Department of Mechanical Engineering

The department of Mechanical Engineering offers the following programs during the academic year 2021-22.

Master of Technology (M.Tech)

- Mechanical Engineering with specialization in Thermal Engineering.
- Mechanical Engineering with specialization in Mechanical Engineering Design.
- Mechanical Engineering with specialization in Production and Industrial Engineering.

Bachelor of Technology (B. Tech)

- Mechanical Engineering with specialisation in Robotics and Automation.

M.Tech in Mechanical Engineering programme for working professionals will impart research-based knowledge in the selected disciplines of mechanical engineering. The programme will be of 3 years with 6 semesters for working professionals under part-time. The programme has total credits of 57. The curriculum is designed in such a way that there are subjects relevant to overall mechanical engineering and specialization-based seminar, minor project, and dissertation in three specializations mentioned above. Students can opt for any one of these specializations by taking the seminar, minor project and dissertation in those specializations.

The NorthCap University is one of the best places to get a B Tech Mechanical in Delhi NCR, and the specialization in Robotics and Automation Engineering course offers students the opportunity to learn new and disruptive technologies and enable them to develop innovative instruments to monitor, manipulate, and control systems. With one of the best private engineering colleges in the NCR region, students will use fundamental concepts of the theory of mechanism, microsensors, and actuators and develop humanoid robots, intelligent control systems, and flexible manipulators. The students will graduate with special skill sets and values to achieve professional goals in process automation and robotics. The B. Tech programme will be of 4 years duration with 8 semesters under regular mode and has a total credit of 175.

DEPARTMENT OF MECHANICAL ENGINEERING

Master of Technology in 'Mechanical Engineering'- (2021-22)

Category	Core	OE	Seminar	Project	Total
Credits	30	06	02	19	57

Programme Core (PC)

S. No.	Course Code	Title	L-T-P	Credits
1	MEL 510	Introduction to FEM	2-1-0	3
2	MEL 530	Advanced Manufacturing Processes	2-1-0	3
3	MEL 550	Advanced Heat & Mass Transfer	2-1-0	3
4	MEL 560	Advanced Machine Design	2-1-0	3
5	MEL 570	Production and Operations Management	2-1-0	3
6	MEL 580	Advanced Fluid Dynamics	2-0-2	3
7	MEL 613-IP	Project Management	2-1-0	3
8	MAL 616	Research Methodology	2-1-0	3
9	MEL614	Technical Writing Skills	2-0-0	2
10	MEP601	Laboratory Training-I	0-0-4	2
11	MEP602	Laboratory Training-II	0-0-4	2
		Total Credits		30

Master of Technology in 'Mechanical Engineering'- (2021-22)

Semester	Semester Course Code, Course Name (L-T-P) Credits				Lecture	L	T	P	Contact Hour per week	Credits
1	**MEL-510** Introduction to FEM (2-1-0) 3	**MEL-613-IP** Project Management (2-1-0) 3	**MEL-580** Advanced Fluid Dynamics (2-0-2) 3	**MEP601** Laboratory Training, I 0-0-4 (2)	3	6	2	6	14	11
2	**MEL-550** Advanced Heat and Mass Transfer (2-1-0) 3	**MEL-560** Advanced Machine Design (2-1-0) 3	**MEL-530** Advanced Manufacturing Processes (2-1-0) 3	**MEP602** Laboratory Training, II 0-0-4 (2)	3	6	3	4	13	11
3	**MEL-570** Production and Operation Management (2-1-0) 3	**MEC-620** Seminar (Specialization based) 0-0-4 (2) Credits	*Open Elective-1 (2-1-0) 3 Credits		2	4	2	4	10	8
4	**MAL616**	**MED 612** Minor Project	**MEL614** Technical		2	4	1	6	11	8

	Research Methodology (2-1-0) 3	(Specialization based) 0-0-6 (3)	Writing Skills 2-0-0 (2)							
5	*Open Elective-2 (2-1-0) 3 Credits	**MED-600** Project Part -1 (Specialization based) (00-12) 6 Credits			1	2	1	12	15	9
6	**MED-610** Project Part -2 (Specialization based) (0-0-20) 10 credits				0	0	0	20	12	10
					Total Credits=					**57**

***Open electives can be chosen from the list of Open Elective courses offered by the University. These may be run as Regular or MOOC (full/blended).**

B.Tech in Mechanical Engineering with specialisation in Robotics and Automation (2021-22)

Category	Credits	Category	Credits
BS	21 Core	SPT	18
HMS	14 Core + 03 Elective	Special Software (VA)	3
ES & TA	30 Core	PE	18
PC	44 Core	OE	12
Community Service	6	GP	6

TOTAL CORE COURSE CREDITS = 112 **TOTAL CREDITS = 175**

Basic Sciences (BS) Core		**L-T-P**	**C**
CHL150	Engineering Chemistry	2-0-2	3
CHL100	Environmental Studies	3-0-0	3
MAL151	Engineering Maths-I	3-0-2	4
MAL152	Engineering Maths-II	3-0-2	4
MEL 209	Materials Science and Engineering	2-0-2	3
PYL150	Engineering Physics	3-0-2	4
	Total BS Core		**21**

Humanities & Management Sciences (HMS) Core		**L-T-P**	**C**
CLL101	Effective Communication-I	2-0-1	2.5
CLL102	Effective Communication-II	2-0-1	2.5
CLL120	Human Values and professional Ethics	2-0-0	2
SML200	Engineering Economics	2-0-2	3
CLP300	Campus to Corporate	1-0-0	1
SML300	Entrepreneurship	3-0-0	3
	Foreign Language Elective	3-0-0	3
	Total HMS Core		**16**

