M. Tech Energy and Environmental Engineering

Scheme and Syllabus

(w.e.f. 2021-2022)

(As per AICTE Model Scheme)

Choice Based Credit System (CBCS)

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA
FARIDABAD, HARYANA -121006

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

VISION

J C BOSE University of Science and Technology, YMCA aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building.

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities

M. Tech Energy and Environmental Engineering

PREFACE

M. Tech. Energy and Environmental Engineering is a two-year Postgraduate Program starting from the session 2020-21. The aim of the program is to prepare future decision-makers in companies, government and non-governmental organizations to analyse and act in an environmentally pro-active way when making decisions about policy, energy production and utilization.

The energy sector is critical for socio-economic development. The development of energy systems is constrained by the depletion of fossil fuel, local environmental impacts and the problem of global warming and associated climate change. There is significant need for engineering, design, research and development inputs in building efficient, economical and eco-friendly energy systems, new energy sources and conversion devices. The course helps to develop skills in the cost-effective management of energy resources and in managing industrial development within tight environmental constraints.

The postgraduate course will provide opportunities in environmental engineering, developing and building of renewable energy technologies, integration of renewable energy generation into existing power systems, electrical power and energy audit.

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD
SCHEME OF M. TECH ENERGY AND ENVIRONMENTAL ENGINEERING
(w.e.f. Academic Session 2020-21)

Semester I

S No	Subject Code	Subject Name	L-T-P	Credits	Marks Weightage		Course Type
					Internal	External	
1	MTEVE101A	Non-Conventional Sources of Energy	3-0-0	3	25	75	Core
2	MTEVE102A	Energy Ecology & Environments	3-0-0	3	25	75	Core
3	MTEVE103A	Discipline specific Elective-I	3-0-0	3	25	75	Program Elective
4	MTEVE104A	Discipline specific Elective-II	3-0-0	3	25	75	Program Elective
5	MTEVE105A	Environment Lab I	0-0-4	2	15	35	Core
6	MTEVE106A	Energy Lab I	0-0-4	2	15	35	Core
7	RMI-101A	Research Methodology and IPR	3-0-0	3	25	75	Core
8	AUD	Audit Course – 1	2-0-0	0	0	0	Audit
		Total	**17-0-8**	**19**	**155**	**445**	

Discipline Specific Elective-I (One course to be chosen amongst the following)
MTEVE103A-1 Introduction to Environmental Chemistry
MTEVE103A-2: Electrical Energy Management
MTEVE103A-3: Energy Conservation in Thermal System

Discipline Specific Elective-II (One course to be chosen amongst the following)

MTEVE104A-1: Direct Energy Conversion
MTEVE104A-2: Water and waste water treatment system
MTEVE104A-3: Solar Photovoltaic Energy Conversion

Audit course 1 & 2
AUD01A: English for Research Paper Writing
AUD02A: Disaster Management
AUD03A: Sanskrit for Technical Knowledge
AUD04A: Value Education
AUD05A: Constitution of India
AUD06A: Pedagogy Studies
AUD07A: Stress Management by Yoga
AUD08A: Personality Development through Life Enlightenment Skills
AUD09A: Basic Thermal Engg.
AUD10A: Basic Electrical Engineering

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD
SCHEME OF M. TECH ENERGY AND ENVIRONMENTAL ENGINEERING
(w.e.f. Academic Session 2020-21)

Semester II

Subject Code	Subject Name	L-T-P	Credits	Marks Weightage		Course Type
				Internal	External	
MTEVE201A	Fuel Technology	3-0-0	3	25	75	Core
MTEVE202A	Energy and Environmental Auditing and Impact Assessment	3-0-0	3	25	75	Core
MTEVE203A*	Discipline specific Elective-III	3-0-0	3	25	75	Program Elective
MTEVE204A*	Discipline specific Elective-IV	3-0-0	3	25	75	Program Elective
MTEVE205A	Environment Lab 2	0-0-4	2	15	35	Core
MTEVE206A	Energy Lab 2	0-0-4	2	15	35	Core
AUD**	Audit Course - 2	2-0-0	0	0	0	Audit
MTEVE207A	Mini-Project	0-0-4	2	15	35	Core
	Total	**14-0-12**	**18**	**145**	**405**	

*Discipline Specific Elective Courses subject to availability of requisite resources/ faculty in the university/department.
**The students have to choose one Audit course from the list provided by the department/university. Only passing of the Audit course will be mandatory.

Discipline specific Elective-III

MTEVE203A-1: Air Pollution Control Engineering

MTEVE203A-2: Energy Storage and Fuel Cell Technology

MTEVE203A-3: Cogeneration and Energy Efficiency

Discipline specific Elective-IV

MTEVE204A-1: Energy Economics and Policy Regulation

MTEVE204A-2: Wind, Hydro & Chemical Energy System

MTEVE204A-3: Instrumentation in Energy and Environmental Systems

Audit course 1 & 2

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD
SCHEME OF M. TECH ENERGY AND ENVIRONMENTAL ENGINEERING
(w.e.f. Academic Session 2020-21)

Semester III

Subject Code	Subject Name	L-T-P	Credits	Marks Weightage		Course Type
				Internal	External	
MTEVE301A	Discipline specific Elective-IV	3-0-0	3	25	75	Program Elective
OEC*	Open Elective	3-0-0	3	25	75	Open Elective
MTEVE302A	Dissertation (Phase -I)	0-0-20	10	75	175	Dissertation
	Total	**6-0-20**	**16**	**125**	**325**	

*The students have to choose one Open elective course related to some other branch of Science/Engg. /Other discipline required for enhancing professional performance as provided by the department/university.

Discipline specific Elective-IV

MTEVE301A-1: Solid and Hazardous waste management

MTEVE301A-2: Green Building Design and simulation

MTEVE301A-3: Environmental Modelling, simulation and Life cycle assessment

Open Elective

OEC101A: Business Analytics

OEC102A: Industrial Safety

OEC103A: Operations Research

OEC104A: Cost Management of Engineering Projects

OEC105A: Composite Materials

OEC106A: Waste to Energy

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD
SCHEME OF M. TECH ENERGY AND ENVIRONMENTAL ENGINEERING
(w.e.f. Academic Session 2020-21)

Semester IV

Subject Code	Subject Name	L-T-P	Credits	Marks Weightage		Course Type
				Internal	External	
MTEVE401A	Dissertation (Phase -II)	0-0-32	16	150	350	Dissertation
	Total	**0-0-32**	**16**	**150**	**350**	
MOOC Course			**02**			

Total Credits for the program = 19 + 18 +16 +16 = **69+2* =71**

***Refer implementation of Credit Transfer/Mobility Policy of online courses,17th meeting of Academic Council (11.6.2019) for details, regarding MOOC credits. Minimum credit to be earned is **02** through MOOC for all M. Tech. students.

Instructions to the students regarding MOOC

1. Two types of courses will be circulated: branch specific and general courses from the website https://swayam.gov.in in the month of June and November every year for the forthcoming semester.

2. The department coordinators will be the course coordinators of their respective departments.

3. Every student has to pass a selected MOOC course within the duration as specified below:

Programme	Duration
B. Tech.	Sem. I to Sem. VIII
M.Sc./M.Tech./MA/MBA	Sem. I to Sem. IV
B.Sc./MCA	Sem. I to Sem. VI

The passing of a MOOC course is mandatory for the fulfilment of the award of the degree of concerned programme.

4. A student has to register for the course for which he is interested and eligible which is approved by the department with the help of course coordinator of the concerned department.

5. A student may register in the MOOC course of any programme. However, a UG student will register only in UG MOOC courses and a PG student will register in only PG MOOC courses.

6. The students must read all the instructions for the selected course on the website, get updated with all key dates of the concerned course and must inform his/her progress to their course coordinator.

7. The student has to pass the exam (online or pen-paper mode as the case may be) with at least 40% marks.

8. The students should note that there will be a weightage of Assessment/quiz etc. and final examination appropriately as mentioned in the instructions for a particular course.

9. A student must claim the credits earned in the MOOC course in his/her marksheet in the examination branch by forwarding his/her application through course coordinator and chairperson.

J C BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA FARIDABAD

M.TECH ENERGY AND ENVIRONMENTAL ENGINEERING

Student Grades

The academic performance of a student shall be graded on a TEN – POINT SCALE and the award of grades based upon marks obtained out of 100 shall be made as follows:

Marks percentage	Grade	Grade points	Category
90-100	O	10	Outstanding
80≤ marks< 90	A+	9	Excellent
70≤ marks< 80	A	8	Very Good
60≤ marks< 70	B+	7	Good
50≤ marks< 60	B	6	Above Average
45≤ marks< 50	C	5	Average
40≤ marks< 45	P	4	Pass
< 40	F	0	Fail
--------	Ab	0	Absent

Cumulative Grade Point Average (CGPA)

A student is required to maintain a Cumulative Grade Point Average (CGPA) which is the weighted average of all the Letter Grade obtained by the student since his/her entry into the Institute upto and including the latest semester and computed as follows:

$$CGPA = \sum(CiGi)/ \sum Ci$$

Where, Ci denotes credits assigned to i^{th} course and G_i indicates the Grade point equivalent to the Letter Grade obtained by the students to the i^{th} course. Provided that when a student re-appears in/repeats a course, the new Grade will replace the earlier one in the calculations of the CGPA.

Note:

i. At the end semester (i.e. after End Semester Examination), students will be supplied a DMC indicating the grades secured in each course, Semester Grade Point Average (SGPA) and up-to-date CGPA.

ii. Multiplication factor for converting the CGPA in percentage will be provided on the respective Detailed Marks Certificate (DMC).

M.TECH ENERGY AND ENVIRONMENTAL ENGINEERING

SEMESTER-I

MTEVE101A: NON-CONVENTIONAL SOURCES OF ENERGY

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory: 75 Marks**
3 0 0 3 **Total: 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: - Students will gain:

1. Various renewable energy sources in nature
2. Uses of renewable energy sources
3. About different types of non-conventional Sources.

UNIT – I

SOLAR ENERGY: Principles of solar radiation and applications: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data. Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

UNIT-II

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria

UNIT-III

BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

UNIT-IV

GEOTHERMAL ENERGY & OCEAN ENERGY: Types of wells, methods of harnessing the energy, potential in India. Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.

Course Outcomes: - Students will be able to:

1. Analyses different types of renewable energy

2. Harnessing different type of energy
3. Know and apply the different sources of renewable energy.

Suggested readings:

1. Ranjan Rakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies", 2nd Ed. Prentice Hall of India,2011
2. Roger A. Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010
3. James F. Manwell, Jon G. McGowan Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed,2010.

