Dr. Babasaheb Ambedkar Technological University

(Established as a University of Technology in the State of Maharashtra)

(under Maharashtra Act No. XXIX of 2014)

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Department of Mechanical Engineering

Proposed Course Structure & Contents

for

M.Tech. Program in Heat Power Engineering

From I to IV Semester

Finalized in BoS meeting held on 7th April, 2017

Vision

The vision of the Department is to achieve excellence in teaching, learning, research and transfer of technology and overall development of students.

Mission

Imparting quality education, looking after holistic development of students and conducting need-based research and extension activities.

Programme Educational Objectives (PEOs)

No.	PEO
PEO1	To train student's within depth and advanced knowledge to become professional and capable of identifying, analyzing and solving complex problems in the areas of Heat power engineering.
PEO2	To enable post graduates to carry out innovative and independent research work, disseminate the knowledge in Academia/Industry/Research Organizations to develop systems and processes in the related field.
PEO3	To prepare the students to exhibit a high level of professionalism, integrity, effective communication skills and environmental and social responsibility.
PEO4	To provide an academic environment that gives adequate opportunity to the students to cultivate life-long independent learning ability for their successful professional career.

Programme Outcomes (POs)

At the end of the program, the students will be able to:

No.	PO
PO1	Acquire, demonstrate and apply advanced knowledge in the area of Heat power engineering.
PO2	Identify problems in the field of Heat power engineering, formulate them and solve by using advanced techniques.
PO3	Conduct independent research and generate new knowledge for the benefit of community, society Industry and country.
PO4	Apply various numerical methods, advanced software and engineering tools to model, analyze and solve thermal engineering problems.
PO5	Work effectively in interdisciplinary teams for solving real life problems in the related field.
PO6	Apply engineering and scientific principles for the effective management of thermal systems.
PO7	Effectively communicate through technical reports, presentations and scientific publications with the engineering community as well as society at large.
PO8	Demonstrate traits of management in handling engineering projects, related finance, and coordinate with workforce towards achieving goals.
PO9	Demonstrate high level of professional and intellectual integrity,ethics of research and scholarly standards.
PO10	Examine critically the out comes of one’s action sand make corrective measures subsequently.
PO11	Demonstrate the ability to work in team in the laboratory in achieving multidisciplinary tasks required for the project.
PO12	Engage in life-long reflective and independent learning with high level of enthusiasm and commitment.

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Department of Mechanical Engineering
M.Tech Heat PowerEngineering
Semester- I
Syllabus effective from 2017 – 2018

Sr. No.	Course Code	Name of the Course	Contact hours			Credits
			L	T	P	
01	MHP1101	Advanced Thermodynamics	3	1	-	4
	MHP1102	Advanced Heat Transfer	3	1		4
02	MHP1103	Numerical Methods & Computational Techniques	3	1	-	4
03	MHP11E1	Elective – I	3	-	-	3
04	MHP11E2	Elective – II	3	-	-	3
05	MHP1106	Communication Skills	2	-	-	2
06	MHP1107	Thermal Engineering Lab	-	-	3	2
Total			**17**	**03**	**03**	**22**

Semester - II

Sr. No.	Course Code	Course	Contact hours			Credits
			L	T	P	
01	MHP1201	Modeling and Analysis in Thermal Engineering	3	1	-	4
02	MHP1202	Fluid Dynamics	3	1		4
03	MHP12E3	Elective – III	3	-	-	3
04	MHP12E4	Elective – IV	3	-	-	3
05	MHP12E5	Elective - V (Open)	3	-	-	3
06	MHP1206	Mini-project	-	-	3	2
07	MHP1207	Seminar	-	-	4	2
Total			**15**	**02**	**07**	**21**

Semester – III

Sr. No.	Course Code	Course	Contact hours			Credits
			L	T	P	
01	MHP2301	Project Management and IPR*	-	-	-	2
02	MHP2302	Project Stage – I	-	-	-	10
Total			**-**	**-**	**-**	**12**

*Self-study course

Semester –IV

Sr. No.	Course Code	Course	Contact hours			Credits
			L	T	P	
01	MHP 2401	Project Stage –II	-	-	-	20
Total			**-**	**-**	**-**	**20**

List of Elective Courses

Semester-I:
Elective (I & II) **List of Courses**

1. MHP11E1a/MHP11E2a Combustion Engineering
2. MHP11E1b/MHP11E2b Utilization of Solar Energy
3. MHP11E1c/MHP11E2c Exergy Analysis of Thermal Systems
4. MHP11E1d/MHP11E2d Energy Conservation management
5. MHP11E1e/MHP11E2e Design of Heat Exchange Equipment
6. MHP11E1f/MHP11E2f Design of Air-Conditioning Systems
7. MHP11E1g/MHP11E2g Advanced Refrigeration
8. MHP11E1h/MHP11E2h Hydraulic, Pneumatic and Fluidic Control
9. MHP11E1i/MHP11E2i Advanced IC engines
10. MHP12E3j/MHP12E4j Pumps, Blowers and Compressors
11. MHP12E3k/MHP12E4k CAD-CAE
12. MHP12E3l/MHP12E4l Thermal Energy Storage
13. MHP12E3m/MHP12E4m Steam Engineering

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Semester-II: Elective (III & IV)

	Corse Code	List of Courses for
1.	MHP12E3a/MHP12E4a	Cryogenic Engineering
2.	MHP11E1b/MHP11E4b	Steam and Gas Turbines
3.	MHP12E3c/MHP12E4c	Biomass Energy
4.	MHP12E3d/MHP12E4d	Computational Fluid Dynamics
5.	MHP12E3e/MHP12E4e	Wind Energy
6.	MHP12E3f/MHP12E4f	Alternative Fuels for IC Engines
7.	MHP12E3g/MHP12E4g	Numerical Heat Transfer
8.	MHP12E3h/MHP12E4h	Power Plant Practice and Control
9.	MHP12E3i/MHP12E4i	Nano Technology
10.	MHP12E3j/MHP12E4j	Boundary Layer Theory
11.	MHP12E3k/MHP12E4k	Advanced Optimization Techniques
12.	MHP12E3l/MHP12E4l	JET & Rocket Propulsion
13.	MHP12E3m/MHP12E4m	Nuclear Power Plant

Semester-II: Open Elective –V

	Course Code	List of Courses
1.	MOE12E5a	Research Methodology
2.	MOE12E5b	Design of Experiments
3.	MOE12E5c	Environmental Engg. and Pollution Control

MHP1101 Advanced Thermodynamics

MHP1101	Advanced Thermodynamics	PCC	3-1-0	4 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of thermodynamics to apply in real engineering problems
2. To familiarize the students about the thermodynamic relations and process and their use to analysis the given thermal application
3. To understand the gas equations for properties generation

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

CO1	Understand properties of pure substances. Represent various processes with steam on property diagrams, Apply and compare equations of state for real gases
CO2	Derive Maxwell Relations, Clapeyrons Equation etc. and apply these for evaluation of thermodynamic properties.
CO3	Evaluate entropy change for flow and non-flow processes under steady and unsteady conditions.
CO4	Estimate thermodynamic properties of substances in gas or liquid state of ideal and real mixture.
CO5	Predict intermolecular potential and excess property behavior of multi-component systems. Study irreversible processes.

Mapping of COs with POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	1		2	1		1						
CO3	2	1		1		1						
CO4	1	1										
CO5	1			1								

Note: 1- Means least contribution, 2- Means medium contribution 3- Maximum contribution

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Course Contents

Unit I

Pure Substance: Introduction, properties and application of thermodynamics to pure substance. Equation of States: Ideal gas equation and its limitations for real gases, other equations of state like Vander walls, Berthelot, Dieterici, Redlich-kwong equations, Bose-Einstein statistic. Fermi-Dirac statistics

Unit II

Thermodynamic Relations Mathematical theorems, Helmoltz and Gibb's function, T-ds equations, Maxwell's relations, energy equations, variation in heat capacities, Clapeyron relation

Unit III

Entropy: The essence of entropy, a law of quantum state, quantum state probability, entropy definition, decrease of exergy principal, exergy analysis of thermal systems (Case study), thermal energy reservoir, mechanical energy reservoir, constituent reservoir.

Unit IV

Composition of gas mixture: mass and molar fraction, P-v-T behavior of gas mixture. Dalton's law of partial pressure, Amagat's law, properties of gas mixture

Unit V

Irreversible thermodynamics: Reversible and irreversible process, the flux postulate, entropy production; heat flux, thermoelectric phenomenon; thermodynamic analysis of the thermocouple, Onseger's reciprocal relation.

Unit VI

Thermodynamic Equilibrium and stability; condition for chemical equilibrium; equilibrium and third law; phase equilibrium; chemical reaction, equation of reaction equilibrium; phase rule; chemical potential of ideal gases and fugacity .

TEXTS/REFERENCES:

1. W.C. Reynolds and H.C. Perkins, *Engineering Thermodynamics*, McGraw-Hill.
2. P.K. Nag, *Engineering Thermodynamics*, Tata McGraw-Hill, 2005 Ed.
3. Michel SAAD*, Engineering Thermodynamics*, McGraw Hill.
4. Jones and Hawkins, *Engineering Thermodynamics*, Prentice Hall India.
5. J.P.Holman, *Engineering Thermodynamics*, McGraw-Hill.
6. Y.A,Cengel and M.A.Boles, *Thermodynamics: an engineering approach*, Tata McGraw-Hill.
7. S.R.Turns, *Thermodynamics Concepts and Applications*
8. P.L.Dhar , Engineering *Thermodynamics, Elsevier Publication*

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MHP1102 Advanced Heat Transfer

MHP1102	Advanced Heat Transfer	PCC	3-1-0	4 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the technical understanding the concepts of heat transfer in the background of real engineering problems
2. To familiarize the students about the importance of heat transfer process apply to industrial applications
3. To understand the heat transfer concepts apply to other domain of thermal engineering in general .

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

CO1	Analyze steady state and transient heat conduction problems of real life Thermal systems
CO2	Analyze extended surface heat transfer problems and problems of phase change heat transfer like boiling and condensation
CO3	Apply the basic principles of classical heat transfer in real engineering application
CO4	Analyze the analytical and numerical solutions for heat transfer problem.
CO5	Understand the basic concepts of turbulence and their impact on heat transfer
CO6	Analyze radiation heat transfer problems of various thermal systems

Mapping of COs with POs

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1			1		1						
CO3	1		2									
CO4	1	1		2								
CO5	1											
CO6	1			1								

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Course Contents

Unit I

Brief introduction to different modes of heat transfer: conduction: general heat conduction equation-initial and boundary conditions.

Finite difference methods for conduction: id & 2d steady state and simple transient heat conduction problems-implicit and explicit methods.

Unit II

Transient heat conduction: lumped system analysis, Heisler charts, semi-infinite solid, use of shape factors in conduction, 2d transient heat conduction, product solutions.

Unit III

Forced Convection: Equations of fluid flow-concepts of continuity, momentum equations, derivation of energy equation-methods to determine heat transfer coefficient: Analytical methods-dimensional analysis and concept of exact solution. Approximate method, integral analysis.

Unit IV

External flows: Flow over a flat plate: integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometries for laminar and turbulent flows.
Internal flows: Fully developed flow: integral analysis for laminar heat transfer coefficient-types of flow-constant wall temperature and constant heat flux boundary conditions hydrodynamic &thermal entry lengths; use of empirical correlations.

Unit V

Free convection: Approximate analysis on laminar free convective heat transfer, Boussinesque approximation, different geometries, combined free and forced convection.
Boiling and condensation: Boiling curve, correlations, Nusselts theory of film condensation on a vertical plate, assumptions & correlations of film condensation for different geometries.

Unit VI

Radiation heat transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting. Reflecting and absorbing media, specular surfaces, gas radiation-radiation from flames. Radiotory heat transfer through participating medium.