Engineering Sciences & Technical Arts (ES & TA) Core		**L-T-P**	**C**
CSL106	FOCP-I	2-0-4	4
CSL108	FOCP-II	2-0-4	4
CSL 110	Problem Solving and Design Thinking	2-0-2	3
ECL110	Basics of Elect. & Electronics Engg	2-0-2	3
MEP110	Engineering Graphics & Drawing	1-0-4	3
MEL150	Basics of Mechanical and Civil Engineering	2-0-2	3
MEL205	Engineering Mechanics	3-1-0	4
MEP 207	Machine Drawing	0-0-4	2
MEL290	Thermodynamics	3-1-0	4
	Total ES & TA		**30**

Programme Core (PC)		**L-T-P**	**C**
MEL 160	Production Engineering	3-0-2	4
MEL203	Mechanics of Solids – I	3-0-2	4
MEL202	Heat & Mass Transfer	3-0-2	4
MEL206	Theory of Machines	3-1-2	5
MEL 207	Machine Design – I	3-1-0	4
MEL208	Fluid Mechanics	3-1-0	4
MEL 310	Industrial Engineering	3-1-0	4
MEL 314	Energy Conversion	3-0-2	4
MEL 326	Instrumentation & Control Engineering	3-0-2	4
MEL 303	Fluid Machines	2-1-2	4
MEL 401	Operations Research	2-1-0	3
	Total Programme Core (PC)		**44**

Seminar/Projects/Trainings (SPT)		**L-T-P**	C
MEC 321	Seminar	--	1
MED 210	Minor Project	-	2
MED 423	Major Project 1	-	4
MED 424	Major Project 2	-	6
MET310	Industrial Training-I	-	2
MET410	Industrial Training II	-	3
	Total SPT Credits		**18**

Value Added and others		**L-T-P**	C
MEP200 MEP220 MEP300	**Special Software: Solid Works/ ANSYS/ MATLAB/other software packages (0-0-2) 1**	**0-0-2 0-0-2 0-0-2**	**1 x 3 = 3**
	General Proficiency	**(1x6)**	**6**
	Open Electives (OE). Four courses of 3 credits each	**(4 x 3)**	**12**

		Programme Electives (PE). Six courses of 3 credits each	**(3 x 6)**	**18**
		Community Service	**---**	**6**
	SEG400	**Self-Study Course GATE**		**NC**

B. Tech in Mechanical Engineering with specialization in Robotics and Automation (2021-22)

Semester	Semester Course Code, Course Name (L-T-P) Credits								GP	Community Service	Hrs. Per week			Contact Hours per Semester	Credits
											L	T	P		
1	**MAL151** Engineering Maths-I (3-0-2) 4	**CSL106** FOCP-I (2-0-4) 4	**CHL150** Engineering Chemistry (2-0-2) 3	**CLL101** Effective Communication-I (2-0-1) 2.5	**MEP110** Engineering Graphics & Drawing (1-0-4) 3	**CSL110** Problem Solving and Design Thinking (2-0-2) 3			**MER118** GP 1 Credit	**MES101** CS-I (70 Hours) NC	12	1	14	405	20.5
2	**MAL152** Engg Maths-II (3-0-2) 4	**CSL108** FOCP-II (2-0-4) 4	**PHY150** Engineering Physics (3-0-2) 4	**CLL102** Effective Communication-II (2-0-1) 2.5	**MEL150** Basic of Mechanical and Civil Engineering (2-0-2) 3	**ECL110** Basic of Electrical & Electronics Engineering (2-0-2) 3			**MER119** GP 1 Credit	**MES102** CS-II (70 Hours) 2 Credits	14	1	12	405	21.5+2
	MED 210: Minor Project + Community Service (Remaining Hours)														02
3	**MEL215** Production Engineering (3-0-2) 4	**MEL203** Mechanics of Solids-I (3-0-2) 4	**MEL290** Thermodynamics (3-1-0) 4	**MEL205** Engineering Mechanics (3-1-0) 4	**MEP207** M/c Drawing (0-0-4) 2	Open Elective-1 (3-0-0) 3		**MEP200** Special Software Solidworks/ANSYS/ MATLAB/other software packages (0-0-2) 1	**MER218** GP 1 Credit	**MES201** CS-III (35 Hours) NC	15	2	10	405	23
4	**MEL 314** Energy Conversion (3-0-2) 4	**MEL206** Theory of Machines (3-1-2) 5	**MEL208** Fluid Mechanics (3-1-0) 4	**MEL209** Materials Science and Engg. (2-0-2) 3	Open Elective-2 (3-0-0) 3	**CLL120** Human Values and Professional Ethics (2-0-0) 2		**MEP220** Special Software Solidworks/ANSYS/ MATLAB/other software packages (0-0-2) 1	**MER219** GP 1 Credit	**MES202** CS-IV (35 Hours) 1 Credit	16	2	8	390	23+1

	MET 310: Industrial Training I + Community Service (70 Hrs)														02
5	**MEL202** Heat and Mass Transfer (3-0-2) 4	**MEL207** Machine Design I (3-1-0) 4	**MEL303** Fluid Machines (2-1-2) 4	**SML300** Entrepreneurship (3-0-0)3	PE-1 (2-0-2) 3	**SML200** Engineering Economics (2-0-2) 3		**MEP300** Special Software Solidworks /ANSYS/ MATLAB/other software packages (0-0-2) 1	**MER318** GP 1 Credit	**MES301** CS-V (35 Hours) NC	15	2	10	405	23
6	**MEL 326** Instrumentation & Control Engineering (3-0-2) 4	**MEL 310** Industrial Engineering (3-1-0) 4	PE-2 (2-0-2) 3	PE-3 (2-0-2) 3	Open Elective-3** (MOOC/45) (3-0-0) 3	Foreign Language Elective (3-0-0) 3	**CLP300** Campus to Corporate (1-0-0) 1		**MER319** GP 1 Credit	**MES302** CS-VI (35 Hours) 1 Credit	17	1	6	360	22+1
	MET 410: Industrial Training-II + Community Service(70 Hrs)														03
7	**MEL401** Operations Research (2-1-0) 3	PE-4 (2-0-2) 3	PE-5 (2-0-2) 3	**CHL100** Environmental Studies (3-0-0) 3	**MED423** Major Project I 4 Credits		**MEC321** Seminar 1 Credit			**MES401** CS-VII (70 Hours) NC	9	1	8	270	17
8	**MED424** Major Project II /Internship 6 Credits	PE-6 (2-0-2) 3	Open Elective-4** (MOOC/45) (3-0-0) 3				**SEG 400** Self study Gate Non Credit			**MES402** CS-VIII (70 Hours) 2 Credit	6	-	6	180	12+2
	Total										109	10	62		**169+6 =175**