MTEVE 102A: ENERGY, ECOLOGY & ENVIRONMENT

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory : 75 Marks
Total : 100 Marks
Duration of Exam: 3 Hours

Course Objectives: - Students will gain:

1. About various aspects of environments.
2. Ecosystem of environments
3. Energy and material flow in the environment.

UNIT I Origin of earth, Earth's temperature and atmosphere, Sun as a source of energy, Solar spectrum, introduction to fossil fuel-petroleum, coal, natural gas and bio mass.

UNIT II Introduction to ecology, concept of biosphere, community characteristics, ecological succession. Forest resources – Forest and environment, World forest resources, National forest Policy, Deforestation and forest management.

UNIT III Energy flow in material cycle, Food chain, Food web, Photosynthesis, ecological pyramids, Autecology, Biogeochemical cycles, Concept of sustainable development, Responses of Ecosystems (Land, Water, Marine) to deforestation, fire, pollution, ecological invasions; Rural vs. Urban systems; Restoration of Degraded Ecosystems.

UNIT IV Thermal pollution, radioactive pollution, noise pollution (Sources, classification and effects), micro climatic effects of pollution, environmental degradation, sources and classification of pollutants, Pollution abatement methods, resources of energy and energy use pattern in different regions of the world,

Course Outcomes: - Students will be able to:

1. Analyses Energy flow in Natural System
2. Evaluate Material flow in environment.
3. Understand the interdependence of different components of the environments.

Recommended Books

1. Introduction to Ecology by P D Sharma.
2. Fundamentals of Ecology by E.P. Odum
3. Living in the environment by T. J. Miller.
4. Environmental Pollution Control Engineering by C. S. Rao.
5. Renewable Energy by N. K. Bansal.
6. Environmental Chemistry by B. K. Sharma.

DISCIPLINE SPECIFIC ELECTIVE-I

MTEVE103A-1: INTRODUCTION TO ENVIRONMENTAL CHEMISTRY

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory: 75 Marks**
3 0 0 3 **Total: 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: - Students will gain:

1. About chemistry of different component of environments.
2. The effect of global environments changes.
3. Knowledge about different instrumentation used in environments studies.

Course contents:

Unit I-Water Chemistry: Fundamentals: Classification, Sources, Ground and surface water chemistry, water ion balancing, water pollution due to heavy metals, organic pollutants, pesticides and radionuclides. Water pollution, Water and wastewater Characterization, BOD, COD, Water quality control, Water quality Standards.

Unit-II - Atmospheric Chemistry: Fundamentals: Chemical composition of atmosphere, the changing global atmosphere, greenhouse gases and global warming, gaseous transformation in the atmosphere and removal mechanisms, residence-time, acid-rain, ozone layer depletion, nuclear winter. Atmospheric Photochemical Reactions: Monoatomic oxygen and ozone formation, role of nitrogen in photooxidation, hydrocarbons in atmospheric photo-chemistry, oxidants in photochemical smog. Hydrocarbon reactivity. Air Pollution and Air pollutants, Air Pollution Control

Unit-III - Soil Chemistry: Fundamentals: Nature, composition and properties of Soil, Chemical Weathering, soil clays, CEC, humus-metal interaction, soil acidity, salinity and sodicity, Effects of modern agriculture on soil geochemistry.

Unit-IV-Instrumentation: Basic principle and working of following instruments (In brief): Atomic absorption spectrophotometer, atomic emission spectrophotometer, gas chromatography, high performance liquid chromatography, mass spectrometry, SEM, TOC analyser, ICP, Ion chromatography, FTIR, RDS.

Course Outcomes: - Students will be able to:

1. Analyses the chemistry of different component of environments.
2. Evaluate the effect of global environments changes.

3. Analyses different instrumentation used in environments studies.

Suggested Readings:

1. Introduction to Environmental Engineering and Science by Gilbert M Masters and Wendell P. Ela
2. Environmental Soil Chemistry by Donald L. Sparks
3. Introduction to Soil & Plant by R.W. Miller & R.L. Dowhan
4. Climate Change by J.T. Honghton, B.A. Callander& S.K. Varney
5. Fundamentals of Air Pollution by Boubel Fox, Turner & Stern
6. Environmental Chemistry by S.C. Manhan
7. Introduction to Environmental Sc. &Engg. by Gilbert M. Masters
8. Environmental Chemistry by Colin Baird
9. Soils and the Environment by Wild
10. Composition, Chemistry and Climate of the atmosphere by H.B. Singh
11. Fundamentals of Analytical Chemistry by Skoog, West & Holler.

MTEVE103A-2: ELECTRICAL ENERGY MANAGEMENT

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Course objectives: Students will gain

1.About the importance of electrical energy management,

2. Knowledge of Energy auditing and energy conservation. •

3. Methods to improve electrical energy efficiency in Industrial/commercial/domestic sectors.

Course contents:

Unit I Importance of energy management, Electrical energy auditing methods,

Unit II Demand control, load scheduling/shifting, Energy management centres and their functions,

Unit III Economic operation of power system, Unit commitment, Supervisory control and scada systems, Optimal resource management in micro grid/decentralized environment,

Unit IV Power factor improvement, Energy efficient motors, Pumps, Variable frequency drives, Energy efficient lighting, Energy conservation in various electrical devices.

UNIT V-Power Electronic Interface with the Grid, Impact of Distributed Generation on the Power System, Power Quality Disturbances.

Course Outcomes: - Students able to:

1. Analyses of electrical energy management,

2. Evaluate the Energy auditing and energy conservation process.

3. Design system for improve electrical energy efficiency in Industrial/commercial/domestic sectors.

Suggested Readings:

1. Savings Electricity in Utility Systems of Industrial Plants by B.G. Desai, B.S. Vaidya D.P. Patel and R. Parman.

2. Manual of variable speed drives by CII

3. Efficient use of electricity in industries by B.G. Desai, B.S. Vaidya, M.P. Parmarad

4. Electrical Power Distribution in Industrial Plants by M.D. Parmar.

5. Energy Conservation in electrical systems, a reading material prepared by D. Buddhi.

6. B.R. Gupta, Generation Of Electrical Energy Edition 2005, Eurasia Publishing House (PVT.) LTD. Ram Nagar.

MTEVE103A-3: ENERGY CONSERVATION IN THERMAL SYSTEM

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory: 75 Marks**
3 0 0 3 **Total: 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: - Students will gain:

1. About various aspects Thermal Energy
2. Conservation of Thermal energy in different type of Thermal System
3. About heat energy recovery from waste heat.

Course contents:

UNIT I-Fuel Analysis: Proximate Analysis, Ultimate Analysis, Calorific Value, Combustion: Theoretical Air Requirement, Efficiency Estimates, Combustion Control, Stability in Flames, Furnaces: Classification, General Fuel Economy Measures in Furnaces, Excess Air and Heat Distribution Losses, Temperature Control, Draft Control, Case Studies.

UNIT II-Insulation and Refractories: Insulation Type and Application, Economic Thickness of Insulation, Heat Savings and Application Criteria, Refractory-Types, Selection and Application of Refractories, Case Studies. Boilers: Types, Analysis of Losses, Performance Evaluation, Feed Water Treatment, Blow Down, Energy Conservation Opportunities, Case Studies. FBC Boilers: Introduction, Mechanism of Fluidized Bed Combustion, AFBC, CFBC, PFBC Boilers, Condensing Boilers, Saving Potential, Case Studies.

Unit III -Steam System: Properties of Steam, Assessment of Steam Distribution Losses, Steam Leakages, Steam Trapping, Condensate and Flash Steam Recovery System, Identifying Opportunities for Energy Saving, Case Studies. Cogeneration: Need, Applications, Advantages, Topping Cycles, Bottoming Cycles, Combined Cycles, Steam Tracking Mode, Electricity Tracking Mode, Saving Potential, Case Studies.

UNIT IV-Waste Heat Recovery: Availability and Reversibility, First and Second Law Efficiencies, Classification, Advantages and Applications, Commercially Viable Heat Recovery Devices, Saving Potential, Case Studies.

UNIT V -HVAC: HVAC and Refrigeration System, Vapor compression Refrigeration Cycle, Refrigerants, Factors Affecting Refrigeration and Air Conditioning System Performance and Savings Opportunities.

UNIT VI -Vapor Absorption Refrigeration System: Working Principle, Types and Comparison with Vapor Compression System, Saving Potential, Distribution systems for conditioned air Types and Performance Evaluation, Efficient System Operation, Cooling Towers Types and

Performance Evaluation, Efficient System Operation, Flow Control Strategies and Energy Saving Opportunities, Case Studies.

Course Outcomes: - Students will be able to:

1. Analyses of thermal system,
2. Evaluate the thermal energy conservation process.
3. Design thermal system for energy efficiency in Industrial/commercial/domestic sectors .

Suggested Reading:

1. G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.

2. Carig,B. Saith, Energy Management Principles, Applications, Benefit and Saving, Per n Press, New York.

3. F. W. Pyne, P gm Energy Conservation Manual, Fairmont Proem, INC.P.O. Box 14227 Atlanta,GA 30224

4. D. Patrick and S.W. Fardo, Energy U-sent and Conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632.

5. Davida, Fuels of Opportunity, Characteristics and Uses in Combustion Systems, Edition 2004 Publisher- ELSEVIER LTD. UK

6. O.P. Gupta, Element of Fuel Furnaces and Refractories, Edition-Second

7. Gunnar, Anderlind, A Theoretical Analysis of Thermal Insulation.

DISCIPLINE SPECIFIC ELECTIVE-2

MTEVE104A-1: DIRECT ENERGY CONVERSION

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory: 75 Marks**
3 0 0 3 **Total: 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: - Students will gain:

1. About various direct energy conversion technology.
2. Fabrication of solar cell
3. Knowledge of different materials for energy conversion.

Course contents:

Unit I: Survey of energy conversion problem. Basic science of energy conversion. Physics of semiconductor junctions for photovoltaic.

Unit II Fabrication and evaluation of various solar cells. Application of solar cells in photo voltaic power generation systems.

Unit III Technology and physics of thermo-electric generators. Thermo-electric materials and optimization studies, Basic concepts and design consideration of MHD generators. Cycle analysis of MHD systems. Thermionic power conversion and basic concept of Fusion Energy.

Unit IV Thermodynamics and performance of fuel cells and their applications, recent developments and their applications.

Course Outcomes: - Students will be able to:

1. Analyses the energy conversion process,
2. Evaluate the applications of solar cell.
3. Understand the different fuel cells.