Text/References

1. Yunus A.Cengel, *Heat and Mass Transfer* – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.
2. Holman J.P, *Heat Transfer*, Tata Mc Graw Hill, 2002.
3. S. P.Sukhatme, *A Textbook on Heat Transfer*
4. OzisikM.N., *Heat Transfer – A Basic Approach*, McGraw-Hill Co., 1985
5. Incropera F.P. and DeWitt. D.P., *Fundamentals of Heat & Mass Transfer*, John Wiley & Sons, 2002.
6. Ghoshdastidar. P.S., *Heat Transfer*, Oxford University Press, 2004
7. M.M. Modest, *Radiative Heat Transfer*, Tata-McGraw-Hill

MHP1103 Numerical Methods & Computational Techniques

MHP1103	Numerical Methods & Computational Techniques	PCC	3-1-0	4 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To inculcate subject knowledge of numerical methods applied to thermal engineering applications
2. To learnt the numerical techniques useful to apply in the areas such as CFD etc.
3. To extent the learning of Numerical method applying the computer programming

Course Outcomes: At the end of the course, student should be able to

CO1	Solve a set of algebraic equations representing steady state models formed in engineering problems
CO2	Fit smooth curves for the discrete data connected to each other or to use interpolation methods over these data tables
CO3	Predict the system dynamic behavior through solution of ODEs modeling the system
CO4	Solve PDE models representing spatial and temporal variations in physical systems through numerical methods.
CO5	Demonstrate proficiency of using MATLAB, VB, ANSYS, EES etc.,
CO6	Solve a set of algebraic equations representing steady state models formed in engineering problems

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	1									
CO2			1									
CO3	1					1						
CO4		1		2								
CO5		1		1								
CO6		2	1	3								2

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Course Contents

Unit I

Introduction to Numerical Analysis: Objectives, Mathematical Modeling, Programming Concepts, MATLAB,FORTAN etc., Computational Accuracy, Precision, Truncation Errors, Taylor Series

Curve fitting and Regression, Interpolation, Fourier Series concepts

Unit II

Roots of equations: Bisection, False position, Fixed Point Iteration, Newton-Raphson, Secant methods, Roots of polynomials

Linear Algebraic Equations, Gauss Elimination

Unit III

Non-linear Systems of Equations, Gauss-Jordan, LU Decomposition and Matrix Inversion, Gauss-Seidel.

Unit IV

Numerical Integration: Trapezoidal and Simpson's Rules, Gaussian Quadrature.

Numerical Differentiation and finite-difference approximations .

Unit V

Ordinary Differential Equations: Euler's and Runge-Kutta Methods, Boundary-Value, Eigen value and Eigen vector Problems .

Unit VI

Partial Differential Equations: Elliptic Equations, Laplace Equation and Boundary Conditions, Control Volume Approach, Parabolic Equations, Explicit and Implicit Methods, Crank-Nicolson, Introduction to Finite Element Methods .

TEXTS / REFERENCES:

- Steven C. Chapra and Raymond P. Canale, Numerical Method for Engineers, 6th Edition, McGraw-Hill, 2010.
- S.S. Sastry, Introductory Methods of Numerical Analysis, 5th Edition, PHI Learning, 2012
- S. P. Venkateshan, Computational Methods in Engineering, 1st Edition, Academic Press, 2013
- S.K. Gupta, Numerical Methods for Engineers, New Age International, 2009
- Gilbert Strang, Computational Science and Engineering, Wellesley-Cambridge, 2007
- K. Atkinson and W. Han, Elementary Numerical Analysis, 3rd Edition, Wiley-India, 2004.
- J. D. Hoffman and Steven Frankel, Numerical Methods for Engineers and Scientists, 2nd Edition, McGraw-Hill, 2001
- S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Edition, McGraw-Hill, 1980

MHP1106 Communication Skills

MHP1106	COMMUNICATION SKILLS	PCC	2-0-0	2 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-sem Examination 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To learn the subject applied to technical paper writing
2. To enhance the oral and written communication
3. To enhance the project writing, report writing and presentations

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

CO1	Confident while using English
CO2	Engage in analysis of speeches or discourses and several articles
CO3	Identify and control anxiety while delivering speech
CO4	Write appropriate communications(Academic/Business)
CO5	Ready to take the examinations like GRE/TOFEL/IELTS
CO6	Identify and control the tone while speaking
CO7	Plan and deliver the well-argued presentations

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		1		2		2	1			2	3
CO2	2						1	2		1	2	3
CO3					1		1	2			2	3
CO4	2		1		1		3	1	2	1	2	3
CO5	1											1
CO6					2		2	2			2	3
CO7			2	1	2	2	3	3	1	1	3	3

Course Content:

Unit I
Communication and Communication Processes
Introduction to Communication, Forms and functions of Communication, Barriers to Communication and overcoming them, Verbal and Non-verbal Communication, Ways of Effective Communication.

Unit II
Oral Communication

Use of Language in Spoken Communication, Features of Good Communication, Principles and Practice of Group Discussion, Public Speaking (Addressing Small Groups and Making Presentation), Interview Techniques, Appropriate Use of Non-verbal Communication,Presentation Skills, Telephonic Etiquettes, Extempore, Elocution, Describing Experiences and Events.

Unit III

Study of Sounds in English

Introduction to phonetics, Study of Speech Organs, Study of Phonemic Script, Articulation of Different Sounds in English, Stress Mark.

Unit IV

English Grammar

Grammar: Forms of Tenses, Articles, Prepositions, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Common Errors, Sentence Formation and Sentence Structures, Use of Appropriate Diction.

Unit V

Writing Skills

Features of Good Language, Difference between Technical Style and Literary Style, Writing Emails, Formal and Informal English, Business Writing, Advertisements, Essay Writing, (Technical, Social, and Cultural Topics), Technical Reports: Report Writing: Format, Structure and Types, Writing Memorandum, Circulars, Notices, Agenda and Minutes, Technical Manuals, Brochures

Letter Writing: Types, Parts, Layouts, Letters and Applications, Use of Different Expressions and Style, Writing Job Application Letter and Resume.

Unit VI

Reading Skills & Listening Skills

Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.

Listening: Importance of Listening, Types of Listening, Barriers to Listening.

Text book:

1. Mohd. Ashraf Rizvi, *Communications Skills for Engineers*, Tata McGraw Hill

Reference Books:

1. Sanjay Kumar, PushpLata, *Communication Skills*, Oxford University Press, 2016
2. Meenakshi Raman, Sangeeta Sharma, *Communication Skills*, Oxford University Press, 2017
3. Teri Kwal Gamble, Michael Gamble, *Communication Works*, Tata McGraw Hill Education, 2010.

MHP1107 Thermal Engineering Lab

MHP1107	Thermal Engineering Lab	PCC	0-0-3	2 Credits
Exam Scheme				
Class Test ---- Marks	Continuous Assessment 25 Marks	End-sem Evaluation (OR/Pract) 25 Marks		Total 50 Marks

Course Objectives: Objectives of this course are

1. To apply the theoretical concepts and enhance understanding of the engineering concepts
2. To familiarize the students about the measurements and error calculations during experiments
3. To understand the design of experiments and report writing

Course Outcomes:

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

CO1	Conduct test on heat transfer enhancement set-up, single-cylinder diesel engine, air conditioning set-up, centrifugal pump etc. to study their performance and analyze the results.
CO2	Draw and analyze performance curves of these machines/systems.
CO3	Compare the results obtained with expected theoretical results.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			2					2	
CO2	1			1								
CO3	2					1						

Experiments on the following set-ups (Any Four):

1. Heat Transfer Enhancement Set-up
2. Computerised Single-Cylinder Diesel Engine Set-up with Alternative Fuel
3. Set-up for Extraction of Vegetable Oil and its Transesterification
4. Air-Conditioning Test-rig
5. Variable speed Centrifugal/Gear Pump Set-ups
6. Unsteady State Heat Transfer Set-up
7. Blower Test-rig

Study includes performance evaluation, calibration of measuring instrument/s and error analysis.It is also expected to conduct innovative experiment/s on the existing set-up with little modifications.

MHP1201 Modeling and Analysis in Thermal Engineering

MHP1201	Modeling and Analysis in Thermal Engineering	PCC	3-1-0	4 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge to learn the thermal modeling of real engineering problems
2. To familiarize the students about the applications of fundamental laws and mathematics principles for thermal modeling
3. To understand the concept of optimization applied to engineering applications

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

CO1	Attempt modeling real life systems of interest in order to predict its dynamic behavior.
CO2	Use simulation tools to determine dynamic response of system following external inputs.
CO3	Understand capabilities and limitations of various numerical and mathematical models.
CO4	Optimization of thermal systems, formulation, optimization methods.
CO5	Deep understanding on the governing equations for convection heat transfer; knowing the dimensionless parameters

Mapping of COs with POs:

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1			2							
CO2	1	1		2								
CO3				1								
CO4	2			1	1							
CO5	1											

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Course Contents

Unit I

Introduction: Engineering Design, design and analysis, Workable and optimum system, formulation Thermal systems, basic characteristics and analysis.

Unit II

Modeling of Thermal systems: Procedure of mathematical modeling, basic features of modeling, System and types of Model, characteristic of models, Curve fitting, exact fit, best fit.

Unit III

Modeling and analysis of thermal systems, including - thermodynamics, fluid mechanics, heat and mass transfer, refrigeration and air-conditioning, system components (heat exchangers, expansion devices, pumps, compressors, turbines, boilers).

Unit IV

Thermal system simulation: Sequential simulation, simultaneous simulation, successive substitution, Newton-Raphson method.

Unit V

Optimization of thermal systems, formulation, optimization methods; Lagrange Multipliers, Search Methods, Linear programming, Dynamic programming and geometric programming.

Unit VI

Develop methodologies for the design and optimization of thermal systems. A non-linear equation solver ,Engineering Equation Solver (EES), Pinch technology: basic concepts, T-h, h-s diagrams, design of recovery system using pinch technology.

TEXTS / REFERENCES:

1. Yogesh Jaluria,*Design and Optimization of Thermal Systems*, McGraw Hill Companies, Inc.
2. W.F.Stoecker: "*Design of Thermal Systems*", 3rd Ed., McGraw Hill,1989.
3. B.K.Hodge: "*Analysis and Design of Thermal Systems*", Prentice Hall Inc., 1990.
4. I.J.Nagrath&M.Gopal: "*Systems Modeling and Analysis*", Tata McGraw Hill.
5. D.J. Wide: "*Globally Optimal Design*", Wiley- Interscience, 1978.
6. R.F.Boehm, Design Analysis of Thermal systems, John Willey and son's
7. A. Bejan,M.moran, Thermal Design and Optimization, John Willey and son's

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MHP1206 Mini-Project (Semester II)

MHP1206	Mini Project	PCC	0-0-3	2 Credits
Exam Scheme				
Class Test ----	Continuous Assessment 25 Marks	OR/Pract 25 Marks		Total 50 Marks

Course Objectives: Objectives of this course are

1. To apply the basic engineering laws through a modeling/ model/setup
2. To understand the report writing and result analysis
3. To understand the problem formulation

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

CO1	Identify methods and materials to carry out experiments/develop code.
CO2	Reorganize the procedures with a concern for society, environment and ethics.
CO3	Analyze and discuss the results to draw valid conclusions.
CO4	Prepare a report as per recommended format and defend the work
CO5	Explore the possibility of publishing papers in peer reviewed journals/conference proceedings.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1		2	2	1	1	2	2	1	2
CO2	1	1	2	2			2	2	1	2	1	2
CO3	2	2		3					2	2		1
CO4				2				2	2	3		1
CO5		1		2	2			2	2	3		1

Contents/Objectives:

Train the students in identification, analysis, finding solutions and execution of live thermal engineering problems. It is also aimed to enhance the capabilities of the students.

Individual students are required to choose a topic of their interest. The subject content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. Students can also choose live problems from Mechanical Engineering as their mini project. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.
Mini Project will have internal marks 50 and Semester-end examination marks 50.

