = 10**	**Title of the unit: Robot Programming Packages and Imaging Geometry**

Robot Parameter Display, Program for Bot Speak, Program for Sonar Reading Display, Program for Wandering Within the Workspace, Program for Tele-operation, A Complete Program for Autonomous Navigation. Module

Introduction – Necessity for 3D Reconstruction – Building Perception – Imaging Geometry – Global Representation – Transformation to Global Co-ordinate System

12. Brief Description of self-learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Books

i)	Patnaik, Srikanta, "Robot Cognition and Navigation - An Experiment with Mobile Robots", Springer Verlag Berlin and Heidelberg, 2007.
ii)	Howie Choset, Kevin LynchSeth Hutchinson, George Kantor, Wolfram Burgard, Lydia Kavraki, and Sebastian Thrun, "Principles of Robot Motion-Theory, Algorithms, and Implementation", MIT Press, Cambridge, 2005.

Reference Books

i)	Sebastian Tharun, Wolfram Burgard, Dieter Fox, "ProbabilisticRobotics", MIT Press, 2005.
ii)	Margaret E. Jefferies and Wai-Kiang Yeap, "Robotics and Cognitive Approaches to Spatial Mapping", Springer-Verlag Berlin Heidelberg 2008.
iii)	HoomanSomani,"Cognitive Robotics", CRC Press, 2015.
iv)	Jared Kroff,"Cognitive Robotics: Intelligent Robotic Systems", Wilford Press, 2016.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Autonomous Vehicle**	**L**	**T**		**P**	
3.Course Code		3	0		0	
4.Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5.Pre-requisite (if any)	Automobile technology	**6.Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7.Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			
8. Course Description						
Self-driving cars have rapidly become one of the most transformative technologies to emerge. Fuelled by Deep Learning algorithms, they are continuously driving our society forward and creating new opportunities in the mobility sector.						
9. Learning objectives: **i)** Introduce the fundamental aspects of Autonomous Vehicles. **ii)** Gain Knowledge about the Sensing Technology and Algorithms applied in Autonomous vehicles. **iii)** Understand the Connectivity Aspects and the issues involved in driverless cars. **iv)** To learn about Autonomous vehicle technology and its biggest Challenges.						
10. Course Outcomes (COs): On completion of this course, the students will be able to **i)** Describe the evolution of Automotive Electronics and the operation of ECUs. **ii)** Compare the different type of sensing mechanisms involved in Autonomous Vehicles. **iii)** Discuss about the use of computer vision and learning algorithms in vehicles. **iv)** Summarize the aspects of connectivity fundamentals existing in a driverless car. **v)** Identify the different levels of automation involved in an Autonomous Vehicle. **vi)** Outline the various controllers employed in vehicle actuation.						
11. Unit wise detailed content						
Unit-1	**Number of lectures = 10**	**Title of the unit: Introduction**				
Evolution of Automotive Electronics -Basic Control System Theory applied to Automobiles -Overview of the Operation of ECUs -Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems-Autonomous Vehicles						
Unit – 2	**Number of lectures = 10**	**Title of the unit: Sensor Technology for Autonomous Vehicles**				
Basics of Radar Technology and Systems -Ultrasonic Sonar Systems -LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters						
Unit – 3	**Number of lectures = 12**	**Title of the unit: Computer Vision and Deep Learning, Connected Car Technology**				

Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing –TensorFlow -Overview of Deep Neural Networks -Convolutional Neural Networks, Connectivity Fundamentals - DSRC (Direct Short Range Communication) - Vehicle-to-Vehicle Technology and Applications -Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications -Security Issues.

Unit – 4	**Number of lectures = 10**	**Title of the unit: Autonomous Vehicle Technology and its biggest Challenges**

Driverless Car Technology-Different Levels of Automation -Localization - Path Planning. Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers, ROS Framework, Technical Issues, Security Issues, Moral and Legal Issues.

12. Brief Description of self learning / E-learning component

The students will be encouraged to learn using the SGT E-Learning portal and choose the relevant lectures delivered by subject experts of SGT University.

The link to the E-Learning portal.

https://sgtlms.org

Journal papers; Patents in the respective field.

13. Books Recommended

Text Book

i) Hong Cheng, “Autonomous Intelligent Vehicles: Theory, Algorithms and Implementation”, Springer, 2011.

ii) Williams. B. Ribbens: “Understanding Automotive Electronics”, 7th Edition, Elsevier Inc, 2012.

Reference Books

i) Shaoshan Liu, Liyun Li, “Creating Autonomous Vehicle Systems”, Morgan and Claypool Publishers, 2017.

ii) Marcus Maurer, J.ChristianGerdes, “Autonomous Driving: Technical, Legal and Social Aspects” Springer, 2016.

iii) Ronald.K.Jurgen, “Autonomous Vehicles for Safer Driving”, SAE International, 2013.

iv) James Anderson, KalraNidhi, Karlyn Stanly, “Autonomous Vehicle Technology: A Guide for Policymakers”, Rand Co, 2014.

v) Lawrence. D. Burns, ChrostopherShulgan, “Autonomy – The quest to build the driverless car and how it will reshape our world”, Harper Collins Publishers, 2018

1. Name of the Department- Mechanical Engineering

2. Course Name	**Automation in Manufacturing Lab**	**L**	**T**		**P**		
3. Course Code		**0**	**0**		**4**		
4. Type of Course (use tick mark)		**Core (✓)**	**PE ()**		**OE ()**		
5. Pre-requisite (if any)	**Manufacturing Processes and Technology & Engineering Graphics and Design**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	

7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)

Lectures = 00	**Tutorials = 0**	**Practical = 56**

8. Course Description

Automation in manufacturing is the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. Students learn the importance of CAD/CAM principles in the Product development, programs related to manufacturing using codes and analyze the importance of networking in manufacturing environment.

9. Learning objectives:

i) To understand the basics of CAD/CAM and concepts of computer graphics.
ii) To learn about the geometric issues concerned to the manufacturing and its related areas.
iii) To understand the latest advances in the manufacturing perspectives and their applications.
iv) To have an idea of Computer Integrated Manufacturing.

10. Course Outcomes (COs): On completion of this course, the students will be able to:

i) To understand the importance of CAD/CAM principles in Product development.
ii) To develop programs related to manufacturing using codes.
iii) To understand the concept of group technology and flexible manufacturing system.
iv) To understand in details about computer integrated manufacturing.

11. Unit wise detailed content

Sr. No.	Title	COs covered
1	Use and learn import/export techniques and customization of software.	i)
2	Construction of simple machine parts and components like Coupling, Crankshaft, Pulley, Piston, Connecting rod, nuts, bolts, gears and helical springs.	i)
3	Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies: Lathe Tail stock, Machine vice, Pedestal bearing, Drill jigs and Milling fixture.	i)
4	Make the part family/family table of a bolt	i)
5	Tool path generation	i)
6	Part programming	ii)
7	G & M codes development for machining operations	ii)
8	Physical interpretation of machining features and tool geometries	iii)
9	Part Programming- CNC Machining Centre i) 1inear Cutting. ii) Circular cutting. iii) Cutter radius Compensation	ii), iv)

	iv) Canned Cycle operations	
10	Part Programming i) Straight, Taper and Radius Turning. ii) Thread Cutting. iii) Rough and Finish Turning Cycle. iv) Drilling and Tapping Cycle.	ii), iv)
11	Contour milling using CNC milling machine	ii), iv)
12	Spur gear cutting in CNC milling machine	ii), iv)
13	CL Data and Post Process generation using CAM packages.	ii), iv)
14	Application of CAPP in Machining and Turning Centre.	ii), iv)

Department Electives-IX Lab

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Nuclear Power Engineering Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**Engg. Thermodynamics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

Nuclear Power Engineering concentrate on the principles, techniques and processes involved in generation of power from nuclear fuels. This involves studying and exploring various aspects of science ranging from processing of nuclear fuel to merits and demerits of various nuclear reactors and from reprocessing of nuclear waste to their safely disposal. Upon completion of this course students will be able to have better understanding of nuclear processes involved in nuclear power generation, know working and pros & cons of various reactors and also have understanding of nuclear power generation and safety rules implemented during power generation from nuclear fuels and nuclear waste disposal.