Suggested Readings:

1. Direct Energy Conversion: W.R. Corliss
2. Aspects of Energy Conversion: I.M. Blair and B.O. Jones
3. Principles of Energy Conversion: A.W.Culp (McGraw-Hill International)
4. Energy conversion principles: Begamudre , Rakoshdas
5. Handbook: Batteries and Fuel cell – linden (Mc.Graw Hill)- 1984
6. Essentials of Solar Cells by R. K. Kotnala & N.P. Singh, Allied Publishers Pvt. Ltds, New Delhi, 1986.
7. Semiconductor Devices by Nauro Zamluto, Mc Graw Hill 1989 (Int. Ed.)
8. Solid State Electronic Devices. III ed. By B. G. Streetman, Prentice Hall India Pvt. Ltd., N.D, 1991.
9. Solar Cells by Martin Green, Pergamon press.
10. Solar Energy Thermal processes: Duffie & Buckman, Wiley & Sons, New York.
11. Solar Energy by S.P. Sukhatme, Tata Mc Graw Hill, New Delhi.
12. Solar Energy: H P Garg & J P Prakash.
13. Non-Conventional Sources of Energy- G D Rai

MTEVE104A-2: WATER & WASTE WATER TREATMENT TECHNOLOGIES

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory: 75 Marks**
3 0 0 3 **Total: 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: Students will gain:

1. Basic of water related pollution.
2. Water treatment process.
3. About biological treatment of water

Course contents:

UNIT I Fundamentals: Definition, Classification, Sources, Water quality Standards. Water Chemistry: Theory of Acid Base Equilibrium, Water Pollution And Control: Indicators, Hardness & Determination of DO BOD, COD of Water, and Water Pollution due to heavy metals and Organic Pollutants. 6 Surface Water Treatment: Water Purification, Processes in Natural Systems (Physical, Chemical, Bio-Chemical Processes) and Its Application, Response of Stream to Bio-Degradable Organic Wastes.

UNIT II Water Treatment Methods: Principles and Design, Aeration Systems, types of settling and settling equations, design criteria and design of settling tanks. Coagulation and Flocculation – types of coagulants, coagulant aids, coagulation theory, optimum dose of coagulant, jar test method, design criteria and numerical examples. Filtration – theory, types, filter backwash, operational problems and trouble shooting.

UNIT III Unit processes, Water Softening- Principles and design- Ions causing hardness, various methods. Waste Water Treatment: Principles and Design, Objectives of wastewater treatment, characteristics, flow variations, types of reactors and reactors analysis. Mass Loading Factors, Impacts, Estimation and Their Unit Loading.

UNIT IV 'Principle of Biological Treatment; Microbial Growth Rates, Treatment Kinetics, Food/Micro Organism Ratio, Substrate Removal Efficiency. Theoretical principles and design Aerobic Suspended Growth Systems, Activated Sludge, Aerated Lagoon, Principles and design of stabilization ponds, Aerobic Attached Growth, Trickling Filters,

UNIT V Anaerobic - UASBS, Sludge Digesters, Anaerobic Ponds. Different Types of Industrial Effluent Treatment Plants. Sludge Processing: separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic. Numerical problems and Case Studies.

Course outcomes: **Students will be able to:**

1. Analyses of water related pollution.
2. Describe water treatment process.
3. Understand biological treatment of water.

Suggested Readings:

1) Environmental Pollution and Its Control Jeffrey J. and P.A. Vesilind.

2) Chemistry for Environmental Engineering Clair N. Sawyer & McCarty, TATA McGraw Hill International Publication IIIrd Edition.1986

3) Environmental Engineering - Howard S. Peavy et.al, TATA McGraw Hill International Publication 1st Edition. 1986

4) Environmental Engineering – Ruth F. Weiner and Robin Matthews fourth edition.

5) Water & Waste Water Technology - Marle J. Hammer, Prentice Hall of India Ltd. New Delhi 2nd

6) Waste Water Treatment, Disposal & Reuse - Metcalf & Eddy, TATA McGraw Hill Publication New Delhi 3rd Edition.

7) Waste Water Treatment for Pollution Control – Soli J. Arceivala, TATA McGraw Hill Publication New Delhi 2nd Edition.

8) Energy Conservation in water and wastewater facilities.

9) Water Treatment Handbook, Vol. 1& 2

10) “Manual on water supply and Treatment ", CPHEEO, Ministry of Urban Development, GOI, New Delhi, 1999.

MTEVE104A-3: Solar Photovoltaic Energy Conversion

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory : 75 Marks**
3 0 0 3 **Total : 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: The students gain

1. A about the properties of semiconductors
2. Knowledge of the fabrication of solar devices
3. Characterization of solar cell

Course contents:

Unit-I Properties of Semiconductor: Semiconductors: Crystals structures, atomic bonding, energy band diagram – direct & indirect band gap- p & n doping and carrier concentration - Hall effect in semiconductors – Intrinsic & extrinsic semiconductor - compound semiconductors - diffusion and drift of carriers, continuity equation – optical absorption – carrier recombination -Effect of temperature.

Unit-II Semiconductors for Solar Cell: Silicon: preparation of metallurgical, electronic and solar grade Silicon - Production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) method – imperfections – carrier doping and lifetime - Germanium - compound semiconductors: growth & characterization.

Unit-III Device fabrication: Semiconductor junctions: Schottky barriers, MIS, P-N junction, p-i-n junction and its properties Homo & hetero junction solar cells, multijunction solar cells Fabrication techniques: Diffusion, thin film technology- physical vapour deposition (PVD)- Electro-deposition- Molecular beam epitaxy (MBE)- Metal organic chemical vapour deposition (MOCVD)- Plasma enhanced chemical vapour deposition (PECVD).

Unit-IV Characterization and analysis: Device isolation & analysis - Ideal cell under illumination solar cell parameters short circuit current, open circuit voltage, fill factor, efficiency; optical losses; electrical losses, surface recombination velocity, quantum efficiency - measurements of solar cell parameters; I-V curve & L-I-V characteristics, internal Quantum yield measurements – Effects of series and parallel resistance and Temperature - Loss analysis.

Unit: V Solar cell module materials and assembly PV modules: Module and Circuit Design - Identical and Non-identical Cells - Module Structuring and assembly - Environmental Protection - Thermal Considerations - Electrical Considerations and output conditioning - assembly materials – interconnects – crystalline and thin film modules - issues with solar PV modules, bypass diode and blocking diode – module testing and analysis.

Course outcomes: The students will be able to:

1. Evaluate the properties of semiconductors
2. Understand for the fabrication of solar devices
3. Describe the characterization of solar cell

Suggested Readings:

1. Semiconductors for solar cells, H. J. Moller, Artech House Inc, MA, USA, 1993.

2. Fundamentals of Solar Cells: PV Solar Energy Conversion, Alan L Fahrenbruch and Richard H Bube , Academic Press, New York , 1983

3. Solar Cells: Operating principles, Technology and Systems Applications, Martin Green, UNSW, Australia, 1997.

4. Solar Cells and their Applications, Larry D Partain (ed.), John Wiley and Sons, Inc, New York, 1995.

5. J. Nelson, The physics of solar cells, Imperial College Press, 2006.

6. Photovoltaic Materials, Richard H Bube, Imperial College Press, 1998

MTEVE105A: ENVIRONMENTAL LAB I

No. of Credits: 2 **Sessional: 15 Marks**

L T P Total **Theory: 35 Marks**

0 0 4 4 **Total: 50 Marks**

Course Objectives:

The objective of the course is to train the students in analysis of various environmental pollutants/parameters present in water, soil and air. They will also get the knowledge about vehicular emission testing. Any eight experiments shall be performed.

From EVS departments.

List of experiments: Water and Soil

1. Study of Physical characteristics of water: Colour, Odour, Turbidity, Temperature.
2. Determination of pH of water/soil sample.
3. Determination of conductivity/TDS of the water/soil sample.
4. Determination of salinity of the water/soil sample.
5. Determination of ORP of the water/soil sample.
6. Determination of alkalinity of the water/soil sample.
7. Determination of Dissolved Oxygen of given water sample by Winkler's method.
8. Determination of Fluoride content in the water sample by Spectrophotometric method.
9. Design of hybrid rain water harvesting system for practical applications.
10. Installation and operation of Human operated treadle pump operation for water lifting.
11. IoT based water flow measurement
12. Rooftop water harvesting system.

Calibration of flow meters for high volume air sampler.

13. Study of TSPM in ambient air.
14. Study of PM10 and PM2.5 in ambient air.
15. Vehicular emission testing.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

Course Outcomes: The students will get first hand training on water and soil analysis and the skills acquired can be used in planning of the various treatment methodologies.

The students will be able to perform air quality measurements in different areas and help in management plans.

MTEVE 106A: ENERGY LAB I

No. of Credits: 2 **Sessional: 15 Marks**

L T P Total **Theory: 35 Marks**

0 0 4 4 **Total: 50 Marks**

Course Objectives:

The objective of the course is to train the students in analysis of various wind Turbine operations/ Solar Photovoltaic modules and learn heat flow phenomena in real life.

List of experiments which can be conducted in energy lab I of Electrical Engg. /Mechanical Engineering Department: Any Eight Experiments shall be performed

Solar Energy:

1. Synchronization of solar PV inverter and it's performance analysis
2. Modelling of PV cell
3. Effect Of Temperature Variation on Photovoltaic Array
4. Effect of irradiation on a photovoltaic array
5. Design of solar PV boost converter using P&O MPPT technique.
6. Evaluation of active and reactive power & apparent energy flow between grid tied inverter, grid & load & net metering concept
7. To demonstrate the I-V and P-V characteristics of PV module with varying radiation and temperature level and characteristics of series and parallel combination of PV modules.
8. To show the effect of variation in tilt angle and shading of solar cell on PV module power.
9. Workout power flow calculations of standalone PV system of AC and DC load with battery.
10. Find the MPP manually by varying the resistive load across the solar PV panel.
11. Find the MPP by varying the duty cycle of DC-DC converter.
12. Observe the Vm, Im, Pm and duty cycle at which MPP occurs, with MPP algorithm.
13. Wind power and annual energy estimation from wind data.
14. Pay back analysis, financial work sheet of a renewable energy project.

Mechanical Engg:

1. To determine the heat transfer coefficient in natural convection.
2. To measure the heat transfer coefficient in forced convection.
3. To determine and compare LMTD, Overall Heat transfer coefficient, efficiency and effectiveness of a heat exchanger in parallel flow and counter flow mode.
4. To determine heat transfer coefficient for drop and film wise condensation.
5. To determine thermal conductivity of an insulating power.
6. Study of heat pipe
7. Study of vapour absorption refrigeration.
8. Study of Cooling Tower

Course Outcomes:

The students will get first hand training on Solar PV Cell, Soler cell Simulations. The students will be able to perform heat transfer experiments and understand phenomena of refrigeration.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

RMI101A: RESEARCH METHODOLOGY AND IPR

No. of Credits: 3 **Sessional: 25 Marks**
L T P Total **Theory: 75 Marks**
3 0 0 3 **Total: 100 Marks**
Duration of Exam: 3 Hours

Course Objectives: Student will gain:

1. Knowledge of research problem formulation.
2. Analyze research related information.
3. About IPR Protection

UNIT I - Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

UNIT II - Effective literature study approaches, analysis Plagiarism, Research ethics.