Internal marks will be awarded by respective guides as per the stipulations given below.
Attendance, regularity of student (20 marks)
Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester end examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.
Report = 25 marks
Concept/knowledge in the topic = 15 marks
Presentation = 10 marks
Total marks = 50 marks

MHP1202 Fluid Dynamics

MHP1202	Fluid Dynamics	PCC	3-1-0	4 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the technical understanding of Fluid mechanics in the back ground of mathematics
2. To familiarize the students about the fluid dynamics and its applications to model the real life engineering problems
3. To apply the subject knowledge in the areas like CFD

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

CO1	Understand and define basic fluid dynamic concept like continuum, surface forces, stress tensor and vector fields, Eulerian and langrangian flow.
CO2	Define the motions of fluid elements and derive continuity equation,stream function and velocity potential.
CO3	Derive and apply Navier-stokes equation to various types of flow systems.
CO4	Apply Boundary layer theory concept, and able to derive solutions by various numerical methods.
CO5	Describe and analyze the different flow, velocity correlation and universal velocity distribution.
CO6	Examine and numerical analysis of PDE and providing techniques for interpreting and analyzing the behavior of numerical schemes.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1	1										
CO3	1											
CO4	1	1		2								
CO5	1	1										
CO6	1	1		2						1		

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Course Contents

Unit I

Concept of continuum and definition of a fluid. Body and surface forces, stress tensor, Scalar and vector fields, Eulerian and Lagrangian approach.

Unit II
Motion of fluid element - translation, rotation and vorticity; strain rate tensor, continuity equation, stream function and velocity potential. Transport theorems, constitutive equations,

Unit III
Derivation of Navier Stokes equations for compressible flow. Exact solutions of Navier Stokes equations : plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow over a flat pate, cylinders and spherical bodies , Stoke's first and second problem, Hiemenz flow, flow near a rotating disk, flow in convergent- divergent channels. Slow viscous flow: Stokes and Oseen's approximation, theory of hydrodynamic lubrication.

Unit IV
Boundary layer: derivation, exact solutions, Non dimensionalization of Boundary layer equation, Blasius (similarity solution) , Falkner Skan, Von-karmon integral equation series solution and numerical solutions. Approximate methods. Momentum integral method.

Unit V
Turbulent flow: algebraic models, hydrodynamic stability, velocity correlations, Reynold's stresses, Prandtl's Mixing Length Theory, Karman's velocity defect law, universal velocity distribution, Plane and axi-symmetric jets, Two equation model(k-epsilon), large eddy simulation.

Unit VI
Compressible flow: 1D flow, speed of sound, variable c/s flow , converging-diverging nozzle, normal shock relation, past slender bodies, compressible boundary layer.
Computational fluid dynamics: Introduction, fundamentals of numerical analysis of partial differential equations (PDE).

TEXTS / REFERENCES:

1. F.M.White ,Fluid Mechanics, McGraw-Hill
2. K.Muralidhar and Bishwas, Advance Engineering fluid mechanics, Alpha science international limited
3. Fox and McDonald, *Introduction to Fluid Mechanics*, J.H. Wiley and Sons.
4. S.M.Yahya, *Fundamentals of Compressible Flow*, Wiley Eastern Ltd.
5. H. Schlichting, Boundary *Layers Theory*, McGraw-Hill.
6. J.M.Robertson, *Hydrodynamics in Theory and Application*, Prentice Hall.
7. A.H.Shapiro, *The Dynamics and Thermodynamics of Compressible Fluid Flow*, Ronald.

MHP1207 Seminar

MHP1107	Seminar	PCC	0-0-4	2 Credits
Exam Scheme				
Class Test -- Marks	Continuous Assessment 25 Marks	PR/OR 25 Marks		Total 50 Marks

Course Objectives: Objectives of this course are

1. To understand the open literature
2. To familiarize the students about collection of technical literature, reading and understanding
3. To learn the report writing and presentation

. **.Course Outcomes:**At the end of the course, student should be able to

CO1	To enable students to aware about recent areas and technologies in thermal engineering and related area.
CO2	To enable students, comprehend importance of system up gradation, improvement and application of new findings for human life.
CO3	To enable students to write technical report and presenting seminar work.
CO4	To enable students to aware about recent areas and technologies in thermal engineering and related area.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1							1				
CO2		1							1	2		1
CO3		2			1		1	2			1	
CO4								1		1		1

Contents/Objectives:

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

MHP2301Project Management and Intellectual Property Rights

MHP2301	Project Management and Intellectual Property Rights	PCC	0-0-4	2 Credits
Exam Scheme				
Class Test -- Marks	Continuous Assessment 50 Marks	PR/OR 50 Marks		Total 100 Marks

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge importance of IPR
2. To familiarize the students about the filing the patent and project scheduling, procurement, specifications etc
3. To understand the report writing and filing patent.

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

CO1	Enumerate and demonstrate fundamental terms such as copy-rights, Patents, Trademarks etc.,
CO2	Interpret and follow Laws of copy-rights, Patents, Trademarks and various IP registration Processes to register own project research.
CO3	exhibit the enhance capability to do economic analysis of IP rights, technology and innovation related policy issues and firms' commercial strategies.
CO4	Develop awareness at all levels (research and innovation) of society to develop patentable technologies.
CO5	Apply trade mark law, copy right law, patent law and also carry out intellectual property audits
CO6	Manage and safeguard the intellectual property and protect it against unauthorized use

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1					1		1			
CO2	1		2				1		2			2
CO3						1		1				
CO4						1			1			
CO5			1						1			1
CO6												

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Course Contents

A. **Project Management:**

Unit-I

Introduction to Project management**:** Characteristics of projects, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization. Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure, LRC, Gantt charts, CPM/PERT Networks.

Unit-II

Developing Project Plan (Baseline), Project cash flow analysis, Project scheduling with resource constraints: Resource Leveling and Resource Allocation. Time Cost Trade off: Crashing Heuristic.

Unit-III

Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, ProjectProcurement Management. Post-Project Analysis.

B. IPR:

Unit-IV

Introduction to IPR; Overview & Importance; IPR in India and IPR abroad; Patents; their definition; granting; infringement; searching& filing; Utility Models an introduction;

Unit-V

Copyrights; their definition; granting; infringement; searching& filing, distinction between related and copy rights; Trademarks, role in commerce, importance, protection, registration; domain names;

Unit-VI

Industrial Designs; Design Patents; scope; protection; filing infringement; difference between Designs & Patents' Geographical indications, international protection; Plant varieties; breeder's rights, protection; biotechnology& research and rights managements; licensing, commercialization; legal issues, enforcement; Case studies in IPR.

Text Books/References:

1. Shtub,BardandGloberson,ProjectManagement: Engineering,Technology,andImplementation,Prentice Hall,India
2. Lock,Gower,ProjectManagementHandbook.
3. PrabuddhaGanguli, IPR published by Tata McGraw Hill 2001.

MHP2302 Project Stage-I

MHP2302	Project Stage-I	PCC	0-0-20	10 Credits
Exam Scheme				
Class Test -- Marks	Continuous Assessment -- Marks	End-Sem Evaluation 100 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To learn the literature survey
2. To familiarize the students about understanding the open literature, preparation of literature review etc
3. To understand the problem formulation based on the literature review

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

CO1	Identify problems and to plan methodologies to solve problems.
CO2	Carry out exhaustive literature review, study &evaluate collected literature critically and identify the gaps based on the review.
CO3	Select the specific problem for the study as a project
CO4	Demonstrate technical writing while preparing project report and present it to evaluation committee to demonstrate presentation skills acquired.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1								1			1
CO2		3								2		1
CO3		2					1	1		2	2	2
CO4	2								1			

Course Contents:

Project (stage-I) should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M. Tech. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review. The preliminary results (if available) of the problem may also be discussed in the report. The work has to be presented in front of the examiners panel set by Head and PG coordinator. The candidate has to be in regular contact with his guide and the topic of dissertation must be mutually decided by the guide and student.

MHP2401 Project Stage-II

MHP2401	Project Stage-II	PCC	0-0-40	20 Credits
Exam Scheme				
Class Test -- Marks	Continuous Assessment -- Marks	End-Sem Eval (PR/OR) 100 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To develop the setup/model based on the literature survey
2. To familiarize the students about the carrying out experimentation/ computer programming/ software
3. To understand the report writing, analysis of result, preparation of manuscript etc.

Course Outcomes:

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

CO1	Solve identified technical problem using acquired knowledge and skill.
CO2	Use latest equipment, instruments, software tools, infrastructure and learning resources available to solve the identified project problem. Procure resources, if required.
CO3	Interpret theoretical/experimental findings using available tools
CO4	Compare the results obtained with results of similar studies
CO5	Draw conclusions based on the results.
CO6	Solve identified technical problem using acquired knowledge and skill.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1								1			1
CO2		3								2		1
CO3		2					1	1		2	2	2
CO4	2								1			
CO5		1						1				2
CO6	1	2			2						1	3

Course Contents/Objective

The Project Work will start in semester III and should preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individual contribution. The dissertation should be presented in standard format as provided by the department/guide. The candidate has to prepare a detailed project report consisting of introduction of the problem,

problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results and discussion. The report must bring out the conclusions of the work and future scope for the study. The work has to be presented before the panel of examiners consisting of an approved external examiner, internal examiner/guide as decided by the Head and PG coordinator/Faculty Advisor. The candidate has to be in regular contact with his guide throughout the project duration.

MHP11E1a/2a Combustion Engineering

MHP11E1a/2a	Combustion Engineering	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of combustion engineering apply in real engineering problems
2. To familiarize the students about the combustion process in the back ground of IC engine
3. To understand the simulation of combustion process

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

CO1	Understand and recognize System Conservation Laws, Reynolds Transport Theorem, Governing 3D Partial Differential Equations etc.,
CO2	Formulate and model, General Probability Density Function, Turbulent Pre-mixed and non-pre-mixed flames.
CO3	knowledge of fuel thermo-chemistry and fuel quality effects on emissions, engine technologies, engine combustion-related emissions and control technologies
CO4	Extend their knowledge of fuels and engines to different situations of engineering context and professional practice.
CO5	Demonstrate the ability to engage in life-long learning.
CO6	Understand and recognize System Conservation Laws, Reynolds Transport Theorem, Governing 3D Partial Differential Equations etc.,

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		2										
CO3	1		1		1		1					
CO4						1			1			
CO5												2
CO6	2											1

Course Contents

Unit I

Review of energy sources and fossil fuels, role of combustion in energy conservation, comprehensive treatment of combustion principles and their applications.

Unit II:

Thermochemistry: Stoichiometry and combustion reactions**,** Enthalpy of formation**,** Calculation of excess air**,** Adiabatic flame temperature**,** Chemical thermodynamics and chemical kinetics, Conservation equations for multi-component systems, System Conservation Laws, Reynolds Transport Theorem, Governing 3D Partial Differential Equations, Shvab-Zeldovich Coupling Functions and Mixture Fraction.

Unit III

Premixed systems detonation and deflagration, laminar flames,1D propagating flame and flame speed Quenching, flammability, ignition and blow off, effects of different variables on burning velocity, methods for measuring burning velocity, flammability limits, ignition and quenching, detonations, their propagation and structure, flame stability.

Laminar Non-premixed (Diffusion) Flames, laminar diffusion flame jet, Jet flames and the Burke-Schumann Solution, Soot Formation, Counter-flow Flames.

Unit IV

Turbulent pre-mixed flames, turbulent flames, turbulent combustion, chemical effects on turbulence, transition from laminar to turbulent diffusion flames.

Non-premixed systems: Flamelet Modeling Approaches, General Probability Density Function (PDF) Formulations.

Unit V

Droplet Combustion, Droplet Evaporation, Droplet Combustion, Simple 1-D Analysis for Multiphase Flows.

Unit VI

Combustion of solids: drying, devolatilization and char combustion, Practical aspects of coal combustion. Pollution and environment**.** Formation and control of pollution in flames, engineering applications; Combustion processes in SI Engines and C.I. Engines, Gas turbine combustors, fluidized bed combustors, Design of burners and Combustion chambers.

