Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

First Year M. Tech.
(Mechanical Heat Power Engineering)
Sem - I to II

AY 2020-21

Professional Core (Theory)

Title of the Course: Research methodology – 4IC501	L	T	P	Cr
	2	0	0	2

Pre-Requisite Courses: Basic courses in Heat and Power engineering andMathematics& Statistics

Textbooks:

1. *C. R. Kothari, Research Methodology*, New Age international 2004
2. *Deepak Chopra and NeenaSondhi, Research Methodology* : Concepts and cases, Vikas Publishing House, New Delhi 2012
3. *Wayne Goddard and Stuart Melville, Research Methodology*: An Introduction

References:

1. E. Philip and Derek Pugh, "How to get a Ph. D. – a handbook for students and their supervisors", open university press, 2001
2. Kumar R., "Research Methodology- A step by step guide for beginners", SAGE, 3rd Edition, 2012.
3. G. Ramamurthy, "Research Methodology", Dream Tech Press, New Delhi, 2009.

Course Objectives:

1. To prepare the students to identify and formulate the research problems,
2. To impart the Knowledge of planning and execution of research project, IPRs, Patents etc
3. To develop the student to prepare and write papers for publications to Conferences and Journals.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Classify the research problem and research plan.	III	Apply
CO2	Analyze the research problem, literature and methodology.	IV	Analyze
CO3	Interpret the research papers, reports, case studies, patent information and database, etc	V	Evaluate

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3			2	3	
CO2				1	3	
CO3				1	2	3

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc. (one assignment per module)

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Meaning of research problem, Sources of research problem, Criteria, Characteristics of a good research problem, and 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	**5Hrs.**
Module 2 Effective literature studies approaches, analysis. Plagiarism, Research ethics.	**4Hrs.**
Module 3 Effective technical writing, how to write report, Paper. Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.	**5Hrs.**
Module 4 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.	**4Hrs.**
Module 5 Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.	**4Hrs.**
Module 6 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.	**4Hrs.**

Module wise Measurable Students Learning Outcomes :

Students will able to

1. Explain the research problem and research plan.
2. Propose methodology for their research topic and understand various analysis techniques.
3. Analyze and interpret the research data.
4. Prepare the conference papers, dissertation report and understand patent related aspects.
5. Handle issues related to IPR.
6. Process and interpret the research data.

Title of the Course: **Thermodynamics and Combustion** - 4HP501	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Basic Mathematics, Chemistry,

Textbooks:

1. An Introduction to Thermodynamics, Y.V.C. Rao, University Press (India) Private Limited, Revised Edition, 2004).
2. Thermodynamics: an Engineering Approach, Y.A.Cengal and M.A.Boles, McGraw Hill (Fifth edition).
3. Fundamentals of Classical Thermodynamics, G.VanWylen, R.Sonntag and C.Borgnakke, John Willey & Sons (Fourth edition).

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. Rao Y.V.C., "Postulational and Statistical Thermodynamics", Allied Publishers Inc, 1994.

Course Objectives :

At the end of the course,

1. Student will get Knowledge of exergy, basic laws governing energy conversion in multicomponent systems and application of chemical thermodynamics.
2. Student will be aware about advanced concepts in thermodynamics with emphasis on the thermodynamic relations, equilibrium and stability of multiphase multi-component systems.
3. Student will be acquire the confidence in analyze the motion of combusting and noncombusting fluids whilst accounting for variable specific heats, non-ideal gas properties, chemical non-equilibrium and compressibility

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Understand the concepts of thermodynamics and kinetics of combustion	II	Understand
CO2	Apply the concepts of Thermodynamics and combustion phenomena in energy conversion devices..	III	Applying
CO3	Analyze the combustion mechanisms of various fuels.	IV	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		2			
CO2		1			3	
CO3			2	3		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 First law and State postulates, Second law and Entropy, Availability and Irreversibility, Transient flow analysis	**Hrs. 7**
Module 2 Nonreactive Ideal-Gas Mixture, PvTBehavior of Real gases and Real Gas mixture	**Hrs. 7**
Module 3 Generalized Thermodynamic Relationship	**Hrs. 7**
Module 4 Combustion and Thermo-chemistry, Second law analysis of reacting mixture, Availability analysis of reacting mixture,Chemical equilibrium	**Hrs. 7**
Module 5 Statistical thermodynamics, statistical interpretations of first and second law and Entropy	**Hrs. 6**
Module 6 Third law of thermodynamics, Nerst heat theorem.	**Hrs. 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Gain Knowledge of exergy, basic laws governing energy conversion in multicomponent systems and application of chemical thermodynamics.
2. Understand the advanced concepts in thermodynamics with emphasis on the thermodynamic relations, equilibrium and stability of multiphase multi-component systems.
3. Understand the molecular basis of thermodynamics.
4. To present theoretical, semi-theoretical and empirical models for the prediction of thermodynamic properties.
5. Analyze the motion of combusting and noncombusting fluids whilst accounting for variable specific heats, non-ideal gas properties, chemical non-equilibrium and compressibility
6. Apply the fundamental principles of thermodynamics to non-ideal models of numerous engineering devices

Title of the Course: **Advanced Fluid Dynamics - 4HP502**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

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

References:

1. Fox R.W., McDonald A.T , *Introduction to Fluid Mechanics*, John Wiley and Sons Inc, 1985
2. Pijush K. Kundu, Ira M Kohen and David R. Dawaling, *Fluid Mechanics*, Fifth Edition, 2005

Course Objectives :

1. To enable the students to analyze and solve fluid related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to fluid dynamics.
3. To train students with effective communication skill to demonstrate fluid dynamics theories.
4. To develop skills in the analysis of fluid systems with mathematical modeling for applications of fluid dynamics in research or design.
5. To develop a professional approach for lifelong learning in the fluid dynamics to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Understand and define the fluid flow problems along with range of governing parameters	II	Understanding
CO2	Devise the experiments in the field of fluid mechanics.	III	Applying
CO3	Analyze the flow patterns and differentiate between the flow regimes and its effects.	IV	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**		1	1	2	1
CO2		**2**		**3**		1
CO3			2	2		1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 **Basic equations of flow** Kinematics of flow, Control volume approach, Continuity equation, Momentum equation Linear momentum equation and angular momentum equation, Energy equation, Bernoulli equation	**Hrs. 7**
Module 2 **Theory of Potential Flow and Hydrodynamic Stability** Kelvin's theorem, Stream function and Velocity potential, Irrational flow, Laplace equation and various flow fields, Combined flows and super positions, Examples of transition, Theoretical determination of Critical Reynolds Number, Stability of Elementary Flow fields, Rayleigh's Theorem, Flow in parallel channels, Stability of Boundary Layers, Numerical solution for Orr-Somerfield number.	**Hrs. 7**
Module 3 **Flow over immersed bodies and boundary layer flow** Boundary layer equations, flow over flat plate, Boundary layers with non-zero pressure gradient, Approximate methods for boundary layer equations, separation and vertex shedding.	**Hrs. 7**
Module 4 **Turbulent flow** Characteristics of Turbulent flow, Laminar turbulent transition, Governing equations for turbulent flow, Turbulent boundary layer equations, measurement of turbulent quantities, shear stress models, universal velocity distribution and friction factor, fully developed turbulent flow, Dynamics of turbulence	**Hrs. 7**
Module 5 **Turbo machinery** Equations of turbo machinery, Axial flow turbines, compressors, pumps and fans, Radial flow turbines, compressors, pumps and fans, Power absorbing vs. power producing devices, Performance characteristics of centrifugal pumps, Performance characteristics of hydraulic turbines	**Hrs. 6**
Module 6 **Compressible Fluid Flow** One dimensional compressible fluid flow – flow through variable area passage – nozzles and diffusers, effect of viscous friction and heat transfer, fundamentals of supersonics flow normal and oblique shock waves and calculation of flow and fluid properties over solid bodies (like flat plate, wedge, diamond) using gas tables	**Hrs. 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Derive various governing equations in fluid mechanics, heat transfer and interpret the same.
2. Define different types of flow, their equations and carry out the analysis.
3. Explain the boundary layer theory and derive/apply the same.
4. Summaries examples of transition, stability of flow fields. Devise the flow requirements in various applications
5. Derive governing equations for turbo machines and analyze performance characteristics.
6. Understand compressible flow and its affect.

Professional Core (Lab)

Title of the Course: Heat Power Engineering lab I-**4HP551**	L	T	P	Cr
	0	0	4	2

Pre-Requisite Courses: Thermodynamics, Heat Transfer, Power plant Engineering, Automobile Engineering

Textbooks:

1. P. K. Nag "*Thermodynamics*", Tata McGraw Hill Publication, 2006, 3rd Edition.
2. V. P. Vasandani and D. S. Kumar, "*Heat Engineering*", Metropolitan Book Company, 1975, 2nd Edition.
3. R. Yadav, "Fundamentals of Thermodynamics", Central Publication house, Allahabad, 2011, Revised 7th Edition.
4. Ganeshan, "*Internal Combustion Engines*" Tata Mac Hill Publication, 1999, 2nd edition.
5. Mathur and Sharma, "*Internal Combustion Engines*" DhanapatRai publication, 2000, 2nd edition.
6. R. K. Rajput, "*Internal Combustion Engines*" Laxmi Publications, 2005, 3rd edition.

References:

1. Cengel and Boles, "Thermodynamics an engineering Approach", Tata McGraw-Hill publication, 2011, Revised 7th Edition.
2. R. Yadav, "Thermodynamics and heat engine", Central Publication house Allahabad, 2007, Revised 7th Edition.
3. R. Yadav, "Steam and Gas Turbine", Central Publication house, Allahabad, 2010, Revised 7thedition.
4. F. Obert, "*Internal Combustion Engines and Air Pollution*", In-text Educational Publishers, 1973 1st edition.
5. John B Heywood, "*Internal Combustion Engines fundamentals*", McGraw-Hill, Revised 2nd Edition, 1988.
6. Maleev J P, "*Internal Combustion Engines Theory and design*", McGraw-Hill, Revised 2nd Edition, 1945.

Course Objectives :

Students should be able to

1. To learnthe techniques to find physical properties of the oils, greases, and solid fuels used insteam generators.
2. To apply laws of thermodynamics to various thermodynamic devices.
3. To develop the skills for evaluating performance of thermodynamics systems.
4. Demonstrate the engine components, systems and its constructional details
5. To measure parameters of the Engines performance
6. Explain the role of parameters affecting volumetric efficiency, valve timing, and port design
7. Make the analysis of working of the engine by studying exhaust gas analysis.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Apply** the techniques to determine the properties of fluids used in various industrialsystems such as Mechanical Power Production systems. **Classify and examine**the IC engine components and systems	III	Applying
CO2	Estimate the calorific value of a given fuel by using Bombcalorimeter. To **study and test**the tools / techniques / instruments for measuring theperformance parameters of engine	IV	Analyzing

CO3	**Estimate and measure** performance of thermal systems by conducting the test on steam power plant to determine plant and componentefficiencies.Asses the performance characteristics during testing.	V	Evaluating

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		**3**				
CO2		**2**	**2**	**2**		
CO3			**1**	**2**		

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.

Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Course Contents:

Conduct any 10 experiments from each Module

List of Experiments for course **Advanced Thermodynamics(Minimum 8 Expt.)** 1. Design / simulation of solar thermal system. 2. Design / simulation of solar thermal/wind hybrid system. 3. Design/Simulation of thermal system components such as heatExchanger 4. Energy Audit case study. 5. Modern power Plant Instrumentation. 6. Economics of power plant and categorize power plant as base and peak plant. 7. Trial on fuel cells and study of Thermoelectric and Thermionic Energy. 8. Determination of operating characteristics of roof top PV system. 9. Prediction of 10. To conduct trial on condenser and cooling tower to determine its efficiency. 11. To conduct Trial on Steam power plant. 12. Visit to steam power plant.	**20 Hrs.**
List of Experiments for course **Advanced Fluid Dynamics (Minimum 8 Expt.)** 1. Study/measurement of lift and drag force of Aerofoil model, symmetric or asymmetric model on wind tunnel. 2. Prediction of boundary layer thickness over flat plate. 3. Determination/simulation of losses in pipes. 4. Determination/simulation of losses in ducts. 5. Study/demonstration of different flow visualization techniques. 6. Study/simulation of turbulent flow domain. 7. Study/simulation of compressible flow domain 8. Simulation of flow measurement devices. 9. Simulation of flow through micro channels. 10. Simulation of developing flow through pipes.	**20 Hrs.**

Professional Elective (Theory) Courses

Title of the Course: PE 1 **Computational Methods in fluid flow and heat transfer - 4HP511**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Fluid Mechanics, Thermodynamics, Mathematics, Heat Transfer, Numerical methods

Textbooks:

1. S.V. Patankar, *"Numerical Fluid Flow & Heat transfer",* Hemisphere Publishing Corp., 1980.
2. T. Sundernajan, K. Muralidhar, *"Computational Fluid Flow and Heat Transfer",* Narosa, 2nd edition, Reprint 2011

References:

1. H. K. Versteeg and W. Malalasekera, *"An Introduction to Computational Fluid Dynamics",* Longman Scientific and Technical, 1st edition, 1995.
2. Hoffman Klaus, *"Computational Fluid Dynamics",* Vol-1 & 2, A Publication of Engineering Education System, Wichita Kansas, USA, 2000.

Course Objectives :

1. Enable the students to analyze and solve fluid related problems by applying principles of mathematics, science and engineering.
2. Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to computational technique in fluid flow and heat transfer.
3. Train students with effective communication skill to demonstrate computational theories.
4. Develop skills in the analysis of fluid systems with mathematical modeling for applications of computers in research or design.
5. Develop a professional approach to lifelong learning in the numerical analysis to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Explain prediction methods, PDEs and numerical methods.	II	Understand
CO2	Apply the FDM and FVM techniques to solve Fluid and Thermal related problems.	III	Apply
CO3	Analyze boundary conditions, solution methods and schemes used in fluid flow and heat transfer problems.	IV	Analyze

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**2**			**2**	
CO2	**2**				**2**	
CO3	**2**			**2**		**2**

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Comparison of experimental, theoretical and numerical approaches Partial differential equations - Physical and mathematical classification - Parabolic, Elliptical and Hyperbolic equations. Computational economy, Numerical stability, Selection of numerical methods, validation of numerical results: Numerical error and accuracy – Round off error, accuracy of numerical results – Iterative convergence – Condition for convergence, Rate of convergence, under-relaxation and over relaxation, Termination of iteration: Tridiagonal Matrix algorithm.	**7**
Module 2	**Hrs.**
Finite Difference method: Discretization – Converting Derivatives to discrete Algebraic Expressions, Taylor's series approach, polynomial fitting approach, Discretization error.	**6**
Module 3	**Hrs.**
Heat conduction Steady one-dimensional conduction in Cartesian and cylindrical co-ordinates, handling of boundary conditions: Two dimensional steady state conduction problems in Cartesian and cylindrical co-ordinates – point by point and line by line method of Solution: Dealing of Dirichlet, Neumann and Robbins type boundary conditions- Formation of discretized equations for regular boundaries, irregular boundaries and interfaces.	**7**
Module 4	**Hrs.**
One dimensional, two dimensional and three dimensional transient heat conduction problems in Cartesian and cylindrical co-ordinates Explicit, Implicit, Crank Nicholson and ADI methods- stability of each system-Conservation form and conservative property of partial differential equations and finite difference equations-Consistency, stability and convergence for marching problems-Discrete perturbation stability analysis- Fourier or Von Neumann stability analysis.	**7**

Module 5	Hrs.
Finite volume method 1 Discretization of governing equations - Diffusion and convection-diffusion problems- steady one-dimensional convection and diffusion, upwind, hybrid and power-law schemes:	**6**
Module 6	**Hrs.**
Finite volume method 2 Discretization equation for two-dimensions: False diffusion, calculation for the Flow-Field- Stream function- vorticity approach, SIMPLE, SIMPLER, SIMPLEC and QUICK Algorithms. Numerical Marching Techniques. Two dimensional parabolic flows with heat; Grid generation methods, Adaptive grids.	**7**

Module wise Measurable Students Learning Outcomes :

1. Describe and recall basics of fluid mechanics and mathematics, methods of prediction and its significance.
2. Apply the FDM method to discretize of governing equation.
3. Solve 1D, 2D conduction problems with discretization method, to apply and interpret different types of boundary conditions.
4. Understand and apply the solution techniques for 1D, 2D, 3D problems; carry out the analysis using these methods.
5. Design the grid with FVM for diffusion and convection diffusion problem.
6. Select the appropriate grid, interpret and apply different solution algorithm.

Title of the Course: PE 1 **Nuclear Engineering- 4HP512**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. Introduction to Nuclear Engineering (3rd Edition) by John R. Lamarsh, Anthony J.Barrata, Prentice Hall, (2001)

References:

1. Introduction to Nuclear Reactor Theory, by John R. Lamarsh, Addison-Wesley, 1966)
2. Nuclear Reactor Analysis, by James J. Duderstadt and Lewis J. Hamilton, John Wiley(1976)

Course Objectives :

- Demonstrate the basic concepts and processes taking place inside a nuclear reactor, such as nuclear fission, neutron production, scattering, diffusion, slowing down and absorption.
- The student will also be familiar with concepts of reactor criticality, the relationship
- The 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.
- The student will also be familiar with concepts of heat removal from reactor core, reactor safety and radiation protection.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to;**	Bloom's Cognitive	
		level	Descriptor
CO1	**Understanding**the basic concepts and processes taking place inside a nuclear reactor	II	Understanding
CO2	**Analyzing** time dependent (transient) behavior of power reactor in non-steady state operation and the means to control the reactor	IV	Analyzing
CO3	**Demonstrating** concepts of heat removal from reactor core, reactor safety and radiation protection.	IV	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**					
CO2		**1**	1			
CO3				1		

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE1	10
MSE	30
ISE2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 : Basics of nuclear fission and power from fission	**Hrs.**
Radioactivity, nuclear reactions, cross sections, nuclear fission, power from fission, conversion and breeding	**6**
Module 2: Neutron transport and diffusion	**Hrs.**
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	**6**
Module 3 :Multigroup, multiregion diffusion equation, concept of criticality	**Hrs.**
Solution of multigroup diffusion equations in one region and multiregion reactors, concept of criticality of thermal reactors	**7**
Module 4 : Reactor kinetics and control	**Hrs.**
Derivation of point kinetics equations, inhour equation, solutions for simple cases of reactivity additions, fission product poison, reactivity coefficients	**6**
Module 5 :Heat removal from reactor core	**Hrs.**
Solution of heat transfer equation in reactor core, temperature distribution, critical heat flux	**7**
Module 6: Reactor safety, radiation protection	**Hrs.**
Reactor safety philosophy, defence in depth, units of radioactivity exposure, radiation protection standards	**6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Demonstrate basics of nuclear fission and power from fission
2. Formulation of Neutron transport equation and its solution
3. Solution to diffusion equation
4. Modeling of reactor core for thermal performance
5. Applying and solving heat transfer equation for reactor core
6. Demonstrating philosophy of reactor safety

Title of the Course: **Energy Conservation and Management - 4HP513**	L	T	P	Cr
	3	**0**	**0**	**3**

Pre-Requisite Courses: Environment Studies, Elements of Mechanical Engineering, Thermodynamics

Textbooks:

1. Witte L.C. Schmidt P.S. and Brown D.R., Industrial Energy Management and Utilization, Hemisphere Publ., Washington, 1988.
2. Callaghn P.W., Design and Management for Energy Conservation, Pergamon Press, Oxford, 1981.
3. Murphy W.R. and McKay G., Energy Management, Butterworths, London, 1987.
   Energy Manager Training Manual , Bureau of Energy Efficiency (BEE) under Ministry of Power, GOI, 2004 (available at www.energymanager training.com).

