UNIVERSITY INSTITUTE OF ENGINEERING & TECHNOLOGY
KURUKSHETRA UNIVERSITY, KURUKSHETRA

('A+' Grade, NAAC Accredited)

MASTER OF TECHNOLOGY IN MECHANICAL ENGINEERING (CREDIT BASED)
(With specialization in Thermal Engineering)
SEMESTER-I

S.No.	Course No.	Course Name	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1.	MTTH-101	Advanced Fluid Dynamics	3:0:0	3	3	60	40	-	100	3
2.	MTTH-103	Advanced Heat Transfer	3:0:0	3	3	60	40	-	100	3
3.	*	Programme Elective - I	3:0:0	3	3	60	40	-	100	3
4.	**	Programme Elective - II	3:0:0	3	3	60	40	-	100	3
5.	MTRM-111	Research Methodology and IPR	2:0:0	2	2	60	40	-	100	3
6.	MTTH-117	Advanced Heat Transfer Lab	0:0:4	4	2	-	40	60	100	3
7.	MTTH-119	Refrigeration and Cryogenics Lab	0:0:4	4	2	-	40	60	100	3
8.	***	Audit Course –I	2:0:0	2	-	-	100*	-	100*	3
		Total	**16:0:8**	**24**	**18**	**300**	**280**	**120**	**700**	

*LIST OF PROGRAMME ELECTIVE – I			**LIST OF PROGRAMME ELECTIVE – II		
1.	MTTH-105	Advanced Thermodynamics	1.	MTTH-111	Refrigeration and Cryogenics
2.	MTTH-107	Design of Thermal Systems	2.	MTTH-113	Air Conditioning System Design
3.	MTTH-109	Energy Conservation and Management	3.	MTTH-115	Gas Turbines

***LIST OF AUDIT COURSES – I					
1.	MTAD-101	English for Research Paper Writing	3.	MTAD-105	Sanskrit for Technical Knowledge
2.	MTAD-103	Disaster Management	4.	MTAD-107	Value Education

Note1: The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

*** **Note2:** Along with the credit course, a student may normally be permitted to take audit course, however for auditing a course; prior consent of the course coordinator of the course is required. These courses shall not be mentioned for any award/calculation of SGPA/CGPA in the DMC. A certificate of successful completion of the audit course will be issued by the Director/Head of institution.

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SEMESTER-II

S. No.	Course No.	Course Name	L:T:P	Hours/ Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1.	MTTH-102	Advanced Internal Combustion Engines	3:0:0	3	3	60	40	-	100	3
2.	MTTH-104	Steam Engineering	3:0:0	3	3	60	40	-	100	3
3.	*	Programme Elective - III	3:0:0	3	3	60	40	-	100	3
4.	**	Programme Elective - IV	3:0:0	3	3	60	40	-	100	3
5.	MTTH-118	Advanced Internal Combustion Engines Lab	0:0:4	4	2	-	40	60	100	3
6.	MTTH-120	Computational Fluid Dynamics Lab	0:0:4	4	2	-	40	60	100	3
7.#	MTTH-122	Mini Project	0:0:4	4	2	-	100	-	100	3
8.	***	Audit Course -II	2:0:0	2	-	-	100*		100*	3
		Total	**14:0:12**	**26**	**18**	**240**	**340**	**120**	**700**	

***LIST OF PROGRAMME ELECTIVE – III**			****LIST OF PROGRAMME ELECTIVE – IV**		
1.	MTTH-106	Design of Solar and Wind Systems	1.	MTTH-112	Computational Fluid Dynamics
2.	MTTH-108	Nuclear Engineering	2.	MTTH-114	Design of Heat Transfer Equipments
3.	MTTH-110	Convective Heat Transfer	3.	MTTH-116	Compressible Flow Machines

*****LIST OF AUDIT COURSES – II (Thermal Engg.)**					
1.	MTAD-102	Constitution of India	3.	MTAD-106	Stress Management by Yoga
2.	MTAD-104	Pedagogy Studies	4.	MTAD-108	Personality Development through Life Enlightenment Skills

Note1: The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

***Note2:** Along with the credit course, a student may normally be permitted to take audit course, however for auditing a course; prior consent of the course coordinator of the course is required. These courses shall not be mentioned for any award/calculation of SGPA/CGPA in the DMC. A certificate of successful completion of the audit course will be issued by the Director/Head of institution.

#Note3: Mini project: During this course the student will be able to understand the contemporary/emerging technologies for various processes and systems. During the semester, the students are required to search/gather the material/information on a specific topic, comprehend it and present/discuss the same in the class. He/she will be acquainted to share knowledge effectively in oral (seminar) and written form (formulate documents) in the form of report. The student will be evaluated on the basis of viva/ seminar (40 marks) and report (60 marks).

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SEMESTER-III

S. No.	Course No.	Course Name	L:T:P	Hours/Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1.	*	Programme Elective-V	3:0:0	3	3	60	40	-	100	3
2.	**	Open Elective	3:0:0	3	3	60	40	-	100	3
3.	MTTH-207	Dissertation Phase - I	0:0:20	20	10	-	100	-	100	-
		Total	**6:0:20**	**26**	**16**	**120**	**180**	**-**	**300**	

*PROGRAMME ELECTIVE – V	
MTTH-201	Advanced Computational Fluid Dynamics
MTTH-203	Finite Element Methods
MTTH-205	Thermal Modeling and Analysis

**LIST OF OPEN ELECTIVES			
MTOE-201	Business Analytics	MTOE-207	Cost Management of Engineering Projects
MTOE-203	Industrial Safety	MTOE-209	Composite Materials
MTOE-205	Operations Research	MTOE-211	Waste to Energy

SEMESTER-IV

S. No.	Course No.	Course Name	L:T:P	Hours/Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1.	MTTH-202	Dissertation Phase - II	0:0:32	32	16	-	100	200	300	-
		Total	**0:0:32**	**32**	**16**	**-**	**100**	**200**	**300**	

Total credits of all four semesters – 68

Note 1: At the end of the second semester each student is required to do his/her Dissertation work in the identified area in consent of the Guide/Supervisor. Broad area for the Dissertation Part-I is to be specified/submitted within three weeks of the beginning of the Third Semester.

Note 2: Each admitted student is required to submit the report of his/her Dissertation Part-I as per the schedule mentioned in Academic calendar for the corresponding academic session otherwise the Dissertation Part-II cannot be continued at any level.

Note 3: Each admitted student is required to submit his/her final Dissertation Part-II as per the schedule mentioned in Academic calendar for the corresponding academic session only after the publication of at least one paper in International/National reputed journals (SCI/Scopus indexed/ UGC approved journals) or reputed conferences with ISSN number.

Note 4: The course of program/open elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

MTTH-101	ADVANCED FLUID DYNAMICS						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	-	-	3	60	40	100	3
Objective	**To understand fluid flow problems & regimes, governing parameters, industrial applications, laminar, turbulent & compressible flows, experiments in the field of fluid mechanics.**						
Course Outcomes							
CO1	**Enabling the understanding of fluid flow problems along with range of governing parameters.**						
CO2	**Enabling the understanding of flow patterns and ability to differentiate between various flow regimes and its effects & take up related problems of industrial base.**						
CO3	**Creating an understanding about turbulent & compressible flows.**						
CO4	**Enabling the students to devise the experiments in the field of fluid mechanics.**						

UNIT-I

Basic equations of fluid flow: Reynold's transport theorem, continuity, momentum and energy equations in integral form and their applications, differential form of these equations, Euler's equation, Bernoulli's equation, Navier Stokes equation.

Ideal flow: Kinematics of fluid flow; potential flow; sources, sinks and vortices; superimposition of uniform stream with above, doublets; Rankine ovals; flow around uniform cylinders with and without circulation; pressure distribution on the surface of these bodies and D'Alembert's paradox.

UNIT-II

Exact solution of N-S equations: Navier Stokes equation, Plane Poiselle and Coutte flows; Hagen-Poiselle flow through pipes; elements of hydrodynamic theory of lubrication; Flows with very low Reynold's numbers; Stokes flow around a sphere.

Boundary layer flows: Elements of two-dimensional boundary layer theory; displacement thickness and momentum thickness; skin friction; Blasius solution for boundary layer on a flat plate; Karman-Pohlhausen integral method for obtaining approximate solutions, boundary layer separation & control.

UNIT-III

Turbulent Flow: Characteristics of turbulent flow, laminar-turbulent transition, Turbulent boundary layer equation, Time mean motion and fluctuations, derivation of governing equations for turbulent flow, Reynold's stresses: shear stress models, universal velocity distribution.

Introduction to Compressible flows: Speed of sound and Mach number, basic equations for one dimensional compressible flow, isentropic relation, propagation of infinitesimal and finite disturbances, stagnation and critical conditions, effect of variable flow area, converging and converging-diverging nozzles and diffusers.

UNIT-IV

Experimental Techniques: Role of experiments in fluid mechanics, Sources of error in experiments, Sources of Error in Measurement, Data analysis: Classification of Data, Analysis of Random Signals, Fourier Transform Technique, Probability Density Function Approach; Introduction to design of experiments; Review of probes and transducers: Introduction to Hot wire Anemometry; Single & double wire measurement; Laser Doppler Velocimetry: Light Sources & LDV; Particle Image Velocimetry: Particle Image Velocimetry, Seeding Arrangement for PIV, Particle Dynamics, Generating a Light Sheet, Synchronizer.

Reference/Text Books:

1. Muralidhar and Biswas, "Advanced Engineering Fluid Mechanics", Alpha Science International, 2005.
2. Irwin Shames, "Mechanics of Fluids", McGraw Hill, 2003
3. R.W., McDonald A.T., "Introduction to Fluid Mechanics", John Wiley and Sons Inc, 1985
4. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, "Fluid Mechanics", Fifth Edition, 2005
5. I.G. Currie, "Fundamentals of Mechanics of Fluid", McGraw-Hill.
6. Yuan, "Foundation of Fluid Mechanics", Prentice Hall.
7. R.W. Fox, P.J. Pritchard & A.T. McDonald, "Introduction to Fluid Mechanics", Wiley India.
8. S.K. Som and G. Biswas, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw.
9. Gupta and Gupta, "Fluid Mechanics and its applications", Willey Easter.