TEXTS/REFERENCES:

1. N.A.Chigier, Energy, *Combustion and Environment*, McGraw-Hill Co, New York, 1981.
2. Glassman, *Combustion*, Academic Press, New York, 1977
3. A.MurthyKanury, *Introduction to Combustion Phenomena*, Gordon and Breach, New York, 1975.
4. S.P.Sharma and Chander Mohan, *Fuels and Combustion*, Tata McGraw-Hill, 1984.
5. K. K. Kuo, *Principles of Combustion*, (excellent more advanced reference)
6. *Combustion – Physical and Chemical Fundamentals*, *Modeling and Simulation, Experiments,*
7. J. Warnatz, U. Mass and R. W. Dibble, *Pollutant Formation*, by (excellent more advanced reference)
8. F. Williams, *Combustion Theory* (a classic - more mathematical treatment)
9. S.R. Turns , Introduction to combustion, Tata McGraw-Hill
10. N. Peters ,*Turbulent Combustion* (a nice up-to-date summary of the state-of-the-art on
11. turbulent combustion modeling for gas phase systems)

MHP11E1b/2b Utilization of Solar Energy

MHP11E1b/2b	Utilization of Solar Energy	PEC	3-0-0	2 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of solar energy
2. To familiarize the students about the solar energy and its applications in real life situations
3. To carry out a case study on the existed solar energy system

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

CO1	Describe measurement of direct, diffuse and global solar radiations falling on horizontal and inclined surfaces, Basic earth sun angles, Beam and diffuse radiations, Radiation on titled surfaces.
CO2	Analyze the performance by conducting research on flat plate collector, air heater and concentrating type collector.
CO3	Understand test procedures and apply these while testing different types of collectors.
CO4	Demonstrate and Design various types of thermal energy storage systems.
CO5	Analyze payback period and annual solar savings due to replacement of conventional systems
CO6	Demonstrate the importance of solar energy effectively to increase awareness of it in society.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1			1								
CO2				1								
CO3				1								1
CO4									1			
CO5						2						
CO6			2		1							1

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Course Contents

Unit-I

Solar Radiation Analysis: Solar constant, Basic earth sun angles, Beam and diffuse radiations, Radiation on titled surfaces (estimation), Measurement of solar radiation (calibration of equipment)

Unit-II

Heat Transfer for Solar Energy Utilization: Basic models of heat transfer, Radiation characteristics of opaque materials and partially transparent media, Heat transfer analysis for flat plate collectors.

Flat Plate Collectors: Physical principles of conversion of solar radiation into heat, Thermal losses and efficiency of FPC, Practical considerations for flat plate collectors, Applications of FPC – Water heating and Drying

Unit-III

Focusing Type Collectors: Orientation and sun tracking systems, Types of concentrating collectors – Cylindrical parabolic collector, Compound parabolic collector, Thermal performance of focusing collectors, Testing of solar collectors.

Unit-IV

Solar cooking, Solar desalination, Solar ponds and Solar space heating Solar Industrial process heating and Solar power generation.

Unit-V

Solar Green Houses, Solar thermo mechanical power, Solar refrigeration & air conditioning and Solar High Temperature Applications

Unit-VI

Energy Storage for Solar Energy Utilization: Importance of storage systems, Different types of thermal storage systems, Alternate storage methods

Texts / Reference Books:

1. John A Duffie& William A Beckman : "Solar Energy Thermal processes" – Wiley Inter science publication
2. H P Garg & J Prakash "Solar Energy – Fundamentals and Applications: - Wiley Inter science
3. G D Rai "Solar Energy Utilization" – Khanna publishers
4. S P Sukhatme"Solar Energy – Principles of thermal Collection & Storage" – Tata McGraw Hill Publishing Company Ltd., New Delhi

MHP11E1c/2c Exergy Analysis of Thermal Systems

MHP11E1c/2c	Exergy Analysis of Refrigeration Systems	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the concept, applications, importance of exergy
2. To familiarize the students about the exergy and its applications in real life situations
3. To carry out a exoeconomic analysis on the existed thermal system

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

CO1	Identify and apply concepts, theorems of thermodynamics to the different thermal and fluid engineering system
CO2	Analyze performance these systems by conducting experiments by applying heat balance method, Carnot cycle method and entropy generation methods.
CO3	Interpret and estimate exergy losses by, exergy calculations, exergetic efficiency, exergy charts.
CO4	Apply and concepts of exergy analyses in Specific applications to the analysis of power stations, refrigeration installations, Cryogenic systems and small capacity units.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1			1								
CO2				2								1
CO3	1											1
CO4	1					1						2

Course Contents

Unit I

Exergy Destruction: Lost available work referred to heat engine cycle, refrigeration cycle, heat pump cycle, non-flow and steady flow processes, Mechanism of exergy destruction, modified Gouy-Stodola theorem, concept of effective temperature

Unit II

Exergy Analysis of Simple Processes: Mixing and separation process of fluids of different temperature, heat transfer across a temperature difference, expansion and compression process, combustion process.

Unit III

Exergy Analysis of Power Plant Cycles: Maximum power subject to size constraint with fixed heat input and its application to Brayton cycle Steam turbine power plants: External and internal irreversibility, superheater, reheater, vacuum condenser, regenerative feed water heating, combined feed water heating and reheating.

Unit IV

Gas turbine power plant: External and internal irreversibility, regeration, reheater, and intercooler, combined steam and gas turbine power plant.

Unit V

Exergy analysis of Refrigeration cycle: Joule-Thomson Expansion, Work-Producing Expansion, Brayton Cycle, Optimal Intermediate Cooling, Exergy analysis of Air-conditioning applications: Mixtures of air and water vapour, total flow exergy of humid air & liquid water, Evaporative cooling process and other aspects,Cryogenic systems and small capacity units.

Unit VI

Exergy-economic Analysis: Fundamental of exergy-economics, exergy costing of different thermal components: steam or gas turbine, boiler, cogeneration system.

TEXTS / REFERENCES:

1. Advanced Engineering Thermodynamics by Adrian Bejan, John Wiley & Sons, Inc.
2. The Exergy Method of Thermal Plant Analysis by T J Kotas, Krieger Publishing Company
3. Thermal Design and Optimization by Adrian Bejan, George Tsatsaronis, Michael Moran, John Wiley & Sons, Inc.
4. Advance Thermodynamics for Engineers by Winterbore D E, Arnold Publication
5. Advanced Thermodynamics for Engineers by Kenneth Wark, McGraw Hill Publishing Co. Ltd.
6. Fundamentals of Engineering Thermodynamics by Michel J Moran, Howard N Shapiro, Daisie D Boettner, Margaret B Bailey, John Wiley & Sons, Inc.

MHP11E1d/2d Energy Conservation &Management

MHP11E1d/2d	Energy Conservation and Management	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of Energy Conservation and management
2. To familiarize the students about the Energy audit and its applications in real life situations
3. To carry out a energy audit on the existed thermal system

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

CO1	Demonstrate energy management principles, identify need, organizing it. carry out energy auditing.
CO2	Conduct economic analysis of any industry or power plant, obtain conclusion and suggest it to industry.
CO3	Interpret financial appraisal methods, and thermodynamic analysis, and estimate financial budget of visited industry.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2			1	1		1		2				
CO3				1	1		1	2				1

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Course Contents

Unit-I

Energy scenario and its various forms, General energy problem, Energy use patterns, Energy balance.

Energy Management Principles: Need, Organizing, Initiating and managing an energy management program.

Energy Auditing: Elements and concepts, Types of energy audits, Instruments used in energy auditing.

Unit-II

Economic Analysis: Cash flows, Time value of money, Formulae relating present and future cash flows - single amount, uniform series.

Unit-III

Financial appraisal methods: Payback period, Net present value, Benefit-cost ratio, Internal-rate of return & Life cycle costs/benefits. Thermodynamics of energy conservation,
Energy conservation in Boilers and furnaces, Energy conservation in Steam and condensate system.

Unit-IV

Cogeneration: Concepts, Types of cogeneration systems, Performance evaluation of a cogeneration system.

Waste Heat Recovery: Potential, benefits, waste heat recovery equipments.

Space Heating, Ventilation Air Conditioning (HVAC) and water heating of building, Transfer of heat, Space heating methods, Ventilation and air conditioning, Heat pumps, Insulation, Cooling load, Electric water heating systems, Electric energy conservation methods.

Unit-V

Industrial Insulation: Insulation materials, Insulation selection, Economical thickness of insulation.Industrial Heating: Heating by indirect resistance, direct resistance heating (salt bath furnace), Heat treatment by induction heating in the electric arc furnace industry.

Unit-VI

Energy Conservation in Electric Utility and Industry: Energy costs and two – part tariff, Energy conservation in utility by improving load factor, Load curve analysis, Energy efficient motors, Energy conservation in illumination systems, Importance of Power factor in energy conservation - Power factor improvement methods, Energy conservation in industries

Texts / Reference Books:

1. S.C.Tripathy: "Electric Energy Utilization and Conservation", TMG Delhi, 1991.
2. Wayne C. Turner: "Energy Management Handbook", Wiley Interscience Publication, NY, 1982.
3. D.A.Reay: "Industrial Energy Conservation", Pergamon Press. 1980.
4. T.L Boten: "Thermal Energy Recovery", Wiley, 1980.
5. Industrial Energy Conservation Manuals: MIT Press.
6. W.C.Turner, Energy Conservation Handbook.

MHP11E1e/2e Design of Heat Exchangers

MHP11E1e/2e	Design of Heat Exchangers	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of thermal design of Heat exchanger
2. To familiarize the students about the heat exchanger design and its applications in real life situations
3. To carry out a computer simulation of heat exchanger design

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

CO1	Demonstrate and of heat exchanger design methodology, and design considerations
CO2	Analyze performance of Heat exchanger by applying basic design theory.
CO3	Design and conduct experiment on one from double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger.
CO4	Demonstrate selection criteria of HEX and conduct an independent research to sugges suitable HEX.
CO5	Model and illustrate heat exchanger based on I-law and irreversibility.
CO6	Study and analyze losses in HEX, and upcoming advancements.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1							1			
CO2	1	1										
CO3			2						2			
CO4	2	1					1		1			
CO5	1											
CO6	1			1	1							

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Course Contents

Unit I

Introduction: Classification, overview of heat exchanger design methodology, Design specifications, thermo hydraulic design, and other considerations.

Unit II

Basic design theory: LMTD method, ε-NTU method, P-NTU method, ψ-P method and P1-P2 method.

Unit III

Heat exchanger design procedures: Design of double pipe, shell and tube, tube fin, plate type and plate-fin heat exchanger, Design of cryogenic heat exchangers.

Unit IV

Selection of heat exchangers: selection criteria, general selection guidelines of shell and tube heat exchanger, plate type heat exchanger.

Unit V

Thermodynamic modeling and analysis: modeling of heat exchanger based on I-law and Irreversibility.

Unit VI

Header design: Flow maldistribution, fouling and corrosion, advances in heat exchangers.

TEXTS / REFERENCES:

1. R.K.Shah and DeusanP.Sekulic, *Fundamentals of heat exchanger design*, 2003, John Willeyand Sons.
2. S. Kakac, Heat *Exchangers – Thermal Hydraulic Fundamentals and Design*, Hemisphere, Mc Graw-Hill.
3. D. Q. Kern and A. D. Kraus; *Extended Surface Heat transfer*, McGraw-Hill.
4. D. Q. Kern, Process Heat Transfer, McGraw-Hill.
5. W. M. Kays and A. C. London, *Compact Heat Exchangers*, McGraw-Hill.