References:

1. Recent reports of agencies: International Energy Agency (IEA), Ministry of New and Renewable energy (MNRE), Technology and Action for Rural Advancement (TARA)
2. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press
3. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press
4. Bureau of Energy Efficiency Reference book: No.1, 2, 3 4

List of Open Source Software/learning website:

1. http://nptel.iitm.ac.in/
2. www.bee.com
3. www.powermin.nic.in

Course Objectives :

1. To introduce energy and power scenario, electrical systems, energy auditing, energy conservation and energy impact on environment.
2. To provide knowledge of energy management, energy auditing and energy conservation.
3. To develop skill to carry out energy audit and to suggest methodologies for energy savings
4. To prepare the students for higher studies and research in the field ofenergy conservation and management.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	Explain: energy and power scenario, electrical, mechanical systems, energy auditing, energy conservation and energy impact on environment	II	Understanding
CO2	Carryout energy accounting and balancing	III	Applying
CO3	Exercise energy audit and suggest methodologies for energy savings	IV	Analyzing

CO-PO Mapping :

PO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**
CO1	**1**		**2**		**2**	
CO2	**1**		**2**		**2**	**2**
CO3	**1**			**3**		**3**

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction	**Hrs.**
Commercial and non-commercial energy, Primary energy resources, Commercial energy production, Final energy consumption, Indian energy scenario, Sectorial energy consumption, Energy needs of growing economy, Energy intensity on purchasing power parity (PPP) basis, Long term energy scenario, Energy pricing, Energy security, Energy strategy for the future, Energy conservation and its importance.	**5**
Module 2 Energy Management & Audit	**Hrs.**
Definition, energy audit, need, types of energy audit. Energy management (audit) approach – understanding energy costs, Bench marking, energy performance, matching energy use to requirements, maximizing systems efficiencies, optimizing the input energy requirements, fuel and energy, substitution, energy audit instruments and metering.	**7**
Module 3 Energy Economics	**Hrs.**
Financial Management – Investment need, Appraisal and criteria Financial Analysis techniques, Simple Payback Period, Return On Investment, Net Present Value, Interest rate of return, Risk and sensitivity analysis, Financing Options, ESCOS.	**7**
Module 4Energy Conservation in Major Utilities	**Hrs.**
Energy Conservation in energy Intensive Industries. Cogeneration – Need, Principle, Technical Options for Cogeneration. Classification, Factors Influencing choice, Heat to Power ratios, Load Patterns, Prime movers used in Conservation. Advantages and Disadvantages of various systems. Case Studies.	**8**
Module 5 Energy conservation in Mechanical and Electrical systems	**Hrs.**
Energy conservation in compressed air systems, HVAC and refrigeration systems, Fans blowers, pumps and pumping systems, cooling towers, motors and lighting systems.	**6**
Module 6 Energy and environment, air pollution, climate change:	**Hrs.**
Energy and environment, Air pollution, Climate change, United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM methodology and procedure, Sustainable Development.	**6**

Module wise Measurable Students Learning Outcomes :

Student will be able to:

1. Understand and analyze the energy data of industries.
2. Employ energy audit and conservation practices
3. Understand efficient electricity utilization, saving and recovery in different and electrical system.
4. Understand energy conservation in major mechanical utilities
5. Understand efficient heat /power, saving and recovery in different thermal system.
6. Learn effect of energy consumption on environment and measures to reduce it.

Title of the Course: PE1 **Design of Thermal Turbo Systems**-4HP514	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. S M Yahya , " Turbines, Compressors and Fans, McGrawHill Publication
2. Shepherd, D.G., "Principles of Turbomachinery", Macmillan, 1969.

References:

1. Bruneck, Fans, Pergamom Press, 1973.
2. Earl Logan, Jr., Hand book of Turbomachinery, Marcel Dekker Inc., 1992.
3. Dixon, S.I., "Fluid Mechanics and Thermodynamics of Turbomachinery", Pergamon Press, 1990.
4. Gopalakrishnan .G and Prithvi Raj .D, "A Treatise on Turbo machines", Scifech Publications (India) Pvt. Ltd., 2002.

Course Objectives :

At the end of the course,

1. Recognize typical designs of turbomachines and Explain the working principles of turbomachines and apply it to various types of machines
2. Determine the velocity triangles in turbomachinery stages operating at design and off-design conditions.
3. Perform the preliminary design of turbomachines (Fans compressors) on a 1-D basis
4. Use design parameters for characterizing turbomachinery stages and determine the off-design behavior of turbines and compressors and relate it to changes in the velocity triangles • Explain and understand how the flow varies downstream of a turbomachinery blade row
5. Recognize relations between choices made early in the turbomachinery design process and the final components and operability
6. Explain the limits of safe operation of compressors

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	Understand the basics of turbo systems, the energy transformation in them.	II	Understand
CO2	Apply the knowledge on design of centrifugal and axial turbo systems.	III	Applying
CO3	Analyze the turbo systems at different operating conditions.	IV	Analyzing

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2			
CO2			2		3	
CO3			2	3		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.	

Course Contents:

Module 1 **Introduction to Turbomachines:** TurbinesPumps and CompressorsFans and BlowersCompressible Flow MachinesIncompressible Flow MachinesTurbine, Compressor and Fan StagesExtended TurbomachinesAxial StagesRadial StagesMixed Flow StagesImpulse StagesReaction StagesVariable Reaction StagesMulti-stage MachinesStage Velocity TrianglesDesign ConditionsOff-design ConditionsApplications	**Hrs. 6**
Module 2 **Fluid Dynamic Principles:** Equations of Motion (in Cartesian, Cylindrical and Natural Coordinate system) Further notes on Energy Equation, Isentropic Flow through Blade passages, High speed flows, Aero foil Blades.	**Hrs. 7**
Module 3 **Dimensional Analysis and Performance Parameters:** Units and Dimensions, Buckingham's Pi theorem, Principle of similarity, Incompressible flow machines, Compressible flow machines, Performance of Compressors, Fans and Blowers.	**Hrs. 7**
Module 4 **Compressor:** Axial and Centrifugal compressor, Elements of centrifugal compressor stage, stage velocity triangle's, Enthalpy – Entropy diagram, Stage losses and Efficiency, Performance characteristics.	**Hrs. 7**
Module 5 **Axial Fans and Propellers:** Fan Applications, Axial fans, Fan stage parameters, types of Axial fan stages, Propellers, Performance of Axial Fans.	**Hrs. 6**
Module 6 **Centrifugal Fans and Blowers:** Centrifugal Fan stage parameters, Design Parameters, Losses, Fan Drives, Bearings and Noise, Dust Erosion of Fans	**Hrs. 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Understand the basic principles of operation of turbo machines.
2. Understand and apply knowledge of fluid dynamics to compressors, fans and blowers.
3. Perform the dimensional analysis of Turbo Machines.
4. Carry out the Thermal Design of Compressors.
5. Carry out Thermal Design of Axial Fans and Propellers.
6. Carry out Thermal Design of Centrifugal Fans and Blowers.

Title of the Course: PE 2 **Design of Hydro Turbo machines - 4HP515**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. 1.Nechleba M., *"Hydraulic Turbine their Design and Equipments*", Constable & Co., 1957.
2. Lazarkieniz&Troskolanrkis, "*Impeller Pumps"*, Pergamon Press, 1st edition, 1965.
3. Robinson J.A., "*Hydraulic Engineering*", Jaico Publishing House, Bombay, 2nd Edition, 1998

References:

1. Andre Kovats, *"Design and Performance of Centrifugal & Axial flow pumps & Compressors"*, Pergamon, 1st edition. 1964.
2. Stapanoff, A.J., *"Centrifugal & Axial Flow Pumps"*, John Wiely, Rev ed, 1993.
3. Editor Brown, J.G., *"Hydroelectric Engineering Practice"*, Vol-I & II, 1st, edition,1958.

Course Objectives :

1. To enable the students to analyze and solve hydrodynamic machine related problems by applying principles of mathematics, science and engineering.
2. To prepare students to handle various strategic issues related to hydrodynamic machines such as turbines, pumps etc.
3. To train students with effective communication skill to demonstrate hydrodynamic theories.
4. To develop skills in designing the hydrodynamic machine component.

   To develop a professional approach to lifelong learning in the hydrodynamic machine to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Describe: different types of hydrodynamic machines and its component.	I	Remembering
CO2	Apply knowledge of mathematics, science, and engineering for the needs in hydrodynamic machine design.	III	Applying
CO3	Carry out analysis and interpret results.	IV	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**	**1**	1	1	2	1
CO2		**2**	1	**3**	3	2
CO3			2	3	2	2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Introduction to Hydrodynamic Machines Classification of turbines and various forms of turbine runners, Impulse turbines; general theory of impulse machines; performance characteristics, Reaction turbines; general theory of reaction machines; performance characteristics, types; Francis and Kaplan turbines; theory of cavitation flows in hydrodynamic runners. Hydrodynamic pumps; classification of pumps and various forms of pump impellers; general theory of centrifugal pumps; performance characteristics	**7**
Module 2	**Hrs.**
Design of centrifugal pumps, selection of speed, determination of impeller inlet and outlet dimensions, meridional geometry inlet and exit blade angles, blade geometry, mixed flow pumps, elementary pump, design of twisted blade, design of volute, vaned diffuser and return passage, suction spiral,	**7**
Module 3	**Hrs.**
Axial flow pumps, selection of speed, pump casing geometry hub diameter, number of blades and cascade solidity, selection of blade geometry on different flow surfaces, diffuser design.	**6**
Module 4	**Hrs.**
Introduction to hydraulic turbine design, Type series and diameter series, selection of type and diameter, Reaction turbine runner spaces, meridional velocity field, elementary turbines, Hydraulic design of Francis turbine, Choice of basic parameters, Inlet and Outlet edges of runner blade, blade profiles on flow surfaces, shape of blade duct-velocity diagrams on different flow surfaces, certain guide lines to finalize the runner design, Guide wheel, Vane geometry and torque on controlling mechanism, Discharge and circulation, spiral, speed ring, draft tube.	**8**
Module 5	**Hrs.**
Hydraulic design of axial turbine runners, characteristics of some aerofoils, meridional flow field, blade geometry on each flow surface, procedure to finalize the runner design.	**7**

Module 6	**Hrs.**
Hydraulic design of pelton wheel, number of nozzles and their diameter, runner diameter, number of buckets, positioning of buckets, bucket geometry and size,- needle regulator, deflector.	**7**

Module wise Measurable Students Learning Outcomes :

Students should be able to

1. Recall and explain basics of Hydrodynamic Machines
2. Select centrifugal pump, design geometrical and operating parameters of Centrifugal pump.
3. Interpret and design axial flow pump.
4. Carry out design of reaction turbine
5. Explain flow field, blade geometry around runner and its effects on design.
6. Apply and analyze design procedure for Pelton wheel.

Title of the Course: PE 2 **Air-Conditioning System Design** -4HP516	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:Thermodynamics, Fluid Mechanics, Heat Transfer, Refrigeration and Air-Conditioning.

Textbooks:

1 Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.

2 Stoecker, "Refrigeration & Air Conditioning", McGraw Hill, 1992.

3 Arora C.P., "Refrigeration & Air Conditioning", Tata McGraw Hill, 1985.

4. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.

5. Stoecker, "Design of Thermal Systems", McGraw Hill, 1992.

References:

1 "Handbook of air-conditioning system design", Carrier Incorporation, McGraw Hill Book Co., U.S.A, 1965.

2 ASHRAE Handbook.: HVAC Systems and Equipment, 1996.

3 Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand

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.

Course Objectives :

1. To enable the students to analyze and solve air conditioning related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to low temperature systems.
3. To train students with effective communication skill to demonstrate air conditioning theories.
4. To develop skills in the analysis of air conditioning systems in research or design.
5. To develop a professional approach to lifelong learning in the air conditioning to include the awareness of social and environment issues associated with engineering practices

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Apply knowledge of mathematics, science and engineering for the needs in air-conditioning.	III	Applying
CO2	Analyze different Air-Conditioning systems and their characteristics.	IV	Analyzing
CO3	Evaluate the performance and interpret the report in the field of Air-Conditioning..	V	Evaluating.