9. Learning objectives:

- **i)** The student will be exposed to the basic physics of nuclear reactions and operation of nuclear reactors.
- **ii)** To learn various types of power generation methods, safety and its impact on environment.
- **iii)** Give understanding of Separators used in reactors.
- **iv)** Learn about how to dispose the waste and get protected from radiations.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Know the nuclear fission and fusion processes.
- **ii)** Understand the working of a nuclear reactors
- **iii)** Understand power generation and safety aspects.
- **iv)** Able to apply the concepts of waste disposal and radiation protection.

11. Lab Content

Sr. No.	**Title**	**COs covered**
1	Nuclear Reactors	i), ii)
2	Reactor Materials	ii)
3	Reprocessing	iii)
4	Separation	iii)
5	Waste Disposal and Radiation Protection	iv)
6	Protection	iii

2. Name of the Department- Mechanical Engineering						
3. Course Name	**Machine Tool Technology Lab**	**L**	**T**		**P**	
4. Course Code		**0**	**0**		**2**	
5. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**EAS ()**	**BSC ()**
6. Pre-requisite (if any)	**Manufacturing Processes and Technology**	**7. Frequency (use tick marks)**	Even (✓)	Odd ()	Either Sem ()	Every Sem ()
8. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 00		**Tutorials = 0**	**Practical = 28**			

9. Course Description

Study of different machine tools and hence educates the students about the scope of the subject. To train the students in the metal cutting domain so as to equip them with adequate knowledge about the various processes. To emphasize upon the prominent theories, concepts and constructional features of machines related to them. To provide an insight about the super finishing operations of gear generating. To lay groundwork for further studies in manufacturing stream.

10. Learning objectives:

- **i)** The course provides students with fundamental knowledge and principles of tool design.
- **ii)** To demonstrate the fundamentals of machining tool guide ways.
- **iii)** To develop fundamental knowledge of gear generating processes.
- **iv)** Understand the basics of press tool engineering and jigs- fixtures.

11. Course Outcomes (COs): The curriculum of the Department is designed to satisfy the diverse needs of students.

- **i)** Understand the cutting tool geometry, mechanism of machine tool design.
- **ii)** Understand the machining tool guide ways to produce a component.
- **iii)** Acquire knowledge of gear generation process with applications, advantages and disadvantages
- **iv)** Acquire knowledge of the basics of press tool engineering and jigs- fixtures.

12. Lab Content

Sr. No.	**Title**	**COs covered**
1	Tool grinding (to provide tool angles) on tool-grinder machine.	i)
2	Experiments on turning and facing on lathe	i)
3	To perform step turning and thread cutting on lathe.	i)
4	To perform taper turning operation on lathe	ii)
5	To perform knurling, drilling operation on lathe.	ii)
6	To study the characteristic features of Milling machine and shaper machine.	ii)
7	To perform Gear cutting on Milling machine.	iii)
8	To study the Machining a block on shaper machine.	iii)

9	To study the Finishing of a surface on surface-grinding machine.	iii)
10	To study the Drilling holes on drilling machine and study of twist-drill.	iv)
11	Study of different types of tools and its angles & materials.	iv)
12	Experiment on jigs/Fixtures and its uses	iv)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Recent Trends in Automotive Technology Lab</td><td>L</td><td>T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td>0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>IC Engines, Automobile Engineering</td><td>6. Frequency (use tick marks)</td><td>Even () | Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="6">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="3">Practical = 28</td></tr>
<tr><td colspan="6">8. Course Description</td></tr>
<tr><td colspan="6">This course provides students a synopsis of latest trends in automotive industry used in evaluation of world. This includes understanding the basic principles of various hybrid and electric vehicles with importance, applications and limitations.</td></tr>
<tr><td colspan="6">9. Learning objectives:
i) Understand the suspension, brakes and safety.
ii) Understand the vehicle operation and control.
iii) Understand the Electric and Hybrid Vehicles.
iv) Understand the Latest Engine Technology Features and 42 Volt Systems.</td></tr>
<tr><td colspan="6">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Know the Hybrid, Battery and Magnetic track Vehicle.
ii) Describe the computer control in automotive.
iii) Describe the working of vehicle for safe ad fast travel.
iv) Know the latest trend in Automotive Industry.</td></tr>
<tr><td colspan="6">11. Lab Content</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	To study the working and constructional details of Electric vehicle.	i)
2	To study the working and constructional details of Hybrid vehicle.	i)
3	To study about the latest safety features like EBD, ABS, Electronic Braking, Traction and Stability control.	ii), iii)
4	To study the working of Collision warning system	ii), iii)
5	To study the various Convenience Systems.	ii), iii)
6	To study in detail about the 42 Volt System.	ii)
7	To study in detail about the working of Regenerative Braking System.	i)
8	To study the function and working of Turbo Boost in Engines.	iv)
9	To study about the application Solar power in Automobile.	iv)
10	To study about the function and working of Safety Belt and Air Bags in Automobile.	iii)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Maintenance Engineering Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>EAS ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">This course introduces the concepts of Maintenance categories Comparative merits of each category, Preventive maintenance, maintenance schedules, repair cycle and Principles and methods of lubrication with TPM.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To know the structure, operation and applications of the concepts of Industrial maintenance and its Management.
ii) To enable the students, apply mathematical, computational and communication skills to learn full cost analysis for maintenance a system.
iii) To introduce students' concept of Condition Monitoring, Cost comparison with and without CM.
iv) To introduce students' concept of key features of Industrial and Total Quality Management.</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On successful completion of this course, the student will be able to:
i) Define and measure various Basic Principles of maintenance planning.
ii) Perform full cost analysis for maintenance a system.
iii) Apply the concept of Condition Monitoring Cost comparison with and without CM
iv) Explain key features of Industrial and Total Quality Management.</td></tr>
<tr><td colspan="8">11. Lab Component</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	To Study the benefits of sound Maintenance systems using case study.	i)
2	To Study the maintenance organization using case study.	i)
3	To study the principles and methods of lubrication using TPM.	ii)
4	To Study the maintenance schedules, using case study.	ii)
5	To Study the Preventive maintenance-using case study.	ii)

6	To study the Methods and instruments for CM – Temperature sensitive tapes.	iii)
7	To study the techniques for Pistol thermometers – wear-debris analysis	iii)
8	To study the Cost comparison with and without CM – On-load testing and offload testing.	iii)
9	To study the Job order systems -Use of computers in maintenance.	iv)
10	To study the Logical fault location methods	iv)

