MECHANICAL ENGINEERING

PG PROGRAM: M.TECH- MECHANICAL

CURRICULUM STRUCTURE

REVISION: YEAR 2011

M Tech (Mechanical Engineering)
Specialization: Thermal Engineering
Semester I

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	OEC-I	Mathematics	3	0	0	3
2.	PCC-I	Fluid Dynamics	3	0	0	3
3.	PCC-II	Advanced Heat Transfer	3	0	0	3
4.	PCC-III	Thermodynamics and Combustion	3	0	0	3
5.	Program Specific Elective-I	A. Refrigeration and Cryogenics B. Fundamentals of Gas Dynamics	3	0	0	3
6.	LC	Seminar	0	0	3	2
7.	PGL	Thermal Engineering Lab Practice - I	0	0	6	3
		Total	**15**	**0**	**9**	**20**

Semester II

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	OEC-II	Open Elective /Science Elective/Humanities	3	0	0	3
2.	PCC-I	Design of Heat Exchangers	3	0	0	3
3.	PCC-II	Computational Fluid Dynamics	3	0	0	3
4.	Program Specific Elective-II	A. Mathematical Modeling of IC Engines B. Energy Conservation and Management C. Microfluidics D. Environmental Pollution and Control	3	0	0	3
5.	Program Specific Elective-III	A. Air Conditioning System Design B. Gas Turbines C. Two phase flow D. Non Conventional Energy Sources	3	0	0	3
6.	MLC	Intellectual Property Rights	1	0	0	1
7.	PGL	Thermal Engineering Lab Practice - II	0	0	8	4
		Total	**16**	**0**	**8**	**20**

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	MLC	Environmental Studies	2	0	0	2
2.	MLC	Constitution of India	2	0	0	2
3.	PS-I	Project Work	0	0	0	16
		Total	**4**	**0**	**0**	**20**

Semester-IV

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	PS-II	Project Work	0	0	0	20
		Total	**0**	**0**	**0**	**20**

M Tech (Mechanical Engineering)
Specialization: Thermal Engineering
Semester I

Course Name: Engineering Mathematics **Course Code: OEC 1**

Boundary Value Problems and Applications: Linear second order partial differential equation in two independent variables – Normal forms hyperbolic, parabolic and elliptic equations – Cauchy problem.Wave equations – Solution of initial value problem – Significance of characteristic curves. Laplace transform solutions – Displacements in a long string – long string under its weight – a bar with prescribed force on one end – Free vibrations of a string.
Calculus of Variations: Concepts of functionals and their stationary values – Euler's equation and solution for the problem and for more general cases – Natural boundary conditions – Variational problems with moving boundaries – Conditional variational problems – Isoparametric problems. Direct Methods: Ritz, Kantorovich and Galerkin techniques.
Eigen Value Problems: Standard Eigen value problems – properties of Eigen values and Eigen vectors – Generalized Eigen value problems – strum sequence – Jacobi, Givens and House holder transformations.
Numerical Methods: Forward and inverse iteration schemes – Graham Schmidt deflation – Simultaneous iteration method – Subspace iteration – Lanczo's algorithm – Estimation of core and time requirements.
Computer Methods in Mechanical Engineering: Applications of digital computers to solutions of problems in mechanical engineering, matrices, roots of equations, solution of simultaneous equations, curve fitting by least squares, differential and integration, differential and partial differential equations.
Statistical Techniques and Design of Experiments:
The scientific method. - The phases of an experiment. - Specifying the problem and the hypotheses - Experimental designs - Analyses of experiments - Statistical inference Hypothesis testing. - The Z-test, the T-test, the X2-test, and the F-test. Sample size.
Design Optimization Techniques. Methods of numerical optimization techniques applied to engineering design. Methods for optimization of both single and multiple variable functions, constrained, and unconstrained. Real-world problems as examples and student projects.
Multi-Disciplinary Design Optimization. Methods of numerical optimization techniques applied to engineering design. Statistical design optimization methodologies utilizing design of experiments and meta-modeling techniques. Multi-criteria formulations and multidisciplinary design optimization (MDG) frameworks. Real-world problems as examples and student projects.