Program Electives for the specialization- Robotics and Automation

Tracks	Robotics and Automation
Program Elective-1	MEL-478 Robotics and Control (2-0-2) 3
Program Elective-2	MEL-479 Industrial Automation and Process Control (3-0-0) 3
Program Elective-3	MEL-480 Mechatronics System Design (2-0-2) 3
Program Elective-4	MEL-481 Advanced Robotics (2-1-0) 3
Program Elective-5	MEL-486 Signal Processing, AI & NN Technique (2-0-2) 3
Program Elective-6	MEL-677-IP Optimization Techniques (2-0-2) 3

Course Descriptions:

M.TECH. (Mechanical Engineering)

MEL 510 (2-1-0) 3 – Introduction to FEM

Linear algebra: matrix operations, numerical solution of linear matrix equations; Elasticity theory: strain-displacement and stress-strain relations, temperature effects, St. Venant's principle; Discretization (1-D and 2-D), Stiffness matrix, FEM equation for simple elements (bar, truss, beam, frame, and CST elements), assembling of elements, boundary conditions, nodal solutions; Coordinate systems, Shape functions, Consistant loads, Variational equation for deriving K; Heat conduction equations, FEM formulation in 2-D conduction problems; Practical points in using FEM software (Types of analysis, Meshing, Post-processing, Non-linear analysis)

Tutorial (T): Numericals on various topics; Modeling and simulation of 1-D and 2-D problems using software: static structural analysis, and heat conduction; Presentations by students about their course mini-projects

MEL 530 (2-1-0) 3 – Advanced Manufacturing processes

Advanced Machining Processes- Introduction, Process principle, Material removal mechanism, Parametric analysis and applications of processes such as ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Abrasive water jet machining (AWJM), Electrochemical machining (ECM), Electro discharge machining (EDM), Chemical Machining(CHM), Electron beam machining (EBM), Laser beam machining (LBM) processes; Advanced Casting Processes- Squeeze casting, Vacuum mould casting, Evaporative pattern casting, Ceramic shell casting; Advanced Welding Processes- LBW, EBW; Advanced Metal Forming- - Details of high energy rate forming (HERF) process, Electro-magnetic forming, explosive forming, Electro-hydraulic forming, Stretch forming, Contour roll forming; Rapid Prototyping and Rapid tooling- principle of Rapid Prototyping (RP) and Rapid tooling, comparison with conventional machining processes, various techniques for RP

MEL 613 IP (2-1-0) 3 Project Management

Introduction to Project management: The growing importance/d relevance in the current environment. Project vs. Ongoing Operations, project characteristics, common terms used in project, growing importance, steps & check points, phases in the project cycle, Project Types: Pure Project, Functional Project and Cross-Functional or matrix structure. People aspect: Project leader, Roles, responsibilities, authority, accountability, team structure, stake holders. Project appraisal: Project Budgeting, Investment Planning, Pay back periods, ROI, IRR, NPV, project selection decisions Project Risk Management: Risk identification, its assessment, Mitigation plan and case study. Project Network techniques: Work Breakdown Structure, Project Control Charts, GANTT charts, Network Planning Models; AOA & AON approach, Critical Path Method (CPM), Program Evaluation and Review Technique (PERT), Floats, Network understanding, drawing and the analysis. Project Software: Primavera software and its application. Project Crashing & Leveling: Time-Cost Trade-off, Crashing, Resource loading and Leveling. Project control and evaluation: Project Control and Evaluation Mechanisms, Project Time and Cost Overruns, Schedule / cost / Time / Resource variation over time. Interaction with an experienced project expert from industry: Sharing of the practical do's/ don'ts and other learnings. Project ethics and contractor management. Project failure prevention: Causes of Project success & Failure, failure preventive measures, Case Studies Relating to Successful and Unsuccessful projects.

MEL 550 (2-1-0) 3 – Advanced Heat and Mass Transfer

Recapitulation of laws governing heat & mass transfer; General conduction equation - in rectangular cylindrical and spherical coordinates; Unsteady state conduction- large plane walls, cylinder and spheres; Heat transfer from extended surfaces- proper length of a fin; Multidimensional conduction; Numerical solution of conduction problems; Thermal radiation gray body radiation, radiation shields; Natural and forced convection; Heat exchangers-

effectiveness-NTU; Phase Change heat transfer- flow boiling and film condensation; Special topics in heat transfer.

Tutorial (T): Experiments will be carried out in lab on different test setups; numerical on heat transfer problems.