UNIT III - Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT IV- Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT.

UNIT V - Patent Rights: Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications.

UNIT VI - New Developments in IPR: Administration of Patent System, New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Course Outcomes: Students will able to:

1. Understand research problem formulation.
2. Analyze research related information.
3. Follow research ethics
4. Understand that today's world and creativity.
4. Understanding that when IPR in Engineering.
5. Understand that IPR protection provides about, economic growth and social benefits.

Suggested readings:

1. Stuart Melville and Wayne Goddard, “Research methodology: an introduction for science &engineering students’”
2. Wayne Goddard and Stuart Melville, “Research Methodology: AnIntroduction”
3. M.L. Aggarwal and Krishan Kumar “Research Methodology & IPR” Jain Brothers Publications, 2018.
4. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd,2007.
5. Mayall, “Industrial Design”, McGraw Hill,1992.
6. Niebel, “Product Design”, McGraw Hill,1974.
7. Asimov, “Introduction to Design”, Prentice Hall,962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, “Intellectual Property inNew Technological Age”,2016.
9. T. Ramappa, “Intellectual Property Rights Under WTO”, S. Chand,2008.

AUDIT COURSES

AUD01A: ENGLISH FOR RESEARCH PAPER WRITING

Course objectives: Students will gain

1. Understanding that how to improve your writing skills and level of readability
2. About what to write in each section
3. The skills needed when writing a Title

Note: Ensure the good quality of paper at very first-time submission

Course Contents:

Unit 1: Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit 2: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

Unit 3: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Unit 4: Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

Unit 5: Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

Unit 6: useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

Suggested reading:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on GoogleBooks)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge UniversityPress
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London,2011

AUD02A: DISASTER MANAGEMENT

Course Objectives: Students will be able to:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries theyworkin.

UNIT I – Introduction: Disaster, Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II - Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem, Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.

UNIT III - Disaster Prone Areas in India: Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches, Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami, Post-Disaster Diseases and Epidemics.

UNIT IV - Disaster Preparedness and Management: Preparedness, Monitoring of Phenomena Triggering a Disaster or Hazard, Evaluation of Risk, Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports, Governmental and Community Preparedness.

UNIT V - Risk Assessment: Disaster Risk, Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation, Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT VI - Disaster Mitigation: Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation, Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation in India.

Suggested readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies".New Royal bookCompany.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, NewDelhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep &Deep
4. Publication Pvt. Ltd., NewDelhi.

AUD-03A: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world.
2. Learning of Sanskrit to improve brain functioning.
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature.

Course Contents:

UNIT I - Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

UNIT II - Order, Introduction of roots, Technical information about Sanskrit Literature.

UNIT III - Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Suggested reading:

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, NewDelhi
2. "Teach Yourself Sanskrit" PrathamaDeeksha-VempatiKutumbshastri, Rashtriya Sanskrit Sansthanam, New DelhiPublication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., NewDelhi.

Course Output: Students will be able to

1. Understanding basic Sanskrit language.
2. Ancient Sanskrit literature about science & technology can beunderstood.
3. Being a logical language will help to develop logic instudents.

AUD04A: VALUE EDUCATION

Course Objectives: Students will be able to

1. Understand value of education and self-development.
2. Imbibe good values in students.
3. Let the should know about the importance of character

UNIT I - Values and self-development, Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgements.

UNIT II - Importance of cultivation of values, Sense of duty. Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity. Power of faith, National Unity. Patriotism, Love for nature, Discipline.

UNIT III - Personality and Behavior Development, Soul and Scientific attitude, Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits. Association and Cooperation, Doing best for saving nature.

UNIT IV - Character and Competence, Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control. Honesty, Studying effectively.

Suggested reading:

Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi.

Course outcomes: Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

AUD05A: CONSTITUTION OF INDIA

Course Objectives: Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course contents:

UNIT I - History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working).

UNIT II - Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT III - Contours of Constitutional Rights &Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV - Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V - Local Administration: District's Administration head, Role and Importance, Municipalities, Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj Introduction, PRI: Zila Pachayat, Elected officials and their roles, CEO Zila Pachayat Position and role, Block level Organizational Hierarchy (Different departments), Village level Role of Elected and Appointed officials, Importance of grass root democracy

UNIT VI - Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested reading:

1. The Constitution of India, 1950 (Bare Act), GovernmentPublication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition,2015.

3. M. P. Jain, Indian Constitution Law, 7thEdn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

Course Outcomes: Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

AUD06A: PEDAGOGY STUDIES

Course Objectives: Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the Df ID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Contents:

UNIT I - Introduction and Methodology:Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions,Overview of methodology and Searching.

UNIT II - Thematic overview: Pedagogical practices used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

UNIT III - Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies, How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV - Professional development: alignment with classroom practices and follow-up support, Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning, limited resources and large class sizes.

UNIT V - Research gaps and future directions:Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Suggested reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3):272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston:Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes: Students will be able to understand:

1. Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. The evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. Teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

AUD07A: STRESS MANAGEMENT BY YOGA

Course Objectives:

1. To achieve overall health of body and mind
2. To overcome stress

Course Contents:

UNIT I - Definitions of Eight parts of yog. (Ashtanga)

UNIT II - Yam and Niyam. Do`s and Don't's in life i) Ahinsa, satya, astheya, bramhacharya and aparigraha ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III - Asan and Pranayami) Variousyog poses and their benefits for mind & body ii)Regularization of breathing techniques and its effects- Types of pranayama.

Suggested reading:

1. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami YogabhyasiMandal,Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department),Kolkata

Course Outcomes: Students will be able to:

1. Develop healthy mind in a healthy body thus improving social healthalso.
2. Improve efficiency

AUD08A: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course contents

UNIT I - Neetisatakam-Holistic development of personality Verses- 19,20,21,22 (wisdom)

Verses- 29,31,32 (pride & heroism) Verses- 26,28,63,65 (virtue)

Verses- 52,53,59 (dont's)

Verses- 71,73,75,78 (do's)

UNIT II - Approach to day to day work and duties. Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48,

Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17,23, 35,

Chapter 18-Verses 45, 46, 48.

UNIT III - Statements of basic knowledge.

Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68

Chapter 12 -Verses 13, 14, 15, 16,17, 18

Personality of Role model. ShrimadBhagwadGeeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,

Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

Suggested reading:

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,Rashtriya Sanskrit Sansthanam, NewDelhi.

Course Outcomes: Students will be able to

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal inlife.
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality ofstudents.

AUD 09 BASIC THERMAL ENGINEERING

Course Objectives: Students will be able to:

1. Learn basic principle of thermodynamics
2. Learn the Basic of Heat Transfer

Course contents:

Unit 1. First and second law of thermodynamics

Unit 2. Thermal fluid systems, Standard cycle

Unit3. Mixtures of gases, Heat transfer

Unit4. Fluid mechanics, Practical examples, Use of steam tables.

Course Outcome On completion of the course students will be able to

1. Apply basic concepts, laws and principles of thermodynamics.
2. Analyses the heat transfer in thermal system

Reference Books

1.Thermodynamics and Heat power Engg. Mathur and Mehta Tata Mcgraw- Hill

2.Thermal Engineering P.L.Ballaney Khanna. Publishers

3.Thermal Engineering R K Rajput Laxmi. Publications

AUD 09 BASIC ELECTRICAL ENGINEERING

Course Objectives: Students will be able to:

1. Learn the Basic of Electrical Engineering.
2. Learn working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.

Course contents:

Unit1. Electrical energy

Unit2. Single phase and Three phase circuits,

Unit 3. Electrical machines, Electrical energy conservation

Unit4. Power electronics and Power quality, Controls.

Course Outcome On completion of the course students will be able to

1. Identify the type of electrical machine used for that particular application.
2. Function on multi-disciplinary teams.

Text books

1. V. Mittle & Arvind Mittal, Basic Electrical Engineering, TMH.
2.Chakrabarti,Nath & Chanda, Basic Electrical Engineering, TMH
3. C.L. Wadhwa, Basic Electrical Engineering, Pearson Education Reference books
4. Kothari & Nagrath, Basic Electrical Engineering, TMH

SECOND SEMESTER

MTEVE201A: Fuel Technology

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course objectives: Students will gain

1.Understanding of various solid, liquid and gaseous fuels which are conventional energy sources in use today for meeting the primary needs.

2. About various techniques for inter-conversion of fuels as well as holistic exposure to the issues related to clean fuels for guarding the environment.

Course contents

Unit-I Energy Scenario: Indian and global, Present and future energy demands, Energy crisis, Modern concepts of fuel, Solid, liquid and gaseous fuels, composition, basic understanding of various properties of different types of fuels.

Unit-II Conventional Sources of Fuels: Coal as a Source of Energy and Chemical in India; Coal Preparation, Carbonization, gasification and liquefaction of coal and lignite**,** Petroleum, properties and its derived products; Inter-conversion of fuels; Gaseous fuels including natural gas and uses

Unit III: Bioenergy - Biomass energy as an energy source, characteristics of biomass, Energy plantations, Biomass conversion technologies.

Types of biofuels - Biodiesel, bioethanol, biogas, biohydrogen - importance, production, technologies and applications.

Unit IV Waste to Energy: Feed stocks, factors affecting biogas generation, Biogas plants: Classification of biogas plants, advantages and disadvantages of biogas plants, community biogas plants. Microbial fuel cell – principle, types and challenges.

Unit V: Principles of combustion: Chemistry and Stoichiometric calculation, thermodynamic analysis and concept of adiabatic flame temperature; Combustion appliances for solid, liquid and gaseous fuels: working, design principles and performance analysis.

Course Outcomes (CO): Students will be able to:

1. Describe the energy scenario of the world.
2. Carry out a comparative analysis of different types of fuels, including their treatment, liquefaction and gasification.
3. Analyze the potential of alternate energy sources and their scope and limitations.
4. Evaluate energy related problems to combustion.