<table>
<tr><td colspan="6">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Operation Research Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>EAS ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="8">8. Course Description</td></tr>
<tr><td colspan="8">Operation research is having many powerful tools to optimize the real-life problems. The study of this subject will give knowledge to the students regarding transportation and inventory related problems. This also describes the method of sequencing of jobs through different number of machines. Focus is also given to most common problems of waiting of either job/machines/peoples. Emphasis is given to decision models and replacement problems. So, the study of this subject will develop the capability among students to solve effectively many problems arising during their career.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To provide students the knowledge of Linear model.
ii) To enable the students, apply mathematical, computational and communication skills to learn Sequencing and Networks needed for the practical utility of Operations Research.
iii) To introduce students concept of inventory model in Operations Research.
iv) To introduce students concept of Queuing Models and decision models</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Apply the concept of Linear model to solve various transportation problems.
ii) Apply the concept of Sequencing and Networks to optimize the production
iii) Apply the concept of inventory model to maximize the profit.
iv) Apply the concept of Queuing Models and decision models to forecast the demand in the industry.</td></tr>
<tr><td colspan="8">11. Lab Component</td></tr>
</table>

Sr. No.	Title	COs covered
1	To Study the Linear Programming - Mathematical Formulation.	i)
2	To Study the transportation problem using case study.	i)
3	To study the M’ machines using modified Johnson’s method.	ii)
4	To Study the Project Network – CPM using case study	ii)
5	To Study the Project Network –PERT using case study	ii)
6	To study the Stochastic Inventory models	iii)

7	To study the techniques for EOQ–Deterministic inventory models	iii)
8	To study the Decision models – Game theory	iii)
9	To study the Queuing models	iv)
10	To study the Monte-Carlo Simulation models	iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Instrumentation and Control Engineering Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>NIL</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 00</td><td colspan="2">Tutorials = 00</td><td colspan="3">Practical = 28</td></tr>
</table>

8. Course Description:

The objective of this Lab-work course is to provide students with sufficient hands-on experience in working with different instruments. This course combines knowledge, techniques, and methodologies from various sources, using techniques from transform theory and basic principle of classical physics based upon which different instruments and sensors are built.

9. Learning Objectives:

- **i)** To understand the principles of measurements, methods of measurements and its application in manufacturing industries.
- **ii)** To understand the principles of temperature and force measurements.
- **iii)** To understand the principles of flow and displacement measurements.
- **iv)** To understand the principles of speed measurement and use of strain gauges.

10. Course Outcomes (Cos): On completion of this course, the students will be able to

- **i)** Demonstrate the various parameters of measurements using instruments.
- **ii)** Determine the magnitude of parametric measurements such as load, torque and temperature.
- **iii)** Measure displacement and flow using different instruments.
- **iv)** Measure speed and know the various uses of strain gauges.

11. Lab component

Sr. No.	Title	COs covered
1	To study the characteristics of LVDT	i), iii)
2	To measure the load using load cell	i), ii)
3	To measure the temperature using thermocouple	i), ii)
4	Measurement of torque using torque measurement setup.	i), ii)
5	To measure the temperature using RTD	i), ii)
6	Speed measurement using stroboscope	i), iv)
7	Flow measurement experiment.	i), iii)
8	DC motor speed control	i), iii)

9	Experiment on Dynamometers.	i), iii)
10	Strain Measurement using Strain Gauge.	i), iv)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Nano-Technology and Surface Engineering Lab</td><td colspan="2">L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td colspan="2">0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td>EAS ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td></td><td colspan="2">6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td colspan="2">Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
<tr><td colspan="2">8. Course Description</td><td colspan="2"></td><td colspan="4"></td></tr>
<tr><td colspan="8">Surface engineering is a sub-discipline of Materials Science and Materials Engineering which deals with the surface of a solid and its modifications. The primary goal of Surface Engineering of nanomaterials is to modify the properties of surface to improve its electrical and thermal properties, and to improve the compatibility of nanomaterials with some matrix when they are used as reinforcing fillers in composites for high performance applications. The course should give a basic introduction to chemical and physical principles in the synthesis of inorganic nanostructured materials. In addition, basic principles of finite size effects will be covered. The course will also cover different methods for synthesis and characterization of different nanostructures and nanostructured bulk materials.</td></tr>
<tr><td colspan="8">9. Learning objectives:
i) To understand the basic concepts of surface engineering
ii) To understand the basic concepts of Nano-coating.
iii) To enhance the knowledge of Nano material.
iv) To allowing students to get familiarized with Microencapsulation</td></tr>
<tr><td colspan="8">10. Course Outcomes (COs): On completion of this course, the students will be able to
i) Use of surface engineering and Nanomaterials for various industrial applications.
ii) To understand the basic concepts of Surface Engineering of Nano materials
iii) Qualitatively describe how the nanoparticle size can affect the morphology, crystal structure, reactivity, and electrical properties.
iv) Describe Microencapsulation and their application in industry</td></tr>
<tr><td colspan="8">11. Lab Component</td></tr>
</table>

Sr. No.	**Title**	**COs covered**
1	To study the effect of wear on the surface of Nano materials	i)

2	To study the effect of corrosion on the surface of Nano materials	i)
3	To study the effect of friction tribology on the surface of Nano materials	i)
4	To study the nano-structured coatings developed using CVD and PVD	ii)
5	To study the Functional coatings developed using CVD and PVD.	ii)
6	To study the advanced coating developed using CVD and PVD	ii)
7	To study the effect in electrochemical properties of nanostructured coatings.	iii)
8	To study the effect in mechanical properties of nanostructured coatings.	iii)
9	To study the effect in physical and other properties of Nanostructured coatings.	iii)
10	To study the Current trends in surface modification of Nanomaterials.	iv)
11	To study the Current trends in surface Modified Nanomaterials.	iv)
12	To study the Main problems in synthesis of Modified Nanomaterials	iv)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Robot Operating Systems Lab**	**L**	**T**	**P**			
3. Course Code		**0**	**0**	**2**			
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**			
5. Prerequisite (if any)	**Materials Engineering and Technology**	**6. Frequency (use tick marks)**	Even ()		Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

8. Course Description

The main aim of this course is to introduce the Robot Operating system. This course gives a brief understanding of the UNIX, architecture of operating system, computation graph level, debugging and Visualization. To give a practical exposure various case studies will be introduced.

9. Learning objectives:

- **i)** Introduce the basics of Robot Operating Systems.
- **ii)** Understand the Architecture of Operating System.
- **iii)** Provide knowledge on the hardware interfacing aspects.
- **iv)** Understand the applications of ROS in real world complex applications

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Describe the need for ROS and its significance. Summarize the Linux commands used in robotics.
- **ii)** Discuss about the concepts behind navigation through file system.
- **iii)** Explain the concepts of Node debugging
- **iv)** Analyze the issues in hardware interfacing and discuss about the applications of ROS

11. Lab content

Sr. No.	Title	COs Covered
1	To study various ROS and their significance.	i)
2	To study and understand the UNIX Commands used in Robotics	i)
3	To study the Navigation through file system	ii)
4	To study the Debugging of Nodes.	iii)
5	To study the visualization using Gazebo	iii)
6	To study the Hardware Interface of Robots	iv)
7	To study the Sensor Interfacing and Sensor Drivers for ROS	iv)
8	To study the Actuator Interfacing and Motor Drivers for ROS	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Modelling and Simulation of EHV**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**Introduction to Electric and Hybrid Vehicles**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			
8. Course Description						
This course introduces the fundamental concepts, principles, analysis and design of hybrid and electric vehicles using the Modelling and Simulation. The material for this course will be prepared in such a manner that it will be useful for graduate students, teachers, practitioners and final year undergraduate students.						
9. Learning objectives: **i)** To know the basics of Modelling in performance parameters. **ii)** Learn about the Modelling of Batteries **iii)** To know the Drivetrain characteristics using Modelling of it. **iv)** Understand the concept of Energy Management.						
10. Course Outcomes (COs): On successful completion of this course, the student will be able to **i)** Understand the modeling of vehicle performance parameters. **ii)** Model battery electric vehicles. **iii)** Describe the drive train characteristics. **iv)** Apply the concepts of energy management system.						
11. Lab Content						