MTTH-103	ADVANCED HEAT TRANSFER						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To understand the subject of Heat Transfer in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.						
Course Outcomes							
CO 1	After completing the course, the students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.						
CO 2	The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer						
CO 3	The students will be able to design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.						

UNIT-I

Conductive Heat Transfer: Review of the basic laws of conduction, convection and radiation. General heat conduction equation in different co-ordinates. One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat sources. Extended surfaces review, tapered fins, design considerations.
Two and three dimensional steady-state conduction, method of separation of variables, graphical method, relaxation technique.

Unsteady heat conduction: lumped capacitance method, validity of lumped capacitance method, general lumped capacitance analysis, spatial effects, plane wall with convection, radial systems with convection, semi-infinite solid, constant surface temperature and heat fluxes, periodic heating, solutions using Heisler’s charts.

UNIT-II

Convective Heat Transfer: Introduction to convection boundary layers, local and average convection coefficients, laminar and turbulent flow, boundary layer equations, boundary layer similarity, boundary layer analogies – heat and mass transfer analogy, Reynold’s and Colburn analogies.

Forced convection: external forced convection - empirical method, flat plate in parallel flow, cylinder in cross flow, flow over a sphere; internal forced convection – hydrodynamic and thermal considerations, energy balance, laminar flow in circular tubes, convection correlations.

Natural Convection: physical considerations, governing equations, laminar free convection on vertical surface, empirical correlations, free convection within parallel plate channels, empirical correlations, combined free and forced convection. Special topics: transpiration cooling, ablation heat transfer, fluidized bed combustion.

UNIT-III

Heat Transfer with Phase Change: dimensionless parameters in boiling and condensation, boiling modes, pool boiling, correlations, forced convection boiling, physical mechanism of condensation, laminar and turbulent film condensation, film condensation in tubes, dropwise condensation.

Exchangers: Basic design methodologies – LMTD and effectiveness NTU methods, overall heat transfer coefficient, fouling of heat exchangers, classification of heat exchangers according to constructional features: tubular, plate type, extended surface heat exchanger, compact heat exchangers, design of double pipe heat exchangers, plate and heat pipe type, heat transfer enhancement - Passive and active techniques.

MTTH-103 (contd….):

UNIT-IV

Radiation Heat Transfer: Fundamental concepts, radiation intensity, irradiation, radiosity, black body radiation, Basic laws of radiation, emission from real surfaces, absorption, reflection and transmission by real surfaces, Kirchoff's law, Gray surface, radiative heat exchange between two or more surfaces, view factor, radiation exchange between opaque, diffuse, gray surface in an enclosure; net radiation exchange at a surface, radiation exchange between surfaces, blackbody radiation exchange, two-surface enclosure, radiation shields, multimode heat transfer, radiation exchange with participating media, radiation of gases and vapour.

Mass Transfer: physical origins and rate equations, mixture composition, Fick's law of diffusion, mass transfer in stationary media, steady state diffusion through a plane membrane, equimolal diffusion, diffusion of water vapours through air, mass transfer coefficient, convective mass transfer, correlations.

Reference/Text Books:

1. Incropera, Dewitt, Bergmann and Levine, "Fundamentals of Heat and Mass Transfer", Wiley India, 2006.
2. J.P. Holman, "Heat Transfer", McGraw Hill, 1996.
3. Y.V.C. Rao, "Heat and Mass Transfer", Universities Press, 2001.
4. D.S. Kumar, "Heat and Mass Transfer", Katson Publication, 2013.
5. Kreith and Bohn, "Principles of Heat Transfer", Cengage Learning, Inc. 7th Edition, 2009.
6. N.H. Afgan and Schliinder, "Heat Exchangers Design and Theory", McGraw Hill.

MTTH-117	ADVANCED HEAT TRANSFER LAB							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical Marks**	**Total**	**Time (Hrs.)**
-	-	4	2	-	40	60	100	3
Objective	**To design and conduct experiments, and acquire, analyze and interpret data.**							
Course Outcomes								
CO 1	**Study the heat pipe and demonstrate its super thermal conductivity.**							
CO 2	**Understand the unsteady state heat conduction.**							
CO 3	**Analyze the heat transfer characteristics in convective heat transfer.**							
CO 4	**Analyze the heat transfer characteristics for different heat exchangers.**							

List of Experiments

1. Study of variation of emissivity of test plate with absolute temperature.
2. To demonstrate the super thermal conductivity of heat pipe.
3. To determine natural convective heat transfer coefficient and to calculate and to plot variation of natural convective heat transfer coefficient along the vertical tube.
4. To determine the LMTD, overall heat transfer coefficient and effectiveness of evaporative heat exchanger.
5. To find out heat transfer coefficient of drop wise and film wise condensation at various flow rates of water.
6. To study different types of heat enhancement techniques.
7. To determine the Biot number, Fourier number and heat transfer coefficient for unsteady heat transfer.
8. To calculate heat transfer coefficient of the fluidized bed.
9. To find out the overall heat transfer coefficient and LMTD of a finned tube heat exchanger.
10. To find out the overall heat transfer coefficient and LMTD of a plate type heat exchanger.
11. To find out the heat flux and temperature difference between metal & liquid in a two phase transfer unit.
12. To determine the overall heat transfer co-efficient under unsteady state conditions at different temperatures and heat transfer coefficient at boiling point.

Note: Total eight experiments are to be performed selecting at least six from the above list.

MTTH-119	REFRIGERATION AND CRYOGENICS LAB							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	4	2	-	40	60	100	3
Objective	To make students understand the applications of refrigeration and cryogenics.							
Course Outcomes								
CO 1	Students will understand about the basics and working of refrigeration and cryogenics systems.							
CO 2	Students will be able to identify the different cycle of operation in refrigeration.							
CO 3	Students will know the working principle to achieve very low temperature and its importance in air-conditioning.							
CO 4	Student will learn about the various working and design of different types of refrigeration systems.							

List of Experiments

1. To study and perform experiment on compound vapour compression Refrigeration Cycle.
2. To study and perform experiment on Solar Air-conditioner based on vapour absorption cycle.
3. To study and perform experiments on multi-load systems.
4. To study and perform experiment on vapour absorption apparatus.
5. To find the performance parameter of cooling tower.
6. To study various components in room air conditioner.
7. To find performance of a refrigeration test rig system by using different expansion devices.
8. To study and perform experiments on cascade system.
9. To study and perform experiments on dry ice machine.
10. To study and perform experiments on gas liquefaction system.

Note: Total eight experiments are to be performed selecting at least six from the above list.

MTTH-105	ADVANCED THERMODYNAMICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of advanced thermodynamics.						
Course Outcomes							
CO 1	Student will get knowledge of exergy, basic laws governing energy conversion in multicomponent systems and application of chemical thermodynamics.						
CO 2	Student will be aware about advanced concepts in thermodynamics with emphasis on thermodynamic relations, equilibrium and stability of multiphase multi-component systems.						
CO 3	To present theoretical, semi-theoretical and empirical models for the prediction of thermodynamic properties.						
CO 4	Student will acquire the confidence in analyze the motion of combusting and non-combusting fluids whilst accounting for variable specific heats, non-ideal gas properties, chemical non-equilibrium and compressibility.						

UNIT – I

Basic Concepts: Thermodynamics - Zeroth law of thermodynamics – first law of thermodynamics - limitations of first law - Corollaries. Concept of internal energy Transient Flow Analysis - second law of thermodynamics - Corollaries. Concept of entropy- Availability and unavailability – availability function of the closed system - availability of steady flow system Irreversibility.

Thermodynamic Relations: Introduction Thermodynamic Potentials – Maxwell Relations – Specific Heat Relations – Mayer's relation –General relations for du, dh, ds.

UNIT – II

Perfect Gases: P.V.T. surface – Equations of state – Real Gas Behavior – Vander Waal's equation - Generalized compressibility Factor – Energy properties of Real Gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient.

Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties –Psychrometric Mixture properties and psychrometric chart – Air conditioning processes – Real Gas Mixture.

UNIT – III

Reactive Gas Mixtures: Combustion: Introduction— Combustion Reactions – Enthalpy of Formation – Entropy of Formation - Adiabatic flame Temperature -first and second law analysis of reacting systems.

Thermodynamic cycles: Vapor power cycles: Second law analysis of vapor power cycles, cogeneration, Binary vapor cycles, and combined gas vapor power cycles. Gas power cycles: Ideal jet propulsion cycles-Second law analysis of gas power cycles.

UNIT – IV

Statistical thermodynamics: Statistical interpretations of first and second law and Entropy, Nernst heat theorem.

Kinetic theory of gases: Molecular model, Clausius equation of state, van der waals equation of state, Maxwell Boltzmann velocity distribution

Reference/Text books:

1. Cengel, "Thermodynamics", Tata McGraw Hill Co., New Delhi, 1980.
2. Howell and Dedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.
3. Van Wylen & Sonntag, "Thermodynamics", John Wiley and Sons Inc., U.S.A.
4. Jones and Hawkings, "Engineering Thermodynamics", John Wiley and Sons Inc., U.S.A, 2004.
5. Holman, "Thermodynamics", McGraw Hill Inc., New York, 2002.
6. Faires V.M. and Simmag, "Thermodynamics", Macmillan Publishing Co. Inc., U.S.A.
7. Rao Y.V.C., "Postulational and Statistical Thermodynamics", Allied Publishers Inc, 1994.