Suggested Readings:

1. Fuels & Combustion by Sharma S.P. & Chander Mohan, Tata McGraw Hill Publishing Co. Ltd.
2. Fuels & Combustion by Sarkar Samir, Orient Longman.
3. Fuels and Petroleum Processing by Sharma, B. K, Goel publishing
4. Rao, S. and Parulekar, B.B., Energy Technology-Non-conventional, Renewable and Conventional, Khanna Publishers (2000).
5. Gupta, O.P., Elements of Fuel, Furnaces and Refractories, Khanna Publishers (1996).
6. Rai, G.D., Non-Conventional Energy Sources, Khanna Publishers (2001)

MTEVE202A: ENERGY AND ENVIRONMENTAL AUDITING AND IMPACT ASSESSMENT

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. Understanding of energy conservation options in various industrial processes.
2. The knowledge of tools and techniques for energy auditing.
3. About Energy Audit report including economic feasibility.

Course contents:

UNIT I: Energy Scenario: Primary and Secondary Energy, Commercial and Non-commercial Energy, Renewable and Non-Renewable Energy, Global and Indian Energy Scenario, Growing Energy Needs and Long-Term Energy Scenario for India, Energy Pricing in India, Energy Sector Reforms, Energy Security, Energy Strategy for the Future, Basics of Energy and Its Various Forms: Various Forms of Energy, Electrical Energy Basics, Thermal Energy Basics, Units and Conversions Energy

UNIT II: Material and Energy Balance: Basic Principles, The Sankey Diagram and its Use, Material Balances, Energy Balances, Process Flow Chart, Facility as an Energy System, Energy Action Planning: Key elements, Formulation, Ratification.

Energy Audit: ESCOs Energy Management & Government Programmes: BEE & State Development Agencies, Government & EESL Programmes, PAT Scheme, Ujala & SEEP Programmes, Municipal & Agriculture DSM Initiatives, Standards and Labelling Programme. Energy Audit: Types and Methodology, Energy Audit Report, Understanding Energy Costs, Maximizing System Efficiency, Fuel and Energy Substitution, Energy Audit Instruments

UNIT III: Environmental Auditing: Definition and types of audits, Guidelines for environmental auditing, methodologies for Environmental Auditing, Matrix methods and Battelle method of auditing, Types of projects requiring Environmental Clearance, EAC, EIA

case studies, Legal requirements for environmental auditing. Restoration and rehabilitation technologies, Environmental planning, urban planning, rural planning and land use pattern.

UNIT IV: Environmental Impact Assessment

Environment Impact Assessment (EIA) - Principles, Origin, development, types, issues, problems and limitations, environmental management plan, environmental impact statement (EIS), Strategic Environmental Assessment (SEA), EIA guidelines (1994) and notifications (Govt. of India 2006), Scope of EIA in project planning and implementation, Indian directions of EIA. Monitoring tools for EIA, surveys, spatial databases, experiments, models, Decision support system, Sources and collection of data for EIA, various appendices and forms for application.

UNIT V: Components of EIA, EIA methodology – project screening, scoping, base line data, impact identification, prediction, evaluation, mitigation. Assessment techniques – cost benefit analysis, analysis of alternatives, methods of prediction matrices, networks, checklists and overlays and assessment of impacts – air, water, soil, noise, biological, social, cultural, economical, environmental factors.

EIA standards and guidelines, public participation- procedure of public hearing, presentation, review and decision making. Quality control – trends in EIA practice, evaluation criteria, expert system in EIA, use of regulations. Documentation and monitoring – Generic structure of EIA Document, planning, collection, use of display materials, team writing, checklist, environmental monitoring guidelines and policies, post audit.

Course Outcomes: The students will be able to:

CO1: To identify the key aspects of energy and environmental audit

CO2: Lay foundation on the concept and components of energy and environmental auditing and environmental impact assessment.

CO3: Develop skill to evaluate the issues and problems in energy and environmental auditing and environmental impact assessment from the perspective of process, methods, and goals.

CO4: Be able to access different case studies/examples of EIA in practice

CO5: Learn to write EIA report

Suggested Readings:

1. LC Witte, PS Schmidt and DR Brown: Industrial Energy Management and Utilization (Hemisphere Publishing Corporation, Washington, 1998).
2. Howard E. Jordan, Energy-Efficient Electric Motors and Their Applications., Plenum Pub Corp; 2nd edition (1994)
3. Giovanni Petrecca. Industrial Energy Management: Principles and Applications. The Kluwer international series -207, 1999.
4. WC Turner: Energy Management Handbook, Seventh Edition, (Fairmont Press Inc., 2007)
5. George Polimeros: Energy Cogeneration Handbook, (Industrial Press, Inc., New York, 1981)
6. Handbook on Energy Audit and Environment Management, Y P Abbi and Shashank Jain, TERI,2006
7. Handbook of Energy Audits Albert Thumann, William J. Younger, Terry Niehus,2009
8. Kulkarni, V. and Ramachandra, T.V. Environmental Management. Capital Pub. Co., New Delhi. 2006.
9. Petts, J. Handbook of Environmental Impact Assessment- Volume 1 and 2. Blackwell Publishers, UK 2005.
10. Glasson, J. Therivel, R. and Chadwick, A. Introduction to Environmental Impact Assessment. Routledge, London. 2006.

Discipline specific Elective-III

MTEVE203A-1: Air Pollution Control Engineering

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. The major problems in air pollution
2. About regulation pertinent to air pollution outcomes
3. How to control of air pollution.

Course contents:

UNIT I - Air Pollution Control, Air Pollution Effects, Effects of Air Pollution on Human Health Air Pollution Control Laws and Regulations, Emission Standard, Air Quality Standard

UNIT II - Emission Estimates, Concentration Determination, Averaging, Standard Analytical Methods, isokinetic Sampling, Meteorology, Horizontal and Vertical Motion in the Atmosphere, Atmospheric Stability

UNIT III - Fixed-Box, Diffusion model, Gaussian Plume Derivation, Plume Rise, Pollutant Creation and Decay in the Atmosphere Air Pollution Control, Process Change, Pollution Prevention, Downstream Pollution Control Device

UNIT IV-Fluid Velocities in Air Pollution Control Equipment, Minimizing Volumetric Flow Rate and Pressure Drop, Calculations on Inert Flow rates, Combustion, Combustion Kinetics, Mixing in Combustion Reactions, Volume and Composition of Combustion Products, Nature of Particulate Pollutants, Settling Velocity and Drag Forces, Stoke Law, Particle Size Distribution Functions, Control of Primary Particulates, Wall Collection Devices, Working and designing of Centrifugal Separators, Electrostatic Precipitators (ESP), Surface Filters, Depth Filters, Scrubbers for Particulate Control, Control of Volatile Organic Compounds (VOCs), Control by Prevention, Substitution, Process Modification, Leakage Control - Control by Concentration and Recovery

UNIT V -Reduction chemistry of Sulfur, Absorbers and Strippers, Removal of SO_2 from Rich and Lean Waste Gases, Control of Nitrogen Oxides, Zeldovich Kinetics of Thermal NO Formation, Air Pollution from Motor Vehicles, Tailpipe Emissions, Lean Operation, Exhaust Gas Recirculation (EGR), Reduce Flame Quenching, Speed the Warm-up, Catalylic Treatment

of Combustion Products, Air Pollutants and Global Climate, Global Warming, Greenhouse Gases

Course Outcomes: Students will be able to:

1. Understand the fundamentals of origin, impacts and control of different air pollutants.
2. Explain the types, nature and behavior of air pollutants under the influence of atmospheric conditions.
3. Appraise the monitoring techniques and control measures to curb the air pollution, considering the standards limits.
4. Understand the technical aspects sound waves and controlling methods for vibration and noise pollution.

Suggested Readings

1. Noel de Nevers.2000. Air Pollution Control Engineering. 2nd Edn., McGraw Hill., New York
2. Rao M.N. and H.V.N. Rao, 2010, Air Pollution, Tata – McGraw hill Pub. Co., New Delhi.
3. Cheremisinoff, N.P., 2002. *Handbook of air pollution prevention and control*. Elsevier.
4. Clarke, A.G. ed., 2012. *Industrial air pollution monitoring*. Springer Science & Business Media.
5. Cheremisinoff, N.P., 2002. *Handbook of air pollution prevention and control*. Elsevier.
6. Clarke, A.G. ed., 2012. *Industrial air pollution monitoring*. Springer Science & Business Media.
7. Rao, C.S., 2007. *Environmental pollution control engineering*. New Age International.
8. Tiwary, A. and Williams, I., 2018. *Air pollution: measurement, modelling and mitigation*. CRC Press.
9. Vallero, D.A., 2014. *Fundamentals of air pollution*. Academic press.
10. Wang, L.K., Pereira, N.C. and Hung, Y.T. eds., 2005. *Advanced air and noise pollution control*. Totowa, NJ, USA: Humana Press.
11. Wark, K., Warner, C.F. and Wayne T, D., 1998. *Air pollution: its origin and control*. Addison-Wesley.
12. Gerard keily, 2011, Environmental Engineering, Tata – McGraw hill Pub. Co., New Delhi.
13. Richard W. Boubel, 1994. Fundamentals of air pollution. Academic press, New York.
14. Kudesia, V.P., 2002. Air pollution. Pragathi Prakashan publishers, Meerut.
15. Kudesia, V.P. and T.N. Tiwari, 2000. Noise pollution and its control. Pragathi Prakashan publishers, Meerut.

MTEVE203A-2: ENERGY STORAGE AND FUEL CELL TECHNOLOGY

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. Knowledge on use of hydrogen for achieving sustainable growth and facilitate analysis of the challenges.
2. In depth knowledge of fuel cell technology.
3.The underlying concepts, methods and application of fuel cell technology.

Course Content:

Unit I Hydrogen Energy: Need and Relevance in relation to depletion of fossil fuels and environmental considerations. Hydrogen Production: Photo-electrolysis, Fossil, Biological Process & Bio Fuels, Benefits and barriers of different production methods.

Unit II Hydrogen Storage technologies: Compressed gas storage, Liquid Storage, Underground storage, Line Packing, Solid State Storage, Advantages and disadvantage of different storage methods. Metal Hydrides: Benefits, PC isotherms, Hydrogen storage methods.

Unit III

Fuel cells: Introduction and overview, operating principle, polarization curves, components, types of fuel cell, low and high temperature fuel cells, fuel cell stacks. Fuel Cell systems and sub-systems, system and sub system integration; Power management, Thermal management; Pinch analysis

Unit IV Hydrogen Fuel Cells: Principle and workings systems, Applications, Safety & Standards. Application of Hydrogen/Hydrides as fuel in Engines, Socio-Economic Aspects. Comparative future viability analysis, Policy implications and Current status.

Unit V Fuel Cells and their applications: Fuel cell usage for domestic power systems, large scale power generation, automobile, space applications, economic and environmental analysis on usage of fuel cell, future trends of fuel cells

Course Outcomes: Students will be able to:

CO-1 To understand and demonstrate the hydrogen production technologies, storage methods.