MHP11E1f/2f Design of Air Conditioning System

MHP11E1f/2f	Design of Air Conditioning System	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of air conditioning
2. To familiarize the students about the air conditioning system design and its applications in real life situations
3. To learn the duct design and load calculation

Course Outcomes:

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

CO1	Demonstrate Air-conditioning processes and psychometric
CO2	Illustrate Ventilation, Necessity, Natural Ventilation, wind effect, Measurement of thermal comfort indices.
CO3	Formulate and solve problems of cooling, heating load calculations.
CO4	Design Air distribution, duct design for suitable problem.
CO5	Analyze Sound propagation, SPL, PWL, Sound Intensity, room acoustics and apply noise control techniques.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1											
CO3		2		2								
CO4		1			1	1						
CO5				1								

Course Contents

Unit I

Psychrometry, Air-conditioning processes, Advanced psychrometry, ERSHF, winter air-conditioning, Preparation of psychrometric charts.

Unit II

Ventilation, Necessity, Natural Ventilation, wind effect, stack effect, flow around building, Thermal Comfort, Thermal human model, Measurement of thermal comfort indices.

Unit III

Solar geometry, Building Heat Transfer, Cooling Load Calculation, CLTD Method Cooling Load and Heat Loss calculations, Concept of energy days, Heating load calculation.

Unit IV

Room Air Diffusion, Filtration, Duct Design for real life applications such as hospitals , hotels, shopping malls etc., Air Distribution Design.

Unit V

Noise control, Sound propagation, SPL, PWL, Sound Intensity, room acoustics, sound control in ducts.

Unit VI

HVAC Equipment, Packaged and Split HVAC Equipment, Heat pump Design and selection, Equipment Selection, Auxiliaries.

TEXTS / REFERENCES:

1. Handbook of Air Conditioning System Design, Carrier Air Conditioning Co., 1965.
2. ASHRAE Handbooks and ISHRAE Handbooks
3. Thermal Environmental Engineering, James L.Threlkeld, Prentice Hall,
4. Air conditioning engineering, W. P. Jones, ELBS
5. Refrigeration and Air-conditioning, Stoecker and Jones, McGraw HillEdward Pita, Air Conditioning Principles and Systems,Prentice Hall

MHP11E1g/2g Advanced Refrigeration

MHP11E1g/2g	Advanced Refrigeration	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of refrigeration
2. To familiarize the students about the refrigeration processes and component design
3. To provide the understanding of the industrial applications of refrigeration

Pre-requisite: Refrigeration and Air-conditioning

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

CO1	Formulate and solve vapor compression refrigeration and multi-stage vapor compression systems.
CO2	Study and identify various types of refrigerants and their properties., such as zeotropic, azeotropic etc.,
CO3	Illustrate Nomenclature, Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, action with lubricating oil, retrofitting, refrigerant blends, effects on refrigeration components.
CO4	Design and analyze vapor absorption system
CO5	select refrigerant control techniques and do piping designing for refrigeration plant

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	1											
CO3	1											1
CO4						1						1
CO5	2	1		1		2						

Course Contents

Unit I

Vapor compression refrigeration, actual cycle, second law efficiency, multistage compression with inter-cooling, Multi-evaporator systems, Cascade systems.

Unit II

Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor, compressor motor selection

Unit III
Design, selection of evaporators, condensers, system balance, control systems.

Unit IV
History, Nomenclature, Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, action with lubricating oil, retrofitting, refrigerant blends, effects on refrigeration components. Thermoelectric and nonconventional refrigeration systems, adiabatic de-magnetization.

Unit V
Vapor absorption refrigeration, Li-Br and aqua ammonia system, calculation of mass flow rate and system performance, energy balance, controls, analysis of rectifier and analyzer, single effect and double effect systems, vapor transformer.

Unit VI
Refrigeration controls, Flow controls, Temperature controls, Expansion devices: design and selection, refrigeration system piping design.

TEXTS / REFERENCES:

1. Stoecker W. F. and Jones J. P.,*Principles of Refrigeration and air-conditioning*, McGraw Hill
2. Arora C. P., *Refrigeration and air-conditioning*, Tata McGraw Hill.
3. Gosney W. B., *Principles of refrigeration*, Cambridge University Press.
4. Stoecker W. F., *H. B. of Industrial refrigeration*, McGraw Hill Companies, Inc.
5. Dossat R. J., Principles of Refrigeration, Pearson Education
6. ASHRAE H. B. – Refrigeration
7. ASHARAE H. B. – FundamentalEdward Pita, Air Conditioning Principles and Systems,Prentice Hall.

MHP11E1h/2h Hydraulic, Pneumatic and Fluidic Control

MHP11E1h/2h	Hydraulic, Pneumatic and Fluidic Control	PEC	3-1-0	4 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of hydraulic and pneumatics
2. To familiarize the students about the hydraulic and pneumatic and its applications in real life situations
3. To carry out a case study on the existed mechanical system

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

CO1	Describe control system and list types of control system and demonstrate their utility.
CO2	construct and design Hydraulic, Pneumatic or Fluidic Control valve, forces acting on valves indifferent type of flows
CO3	Operate and maintain various hydraulic devices such as hydraulic brake, power steering, jack etc.
CO4	Design hydraulic circuits by selecting suitable components for a given application.
CO5	Operate and maintain various hydraulic devices such as hydraulic brake, power steering, jack etc
CO6	Install, maintain, and troubleshoot various hydraulic systems.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	2		1		2	1						
CO3	2	1										
CO4	1				1							
CO5					1	1						1
CO6	2				1							2

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Course Contents

Unit I
Introduction to control system. Types of control system and their utility.

Unit II

Hydraulic power generation and transmission, valve control pressure flow relationship and constructions, steady state operating forces, transient forces and valve instability.

Unit III
Circuit design. Pneumatic valves. Hydraulic and pneumatic drives.

Unit IV
Introduction to fluidic devices and sensors lumped and distributed parameter fluid systems.

Unit V
Fluid mechanics of jets, wall attachment and vortex devices. Pure fluidic analog amplifiers. Analog signal control techniques. Design of pure fluid digital elements

Unit VI
Maintenance and trouble shooting.

TEXTS / REFERENCES:

1. J.F.Blackburn, G.Rechthof, J.L. Shearer, *Fluid Power Control,*MIT, 1960
2. B.W.Anderson, *The Analysis and Design of Pneumatic Systems*, Wiley, 1967.
3. K.Foster, G.Parker, *Fluidic Components and Circuits*, Wiley, 1970.
4. A.B.Goodwin, *Fluid Power Systems*, Macmillan, 1976.

MHP11E1i/2i   Advanced IC Engines

MHP11E1i/2i	Advanced IC Engines	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1. To provide the sufficient knowledge of concept, applications, importance of IC engines
2. To familiarize the students about the IC engines systems, processes, alternative fules etc
3. To understand the environment aspects of IC engines

Course Outcomes: At the end of the course, students will be able to

CO1	Illustrate fundamental and actual thermodynamic cycle analysis in IC engines.
CO2	Describe and simulate actual heat exchange and gas flows in combustion chamber.
CO3	Analyze combustion and apply remedial measures to avoid abnormal combustion in IC engine.
CO4	Apply various emission control system and modification to take corrective actions to reduce pollution.
CO5	Acquire and use knowledge of genetic algorithm to optimize real life problems.
CO6	Understand Modern trends coming in IC Engine technology.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		2									
CO2	1		1	2								
CO3	1	2	1	1				1				
CO4						1				1		1
CO5		1	2									
CO6	1	2		2						1		2

Course contents

Unit I

Spark Ignition Engines

Mixture requirements, Fuel Induction systems, Stages of combustion, Normal and abnormal combustion, factors affecting knock, Combustion chambers, Engine design, Basic concepts of SI engine simulation technique.

Unit II

Compression Ignition Engines

Stages of combustion in C.I. Engine, Direct and indirect Injection systems, Combustion chambers, Fuel spray behavior, spray structure, spray characteristics, air motion, engine design, Basic concepts of CI engine simulation technique.

Unit III
Fuels for SI and CI Engines
Qualities of SI & CI engine fuels, rating of SI & CI engine fuels, fuel additives for SI & CI engines, Fuel supply systems for SI and CI engines to use gaseous fuels like hydrogen, CNG, biogas and, other possible fuels.

Unit IV
Super-charging and Turbo-charging
Purpose of supercharging, effects of supercharging on SI & CI engines performance and its limitations, different types of turbo-charges, methods of turbo charging & its limitations.

Unit V
Engine Emissions & Control: Air pollution due to IC engines, Emissions-HC, CO, NOx, particulates, GHGs (CO_2, CH_4 and N_2O), emission norms, emission control methods-exhaust gas recirculation, three-way catalytic convertor, particulate trap, modern methods.

Unit VI
Recent Trends
Homogeneous Charge Compression Ignition Engine, Lean Burn Engine, Stratified Charge Engine, Electronic Engine Management, Common Rail Direct Injection Diesel Engine, Gasoline Direct Injection Engine, Data Acquisition System –pressure pick up, charge amplifier PC for Combustion and Heat release analysis in Engines.

Reference Books:

1. E.F. Obert, Internal Combustion Engines and Air Pollution, Intext Educational Publishers, 1973.
2. John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill
3. M.L. Mathur and R.P.Sharma, Internal Combustion Engines, DhanapatRai Publications, New Delhi.
4. L.C. Litchy, Combustion Engines Processes, McGraw Hill, 1967.
5. V. Ganesan, Int. Combustion Engines, II Edition, TMH, 2002.
6. V. Ganesan, Computer simulation of spark ignition process: University process, Hyderabad 1993.

MHP11E1j/2j Pumps, Blowers and Compressors

MHP11E1j/2j	Pumps, Blowers and Compressors	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To provide the sufficient knowledge of concept, applications, importance of pumps blower and compressors
2. To familiarize the students about the Pumps blowers and compressors and their applications in real life situations
3. To understand the industrial applications of Pumps blowers and compressors

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

CO1	Demonstrate Law of momentum, Vortex theory of Euler's head. Hydraulic performance of pumps, Cavitation,
CO2	Design of centrifugal pumps, axial flow pump and analyze their performance using engineering software's etc.,
CO3	Study types of fans and blowers, calculate their efficiency, stresses, and characteristics, draw performance characteristics.
CO4	Modeling of cooling tower fans Surging Design of blowers and fans.
CO5	Demonstrate and interpret performance analysis of Axial flow and centrifugal flow compressors.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1	2										
CO3	1	1										1
CO4		1										1
CO5	1								1			

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Course Contents

Unit I
Centrifugal and Axial Flow Pumps
Law of momentum, Vortex theory of Euler's head.Hydraulic performance of pumps; Cavitation, Losses in Pumps, Priming, Jet pumps. The centrifugal pump, definitions, pump

output and efficiency, multistage centrifugal pumps, axial flow pump, Design of pumps, Pumps in series and parallel.

Unit II

Power Transmitting Turbo-machines, Introduction, theory, fluid of hydraulic coupling, torque converter.

Unit III

Rotary fans and blowers Introduction, Centrifugal blower, types of Vane shapes, Size and speed of Machine, Vane shape: efficiency, stresses, and characteristics. Actual performance characteristics, the slip co-efficient, Drum and partial flow fans, Fan laws and characteristics, Losses in fans and blowers.

Unit IV

Turbo blowers and their characteristics. Cooling tower fan, Surging Design of blowers and fans.

Unit V

Axial Compressors: Stage velocity triangles, enthalpy – entropy diagrams, flow through blade rows, stage losses and efficiency, work done factor, low hub-tip ratio stages, supersonic and trans sonic stages, performance characteristics and design.

Unit VI

Centrifugal Compressors: Elements of centrifugal compressor stage, stage velocity diagrams, enthalpy-entropy diagram, nature of impeller flow, slip factor, diffuser, volute casing, stage losses, performance characteristics and design.

TEXT / REFERENCES:

1. A.J.Stepanoff, *Centrifugal and Axial /flow Pumps*, Wiley, 1962.
2. A.Kovats, *Design and Performance of Centrifugal and Axial Flow Pumps and Compressors*, Oxford, Pergamon, 1958.
3. V. Kadambi and Manohar Prasad: “*An Introduction to energy conversion* VolumeIII,2002
4. S M Yahya: “*Turbines, Compressors and Fans*”, Second Edition.
5. V Ganesan: “*Gas Turbines*”, 2002.
6. R.Yadav, *Steam and Gas Turbine*, Central Publishing Home, Allahabad.