MTTH-107	DESIGN OF THERMAL SYSTEMS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	This course provides the mathematical modelling and analysis for designing the thermal systems. Also students will be able to understand the dynamic behaviour of thermal systems.						
Course Outcomes							
CO 1	Enable the students to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						
CO 2	Equip the students for modelling the thermal systems like heat exchangers, evaporators, condensers etc. Also to understand their solution procedures.						
CO 3	Students will understand the concepts of optimization and its various methods for solving the thermal problems. Also to study geometric, linear and dynamic programming.						
CO 4	Students will learn the dynamic behaviour of thermal systems. Also to learn stability analysis and non-linearity.						
CO 5	Enable the students to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						

UNIT-I

Design of Thermal System: Design Principles, Workable systems, Optimal systems, Matching of system components, Economic analysis, Depreciation, Gradient present worth factor.

Mathematical Modeling: Equation fitting, Empirical equation, Regression analysis, Different modes of mathematical models, Selection, Computer programmes for models.

UNIT-II

Modeling Thermal Equipments: Modeling heat exchangers, Evaporators, Condensers, Absorption and rectification columns, Compressor, Pumps, Simulation studies, Information flow diagram, Solution procedures.

UNIT-III

Systems Optimization: Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, Linear programming methods, Solution procedures.

UNIT-IV

Dynamic Behavior of Thermal System: Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties.

Reference/Text Books:

1.Hodge, B.K. and Taylor, R. P., "Analysis and Design of Energy Systems", Prentice Hall (1999).
2.Bejan, A., Tsatsaronis, G. and Michel, M., "Thermal Design and Optimization", John Wiley and Sons (1996).
3.Jaluria, Y., "Design and Optimization of Thermal Systems", CRC Press (2008).
4.Ishigai, S., "Steam Power Engineering Thermal and Hydraulic Design Principle", Cambridge University Press (1999).

MTTH-109	ENERGY CONSERVATION AND MANAGEMENT						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To understand the method of utilization of energy, types, site selection & other important aspects of Solar, wind, hydro, ocean, wave, tidal, geothermal, bio-mass & energy management.						
Course Outcomes							
CO 1	Understanding of methods of utilization, types, site selection & surveys etc. of Solar, Wind, Chemical, MHD sources of energy.						
CO 2	Understanding of methods of utilization, types, site selection & surveys etc. regarding Energy from Oceans and Hydropower.						
CO 3	Understanding of methods of utilization, types, site selection & surveys etc. regarding Bio-energy and Geothermal energy.						
CO 4	Understanding of generation of scenarios of energy consumption and predict the future trend. The student should be able to suggest and plan energy conservation solutions.						

UNIT-I

Alternative Sources of Energy:
Solar Energy: Introduction; direct solar energy utilization; solar thermal applications. **Chemical Energy Sources:** Introduction, Fuel cells: Design, Principle, operation, classification, types. **Magneto Hydro Dynamic Power Generation:** Introduction, Principle of MHD power generation, MHD Systems.
Wind energy: Introduction, Basic principles of wind energy conversion: Nature of wind, Power in the wind, forces on blades, wind energy conversion, design of windmills; wind data and energy estimation; site selection considerations, Basic components of WECS.

UNIT-II

Energy from Oceans: Wave energy generation – energy from waves; wave energy conversion devices; advantages and disadvantages of wave energy; Tidal energy – basic principles; tidal power generation systems; estimation of energy and power; advantages and limitations of tidal power generation; ocean thermal energy conversion (OTEC); methods of ocean thermal electric power generation.
Hydro power: Classification of small hydro power (SHP) stations; description of basic civil works design considerations; turbines and generators for SHP; advantages and limitations.

UNIT-III

Biomass and bio-fuels: Energy plantation; biogas generation; types of biogas plants; applications of biogas; energy from wastes.
Energy conservation in Industries: Cogeneration, Combined heating and power systems, Relevant international standards and laws.

UNIT-IV

Energy conservation management: General principles of energy management and energy management planning; application of Pareto's model for energy management; obtaining management support; establishing energy data base; Energy economics.
Energy Auditing: Conducting energy audit; identifying, evaluating and implementing feasible energy conservation opportunities; energy audit report; monitoring, evaluating and following up energy saving measures/projects.

Reference/Text Books:

1. L.C. Witte, P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilization", Hemispherical Publication, 1988.
2. Paul W. O'Callaghan, "Design and Management for Energy Conservation" Pergamon Pr; 1st edition (December 1, 1981)
3. D.A. Reeg, "Industrial Energy Conservation", Pergamon Press, 1980.

4. T.L. Boyen, “Thermal Energy Recovery” Wiley, 1980.
5. L.J. Nagrath, “Systems Modeling and Analysis”, Tata McGraw Hill, 1982.
6. W.C. Turner, “Energy Management Handbook “, Wiley, New York, 1982.
7. I.G.C. Dryden, “The Efficient Use of Energy “, Butterworth, London, 1982.
8. Godfrey Boyle (Edited by), “Renewable energy – power for sustainable future”, Oxford University Press in association with the Open University, 1996.
9. S.A. Abbasi and Naseema Abbasi, “Renewable energy sources and their environmental impact” Prentice-Hall of India, 2001.
10. G.D. Rai, “Non-conventional sources of energy” Khanna Publishers, 2000.
11. G.D. Rai, “Solar energy utilization” Khanna Publishers, 2000.
12. S.L.Sah, “Renewable and novel energy sources”, M. I. Publications, 1995.
13. S.Rao and B.B. Parulekar, “Energy Technology”, Khanna Publishers, 1999.

MTTH-111	REFRIGERATION AND CRYOGENICS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of refrigeration and cryogenics.						
Course Outcomes							
CO 1	Students will learn the basics of refrigeration and cryogenics and its application area.						
CO 2	Students will be able to design the refrigeration systems for domestic and industrial applications like cold storages.						
CO 3	Students will learn about ODP, GWP and related environment issues.						

Unit-I

Vapour compression system: Vapour compression refrigeration, Ewing's construction, Standard rating cycle and effect on operating conditions, actual cycle, standard rating cycle for domestic refrigerator, second law efficiency,

Multi-pressure systems: Working and analysis of Multi-stage compression with inter-cooling, Multi-evaporator systems, Cascade systems.

Unit-II

Refrigerant Compressors: Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor,

Components of Vapor compression system: Design, selection of evaporators, condensers, control systems, motor selection.

Unit-III

Refrigerants: Introduction, designation of refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, atmospheric gases as substitute for CFC refrigerants, Binary and Azeotropic mixtures.

Refrigeration applications: food preservation, cooling and heating of foods, freezing of foods, freeze drying and heat drying of foods, transport refrigeration

Unit-IV

Vapour absorption system: Introduction to Vapor absorption refrigeration, common refrigerant-absorbent systems, single effect and double effect systems, new mixtures for absorption system.

Gas liquefaction systems: Linde-Hampson, Linde dual pressure, Claude cycle.

Reference/Text Books:

1. R. J. Dossat, "Principles of Refrigeration", Pearson Education Asia, 2001.
2. C. P. Arora, "Refrigeration and Air-conditioning", Tata McGraw-Hill, 2000.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, New York, 1982.
4. A. R. Trott, "Refrigeration and Air-conditioning", Butterworths, 2000.
5. J. L. Threlkeld, "Thermal Environmental Engineering", Prentice Hall, 1970.
6. R. Barron, "Cryogenic systems", McGraw–Hill Company, New Yourk, 1985.
7. G. G. Hasseldon. "Cryogenic Fundamentals", Academic Press.
8. Bailey, "Advanced Cryogenics", Plenum Press, London, 1971.
9. W. F. Stoecker, "Industrial Refrigeration Handbook", McGraw-Hill, 1998.
10. John A. Corinchock, "Technician's Guide to Refrigeration systems", McGrawHill.
11. P. C. Koelet, "Industrial Refrigeration: Principles, Design and Applications", Macmillan, 1992.
12. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
13. Graham Walker, "Miniature Refrigerators for Cryogenic Sensors and Cold Electronics", Clarendon Press, 1989.

MTTH-113	AIR CONDITIONING SYSTEM DESIGN						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of heating, ventilation and air-conditioning.						
Course Outcomes							
CO 1	Student should be able to understand construction and design features of Air-conditioning system.						
CO 2	Student should be able to understand various types and its adoptability in the various environment and application areas.						
CO 3	Student should be able to understand various health issues						
CO 4	Student should be able to design seasonal energy efficient system						

Unit-I

Air conditioning systems: the complete system, System selection and arrangement, HVAC components and distribution system, All-air, Air-water and All-water systems, decentralized cooling and heating.

Various air-conditioning processes: Moist air and standard atmosphere, Adiabatic saturation, classic moist air processes, Space air conditioning: design conditions, off-design conditions.

Unit-II

Comfort and health-Indoor air quality: Enthalpy deviation curve, psychrometry, SHF, dehumidified air quantity, human comfort, indoor air quality.

Heat transmission in building structures: Basic heat transfer modes, Tabulated overall heat-transfer coefficient.

Unit-III

Design conditions and load calculations: Space heating load: outdoor and indoor design conditions, transmission heat losses, infiltration, heat losses from air duct. Solar radiation

The cooling load: Design conditions, Internal heat gain, Transient conduction heat transfer, Fenestration: Transmitted solar radiations.

Unit-IV

Fan and Building air distribution: fan performance and selection, Fans and variable-air-volume systems, Air flow in ducts and fittings, pressure drop, duct design, & blowers, Performance & selection, noise control.

Reference/Text Books:

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
3. Norman C. Harris, "Modern Air Conditioning", McGraw-Hill, 1974.
4. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
5. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand
6. Reinhold Co., New York, 1984. 7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
7. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
8. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
9. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.
10. F. C. McQuiston, J. D Parker, J. D. Spitler "Heating, Ventilation and Air-conditioning", Wiley publications.

MTTH-115	**GAS TURBINES**						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**-**	**-**	**3**	**60**	**40**	**100**	**3**
Objective	**Design and analyze the performance of gas turbines and propulsion devices.**						

Course Outcomes	
CO 1	**Understand the ideal and real thermodynamic cycles of air-breathing engines and Industrial gas turbines**
CO 2	**Design the blading, study the velocity triangles and estimate the performance of centrifugal and axial flow compressors.**
CO 3	**Understand the combustion process and design the combustion chamber of a gas Turbine.**
CO 4	**Design the blading, study the velocity triangles and estimate the performance of axial and radial in-flow turbines**
CO 5	**Analyze the off-design performance and matching of the components of a gas turbine**

UNIT-I

Introduction: Classification of Turbomachines, Applications of Gas Turbines, Assumptions for Air-Standard Cycles, Simple Brayton Cycle, Heat Exchange Cycle, Inter-cooling and Reheating Cycle, Comparison of Various Cycles.

