M. Tech. (Mechanical Engineering) Curriculum Structure
Specialization: Thermal Engineering
(w. e. f. 2015-16)

List of Abbreviations

ILE- Institute level Open Elective Course
PSMC – Program Specific Mathematics Course
PCC- Program Core Course
DEC- Department Elective Course
LLC- Liberal Learning (Self learning) Course
MLC- Mandatory Learning Course (Non-credit course)
LC- Laboratory Course

Semester I

Sr. No.	Course Type/Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	ILE	Steam Engineering [To be offered to other programs]	3	--	--	3
2.	PSMC	Mathematical Methods in Engineering	3	--	--	3
3.	PCC-I	Thermodynamics and Combustion	3	--	--	3
4.	PCC-II	Fluid Dynamics	3	--	--	3
5.	PCC-III	Refrigeration and cryogenics	3	--	--	3
6.	PCC-IV	Advance Heat Transfer	3	--	--	3
7.	LC-I	Thermal Engineering Lab Practice	--	--	4	2
8.	MLC-I	Research Methodology	1	--	--	--
9.	MLC-II	Humanities	1	--	--	--
		Total	**20**	**--**	**4**	**20**

Semester II

Sr. No.	Course Code/Type	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	PCC-V	Design of Heat Exchanger	3		--	3
2.	PCC-VI	Computational Fluid Dynamics	3	--	--	3
3.	PCC-VII	Modelling of IC Engines	3	--	--	3
4.	DEC-I	**Elective – I** a. Nuclear Engineering b. Energy Conservation and Management.	3	--	--	3
5.	DEC-II	**Elective – II** a. Air Conditioning System Design b. Gas Turbines c. Design of Solar and Wind System	3	--	--	3
6.	LC-II	Mini-Project	--	--	4	2
7.	LC-III	Thermal Engineering Lab Practice	--	--	4	2
8	MLC-III	Intellectual Property Rights	1	--	--	--
9.	LLC	Liberal Learning Course	1	--	--	1
		Total	**17**	**--**	**8**	**20**

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	Dissertation	Dissertation Phase – I	--	--	--	14
		Total	**--**	**--**	**--**	**14**

Semester-IV

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	Dissertation	Dissertation Phase - II	--	--	--	18
		Total	**--**	**--**	**--**	**18**

(ILE) Steam Engineering

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Students will have the ability to explain working of different boilers and significance of mountings and accessories.
2. Students will have the ability to use techniques, skills, and modern engineering tools necessary for boiler performance assessment.
3. 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.
4. Students will have the ability to design a steam piping system, its components for a process and also design economical and effective insulation.
5. Students will have the ability to analyze a thermal system for sources of waste heat design a systems for waste heat recovery.
6. Students will have the ability to design and develop controls and instrumentation for effective monitoring of the process.

Syllabus Contents:

- Introduction (7 hrs)
  Fundamentals of steam generation, 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 (8 hrs)
  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.

- Steam Systems (8 hrs)
  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 (8hrs)
  Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

- Energy Conservation and Waste Minimization,(5hrs)
  Energy conservation options in Boiler; waste minimization, methodology; economical viability of waste minimization

- Instrumentation & Control (6hrs)
  Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection

References:

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 Answes; Tata McGrawHill Education Pvt Ltd, N Delhi

(PSMC) Mathematical Methods in Engineering

Teaching Scheme
Lectures: 3 hrs/week, Tutorial:1hr/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Students will be able to analyse and develop the mathematical model of thermal system.
2. Student should able analyse the reliability and maintainability of the series and parallel thermal system.
3. Students will be able to solve differential equations using numerical techniques.

Syllabus Contents:

- Ordinary Differential Equations: First-order equations (Linear, Equidimensional, Separable, Exact, Homogeneous,); Second-order linear differential equations (homegeneous and nonhomogeneous); Solution methods such as undertermined coefficients and variation of parameters.
- Partial Differential Equations: First order partial differential equations; Second order linear partial differential equations; Canonical forms; Fourier series, Second order equations (Parabolic, Elliptic and Hyperbolic) in rectangular, cylindrical polar and spherical coordinate systems; Solution techniques such as separation of variables, eigenfunction expansions, integral transforms (Fourier and Laplace transforms); D'Alembert's solution for the Wave equation; Maximum principle for Elliptic equations; Variational methods for approximate solutions of differential equations.
- Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.
- ANOVA: One – way, Two – way with/without interactions, Latin
- Squares ANOVA technique, Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD.
- Some of the relevant topics required for ANOVA (sample estimates and test hypothesis) may also be included.