MEL 560 (2-1-0) 3 – Advanced Machine Design
Design methodology (Phases of a design project, Need identification and problem formulation, Designing to codes and standards); Failure theories (static failure theories, fatigue failure, fracture mechanics); Stress analysis and design of machine elements under conditions of impact, inertial forces, thermal, and residual stresses; Surface Failure (Surface geometry, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue, Spherical contact, Cylindrical contact); Reliability engineering (Distribution models, Probabilistic approach to design, Definition of reliability, Constant and variable failure rates, System reliability, Maintenance and repair, Design for reliability, FMEA, Fault tree analysis).
Tutorial (T): Presentations and case studies by students related to the course content; Presentations and case studies by students related to their mini projects; case studies; solving problems related to the syllabus.

MEL 570 (2-1-0) 3 – Production and Operations Management
Production and Operations function- Production systems, Product Strategy and integrated product development, Process planning, Capacity Planning, Facilities Location Strategies, Methods study and Work Measurement, Line balancing, Group Technology, Cellular Manufacturing, Flexible manufacturing system, Aggregate production planning, Master Production Scheduling, Shop Scheduling and Shop Floor Control; Inventory control- JIT purchasing, Lead-time control; Maintenance Planning and Management- Corrective, Preventive and Predictive maintenance; Manpower Scheduling- Techniques of manpower scheduling, Service Operations Management. Value flow and application of VSM. QFD.

MEL 580 (2-0-2) 3 – Advanced Fluid Dynamics
Recapitulation of basic laws of fluid flow in integral and differential form. Newtonian fluid flow-Governing Equations for incompressible non-viscous & viscous internal and external flows. Fundamental of compressible and unsteady flows. Introduction to Computational Fluid Dynamics.
Tutorial (T): Numerical, problem solving on CFD software and presentations.

MAL 616 Research Methodology
3 credits (2-1-0)
Foundations of Research, Scientific Research, Motivation, Research Objectives, Research Designs, Research Processes, Understanding Feasibility of Objectives and Processes, Qualitative and Quantitative Research Methods, Data Collection Processes, Biases in Data Collection, Data Pre-processing, Sampling Distribution and Confidence Intervals, Hypothesis Testing, Interpretation of Results, Literature Review, Technical Writing, Citations, Reference management software, Plagiarism, Software for Detection of Plagiarism.

MEC-620: Seminar
(2 Credits)
Every student will be required to present a seminar on a topic approved by the department except on his/her Major Project . The committee constituted by the Head of the Department will evaluate the presentation and will award one of the grades on the basis of “NCU Course credit Regulation-Engineering.

MEL514 Technical Writing skills
2 (2-0-0) credits

Types of technical writing, definition writing and analysis of material, description of mechanisms and processes, library resources, research techniques, and proposal writing, collecting notes, writing outlines, and writing rough drafts, the elements of the formal research report, graphic aids in technical reports, grammar, technical writing style, and paper revision, plagiarism and professional ethics.

MED512 Minor project
(Specialization based) 0-0-6 (3)
The minor project will be a design project (hardware/software) on a topic suggested by the course coordinator to be completed during the designated duration. It may be of practical and theoretical interest. It has to be done under the guidance of a faculty and students are expected to complete literature survey, feasibility testing, develop or implement the research work.

MEP501 Laboratory Training I
2 Credits (0-0-4)
This is a lab/practical course and the lab experiments of core courses running in that semester will be conducted under this laboratory training.

MEP502 Laboratory Training II
2 Credits (0-0-4)
This is a lab/practical course and the lab experiments of core courses running in that semester will be conducted under this laboratory training.

MED-600: Major Project Part -1
(6 Credits)
Every student will carry out Major Project under the supervision of supervisor(s). The topic will be approved by the committee formed by the Head of Department. The Major Project work should involve extensive literature survey, design, development, analysis and computer simulation (if applicable), fabrication and experimentation work. The project report is expected to show clarity of thought and expression and analytical or experimental or design skills. Every student will be required to present two Major Project seminar talks. First at the beginning of the Major Project to present the scope of the work and to finalize the topic, and the second towards the end of the semester, presenting the work carried out by him/her in the semester. The committee constituted by the Head of the Department will screen both the presentations so as to award grades. The grading shall be done on the basis of “NCU Course credit Regulation-Engineering.”

MED-610: Major Project Part -2
(10 Credits)
The Major Project Part -I (MED-600) will be continued as Major Project part - II in 4th semester. Major Project will be evaluated and grades will be awarded by the committee of examiners formulated by the Head of the department based on the “NCU Course credit Regulation-Engineering.” As in Major Project part -I.

Syllabus: B.TECH. (Mechanical Engineering)

MEP 110 (1-0-4) 3 – Engineering Graphics and Drawing

Types and use of lines and lettering; dimensioning; first and third angle systems of orthographic projection; projection of points in different quadrants; projection of lines; projection of planes; projections of solids; development of surfaces; section of solids (section planes, sectional views, true shape of sections); isometric projections; intersection of solids.

Practice(P): Tutorial sheets to be completed during practical classes.

MEL 150 (2-0-2) 3 Basics of Mechanical and Civil Engineering

Brief Syllabus: Introduction to Thermodynamics: Thermodynamics Laws and applications; Concepts of state, work and heat, internal energy, enthalpy and entropy. Boilers: construction, classification and application. I.C engines: two-stroke and four-stroke petrol and diesel engines; MPFI technology. Advances in automobile technologies. Simple lifting Machine. Power Transmission. Stress and strain. Applied Mechanics: Force System, Laws of Mechanics and Introduction of Moment of Inertia. Engineering materials: classification, properties & applications. Introduction to Conventional and Unconventional Manufacturing processes; Plant layout. Introduction to Mechatronics and Robotics. Introduction to Engineering Surveying and Smart Infrastructure.

Tutorials: Numericals based on thermodynamics, stress-staring, applied mechanics, lifting machines, and Surveying.

Practicals: Experiments of lifting machines. Study of engine and boiler models. Making jobs in welding shop, Machining Shop, Foundry Shop and Carpentry Shop. Field Exercises of surveying.