Ideal Shaft Power Cycles and their Analysis: Assumptions for Air-Standard Cycles, Simple Brayton Cycle, Heat Exchange Cycle, Inter-cooling and Reheating Cycle, Comparison of Various Cycles.

UNIT-II

Real Cycles and their Analysis: Methods of Accounting for Component Losses, Isentropic and Polytropic Efficiencies, Transmission and Combustion Efficiencies, Comparative Performance of Practical Cycles, Combined Cycles and Cogeneration Schemes.

Jet Propulsion Cycles and their Analysis: Criteria of Performance, Simple Turbojet Engine, Simple Turbofan Engine, Simple Turboprop Engine, Turbo-shaft Engine, Thrust Augmentation Techniques.

Combustion System: Operational Requirements, Classification of Combustion Chambers, Factors Effecting Combustion Chamber Design, The Combustion Process, Flame Stabilization, Combustion Chamber Performance, Some Practical Problems Gas Turbine Emissions

UNIT-III

Fundamentals of Rotating Machines: General Fluid Dynamic Analysis, Euler's Energy Equation, Components of Energy Transfer, Impulse and Reaction Machines.

Centrifugal Compressors: Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio, The Diffuser, The Compressibility Effects, Pre-rotation and Slip Factor, Surging and Choking, Performance Characteristics.

UNIT-IV

Flow Through Cascades: Cascade of Blades, Axial Compressor Cascades, Lift and Drag Forces, Cascade Efficiency, Cascade Tunnel.

Axial Flow Compressors: Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio, Degree of Reaction, Work done factor, Three Dimensional Flow, Design Process, Blade Design, Stage Performance, Compressibility Effects, Off-Design Performance.

Axial and Radial Flow Turbines: Construction and Operation, Vortex Theory, Estimation of Stage Performance, Overall Turbine Performance, Turbine Blade Cooling, The Radial Flow Turbine.

Off-Design Performance: Off-Design Performance of Single Shaft Gas Turbine, Off-Design Performance of Free Turbine Engine, Off-Design Performance of the Jet Engine, Methods of Displacing the Equilibrium Running Line

Reference/Text Books:

1. Sarvana Muttoo, H.I.H., Rogers, G. F. C. and Cohen, H., "Gas Turbine Theory", 6th Edition, Pearson 2008.
2. Dixon, S.L., "Fluid Mechanics and Thermodynamics of Turbomachinery", 7th Edition, Elsevier, 2014.
3. Flack, R.D., "Fundamentals of Jet Propulsion with Applications", Cambridge University Press, 2011.
4. Ganesan, V., "Gas Turbines", 3rd Edition, Tata McGraw Hill, 2010.

5. Yahya, S. M., "Turbines, Compressors and Fans", 4th Edition, McGraw Hill.

MTRM-111	**Research Methodology and IPR**						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**2**	**60**	**40**	**100**	**3 Hrs.**
Program Objective (PO)	*To enable students to Research Methodology and IPR for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.*						
Course Outcomes (CO)							
CO1	Understand research problem formulation.						
CO2	Analyze research related information						
CO3	Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.						
CO4	Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.						

Unit 1

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 2

Effective literature studies approaches, analysis, Plagiarism, Research ethics, 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 3

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 4

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

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.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'.
2. C.R. Kothari, "Research Methodology: Methods & Techniques, 2nd edition or above, New Age Publishers.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2 nd Edition , "Research Methodology: A Step by Step Guide for beginners"
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, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.

MTTH-102	ADVANCED INTERNAL COMBUSTION ENGINES						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	Enable the students to understand the various theories, cycles and processes of Internal Combustion Engines. Also to understand the various devices and types of emission associated with engines.						
Course Outcomes							
CO 1	Student will be able to analyze the cycles, operating variables and the basic concepts of internal combustion engines. Also to learn various processes and comparison of real and fuel air cycles. To understand the thermo-chemistry of fuel-air mixtures. Also to study the combustion charts of the fuel-air mixture in internal combustion engines.						
CO 2	Students will understand the gas exchange processes and motion of charge in the cylinder and its effects on combustion process in SI and CI engines and control the pollutant formation.						
CO 3	Understand the combustion in SI and CI engine with the thermodynamics of the combustion.						
CO 4	Understand modern concepts like Lean burn, HCCI, GDI, MPFI and evaluate method for pollution control.						

UNIT-I

Cycle Analysis: Fuel-air cycles, variable specific heats, dissociation, effect of operating variables, comparison with air standard cycle. Actual cycles, time and heat loss factors, exhaust blow down, comparison of real engine cycle and fuel air cycle, availability analysis of engine processes.

Thermochemistry of fuel-air mixtures: composition of air and fuels, first law and second law applied to combustion, unburned mixture composition, combustion charts.

UNIT-II

Heat Transfer: Heat transfer and engine energy balance, parameters affecting heat transfer, convective and radiative heat transfer, measurement of instantaneous heat transfer rate, thermal loading.

Gas Exchange Processes: flow through valves and ports, exhaust gas flow rate, scavenging in two stroke engines, scavenging models, actual scavenging processes, supercharging and turbocharging, types and methods of supercharging, basic relationships, compressors, turbines, wave-compression devices, effects and limitations, charge cooling.

UNIT-III

Combustion: combustion in SI engines, thermodynamic analysis of SI engine combustion, burned and unburned mixture states, flame structure and speed, cycle variations, spark ignition, abnormal combustion, combustion in CI engines, types, CI engine combustion model, analysis of cylinder pressure data, fuel spray behavior, ignition delay, mixing controlled combustion.

UNIT-IV

Fuel Injection: fuel injection systems, mechanism of spray formation, electronic injection systems, MPFI system, feedback systems, flow in intake manifolds, design requirements.

Pollution Formation and Control: trends in vehicle emission standards, unburned hydrocarbon emissions, nitrogen oxides, CO, particulate emissions, exhaust gas treatment, non-exhaust emissions.

Reference/Text Books:

1. J.B. Heywood, “Internal Combustion Engine Fundamentals” McGraw Hill.
2. C.P. Taylor, “I.C. Engine Vol. I & II”, MIT press.
3. V. Ganesan, “Internal Combustion Engines”, Tata McGraw Hill.
4. Rowland S. Benson, J. H. Horlock & D E Winterbone, “Thermodynamics and Gas Dynamics of I.C. Engine, Vol. I & II”, Oxford University press.
5. Campbell, A. S., “Thermodynamic Analysis of Combustion Engines” Krieger Publishing Company.

MTTH-104	STEAM ENGINEERING						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To familiarize the students with the fundamentals of steam engineering and thermal systems for energy conservation and waste heat recovery.						

Course Outcomes	
CO 1	Students will have the ability to explain working of different boilers and significance of mountings and accessories, usage of techniques, skills, and modern engineering tools necessary for boiler performance assessment.
CO 2	Students will have a theoretical and practical background in thermal systems and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.
CO 3	Students will have the ability to design a steam piping system, its components for a process and also design economical and effective insulation.
CO 4	Students will have the ability to analyze a thermal system for sources of waste heat design a system for waste heat recovery. Students will have the ability to design and develop controls and instrumentation for effective monitoring of the process.

UNIT-I

Fundamentals of steam generation: Introduction, Quality of steam, Use of steam table, Mollier Chart.
Boilers: Types, Mountings and Accessories, Combustion in boilers, Determination of adiabatic flame temperature, quantity of flue gases, Feed Water and its quality, Blow down; IBR, Boiler standards.
Piping & Insulation: Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory-types, selection and application of refractory, Heat loss.

UNIT-II

Steam Systems: Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipments / Systems.
Boiler Performance Assessment: Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

UNIT-III

Boiler Performance Assessment Performance: Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.
Energy Conservation and Waste Minimization: Energy conservation options in Boiler; waste minimization, methodology; Economical viability of waste minimization.

UNIT-IV

Instrumentation & Control: Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection.

Reference/Text Books:

1. T. D. Estop, A. McConkey, “Applied Thermodynamics”, Parson Publication.
2. Domkundwar; “A Course in Power Plant Engineering”, Dhanapat Rai and Sons.
3. Yunus A. Cengel and Boles, “Engineering Thermodynamics”, Tata McGraw-Hill Publishing Co. Ltd.
4. Book II - Energy Efficiency in Thermal Utilities; Bureau of Energy Efficiency.
5. Book IV - Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency.
6. Edited by J. B. Kitto & S C Stultz, “Steam: Its Generation and Use”, The Babcock and Wilcox Company.
7. P. Chatopadhyay, “Boiler Operation Engineering: Questions and Answers”, Tata McGraw Hill Education Pvt Ltd, N Delhi.

MTTH-118	ADVANCED INTERNAL COMBUSTION ENGINES LAB							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	4	2	-	40	60	100	3
Objective	To make the students aware of petrol and diesel engines along-with multi fuels based engines using different experiments.							
Course Outcomes								
CO 1	Ability to analyze the performance curves of SI and CI engines.							
CO 2	Ability to determine the exhaust emissions from engines using gas analyzer.							
CO 3	To understand the Wankel engine, bomb calorimeter.							
CO 4	To perform test on reciprocating air compressor unit.							
CO 5	Ability to analyze smoke emissions through smoke meter.							

List of Experiments

1. To analyze the performance of single cylinder VCR Engine [Computerised],
2. To evaluate the Performance of Reciprocating Air-Compressor unit.
3. To analyze the Valve / Port Timing Diagrams of IC engines.
4. To study the sectional light weight models of IC Engine, injection system and carburetor, sectional working model for 4 stroke petrol engine.
5. Study of sectional light weight models of IC Engine, injection system and carburetor, sectional working model for 2 stroke petrol engine.
6. To study sectional working model for four stroke cycle diesel engine.
7. To study Wankel engine model.
8. To analyze the smoke emissions of microprocessor based Smoke meter.
9. To analyze the various exhaust gases of IC Engines through five gas analyzer.
10. To study hydraulic dynamometer.
11. To analyze the performance of four Cylinder 4 stroke Multi-fuel diesel Engine [Computerised].