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			**3**			
CO2			**2**	**2**		
CO3				**1**		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Psychrometry. Moist Air properties , use of Psychometric Chart , Various Psychometrics processes , Air Washer , Adiabatic Saturation. Fundamental properties of air and water vapor mixtures. - Definitions, equations and explanations, psychometric table and charts, Enthalpy deviation curve,psychometric processes and their analysis, SHF, effective surface temperature and bypass factor. Air quality required. Analysis of combination of processes psychometric system. Load Analysis: Inside design conditions, outside design conditions, sensible heat load and latent heat loads, heat gains from infiltration ventilation, solar radiation from walls, occupants and other sources. Heating load, Load estimation chart.	**6**
Module 2	**Hrs.**
Summer And Winter Air Conditioning Air conditioning processes-RSHF, summer Air conditioning, Winter Air conditioning, Applications with specified ventilation air quantity- Use of ERSHF , Application with low latent heat loads and high latentheat loads, performance and selection.	**6**
Module 3	**Hrs.**
Heating &Cooling Load Calculations Introduction, Health & comfort criteria, thermal comfort, air quality, estimating heat loss & heat gain, design conditions, thermal transmission , infiltration & ventilation loads, components of cooling load, internal loads, solar load through transparent surfaces, opaque surfaces, problems. Selection of components and system performance,	**6**
Module 4	**Hrs.**
Air Distribution Flow through Ducts, Static & Dynamic Losses, Air outlets, Duct Design–Equal Friction Method, Duct Balancing, Indoor Air Quality, Thermal Insulation, Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units.	**6**
Module 5	**Hrs.**
Air Handling Equipments Fans, air conditioning apparatus, unitary equipment, accessory equipment, Classification - all air- system, air water system, heat recovery system, radiation panel system, heat pump ,air washers.noise control.	**6**
Module 6	**Hrs.**
Industrial Applications of A.C Major uses of air conditioning of medium sized & large buildings, industrial air conditioning, residential air conditioning, air conditioning of vehicles, food storage & distribution, food	**6**

	processing, pharmaceutical , chemical & process industry, special applications of air conditioning.	

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

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

Title of the Course: PE 2 Gas Turbines - 4HP517	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Thermodynamics, Mathematics, Fluid Mechanics, Numerical Methods

Textbooks:

3. V. Ganesan *"Gas Turbine"* Tata McGraw-Hill Education, 2nd edi. ,2003

References:

1. Cohan, Rogers "*Gas Turbine*" Person, 5th edition. ,2001
2. Dr.Meherwan P. Boyce, P.E *"Gas Turbine Engineering"* Handbook, 3rd edition, 2011.
3. Earl Logan"*Handbook of Turbomachinery*" CRC press, 2003.

Journal

1. *Journal of Turbomachinery* - ASME Pub.
2. *Journal of Engineering for Gas Turbines and Power* - ASME Pub.

Course Objectives :

5. To enable the students to analyze and solve gas turbine related problems by applying principles of mathematics, science and engineering.
6. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to gas turbine systems.
7. To train students with effective communication skill to demonstrate gas turbine theories.
8. To develop skills in the analysis of gas turbine systems in research or design.
9. To develop a professional approach to lifelong learning in the gas turbine to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Apply knowledge of mathematics, science, and engineering for design gas turbine system.	III	Applying
CO2	Analyze different gas turbine systems and their characteristics	IV	Analyzing
CO3	Evaluate the performance of gas turbine systems.	V	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**				**2**	
CO2	**2**			**2**	**2**	
CO3	**2**					**2**

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Gas Turbine Plant: Historical review. Thermodynamic analysis of practical gas turbine cycles. The turboprop engine. The compressor, combustor, turbine and exhaust nozzle characteristics. Performance characteristics of the stationary and turboprop and turbojet engine. The turbojet engine, components. Specific thrust and overall efficiency. Static and flight performance at the design point. Fundamentals of rotating machines. Impulse and reaction machines. The centrifugal compressor: Works done and pressure rise. Design of centrifugal compressor, surge & stall.	**7**
Module 2	**Hrs.**
Axial Flow Compressor: Principle of operation, velocity triangles. Design procedure for single and multistage compressors. Three dimensional effect compressor performance. Description and problems of transonic and supersonic compressors.	**6**
Module 3	**Hrs.**
Turbine: The impulse turbine. Single and multi wheel turbine efficiency, Number of stages blade passages, Vortex design of turbine blades. Blade design & manufacture blade material and blade cooling, limiting factors in turbine design.	**6**
Module 4	**Hrs.**
Combustion in Gas Turbine: Problem to be faced in the design of gas turbine combustion systems. Fuel injection system. Combustion chamber designs. Pressure loss. Temperature distribution, Reaction time, Flame stabilization.	**7**
Module 5	**Hrs.**
Turbine Characteristics: Off design performance of gas turbine plant, Matching of the engine components, equilibrium running diagram. Specific thrust and specific fuel consumption in such case for stationary turbojet and turboprop units.	**7**
Module 6	**Hrs.**
Materials used in Gas Turbine system, Environmental Considerations and Applications, Failure analysis.	**5**

Module wise Measurable Students Learning Outcomes :

Student will be able to

1. Summarize Gas Turbine plant and performance characteristics.
2. Interpret compressors and its design.
3. Select and design various parameters of turbine.
4. Explain combustion phenomenon in Gas Turbine plant and combustion chamber design.
5. Describe Gas Turbine characteristics.
6. Explain Gas Turbine applications in various fields.

Professional Elective (Lab) Courses

Title of the Course: Professional Elective Heat Power Engineering Lab.2 - 4HP552	L	T	P	Cr
	0	0	4	2

Pre-Requisite Courses: Basics and some applications and fluid mechanics. Basic of numerical techniques.

Textbooks:

1. From respective theory courses

References:

1. From respective theory courses

Course Objectives :

1. To introduce the students about the techniques used to measure properties of various substances.
2. To educate the student about use of numerical techniques and commercial tools available for analysis of thermal system.
3. To prepare the student to do experiment and calculate the various parameters in the field of Fluid Mechanics, Heat Transfer.
4. To train the students to analyze the performance of various thermal systems systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Perform the experiments to find thermal properties of given substances.	III	Applying
CO2	Carry out the analysis of various thermal systems by through lab set ups	IV	Analyze
CO3	Evaluate the performances of various thermal systems by conducting experiments.	V	Evaluate

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**3**				
CO2		**2**	**2**	**2**		
CO3			**1**	**2**		

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.

Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Course Contents:
Experiments from PE 1 and PE 2 based on elective selected.

PE1- Computational methods in fluid flow and heat transfer Computational methods in fluid flow and heat transfer (any 10 experiments from given list) 1. Introduction to prediction methods 2. Numerical simulation of 1D conduction problem using FDM. 3. Numerical simulation of 2D conduction problem using FDM 4. Numerical simulation of 1D conduction problem using FVM. 5. Numerical simulation of 2D conduction problem using FVM 6. Numerical simulation of mass diffusion problem using FVM. 7. Study of different schemes used computational methods. 8. Computer programming for numerical simulation of conduction problem using FDM. 9. Computer programming for numerical simulation of conduction problem using FVM. 10. Computer programming for numerical simulation of Convection problem using FVM 11. Computer programming for numerical simulation of mass diffusion problem using FVM	20 Hrs.
PE1- Nuclear Engineering 1. Eight assignments based of theory.	20 Hrs.
PE1- Energy conservation and management 1. Six assignments based of theory. 2. Four case studies: two commercial and two industrial applications	20 Hrs.
PE1- Design of thermal turbo systems 1. Two assignments on first three modules (Total 6 assignments) 2. Trial on two stage air compressor 3. Two assignments each on 5 and 6 modules. (Total 4 assignments) **Note:** Instructor may take some trials or give assignments other than mentioned based on the course modules.	20 Hrs.
PE 2- Design of hydro turbo machines 1. Derivation of Eulers equation for Rotodynamic machines. 2. Study of cavitation phenomenon in hydrodynamic machines. 3. Study of effect of different blade angles and types of runner shapes on performance of hydrodynamic machines. 4. Study of effects of numbers blades in axial flow machines on their performance. 5. Study of design of volute casing in hydrodynamic machines. 6. Study of governing mechanisms in hydraulic machines. 7. Trial on Centrifugal pump. 8. Trial on centrifugal pump in series. 9. Trial on centrifugal pump in parallel. 10. Trial on Pelton Turbine. 11. Trial on Francis Turbine.	20 Hrs.
PE 2- Air conditioning system design	20 Hrs.

1. Design / simulation of residential air conditioning systems. 2. Design and analysis of commercial air conditioning system 3. Design/Simulation of compressors for A.C. systems 4. Design / simulation of Flow through ducting system 5. Performance study of different types of air conditioning systems. 6. Design of ducting systems using different duct designing methods. 7. Cost estimation for air conditioning system. 8. Use of commercially available component/equipment selection soft wares for design of air conditioning system. 9. Air distribution and air distribution testing methods . 10. Study and performance analysis of different types of air outlets.	
PE 2- Gas turbines Gas turbines (any 10 experiments from given list) 1. Trial on Compressor (Centrifugal/Reciprocating/Axial) 2. Study of transonic and supersonic compressors. 3. Study of transonic and supersonic Turbines. 4. Study of materials and manufacturing techniques for gas turbine. 5. Study of different cooling methods used in gas turbine. 6. Study of component matching and performance evaluation in gas turbine. 7. Study on Environmental considerations used in gas turbine design. 8. Sketch a component layout diagram for a turbojet, a turbofan, a turboprop and a gas turbine for power generation. 9. Gas Turbine Thermodynamic and Performance Analysis Methods 10. Study of real time gas turbine model and simulation. 11. Study of design criteria and performance of gas turbine in combined power cycle. 12. Study of commercial tools used to simulate gas turbine system.	20 Hrs.

Professional Core (Theory) Courses

Title of the Course: **Advanced Heat Transfer -** 4HP521	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. S. P. Sukhatme, " A Text Book on Heat Transfer", Universities Press, 4th Edition,2006**.**
2. Yunus. A. Cengel, *"Heat Transfer – A Practical Approach",* Tata McGraw Hill, 3rd Edition, 2006.
3. Incropera and Dewitt, *"Fundamentals of Heat and Mass Transfer"*, Wiley publications, 2nd Edition, 2007.
4. P. K Nag, " Heat and Mass transfer", Tata McGraw Hill, 2nd Edition,

References:

1. Eckert and Drabe, "Analysis of Heat and Mass Transfer", McGraw Hill Higher Education, 2003.
2. Latif M. Jiji, "Heat Conduction", Springer, 3rd edition, 2009.
3. H. Schlichting , K. Gersten, " Boundary Layer Theory" Springer, 8th edition, 2000.
4. J. P. Holman, " Heat Transfer", McGraw Hill Book Company, New York, 1990.
5. Frank Kreith,"Principles of Heat Transfer", Harper and Row Publishers, New York, 1973.
6. Donald Q. Kern, " Process Heat Transfer", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
7. R. C. Sachdeva,"Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., India.