Sr. No.	**Title**	**COs covered**
1	To Simulate the battery electric vehicle by using MATLAB.	i)
2	To Simulate the Motor performance of electric vehicle by using MATLAB.	i)
3	To study about Modelling and Characteristics of EV/HEV Power trains Components.	i)
4	To study about the acceleration performance of a car.	ii)
5	To study & Analysis of Electric and Hybrid Electric Vehicles Propulsion and Braking.	ii)
6	To study about energy management system of EVs.	ii)
7	To study about the MATLAB & Simu-link software for EVs.	iii)
8	To Study about control strategies of simulation.	iv)

Department Electives-
X Lab

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Advanced Heat Transfer Laboratory**	**L**	**T**		**P**		
3. Course Code		**0**	**0**		**2**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite (if any)	**Engineering Thermodynamics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures =0		**Tutorials = 0**	**Practical = 28**				

8. Course Description

An introductory course in heat and mass transfer covering conduction, convection and radiation heat transfer, principals of heat exchanger and mass transfer. Heat transfer and mass transfer are kinetic processes that may occur and be studied separately or jointly. Studying them apart is simpler, but both processes are modelled by similar mathematical equations in the case of diffusion and convection (there is no mass-transfer similarity to heat radiation), and it is thus more efficient to consider them jointly. Besides, heat and mass transfer must be jointly considered in some cases like evaporative cooling and ablation

9. Learning Objectives:

- **i)** To comprehend and evaluate various modes of heat and mass transfer.
- **ii)** To design fin enhanced systems, evaporators, condensers and heat exchangers.
- **iii)** To understand boundary layer theory, condensation and boiling.
- **iv)** To determine effectiveness of heat exchangers using LMTD and NTU.

10. Course Outcomes (COs): On completion of this course, the student will be able to:

- **i)** Apply basic principles of fluid mechanics, thermodynamics, heat transfer for designing heat and mass transfer systems.
- **ii)** Model heat, mass and momentum transport systems and develop predictive correlation.
- **iii)** Assess and evaluate various designs for heat and mass transfer and optimize the solution.
- **iv)** Apply the basic principles of heat exchanger applications.

11. Lab Components

Sr. No.	Title	COs Covered
1	To calculate thermal conductivity of insulating material in the form of slab.	i), ii)
2	To calculate total thermal resistance and thermal conductivity of composite wall.	ii), iii)

3	To calculate the thermal conductivity of insulating powder.	ii)
4	To calculate the thermal conductivity of given liquid (glycerin).	ii), iii)
5	To calculate the average heat transfer co-efficient of vertical cylinder under natural convection.	ii), i)
6	To calculate surface heat transfer coefficient for a pipe by forced convection and compare heat transfer coefficient for different air flow rates and heat flow rates.	ii)
7	To calculate the heat transfer coefficient experimentally and theoretically for free and forced convection and compare the theoretical temperature distribution with experimentally obtained distribution.	iii), iv)
8	To study the Boiling Heat Transfer phenomenon for pool boiling of water.	iii)
9	To conduct test on a heat pipe and compare the temperature distribution and rate of heat transfer with geometrically similar copper and stainless-steel tubes.	ii), iii)
10	To determine the value of Stefan-Boltzmann constant for radiation heat transfer.	ii), iii)
11	To measure the property of emissivity of the test plate surface at various temperatures.	ii), iii)
12	To study and compare temperature distribution, heat transfer rate, overall heat transfers co-efficient in parallel flow and counter flow heat-exchanger.	iv)

<table>
<tr><td colspan="8">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Modeling and Simulation of Manufacturing Systems Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>0</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite</td><td>Computer Aided Machine Design</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="8">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="3">Lectures = 00</td><td colspan="2">Tutorials = 00</td><td colspan="2">Practical = 28</td></tr>
</table>

8. Course Description:

The objective of this course is to give a sound knowledge of the fundamental aspects of system simulation, which is used in the analysis of complex system and finds applications in a wide range of real life situations. Modeling and Simulation of Manufacturing Systems course is concerned with the concepts of system, system modeling and simulation, has been expanded to include the details of types of models and simulation software. This course covers the mathematical and statistical models. This course provides the knowledge of random number generation and inverse transform techniques. This course also discusses the analysis of simulation data and application of simulation system in manufacturing and material handling systems.

9. Learning objectives:

i) To learn about discrete event simulation basics.
ii) To introduce modeling, simulation and optimization as it applies to the study and analysis of manufacturing systems for decision support.
iii) To expose with a wide range of applications for simulation methods and models and to integrate them with their introduction to operations management.
iv) To familiarize students with the process of analyzing different types of simulation data.

10. Course Outcomes (COs): On completion of this course, the students will be able to

i) Develop the practical skills necessary to design, implement and analyze discrete-event simulation systems.
ii) Cover the basic theory underlying discrete-event simulation methodologies in order to enable a critical understanding of simulation output in managerial environments.
iii) Get comfortable in applying and analyzing the process of operations management. Build the foundations necessary to quickly adapt for future advances in simulation technology.
iv) Build the foundations necessary to quickly adapt for future advances in simulation technology.

11. Lab Content

Sr. No.	Title	CO covered
1	Simulation of a single server system	i)
2	Simulation of 2 machine n-job system for Johnson job sequencing rules	i), ii)
3	Simulation of a multi server system with different dispatching rules	i), ii)

4	Simulation of an FMS	iii), iv)
5	Simulation of Manufacturing system for different scheduling rules	ii), iii), iv)
6	Simulation of a simple supply chain	i), iii)
7	To generate Random variates using C	iii)
8	To apply Linear programming model for an industrial scenario	i)
9	To evaluate material flow in Facilities layouts	iii), iv)
10	Simulation of manufacturing systems with different Inventory control policies	i), ii)

<table>
<tr><td colspan="7">1. Name of the Department- Mechanical Engineering</td></tr>
<tr><td>2. Course Name</td><td>Gas Dynamics and Jet Propulsion Lab</td><td>L</td><td colspan="2">T</td><td colspan="2">P</td></tr>
<tr><td>3. Course Code</td><td></td><td>3</td><td colspan="2">0</td><td colspan="2">2</td></tr>
<tr><td colspan="2">4. Type of Course (use tick mark)</td><td>Core ()</td><td colspan="2">PE (✓)</td><td colspan="2">OE ()</td></tr>
<tr><td>5. Pre-requisite (if any)</td><td>Engineering Thermodynamics</td><td>6. Frequency (use tick marks)</td><td>Even ()</td><td>Odd (✓)</td><td>Either Sem ()</td><td>Every Sem ()</td></tr>
<tr><td colspan="7">7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)</td></tr>
<tr><td colspan="2">Lectures = 0</td><td>Tutorials = 0</td><td colspan="4">Practical = 28</td></tr>
</table>

8. Course Description

The principles of jet propulsion are of prime significance in designing and constructing aircraft engines. The primary focus of this course is on the teaching of thermodynamics and gas dynamics in aircraft engines. This course provides information that will enable the engineering analysis of ramjets and turbine engines and its separate components including inlets, nozzles, combustion chambers, compressors.

9. Learning objectives:

- **i)** To learn about various types of fuels, their composition and properties
- **ii)** To provide an insight into applications of compressible flows and the fundamentals of jet propulsion systems.
- **iii)** To formulate and solve problems in one-dimensional steady compressible flow.
- **iv)** To solve problems in two-dimensional compressible flows.