Note: Total eight experiments are to be performed selecting at least six from the above list.

MTTH-120	COMPUTATIONAL FLUID DYNAMICS LAB							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical Marks	Total	Time (Hrs.)
-	-	4	2	-	40	60	100	3
Objective	To acquaint the students with fundamentals of programming of 1 D and 2 D heat transfer and fluid flow problems using finite differencing.							
Course Outcomes								
CO 1	Develop an understanding of the difference between dimensional and non-dimensional programming techniques.							
CO 2	Understanding of fundamentals of programming of heat transfer in pin fin problems.							
CO 3	Understanding of fundamentals of programming of fluid flow problems.							
CO 4	Understanding of fundamentals of programming of steady and transient heat conduction problems.							

List of Experiments

1. To make and validate a computer programme for the one dimensional pin fin steady state heat conduction when fin is insulated at tip.
2. To make and validate a computer programme for the one dimensional pin fin steady state heat conduction when fin is losing heat at tip.
3. To make and validate a computer programme for the one dimensional transient heat conduction.
4. To make and validate a computer programme for the plate in two dimensions in steady state conduction.
5. To make and validate a computer programme for the plate in two dimensions in transient state.
6. To make and validate a computer programme for the comparison of explicit, implicit, semi- implicit method of computation of heat transfer equation.
7. To make and validate a computer programme for the fully developed laminar flow in circular pipe.
8. To make and validate a computer programme for the Coutte flow.
9. To make a project by using MAC /SIMPLER method

Note: Total eight experiments are to be performed selecting at least six from the above list. The programs may be validated using any software.

MTTH-106	DESIGN OF SOLAR AND WIND SYSTEMS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	To acquaint the students with fundamentals of solar and wind systems and devices.						
Course Outcomes							
CO 1	Students will learn about the technological status of implementation of NCES in India						
CO 2	Student should be capable to analyze various techno economical obstacles in the commercial development of NCES in India						
CO 3	Student should be capable to conceptually model and design general NCES systems and predict the long term performance.						
CO 4	Student should suggest and plan hybrid NCES solutions to conventional energy systems						

Unit-I

Fundamental of energy science and technology: energy, economy and social development, classification of energy sources, energy scenario in India.

Conventional sources of energy: Consumption trend of primary energy sources, energy-environment economy, Nuclear, Alternative energy sources.

Unit-II

Solar Radiation: Estimation, prediction & measurement, solar energy utilization, extraterrestrial and terrestrial radiations, spectral power distribution of solar radiation, solar time, and solar radiation geometry, Estimation of solar radiation on horizontal and tilted surface.

Solar Thermal Systems: Solar water heater, Solar cooker, Solar furnace, Solar dryer, Solar distillation, Solar greenhouse.

Unit-III

Solar radiation collector: Performance of Solar flat plate collectors, concentrating collectors.

Thermal storage: Sensible, latent and chemical heat storage. Solar air heaters, solar air-conditioning systems.

Unit-IV

Wind energy: Direct Energy conversion- PV, MHD.

Non-conventional Energy Technologies: Fuel cells, thermionic, thermoelectric, Biomass, biogas, hydrogen, Geothermal.

Reference/Text Books:

1. D.Y. Goswami, F. Kreith and J.F. Kreider, “Principle of Solar Engineering”, Taylor and Francis, 2000.
2. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
3. J.F. Kreider, F. Kreith, “Solar Energy Handbook”, McGraw Hill, 1981
4. J.A. Duffie and W.A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley, 1991.

MTTH-108	NUCLEAR ENGINEERING

Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	**To understand Nuclear Reactor: inside processes, energy release, criticality, types, dimensions, materials, control, behavior, heat removal, safety, radiation protection, isotopes.**						

Course Outcomes	
CO 1	**Student will understand the basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.**
CO 2	**Student will also be familiar with concepts of energy release, reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.**
CO 3	**Student will also be familiar with Time dependent (transient) behavior of power reactor in non-steady state operation and the means to control the reactor & types of nuclear reactors.**
CO 4	**Student will also be familiar with concepts of heat removal from reactor core, reactor safety and radiation protection. Applications of radio-isotopes.**

UNIT-I

Concepts of Nuclear Physics: The atom, structure, the nucleus, nuclear structure, atomic transmutation of elements, detection of radio-activity, particle accelerator, decay, natural of elements, nucleus interactions, decay rates, half-life, transuranic elements, Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding.

Neutron transport and diffusion: Neutron transport equation, diffusion theory approximation, Fick's law, solutions to diffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutron slowing down.

UNIT-II

Energy Release: Mass energy equivalence, mass defect, binding energy, energy release in fission & fusion, thermonuclear reaction, fusion bomb.

Multi-group, multi-region diffusion equation, concept of criticality: Solution of multigroup diffusion equations in one region and multi-region reactors, concept of criticality of thermal reactors, Reactor Materials Fissile & fertile materials, cladding & shielding materials, moderators, coolants.

UNIT-III

Reactor kinetics and control: Basic principles, fuel assembly, Neutron balance, Reactor kinetics, Derivation of point kinetics equations, in-hour equation, Solutions for simple cases of reactivity additions, Excess reactivity, Reactivity control, Reactor stability, Fission product poison or Xenon poisoning, Reactivity coefficients, Burnable absorbers.

Nuclear Reactors: Types of nuclear reactors, pressurized water reactors, boiling water reactors, CANDU type reactors, gas cooled & liquid metal cooled reactors, fast breeder reactors.

UNIT-IV

Heat removal from reactor core: Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux, heat balance, production & transfer of heat to the coolant, structural considerations.

Reactor safety, radiation protection: Reactor safety philosophy, defense in depth, units of radioactivity exposure, radiation protection standards, Waste Disposal Hazards, plant site selection, safety measures incorporated in; plant design, accident control, disposal of nuclear waste, Health Physics & Radio-isotopes Radiation: units, hazards, prevention, preparation of radio-isotopes & their use in medicine, agriculture & industry.

Reference/Text Books:

1. M.M. El-Wakel, 'Nuclear Power Engineering". McGraw-Hill Inc., US
2. John R Lamarsh, "Introduction to nuclear engineering", Pearson Publication
3. J.J. Duderstadt, L. J. Hamilton, "Nuclear reactor analysis" Wiley publication

MTTH-110	**CONVECTIVE HEAT TRANSFER**

Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3

Objective	**To impart an in depth knowledge about the fundamentals and applications of the convective heat transfer.**
Course Outcomes	
CO 1	**Students will be able to differentiate between laminar forced convection external and internal flows.**
CO 2	**Students will develop an understanding of boundary layer flow in external and internal natural convection.**
CO 3	**Students will be able to analyze the turbulent boundary layer and duct flows.**
CO 4	**Students will understand the mechanism of phase change and convection in porous media.**

UNIT-I

Fundamental Principles: Continuity, momentum and energy equations, Second law of thermodynamics, Rules of Scale analysis, Concept of Heat line visualization.

Laminar Forced Convection-External Flows: Boundary layer concept, velocity and thermal boundary layers, governing equations, similarity solutions, various wall heating conditions, Flow past a wedge and stagnation flow, blowing and suction, entropy generation minimization, heat lines in laminar boundary layer flow.

Laminar Forced Convection-Internal Flows: Fully developed laminar flow, heat transfer to fully developed duct flow, constant heat flux and constant wall temperature, heat transfer to developing flow, heat lines in fully developed duct flow. .

UNIT-II

External Natural Convection: Boundary layer equations, Scale analysis, Low and high Prandtl number fluids, integral solution, similarity solution, uniform heat wall flux, conjugate boundary layers, vertical channel flow, combined natural and forced convection, vertical walls, horizontal walls, inclined walls, horizontal and vertical cylinder, sphere.

Internal Natural Convection: transient heating from side, boundary layer regime, isothermal and constant heat flux side walls, partially divided and triangular enclosures, and enclosures heated from below, inclined enclosures, annular space between horizontal cylinders and concentric spheres.

.UNIT-III

Transition to Turbulence: empirical transition data, scaling laws of transition, buckling of inviscid streams, instability of inviscid flow.

Turbulent Boundary Layer Flow: Boundary layer equations, mixing length model, velocity distribution, heat transfer in boundary layer flow, flow over single cylinder, cross flow over array of cylinders, Natural convection along vertical walls.

Turbulent duct flow: velocity distribution, friction factor and pressure drop, heat transfer coefficient, isothermal wall, uniform wall heating, heat lines in turbulent flow near a wall, optimal channel spacing.

UNIT-IV

Convection with Change of Phase: Condensation, laminar and turbulent film on a vertical surface, film condensation, drop condensation, Boiling, pool boiling regimes, nucleate boiling, film boiling and flow boiling, contact melting and lubrication, melting by natural convection.

Convection in Porous Media: Mass conservation, Darcy and Forchheimer flow models, enclosed porous media heated from side, penetrative convection, enclosed porous media heated from below.

Reference/Text Books:

1. A. Bejan, “Convection Heat Transfer”, Wiley Publications.
2. Louis C. Burmeister, “Convective Heat Transfer”, Wiley Publications.
3. W.M. Kays and M.E. Crawford, “Convective Heat and Mass Transfer”, McGraw Hill.