References:

1. J.B. Doshi, “Differential Equations for Scientists and Engineers”, Narosa, 2010.
2. Peter O'Neil, “Advanced Engineering Mathematics”, Seventh Edition, Cengage Learning, 2012 (Indian Edition).
3. Michael Greenberg, “Advanced Engineering Mathematics”, Second Edition, Pearson Education, 2002 (Indian Edition).
4. Jennings. A., Matrix Computation for Engineers and Scientists. John Wiley and Sons, 1992.
5. Prem.K.Kythe, Pratap Puri, Michael R.Schaferkotter, Introduction to Partial Differential Equations and Boundary Value problems with Mathematics, CRC Press, 2002.
6. Kreyszig, Erwin, I.S., Advanced Engineering Mathematics, Wiley, 1999.
7. Ramamurthy. V., Computer Aided Design in Mechanical Engineering., Tata McGraw Hill Publishing Co., 1987
8. Fundamental Concepts in the Design of Experiments, 5th Ed., by Hicks and Turner
9. Devore, Jay L., Probability and Statistics for Engineering and the Sciences, 5th edition, Brooks- Cole (1999)

(PCC-I) Thermodynamics and Combustion

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course,:

1. Student will get Knowledge of exergy, basic laws governing energy conversion in multi-component systems and application of chemical thermodynamics.
2. Student will be aware about advanced concepts in thermodynamics with emphasis on thermodynamic relations, equilibrium and stability of multiphase multi-component systems.
3. Student will be aware about the molecular basis of thermodynamics.
4. To present theoretical, semi-theoretical and empirical models for the prediction of thermodynamic properties.
5. Student will be 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
6. Student should apply the fundamental principles of thermodynamics to non-ideal models of numerous engineering devices
7. Student can use a systems approach to simplify a complex problem

Syllabus Contents:

- First law and State postulates, Second law and Entropy, Availability and Irreversibility, Transient flow analysis
- Nonreactive Ideal-Gas Mixture, PvT Behavior of Real gases and Real Gas mixture
- Generalized Thermodynamic Relationship
- Combustion and Thermo-chemistry, Second law analysis of reacting mixture, Availability analysis of reacting mixture ,Chemical equilibrium
- Statistical thermodynamics, statistical interpretations of first and second law and Entropy,
- Third law of thermodynamics, Nerst heat theorem.

References:

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. 7. Rao Y.V.C., “Postulational and Statistical Thermodynamics”, Allied Publishers Inc, 1994.

(PCC-II) Fluid Dynamics

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The Students shall be able to understand and define the fluid flow problems along with range of governing parameters
2. The student shall be eligible to take up the fluid flow problems of industrial base.
3. The students shall be able to devise the experiments in the field of fluid mechanics.
4. The Students shall be able understand the flow patterns and differentiate between the flow regimes and its effects.

Syllabus Contents:

- Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities
- Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows
- Potential Flow: Kelvin's theorem, Irrotational flow, Stream function-vorticity approach,
- Laminar Boundary layers: Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations
- Turbulent Flow: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, universal velocity distribution
- Experimental Techniques: Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry

References:

1. Muralidhar and Biswas, Advanced Engineering Fluid Mechanics, , Alpha Science International, 2005
2. Irwin Shames, Mechanics of Fluids, , McGraw Hill, 2003
3. Fox 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

(PCC-III) Refrigeration and Cryogenics

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week, Tutorial:1hr/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course, students will demonstrate the ability:

1. To learn the basics of refrigeration and cryogenics and its application area.
2. To design the refrigeration systems for domestic and industrial applications like cold storages
3. To learn about ODP, GWP and related environment issues

Syllabus Contents:

- Vapour compression refrigeration, actual cycle, second law efficiency,
- Multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems,
- Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor,
- Design, selection of evaporators, condensers, control systems, motor selection,
- Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations,
- Refrigeration applications, food preservation, transport,
- Introduction to Vapor absorption refrigeration, single effect and double effect

systems,

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

References:

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

(PCC-IV) Advance Heat Transfer

Teaching Scheme	Examination Scheme
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The students are expected 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

Syllabus Contents:

- 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 & vapours.

References:

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, NewYork, 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,

(LC) Thermal Engineering Lab Practice

Teaching Scheme	**Examination Scheme**
Practical: 4 hrs/week, Tutorial: 2 hrs/week	Exam 100

Course Outcomes:

At the end of the course,:

1. Students will acquire hands on experience on the various test-rigs, Experimental set up.
2. Students should able to measure the various technical parameters by instrument and by mathematical relationship.
3. Students will able to identify the effect of various parameters on the system and able to co- relate them.