Course Objectives :

1. To provide the student with general techniques to formulate, model and mathematically solve advanced heat transfer problems;
2. To provide the student with a detailed, but not exhaustive, presentation of selected advanced topics in convective heat transfer that are representative of "real world" engineering problems;
3. To introduce basic numerical methods and software tools for solving heat transfer problems.
4. To use appropriate analytical and computational tools to investigate heat and mass transport Phenomena.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Understand the physical modeling aspects of heat transfer and an ability to make the appropriate choice between exact and approximate calculations in solving problems of heat transfer in complex systems.	II	Understanding
CO2	Identify the analogy of flow and momentum diffusion to heat and mass transfer and identify the interdisciplinary character of real-life thermal engineering.	I	Remembering
CO3	Analyze heat transfer in complex internal flow systems and in boundary layers and external flow configurations	IV	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**		**1**			
CO2		**2**		**2**		
CO3		**1**				

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Conduction- One and Two Dimension.	**7**
Module 2	**Hrs.**
Fins, conduction with heat source, unsteady state heat transfer.	**6**
Module 3	**Hrs.**
Natural and forced convection, integral equation, analysis and analogies.	**6**
Module 4	**Hrs.**
Transpiration cooling, ablation heat transfer, boiling, condensation and two phase flow mass transfer, cooling, fluidized bed combustion.	**6**
Module 5	**Hrs.**
Heat pipes, Radiation, shape factor, analogy, shields.	**7**
Module 6	**Hrs.**
Radiation of gases, vapors and flames, Network method of analysis for Radiation Problem.	**7**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

The students are expected to understand the subject of Heat Transfer in detail with capability to solve Industrial Problems. This will also base and interest among the students to carry out the Future Research. Student will be able to

1. Interpret Heat Transfer by conduction and advances in conduction.
2. Analyze Heat Transfer by forced convection.
3. Explain Heat Transfer by Radiation.
4. Summarize Condensation and boiling phenomenon.
5. Paraphrase Heat Transfer by natural convection.
6. Apply knowledge of Heat transfer to design and evaluate the performance of thermal system.

Title of the Course:	L	T	P	Cr
Steam Engineering - 4HP522	3	0	0	3

Pre-Requisite Courses:

Textbooks:

1. T. D. Estop, A. McConkey, *Applied Thermodynamics*, Parson Publication.
2. Domkundwar; *A Course in Power Plant Engineering*; DhanapatRai and Sons.
3. Yunus A. Cengel and Boles, "*Engineering Thermodynamics* ", Tata McGraw-Hill Publishing Co. Ltd.

References:

1. Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy Efficiency.
2. Edited by J. B. Kitto& S C Stultz; *Steam: Its Generation and Use*; The Babcock and Wilcox Company.
3. P. Chatopadhyay; *Boiler Operation Engineering: Questions and Answes*; Tata McGrawHill Education Pvt Ltd, N Delhi

Course Objectives :

1.To analyze different types of steam cycles and estimate efficiencies in a steam power plant.
2.To design pipe insulation trough proper selection of materials with the help of basic heat transfer theory.
3.To access boiler performance for different loading conditions.
4.To develop a professional approach for lifelong learning in the steam engineering to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Descriptor
CO1	Explain working of different boilers and significance of mountings and accessories. and to use techniques, skills, and modern engineering tools necessary for boiler performance assessment	I	Remembering
CO2	Design a steam piping system, its components for a process and also design economical and effective insulation. And to analyze a thermal system for sources of waste heat design a systems for waste heat recovery	III	Applying
CO3	Design and develop controls and instrumentation for effective monitoring of the process	IV	Analyzing

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	2	1	2	1
CO2	1	1	1	3	2	2
CO3	1	1	2	3	3	2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Introduction 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.	**Hrs 7**
Module 2 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.	**Hrs 8**
Module 3 Steam Systems Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipment's Systems.	**Hrs 8**
Module 4 Boiler Performance Assessment Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.	**Hrs 8**
Module Energy Conservation and Waste Minimization Energy conservation options in Boiler; waste minimization, methodology; economic viability of waste minimization.	**Hrs 5**
Module 6 Instrumentation & Control Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments, its selection.	**Hrs 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. UnderstandFundamentals of steam generation and other necessary factors.
2. design pipe insulation trough proper selection of materials with the help of basic heat transfer theory
3. Understand the working principles of different steam systems through leakages and losses.
4. Analyze boiler performance and factors affecting it.
5. Comprehend Energy Conservation and Waste Minimization
6. Select different types of instruments for various applications.

Professional Core (Lab) Courses

Title of the Course: Heat Power Engineering lab 3-**4HP571**	L	T	P	Cr
	0	0	4	2

Pre-Requisite Courses: Thermodynamics, Heat Transfer, Power plant Engineering, Automobile Engineering

Textbooks:

1. P. K. Nag "*Thermodynamics*", Tata McGraw Hill Publication, 2006, 3rd Edition.
2. V. P. Vasandani and D. S. Kumar, "*Heat Engineering*", Metropolitan Book Company, 1975, 2nd Edition.
3. R. Yadav, "Fundamentals of Thermodynamics", Central Publication house, Allahabad, 2011, Revised 7th Edition.
4. Ganeshan, "*Internal Combustion Engines*" Tata Mac Hill Publication, 1999, 2nd edition.
5. Mathur and Sharma, "*Internal Combustion Engines*" DhanapatRai publication, 2000, 2nd edition.
6. R. K. Rajput, "*Internal Combustion Engines*" Laxmi Publications, 2005, 3rd edition.

References:

1. Cengel and Boles, "Thermodynamics an engineering Approach", Tata McGraw-Hill publication, 2011, Revised 7th Edition.
2. R. Yadav, "Thermodynamics and heat engine", Central Publication house Allahabad, 2007, Revised 7th Edition.
3. R. Yadav, "Steam and Gas Turbine", Central Publication house, Allahabad, 2010, Revised 7thedition.
4. F. Obert, "*Internal Combustion Engines and Air Pollution*", In-text Educational Publishers, 1973 1st edition.
5. John B Heywood, "*Internal Combustion Engines fundamentals*", McGraw-Hill, Revised 2nd Edition, 1988.
6. Maleev J P, "*Internal Combustion Engines Theory and design*", McGraw-Hill, Revised 2nd Edition, 1945.

Course Objectives :

Students should be able to

1. To learnthe techniques to find physical properties of the oils, greases, and solid fuels used insteam generators.
2. To apply laws of thermodynamics to various thermodynamic devices.
3. To develop the skills for evaluating performance of thermodynamics systems.
4. Demonstrate the engine components, systems and its constructional details
5. To measure parameters of the Engines performance
6. Explain the role of parameters affecting volumetric efficiency, valve timing, and port design
7. Make the analysis of working of the engine by studying exhaust gas analysis.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive level	Bloom's Cognitive Descriptor
CO1	**Apply** the techniques to determine the properties of fluids used in various industrial Systems such as Mechanical Power Production systems. **Classify and examine**the IC engine components and systems	III	Applying
CO2	Estimate the calorific value of a given fuel by using Bombcalorimeter.	IV	Analyzing

	To **study and test**the tools / techniques / instruments for measuring theperformance parameters of engine		
CO3	**Estimate and measure** performance of thermal systems by conducting the test on steam power plant to determine plant and component efficiencies. Asses the performance characteristics during testing.	V	Evaluating

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1		**3**				
CO2		**2**	**2**	**2**		
CO3			**1**	**2**		

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.

Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Course Contents:

1. List of Experiments for course Advance Heat transfer**(Minimum 8 Expt.)** 2. Determination of thermal conductivity: Composite wall apparatus 3. Determination of thermal conductivity- Solids. 4. Determination of thermal conductivity- fluids 5. Determination of forced convection heat transfer coefficient. 6. Determination of free convective heat transfer coefficient 7. Determination of Emissivity of a given surface 8. Heat transfer through extended surfaces. 9. Determination of Stefan –Boltzmann constant: Stefan –Boltzmann Apparatus 10. Pool Boiling and critical heat flux 11. Performance study of cooling tower 12. Unsteady state heat transfer apparatus.	**20 Hrs.**
List of Experiments for course Steam engineering**(Minimum 8 Expt.)** 1. Study of different boiler mountings and accessories through available educational models. 2. Determination of adiabatic flame temperature of different fuels at constant volume and constant pressure conditions. 3. Study and understanding of boiler regulations and boiler standards. 4. Design of piping for steam line. 5. Design of proper insulation on piping through heat transfer considerations. 6. Trial on steam power plant to calculate boiler efficiency. 7. Trial on steam power plant to calculate isentropic efficiency of single stage impulse turbine. 8. Trial on steam power plant to calculate condenser effectiveness. 9. Study and demonstration of working principle of cooling tower and calculation of cooling tower performance. 10. Study of different losses in boiler.	**20 Hrs.**

	11. Study of different methods of energy conservation in all components of steam power plant unit. 12. Study of different types of flow, pressure and temperature measuring instruments.	

Title of the Course: Industrial Project 4HP572	L	T	P	Cr
	-	-	4	2

Pre-Requisite Courses:

Textbooks: As per topic Selected and Journal papers, Conference papers, Handbooks.

References: As per topic Selected and Journal papers, Conference papers, Handbook.

Course Objectives:

1. To Review and increase students' understanding of the specific topics.
2. To induce Learning management of values.
3. To teach how research papers are written and read such papers critically and efficiently and to summarize and review them to gain an understanding of a new field, in the absence of a textbook.
4. To teach how to judge the value of different contributions and identify promising new directions in specified area.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		Level	Descriptor
CO1	Apply the existing knowledge on real life problems	III	Applying
CO2	Investigate the selected topic/ system.	IV	Analyzing
CO3	Verify the outcomes of the work have solved the specified problems.	V	Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	2	2	1			
CO2	3				1	
CO3		3			2	

Assessment:

There are four components of assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Project Progress	Course Faculty/ Industrial Guide	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Project Progress	Course Faculty/ Industrial Guide	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Project Progress	Course Faculty/ Industrial Guide	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Project Progress	Course Faculty/ Industrial Guide	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.

Project activities/Project performance shall include literature review, problem statement, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the industrial project.

Course Contents:

The industrial project work will start in semester II and should be an industrial problem with research potential and should involve scientific research review, design, generation/collection and analysis of data,

determining solution and must preferably bring out the individual contribution. Student should undergo industrial project in registered company/organization after consulting with faculty guide assigned by the department. Industrial project should be based preferably in the area in which the candidate is interested to undertake the dissertation work. The student has to be in regular contact with guide and the topic of industrial project must be mutually decided. The examination shall consist of the preparation of report consisting literature review, detailed problem statement, methodology, etc, according to type of work carried out. The work has to be presented in front of the examiners panel formed by DPGC for evaluation.