MTTH-112	COMPUTATIONAL FLUID DYNAMICS

Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	**To familiarize the students with the basic concepts of Computational Fluid Dynamics and problem solving approach using CFD.**						
Course Outcomes							
CO 1	**After completion of the course students will be able to model the basic equations which govern the fluid flow and heat transfer phenomena and analyze their mathematical behaviour.**						
CO 2	**The students will understand the basic concepts of discretization and error analysis. Also develop the understanding of some simple CFD techniques.**						
CO 3	**The students will be able to analyze the steady and unsteady heat conduction & combined conduction diffusion problems using control volume formulation.**						
CO 4	**The students will be able to apply CFD to actual fluid flow problems.**						

UNIT-I

Introduction: Introduction to C.F.D., comparison of the three basic approaches in engineering problem solving-analytical, experimental and computational; models of the flow, substantial derivative, governing equations – continuity equation, momentum equation, energy equation, Navier-Stokes equation; physical boundary conditions.

Mathematical behavior of governing equations: classification of quasi linear partial differential equations, general method of determining the classification of partial differential equations, general behavior of hyperbolic, parabolic, elliptic equations.

UNIT-II

Discretization: Introduction, finite difference method, difference equations, explicit and implicit approaches, error and stability analysis, Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance.

UNIT-III

Heat Conduction: control volume formulation of one-dimensional steady state diffusion, unsteady one-dimensional diffusion, two and three dimensional diffusion problems, over and under relaxation.

Convection & Diffusion: Steady one-dimensional convection and diffusion, central differencing scheme, upwind differencing scheme, exact solution, exponential, hybrid, and power law schemes, discretization equations for two dimensions & three dimensions.

UNIT-IV

Simple CFD Techniques: Lax-Wendroff technique, MacCormack's technique, space marching, relaxation technique, pressure correction technique, SIMPLE algorithm.

Fluid Flow: CFD solution of subsonic-supersonic isentropic nozzle flow, solution of incompressible Couette flow problem by F.D.M., solution of Navier-Stokes equations for incompressible flows using MAC and SIMPLE methods.

Reference/Text Books:

1. Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press (Reprint 2017).
2. John D.Anderson, Jr, "Computational fluid dynamics", McGraw Hill Education, 1 July, 2017.
3. H. Versteeg & W. Malalasekra, "An Introduction to Computational Fluid Dynamics", Pearson; 2 edition (2008).
4. Atul Sharma, "An Introduction to CFD: Development, Application & Analysis", Ane/Athena Books, Wiley, November, 2016.
5. K. Muralidhar & T. Sundararajan, "Computational Fluid Flow & Heat Transfer", Alpha Science Intl Ltd.
6. Anil W. Date, "Introduction to Computational fluid dynamics" Cambridge University Press, August, 2005.
7. J.C. Tannehill, D. A. Anderson and R.H. Pletcher, "Computational Fluid Dynamics", CRC Press; 3rd edition (April 15, 2011).
8. J. Blazek, "Computational Fluid Dynamics: Principles and Applications", Elsevier Science & Technology, 2001.
9. T.J. Chung, "Computational Fluid Dynamics", Cambridge University Press (7 February 2002).

MTTH-114	DESIGN OF HEAT TRANSFER EQUIPMENTS

Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	**To familiarize the students with different types of heat exchangers used in industries and their design parameters.**						
Course Outcomes							
CO 1	**Students will demonstrate a basic understanding of several types of heat exchangers that will include shell-and-tube, double pipe, plate-and-frame, finned tube, and plate-fin heat exchangers, Heat pipes.**						
CO 2	**Students will design and analyses of shell-and-tube double pipe, compact, plate heat exchangers.**						
CO 3	**Students will demonstrate the performance degradation of heat exchangers subject to fouling.**						

Unit-I

Heat Exchangers – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger.

Heat exchanger design methodology- assumption for heat transfer analysis, problem formulation, e-NTU method, *P*-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling.

Unit-II

Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop.

Compact Heat Exchangers: Thermal and Hydraulic design of compact heat exchanger Shell and Tube heat exchangers – Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers.

Unit-III

Heat Exchanger Pressure Drop Analysis: Importance of Pressure Drop, Devices, Extended Surface Heat Exchanger Pressure Drop, Tubular Heat Exchanger Pressure Drop, Tube Banks, Shell-and-Tube Exchangers, Plate Heat Exchanger Pressure Drop, Pipe Losses, Non-dimensional Presentation of Pressure Drop Data

Heat Transfer Characteristics: Dimensionless Surface Characteristics, Experimental Techniques for Determining Surface Characteristics, Steady-State Kays and London Technique, Wilson Plot Technique, Transient Test Techniques, Friction Factor Determination, Hydrodynamic ally Developing Flows, Thermally Developing Flows, Extended Reynolds Analogy, Heat Exchanger Surface Geometrical Characteristics, Selection of Heat Exchangers and Their Components, Temperature Difference Distributions

Unit-IV

Mechanical Design of Heat Exchangers – Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

Hair-Pin Heat Exchangers: Introduction to Counter-flow Double-pipe or Hair-Pin heat exchangers, Industrial versions of the same, Film coefficients in tubes and annuli, Pressure drop, Augmentation of performance of hair-pin heat exchangers, Series and Series-Parallel arrangements of hair-pin heat exchangers, Comprehensive Design Algorithm for hair-pin heat exchangers, Numerical Problems.

Reference/Text Books:

1. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley & sons Inc., 2003.
2. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
3. Sadik Kakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
4. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
5. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book".
6. T. Kuppan, "Hand Book of Heat Exchanger Design".
7. "T.E.M.A. Standard", New York, 1999.
8. G. Walkers, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

MTTH-116	COMPRESSIBLE FLOW MACHINES						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	Students can able to understand the various fluid devices like turbine, compressors, pumps etc. Also to understand the concepts of shock waves and their properties.						
Course Outcomes							
CO 1	Enable the students to understand the basic concepts of fluid machines. Also to learn the concepts of various turbines along with their general equations of power developed.						
CO 2	Students will able to understand the various types of pumps along with their advantages, disadvantages and applications.						
CO 3	Students will study the various compressors and diffusers. Also to learn the various terms and parts related to these devices.						
CO 4	Enable the students to understand the basic concepts of shock waves. Also to learn the various types of shock waves through various equations.						
CO 5	Enable the students to understand the basic concepts of fluid machines. Also to learn the concepts of various turbines along with their general equations of power developed.						

UNIT-I

Introduction*:* Introduction to Fluid Machines, Energy Transfer in Fluid Machines, Energy Transfer-impulse and Reaction Machines, efficiencies of Fluid Machines, Principles of Similarity in Fluid Machines, Concept of Specific Speed and introduction to Impulse Hydraulic Turbine.

Turbines: Analysis of Force on the Bucket of Pelton wheel and Power Generation, Specific Speed, Governing and Limitation of a Pelton Turbine, Introduction to reaction Type of Hydraulic Turbine- A Francis Turbine, Analysis of Force on Francis Runner and Power Generation, Axial Flow machine and Draft Tube, Governing of Reaction Turbine.

UNIT-II

Pumps: Introduction to Rotodynamic Pumps, Flow and Energy Transfer in a Centrifugal Pump, Characteristics of a Centrifugal Pump, Matching of Pump and System Characteristics, Diffuser and Cavitation, Axial Flow Pump, Reciprocating Pump.

UNIT-III

Compressors: Centrifugal and Axial Flow Compressor, their characteristics.

Flow through Diffusers: Classification of diffusers, internal compression subsonic diffusers, velocity gradient, effect of friction and area change, the conical internal-compression Subsonic diffusers, external compression subsonic diffusers, supersonic diffusers, Normal shock supersonic diffusers, the converging diverging supersonic diffusers.

UNIT-IV

Shock wave: Introduction to Compressible Flow, Thermodynamic Relations and Speed of Sound, Disturbance propagation, Stagnation and Sonic Properties, Effects of Area variation on Properties in an Isentropic Flow, choking in a Converging nozzle, Isentropic Flow Through Convergent-Divergent Duct, Normal Shock, Oblique Shock**,** Introduction to Expansion Wave and Prandtl Meyer Flow**.**

Reference/Text Books:

1. S. M. Yahya, “Fundamentals of Compressible Flow”, New Age International.
2. S.M. Yahya, “Turbines, Compressors and Fans”, Tata McGraw Hill.
3. P.H. Oosthvizen and W.E. Carscallen, “Compressible Fluid Flow”, McGraw Hill.

MTTH-201	ADVANCED COMPUTATIONAL FLUID DYNAMICS

Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3

Objective	**To familiarize the students with the advanced concepts of Computational Fluid Dynamics.**
	Course Outcomes
CO 1	**Develop the understanding of the modeling of turbulence and its effects.**
CO 2	**Analyze the convection diffusion problems and develop algorithms for pressure velocity coupling in steady flows and unsteady flows.**
CO 3	**Develop skills to implement and handle boundary conditions; errors and uncertainty; and complex geometries.**
CO 4	**Able to model the combustion phenomenon and radiative heat transfer using CFD.**

UNIT-I

Introduction: Revision of pre-requisite courses, finite differences and finite volume methods.

Turbulence and its modeling: transition from laminar to turbulent flow, descriptors of turbulent flow, characteristics of turbulent flow, effect of turbulent fluctuations on mean flow, turbulent flow calculations, turbulence modeling, Large eddy simulation, Direct Numerical Simulation.

UNIT-II

Finite volume method for convection-diffusion problems: Steady 1-D convection-diffusion, Conservativeness, Boundedness and Transportiveness, Central, Upwind, Hybrid and Power law schemes, QUICK and TVD schemes.

Pressure - velocity coupling in steady flows: Staggered grid, SIMPLE algorithm, Assembly of a complete method, SIMPLER, SIMPLEC and PISO algorithms, Worked examples of the above algorithms.

Finite volume method for unsteady flows: 1-D unsteady heat conduction, Explicit, Crank-Nicolson and fully implicit schemes, Transient problems with QUICK, SIMPLE schemes.

.UNIT-III

Implementation of boundary conditions: Inlet, Outlet, and Wall boundary conditions, Pressure boundary condition, Cyclic or Symmetric boundary condition.

Errors and uncertainty in CFD modeling: Errors and uncertainty in CFD, Numerical errors, Input uncertainty, Physical model uncertainty, Verification and validation, Guide lines for best practices in CFD, Reporting and documentation of CFD results.