References

1. Jennings. A., Matrix Computation for Engineers and Scientists., John Wiley and Sons, 1992.
2. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press, 2002
3. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
4. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987.
5. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
6. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks-Cole (1999).

Course Name: Fluid Dynamics **Course code: (PCC 1)**

Fluid kinematics: Fluid properties, Description of Fluid Motion- Lagrangian method, Eulerian method. steady and unsteady flows, uniform and non-uniform flows. Material Derivative and Acceleration, Streamlines, path lines and streak lines. one-, two-, and three-dimensional flows. Translation, Rate of deformation and Rotation, Vorticity, Generalized Expression of the Movement of a Fluid Element.

Conservation equations and analysis of finite control volume: continuity equation-differential form, Stream function, continuity equation-Integral form, momentum theorem, Reynolds Transport Theorem, application of Reynolds Transport Theorem to conservation of Mass and Momentum, analysis of finite control volume.

Flow of ideal fluids: A Control Volume approach for the derivation of Euler's Equation, Euler's equation along a streamline, Potential function, Bernoulli's Equation, Uniform flow, Source or sink flow, Vortex flow.

Viscous incompressible flows: General viscosity law, Derivation of Navier-Stokes Equation, Exact solutions of Navier-Stokes Equation, parallel flow in a straight channel, Couette flow, Hagen Poiseuille flow.

Boundary Layer theory: Laminar Boundary layer theory, Prandlt boundary layer equation Blasius flow over a flat plate, boundary layer thickness, displacement thickness and momentum thickness.

Compressible flows: Thermodynamic relations of perfect gases, speed of sound, Stagnation and Sonic Properties. Isentropic flow through convergent, convergent–divergent nozzles, Normal Shocks, Oblique Shock.

Reference Books:

1. Streeter V.L., Wylie E.B., Bedford K.W "Fluid Mechanics", McGraw Hill, 1998.
2. Fox R.W., McDonald A.T "Introduction to Fluid Mechanics", John Wiley and Sons Inc, 1985.
3. White F.M "Fluid Mechanics", McGraw Hill.
4. Shames I.H "Mechanics of Fluids", McGraw Hill, 2003.
5. Anderson John D.J "Computational Fluid Dynamics" The basics with Applications, McGraw Hill.
6. Bird R.B., Stewart W.F., Lightfoot E.N. "Transport Phenomena", John Wiley & Sons, 1960.
7. Som S. K. and Biswas G, "Introduction to Fluid Mechanics and Fluid Machines", Tata McGraw Hill, 2008,

Course Name: Advanced Heat Transfer **Course code: (PCC 2)**

Conduction- one and two dimensional, Fins, conduction with heat source, unsteady state heat transfer, Natural and forced convection, integral equation, analysis and analogies, Transpiration cooling, ablation heat transfer, boiling, condensation and two phase flow mass transfer, cooling, fluidized bed combustion, heat pipes, Radiation, shape factor, analogy, shields, radiation of gases & vapors.

Reference Books

1. J.P. Holman, "Heat Transfer", McGraw Hill Book Company, New York, 1990.
2. Incropera and Dewitt, "Fundamentals of Heat and Mass Transfer", John Wiley and Sons, New York, 2000.
3. Frank Kreith, "Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
4. Donald Q. Kern "Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
5. Gupta and Prakash, "Engineering Heat Transfer", New Chand and Bros, Roorkee (U.P.) India,

1996.
6. R.C. Sachdeva “Fundamentals of Engineering Heat and Mass Transfer”,Wiley Eastern Ltd., India,

Course Name: Thermodynamics and Combustion Course code: (PCC 3)

First law, Second law, Tds equations, Maxwell relations, Clapeyron equation, pure substances, thermodynamic property relations, thermo-electricity, equations of state, Gas mixtures, Chemical Thermodynamics and Equilibrium, Statistical thermodynamics, statistical interpretations of first and second law, Third law of thermodynamics, Nerst heat theorem.