MEL 160 (3-0-2) 4 Production Engineering

Casting – Introduction and classification, design of patterns patterns, moulds and cores, solidification and cooling, riser and gating design. Plastic deformation and yield criteria, fundamentals of hot and cold working processes, load estimation for bulk metal forming processes (forging, rolling, extrusion, drawing), load estimation for sheet metal forming processes(shearing, deep drawing, bending). Principles of powder metallurgy (metal and ceramic powders), product types and characteristics. Principles of welding, brazing, soldering and adhesive bonding. Raw material manufacturing. Surface treatment processes. Metal Cutting (Introduction, system of tool nomenclature, tool geometry and materials, mechanics of chip formation, Introduction to single & multipoint cutting tool). Economics of machining. Analysis of machining (forces in orthogonal cutting, merchant's force circle diagram, temperature distribution at tool chip interface, wear of cutting tools, optimum tool life, tool life equations, machinability, surface roughness). Introduction to Machining processes.

Use of coolant in machining. Principles of work holding, design of jigs and fixtures. Metrology (introduction to metrology, types of inspection, limits, fits & tolerance, tolerance analysis in manufacturing and assembly). Measuring Instruments (Linear and angular measurement), form measurement (Roundness & Flatness). Surface finish measurement.

Practice(P): Practice in workshop (job making) based on above topics.

MEL203 (3-0-2) 4 - Mechanics of Solids – I

Concept of stress and strain, Hooke's law, elastic constants, Poisson's ratio, Principle of superposition, One and two-dimensional stress problems, Thermal stresses and strains, Complex stresses and strains, Principal stresses, 2D & 3D Mohr's circle of stress and strain. Shear force and bending moment diagrams for beams. Bending and shearing stresses in beams, Deflection of beams. Torsion of circular sections and thin walled tubes. Concept of strain energy, Strain energy due to axial loading, pure shear, bending, and twisting. Stresses due to gradually applied load, suddenly applied load, impact or shock load.

Practice(P):

- Tensile Test, Compression Test, Bending Test, Shear Test, Torsion Test, Impact Test, Hardness test, Cupping Test and numerical practice on related topics.
- Virtual tests from Virtual Labs (http://vlab.co.in/)
- Case study on Stress analysis of simple structural elements using FEM software

MEL 290 (3-1-0) 4 – Thermodynamics

Basic Concepts: Thermodynamic systems and processes, ideal gas, calculation of heat and work in various processes. Laws: Zeroth Law, 1st law of thermodynamics for closed and open systems, concept of internal energy and enthalpy, 2nd law of thermodynamics-corollaries, Clausius inequality, entropy, statement of 3rd law of thermodynamics. Availability Concepts: Availability, irreversibility and Application of 2nd Law Efficiency. Pure substance and its properties. Properties of steam, property chart, and steam table. Joule-Kelvin Effect. Clausius-Clapeyron Equation. Thermodynamic relations. Behaviour of real gas.

Turorial (T): Numericals based on above topics.

MEL205 (3-1-0) 4-Engineering Mechanics

Introduction: idealization of mechanics, force system, moment of force system, laws of mechanics. Equilibrium: free body diagrams, equilibrium equations. Structures: Simple trusses, frames and analysis of structures. Moment of inertia: types, principal axes theorem, parallel axes theorem, product of inertia, Principle of virtual work,

methods of minimum potential energy, stability. Kinematics of particles and rigid bodies in plane motion, Kinetics of particles and rigid bodies: Particle dynamics, Newton's laws for plane motion, D 'Alembert's principle (Dynamic equilibrium), Impulse and momentum, Work energy equations, Impact, Collision of particles. Friction force, laws of sliding and rolling friction, equilibrium analysis of simple systems with sliding friction.

Tutorial (T): Numerical Problems on force system, equilibrium, kinematics and kinetics; Case studies on identification of force system, kinematics of rigid body; Presentations on given topics and mini projects (if possible).

MEP 207 (0-0-4) 2 – Machine Drawing

Sectional views: full and half section views, standard practices; Tolerance: coordinate tolerancing, geometric tolerancing, gauging and measuring principles, material conditions, tolerance symbols; Assembly drawing: types of assembly drawing, sectioning, dimensioning, and hidden lines in assembled views, standard parts in assembled views; Computerized 2-D drawing using AutoCAD: draw toolbar; modify toolbar; dimensioning toolbar; properties toolbar; ortho and OSnap; layers.

Practice(P): Exercises on the above topics should be done with common machine components such as: threaded joints (threaded fasteners, locking arrangements); keys, cotter and knuckle joints; couplings (flange, muff, and Oldham's couplings). Minimum 4 manual drawing sheets and 4 CAD sheets must be made by the students during the course. AutoCAD drawing should be taught from the beginning of the course.

MEL 314 (2-0-2) 3- Energy Conversion

Energy Sources, Fuels and Combustion: Types of fuels, Combustion equations, Stoichiometric air fuel ratio, orsat analyser, Determination of calorific value of fuels; Fundamentals of Steam power: Rankine cycle, Reheat & Regeneration, Binary Vapour cycles, steam turbines and nozzles; Thermal power plant: Boilers, Low pressure and High pressure, boilers mountings and accessories, Compounding of Turbine, , Cooling Towers; Gas power cycles: Air standard Otto Cycle, Diesel Cycle, Dual Cycle, Brayton cycle, Stirling cycle and Ericsson cycle; Gas Turbines: Gas turbine cycles, operation and materials; Condensers; Gas compressors; Refrigeration and air conditioning: Refrigeration cycles, refrigerants, psychometry.

Practice(P): Numerical on energy conversion and power point presentation by students. Experiments in the energy conversion lab.