Methods for Dealing with complex geometries: Introduction, body-fitted co-ordinate grids, curvilinear grids, block structured and unstructured grids, discretization in unstructured grids, diffusion and convective term, treatment of source term, assembly of discretized equations, pressure-velocity coupling, extension of face velocity interpolation method to unstructured meshes.

UNIT-IV

CFD modeling of combustion: Enthalpy of formation, Stoichiometry, Equivalence ratio, Adiabatic flame temperature, Equilibrium and dissociation, governing equations of combusting flows, modeling of a laminar diffusion flame, SCRC model for turbulent combustion, probability density function approach, eddy break up model.

CFD for radiation heat transfer: Governing equations for radiation heat transfer, popular radiation calculation techniques using CFD, The Monte Carlo method, the discrete transfer method, Ray tracing, the discrete ordinates method.

Reference/Text Books:

1. H. Versteeg & W. Malalasekra, “An Introduction to Computational Fluid Dynamics”, Pearson; 2 edition (2008)
2. Suhas V. Patankar, “Numerical Heat Transfer and Fluid Flow”, CRC Press (Reprint 2017).
3. J.C. Tannehill, D. A. Anderson and R.H. Pletcher, “Computational Fluid Dynamics”, CRC Press; 3rd edition (April 15, 2011).
4. J. Blazek, “Computational Fluid Dynamics: Principles and Applications”, Elsevier Science & Technology, 2001.
5. T.J. Chung, “Computational Fluid Dynamics”, Cambridge University Press (7 February 2002).

MTTH-203	FINITE ELEMENT METHODS						
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Total**	**Time (Hrs.)**
3	**-**	**-**	**3**	**60**	**40**	**100**	**3**
Objective	**To acquaint the students with fundamentals and various methods for solving the finite element problems. Also FDM, convergence and stability of FD scheme.**						
Course Outcomes							
CO 1	**Students will be able to understand the basic steps in FEM formulation. Also to study various concepts associated and assembly along with the boundary conditions in FEM formulation.**						
CO 2	**Students will be able to understand how FEM problem is formulated in 1-D elements. Also to discuss shape functions, h and p approximations; and various solvers associated in FEM.**						
CO 3	**Students will study FEM formulation of 2-D element using various methods like Galerkin approach, Weighted Residual etc. Also to understand the natural co-ordinates, numerical integration and various other concepts related to 2-D FEM formulation.**						
CO 4	**Students will be able to understand the axi-symmetric problems along with plane stress and plane strain problems with regards to solid mechanics. Also to discuss various elements of FEM, FEM with CI continuity and FDM problems.**						

UNIT-I

Basic Steps in FEM Formulation, General Applicability of the Method; Variational Functional, Ritz Method. Variational FEM: Derivation of Elemental Equations, Assembly, Imposition of Boundary Conditions, Solution of the Equations.

UNIT-II

1-D Elements, Basis Functions and Shape Functions, Convergence Criteria, h and p Approximations. Natural Coordinates, Numerical Integration, Gauss Elimination based Solvers. Computer implementation: Pre-processor, Processor, Post-processor.

UNIT-III

Alternate Formulation: Weighted Residual Method, Galerkin Method; Problems with C1 Continuity: Beam Bending, Connectivity and Assembly of C1 Continuity Elements. Variational Functional; 2-D Elements (Triangles and Quadrilaterals) and Shape Functions. Natural Coordinates, Numerical Integration, Elemental Equations, .Connectivity and Assembly, Imposition of Boundary Conditions.

UNIT-IV

Axisymmetric (Heat Conduction) Problem, Plane Strain and Plane Stress Solid Mechanics Problems. Sub-parametric, Iso-parametric and Super-parametric Elements; Elements with C1 Continuity. Free Vibration Problems, Formulation of Eigen Value Problem, FEM Formulation. Time-dependent Problems, Combination of Galerkin FEM and FDM (Finite Difference Method), Convergence and Stability of FD Scheme.

Reference/Text Books:

1. C. S. Krishnamoorty, “Finite element analysis”, Tata McGraw Hill
2. J. N Reddy, “An introduction to Finite element method”, Tata Mc. Graw Hill
3. Y. M. Desai, “Finite Element Method with applications in engineering”, Pearson Education India
4. Ted Belytschko, W.K. Liu and Brian Moran, “Nonlinear Finite Elements for Continua and Structures (Paperback)” Wiley-Blackwell (16 August 2000)
5. Guido Dhondt, “The Finite Element Method for Three-Dimensional Thermomechanical Applications”, Wiley; 1 edition (June 18, 2004).

6. Claes Johnson, "Numerical Solution of Partial Differential Equations by the Finite Element Method", Dover Publications (January 15, 2009).

MTTH-205	THERMAL MODELING AND ANALYSIS						
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Total	Time (Hrs.)
3	-	-	3	60	40	100	3
Objective	This course provides the mathematical modelling and analysis for designing the thermal systems. Also students can able to understand the dynamic behaviour of thermal systems.						
Course Outcomes							
CO 1	Enable the students to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						
CO 2	Equip the students for modelling the thermal systems like heat exchangers, evaporators, condensers etc. Also to understand their solution procedures.						
CO 3	Understand the concepts of optimization and its various methods for solving the thermal problems. Also to study geometric, linear and dynamic programming.						
CO 4	Learn the dynamic behaviour of thermal systems. Also to learn stability analysis and non-linearity.						
CO 5	Enable the students to understand the basic concepts for designing the thermal systems. Also to discuss mathematical modelling of thermal systems using computer programmes.						

UNIT-I

Design of Thermal System: Design Principles, Workable systems, Optimal systems, Matching of system components, Economic analysis, Depreciation, Gradient present worth factor.

Mathematical Modeling: Equation fitting, Empirical equation, Regression analysis, Different modes of mathematical models, Selection, Computer programmes for models.

UNIT-II

Modeling Thermal Equipments: Modeling heat exchangers, Evaporators, Condensers, Absorption and rectification columns, Compressor, Pumps, Simulation studies, Information flow diagram, Solution procedures.

UNIT-III

Systems Optimization: Objective function formulation, Constraint equations, Mathematical formulation, Calculus method, Dynamic programming, Geometric programming, Linear programming methods, Solution procedures.

UNIT-IV

Dynamic Behavior of Thermal System: Steady state simulation, Laplace transformation, Feedback control loops, Stability analysis, Non-linearties

Reference/Text Books:.

1. Hodge, B.K. and Taylor, R. P., "Analysis and Design of Energy Systems", Prentice Hall (1999).
2. Bejan, A., Tsatsaronis, G. and Michel, M., "Thermal Design and Optimization", John Wiley and Sons (1996).
3. Jaluria, Y., "Design and Optimization of Thermal Systems", McGraw-Hill (1998).
4. Jaluria, Y., "Design and Optimization of Thermal Systems", CRC Press (2008).
5. Ishigai S., "Steam Power Engineering Thermal and Hydraulic Design Principle", Cambridge University Press (1999).

MTOE-201	Business Analytics						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	60	40	100	3 Hrs.
Program Objective (PO)	The main objective of this course is to give the student a comprehensive understanding of business analytics methods.						
Course Outcomes (CO)							
CO1	*Able to have knowledge of various business analysis techniques.*						
CO2	*Learn the requirement specification and transforming the requirement into different models.*						
CO3	*Learn the requirement representation and managing requirement assests.*						
CO4	*Learn the Recent Trends in Embedded and collaborative business*						

Unit 1

Business Analysis: Overview of Business Analysis, Overview of Requirements, Role of the Business Analyst.
Stakeholders: the project team, management, and the front line, Handling, Stakeholder Conflicts.
Life Cycles: Systems Development Life Cycles, Project Life Cycles, Product Life Cycles, Requirement Life Cycles.

Unit 2

Forming Requirements: Overview of Requirements Attributes of Good Requirements, Types of Requirements, Requirement Sources, Gathering Requirements from Stakeholders, Common Requirements Documents.
Transforming Requirements: Stakeholder Needs Analysis, Decomposition Analysis, Additive/Subtractive Analysis, Gap Analysis, Notations (UML & BPMN), Flowcharts, Swim Lane Flowcharts, Entity-Relationship Diagrams, State-Transition Diagrams, Data Flow Diagrams, Use Case Modeling, Business Process Modeling

Unit 3

Finalizing Requirements: Presenting Requirements, Socializing Requirements and Gaining Acceptance, Prioritizing Requirements.
Managing Requirements Assets: Change Control, Requirements Tools

Unit 4

Recent Trends in: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data Journalism.

References:

1. Business Analysis by James Cadle et al.
2. Project Management: The Managerial Process by Erik Larson and, Clifford Gray

MTOE-203	Industrial Safety						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	60	40	100	3 Hrs.
Program Objective (PO)	*To enable students to aware about the industrial safety.*						
Course Outcomes (CO)							
CO1	*Understand the industrial safety.*						
CO2	*Analyze fundamental of maintenance engineering.*						
CO3	*Understand the wear and corrosion and fault tracing.*						
CO4	*Understanding that when to do periodic inceptions and apply the preventing maintenance.*						

Unit-1

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, washrooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

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-2

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

Unit-3

Fault tracing: 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-4

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:

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

MTOE-205	Operations Research						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**0**	**0**	**3**	**60**	**40**	**100**	**3 Hrs.**
Program Objective (PO)	To enable students to aware about the dynamic programming to solve problems of discreet and continuous variables and model the real world problem and simulate it.						
Course Outcomes (CO)							
CO1	*Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.*						
CO2	*Students should able to apply the concept of non-linear programming*						
CO3	*Students should able to carry out sensitivity analysis*						
CO4	*Student should able to model the real world problem and simulate it.*						

Unit -1

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

Unit -2

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

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit- 3

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

Unit -4

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

References:

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 India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

MTOE-207	Cost Management of Engineering Projects						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	60	40	100	3 Hrs.
Program Objective (PO)	*To enable students to make aware about the cost management for the engineering project and apply cost models the real world projects.*						
Course Outcomes (CO)							
CO1	*Students should able to learn the strategic cost management process.*						
CO2	*Students should able to types of project and project team types*						
CO3	*Students should able to carry out Cost Behavior and Profit Planning analysis.*						
CO4	*Student should able to learn the quantitative techniques for cost management.*						

Unit-1

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-2

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-3

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. 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-4

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

References:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
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.