Reference 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.

Course Name: Refrigeration and Cryogenics Course code: PSE 1A

Introduction, refrigeration applications, nonconventional refrigeration systems, aircraft refrigeration, Vapour compression refrigeration, actual cycle, second law efficiency, multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems. Refrigerants, CFC/HCFC phase-out regulations, Classification of compressors, various compressors used in RAC, Performance, selection as per the requirement. Capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor. Design, selection of evaporators, condensers, system balance, control systems, motor selection, refrigerants, alternative refrigerants, Food preservation, transport, vapor absorption refrigeration, single effect and double effect systems, alternative working fluids, Applications of cryogens, Gas liquefaction systems - Linde-Hampson, Linde dual pressure, Claude cycle. Cryogenic air separation Technology

Reference 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. Jordan & Priester, “Refrigeration and Air-conditioning”.
5. A.R.Trott, “Refrigeration and Air-conditioning”, Butterworths, 2000.
6. J.L.Threlkeld, “Thermal Environmental Engineering”, Prentice Hall, 1970.
7. R.Barron, “Cryogenic systems”, McGraw–Hill Company, New Yourk, 1985.
8. G.G.Hasseldon. “Cryogenic Fundamentals”, Academic Press.
9. Bailey, “Advanced Cryogenics”, Plenum Press, London, 1971.
10. W.F.Stoecker, “Industrial Refrigeration Handbook”, McGraw-Hill, 1998.
11. John A.Corinchock, “Technician’s Guide to Refrigeration systems”, McGraw–Hill.

12. P.C.Koelet, “Industrial Refrigeration: Principles, Design and Applications”, Macmillan, 1992.
13. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.
Graham Walker, “Miniature Refrigerators for Cryogenic Sensors and Cold Electronics”, Clarendon Press, 1989.

Course Name Fundamentals of Gas Dynamics **Course Code: PSE 1B**

Introduction, Cycles, Performance characteristics and improvement, Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics, Turbine construction, Blade materials, manufacturing techniques, blade fixing, problems of high temperature operation, blade cooling, practical air cooled blades Combustion Systems, various fuels and fuel systems, Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation, environmental considerations and applications.

Reference Books

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, “Gas Turbine Theory”, Pearson Education, 2000.
2. V. Ganesan, “Gas Turbines”, Tata McGraw Hill, 2003.
3. S.M.Yahya “Turbines, Compressors and Fans”, Tata McGraw Hill, 1992.
4. Vincent “The theory and design of Gas Turbine and Jet Engines”, McGraw Hill, 1950.
5. W W Bathic, “Fundamentals of Gas Turbines”, John Wiley and Sons.

Course Name: Seminar **Course Code: LC**

The seminar shall consist of the preparation of the report by the candidate on the topic mutually decided by himself and the supervisor. The topic should be a problem in the field of Thermal Engineering and should have the sufficient research orientation. The recent development in the field of the chosen topic needs to be understood by the candidate. The report has to be presented in front of the examiners committee and other faculty members and students of the department. The committee should be set by the PG coordinator and Head, Mechanical Engineering.

Course Name: Thermal Engineering Lab Practice – I **Course Code: PGL1**

The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC) namely Fluid Dynamics, Advanced Heat Transfer and Thermodynamics and Combustion

M Tech (Mechanical Engineering)
Specialization: Thermal Engineering
Semester II

Open Elective Course : Institute level **OEC 1**

The candidate has to select one of the following courses offered at Institite level

Open Elective Courses *To be selected for "Open Elective-I" and "Open Elective-II"* **(This list is dynamic)**	**Offered by**
Engineering Mathematics for Problems Solving	COEP
Mechanics of Composite Materials	COEP
Engine Tribology	COEP
Finite Element Method	COEP
Automotive Electronics	COEP
Industrial Automation	COEP
Industrial Drives	COEP
ERP	COEP
FEM	COEP
Complex Analysis	COEP
Quantum Information Theory	COEP

Course Name : Design of Heat Exchangers **Course Code : PCC 1**

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.