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MHP11E1k/2k CAD-CAE

MHP11E1k/2k	CAD-CAE	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Pre-requisites

Numerical Methods & Computational Techniques (PC3), Structured or Object Oriented Programming (FORTRAN / C / C++ / Java / VB)

Course Objectives:

1. To provide the sufficient knowledge of concept, applications, importance of CAD -CAE
2. To familiarize the students about the CAD - CAE and their applications in real life situations
3. To understand the industrial applications of CAD CAE and solving industrial problem

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

CO1	Demonstrate - Polynomial and spline interpolation, Bezier curves, B-splinesto surfaces representation, patches and composite surfaces.
CO2	Design and create Solid model assembly of thermal and fluid engineering system in CAD software.
CO3	Analyze simple Engineering problem by selecting appropriate Mesh generation.
CO4	Modeling and Meshing of Thermal and Fluid Flow equipment in CAD.
CO5	Simulate and demonstrate Thermal and Fluid systems by using ANSYS, EES, MATLAB etc.
CO6	Understand and simulate computer aided manufacturing.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		1		1	1							
CO3		2		1								
CO4	1	1		1								1
CO5	1	1		3								
CO6	1	1										1

Course Contents

Unit I

Overview of CAD Applications, Curves - Polynomial and spline interpolation, Bezier curves, B-splines, Introduction to surfaces representation, patches and composite surfaces

Solid Modeling: Representation of Solids, Topology, Wireframe, Boundary representation (B-Rep), CSG, Solid modeling operations

Unit II

Computer Graphics: Mathematical principles for 2D and 3D visualization, Matrix transformations, Modeling, viewing, projection and rendering, OpenGL graphics library Meshing – Mesh topology, Data structures, Introduction to Mesh generation algorithms, Surface meshes, Element types and quality criteria

Unit III

CAD data formats and exchange
Hands-on lab sessions: Modeling and Meshing of Thermal and Fluid Flow equipment

Unit IV

Numerical solutions and techniques for thermal and fluid flow and heat transfer.

Unit V

Development of algorithm and programming (coding by using C/C++/VB/ FORTRAN etc.,) of the thermal, fluid flow and combustion related problems.

Unit VI

Computational Fluid Dynamics: Lab simulations for Fluid Flow and Heat transfer (case study)

TEXTS / REFERENCES:

1. Kunwoo Lee, Principles of CAD/CAM/CAE
2. Chris McMahon and Jimmie Browne, CAD/CAM – Principle Practice and Manufacturing Management, Addision Wesley England, Second Edition, 2000
3. Groover M.P. and Zimmers E. W., CAD/CAM: Computer Aided Design and Manufacturing, Prentice Hall International, New Delhi, 1992.
4. Software Engineering – Ian Sommerville, Pearson Education

MHP11E1l/2l Nuclear Power Plant

MHP11E1l/2l	Nuclear Power Plant	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To provide the sufficient knowledge of concept, applications, importance of Nuclear Power plant
2. To familiarize the students about the design of Nuclear Power plant
3. To understand the environment impact and policies about the NPP

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

CO1	Identify various energy sources, Indian Power Scenario, Nuclear Power Scenario in the World, Nuclear Power Scenario in India, Scope
CO2	Describe Nuclear physics, reactor, classification and types of nuclear reactor, economics of power plant.
CO3	Illustrate effect of nuclear radiation on health, safety and licensing
CO4	Analyze heat transfer from nuclear, heat flux radiation.
CO5	Analyze economics of nuclear power plant, load generation.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	2						1					
CO3		2					1			1		2
CO4			1	1								
CO5			1									

Course Content

Unit I

Introduction – World Energy Sources, Indian Power Scenario, Nuclear Power Scenario in the World, Nuclear Power Scenario in India, Scope of the Present Course.

Unit II

Nuclear Power Plant: Nuclear physics, Nuclear Reactor, Classification, Types of reactors, Site selection. Method of enriching uranium. Application of nuclear power plant. Nuclear Power Plant Safety: Bi-Product of nuclear power generation, Economics of nuclear power plant, Nuclear power plant in India, Future of nuclear power.

Unit III

Basic Concepts in Neutron Reactions, Neutron Moderation and Diffusion, Nuclear Reactor Theory. Nuclear Reactor Dynamics and Control., Nuclear Reactor Thermal-Hydraulics.

Unit IVPower Plant Instrumentations: Classification, Pressure measuring instrument, Temperature measurement and Flow Measurement, Analysis of combustion gases, Pollution types, Methods of control.

Unit V

Health Physics, Radiation Shielding., Nuclear Reactor Safety and licensing.

UnitVI

Economics of Power Generation: Factors affecting the economics, loading factors, Utilization factor, Performance and operating characteristics of power plant, Point economic load sharing, Depreciation. Energy rate, Criteria for optimum loading. Specific economic energy problem

TEXT/REFERENCES:

1. Power Plant Engineering / P.K.Naga / TMH
2. Power Plant Technology / El Wakil, McGraw Hill Publication.
3. Power Plant Engineering / R.K.Rajput/ Lakshmi Publications.
4. Power Plant Engineering / P.C.Sharma/ Kotearia Publications.

MHP11E1m/2m   Thermal Energy Storage

MHP11E1m/2m	Thermal Energy Storage	PCC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To provide the sufficient knowledge of concept, applications, importance of Thermal energy storage
2. To familiarize the students about the design of thermal energy storage systems
   To understand the industrial applications of thermal energy storage.

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

CO1	Survey litterateur on importance of energy transport and storage of thermal, mechanical, electro-chemical energies etc.,
CO2	Interpret and analyze energy storage and conversion performance from one to another.
CO3	Design system for Chemical energy storage (organic fuels) High temperature storage Compressed air energy storage

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		1		1	1							
CO3			1	1		1						

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Course Contents

Importance and modes of energy transport and storage
Thermal energy storage (sensible and latent heat storage)
Mechanical Energy Storage: gravitational energy storage, elastic energy storage

Electromagnetic energy storage: static field, transient electric field, magnetic materials, radiant storage.

Electro-chemical energy conversion and storage: The electrochemical cell, Fuel cells, batteries.
Chemical energy storage (organic fuels)
High temperature storage
Compressed air energy storage

Thermo chemical storage
Emerging technologies and examples of energy storage

Testing of storage systems

Thermal modeling of energy storage systems
Total energy systems

Texts / Reference Books:

1. Johannes Jensen & Bent Sorensen "Fundamentals of energy storage"
2. Collins "Batteries Vol. I & II".
3. S.U. Faulk& A.J.S SaIkins"Silver Zinc - Alkaline storage systems".

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MHP11E1n/2n Steam Engineering

MHP11E1n/2n	Steam Engineering	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives: Objectives of this course are

1.To Understand of the working of different boilers and accessories..

2.To analyze thermal systems for energy conservation and waste heat recovery.

3.To design and develop controls and instrumentation.

Course Outcomes: At the end of the course, student should be able to:

CO1	Explain working of different boilers and significance of mountings and accessories.
CO2	Use techniques, skills, and modern engineering tools necessary for boiler performance assessment
CO3	Understand theoretical and practical background in thermal systems, and will have a good understanding of energy conservation fundamentals. Students will have the ability to analyze thermal systems for energy conservation.
CO4	Design a steam piping system, its components for a process and also design economical and effective insulation.
CO5	Analyze a thermal system for sources of waste heat design a system for waste heat recovery.
CO6	Design and develop controls and instrumentation for effective monitoring of the process.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1			1				
CO2	2	1		3				2		1		
CO3	1	2	1			1						1
CO4	2	1				1	2					1
CO5	1	1	1									1
CO6	2							2				

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Course Content

Unit I

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.

Unit II

Piping & Insulation Water Line, Steam line design and insulation; Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria, Refractory types, selection and application of refractory, Heat loss.

Unit III

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.

Unit IV

Boiler Performance Assessment Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; performance evaluation of accessories; factors affecting boiler performance.

Unit V

Energy Conservation and Waste Minimization

Energy conservation options in Boiler; waste minimization, methodology;economic viability of waste minimization.

Unit VI

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

Texts/References:

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

MHP12E3a/4a Cryogenic Engineering

MHP12E3a/4a	Cryogenic Engineering	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

- To cover the basic principles of cryogenic engineering.
- To develop an intuitive understanding of cryogenics for the student who are interested to study the science technology of low temperatures.

Course Objectives:

- To cover the basic principles of cryogenic engineering.
- To develop an intuitive understanding of cryogenics for the student who are interested to study the science technology of low temperatures.

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

CO1	Demonstrate and identify role of cryogenics in the industrial applications.
CO2	Describe mechanical, thermal, thermo-electric properties of cryogenic fluids.
CO3	Illustrate Ideal separation, properties of mixtures, Rectifiers column, separation of air, purification.
CO4	List and give details about various types of cryogenic refrigeration system, such as J-T Refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solve refrigerator, G-M refrigerator
CO5	Study and describe Insulation and storage systems in cryogenic engineering
CO6	Demonstrate and identify role of cryogenics in the industrial applications.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	1	2										
CO3	1	2		1	1							
CO4	1	1		1	1	1						
CO5	1	2			1							
CO6						1	1					2

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Course Contents

Unit I

Introduction:

Industrial applications, research and development, properties of cryogenic fluids-oxygen, nitrogen, air, hydrogen and helium.

Behaviour of Structural Materials at Cryogenic temperature:

Mechanical properties, thermal properties, thermoelectric properties.

Unit II

Liquefaction of Cryogenic Gases:

Inversion Temperature, Liquefaction Performance Parameters, Ideal cycle, liquefaction of air, Hydrogen and helium, critical components of liquefiers, efficiency, Cryogenic heat exchangers.

Separation of Gases: Ideal separation, properties of mixtures, Rectifiers column, separation of air, purification.

Unit III

Cryogenic Refrigeration Systems:

Ideal refrigeration systems, J-T Refrigeration systems, Philips refrigerator, Vuilleumier refrigerator, Solvey refrigerator, G-M regrogerator.

Unit IV

Insulation:

Vacuum insulation, fibrous materials, Solid foams, Gas filled power, comparison, critical thickness.

Unit V

Storage:

Size and shape of vessel, portable commercial containers, large stationary container, power, transport, storage system, Liquid level indicators.

Unit VI

Transfer of Liquefied Gases:

Two phase flow transfer through insulated and uninsulated lines, cryogenic pumps and valves.

TEXTS:

1. R. F. Barron, Cryogenic Systems, Oxford University Press, 1985.
2. *Advanced Cryogenic Engineering*, Proceedings of Cryogenic Engineering Conference, Vol 1-145, Plenum press, New York, 1968.

MHP12E3b/4b Steam and Gas Turbines

MHP12E3b/4b	Steam and Gas Turbines	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To provide the sufficient knowledge of working, construction and control of ST and GT
2. To familiarize the students about the industrial applications of ST and GT
3. To understand the analysis of GT and ST employing real life data

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

CO1	Illustrate properties of Steam, Draw P-V, T-s, H-s(Mollier) diagrams for steam, Describe Theoretical steam turbine cycle.
CO2	Demonstrate and analyze vortex flow, energy lines and reheat factors of steam turbines. Solve problems of finding performance steam turbine power plant.
CO3	Demonstrate simple brayton cycle for gas turbine analyze its performance on computer simulation, suggest suitable modification and then analyze it.
CO4	Study and apply various Performance Improvement Techniques in steam and gas Turbines
CO5	Design and suggest and analyze cooling accessories and protective material for steam turbine.
CO6	Visit thermal power plant and enumerate performance and maintenance and troubleshooting criteria for steam turbine.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2		2										
CO3	1	1		3	1							
CO4	2	1			2	1						
CO5	1	1		1	1							
CO6			2	1	1							

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Course Contents

Unit I

Introduction, properties of steam, steam quality, Theoretical steam turbine cycle. The flow of steam through Impulse and Impulse–Reaction turbine blades, compounding of steam turbine.