Professional Elective (Theory) Courses

Title of the Course: PE 3 **Internal Combustion Engine Design** -4HP531	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Mathematics,Thermodynamics, Fluid Mechanics, Heat Transfer

Textbooks:

1. J. B. Heywood *I. C Engine Fundamentals",* Tata McGraw Hill Pub.1st edition 1998.
2. V. Ganesan, 'Internal Combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.

References:

1. F. Obert, "*Internal Combustion Engines and Air Pollution*", In-text Educational Publishers, 1st edition 1973.
2. P. M. Heldt, *"High Speed Combustion Engines",* Chilton company 4th edition 1956.
3. Colin Fergusson, Allan Kirkpatrick, "Internal Combustion Engines" Wiley Publication.

Course Objectives :

At the end of the course:

1. To enable the students to analyze and solve I.C.Engine related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related I.C.Engine systems.
3. To train students with effective communication skill to demonstrate I.C.Engine theories.
4. To develop skills in the analysis of I.C.Engine systems in research or design.
5. To develop a professional approach to lifelong learning in the I.C.Engine to include the awareness of social and environment issues associated with engineering practices

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Apply the knowledge of mathematics, science, and engineering for the needs in I.C.Engine.	III	Applying
CO2	Analyse diffeAnalyse the I C engine systems and its design report	IV	Analyzing
CO3	Evaluate performance of I.C. Engines under different conditions and interpret the reports.	V	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1					2	
CO2		2		3		
CO3	1		2			2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50
ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.	

Course Contents:

Module 1 **Introduction to Engine Design:** Engine selection, basic data for design like power torque, speed, mean effective pressure, air consumption, fuel consumption, stroke to bore ratio, heat distribution, exhaust temperature, power to weight ratio, rating and de-rating for four-stroke and two-stroke engines.	**Hrs. 6**
Module 2 **Design Considerations:** Combustion chamber design considerations for S.I. and C.I. engines. Thermal and Mechanical design of cylinder, piston, piston rings, cylinder head, valves, Mechanical design of connecting rod, crankshaft and crank case. Design considerations for fuel injection and governing systems; cooling and lubrication systems	**Hrs. 7**
Module 3 **Simulation of I.C. Engine Processes** Simulation, S.I. Engine simulation with air as working medium, simulation with adiabatic combustion. Definitions of progressive combustion model, gas exchange process model and heat transfer process model	**Hrs. 6**
Module 4 **Carburetion and Injection:** Carburetion Mixture characteristics ,distribution, Carburetor systems, Carburetor and stratified charge engines, S.I. Engine fuel injection system and type, Modern Carburetor designs and air Pollution control, altitude compensation. **Stratified Charged Engine:** General characteristics, methods of stratification, applications, advantage and disadvantages **Injection Systems:** Design, Bosch distribution pump, Cummins- P-T injection system, Spray characteristics ,quantity of fuel per cycle, types of nozzles, injection timing, fuel line hydraulics, determination of pressure time and velocity time functions, effect of elasticity of pipe and fuel	**Hrs. 7**
Module 5 **Lubrication System:** Design,Lubrication principles, properties of lubrication oil, c1assification, additives, lubrication system, types of pumps and filters, crank case ventilation. **Cooling System:** Design,Heat transfer in I.C. engines, piston and cylinder temperatures, heat rejected to coolant, comparison of air and water cooling, temperature distribution for air and water cooled engine across the cylinder wall, cooling system types and components, water treatment, antifreeze Additives.	**Hrs. 7**

Ignition System: Requirements, battery ignition, magneto ignition and electronic ignition systems, centrifugal and vacuum advance; spark plug types and selection, firing order and its importance. **Intake and Exhaust System:** Functions components, piping layouts, materials and sizing, exhaust purifiers. **Governing System:** Types, limiting speed, variable speed, hydraulic, pneumatic and electrical governors	
Module 6 **Other Engine Designs** **Wankel Engine:** Working principle, engine geometry, engine scaling, lubrication, cooling, induction, ignition systems, combustion in rotary engine, performance, advantages and applications **Stirling Engine:** Working principle of two piston engine, advantages and disadvantages	**Hrs 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Summarize various engine design parameters.
2. Interpret various design consideration and decide various parameters.
3. Carry out the I.C Engine simulation.
4. Identify and explain the carburetion and injection system used.
5. Describe lubrication, intake and exhaust, cooling and governing system used in I. C. Engine.

6 Explain other engine designs and their applications.

Title of the Course: PE 3 **Design of Heat Exchangers -4HP532**	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Fundamentals of heat transfer and fluid mechanics

Textbooks:

1. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley and sons Inc., 2003.

References:

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

Course Objectives :

1. Enable the students to analyze and solve heat exchanger problems by applying principles of mathematics, science and engineering.
2. Prepare students to use modern tools, techniques and skills to fulfill industrial needs related to design of heat exchanger.
2. Train students with effective communication skill to demonstrate heat exchanger theories.
3. Develop skills in the analysis of heat exchanger with mathematical modeling for applications in research or design.
4. Develop a professional approach to lifelong learning in the heat exchangers to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to;**	Bloom's Cognitive	
		level	Descriptor
CO1	**Apply** fundamental knowledge of mathematics, science, and engineering for the needs in heat exchanger designing.	III	Applying
CO2	Thermal and Hydraulic **design**of different types of heat exchangers	IV	Analyzing
CO3	Mechanical Design of Heat Exchangers	V	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**					
CO2	**3**	**2**				2
CO3	**3**		2	2		

Assessments :

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weightage respectively.

Assessment	Marks
ISE1	10
MSE	30
ISE2	10
ESE	50

ISE 1 and ISE 2 are based on assignment, oral, seminar, test (surprise/declared/quiz), and group discussion.[One assessment tool per ISE. The assessment tool used for ISE 1 shall not be used for ISE 2]
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 : Types of heat exchanger	**Hrs.**
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.	**6**
Module 2: Heat exchanger design methodology	**Hrs.**
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.	**6**
Module 3 : Compact and **Double Pipe Heat Exchangers**	**Hrs.**
Thermal and Hydraulic design of compact heat exchanger. Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop.	**7**
Module 4 : Direct-contact heat exchanger, cooling towers	**Hrs.**
Relation between the wet-bulb and dew point temperatures - The Lewis number -Classification of cooling towers cooling-tower internals and the role of fill – Heat exchange heat transfer by simultaneous diffusion and convection - Analysis of cooling towers measurements - Design of cooling towers - Determination of the number of diffusion units - Calculation of cooling tower performance - The influence of process conditions upon design - The influence of operation tables.	**6**
Module 5 :Shell and Tube heat exchangers	**Hrs.**
Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers	**6**
Module 6:Mechanical Design of Heat Exchangers	**Hrs.**
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.	**7**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. **Applying** the basics of heat Exchangers
2. Formulation of **design** equations and its solution methodology
3. Thermal and hydraulic **analysis** of compact and double pipe heat exchanger
4. **Design** of direct-contact heat exchanger
5. Thermal and Hydraulic **design** of shell and tube heat exchanger
6. Mechanical **Design** of Heat Exchangers

Title of the Course: PE 3 **Industrial Refrigeration -** 4HP533	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Thermodynamics, Fluid Mechanics, Heat Transfer

Textbooks:

1. *C. P.* Arora *, "Refrigeration and Air conditioning",* Tata Mcgraw Hill Education Private Limited , third edition,2008.
2. Wilbert F. Stoecker, *Industrial refrigeration handbook*, Mcgraw-hill Professional Publishing 1st edition., ,1998

References:

1. Roy J. Dossat "*Principals ofRefrigeration",* Pearson, 4th edition, 2007
2. *ASHRAE Hand Book*: Refrigeration, 1998.
3. ASHRAE Hand Book: HVAC Systems and Equipment, 1996.
   Journal of Air conditioning and refrigeration- ISHRAE, ASHRAE.

Course Objectives :

1. 1. To enable the students to analyze and solve refrigeration related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to refrigeration systems.
3. To train students with effective communication skill to demonstrate refrigeration/ theories.
4. To develop skills in the analysis of refrigeration systems in research or design.
5. To develop a professional approach to lifelong learning in the refrigeration/ to include the awareness of social and environment issues associated with engineering practices.

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Apply knowledge of mathematics, science, and engineering for the needs in Refrigeration .	III	Applying
CO2	Analyze different Refrigeration systems and their characteristics	IV	Analyzing
CO3	Evaluate the performance of different refrigeration systems	V	Evaluating

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**			**1**		
CO2	**2**		**2**	**2**		
CO3			**1**	**2**		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Industrial refrigeration as distinguished from comfort air-conditioning, What is industrial refrigeration, Refrigerated storage of unfrozen food, Frozen food, Refrigeration in food processing, freeze drying, Refrigeration in manufacturing plant, Refrigeration in construction, Refrigeration in chemical industry. low temperature applications like manufacture of ice cream,	**6**
Module 2	**Hrs.**
Carnot cycle ,conditions for high cop of Carnot cycle ,Steady flow energy equation, Analysis of Carnot cycle using refrigerant enthalpies, Dry vs wet compression, The standard vapor compression cycle, Variations in standard vapor compression cycle, Usefulness of thermodynamic foundation.	**7**
Module 3	**Hrs.**
Reciprocating, scroll and screw compressor: Multistage industrial applications, cylinder arrangement, cooling methods - oil injection and refrigeration injection, capacity regulations - Economizers.	**6**
Module 4	**Hrs.**
Types of Evaporators, Liquid circulation: Mechanical pumping and gas pumping - advantage and disadvantage of liquid re-circulation - circulation ratio - top feed and bottom feed refrigerant - Net Positive Suction Head (NPSH) - two pumping vessel system - suction risers – design - piping loses. Different Industrial Condensers arrangement, Evaporators- Types and arrangement, liquid circulation, type of feed, refrigerant piping design, functional aspects. Lubricating oil: types - physical properties, types of circulation and oil separator. Cfc, noncfc and natural refrigerants and its applications.	**7**
Module 5	**Hrs.**
Vessels in industrial refrigeration: High pressure receiver - flash tank - liquid and vapor separator - separation enhancers - low pressure receivers - surge drum - surge line accumulator thermosyphon receiver - oil pots	**6**
Module 6	**Hrs.**
Conservation and design considerations - source of losses - critical thickness - insulation cost and energy cost - vapor barriers – construction methods of refrigerated spaces. energy efficient components - heat reclaim - thermal storage: ice builder and ice harvester. Insulation.	**7**

Module wise Measurable Students Learning Outcomes :

Student will be able to

1. Summarize basics of refrigeration, thermal principles, and vapor compression systems.
2. Explain industrial refrigeration requirements, classification and applications.
3. Make decision regarding selection of compressors, and related operations.
4. Summarize components of system & interpret liquid circulation methods.
5. Explain vessels & receivers of refrigeration system.
6 Understand various design consideration of industrial refrigeration system.