MEL206 (3-1-2) 5- Theory of Machines

Introduction: Kinematic Links, Kinematic Pairs, Kinematic Chains, Planar Mechanisms, Degree of Freedom, Inversions of Planar Mechanisms. Kinematics: Displacement, Velocity and Acceleration analysis of planar mechanisms. Dynamics: Static and Dynamic Force Analysis of Planar Mechanisms, Flywheel, Balancing of Rotating and Reciprocating Masses. Classification of Gears, Gear Terminology, Law of Gearing, Velocity of sliding, Gear Teeth Profile, Path of Contact, Arc of Contact, Contact Ratio, Interference of in Involute Gears, Minimum Number of Teeth, Undercutting, Gear Forces, Different Types of Gear Trains, Analysis of Epicyclic Gear Train, Types of Cams and Followers, Cam Terminology, Derivatives of Follower Motion, Cam Profile Layout, working of Governors and Gyroscope.

Tutorial: Numerical on velocity analysis, acceleration analysis, static and dynamic force analysis, balancing of rotating and reciprocating masses, balancing of different configuration of engines, Projects to design mechanisms.

Practical: Experiments on linkages & mechanisms, Governers, balancing and Gyroscope..

MEL208 (3-1-0) 4-: Fluid Mechanics

Fluid Properties - Concept of fluid-flow, ideal and real fluids, properties of fluids, Newtonian and non-Newtonian fluids; Fluid Statics - Pascal's law, hydrostatic forces on bodies, stability of floating and submerged bodies; Fluid Kinematics - Eulerian and Lagrangian description of fluid flow; fluid acceleration, stream, streak and path lines, types of flows, continuity equation, rotation, vorticity and circulation, stream and potential functions; Fluid Dynamics - Concept of system and control volume, Euler's equation, Bernoulli's equation, correction factors, Impulse momentum relationship and its applications; Laminar Flow - Flow regimes and Reynolds number, analysis of uni-directional flow between parallel plates; Flow through Pipes - Losses in pipes, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes. Boundary Layer Flow (External Flows)- Concept, displacement, momentum and energy thickness, Von-Karman momentum integral equation, laminar and turbulent boundary layer flows, boundary layer separation and control, concept of drag and lift.

Tutorial (T): Numericals based on above topics.

MEL-209(2-0-2) 3- Materials Science and Engineering

Introduction to Materials Science- Type of materials, Atomic Structure, Interatomic Bonding and Structure of Crystalline Solids, Crystal imperfections; Metallographic techniques of sample preparation; Mechanical Properties of metals- elastic and plastic

deformations; Thermo-mechanical processing of metals and alloys; Phase diagrams; Heat treatment processes; Failure in materials-Ductile & Brittle Fracture and Fatigue, Creep and stress rupture, stress strain diagrams for engineering materials; Types of materials systems-Metallic alloys, Ceramics, Polymeric and Composite materials, magnetic and diamagnetic materials; Corrosion- electrochemistry, types of corrosion; Oxidation; Characterization of materials- x-ray diffraction and scanning electron microscopy.

Practice(P): Presenting demo model for crystal structures and imperfections in crystals, Metallographic techniques for sample preparation; microstructure observations of deformed and corroded samples under electron microscope; characterization and analysis of deformed specimens under both metallographic and electron microscopes. Impact Testing after Heat Treatment with different cooling media.

MEL 202 (3-0-2) 4- Heat & Mass transfer

Modes and Basic laws of Heat & Mass transfer; General conduction equations in Cartesian, Cylindrical and Spherical coordinates; Steady state one dimensional heat conduction with and without heat generation, Electrical analogy, Critical thickness of insulation, Fins; Unsteady heat conduction, lumped analysis, Heisler's charts; Governing equations for Convective heat transfer, Thermal boundary layer; Forced convection, Free convection; dimensionless parameters in free and forced convective heat transfer; Heat transfer correlations for flow over flat plates and through pipes, effect fo turbulence; Boiling and condensation; Heat exchangers, LMTD and NTU methods; Radiative heat transfer, Stefan-Bolzmann law, Wien's displacement law, black and gray surfaces, view factor; Radiation network analysis; Radiation shields; Heat and mass transfer analogy; Mass diffusion equation.

Practice (P): Experiments will be carried out in lab on different test setups; Numerical on heat transfer problems.

MEL207 (3-1-0) 4 - Machine Design I

Factors to be considered in design projects; phases of a design project; mission and requirements documents; design engineer's professional responsibilities; introduction to CAE; design for static and dynamic loading; factor of safety; theories of static failure (Tresca, von Mises, modified Mohr); stress concentration; basics of statistics (Frequency distribution; measures of central tendency and dispersion; normal distribution); fatigue failure (fatigue test, S-N curve, Goodman's line); design of shafts and keys (design based on strength, design based on deformation, design of keys); rolling and sliding contact bearings (types of rolling contact bearings, selection of deep groove ball bearings, reliability and life of bearings); design of belt drive systems (types of belts, design of flat and V belt systems); design of welded joints (types of weld, weld symbols, Butt and fillet weld calculations, welded joints under torsion and bending, weld inspection); Design of riveted joints; Manufacturing considerations in design (casting, forging, machining, cold working, welding, DFMA)

Tutorial (T): Brain storming and class activities related to determination of design requirements; solving numericals related to the course content; presentations by students about their projects

MEL303 (2-1-2) 4 Fluid Machines

Impact of free jets: Impulse – momentum principle, jet impingement on various stationary and moving geometries, jet propulsion of ships. Hydraulic Turbines: Classification, Impulse & reaction principles, component parts, construction, operation, governing mechanism, design aspects, velocity diagrams and performance characteristics of a Pelton wheel, Francis and Kaplan turbine, slow, medium and fast runners, degree of reaction, unit quantities, specific speed and model relationships for turbines, scale effect, cavitations. Centrifugal Pumps: Classification, construction, operation, design aspects and performance characteristics, minimum starting speed, multi-stage pumps. Similarity relations, specific speed, net positive suction head, cavitation and maximum suction lift. Reciprocating Pumps: Construction and operational details, effect of acceleration and friction on indicator diagram (pressure – stroke length plot), separation, air vessels and their utility, rate of flow into or from the air vessel, maximum speed of the rotating crank, characteristic curves. Hydraulic systems: Function, construction and operation of Hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic lift and hydraulic press, Fluid coupling and torque converter, Hydraulic ram. Dimensional Analysis.