Unit II

Vortex flow in steam turbines, Energy lines, State point locus, Reheat factor and Design procedure. Governing and performance of steam turbine, Effect of operating variables on thermal efficiency.

Unit III
Steam nozzles, Turbine Blade-Design, Selection of blade profile, blade cooling techniques, material, protective coating.

Unit IV
Gas turbine Introduction, simple open cycle gas turbine, Actual Brayton cycle, Means of Improving the efficiency and the specific output of simple cycle, Regeneration, Reheat, Intercooling,

Unit V
Closed-cycle gas turbine,turbine velocity diagram and work done, Performance improvement, Effect of operating variables on thermal efficiency.

Unit VI
Fuel supply techniques and control, Combuster design, Lubrication, Maintenance and trouble shooting.

TEXTS / REFERENCES:

1. W.J.Kearton, *Steam Turbine Theory and Practice*, ELBS.
2. R.Yadav, *Steam and Gas Turbine*, Central Publishing Home, Allahabad.
3. Jack D. Mattingly., *Elements of Gas Turbine propulsion*, McGraw – Hill Pub.,
4. Cohen Rogers, *Gas Turbine Theory*, Longman Publishing.
5. V Ganesan: “*Gas Turbines*”, 2002

MHP12E3c/4c Biomass Energy

MHP12E3c/3c	Biomass Energy Systems	PEC	3-0-0	3 Credits

Exam Scheme			
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks

Course Objectives:

1. To Understand the concept of Biomass its importance, availability, and energy conversion process
2. To familiarize the students about the biomass systems design
3. To understand the industrial applications of Biomass systems through real life problems

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

CO1	Illustrate relevance of biomass as energy source, enumerate advantages and disadvantages of biomass resources.
CO2	Survey and identify wasteland in India, suggest suitable biomass resource management.
CO3	Interpret biomass conversion processes, design gasification system and identify its use in SI and CI engines and analyze its performance.
CO4	Conduct an experiment and calculate load capacity, efficiency and identify maintenance, troubleshooting and exhaust emission problems.
CO5	Design and construct down draft gasifier, its Cooling–cleaning systems and Performance evaluation of a Down draft gasifier.
CO6	Illustrate relevance of biomass as energy source, enumerate advantages and disadvantages of biomass resources.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	1		2		1	1		1				
CO3	1	1			2							
CO4			2	2	1	1					1	
CO5	2	1		1		1						
CO6	1				1			1				2

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Course Contents

Unit I

Introduction: Relevance of biomass as an energy source, Biomass Resources, Cultivated biomass resources, Water-to-biomass resources, Advantages associated with biomass resources, Availability of biomass for energy generation.

Unit II
Energy plantation: Concept, Objectives and advantages.
Wasteland development: Extent of water lands in India, Nature of waste lands.

Unit III
Biomass Conversion Processes: Combustion, Biochemical and Thermo chemical.
Gasification: Fuels for gasification, Properties of biomass - size, size distribution, bulk density, volatile matter, ash and ultimate analysis.Air gasification in a down draft gasifier, Types of gasifiers, Gasifier engine system, Use of producer gas in SI & CI engines, Reasons for decorating, Problems associated with gasifier engine system and its efficiency.

Unit VI
Design of a Down draft gasifier
Cooling–cleaning systems
Performance evaluation of a Down draft gasifier.

Unit V
Performance of Dual Fuel Engine: Power capacity, Diesel substitution, Thermal efficiency, Smoothness of operation, Load following capability, Maintenance and durability, Exhaust emissions.

Unit VI
Bio-conversion Process: The process, Types of biogas plants, Design of biogas plants, Factors affecting gas generation rate, Biogas engine for water pumping and electric power generation applications, Government programmes,
Wood fuelled Cooks stoves, Effects of various stove parameters, Effects of various stove components, Current versions of improved stoves, Efficiency of stoves, Utilization of biomass based fuels for thermal and shaft power applications.

TEXTS / REFERENCES:

1. T.B.Reed: "*Biomass Gasification Principles and Technology*", Noyes Data Corporation,Energy Technology Review, No.67, U.S.A., 1981.
2. P Vimal& M S Bhatt: "*Wood Energy Systems*", K L Publications, New Delhi – 1989
3. S Rao& B BParulkar: "*Energy Technology*" Khanna Publishers Delhi – 1999
4. A.Kaupp and J.R.Goss: "*State of Art Report for small scale Gas Producer Engine Systems*", FriedrVieweg&SohnVerlags, Gmbh, Braunschweig, 1984

MHP12E3d/4d Computational Fluid Dynamics

MHP12E3d/4d	Computational Fluid Dynamics	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the concept of fluid dynamics, CFD techniques, convergence criteria
2. To familiarize the students about the implementation of CFD in fluid mechanics and heat transfer problems
3. To understand the use of software based on CFD

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

CO1	Identify applications of finite volume and finite element methods to solve Navier-Stokes equations.
CO2	Evaluate solution of aerodynamic flows. Appraise & compare current CFD software. Simplify flow problems and solve them exactly.
CO3	Design and setup flow problem properly within CFD context, performing solid modeling using CAD package and producing grids via meshing tool.
CO4	Interpret both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.
CO5	Use CFD software to model relevant engineering flow problems. Analyse the CFD results. Compare with available data, and discuss the findings.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	1		2	3	1	1						
CO3	2	1	1	2	1		1					
CO4	1			1	1	1						
CO5			2	2	2	1				2		1

Course Contents

Unit I
Introduction and Governing Equations of CFD
Historical background, impact of CFD, derivation, discussion of physical meanings and presentation of forms particularly suitable to CFD.

Unit II
Basic Aspects of Discretization

Introduction to FDM, FEM and FVM, detailed treatment of FDM, explicit and implicit methods, errors and stability analysis.

Grids with Appropriate Transformations

Adaptive grids and unstructured meshes, uniform and non-uniform grids, Numerical errors.

Unit III

CFD Techniques

The Lax-Wendroff Technique, MacCormack's Technique, Space marching, Relaxation Technique, Numerical dissipation and dispersion, artificial viscosity, The ADI Technique, Pressure correction Technique: Application to incompressible viscous flow, the SIMPLE algorithm, Computation of Boundary layer flow, Finite deference approach.

Unit VI

Numerical Solution of Governing equations:

Numerical solution of elliptical equations, Linear system of algebraic equations, Iterative solution of system of linear equation, Model Equations, Wave equations, Numerical solution of parabolic equations, Stability analysis, Solutions of convection, Diffusion equation, Conservative and non-conservative schemes, Navier-Stokes equations, Basics of grid generation, Numerical solution of hyperbolic equations.

Unit V

Convection Heat Transfer

Steady One-Dimensional and Two-Dimensional Convection, Diffusion, Unsteady one-dimensional convection, Diffusion, Unsteady two-dimensional convection, Diffusion.

Unit VI

Incompressible Couette Flow: Solution by implicit method and the pressure correction method, Governing Equations, Stream Function, Vorticity method, Determination of pressure for viscous flow.

Numerical Solution of 2D Supersonic Flow: Prandtl-Meyer Expansion Wave.

Supersonic Flow over a Flat Plate: Numerical Solution by solving complete Navier Stokes equation.

Reference Books:

1. J. D. Anderson, Computational Fluid Dynamics-The Basics with Applications, McGraw Hill.
2. Fletcher C.A.J., Computational Techniques for Fluid Dynamics, Volumes I and II, Springer, Second Edition 2000
3. C. Hirsch, Numerical Computation of Internal and External Flows, Volumes I and II, John Wiley & Sons, 2001
4. Muralidhar K. and Sundararajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi1995.
5. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, T & F.
6. Ghoshdastidar,Computational fluid dynamics.

MTF12E3e/4e Wind Energy

MTF12E3e/4e	Wind Energy	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives: Objectives of this course are

1. To understand history of wind energy and its scope in future.
2. To get practical knowledge about use various wind energy measurement indicators, anemometers
3. To calculate various parameters of wind turbine.

Course Outcomes: At the end of the course, student should be able to

CO1	Identify and describe history of wind energy and its scope in future.
CO2	survey and analyze through a literature review world distribution of wind,Weibull statistic, variation in wind energy etc.,
CO3	Conduct an experiment to use various wind energy measurement indicators, anemometers, and apply it to analyze and check data obtained from surveys.
CO4	Demonstrate and calculate performance parameters wind energy turbine.
CO5	Illustrate various electrical systems used in wind energy power plant.
CO6	Examine and justify economics of wind system.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	1	2								
CO2	1		2		1	1					1	
CO3	2	1	1									
CO4	1			2	1	1						
CO5	1	1										
CO6	1	1			1			1				

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Course Contents

Unit I

Introduction: Historical uses of wind, History of wind electric generations.

Unit II

Wind Characteristics: Metrology of wind, World distribution of wind, Atmospheric stability, Wind speed variation with height, Wind speed statistics, Weibull statistics, Weibull parameters, Rayleigh and normal distribution.

Wind Measurements: Biological indicators, Rotational anemometers, other anemometers, Wind direction.

Unit III

Wind Turbine Power, Energy and Torque: Power output from an ideal turbine, Aerodynamics, Power output from practical turbines, Transmission and generation efficiency, Energy production and capacity factor, Torque at constant speeds, Drive train oscillations, Turbine shaft power and torque at variable speeds.

Unit IV

Wind Turbine Connected to the Electrical Network: Methods of generating synchronous power, AC circuits, the synchronous generator, per unit calculations, the induction machine, Motor starting, Capacity credit features of electrical network.

Wind turbines with Asynchronous Electric Generators: Asynchronous systems, DC shunt generator with battery load, Per unit calculation, Self excitation of the induction generators, Single phase operation the induction generator, Field modulated generators, Roesel generator.

Unit V

Asynchronous Load: Piston water pumps, Centrifugal pumps, Paddle wheel heaters, Batteries, Hydrogen economy, and Electrolysis cells.

Unit VI

Economics of Wind Systems: Capital costs, Economic concepts, Revenues requirements, Value of wind generated electricity

Text/Reference Books:

1. Garg L Johnson: "Wind Energy Systems" Prentice Hall. Inc, New Jersey – 1985
2. Desire Le Gouriers: "Wind Power Plants: Theory and Design" Pergamon Press – 1982

MHP12E3f/4f Alternative Fuels for IC Engines

MHP12E3f/4f	Alternative Fuels for IC Engines	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the need of alternative fuels, environment impact, types of alternative fuels, preparation of alternative fuels
2. To familiarize the students about engine alteration to use alternative fuels
3. To understand the current status of alternative fuels

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

CO1	Demonstrate Structure of petroleum, Refining process, Products of refining process, Select suitable fuels for use in SI engines. Understand various performances rating in SI engines.
CO2	Illustrate properties of petroleum products and classify them on their characteristic.
CO3	Describe and analyze Need for alternative fuels such as Ethanol, Methanol, LPG, CNG, Hydrogen and their manufacturing procedure.
CO4	calculate and estimate performance and emission characteristics of alternative fuels

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2		1										
CO3	1	1		1	1							
CO4			1	1								

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Course Contents

Unit I

Introduction

Need for alternate fuel, availability and properties of alternate fuels, general use ofalcohols, LPG, hydrogen, ammonia, CNG and LNG, vegetable oils and biogas, meritsand demerits of various alternate fuels, introduction to alternate energy sources. LikeElectric vehicle, hybrid, fuel cell and solar cars.

Unit II

Alcohols

Properties as engine fuel, alcohols and gasoline blends, performance in SI engine,methanol and gasoline blends, combustion characteristics in CI engines, emissioncharacteristics,DME, DEE properties performance analysis, performance in SI & CIEngines.

Unit III

CNG, LPG, Hydrogen and Biogas

Availability of CNG, properties, modification required to use in engines, performance andemission characteristics of CNG, LPG and Biogas using in SI & CI engines, Hydrogen; storage and handling, performance and safety aspects.

Unit IV

Vegetable Oils

Various vegetable oils for engines, transesterification, biodiesel and its properties, performance, emission and combustion characteristics of engine.