CO-2 To know the concepts and characteristics of various types of fuel cell

CO-3 To consist and demonstrate the working of fuel cells.

CO-4 To know the application of fuel cells with economic and environment analysis

Suggested Readings

1.Fuel cell and their applications, K. Kordesch, G. Simader, VCH, Weinheim, Germany, 1996.

1. Detlef Stolten,"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", Wiley, 2010.

2. Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "Electrochemical Technologies for Energy Storage and Conversion", John Wiley and Sons, 2012. 3. Francois Beguin and Elzbieta Frackowiak ,"Super capacitors", Wiley, 2013.

4. Doughty Liaw, Narayan and Srinivasan, "Batteries for Renewable Energy Storage", The Electrochemical Society, New Jersy,2010.

MTEVE203A-3: COGENERATION AND ENERGY EFFICIENCY

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objective: Students will gain

1. About the importance of cogeneration in improving the overall efficiency.
2. Cogeneration plants may be based on Steam turbine, Gas turbine or IC Engines: to make the students aware of different technologies.
3. Knowledge of practical cogeneration possibilities through case studies related to different types of process industries (sugar/textile/paper etc.).

Course contents:

Unit I: The cogeneration concept, Need for Cogeneration, Principle of Cogeneration, Design parameters for cogeneration, Cogeneration alternatives, Bottoming and Topping cycles,

Unit II: Steam turbine plants, Gas turbine plants, Diesel and gas engine plants, Thermodynamic evaluation,

Unit III: Thermodynamic evaluation, Combined cycle applications, Sterling engine, Industry/Utility cogeneration.

Unit IV: Cogeneration, Trigeneration, Techno economic and environmental aspects,

Unit V: Cogeneration in sugar, textile, paper and steel industry, Case studies.

Course Outcomes: Students will be able to

1. Describe the basics of cogeneration.
2. Demonstrate performance evaluation of cogeneration power plants.
3. Determine techno-economical feasibility of cogeneration energy system

Suggested Readings:

1. Energy Cogeneration Hand Book for Central Plant Design by George Polimeros.
2. Power Plant Technology by M. M. EI- Wakil.
3. G. Polimeros, Energy Cogeneration Hand Book for Central Plant Design, Industrial Press, N.Y., 1981.
4. P. K. Nag, Power Plant Engineering, 3rd edition, Tata McGraw-Hill Publishing Company Ltd, 2008.

DISCIPLINE SPECIFIC ELECTIVE-IV

MTEVE204A-1: ENERGY ECONOMICS AND POLICY REGULATION

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. The knowledge of Energy Economics.
2. Characterization of various energy sources.
3. The knowledge of energy policy Acts & regulations.
4. The knowledge of various modeling frameworks.

Course contents:

UNIT I : Energy demand analysis and forecasting, Energy supply assessment and evaluation, energy models, energy balances, the system boundary Energy and non-energy flows, commercial and non-commercial energy sources, energy industries, energy production and distribution Boundaries between flows and stocks, top-down and bottom-up balances, statuary requirements, tariff determination issue, Renewable energy credit schemes in Indian and Global scenario, National Solar Mission, Regulations regarding grid interconnections of renewable energy systems, Case studies on techno-economic feasibility of energy conservation and renewable energy technologies.

UNIT II: Financial and economic feasibility evaluation of energy technologies and systems, Integrated framework for energy pricing, Energy demand & supply balancing, Energy models, Energy investment planning and project formulation, Basic energy pricing principles, Short run versus long run marginal cost pricing, peak load and seasonal pricing, Energy Prices and Markets, Pricing of Exhaustible Resources, Economic regulation of energy markets, Concepts of energy intensity and elasticity, Statistical tools and techniques for demand forecasting scenarios, development, Interpretation of results and policy implications.

UNIT III : Energy policy Acts and regulations, Energy policy and planning implications, clean development mechanism, concept of net present value, incremental costs and benefits, cash flow analysis, Private and social Economics of disccosts, Financing of energy

projects, Financial and economic analysis of energy technologies, Short run and long run implications of conventional energy systems.

UNIT IV: Quantitative modelling frameworks, Energy sector models, modelling and optimization of energy systems, Software for energy planning such as RETScreen, HOMER and System Advisor Model.

UNIT V : Scope and challenges in implementing off grid technologies, Policy and regulatory Framework for rural electrification, Relevant policies and frameworks in Indian and Global context, Recent off grid programs started by Govt. of India for electrification through off-grid solutions in rural area, DDG schemes such as Village Energy Security Programme (VESP), Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY), Remote Village Electrification Program, , Off grid programme under JNNSM, Organizational structure and key developments in India's energy planning and policies for sustainable energy efficiency, regulatory frameworks and reforms across various energy sectors with case studies.

Course Outcomes: Students will be able to

1. Understand the knowledge of Energy Economics.
2. Characterization of various energy sources.
3. Apply the knowledge of energy policy Acts & regulations.
4. Analyse various modeling frameworks.

Suggested reading:

1. Thomas Tietenberg, Environmental and Natural Resource Economics, seventh edition, (Boston, MA: Addison Wesley, 2006).
2. Robert S. Pindyck and Daniel L. Rubinfeld, Microeconomics, 6th edition (New Delhi: Prentice Hall of India, 2005).
3. Subhes C. Bhattacharyya, Energy Economics: Concepts, Issues, Markets and Governance, (London: Springer, 2011).
4. Kornelis Block, Introduction to Energy Analysis, (Amsterdam: Techne Press, 2009) .
5. T.C. Kandpal and HP Garg. Financial Evaluation of Renewable Energy Technologies, (New Delhi: Macmillan India, 2003).
6. Comparative Study on Rural Electrification Policies in Emerging Economies: Keys to Successful Policies. International Energy Agency.
7. Distributed Power Generation Planning and Evaluation, H.Lee Willis, Walter G. Scott, IET Power Marcel Dekker, Inc. (2000)

MTEVE204A-2: Wind, Hydro & Chemical Energy System

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. The knowledge of Wind, Hydro and Chemical Energy system.
2. Basic of electrochemical energy devices

Content:

Unit -1 Introduction: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics, Wind resource map of India, screening probable sites and various indicators involved, instrumentation, wind speed measurement, Micrositing of wind turbines, site identification, wind mast installation, Annual Energy Output estimation Uncertainties in estimation, Probabilities of Estimation

Unit -2 Wind Energy System Design: Aerodynamic design principles, Aerodynamic theories; (2-D, 3-D aerodynamics), Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt's tip loss correction. Wind turbine design considerations.

Unit – 3 Wind Energy Application: Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies, Environmental Impacts of Wind Farms.

Unit-4, Small Hydropower Systems: Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works; Speed and voltage regulation; Investment issues load management and tariff collection; Distribution and marketing issues, case studies.

Unit 5: Basic of electrochemical energy devices; mechanism and materials for different types of batteries, supercapacitor and hybrid; fuel cells (Polymer membranes for fuel cells, PEM fuel

cell, Acid/alkaline fuel cells.), electrochemical and photoelectrochemical water splitting. Details of Pb-acid Nickel-metal hydride (Ni-MH), NiCd-alkaline battery, Ni-iron, Li/Na-ion, Mg-ion, Li/Na-S batteries, Metal-air battery, battery maintenance and safety precautions. Application of phase-change materials for energy conservation.

Course Outcomes: Students will be able to

1. Acquire the knowledge of Wind, Hydro and Chemical Energy system.
2. Characterization of Wind, Hydro and Chemical Energy system.
3. Analyse the wind and Hydro energy System.
4. Describe the Basic of electrochemical energy devices

Suggested Readings: –

1. Non-conventional energy sources by G.D. Rai, Khanna Publishers
2. Renewable Energy Focus – Handbook by Elsevier References
3. Wind Energy Engineering, Pramod Jain, The McGraw-Hill Companies, Inc
4. Advanced Renewable Energy Sources, By G. N. Tiwari, Rajeev Kumar Mishra
5. Renewable Energy Engineering and Technology: principles and practice edited by V. V. N. Kishore
6. Battery technology handbook, edited by H.A. Kiehne, Marcel Dekker, New York, 1989 • B. E.
7. Conway Electrochemical Supercapacitors; Scientific Fundamentals and Technological Applications

MTEVE204A-3: INSTRUMENTATION IN ENERGY AND ENVIRONMENTAL SYSTEMS

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. The knowledge of Measurement errors
2. The optimisation of miscellaneous measurements and their uses.

Course Content

Unit I: Measurement Errors - Materials, radiant storage- Transducer classification Static and dynamic characteristics of transducers, Transient analysis of a control system.

Unit II: Temperature Measurement-Bimaterials, Pressure thermometers, Thermocouples, RTD, Thermisters, and Pyrometry, pyrometers- Calibration of Pressure measuring equipment.

Unit III: Flow Measurement-Variable head flow meters- Rota meters, Electromagnetic flow meters, Hot wire anemometers, Hot film transducers, Ultrasonic flow meters.

Unit IV: Air pollution and Miscellaneous Measurements- Particulate sampling techniques, SO2, Combustion Products, Opacity, odour measurements - Measurement of liquid level, Humidity, O2, CO2 in flue gases- pH measurement

Unit V: Moving Iron/coil, Energy measurement, power factor meter-Analog signal conditioning, Amplifiers, Instrumentation amplifier, A/D and D/A converters, Digital data processing and Data acquisition system.

Course Outcomes: Students will be able to

1. Understand the measurement errors.
2. Know the concepts and characteristics of various types of temperature measurement.
3. Analyse the application of Energy measurement Equipments.

Suggested Readings:

1. A. K. Sawhney. Puneet Sawney: A course in Mechanical Measurements and Instrumentation. Dhanpat Rai & Co 2002

2. Bechwith. Marangoni. Lienhard: Mechanical Measurements Fifth edition. Addison Wesley 2000.

3. J.P.Holman: Experimental methods for engineers Sixth edition, McGraw-Hill .1994

MTEVE 205A - Environment Lab 2

Air pollution Control Engineering

No. of Credits: 2 **Sessional: 15 Marks**

L T P Total **Practical: 35 Marks**

0 0 4 4 **Total: 50 Marks**

Course objectives: Students will gain

1. About the different air pollutants, identified by the pollution regulatory authorities. The student will be able to understand the methods of analysis and working of instrument used for sampling and analysis of air pollutants.
2. The skills among the students to assess the quality of air and suggest possible measures to control the air pollutants.