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

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.

Reference Books

1. Ramesh K. 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.

Course Name : Computational Fluid Dynamics **Course Code : PCC 2**

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

Governing Equations: Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.

Finite Volume Method: Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach

Geometry Modeling and Grid Generation: Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

Methodology of CFDHT: Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation

Solution of N-S Equations for Incompressible Flows: Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows

Reference Books

1. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series.
2. Numerical Methods in Fluid Flow & Heat Transfer by Dr. Suhas Patankar.
3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall
4. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication.
5. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication.
6. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

Course Name : Mathematical Modeling of IC Engines **Course Code : PSE 2A**

Fundamentals: Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, approaches of modeling, model building and integration methods, gas exchange through valves, engine and porting geometry, exhaust gas recirculation, valve lift curves.

Thermodynamic Combustion Models of CI Engines: Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function, wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.

Fuel spray behavior: Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls.

Modeling of charging system: Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.

Mathematical models of SI Engines: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly, bearings and valve train etc. friction estimation for warm and warm up engines.

Reference Books

1. Haywood, "I.C. Engines", Mc Graw Hill.
2. Ramos J **(1989)** Internal Combustion Engine Modeling**.** Hemisphere Publishing Company
3. C. D. Rakopoulos and E. G. Giakoumis, "Diesel Engine Transient Operation Principles of Operation and Simulation Analysis", Springer, 2009.
4. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996.
5. P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010
6. Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth-Heinemann, 1999.

Course Name : Energy Conservation and Management Course Code : PSE 2B

The energy market, energy scenario, planning, utilization pattern and future strategy, Importance of energy management. Energy auditing- methodology and analysis, Energy economics, Energy conservation in industries, Cogeneration, Combined heating and power systems, relevant international standards and laws.

Reference Books

1. L.C. Witte, P.S. Schmidt, D.R.Brown, "Industrial Energy Management and Utilization", Hemispherical Publication, 1988.
2. Callaghan "Energy Conservation".
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. R. Loftnen, Van Nostrarid Reinhold C. "Energy Handbook", 1978.
9. TERI Publications.

Course Name : Microfluidics PSE 2C

Introduction to MEMS and microfluidics, Physics at the micrometric scale, Hydrodynamics of microfluidic systems, Diffusion, mixing, and separation in microsystems, Microfluidics and thermal transfers, microfluidic devices

Reference Books

1. Introduction to Micro-fluidics, Patrick Tabling, MIT Cambridge
2. Theoretical Microfluidics, Henrick Burus, Oxford University Press 2008

Course Name : Environnemental Pollution and Control Course Code : PSE 2D

Air Pollution, effects, sampling and control, equipments and systems, control of gaseous contaminants, automotive emission and control, Industrial Air Pollution Water Pollution: pollutants and their effects, waste water treatment Pollution Control and Conservation The legal basis of environmental protection and provision, Noise -sources, measurement and control.

Reference Books

1. M.N. Rao, H.V. Rao, "Air Pollution", Tata McGraw Hill , New Delhi, 1993
2. C.S. Rao, "Environmental Pollution Control Engineering", New Age International Publishers (p) Ltd., 1996.
3. Howard S. Peavy, D.R. Rowe, "Environmental Engineering", McGraw Hill International.
4. DeNevers, "Air Pollution Control Engineering", McGraw Hill companies, 1994.
5. S.P. Mahajan, "Pollution Control in Process Industries", Tata McGraw Hill, 1985.
6. Metcalf and Eddy, "Waste Water Engineering", Tata McGraw Hill

Course Name: Air Conditioning System Design **Course Code: PSE3A**

Air conditioning systems, various air-conditioning processes, enthalpy deviation curve, psychrometry , SHF, dehumidified air quantity, human comfort, indoor air quality, design conditions and load calculations, air distribution, pressure drop, duct design, fans &, blowers, performance & selection, noise control.