10. Course Outcomes (COs): On completion of this course, the students will be able to

- **i)** Demonstrate the knowledge of major elements in a jet engine and calculate the overall performance of a jet engine.
- **ii)** Apply the concepts of gas dynamics for applications related to compressible flows and jet propulsion.
- **iii)** Possess the knowledge of combustion in Jets.
- **iv)** Possess the knowledge of jet engines and aircraft propulsion theories.

11. Lab Content

Sr. No.	Title	COs covered
1	Tutorial on Momentum and energy in steady flow	i)
2	Tutorial on Effect of Mach number on compressibility	i), ii)
3	Tutorial on Isentropic flow through a constant area duct	i), ii)
4	Tutorial on Mass flow rate through nozzles and diff users	i), ii)
5	Tutorial on Fanno curves - Equation and its solution	i), iii)
6	Tutorial on Strength of shock wave - entropy change	i), iii)
7	Tutorial on Rayleigh flow equation - Rayleigh line	i), iii)
8	Tutorial on Thrust - Thrust power and Propulsive efficiency	iii), iv)
9	Tutorial on Rocket engine performance - Solid and Liquid propellant rockets	iii), iv)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Industrial Safety Engineering Lab**	**L**	**T**		**P**		
3. Course Code		**0**	**0**		**2**		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

8. Course Description

This course provides students a brief overview on Industrial Safety. This includes understanding the safety precautions in various manufacturing processes. Also give overview on safety in finishing and testing.

9. Learning objectives:

- **i)** Possess a mastery of Health safety and environment knowledge and safety management skills, to reach higher levels in their profession, Safety in metal working and wood working machines.
- **ii)** Design, Establish, Implement maintain and continually improve an occupation health and management system to improve safety.
- **iii)** Conduct investigations on unwanted incidents using root cause analysis and generate corrective and preventive action to prevent recurrence and occurrence of such incidents.
- **iv)** Design complex man machine systems using human factors engineering tools so as to achieve comfort, worker satisfaction, efficiency, error free and safe workplace environment.

10. Course Outcomes (COs): On completion of the course,

- **i)** Apply operations research techniques in industrial Safety in metal working and wood working machines.
- **ii)** Understanding the concept of Principles of Machine Guarding
- **iii)** Understanding the concept of Safety in Welding and Gas Cutting
- **iv)** Understanding the concept of Safety in Finishing, Inspection and Testing

11. Lab Content

Sr. No.	**Title**	**CO covered**
1	To Study the selection and care of cutting tools.	i)
2	To Study the periodical checks for safe operation – associated hazards and prevention.	i)
3	To study the Zero Mechanical State using case study.	ii)
4	To Study the pulleys and belts-authorized entry to hazardous installations.	ii)
5	To Study the sprockets wheels and chains authorized entry to hazardous installations.	ii)
6	To study the resistances welding	iii)
7	To study the Gas welding and oxygen cutting	iii)
8	To study the steam testing-safety in radiography- personal monitoring devices-radiation hazards using case study.	iv)

9	To study the Indian Boilers Regulation-using case study.	iv)
10	To study the Health and welfare measures in engineering industry-pollution control in engineering industry using case study.	iv)

1. **Name of the Department- Mechanical Engineering**							
2. **Course Name**	**Sales & Marketing Lab**	**L**		**T**		**P**	
3. **Course Code**		**0**		**0**		**2**	
4. **Type of Course (use tick mark)**		**Core ()**	**EAS ()**	**PE (✓)**		**OE ()**	
5. **Pre-requisite (if any)**		6. **Frequency (use tick marks)**		Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. **Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)**							
Lectures = 0		**Tutorials = 0**		**Practical = 28**			
8. **Course Description**							
This is a course based on practical introduction to marketing and sale management, students improve their ability to make effective sales and marketing decisions, including assessing marketing opportunities and developing marketing strategies and implementation plans							

9. **Learning objectives:**

- **i)** Develop effective marketing strategies and sales strategies to achieve organizational objectives.
- **ii)** Design a strategy implementation program to Developing Sales Training
- **iii)** To develop practical concept of Principles of Management
- **iv)** To develop practical concept of Marketing Management and Financial Management.

10. **Course Outcomes (COs):** On completion of this course, the students will be able to:

- **i)** Understanding the Nature and Scope of Sales Management.
- **ii)** Understanding the Developing Sales Training
- **iii)** Understanding the concept and Principles of Management
- **iv)** Understanding the concept of Marketing Management and Financial Management

11. **Lab Component**

Sr. No.	**Title**	**COs covered**
1	To Study the Objectives and functions of Sales management.	i)
2	To Study the Designing and delivering of sales presentation.	i)
3	To study the evaluation of sales performance using case study.	i)
4	To Study the Designing and Administering various Compensation Plans.	ii)
5	To Study the consumer behavior and demand analysis using case study.	iii)
6	To study the Theory of production cost analysis- using case study.	iii)

7	To study the business economics and fundamental concepts using case study	iii)
8	To study the marketing logistics and supply chain management using case study.	iv)
9	To study the Journal sizing transactions -using case study.	iv)
10	To study the product innovation and diffusion. Meaning and scope using case study.	iv)

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Neural Networks and Fuzzy Systems Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

Basic introduction to neural networks & fuzzy logic, development and implementation. It includes; Neural versus conventional computing. Learning processes. The MLP NN, backpropagation learning algorithm. Recurrent networks. Self-organization Feature maps. Applications. Introduction to Fuzzy theory. Fuzzy Logic. Neuro-Fuzzy system in engineering

9. Learning objectives:

i) Introduce the fundamentals of Neural Networks and its applications.

ii) Provide an overview of deep learning and convolutional neural networks.

iii) Gain understanding about the fundamentals of Fuzzy Logic and its applications

iv) To understand membership functions and applications.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

i) Classify the types of neural networks.
ii) Discuss about the applications of neural networks.
iii) Describe the concepts of deep learning and convolutional neural networks
iv) Compare fundamentals of classical logic and fuzzy logic concepts.
v) Characterize the fuzzy membership functions.
vi) Summarize the applications of fuzzy logic controllers.

11. Lab Component

Sr. No.	Title	COs covered
1	Learning rules and activation functions in NN	i)
2	Development of logic using MP and Hebb neuron model	i)

3	Development of supervised learning using NN Toolbox	**ii)**
4	Development and testing of perceptron NN algorithm	**ii)**
5	Development of ADALINE algorithm with bipolar inputs and outputs.	**ii)**
6	Development of auto associative network using outer product rule	**iii)**
7	Development of fuzzy membership functions and fuzzy set properties	**iii)**
8	Development of logic for fuzzy relations	**iii)**
9	Design of a fuzzy controller systems using fuzzy tool of MATLAB	**iii)**
10	Application development using NN/Fuzzy logic	**iii)**

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Aerospace Materials Lab**	**L**	**T**		**P**	
3. Course Code		**0**	**0**		**2**	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**	**OE ()**	**Specialization ()**	
5. Pre-requisite (if any)	**Engineering Mechanics**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 0		**Tutorials = 0**	**Practical = 28**			

8. Course Description

To provide broad based understanding of the subject "Tribology" and its technological significance, syllabus includes the genesis of friction, the theories/laws of sliding and rolling friction and the effect of viscosity. To learn about consequences of wear, wear mechanisms, wear theories and analysis of wear problems and to get knowledge about different bearing materials.