MTOE-209	Composite Materials						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	60	40	100	3 Hrs.
Program Objective (PO)	*To enable students to aware about the composite materials and their properties.*						
Course Outcomes (CO)							
CO1	*Students should able to learn the Classification and characteristics of Composite materials.*						
CO2	*Students should able reinforcements Composite materials.*						
CO3	*Students should able to carry out the preparation of compounds.*						
CO4	*Student should able to do the analysis of the composite materials.*						

UNIT–1:

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.
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. Iso-strain and Iso-stress conditions.

UNIT – 2

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–3

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 – 4

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal 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.
3. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

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.

MTOE-211	Waste to Energy						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	60	40	100	3 Hrs.
Program Objective (PO)	*To enable students to aware about the generation of energy from the waste.*						
Course Outcomes (CO)							
CO1	*Students should able to learn the Classification of waste as a fuel.*						
CO2	*Students should able to learn the Manufacture of charcoal.*						
CO3	*Students should able to carry out the designing of gasifiers and biomass stoves.*						
CO4	*Student should able to learn the Biogas plant technology.*						

Unit-1

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

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

Unit-2

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-3

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-4

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.

References:

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.

MTAD-101	English For Research Paper Writing						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	0	0	0	-	100	100	3 Hrs.
Program Objective (PO)	*Student will able to understand the basic rules of research paper writing.*						
Course Outcomes (CO)							
CO1	*Understand that how to improve your writing skills and level of readability*						
CO2	*Learn about what to write in each section*						
CO3	*Understand the skills needed when writing a Title*						
CO4	*Ensure the good quality of paper at very first-time submission*						

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 Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit 3

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check. 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 4

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 Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission.

References:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
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

MTAD-103	Disaster Management						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	*Develop an understanding of disaster risk reduction and management*						
Course Outcomes (CO)							
CO1	*Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.*						
CO2	*Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.*						
CO3	*Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.*						
CO4	*critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in*						

Unit 1

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

Unit 2

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 3

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 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 4

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

References:

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

MTAD-105	Sanskrit for Technical Knowledge						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	*Students will be able to Understanding basic Sanskrit language and Ancient Sanskrit literature about science & technology can be understood and Being a logical language will help to develop logic in students*						
Course Outcomes (CO)							
CO1	*To get a working knowledge in illustrious Sanskrit, the scientific language in the world*						
CO2	*Learning of Sanskrit to improve brain functioning*						
CO3	*Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power*						
CO4	*The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature*						

Unit –1

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

Unit – 2

Order, Introduction of roots,Technical information about Sanskrit Literature

Unit –3

Technical concepts of Engineering: Electrical, Mechanical

Unit –4

Technical concepts of Engineering: Architecture, Mathematics

References

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

MTAD-107	Value Education						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	*Understand value of education and self- development, Imbibe good values in students and Let the should know about the importance of character*						
Course Outcomes (CO)							
CO1	*Knowledge of self-development*						
CO2	*Learn the importance of Human values*						
CO3	*Developing the overall personality*						
CO4	*Know about the importance of character*						

Unit 1

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 2

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 3

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 4

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

References

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

MTAD-102	Constitution of India						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	*Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and 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.*						
Course Outcomes (CO)							
CO1	*Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.*						
CO2	*Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.*						
CO3	*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.*						
CO4	*Discuss the passage of the Hindu Code Bill of 1956.*						

Unit I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features

Unit 2

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.

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 3

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

Unit 4

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.

References

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

MTAD-104	Pedagogy Studies						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	*Review existing evidence on the review topic to inform programme design and policy making undertaken by the DFID, other agencies and researchers and Identify critical evidence gaps to guide the development.*						
Course Outcomes (CO)							
CO1	*What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?*						
CO2	*What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?*						
CO3	*How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?*						
CO4	*What is the importance of identifying research gaps?*						

Unit 1

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

Unit 2

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 3

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

Unit 4

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

References

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.

MTAD-106	Stress Management by Yoga						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	To achieve overall health of body and mind and to overcome stress						
Course Outcomes (CO)							
CO1	*Develop healthy mind in a healthy body thus improving social health.*						
CO2	*Improve efficiency*						
CO3	*Learn the Yog asan*						
CO4	*Learn the pranayama*						

Unit – 1

Definitions of Eight parts of yog (Ashtanga).

Unit- 2

Yam and Niyam, Do`s and Don't's in life; Ahinsa, satya, astheya, bramhacharya and aparigraha; Shaucha, santosh, tapa, swadhyay, ishwarpranidhan.

Unit- 3

Asan and Pranayam, Various yog poses and their benefits for mind & body,

Unit- 4

Regularization of breathing techniques and its effects-Types of pranayam.

References

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

MTAD-108	Personality Development through Life Enlightenment Skills						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	**0**	**0**	**0**	**-**	**100**	**100**	**3 Hrs.**
Program Objective (PO)	To learn to achieve the highest goal happily To become a person with stable mind, pleasing personality and determination To awaken wisdom in students						
Course Outcomes (CO)							
CO1	*Students become aware about leadership.*						
CO2	*Students will learn how to perform his/her duties in day to day work.*						
CO3	*Understand the team building and conflict*						
CO4	*Student will learn how to become role model for the society.*						

Unit – 1

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 (don's); Verses: 71, 73, 75, 78 (do's).

Unit – 2

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 - 3

Statements of basic knowledge; Shrimad Bhagwad Geeta: Chapter-2: Verses: 56, 62, 68; Chapter-12: Verses: 13, 14, 15, 16, 17, 18.

Unit – 4

Personality of Role model; Shrimad Bhagwad Geeta: Chapter-2: Verses: 17; Chapter-3: Verses: 36, 37, 42: Chapter-4: Verses: 18, 38, 39; Chapter-18: Verses: 37, 38, 63.

References:

1. Srimad Bhagavad Gita, Swami Swarupananda Advaita Ashram (Publication Department), Kolkata.
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya), P. Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.

MTTH-207	DISSERTATION PART – I							
Lecture	**Tutorial**	**Practical**	**Credits**	**Major Test**	**Minor Test**	**Practical Marks**	**Total**	**Time (Hrs.)**
0	**0**	**20**	**10**	**-**	**100**	**-**	**100**	**-**
Objective	The main objective of this course is to plan a research work (which includes the problem formulation/literature review, proposed objectives, proposed methodologies and references) in the field of Industrial and Production Engineering or interrelated fields of applications.							
Course Outcomes								
CO 1	Students will be exposed to various self-learning topics.							
CO 2	Students will be exposed to an exhaustive survey of the literature such as books, national/international refereed journals, resource persons and industrial surveys for the selection/ identification of engineering/research problem.							
CO 3	Students will be able to set the research objectives of the identified engineering/research problem.							
CO 4	Students will learn modern tools/techniques related to the identified engineering/research problem for the solution and able to learn technical report writing skills.							
CO 5	Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience.							

The students will start their research work in third semester with a research problem having research potential involving scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution.

The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his/her supervisor and the topic of dissertation must be mutually decided by the supervisor and student.

The students will be required to submit a progress report related to their dissertation work by the end of September. The progress report will cover the following:

- The goal set for the period.
- Research papers studied.
- Methodology used in achieving the goal.
- The extent of fulfillment of the goal.

The progress report must be at least of 3-4 pages and the cover page should include the tentative topic, name of the candidate, name of the supervisor, period of progress report, signature of candidate and supervisor.

The students will be required to appear for comprehensive Seminar & Viva-voce and submit a synopsis report based on their progress related to the dissertation as per the presentation date mentioned in the academic calendar for the session. The synopsis report will be submitted in the same format as that of the thesis and will contain the following:

1. Introduction
2. Literature Survey
3. Gaps in Literature
4. Objectives of the Proposed Work
5. Methodology
6. References

*** Student will choose (be offered) his/her guide in the end of second semester.**

MTTH-202	DISSERTATION PART -II							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical	Total	Time (Hrs.)
0	0	32	16	-	100	200	300	-
Objective	The main objective of the course is to make the students able to do some good research in the field of their interests related to Industrial and Production Engineering or interrelated fields of applications.							
Course Outcomes								
CO 1	Students will be able to design solutions for engineering problems that meet the specified needs with appropriate considerations.							
CO 2	Students will be able to conduct investigations of engineering problems using research-based knowledge and experimental/research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.							
CO 3	Students will be able to apply resources and modern engineering tools and techniques with an understanding of the limitations.							
CO 4	Students will be able to either work in a research environment or in an industrial environment.							
CO 5	Students will be conversant with technical report writing, professional ethics, responsibilities and norms of the engineering practice.							
CO 6	Students will be able to present and convince their topic of study to the engineering community.							

The students are required to continue Analytical/Experimental/Computational/Industrial Problems or Case studies investigations in the field of Industrial and Production Engineering or other related fields which have been finalized in the third semester. They would be working under the supervision of a faculty member.

The students will be required to submit a progress report duly signed by their respective supervisors to the department, related to their dissertation work in the last week of March. The progress report will cover the following:

- The goal set for the period.
- Research papers studied.
- Methodology used in achieving the goal.
- The extent of fulfillment of the goal.
- References

The progress report must be of at least of 3-4 pages and the cover page should include the tentative topic, name of the candidate, name of the supervisor, period of progress report, signature of candidate and supervisor.

The candidate has to prepare a detailed dissertation report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up/numerical details/industrial case study etc. as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study.

The final dissertation will be submitted in the end of semester as per academic calendar for the session, which will be evaluated by internal as well as external examiners based upon his/her research work. At least one publication is expected before final submission of the dissertation from every student in peer reviewed referred journals or reputed conference from the work done by them in their dissertation. The dissertation should be presented in standard format as provided by the department.

The work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a supervisor, co- supervisor etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his supervisor.