Title of the Course: PE 4 **Cryogenics** - 4HP534	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses: Thermodynamics, Fluid Mechanics, Refrigeration and Air Conditioning, Het Transfer, Mathematics

Textbooks:

1. Barron. R.F. *Cryogenic Systems,* McGraw-Hill, 2nd edition 1985.

References:

1. Thomas M. Flynn, "*Cryogenic Engineering*", Marcel Dekker. Inc New York illustrated edition 1997.
2. Marshall Sittig, D. Van Nostrand Co. "*Cryogenics - Research and Applications*", Princeton N.J, Van Nostrand . 1963Scott, R. B, *Cryogenic Engineering*, Scott, R. B. D'Van-Nostrand, 1962.
3. Vance, R. W., *Applied Cryogenic Engineering, ,* John Wiley and sons, 1st edition 1962.
4. M. Sitting , "*Cryogenic*", D' Van-Nostrand company, 1st edition 1963.

Course Objectives :

1. To enable the students to analyze and solve cryogenics related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to low temperature systems.
3. To train students with effective communication skill to demonstrate cryogenics theories.
4. To develop skills in the analysis of cryogenics systems in research or design.
5. To develop a professional approach to lifelong learning in the refrigeration/air conditioning/cryogenics to include the awareness of social and environment issues associated with engineering practices

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Apply knowledge of mathematics, science, and engineering for the needs in Cryogenic.	III	Applying
CO2	Analyze different Cryogenic systems.	IV	Analyzing
CO3	Evaluate and interpret the analysis reports in the field of Cryogenic	V	Evaluating

CO-PO Mapping :

	PO1	PO2	PO3	PO4	PO5	PO6
CO1					1	
CO2	**2**	**2**	2	**2**		
CO3	**2**					1

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1 Cryogenic fluids and applications	**Hrs.**
Introduction, properties of cryogenic fluids, properties of materials used in cryogenics at lower temperature, superconductive materials, applications of cryogenics, cryogenic space technology, space simulation, cryogenics in biology & medicines.	**6**
Module 2 Gas Liquefaction	**Hrs.**
Gas liquefaction & refrigeration systems, Basics of refrigeration & liquefaction, ideal thermodynamic cycle, Joule Thomson effect, adiabatic expansion, various liquefaction cycles, Liquefaction systems for air, Neon, Hydrogen & Helium gas, Effect of components' efficiencies on system performance.	**8**
Module 3 Gas Separation and Purification	**Hrs.**
Gas separation and purification – principles, Gas separation systems for air, hydrogen, and helium.	**6**
Module 4 Cryocoolers	**Hrs.**
Cryogenic refrigeration systems, Ideal and practical systems, Joule-Thompson cryocoolers, Stirling Cycle Refrigerators, Gifford-McMahon Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Dilution refrigerators.	**8**
Module 5 Cryogenic fluid storage and transfer systems	**Hrs.**
, Cryogenic Dewar, Cryogenic Transfer Lines, Two phase flow in cryogenic transfer system, Insulations used in Cryogenic Systems	**6**
Module 6 Instrumentation and safety	**Hrs.**
Instrumentation in cryogenics to measure Flow, Level and Temperature, Introduction to vacuum technology, safety in cryogenics	**6**

Module wise Measurable Students Learning Outcomes :

1. Illustrate use of cryogenics in various field of engineering.
2. Detail study of gas liquefaction process.
3. Study of different gas separation and purification processes.
4. Understanding and application of cryogenic equipment.
5. Transportation and storage of cryo fluids.
6. Study of different instruments used in cryotechnology.

Title of the Course: PE 4 **Modelling of Internal Combustion Engines** - 4HP535	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:Mathematics,Thermodynamics, Fluid Mechanics, Heat Transfer

Textbooks:

1. J.B.Heywood, 'Internal Combustion Engine Fundamentals', McGraw Hill Book Co, 1988.
2. V. Ganesan, 'Internal Combustion Engines', Tata McGraw Hill Book Co, Eighth Reprint, 2005.

References:

1. Heywood, "I.C. Engines", McGraw Hill.
2. Ramos J (1989**), "**Internal Combustion Engine Modeling**",**Hemisphere Publishing Company
3. C. D. Rakopoulos and E. G. Giakoumis, "Diesel Engine Transient Operation".
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 RodicaBaranescu, "Diesel Engine Reference Book" Butterworth-Heinemann, 1999.

Course Objectives :

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 modelled engines

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Apply knowledge of basic I C Engine to model SI and CI Engine	III	Applying
CO2	Analyze the different Engine processes	IV	Analyzing
CO3	Evaluate the Engine cycle parameters for different conditions	V	Evaluate

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1				3	
CO2		2		3		
CO3		1			2	2

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50
ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc. MSE: Assessment is based on 50% of course content (Normally first three modules) ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.	

Course Contents:

Module 1 **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.	**Hrs. 7**
Module 2 **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.	**Hrs. 7**
Module 3 **Fuel spray behavior:** Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, droplet impingement on walls.	**Hrs. 7**
Module 4 Modeling of charging system: Constant pressure and pulse turbo charging, compressor and turbine maps, charge air cooler.	**Hrs. 7**
Module 5 **Mathematical models of SI Engines**: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Autoignitionmodeling, 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.	**Hrs. 6**

Module wise Measurable Students Learning Outcomes :

After the completion of the course the student should be able to:

1. Understand the fundamentals of Governing Equations relating to Engine Processes.
2. Demonstrate the thermodynamic combustion model of I C Engine.
3. Understand the Fuel spray behavior and related parameters.
4. Apply the models to different systems.
5. Analyze the Engine cycles.

Title of the Course: PE 4 **Industrial Air-Conditioning -** 4HP536	L	T	P	Cr
	3	0	0	3

Pre-Requisite Courses:Thermodynamics, Fluid Mechanics, Heat Transfer, Refrigeration and Air-Conditioning.

Textbooks:

1 Manohar Prasad, "Refrigeration & Air Conditioning", New Age Publishers.
2 Stoecker, "Refrigeration & Air Conditioning", McGraw Hill, 1992.
3 Arora C.P., "Refrigeration & Air Conditioning", Tata McGraw Hill, 1985.
4. "Refrigeration and air-conditioning", ARI, Prentice Hall, New Delhi, 1993.
.

References:

1 ASHRAE Handbook.: HVAC Systems and Equipment, 1996.
2 Hainer R.W., "Control Systems for Heating, Ventilation and Air-Conditioning", Van Nostrand
3 Norman C. Harris, "Modern Air Conditioning", New York, McGraw-Hill,1974.
4 Jones W.P., "Air Conditioning Engineering", Edward Arnold Publishers Ltd., London,1984.
5 Carrier Hand Book.
6 Roy J Dossat " Principles of Refrigeration.

Course Objectives :

1. To enable the students to analyze and solve air conditioning related problems by applying principles of mathematics, science and engineering.
2. To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to air-conditioning..
3. To train students with effective communication skill to demonstrate air conditioning theories.
4. To develop skills in the analysis of air conditioning systems in research or design.
5. To develop a professional approach to lifelong learning in the air conditioning to include the awareness of social and environment issues associated with engineering practices

Course Learning Outcomes:

CO	**After the completion of the course the student should be able to**	Bloom's Cognitive	
		level	Descriptor
CO1	Apply knowledge of mathematics, science and engineering for the needs in air-conditioning.	III	Applying
CO2	Analyze different Air-Conditioning systems and their characteristics.	IV	Analyzing
CO3	Evaluate the performance and interpret the report in the field of Air-Conditioning..	V	Evaluating.

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**			**3**		
CO2	**2**		**2**	**2**		
CO3			**1**	**1**		

Assessments :

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 70-80% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1	**Hrs.**
Psychrometery: moist air properties; mass transfer and evaporation of water into moist air; theory of psychrometer; correlation of w.b.t. with temperature of adiabatic saturation; Lewis number; construction of psychrometric chart.	**6**
Module 2	**Hrs.**
Heat and Mass Transfer: Direct contact transfer equipment; simple air washer and indirect evaporative cooling contact mixture principle; enthalpy potential; basic equation for direct contact transfer equipment; graphical and analytical methods for heat and mass transfer analysis of air washers with heated and chilled water sprays; cooling towers. Extended Surface Heat Transfer Apparatus: Cooling and Dehumidifying coils, Design of finned surfaces, Adsorption cooling systems..	**6**
Module 3	**Hrs.**
Ventilation: Necessity; ventilation standards; natural and mechanical ventilation; forces for natural ventilation; general ventilation rules; advantages of mechanical ventilation; various methods; ejector systems; determining ventilation requirement; use of decay equation.	**6**
Module 4	**Hrs.**
Air Cleaning: Physical and chemical vitiation of air; permissible concentration of air contaminants; mechanical and electronic air cleaners; dry and wet filters; air sterilization; odour control. Steam Heating Systems: Elements of steam, water and warm-air heating systems; radiators and convectors. Design of a year-round air conditioning system.,	**6**
Module 5	**Hrs.**
Air handling Equipment: Fans & Duct System Characteristics, Fan Arrangement Variable Air Volume systems, Air Handling Units and Fan Coil units. air conditioning apparatus, unitary equipment, accessory equipment, Noise control.Piping and Ducts: Pressure drops in piping and fittings; design of water and refrigerant piping; Air conditioning duct design methods.	**6**
Module 6	**Hrs.**
Industrial Applications: Major uses of air conditioning for medium sized & large industrial buildings. Application of air conditioning in Pharmaceutical, textile, electronic, precision tool room and paper industry.	**6**

Module wise Measurable Students Learning Outcomes :
After the completion of the course
1. Student should understand psychrometric principles of Air-conditioning system.
2. Student should understand application of heat and mass transfer principles in air conditioning.
3. Student should understand ventilation requirements for various applications.
4. Student should analyze air cleaning method required for the specific application.
5. Students should apply the knowledge of air conditioning equipment in the design of air conditioning system for the given application.
6. Students should understand air conditioning requirement of the specific industry.

Professional Elective (Lab) Courses

Title of the Course: Professional Elective Heat Power Engineering Lab.4 - 4HP573	L	T	P	Cr
	0	0	4	2

Pre-Requisite Courses: Basics and some applications and fluid mechanics. Basic of numerical techniques.

Textbooks:

1. From respective theory courses

References:

1. From respective theory courses

Course Objectives :

1. To introduce the students about the techniques used to measure properties of various substances.
2. To educate the student about use of numerical techniques and commercial tools available for analysis of thermal system.
3. To prepare the student to do experiment and calculate the various parameters in the field of Fluid Mechanics, Heat Transfer.
4. To train the students to analyze the performance of various thermal systems systems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Perform the experiments to find thermal properties of given substances.	III	Applying
CO2	Carry out the analysis of various thermal systems by through lab set ups	IV	Analyze
CO3	Evaluate the performances of various thermal systems by conducting experiments.	V	Evaluate

CO-PO Mapping :

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**3**				**1**
CO2		**2**	**2**	**2**		**1**
CO3			**1**	**2**		**1**

Lab Assessment:

There are four components of lab assessment, LA1, LA2, LA3 and Lab ESE.