Tutorial (T) and Practical (P): Numerical solving and conduct of experiments.

MEL326 (3-0-2)4- Instrumentation and Control Engineering

Introduction of Instruments and their types, standards and their calibration, strain gauges and rosettes, static and dynamics characteristics of instruments, , first and second order systems: transient and frequency response, error and uncertainties in performance parameters, transducers, digital logic number system, signal conditioners, Data acquisition system, introduction to control systems, types of control systems, transfer function of the systems, sequence control, stability check using Routh, root locus, Bode and Nyquist method, Fundamentals of vibration, free, damped and forced vibrations for single DOF system, vibration isolation, critical speeds of shafts.

Practice (P): Questions on classification of different types of instruments, numerical on static and dynamic characteristics based upon order of systems, descriptive questions on transducers and signal conditioners with numerical, questions on stability criterion, Practical measurement of displacement, load etc.; Data acquisition;

Experimental study of 1st and 2nd order systems; Stability analysis using Matlab; experiments on different control systems, PID Controller

MEL310 (3-1-0) 4- Industrial Engineering

Introduction to the need of IE and industrial safety, Productivity and productivity measurement; Work Study- Method Study and Work measurement, Job evaluation, wage incentives; Plant Location and Layout- Plant Location, Plant Layout; Material Handling and ergonomics, Production systems and their characteristics, systems analysis, Sequencing and scheduling; Inventory Management- Forecasting models, Inventory Control, Determinisic models and applications, safety stock inventory control systems; Aggregate production planning; Quality Management- Basic concepts in quality, cost reduction, 7 QC tools, Control charts and Process capability, Six Sigma and TPS; Materials requirement planning; Value Engineering- Value engineering, waste management; Selected topics- Introduction to Lean Systems, Value Stream Mapping, SMED, Total Productive Maintenance, the big losses and OEE.

Tutorial (T): To carry out case study on productivity measurement, Method study, Time study, Plant Location, Plant Layout, select material handling system for particular product, Problems related to inventory management, Value engineering, Value stream mapping.

MEL401 (2-1-0) 3- Operations Research

Role of operations research in decision making, applications in industry; concepts in OR model building; Linear programming: Graphical method and Simplex methods, BIG-M and Two phase methods; computational problems; Allocation models: Transportation and Assignment problems; Advanced topics of linear programming: Duality, Primal-Dual relations, sensitivity analysis, dual simplex method; Simulation models, Monte Carlo technique and its applications, Queuing models and its applications; Software tools for Operations Research

Tutorial (T): Numericals Based on above topics. Case Studies

MEL-677-IP (2-0-2) 3-: Optimization Techniques

Introduction and Basic Concepts:- Historical Development; Engineering applications of Optimization; Art of Modeling, Objective function; Constraints and Constraint surface; Formulation of design problems as mathematical programming problems; Classification of optimization problems; Optimization techniques; Functions of single and two variables; Global Optimum; Convexity and concavity of functions of one and two variables; Optimization of function of one variable and multiple variables; Gradient vectors; Optimization of function of multiple variables subject to equality constraints; Lagrangian function; Optimization of function of multiple variables subject to equality

constraints; Hessian matrix formulation; Eigen values; Standard form of linear programming (LP) problem; Canonical form of LP problem; Assumptions in LP Models; Elementary operations; Graphical method for two variable optimization problem; Examples; Motivation of simplex method, Simplex algorithm and construction of simplex tableau; Simplex criterion; Minimization versus maximization problems; Revised simplex method; Duality in LP; Primal dual relations; Dual Simplex; Use of software for solving linear optimization problems using graphical and simplex methods; Examples for transportation, structural and other optimization problems; Sequential optimization; Representation of multistage decision process; Types of multistage decision problems; Concept of sub optimization and the principle of optimality; Problem formulation and application in Design of continuous beam and Optimal geometric layout of a truss; Water allocation as a sequential process; Capacity expansion and Reservoir operation; Integer linear programming; Concept of cutting plane method; Mixed integer programming; Solution algorithms; Examples; Piecewise linear approximation of a nonlinear function; Multi objective optimization – Weighted and constrained methods; Multi level optimization; Direct and indirect search methods; Evolutionary algorithms for optimization and search; Applications in Robotics
List of experiments: 1 Matrix operations in Matlab 2 Differentiation of a vector and matrix in Matlab 3 Integration of a vector and matrix in Matlab 4 Simplex algorithm in Matlab 5 Implementation of Newton's method in Matlab 6 Implementation of Secant method in Matlab 7 Implementation of Lagrange multiplier method in Matlab 8 Implementation of KKT theorem in Matlab 9 Implementation of BFGS method in Matlab

MEL-478 (2-1-0) 3-: Robotics and Control

Introduction to robotics: Evolution of Robots and Robotics, Progressive advancement in Robots, Robot component , Robot Anatomy, Robot Degree of Freedom, Robot Joints, Robot Co-ordinates, Robot Reference frames, Programing Modes, Robot characteristics, Robot Workspace, Robot Applications. Kinematics of robots- Position analysis: Robot as Mechanism, Conventions, Matrix representation, Homogeneous Transformation, Representation of transformation, Inverse of Transformation, Forward and Inverse Kinematic of Robots, Forward and Inverse kinematics equations: position and orientation, Roll, Pitch ,Yaw Angles, Euler Angles, Articulated Joints, Denavit Hartenberg Representation of forward kinematics, Inverse Kinematic Programming of Robot, Degeneracy and Dexterity , Differential motions and velocities: Differential relationship, Jacobian, Differential versus large scale motions, Differential motions of a frame versus a Robot, Differential motion of a frame about Reference axes, General axis, Frame, Interpretation of the differential change, Differential Change between frames, Simple manipulators: Two /three arm manipulators and their kinematics equations, Work space Homogeneous Transformation: Rotation, Translation, Composition of homogeneous transformations.