9. Learning objectives: Students undergoing this course are expected to**:**

- **i)** To study the mechanical behavior of aerospace materials.
- **ii)** To study the thermal behavior of aerospace materials.
- **iii)** To study the deformation behavior of aerospace materials.
- **iv)** To study the selection of materials in deferent applications of aerospace.

10. Course Outcomes (COs): On course completion students will be able to:

- **i)** To perform the hardness and tensile test using universal testing machine.
- **ii)** To understand the effect of hot and cold working process on the crystal structure of materials.
- **iii)** To perform the bending and impact test using universal and Charpy impact testing machine.
- **iv)** To understand the characteristic properties of materials that influences the selection of materials.

11. Lab Component

Sr. No.	**Title**	**CO covered**
1	Deformation behavior of hot and cold rolled steels	**iii)**
2	Crystalline structures and dislocations	**ii)**
3	Aluminum alloys and strengthening mechanisms	**i)**
4	Solid solutions and heat treatments	**ii)**
5	High-temperature creep	**ii)**

6	Ceramics and glasses	**i)**
7	Deformation behavior of polymers	**iii)**
8	Deformation behavior of fiber reinforced composites	**iii)**
9	Fractography and fracture toughness	**i), ii)**
10	Embrittlement and environmental effects	**ii)**
11	Fatigue and fatigue crack growth	**iv)**
12	Material selection and case studies	**iv)**

Laboratory Tests: Tension tests, hardness tests, creep tests, relaxation tests, fracture toughness tests, Charpy impact tests, fatigue tests, microscopy.

Electromechanical and servo hydraulic test machines, Rockwell hardness testers, level arm creep testers, Charpy impact tester, fatigue testers, microscopes, computer data acquisition.

1. Name of the Department- Mechanical Engineering						
2. Course Name	**Cognitive Robotics Lab**	**L**	**T**		**P**	
3. Course Code		0	0		2	
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**	
5. Pre-requisite (if any)	**Robotics Engineering and Its Application**	**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)						
Lectures = 42		**Tutorials = 0**	**Practical = 0**			

8. 8. Course Description

This course teaches the fundamentals for the Cognitive Robots. This course provides an introduction about the Cybernetic View of Robot Cognition and Perception, Map Building. materials used for aerospace applications. The course gives a detailed knowledge of the Randomized Path Planning and Simultaneous Localization and Mapping (SLAM). Also provide the detailing of Robot Programming Packages and Imaging Geometry.

9. Learning objectives: Students undergoing this course are expected to

- **i)** Provide brief introduction to robot cognition and perception.
- **ii)** Understand the concepts of path planning algorithms.
- **iii)** Gain knowledge on the robot programming packages used in localization and mapping.
- **iv)** Describe the aspects of Imaging Techniques used in Robotic Applications.

10. Course Outcomes (COs): On course completion students will be able to

- **i)** Discuss about the basics of robot cognition and perception.
- **ii)** Illustrate the different methods of map building and the robot simulation and execution of a program.
- **iii)** Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs used.
- **iv)** Develop knowledge about simultaneous localization and mapping based techniques and paradigms.
- **v)** Elaborate the various robot programming packages for display, tele-operation and other applications.

11. Lab Content

Sr. No.	**Title**	**COs Covered**
1	To study in detail about the Cognition and perception.	i)
2	To study the different types of map building	ii)
3	To study how to execute the programs in robots.	ii)
4	To analyze the various path planning techniques.	iii)
5	To study the different programs used for robot's environment.	iii)
6	To study the simultaneous localization and mapping based techniques,	iv)
7	To study various robot programming packages for Display, tele-operation etc.	v)
8	To study and perform robot simulation.	ii)

1. Name of the Department- Mechanical Engineering							
2. Course Name	**Autonomous Vehicle Lab**	**L**	**T**		**P**		
3. Course Code		0	0		2		
4. Type of Course (use tick mark)		**Core ()**	**PE (✓)**		**OE ()**		
5. Pre-requisite (if any)		**6. Frequency (use tick marks)**	Even ()	Odd (✓)	Either Sem ()	Every Sem ()	
7. Total Number of Lectures, Tutorials, Practical (assuming 14 weeks of one semester)							
Lectures = 0		**Tutorials = 0**	**Practical = 28**				

8. Course Description

Self-driving cars have rapidly become one of the most transformative technologies to emerge. Fuelled by Deep Learning algorithms, they are continuously driving our society forward and creating new opportunities in the mobility sector.

9. Learning objectives:

- **i)** Introduce the fundamental aspects of Autonomous Vehicles.
- **ii)** Gain Knowledge about the Sensing Technology and Algorithms applied in Autonomous vehicles.
- **iii)** Understand the Connectivity Aspects and the issues involved in driverless cars.
- **iv)** To learn about Autonomous vehicle technology and its biggest Challenges.

10. Course Outcomes (COs): After the completion of the course, the student shall be able to

- **i)** Describe the evolution of Automotive Electronics and the operation of ECUs.
- **ii)** Compare the different type of sensing mechanisms involved in Autonomous Vehicles.
- **iii)** Discuss about the use of computer vision and learning algorithms in vehicles.
- **iv)** Summarize the aspects of connectivity fundamentals existing in a driverless car.
- **v)** Identify the different levels of automation involved in an Autonomous Vehicle.
- **vi)** Outline the various controllers employed in vehicle actuation.

11. Lab Component

Sr. No.	Title	COs covered
1	Study of an Automobile Chassis	**i)**
2	Study of Differential Mechanism of an Automobile	**i)**
3	Study of Multiple Clutch of an Automobile	**ii)**
4	Study of Braking System (Hydraulic / Air Brake)	**ii)**
5	Study and Demonstration of different circuit of carburetor	**ii)**
6	Checking the spark plug and setting the port and check the ignition in the spark plug	**iii)**

7	Study the Electrical System of an Automobile	**iii)**
8	Study the assembly of Car Engine	**iii)**

Name of the Faculty : Faculty of Engineering & Technology

Name of the Course : - B. Tech. Mechanical Engineering with specialization in (Robotics, Machine Design, Thermal Engineering, Computer Enable Manufacturing, Automotive Design and Development, Mechatronics, and Electric Vehicles)
- B. Tech. Mechanical Engineering (Research) [2021-22]