IMP: Lab ESE is a separate head of passing.

Assessment	Based on	Conducted by	Conduction and Marks Submission	Marks
LA1	Lab activities, attendance, journal	Lab Course Faculty	During Week 1 to Week 4 Submission at the end of Week 5	25
LA2	Lab activities, attendance, journal	Lab Course Faculty	During Week 5 to Week 8 Submission at the end of Week 9	25
LA3	Lab activities, attendance, journal	Lab Course Faculty	During Week 10 to Week 14 Submission at the end of Week 14	25
Lab ESE	Lab Performance and related documentation	Lab Course faculty	During Week 15 to Week 18 Submission at the end of Week 18	25

Week 1 indicates starting week of Semester.

Lab activities/Lab performance shall include performing experiments, mini-project, presentations, drawings, programming and other suitable activities, as per the nature and requirement of the lab course.

Course Contents:
Experiments from PE 3 and PE 4 based on elective selected.

PE 3 - IC engine design 1. Study Constructional details of I.C. Engines by Dismantling and assembly of I.C .engine. 2. Study of Various systems of I C Engine (air inlet, exhaust, cooling, lubrication, Fuel supply, Ignition, starting – SI and CI Engines) 3. Study of fuel injection system of diesel engine. 4. Trail on 1 cy diesel Engine. (non-computerized) 5. Trail on 1 cy diesel engine (computerized) 6. Trail on multi cylinder four stroke petrol engine. 7. Assignment on Design of intake and exhaust manifold system 8. Assignment on Thermal design of Piston, Connecting Rod, 9. Assignment on Thermal design of Crankshaft, camshaft and cylinder head. 10. Assignment on Design of Fuel injection system. **Note:** Instructor may take some trials or give assignments other than mentioned based on the course modules.	20 Hrs.
PE 3 - Design of heat exchanger Design of heat exchanger (any eight) 1. Study/trial on double pipe heat exchanger 2. Study/ trial on shell and tube heat exchanger 3. Study/trial on shell and screw heat exchanger 4. Study/trial on baffled heat exchanger 5. Study/trial on compact heat exchanger 6. Thermal analysis of calorimeter 7. Study/trial on cooling tower 8. Study/trial for performance comparison compact heat exchanger 9. Study/trial on cross flow heat exchanger 10. Study/trial on fine tube heat exchanger 11. Design of heat exchanger using standards and code	20 Hrs.
PE 3 - Industrial refrigeration ((any 10 experiments from given list) 1. Trial on refrigeration tutor. 2. Trial on cascade system. 3. Trial on ICE plant 4. Trial on multi evaporator system. 5. Trial on Fault simulator. 6. Design/Simulation of domestic refrigeration systems 7. Design and analysis commercial refrigeration systems 8. Performance study of Cold room 9. Visit to Cold Storage unit 10. Visit to Milk processing and Storage unit 11. Visit to Commercial refrigeration Equipment manufacturing unit.	20 Hrs.
PE 4–Cryogenics 1. Study/Demonstration of behavior of material at cryogenic temperature 2. Study/demonstration of applications of cryogenics 3. Study/ demonstration of cryocooler 4. Study/trial on pulse tube cryocooler 5. Study/demonstration of cryogenic storage system 6. Study/demonstration of cryogenic insulators 7. Study/demonstration of vacuum system	20 Hrs.

8. Simulation of cryocooler 9. Study/demonstration of measurement.	
PE 4 - Modeling of IC engines 1. Study of different Modeling techniques. 2. Modeling of Internal Combustion Engine processes SI and CI Engines 3. Simulation of Otto Cycle with Air as working medium 4. Simulation of Otto Cycle with Adiabatic combustion 5. Simulation of Otto Cycle with Progressive combustion 6. SI Engine simulation with Gas exchange processes 7. Simulation of Diesel Cycle with Air as working medium 8. Simulation of Diesel Cycle with Adiabatic combustion 9. Simulation of Diesel Cycle with Progressive combustion 10. CI Engine simulation with Gas exchange processes	20 Hrs.
PE 4 - Industrial air conditioning (any 10 experiments from given list) 1. Trial on Air Conditioning Tutor. 2. Trial on Central AC plant. 3. Visit to Central air conditioning plant for a Mall . (Study of Design, installation and Performance of the system) 4. Visit to Central air conditioning plant for Theatre. (Study of Design, installation and Performance of the system) 5. Visit to automobile air conditioning service station. 6. Analysis of air distribution in air conditioned room. 7. Clean rooms and its applications. 8. Selection of air conditioning systems for different applications. 9. Air conditioning applications of heat Pumps. 10. Energy analysis for air conditioning system –Case study 11. Determination of pressure loss and heat loss through ducting system	20 Hrs.

Mandatory Life Skill Courses

Title of the Course: Constitution of India 4IC601	L	T	P	Cr
	02	-	-	-

Pre-Requisite Courses: -

Textbooks:

1. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
2. M. P. Jain, Indian Constitution Law, 7thEdn., Lexis Nexis, 2014.
3. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

References:

1. The Constitution of India, 1950 (Bare Act), Government Publication

Course Objectives :

The objectives of the course are:

1. To review and create awareness on various provisions in the constitution of India.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Explain the premises informing the twin themes of liberty and freedom from a civil rights perspective.	2	Understanding
CO2	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.	2	Understanding
CO3	Address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.	2	Understanding

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**
CO1						
CO2						
CO3						

Assessments :

Teacher Assessment:

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Course Contents:

Module 1	**4 Hrs.**
History of Making of the Indian Constitution Drafting Committee, (Composition & Working)	
Module 2 Philosophy of the Indian Constitution	**4 Hrs.**
Preamble, Salient Features	
Module 3 Contours of Constitutional Rights & Duties	**5 Hrs.**
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.	
Module 4 Organs of Governance	**5 Hrs.**
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions	
Module 5 Local Administration	**5 Hrs.**
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Pachayati raj: Introduction, PRI: ZilaPachayat. Elected officials and their roles, CEO ZilaPachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy	
Module 6 Election Commission	**5 Hrs.**
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.	

Title of the Course: Pedagogy Studies 4IC602	L	T	P	Cr
	02	-	-	-

Pre-Requisite Courses: -

Textbooks:

1. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
2. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
3. 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.
4. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
5. www.pratham.org/images/resource%20working%20paper%202.pdf.

References:

1. Alexander RJ, 2001, Culture and pedagogy: International comparisons in primary education, Oxford and Boston: Blackwell.
2. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.

Course Objectives :

The objectives of the course are:

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

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive level	Descriptor
CO1	Outline pedagogical practices, and existing evidence on the review topic to inform programme design and policy making undertaken.	2	Understanding
CO2	Explain critical evidence gaps to guide the development	2	Understanding

CO-PO Mapping :

	1	2	3	4	5	6
CO1						
CO2						
CO3						

Assessments :

Teacher Assessment:

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Course Contents:

Module 1 Introduction and Methodology	**5Hrs.**
Aims and rationale, Policy background, Conceptual framework and Terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions**,** Overview of methodology and Searching.	
Module 2	**5 Hrs.**
Thematic overview: Pedagogical practices are being used by teachersin formal and informal classrooms in developing countries. Curriculum, Teacher education.	
Module 3	**5 Hrs.**
Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of includedstudies. How can teacher education (curriculum and practicum) and the schoolcurriculum and guidance materials best support effective pedagogy?Theory of change. Strength and nature of the body of evidence for effective pedagogicalpractices. Pedagogic theory and pedagogical approaches, Teachers' attitudes and beliefs and Pedagogic strategies.	
Module 4	**5 Hrs.**
Professional development: alignment with classroom practices andfollow-up support Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes	
Module 5	**5 Hrs.**
Research gaps and future directions Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment Dissemination and research impact.	

Title of the Course: Disaster Management 4IC603	L	T	P	Cr
	02	-	-	-

Pre-Requisite Courses: -

Textbooks:

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

Course Objectives :

The objectives of the course are:

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

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	Explain disaster risk reduction and humanitarian response policy and practice from multiple perspectives	2	Understanding
CO2	Summarize standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.	2	Understanding
CO3	Outline the strengths and weaknesses of disaster management approaches, planning and programming in different countries.	2	Understanding

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**
CO1						
CO2						
CO3						

Assessments :

Teacher Assessment:

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10

ESE	50

Module 1 Introduction	**4 Hrs.**
Disaster: Definition, Factors and Significance; Difference Between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.	
Module 2 Repercussions Of Disasters And Hazards	**4 Hrs.**
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.	
Module 3 Disaster Prone Areas In India	**4 Hrs.**
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	
Module 4 Disaster Preparedness And Management	**4 Hrs.**
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.	
Module 5 Risk Assessment	**4 Hrs.**
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.	
Module 6 Disaster Mitigation	**4 Hrs.**
Meaning, Concept and Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.	

Title of the Course: Value Education 4IC604	L	T	P	Cr
	02	-	-	-

Pre-Requisite Courses: -

Textbooks:

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

Course Objectives :

The objectives of the course are:

1. To impart knowledge on value of education and self- development.
2. To imbibe good values in students.
3. To highlight importance of character.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		level	Descriptor
CO1	Explain value of education and self- development.	2	Understanding
CO2	Summarize importance of good character and Behavior development.	2	Understanding

CO-PO Mapping :

	1	**2**	**3**	**4**	**5**	**6**
CO1						
CO2						
CO3						

Assessments :

Teacher Assessment:

Assessment	Marks
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Module 1	**6Hrs.**
1. Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. 2. Moral and non- moral valuation. Standards and principles. 3. Value judgments	

Module 2	**6 Hrs.**
1. Importance of cultivation of values 2. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. 3. Honesty, Humanity. Power of faith, National Unity. 4. Patriotism. Love for nature, Discipline	
Module 3	**7 Hrs.**
1. Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. 2. Punctuality, Love and Kindness. 3. Avoid fault Thinking. 4. Free from anger, Dignity of labour. 5. Universal brotherhood and religious tolerance. 6. True friendship. 7. Happiness Vs suffering, love for truth. 8. Aware of self-destructive habits. 9. Association and Cooperation. 10. Doing best for saving nature	
Module 4	**7 Hrs.**
1. Character and Competence –Holy books vs Blind faith. 2. Self-management and Good health. 3. Science of reincarnation. 4. Equality, Nonviolence, Humility, Role of Women. 5. All religions and same message. 6. Mind your Mind, Self-control. 7. Honesty, Studying effectively	