MEL-479 (3-0-0) 3-: Industrial Automation and Process Control

Production systems Categories of manufacturing systems, manufacturing support systems, automation in production systems, automated manufacturing systems, opportunities for automation and computerization, types of automation, computerized manufacturing support systems, reasons for automating, automation principles and strategies, the USA principle, ten strategies for automation, automation migration strategy ,Automation and control technologies in production system Basic elements of an automated system, advanced automation functions, levels of automation, continuous and discrete control systems, computer process control, common measuring devices used in automation, desirable features for selection of measuring devices ,Material handling system Material handling equipment, design considerations for material handling system, material transport equipment, analysis of material transport systems, storage systems and their performance and location strategies, conventional and automated storage systems, overview of automatic identification and data capture, bar code technology, RFID, other AIDC technologies ,Production and assembly systems Automated production lines- fundamentals, system configurations, work part transfer mechanisms, storage buffers, control of production line, applications Automated assembly systems- fundamentals, system configurations, parts delivery at work stations, applications ,Cellular manufacturing Group technology, part families, parts classification and coding, production flow analysis, Opitz coding system, composite part concept, machine cell design, applications of GT ,Flexible manufacturing systems Introduction to FMS, types of FMS, FMS components, applications and benefits, planning and implementation issues in FMS, quantitative analysis of FMS.

MEL-480 (2-0-2) 3-: Mechatronics System Design

Introduction to Mechatronics, Integrated design issues in mechatronics, The mechatronics design process, Mechatronics Key elements, Application in mechatronics.Operator notation and transfer functions, block diagram , manipulations , and simulation, Block diagram modeling direct method and analogy method, electrical system, mechanical translational systems, Mechanical Rotational system, electrical mechanical coupling, fluid system Introduction to sensors and transducers, sensitivity Analysis sensors for motion and position measurement, force , torque and tactile sensors, vibration-acceleration sensors, sensors flow measurement , temperature sensing device, sensor application ,Direct current motors, Permanent magnet stepper motor, fluid power actuation, fluid power design elements, pie zoelectric actuators. Number system in mechatronics, Binary logic , Karnaugh map minimization, Programmable logic controllers, Introducing to signals, systems, and controls, Laplace transform solutions of ordinary differential equations, System representations, linearization of nonlinear systems, Time delays, measured of systems performance, controller design using pole placement method, elements of data acquisition and control system, transducers and signal conditioning, device for data conversing, data conversion process. Application software

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MEL-481 (2-1-0) 3-: Advanced Robotics

Calculation of the Jacobian, Inverse Jacobian ,Dynamic analysis of robot: Lagrangian Mechanics, Effective moment inertia, Dynamic Equation for multiple degree of freedom

robots, Static force analysis of Robots, Transformation of forces and moments between coordinates frames ,Trajectory planning: Path versus Trajectory, Joint space versus Cartesian space Descriptions, Basics of trajectory Planning, Joint space trajectory, Cartesian space Trajectories, Continuous trajectory. Control of manipulators: Open and closed loop control, Linear control schemes. Model of manipulator joint, Joint actuator, Partitioned PD control Schemes, PID control schemes, Computed Torque Control, Force control of Robotics Manipulators tasks, Force control strategy, Hybrid Position/ Force control , Impedance force /Torque control. The DH parameters: As axis placement in 3D space, Transformations in 3D, Euler's Theorem: Chasale's Theorem, Interpolating for general motion in space – finite screws. Jacobian control of planar linkage: Pseudo inverse and Redundant system, Infinitesimal screws, Jacobians for 3D manipulators Kinematics of redundant systems. Parallel manipulators: Some configurations of parallel manipulators, Forward kinematics, Inverse Kinematics, Dynamics. Serial manipulators: Inverse Dynamics of serial manipulators, Forward Dynamics of serial manipulators. Position control of manipulators: Force control of manipulators, Hybrid control strategies, Variable structure control, Impedance control

MEL-486 (2-0-2) 3-: Signal Processing, AI & NN Technique

Basic Elements of Digital Signal Processing Systems, Classification of Signals, The concept of frequency in Continuous time and Discrete time domain, Discrete-time Signals and Systems, Analysis of Discrete Time, Linear Shift Invariant Systems-Linearity, Causality and Stability criterion, AI problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation, Searching : Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search) Greedy best first search, A* search Game Playing: Adversial search, Games, minimax, algorithm, optimal decisions in multiplayer games, Knowledge Representation & Reasons logical Agents, Resolution, Forward & Backward. Chaining, Characteristics of Neural Networks, Historical Development of Neural Networks Principles, Artificial Neural Networks: Terminology, Models of Neuron, Topology, Basic Learning Laws, Pattern Recognition Problem, Basic Functional Units, Pattern Recognition Tasks by the Functional Units..Feed-forward Neural Networks: Analysis of pattern Association Networks, Pattern Classification Networks, pattern storage Networks. Pattern Mapping Networks., Linear Auto associative FF Networks, Pattern Storage Networks, Competitive Learning Neural Networks & Complex pattern Recognition.