Syllabus Contents:

- 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, Thermodynamics and Combustion, Refrigeration and Cryogenics.

Humanities Syllabus

Teaching Scheme:
Lecture: 1.0 hour per week

Examination Scheme:
T1: 20 marks, T2: 20 marks
ESE: 60 marks

Objectives:

To appreciate and understand, with special reference to the engineering profession:

1. The development of Civilization, Culture and Social Order over the Centuries
2. The development of Technology and its impact on the Society's Culture and vice-versa, as well as the concept of Globalization and its effects.
3. The process of Industrialization and Urbanization, their positive and negative effects, like social problems, etc.

Unit 1 **(1)**

Introduction

The meaning of Humanities and its scope. The importance of Humanities in Society in general and for Engineers in particular.

Unit 2 **(6)**

Social Science and Development

Development of Human Civilization over the centuries – Society and the place of man in society – Culture and its meaning -- Process of social and cultural change in modern India -- Development of technology, Industrialization and Urbanization -- Impact of development of Science and Technology on culture and civilization -- Urban Sociology and Industrial Sociology – the meaning of Social Responsibility and Corporate Social Responsibility – Engineers' role in value formation and their effects on society.

Unit 3 **(7)**

Introduction to Industrial Psychology

The inevitability of Social Change and its effects -- Social problems resulting from economic development and social change (e.g. overpopulated cities, no skilled farmers, unemployment, loss of skills due to automation, addictions and abuses, illiteracy, too much cash flow, stressful working schedules, nuclear families etc.) – Job Satisfaction -- The meaning of Motivation as a means to manage the effects of change – Various theories of Motivation and their applications at the workplace (e.g. Maslow's Hierarchy of Needs, McGregor's Theory X and Y, The Hawthorne Experiments, etc.) – The need to enrich jobs through skill and versatility enhancement – Ergonomics as a link between Engineering and Psychology

- **References:**

1. Jude paramjit S and Sharma Satish K Ed: dimensions of social change
2. Raman Sharma. Social Changes in India;
3. Singh Narendar. (2011). Industrial Psychology. Tata McGraw-Hill: New Delhi.
4. Ram Ahuja. Social Problems in India.

M Tech (Mechanical Engineering)

Specialization: Thermal Engineering
Semester II

(PCC-V) Design of Heat Exchanger

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

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.
2. Students will design and analyses of shell-and-tube double pipe, compact, plate heat exchangers**.**
3. Students will demonstrate the performance degradation of heat exchangers subject to fouling.

Syllabus Contents:

- 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.

References:

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.

(PCC-VI) Computational Fluid Dynamics

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week, Tutorial :1hr/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The students are expected to understand the subject of Computational Fluid Dynamics and know how to use it as tool to solve the Heat Transfer and Fluid Mechanics related Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Syllabus Contents:

- **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

References:

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.

(PCC-VI) Modelling of IC Engine

Teaching Scheme	**Examination Scheme**
Lectures: 3 hrs/week	T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Students will demonstrate a basic understanding of several types of engine models that will include zero dimensional thermodynamic model, one dimensional and multi dimensional, single zone, two zone etc models.
2. Students will develop models and simulate them for diesel engine petrol engine, gas engine**.**
3. Students will demonstrate the performance evaluation and emission standards for such modeled engines

Syllabus Contents:

- **Fundamentals:** Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and 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.

References:

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
4. Operation Principles of Operation and Simulation Analysis", Springer, 2009.
5. V. Ganeshan, "Internal Combustion Engines", Tata McGraw Hill, New Delhi, 1996.
6. P.A. Lakshminarayanan and Y. V. Aghav, " Modelling Diesel Combustion" Springer, 2010
7. Bernard Challen and Rodica Baranescu, "Diesel Engine Reference Book" Butterworth-Heinemann, 1999.

(DCE-I) Nuclear Engineering

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

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.

2. The student will also be familiar with concepts of reactor criticality, the relationship between the dimension and fissile material concentration in a critical geometry.

3. The student will also be familiar with Time dependent (transient) behaviour of power reactor in non-steady state operation and the means to control the reactor.

4. The student will also be familiar with concepts of heat removal from reactor core, reactor safety and radiation protection.