Reference Books

1. ASHRAE Handbook.
2. "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.
3. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.
4. Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill,1974.
5. Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London, 1984.
6. Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand Reinhold Co., New York, 1984. 7. Arora C.P., "Refrigeration & Air Conditioning", Tata Mc Graw Hill, 1985.
8. Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
9. Stoecker, "Refrigeration & Air Conditioning", Mc Graw Hill, 1992.
10. Stoecker, "Design of Thermal Systems", Mc Graw Hill, 1992.

Course Name: Gas Turbines **Course Code: PSE3B**

Introduction, Cycles, Performance characteristics and improvement, Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics, Turbine construction, Blade materials, manufacturing techniques, blade fixing, problems of high temperature operation, blade cooling, practical air cooled blades Combustion Systems, various fuels and fuel systems, Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation, environmental considerations and applications.

Reference Books

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, "Gas Turbine Theory", Pearson Education, 2000.
2. V. Ganesan, "Gas Turbines", Tata McGraw Hill, 2003.
3. S.M.Yahya "Turbines, Compressors and Fans", Tata McGraw Hill, 1992.
4. Vincent "The theory and design of Gas Turbine and Jet Engines", McGraw Hill, 1950.
5. W W Bathic, "Fundamentals of Gas Turbines", John Wiley and Sons.

Course Name: Non-conventional Energy Source **Course code: PSE 3C**

Conventional sources of energy, Nuclear, Alternative energy sources, Solar Radiation-estimation, prediction & measurement, Solar energy utilization, Performance of Solar flat plate collectors, concentrating collectors, thermal storage, Wind energy, Direct Energy conversion- PV, MHD, Fuel cells, thermionic, thermoelectric, Biomass, biogas, hydrogen, Geothermal.

Reference Books

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

Course Name: Intellectual Property Rights **Course Code: MLC 1**

Patent as an intellectual property right; Patent act and patent rules; patent for process, product and product and process together; Jurisdiction of patent; Invention as an intellectual property; Patent offices; Submission of application for patent; Patent of addition, granted on convention application, applicants for patent, application for ordinary patent; applicant working in Government; Patentable invention; Term of patent, Procedure to obtain patent in India, Overview of patenting abroad.

Reference Books:

1. Manual of Patent (Practice and Procedure) Patent office, India
2. Patent law, P Narayanan, Eastern Law House Pvt Ltd, Third Edition 1998
3. Terrel on law of patents, Douglas Falconer & William Aldous & David Young

Course Name: Thermal Engineering Lab Practice – II **Course code: PGL 2**

The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC) namely Design of Heat Exchangers and Computational Fluid Dynamics

M Tech (Mechanical Engineering)
Specialization: Thermal Engineering
Semester III

Course Name: Project I **Course Code: PS-I**

Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. 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 guide and the topic of dissertation must be mutually decided by the guide and student.

Course Name: Environmental Studies **Course Code: MLC 2**

To be decided

Course Name: Constitution of India **Course Code: MLC 3**

Preamble of the Constitution, Concept of Federal State, Fundamental Rights, Directive Principles of State, Structure of the Executive, Legislative and Judiciary at Union and State level, Powers and responsibilities of Executive, Legislative and Judiciary at Union and State level, Amendment acts, writ petitions, Schedules of the Constitutions.

References:
Constitution of India, D. D. Basu (publication ….)

M Tech (Mechanical Engineering)
Specialization: Thermal Engineering
Semester III

Course Name: Project II **Course Code: PS 2**

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format as provided by the department. The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details 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 work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and PG coordinator. The candidate has to be in regular contact with his guide.