											Theory							Practical				Practical (Internal)							
Sr. No.	Semester/Year	Subject Code	Nomenclature	Theory/ Practical	Core/ AECC/ SEC/ DSE/ GE	ERP	L	T	P	Credits	Max	Pass	Midterm	Assignment	Professional Activities	Max	Pass	Demonstration/Presentation	Viva-voce	Max	Pass	Attendance	Project/ Laboratory Work	Mid Term	Conduct/ Demonstration	Max	Pass	Overall Pass Marks	Scheme of Examinations (Theory+Internal +Practical+Oral/ Theory+Internal +Practical/ Theory+Practical
1	1st	13030101	Applied Mathematics	Theory	BSC	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
2	1st	13030102	Design Thinking	Theory	EAS	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
3	1st	13030103	Basics of Mechanical Engineering	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
4	1st	13030104	Biology for Engineers	Theory	BSC	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
5	1st	13030105	Material Engineering and Technology	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
6	1st	13030106	Metrology and Material Engineering Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
7	1st	13030107	Workshop Technology Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
8	1st	13030108	Engineering Graphics and Design Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
9	1st	University Umbrella	Value Addition Course-I	Theory	VAC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
10	1st	University Umbrella	Ability Enhancement Course-I	Theory	AEC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
11	2nd	13030201	Applied Physics	Theory	BSC	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
12	2nd	13030202	Engineering Thermodynamics	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
13	2nd	13030203	Advance Graphics and Design	Theory	Core	Core	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
14	2nd	13030204	Basics of Automobile Engineering	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
15	2nd	13030205	Probability and Statistics	Theory	BSC	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
16	2nd	13030206	Engineering Thermodynamics Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
17	2nd	13030207	Advance Graphics and Design Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
18	2nd	13030208	Basics of Automobile Engineering Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
19	2nd	13030209	Object Oriented Programming Lab	Practical	EAS	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
20	2nd	University Umbrella	Ability Enhancement Course-II	Theory	AEC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
21	3rd	13030301	Strength of Materials	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
22	3rd	13030302	Engineering Mechanics	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
23	3rd	13030303	Refrigeration & Air Conditioning	Theory	DE-I	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
24	3rd	13030304	Advanced Machining Processes	Theory	DE-I	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
25	3rd	13030305	Advance Automobile Engineering	Theory	DE-I	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
26	3rd	13030306	Industrial Engineering	Theory	DE-I	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
27	3rd	13030307	Product Design for Manufacturing	Theory	DE-I	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
28	3rd	13030308	Advance Materials	Theory	DE-I	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
29	3rd	13030309	Steam Power Generation	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
30	3rd	13030310	Production Planning & Control	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
31	3rd	13030311	Fuel & Combustion	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
32	3rd	13030312	Estimation & Costing	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
33	3rd	13030313	Total Quality Management	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
34	3rd	13030314	Tool Design	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
35	3rd	13030315	Composite Materials	Theory	DE-II	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
36	3rd	13030316	Strength of Materials Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
37	3rd	13030317	Engineering Mechanics Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
38	3rd	13030318	Refrigeration & Air Conditioning Lab	Practical	DE-I	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
39	3rd	13030319	Advanced Machining Processes Lab	Practical	DE-I	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
40	3rd	13030320	Advance Automobile Engineering Lab	Practical	DE-I	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
41	3rd	13030321	Industrial Engineering Lab	Practical	DE-I	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
42	3rd	13030322	Product Design for Manufacturing Lab	Practical	DE-I	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
43	3rd	13030323	Advance Materials Lab	Practical	DE-I	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
44	3rd	13030324	Steam Power Generation Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal

45	3rd	13030325	Production Planning & Control Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
46	3rd	13030326	Fuel & Combustion Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
47	3rd	13030327	Estimation & Costing Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
48	3rd	13030328	Total Quality Management Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
49	3rd	13030329	Tool Design Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
50	3rd	13030330	Composite Materials Lab	Practical	DE-II	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
51	3rd	13030331	Industrial Internship	Practical	Core	Core	0	0	4w	2								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
52	3rd	University Umbrella	Open Elective-I	Theory	OE-I	DSE	4	0	0	4	60	24	20	10	10	40	16											40	Theory+Internal
53	3rd	University Umbrella	Value Addition Course-II	Theory	VAC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
54	4th	13030401	Mechanical Machine Design	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
55	4th	13030402	Manufacturing Processes and Technology	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
56	4th	13030403	Research Methodology	Theory	EAS	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
57	4th	13030404	Cryogenic Engineering	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
58	4th	13030405	Computer Aided Manufacturing	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
59	4th	13030406	Hydrogen and Fuel Cells	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
60	4th	13030407	Plant Layout and Material Handling	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
61	4th	13030408	Lean enterprise & Advanced Manufacturing Technologies	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
62	4th	13030409	Mechanical Vibration	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
63	4th	13030410	Nanomaterials	Theory	DE-III	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
64	4th	13030411	Fluid Power System	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
65	4th	13030412	CNC Programming	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
66	4th	13030413	Chassis Design	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
67	4th	13030414	Work Study	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
68	4th	13030415	Supply Chain and Logistic Managements	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
69	4th	13030416	Finite Element Methods	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
70	4th	13030417	Biomaterials	Theory	DE-IV	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
71	4th	13030418	Mechanical Machine Design Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
72	4th	13030419	Manufacturing Processes Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
73	4th	13030420	Cryogenic Engineering Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
74	4th	13030421	Computer Aided Manufacturing Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
75	4th	13030422	Hydrogen and Fuel Cells Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
76	4th	13030423	Plant Layout and Material Handling Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
77	4th	13030424	Lean enterprise & Advanced Manufacturing Technologies Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
78	4th	13030425	Mechanical Vibration Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
79	4th	13030426	Nanomaterials Lab	Practical	DE-III	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
80	4th	13030427	Fluid Power System Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
81	4th	13030428	CNC Programming Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
82	4th	13030429	Chassis Design Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
83	4th	13030430	Work Study Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
84	4th	13030431	Supply Chain and Logistic Managements Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
85	4th	13030432	Finite Element Methods Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
86	4th	13030433	Biomaterials Lab	Practical	DE-IV	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
87	4th	University Umbrella	Open Elective-II	Theory	OE-II	DSE	4	0	0	4	60	24	20	10	10	40	16											40	Theory+Internal
88	5th	13030501	Fluid Mechanics and Machines	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
89	5th	13030502	Kinematics of Machines	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
90	5th	13030503	Robotics Engineering & Applications	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
91	5th	13030504	Solar & Nuclear Power Engineering	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
92	5th	13030505	Rapid Manufacturing Technologies	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
93	5th	13030506	Design for Manufacturing & Assembly	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
94	5th	13030507	Advance Automotive Electronics	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
95	5th	13030508	Mechatronics Systems and its Applications	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
96	5th	13030509	Introduction to Hybrid and Electric Vehicles	Theory	DE-V	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
97	5th	13030510	Sensors & Actuators	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
98	5th	13030511	Design of Thermal Systems	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
99	5th	13030512	Non-Conventional Machining	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
100	5th	13030513	Mechanism & Manipulator Design	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
101	5th	13030514	Engine Design	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
102	5th	13030515	Sensors & Actuators	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
103	5th	13030516	Battery Management System	Theory	DE-VI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
104	5th	13030517	Fluid Mechanics and Machines Lab	Practical	Core	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal

105	5th	13030518	Kinematics of Machines Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
106	5th	13030519	Robotics Engineering & Applications Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
107	5th	13030520	Solar & Nuclear Power Engineering Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
108	5th	13030521	Rapid Manufacturing Technologies Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
109	5th	13030522	Design for Manufacturing & Assembly Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
110	5th	13030523	Advance Automotive Electronics Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
111	5th	13030524	Mechatronics Systems and its Applications Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
112	5th	13030525	Introduction to Hybrid and Electric Vehicles Lab	Practical	DE-V	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
113	5th	13030526	Sensors & Actuators Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
114	5th	13030527	Design of Thermal Systems Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
115	5th	13030528	Non-Conventional Machining Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
116	5th	13030529	Mechanism & Manipulator Design Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
117	5th	13030530	Engine Design Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
118	5th	13030531	Sensors & Actuators Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
119	5th	13030532	Battery Management System Lab	Practical	DE-VI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
120	5th	13030533	Industrial Training-I	Practical	Core	Core	0	0	4w	2								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
121	5th	University Umbrella	Open Elective-III	Theory	OE-III	DSE	4	0	0	4	60	24	20	10	10	40	16											40	Theory+Internal
122	5th	University Umbrella	Ability Enhancement Course-III	Theory	AEC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
123	6th	13030601	Heat and Mass Transfer	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
124	6th	13030602	Dynamics of Machines	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
125	6th	13030603	Pneumatics & Control	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
126	6th	13030604	Power Plant Engineering	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
127	6th	13030605	Non-Destructive Evaluation & Testing	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
128	6th	13030606	Advance Tribology	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
129	6th	13030607	Design of Transmission System	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
130	6th	13030608	Pneumatics & Control	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
131	6th	13030609	Plug-in Electric Vehicles in Smart Grid	Theory	DE-VII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
132	6th	13030610	Mobile Robots	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
133	6th	13030611	Computational Fluid Dynamics	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
134	6th	13030612	Press Tools & Dies	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
135	6th	13030613	Finite Element Analysis	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
136	6th	13030614	Vehicle Body Dynamics	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
137	6th	13030615	MEMS & Micro-Systems	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
138	6th	13030616	EV Charging Infrastructure Technology	Theory	DE-VIII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
139	6th	13030617	Heat and Mass Transfer Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
140	6th	13030618	Dynamics of Machines Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
141	6th	13030619	Pneumatics & Control Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
142	6th	13030620	Power Plant Engineering Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
143	6th	13030621	Non-Destructive Evaluation & Testing Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
144	6th	13030622	Advance Tribology Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
145	6th	13030623	Design of Transmission System Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
146	6th	13030624	Pneumatics & Control Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
147	6th	13030625	Plug-in Electric Vehicles in Smart Grid Lab	Practical	DE-VII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
148	6th	13030626	Mobile Robots Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
149	6th	13030627	Computational Fluid Dynamics Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
150	6th	13030628	Press Tools & Dies Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
151	6th	13030629	Finite Element Analysis Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
152	6th	13030630	Vehicle Body Dynamics Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
153	6th	13030631	MEMS & Micro-Systems Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
154	6th	13030632	EV Charging Infrastructure Technology Lab	Practical	DE-VIII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
155	6th	University Umbrella	Open Elective-IV	Theory	OE-VI	DSE	4	0	0	4	60	24	20	10	10	40	16											40	Theory+Internal
156	6th	University Umbrella	Value Addition Course-III	Theory	VAC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
157	7th	13030701	Automation in Manufacturing	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
158	7th	13030702	Nuclear Power Engineering	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
159	7th	13030703	Machine Tool Technology	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
160	7th	13030704	Recent Trends in Automotive Technology	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
161	7th	13030705	Maintenance Engineering	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
162	7th	13030706	Operation Research	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	
163	7th	13030707	Instrumentation & Control Engineering	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
164	7th	13030708	Nano-Technology and Surface Engineering	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal

165	7th	13030709	Robot Operating Systems	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
166	7th	13030710	Modelling and Simulation of EHV	Theory	DE-IX	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
167	7th	13030711	Advance Heat Transfer	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
168	7th	13030712	Modelling and Simulation of Manufacturing System	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
169	7th	13030713	Gas Dynamics & Jet Propulsion	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
170	7th	13030714	Industrial Safety Engineering	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
171	7th	13030715	Sales & Marketing	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
172	7th	13030716	Neural Networks and Fuzzy Systems	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
173	7th	13030717	Aerospace Materials	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
174	7th	13030718	Cognitive Robotics	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
175	7th	13030719	Autonomous Vehicles	Theory	DE-X	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
176	7th	13030720	Automation in Manufacturing Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
177	7th	13030721	Nuclear Power Engineering Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
178	7th	13030722	Machine Tool Technology Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
179	7th	13030723	Recent Trends in Automotive Technology Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
180	7th	13030724	Maintenance Engineering Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
181	7th	13030725	Operation Research Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
182	7th	13030726	Instrumentation & Control Engineering Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
183	7th	13030727	Nano-Technology and Surface Engineering Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
184	7th	13030728	Robot Operating Systems Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
185	7th	13030729	Modelling and Simulation of EHV Lab	Practical	DE-IX	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
186	7th	13030730	Advance Heat Transfer Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
187	7th	13030731	Modelling and Simulation of Manufacturing System Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
188	7th	13030732	Gas Dynamics & Jet Propulsion Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
189	7th	13030733	Industrial Safety Engineering Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
190	7th	13030734	Sales & Marketing Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
191	7th	13030735	Neural Networks and Fuzzy Systems Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
192	7th	13030736	Aerospace Materials Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
193	7th	13030737	Cognitive Robotics Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
194	7th	13030738	Autonomous Vehicles Lab	Practical	DE-X	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
195	7th	13030739	Capstone Project	Practical	Core	Core	0	0	4	2								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
196	7th	13030740	Industrial Training-II	Practical	Core	Core	0	0	4w	2								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
197	7th	13030741	Research Phase-1	Practical	Core	Core	0	0	0	10								40	40	80	32	20	20	20	60	120	48	80	Practical + Internal
198	7th	University Umbrella	Value Addition Course-IV	Theory	VAC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
199	7th	University Umbrella	Ability Enhancement Course-IV	Theory	AEC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal
200	8th	13030801	Industrial Internship with Project (Industrial oriented/Research oriented)	Practical	Core	Core			20 w	20								60	40	100	40	10	20	20	50	100		80	Practical+Internal
201	8th	13030802	Computer Aided Engineering	Theory	Core	Core	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
202	8th	13030802	Advance Fluid Mechanics	Theory	DE-XI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
203	8th	13030803	Energy Conservation and Management	Theory	DE-XI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
204	8th	13030803	Numerical and Optimization Methods	Theory	DE-XI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
205	8th	13030804	Statistics for Decision Making	Theory	DE-XI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
206	8th	13030804	Advanced Design of Mechanical Systems	Theory	DE-XI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
207	8th	13030805	Advanced Mechanics of Solids	Theory	DE-XI	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
208	8th	13030805	Design of Solar and Wind System	Theory	DE-XII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
209	8th	13030806	Analysis of Manufacturing Processes	Theory	DE-XII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
210	8th	13030806	Advance Heat Transfer	Theory	DE-XII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
211	8th	13030807	Production & Operations Management	Theory	DE-XII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
212	8th	13030807	Vibration and Condition Monitoring	Theory	DE-XII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
213	8th	13030808	Advanced Composite Materials	Theory	DE-XII	DSE	3	0	0	3	60	24	20	10	10	40	16											40	Theory+Internal
214	8th	13030808	Computer Aided Engineering Lab	Practical	Core	Core	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
215	8th	13030809	Advance Fluid Mechanics Lab	Practical	DE-XI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
216	8th	13030809	Energy Conservation and Management Lab	Practical	DE-XI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
217	8th	13030810	Numerical and Optimization Methods Lab	Practical	DE-XI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
218	8th	13030810	Statistics for Decision Making Lab	Practical	DE-XI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
219	8th	13030811	Advanced Design of Mechanical Systems Lab	Practical	DE-XI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
220	8th	13030811	Advanced Mechanics of Solids Lab	Practical	DE-XI	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
221	8th	13030812	Design of Solar and Wind System Lab	Practical	DE-XII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
222	8th	13030812	Analysis of Manufacturing Processes Lab	Practical	DE-XII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
223	8th	13030813	Advance Heat Transfer Lab	Practical	DE-XII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
224	8th	13030813	Production & Operations Management Lab	Practical	DE-XII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
225	8th	13030814	Vibration and Condition Monitoring Lab	Practical	DE-XII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal

226	8th	13030814	Advanced Composite Materials Lab	Practical	DE-XII	DSE	0	0	2	1								20	20	40	16	10	10	10	30	60	24	40	Practical + Internal
227	8th	13030815	Research Phase-II	Practical	Core	Core	0	0	0	10								40	40	80	32	20	20	20	60	120	48	80	Practical + Internal
228	8th	University Umbrella	Ability Enhancement Course-IV	Theory	AEC	DSE	2	0	0	2	60	24	20	10	10	40	16											40	Theory+Internal

BSC	Basic Science Course
EAS	Engineering Applied Science
VAC	Value Added Course
DE	Department Electives
OE	Open Electives
AEC	Ability Enhancement Course