Syllabus Contents:

- **Basics of nuclear fission and power from fission**

  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

  Multigroup, multiregion diffusion equation, concept of criticality

  Solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors

  Reactor kinetics and control

  Derivation of point kinetics equations, inhour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients

  Heat removal from reactor core

  Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux

  Reactor safety, radiation protection

  Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards

References:

1. Introduction to Nuclear Engineering (3rd Edition) by John R. Lamarsh, Anthony J.Barrata, Prentice Hall, (2001)
2. Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, 1966)
3. Nuclear Reactor Analysis, by James J. Duderstadt and Lewis J. Hamilton, John Wiley(1976)

(DCE-I) Energy Conservation and Management

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. The student should acquire insight about the importance of energy
2. The student should capable to analyze all scenarios from energy consumption
3. The student should generate scenarios of energy consumption and predict the future trend
4. The student should Suggest and plan energy conservation solutions

Syllabus Contents:

- 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.

References:

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.

(DCE-II) Air conditioning system Design

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Student should understand construction and design features Air-conditioning system.
2. Student should understand various types and its adoptability in the various environment and application areas.
3. Student should understand various health issues
4. Student should design seasonal energy efficient system

Syllabus Contents:

- 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.

References:

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

(DCE-II) Gas Turbine

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Student should understand construction and design features of gas turbines as used for power generation.
2. Student should understand thermodynamics cycles a, and different sizes and layouts of gas turbine plant
3. Able to understand thermodynamics and fluid mechanics component for enhancing the efficiency and effectively of gas turbines

Syllabus Contents:

- 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.

References:

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.

(DCE-III) Design of Solar and Wind System

Teaching Scheme
Lectures: 3 hrs/week

Examination Scheme
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes:

At the end of the course:

1. Student should update about the technological status of implementation of NCES in India
2. Student should capable to analyze various techno economical obstacles in the commercial development of NCES in India
3. Student should capable to conceptually model and design general NCES systems and predict the long term performance.
4. Student should suggest and plan hybrid NCES solutions to conventional energy systems

Syllabus Contents:

- 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.

References:

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. Bansal and othes, "Non-Conventional Energy Sources".
4. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

(LC) Mini project

Teaching Scheme
Lectures: 2 hrs/week

Examination Scheme
End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Students will get an opportunity to work in actual industrial environment if they opt for internship.
2. In case of mini project, they will solve a live problem using software/analytical/computational tools.
3. Students will learn to write technical reports.
4. Students will develop skills to present and defend their work in front of technically qualified audience.

Syllabus Contents:

- Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

(LC) Thermal Engineering Lab Practice

Teaching Scheme
Practical: 2 hrs/week, Tutorial: 2 hrs/week

Examination Scheme
Exam 100

Course Outcomes:

At the end of the course,:

4. Students will acquire hands on experience on the various test-rigs, Experimental set up.
5. Students should able to measure the various technical parameters by instrument and by mathematical relationship.
6. Students will able to identify the effect of various parameters on the system and able to co- relate them.

Syllabus Contents:

- 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, Modelling of I C Engine.

(MLC) Intellectual Property Rights

Teaching Scheme
Lectures: 1 hr/week

Examination Scheme
End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Students will understand the rights of an individual towards intellectual property.
2. Students will know the procedure to file a national/international patent.

Syllabus Contents:

- 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.

References:

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

(LLC) Liberal Learning Course

Examination Scheme
End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Improve the Students' personality.
2. Student will learn to interact with people to get inputs for the topic of their study. Student will learn to convince his point of view on a particular topic to a non cohesive group of people

Syllabus Contents:

- Student will find a topic of his interest.

M Tech (Mechanical Engineering)

Specialization: Thermal Engineering

Semester III

(Dissertation) Dissertation Phase-1

Teaching Scheme	**Examination Scheme**
Lectures: 14 hr/week	End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Students will be exposed to self learning various topics.
2. Students will learn to survey the literature such as books, national/international refereed journals and contact resource persons for the selected topic of research.
3. Students will learn to write technical reports.
4. Students will develop oral and written communication skills to present and defend their work in front of technically qualified audience.

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Guidelines:

- 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. 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.

M Tech (Mechanical Engineering)

Specialization: Thermal Engineering

Semester IV

(Dissertation)Dissertation Phase- II

Teaching Scheme
Lectures: 18 hr/week

Examination Scheme
End-Sem Exam 100

Course Outcomes:

At the end of the course:

1. Students will be able to use different experimental techniques.
2. Students will be able to use different software/ computational/analytical tools.
3. Students will be able to design and develop an experimental set up/ equipment/test rig.
4. Students will be able to conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
5. Students will be able to either work in a research environment or in an industrial environment.
6. Students will be conversant with technical report writing.
7. Students will be able to present and convince their topic of study to the engineering community.

Guidelines:

- It is a continuation of Project work started in semester III. He has to submit the report in prescribed format and also present a seminar. 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.