List of Experiments

1. To study principle, components and working operation of Respirable Dust Sampler (RDS) for collection of respirable dust.
2. To study principle, components and working operation of Fine Dust Sampler for sampling.
3. Assessment of PM_{10} level in the ambient air.
4. Assessment of fine dust ($PM_{2.5}$) concentration in outdoor environment.
5. Understanding of principle, component and working of gaseous sampler for sampling of gaseous air pollutants in surrounding air.
6. Determination of gaseous air pollutants concentration in the ambient air

a) Oxides of Nitrogen (NOx)

b) Oxides of Sulphur (SO_2)

c) Ammonia (NH_3)

d) Oxone (O_3)

7. Study of plume behavior in relation with wind velocity in your surrounding area.
8. Sampling of particulate and gaseous pollutants from stationary sources.
9. Determination of SPM and gaseous pollutants concentration from stack emission of an industrial unit.
10. Determination of different noise indices (L_{10}, L_{50}, L_{90}, L_{eq}) at different locations (residential, industrial, commercial and silent zone) using Sound Level Meter.

Note: Addition and deletion in the list of experiments may be made from time to time by the department depending on the availability of resources.

Course outcome: On performing the experiments, the students will be able to:

1. Explain the different methods followed for sampling and analysis of analysis of air pollutants.
2. Appraise the quality of air and suggest management plans to control the air pollutants.
3. Determine the air pollutants level in stationary sources and explain the dispersion pattern with reference to the meteorological conditions.
4. Assess the noise level at different locations and the possible measures to control the noise level for minimizing the impacts

MTEVE206A - ENERGY LAB 2

FUEL TECHNOLOGY LAB

No. of Credits: 2 **Sessional: 15 Marks**

L T P Total **Practical: 35 Marks**

0 0 4 4 **Total: 50 Marks**

Course Objectives: Students will gain

1. The different types of fossil fuels.

2. The emphasis of the course will be on the characterizations and utilizations of solid fuels, basics of liquid and gaseous fuels**.**

Course Content

1. Ultimate Analysis of coal
2. FSI Analysis of coal
3. Determination of Caking Index of coal
4. Determination of LTGK of coal
5. Determination of Flash Point and Fire point of Liquid Fuel
6. Determination of Viscosity of petroleum oils.
7. Determination of Aniline Point of diesel oil
8. Determination of Penetration Index of Bitumen & Wax.
9. Determination of Cloud and Pour Point of diesel oil
10. ASTM Distillation of crude oil and petroleum products
11. Determination of Smoke point of kerosene oil.
12. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter.
13. To determine the flash point of the sample
14. To determine the cloud and pour point of the sample
15. To analyze the biogas composition by gas chromatography
16. To determine the volatile solids present in the sample
17. Preparation and characterization of biodiesel.
18. To estimate acid value of the sample
19. To estimate iodine value of the sample
20. To determine the kinematic viscosity of the sample by viscometer

Course Outcomes: The Students will be able to

1. Analyze quality of fuels based on its properties and possible utilizations.

MTEVE207A: MINI-PROJECT

No. of Credits: 2	**Sessional: 15 Marks**
L T P Total	**Theory: 35 Marks**
0 0 4 4	**Total: 50 Marks**

Course Objectives: Students will gain

About Project Framework and the programming knowledge into a real- world situation/problem

Course contents:

- Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.
- End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.
- Continuous assessment of Mini Project at Mid Semester and End Semester will be monitored by the departmental committee.

Course Outcomes: the student will be able to:

1. Identify Energy and Environmental Engineering problems reviewing available literature.
2. Study different techniques used to analyze complex structural systems.
3. Work on the solutions given and present solution by using his/her technique applying engineering principles.

SEMESTER - III

DISCIPLINE SPECIFIC ELECTIVE-V

MTEVE301A-1: SOLID AND HAZARDOUS WASTE MANAGEMENT

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course objective: Students will gain

1.Knowledge on generation and management of solid waste.

2. Solid waste disposal through landfills and various water treatment techniques

3. Industrial waste management and recycling.

Course contents:

UNIT - I: Solid Waste Generation and Collection Solid wastes: Definition, types, sources, classification and composition of solid waste, Types and Sources of solid and hazardous wastes and impact on environmental health. Waste generation rates. Collection and storage of municipal solid wastes, Handling and segregation of wastes at source. Concepts of waste reduction, recycling and reuse.

UNIT - II: Solid Waste Treatment and Disposal Solid waste processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery. Composting, Vermi-composting, Sanitary land filling: site selection, design, and operation of sanitary landfills; secure landfills and landfill bioreactors; leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation, Incineration of solid wastes. Recycling of household and commercial waste, recycling of paper, recycling of tire, recycling of plastics, recycling of Aluminum can.

UNIT - III: Solid Waste Management Legislation Need for solid and hazardous waste management –- Salient features of Indian legislations on management and handling of municipal solid wastes, Solid waste management plan, Municipal Solid Waste (Management and Handling) Rules, 2000, 2015, Hospital waste management, Biomedical Waste

(Management and Handling) Rules, 1988; Fly ash management, Fly ash Management Rules, (1999), recycled plastic usage rules, batteries (management and handling) rules.

UNIT - IV: Hazardous Waste Management Definition of hazardous wastes, Sources, classification, collection, segregation, characterization of Hazardous waste, Physicochemical properties of hazardous waste needed in management. Hazardous waste control, treatment and management, Nuclear Waste: Sources, classification, collection, segregation, Treatment and Disposal. E-waste: Sources, classification, collection, segregation, Treatment and Disposal. Hazardous Waste (Management and Handling) Rules (1989) and (2000) Amendments.

UNIT V: Solid Waste Processing Technologies Solid waste material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes - treatment of biomedical wastes, Landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring.

Course Outcome: Student will be able to:

1. Analyse physical and chemical analysis of solid wastes and apply them for a management system that will be set up.
2. Understand route optimization for a solid waste collection.
3. Apply rules and regulations related to solid and hazardous waste management.

References:

1. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid waste processing & recovery. The Humane press, Cliton, New Jersey.

2. N.C. Cheremenisoff, P.N. Cheremenisoff& F. Ellurbrush, Biomass- Application, technology & production, Marcel Dekker, New York, 1980. 19

3. W. Salonas&Frostner D., Environmental Management of Solid waste- dredged material & tail minings. Springer_Yedag,New York, 1988.

4. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste management collection, disposal & reuse, McGraw Hill, 1994

5. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).

6. Hazardous Waste Management – Charles A. Wentz

7. T V Ramchandra- Management of Municipal Waste

8. Solid Waste Management Manual CPCB, New Delhi.

9. J. D. Gilchrist, Fuels, Furnaces & Refractories, Pergamom Press,

10. Blokh A.G, Heat Transmission in Steam Boiler furnaces, Hemisphere Publishing Corpn,1988

11. Gupta O.P, Elements of Fuels, Furnaces & Refractories, 3rd edition, Khanna Publishers,1996.

12. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990

13. Bhatt, Vora, Stoichiometry, 2nd Edition, Tata McGraw Hill, 1984

14. K.L. Wang & N.C. Periera, Handbook of Environmental Engineering, Vol. 2, Solid wasteprocessing& recovery. The Humane press, Cliton, New Jersey.

15. N.C. Cheremenisoff, P.N. Cheremenisoff& F. Ellurbrush, Biomass-Application,technology& production, Marcel Dekker, New York, 1980.

16. W. Salonas&Frostner D., Environmental Management of Solid waste- dredged material &tail minings. Springer Yedag,New York, 1988.

17. G. Technobanogalous, H.Vigil. & T. Theilsein, Integrated Solid waste managementcollection, disposal & reuse, McGraw Hill, 1994

18. Handbook of solid management" Frank Kerith, McGraw Hill, Inc. USA (1994).

19. Hazardous Waste Management – Charles A. Wentz

20. T V Ramchandra- Management of Municipal Waste

MTEVE301A-2: GREEN BUILDING DESIGN AND SIMULATION

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course Objectives: Students will gain

4. About thermal comfort requirements of a building
5. The basics in calculating the heat gains and losses through various building components
6. Different building types and using commercial software used in Simulation of Building.
7. The knowledge to perform energy rating of a building

Course contents:

UNIT I: Introduction on thermal comfort in buildings, Classification of climate zones in India, Energy Conservation and its Importance, Energy Conservation Act.

UNIT II: Heat flow calculations in buildings, Unsteady heat flows through building components such as walls, roof, windows etc., Direct heat gains through windows, Convective heat gains and losses, air exchange rates, Heat gains from people, appliances etc., Air conditioning load calculations, HVAC systems. Description of different components of HVAC systems.

UNIT III: Passive cooling/heating concepts and applications, Building type and orientation, Internal and external shading devices, Ventilation, passive concepts for composite climates, air source and ground source heat pump systems, hybrid systems.

UNIT IV: Introduction and use of different building simulation software for modelling of non-air conditioned spaces such as TRNSYS.
Introduction and use of different building simulation software for modelling of air-conditioned spaces such as Energy Builder.

UNIT V: Rating systems for energy efficient buildings in India and other countries. Green building rating systems and certification such as LEED, GRIHA, ASOOCHAM GEM, BEE

and ECBC, Energy Conservation Building Code: requirements, applicability, compliance options, whole building performance routes for compliance, estimation of green star rating for a new building, India Cooling Action Plan 2019.

Course Outcomes: Student will be able to

1. Learn about methods of construction and maintenance of Building
2. Understand various type of software for modeling for green building.
3. Apply the basics in calculating the heat gains and losses through various building components
4. To gain knowledge about contemporary issues.

Text books & references:

1. Minke, G., 2006. Building with Earth: design & technology of a sustainable architecture, SpringerLink
2. Givoni, B., 1998. Climatic Considerations in Buildings and Urban Design, John Wiley & Sons, Canada
3. Design Handbook for Energy Efficient Buildings, Tata McGraw-Hill, New Delhi
4. N. K. Bansal, Gerd Hauser, GernotMinke, 1994. Passive building design: a handbook of natural climatic control, Elsevier Science B.V.
5. Givoni, B., 1994. Passive and Low Energy Cooling of Buildings, John Wiley &Sons Inc., New York
6. Karlen, M and Benya, J., 2004. Lighting Design Basics, John Wiley &Sons Inc., New York
7. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE): Fundamentals, Equipment
8. Indian Society of Heating, Refrigerating and Air-Conditioning Engineers (ISHRAE) Standards
9. HVAC: Heating, Ventilation and Air-Conditioning Handbook for design & Implementation, Industrial Press, New York
10. Jan F. Kreider, Peter S. Curtiss and Ari Rabl, 2010. Heating and Cooling of Buildings-Design for efficiency, revised second edition, CRC Press, USA
11. BEE, 2007. Energy Conservation Building Code
12. http://www.usgbc.org/, United States Green Building Council, USA
13. http://www.igbc.in,Indian Green Building Council, LEED India
14. http://www.grihaindia.org/, GRIHA Website, India
15. Construction Manual, Ministry of Environment & Forests, Government of India, New Delhi

16. Sustainable Building Design Manual- Volume I & II, The Energy and Resources Institute (TERI)
17. Environmental Impact Assessment Guidance Manual for Building, Construction, Townships and Area Development Projects, Ministry of Environment & Forests, Government of India, New Delhi

MTEVE301A-3: ENVIRONMENTAL MODELLING, SIMULATION AND LIFE CYCLE ASSESSMENT

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Course Objectives: Students will gain

1. About life cycle assessment.
2. The basics of various optimization models.
3. About role of modeling in energy policy analysis.

Course Contents:

UNIT I -Principles of model development & solution for environmental systems (air, water and soil), Basic steps in the model development: problem definition, model design and development & evaluation. Concept of system, sub-system, system modelling and simulation. Simple and complex calculation models, linear vs. non-linear models, Time series analysis.

UNIT II-Optimization models and their evaluation, Probabilistic methods for modeling, weibull, gamma and lognormal models, Predictive and Forecasting modeling of air pollution, hydrology and climate change, Gaussian plume model, gradient transport, eddy diffusion modelling, modelling fugitive emissions.

UNIT III -Modelling of Spatio-Temporal Dynamics, Surface water modelling, DO sag model, BOD model, Eutrophication model, Elements of groundwater modelling, Case study: predicting the mixing and dispersion of air pollutants in the environment, GIS-based human exposure modelling system for traffic air pollution, Model applications in the area of climate change, air and water pollution, biodiversity, Natural resource management, Forecast service, Social and economic aspects of environmental modelling, Role of modeling in energy policy analysis.

UNIT IV - Life cycle assessment. General principle of conducting life cycle assessment (LCA), Life cycle approach and analysis, conception, definition, planning, feasibility and analysis. Stages and scope of LCA and LCA inventory

Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for solar water heating system (SWH) using RETScreen software.

Evaluate the energy production, life-cycle costs and greenhouse gas emissions reduction for PV applications using RETScreen software.

Course Outcomes: The students will be able to

1. Get detailed knowledge of Environmental Modelling, simulation and Life cycle assessment.

2. Analyse various optimization models.

3. Understand the role of modeling in energy policy analysis.

Suggested Reading:

1. Lo, C.P. and Yeung A. K.W. 2006. Concepts and Techniques of Geographic Information Systems, Prentice Hall, New Delhi.

2. John, W. and Mark, M. (eds). 2004. Environmental Modeling: Finding Simplicity in Complexity, John Wiley and Sons Inc., New York.

3. S.E. Jorgensen, Developments in Environmental Modelling.

4. Andrew Ford, 2009. Modeling the Environment, Island Press; 2 edition

5. Jo Smith, Peter Smith, 2007. Environmental Modelling: An Introduction. Oxford University Press.

6. Fung, F., Lopez, A. and New, M. (eds.). 2011. Modelling the impact of climate change on water resources. Willey-Blackwell Ltd., U.K.

7. Barnsley, Michael, J. 2007. Environmental Modelling: A practical introduction. CRC Press, USA.

8. B. Sorensen, Life Cycle Analysis of Energy Systems, Royal Society of Chemistry Publishing, 201

OEC101A: BUSINESS ANALYTICS

No. of Credits: 3	Sessional: 25 Marks
L T PTotal	Theory: 75 Marks
3 0 0 3	Total: 100 Marks
	Duration of Exam: 3 Hours

Course objective:

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

Course contents:

UNIT I - Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II - Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III - Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process,

Prescriptive Modelling, nonlinear Optimization.

UNIT IV - Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with

Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V - Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, the Value of Information, Utility and Decision Making.

UNIT VI - Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Course outcomes:

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.
4. Students will demonstrate the ability to translate data into clear, actionableinsights.

Reference books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OEC102A: INDUSTRIAL SAFETY

No. of Credits: 3	**Sessional: 25 Marks**
L T P Total	**Theory: 75 Marks**
3 0 0 3	**Total: 100 Marks**
	Duration of Exam: 3 Hours

Course contents:

UNIT I - Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948
for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II - Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III - Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition, principle and factors affecting the corrosion, Types of corrosion, corrosion prevention methods.

UNIT IV - Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, i. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V - Periodic and preventive maintenance, Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair

complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: i. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

Reference books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgraw Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman &Hall London.

OEC103A: OPERATIONS RESEARCH

No. of Credits: 3
L T P Total
3 0 0 3

Sessional: 25 Marks
Theory: 75 Marks
Total: 100 Marks
Duration of Exam: 3 Hours

Course Outcomes:

The student should be able to

1. Apply the dynamic programming to solve problems of discreet and continuous variables.
2. apply the concept of non-linear programming
3. carry out sensitivity analysis
4. model the real-world problem and simulate it

Course contents:

UNIT I - Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models.

UNIT II - Formulation of a LPP, Graphical solution revised simplex method, duality theory, dual simplex method, sensitivity analysis, parametric programming.

UNIT III - Nonlinear programming problem, Kuhn-Tucker conditions min cost flow problem, max flow problem, CPM/PERT.

UNIT IV - Scheduling and sequencing, single server and multiple server models, deterministic inventory models, Probabilistic inventory control models, Geometric Programming.

UNIT V - Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Reference books:

1. H.A. Taha, Operations Research, An Introduction, PHI,2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi,1982.

3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi,2008
4. Hitler Libermann Operations Research: McGraw Hill Pub.2009
5. Pannerselvam, Operations Research: Prentice Hall of India2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India2010

OEC104A: COST MANAGEMENT OF ENGINEERING PROJECTS

No. of Credits: 3	**Sessional: 25 Marks**
L T PTotal	**Theory : 75 Marks**
3 0 0 3	**Total : 100 Marks**
	Duration of Exam: 3 Hours

Course contents:

UNIT I - Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II - Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution, conception to commissioning, Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents Project team, Role of each member. Importance Project site, Data required with significance, Project contracts, Types and contents, Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process.

UNIT III - Cost Behavior and Profit Planning Marginal Costing, Distinction between Marginal Costing and Absorption Costing, Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Standard Costing and Variance Analysis, Pricing strategies, Pareto Analysis, Target costing, Life Cycle Costing, Costing of service sector.

UNIT IV - Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control, Flexible Budgets, Performance budgets, Zero-based budgets, Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V - Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Reference books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, NewDelhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management &CostAccounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co.Ltd.

OEC105A: COMPOSITE MATERIALS

No. of Credits: 3	**Sessional: 25 Marks**
L T PTotal	**Theory : 75 Marks**
3 0 0 3	**Total : 100 Marks**
	Duration of Exam: 3 Hours

Course contents:

UNIT I - Introduction: Definition – Classification and characteristics of Composite materials, Advantages and application of composites, Functional requirements of reinforcement and matrix, Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II – Reinforcements, Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements, Mechanical Behavior of composites, Rule of mixtures, Inverse rule of mixtures, Isostrain and Isostress conditions.

UNIT III - Manufacturing of Metal Matrix Composites, Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing, Properties and applications, Manufacturing of Ceramic Matrix Composites, Liquid Metal Infiltration – Liquid phase sintering, Manufacturing of Carbon – Carbon composites, Knitting, Braiding, Weaving, Properties and applications.

UNIT IV - Manufacturing of Polymer Matrix Composites, Preparation of Moulding compounds and prepregs, hand layup method, Autoclave method, Filament winding method, Compression moulding, Reaction injection moulding, Properties and applications.

UNIT V – Strength, Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro-thermal failure, Laminate first play failure-insight strength, Laminate strength-ply discount truncated maximum strain criterion, strength design using caplet plots, stress concentrations.

Text Books:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Bala subramaniam, John Wiley & Sons, NY, Indian edition,2007.

Reference books:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials –K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L.Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

OEC106A: WASTE TO ENERGY

No. of Credits: 3	**Sessional: 25 Marks**
L T PTotal	**Theory : 75 Marks**
3 0 0 3	**Total : 100 Marks**
	Duration of Exam: 3 Hours

Course contents:

UNIT I - Introduction to Energy from Waste: Classification of waste as fuel, Agro based, Forest.

UNIT II - Biomass Pyrolysis Types, slow fast, Manufacture of charcoal, Methods, Yields and application, Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III - Biomass Gasification,Gasifiers, Fixed bed system, Downdraft and updraft gasifiers, Fluidized bed gasifiers, Design, construction and operation, Gasifier burner arrangement for thermal heating,Gasifier engine arrangement and electrical power, Equilibrium and kinetic consideration in gasifier operation.

UNIT IV - Biomass Combustion, Biomass stoves, Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation, Operation of all the above biomass combustors.

UNIT V – Biogas, Properties of biogas (Calorific value and composition), Biogas plant technology and status, Bio energy system, Design and constructional features, Biomass resources and their classification, Biomass conversion processes, Thermo-chemical conversion, Direct combustion, biomass gasification, pyrolysis and liquefaction, biochemical conversion, anaerobic digestion, Types of biogas Plants, Applications, Alcohol production from biomass, Bio diesel production, Urban waste to energy conversion, Biomass energy programme in India.

Reference Books:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd.,1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I &II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd.,1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

MTEVE-302A: DISSERTATION PHASE-I

No. of Credits: 10	Sessional: 75 Marks
L T P Total	Theory: 175 Marks
0 0 20 20	Total: 250 Marks

Course Objectives: Critically analyse and evaluate the knowledge and understanding in relation to the agreed area of study.

Course contents:

Dissertation-I will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions and must bring out individual contribution.

Continuous assessment of Dissertation – I and Dissertation – II at Mid Sem and End Sem will be monitored by the departmental committee.

Course Outcomes:

At the end of the course, the student will be able to:

1. Identify energy and environmental engineering problems reviewing available literature.
2. Identify appropriate techniques to analyze complex structural systems.
3. Apply engineering and management principles through efficient handling of project

SEMESTER –IV

MTEVE401A: DISSERTATION PHASE-II

No. of Credits: 16
L T P Total
0 0 32 32

Sessional: 150 Marks
Theory: 350 Marks
Total: 500 Marks

Course Objectives: Critically analyze and evaluate the knowledge and understanding in relation to the agreed area of study.

Course contents:

Dissertation – II will be extension of the work on the topic identified in Dissertation – I. Continuous assessment should be done of the work done by adopting the methodology decided involving numerical analysis/ conduct experiments, collection and analysis of data, etc.There will be pre-submission seminar at the end of academic term. After the approval the student has to submit the detail report and external examiner is called for the viva-voce to assess along with guide.

Course Outcomes:

At the end of the course, the student will be able to:

1. Solve complex structural problems by applying appropriate techniques and tools.
2. Exhibit good communication skill to the engineering community and society.
3. Demonstrate professional ethics and work culture.

****