Unit V

Electric and Hybrid Vehicle

Layout of an electric vehicle, advantage and limitations, specifications, systemcomponents, electronic control system, high energy and power density batteries, hybridvehicle.

Unit VI

Fuel Cell and Solar

Fuel cell vehicles, specifications, systemcomponents, selection of fuel cell, thermal management, maintenance, advantage and limitations, Solar powered vehicles, specifications, systemcomponents, advantage and limitations,

Reference Books:

1. M.K. GajendraBabu, K.A. Subramanian, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, 2013.
2. Richard L. Bechfold, Alternative Fuels Guide Book - SAE International Warrendale 1997.
3. B. P. Pundir, Engine Emissions, Alpha Science International Limited, 2007
4. B. P. Pundir, IC Engines Combustion and Emissions, Alpha Science International Limited, 2010.
5. Nagpal, Power Plant Engineering, Khanna Publishers - 1991.

MHP12E3g/4g Numerical Heat Transfer

MHP12E3g/4g	Numerical Heat Transfer	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Pre-Requisites: Heat Transfer

Course Objectives:

1. To Understand the concept of heat transfer and numerical techniques applied to heat transfer
2. To familiarize the students about the relation of numerical heat transfer and CFD
3. To understand the application of NHT in real life problem

Course Outcomes: At the end of the course, students will be able to

CO1	Learn the concept of Numerical Heat Transfer and its application
CO2	Explain boundary conditions and partial differential equations and formulation
CO3	Analysis the conduction problems using Numerical technique
CO4	Learn the converge methodology and techniques
CO5	Write programme based 1-D and 2-D conduction problem using NHT

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		1			1	2	1				
CO2	3	1										
CO3	3	3	1					1				
CO4	3	3	1		2			1				
CO5				3	3	1	1	2				2

Course Contents:

Unit I

Introduction

Basic approach in solving a problem by Numerical Methods, Finite difference method, Method of discretization, control volume approach, Numerical error, Grid independence test.

Unit II

Partial Differential Equations

Classification of PDEs,Elliptic, Parabolic and Hyperbolic Equations, Initial and Boundary conditions, Initial and boundary value problems.

Unit III

Numerical Methods for Conduction Heat Transfer (Part 1)

Application of heat conduction, steady and unsteady heat conduction, Dimensionality in conduction, Basic approach in Numerical Heat conduction, one dimensional steady state problem.

Unit IV
Numerical Methods for Conduction Heat Transfer (Part 2)
Two dimensional problems, Transient one dimensional problem, Euler, crank – Nicholson and pure implicit method, stability.

Unit V
Numerical Methods for Incompressible Fluid Flow
Introduction, Governing equations, Navier Stokes Equations, Stream function velocity method, general algorithm inviscid flow.

Unit VI
Numerical Methods for Convection Heat Transfer
Introduction, Convection diffusion, Thermal boundary layer flow, transient free convection.

Texts:

1. P. S.Ghoshdastidar, "Computer Simulation of Flow and heat transfer", Tata McGraw Hill Publications, New Delhi.
2. Suhas V.Patankar, "Numerical Heat Transfer and Fluid Flow", Tata McGraw Hill Book Company.
3. Varsteeg, Malalasekera, "An introduction to Computational Fluid Dynamics The finite volume method", Pearson Prentice hall.

References:

1. M. NecatiOzisik, "Finite Difference Methods in Heat transfer", CRC Press.
2. D. A. Anderson, J. C. Tannehill, R. H. Pletcher, "Computational Fluid Dynamics and Heat transfer", Hemisphere Publishing.

MHP12E3h/4h Power Plant Practice and Control

MHP12E3h/4h	Power Plant Practice and Control	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Outcomes: At the end of the program, the student will be able to

CO1	Understand merits and demerits of various power plant and Criteria for selection of power plant and economics
CO2	Understand various safety devices and controlling devices for power plant
CO3	Comparison of various power plant on efficiencies, working performance, and characteristics
CO4	Plan and design the experimental investigations efficiently and effectively
CO5	Practice statistical software to achieve robust design of experiments.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2		1										
CO3		1	1									
CO4						1						
CO5				1				1				

Course Contents

Unit I

Introduction: Energy reserves and Energy utilization in the world, Electrical power Generation & consumption in India. Types of power plants, merits and demerits, Criteria for selection of power plant. Power Plant Economics.

Hydro Electric Power Plants: Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants, site selection, comparison with other types of power plants.

Unit II

Steam Power Plant: Layout, Super Heaters, Reheaters, Condensers, Economizers and Feed Water heaters, Operation and performance, Rankine cycle with Superheat, Reheat and Regeneration. Super critical boilers,Fluidized Bed combustion boiler - Advantages, Waste heat Recovery boilers, Co-generation Power Plant, Emissions and their controls.

Unit III

Nuclear Power Plant: Overview of Nuclear Power Plant, Nuclear physics Radio activity-fission process Reaction Rates, diffusion theory and Critical heat flux -Nuclear Power Reactors, different types, advantages and limitations, Materials used for Reactors. Hazards in nuclear power plant, remedial measures, safety precautions, methods of waste disposal, different form of waste from power plant.

Unit IV

Gas Turbine: Layout of Gas Turbine, Basic Gas turbine cycle, cycle improvements, Intercoolers, Reheaters and regenerators, Thermodynamic analysis of Gas turbine, Operations and performance of Gas Turbine. Combined Cycle Power Plant: Binary vapour cycles, Coupled cycles, Combined Power cycle Plants, Advantages and Limitations, Gas turbine,Steam turbine Power Plant and MHD, Steam Power Plant. Water pollution and Solid waste management in power plants, Effluent quality standards

References

1. Power Plant Engineering, P. K. Nag, McGraw Hill
2. Power Plant Engineering Technology, M.M. Wakil, Mc Graw Hill Publication.
3. Power Plant Engineering, byArrora&Domkundwar‟, Dhanpat Rai & Sons, New Delhi, 2008
4. Power Plant Engineering, by P C Sharma‟, S.K. Kataria& Sons, New Delhi, 2010

MHP12E3i/4i Nano Technology

MHP12E3i/4i	Nano Technology	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the concept of nano technology and its importance in real engineering applications
2. To familiarize the students about the use of nano technology in industrial world
3. To understand the physics of nana technology

Course Outcomes: At the end of the course, students will be able to

CO1	Demonstrate the understanding of length scales concepts, nanostructures and nanotechnology.
CO2	Identify and to compare various synthesis and characterization techniques involved in Nanotechnology.
CO3	Define and interpret the interactions at molecular scale.
CO4	Evaluate and analyze the mechanical properties of bulk nano-structured metals and alloys, nano-composites and carbon nanotubes.
CO5	Compare and analyze the effects of using nanoparticles over conventional methods.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1				2	1				1	
CO2		2					2				1	
CO3	1	1	1		2				2	1		1
CO4	1	1				2	1				1	
CO5	1	1	1		2				2	1		1

Course Contents:

Unit I

Scientific Revolutions

Types of Nanotechnology and Nano machines: the Hybrid nanomaterial. Multiscale hierarchical structures built out of Nano sized building blocks (nano to macro).Nanomaterials in Nature: Nacre, Gecko, Teeth. Periodic table, Atomic Structure, Molecules and phases, Energy, Molecular and atomic size, Surfaces and dimensional space: top down and bottom up.

Unit II

Forces between Atoms and Molecules

Particles and grain boundaries, strong Intermolecular forces, Electrostatic and Vander Waals forces between surfaces, similarities and differences between intermolecular and inter particle forces covalent and coulomb interactions, interaction polar molecules, Thermodynamics of self-assembly.

Unit III

Opportunity at the Nano Scale

Length and time scale in structures, energy landscapes, Inter dynamic aspects of inter molecular forces, Evolution of band structure and Fermi surface.

Unit IV

Quantum dots – Nano wires – Nano tubes - 2D and 3D films - Nano and mesopores, micelles, bilayer, vesicles – bionano machines – biological membranes.

Unit V

Influence of NanoStructuring

Influence of Nano structuring on mechanical, optical, electronic, magnetic and chemical properties-gram size effects on strength of metals- optical properties of quantum dots.

Unit VI

Quantum wires - electronic transport in quantum wires and carbon nano-tubes - magnetic behavior of single domain particles and nanostructures – surface chemistry of Tailored monolayer – self assembling.

Texts/References:

1. C. C. Koch, “Nanostructured materials: Processing, Properties and Potential Applications”, Noyes Publications, 2002.
2. C. C. Koch, I. A. Ovidko, S. Seal and S. Veprek, “Structural Nano crystalline Materials: Fundamentals & Applications”, Cambridge University Press, 2011.

MHP12E3j/4j Boundary Layer Theory

MHP12E3j/4j	Boundary Layer Theory	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the concept of fluid mechanics and physics of boundary layer
2. To familiarize the students about the boundary layer formation over the stream lined body, bluff body and thickness measurement
3. To understand the real life application of BL

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

CO1	Evaluate exact solution of Navier-stokes equation in boundary layer that exhibit small viscosity by applying mathematical, Numerical techniques.
CO2	Demonstrate boundary-layer equations in the spirit of Prandtl, Prandtl boundary-layer equations in two dimensions deduced by order-of-magnitude arguments, skin friction drag.
CO3	calculate and solve ODE's for classical boundary-layer equations of Prandtl
CO4	Formulate and develop Exact solutions of the classical boundary-layer equations,
CO5	Analyze occurrence in steady flows, and at rear stagnation point of impulsively started cylinder, Goldsten singularity.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		1		1		1						
CO2		2										
CO3	1			2		1						
CO4		1										
CO5	1			2								

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Course Contents

Unit I

Exact solutions of the Navier-Stokes equation that exhibit a boundary layer at small values of the viscosity.

Unit II

The boundary-layer equations in the spirit of Prandtl. Scaling, non-depersonalization and Reynolds number. Limitations of potential flow past a cylinder. Prandtl boundary-layer equations in two dimensions deduced by order-of-magnitude arguments. Blasius solutions, displacement thickness, skin friction, drag.

Unit III
Introduction to perturbation theory. Regular and singular perturbations. Examples from algebraic equations and ordinary differential equations. The classical boundary-layer equations of Prandtl as the leading term in a matched asymptotic expansion.

Unit IV
Exact solutions of the classical boundary-layer equations, examples. A selection of those below .Flow past a wedge, Falkner Skan. Far wake of a flat plate. Two-dimensional jet. Lock'mixing layer. Prandtl transformation. Axisymmetric flows: Mangler's transformation. Splitdisc Ekman layer problems: Stewartson layers. Glauert wall jet.

Unit V
Separation in adverse pressure gradients. Concept of and occurrence in steady flows, and at rear stagnation point of impulsively started cylinder. Form of skin friction near separation point: Goldstein singularity.

Unit VI
Introduction to interactive boundary layers. Goldstein near wake. Trailing-edge triple deck.

TEXTS / REFERENCES:
1. Batchelor, G. K. *An Introduction to Fluid Mechanics*. CUP.
2. Curle, N. *The Laminar Boundary-Layer equations*. OUP.
3. Curle, N. & Davies, H. J. *Modern Fluid Dynamics*, VolI. Incompressible Flow.
4. Hinch, E. J., *Perturbation Methods*, CUP.
5. H.Schlichting, *Boundary Layer Theory*. McGraw Hill.
6. Van Dyke, M., *Perturbation Methods in Fluid Mechanics*. Parabolic Press.
7. Rosenhead, L. (ed). *Laminar Boundary Layers*. OUP.
8. Nayfeh, A. *Introduction to Perturbation Techniques*.
9. Sobey, I. J. *Introduction to Interactive Boundary Layer Theory OUP*.

MHP12E3k/4k Advanced Optimization Techniques

MHP12E3k/4k	Advanced Optimization Techniques	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks		Total 100 Marks

Course Objectives:

1. To Understand the concept of optimization and its importance in the back ground of real life engineering systems
2. To familiarize the students about the optimization techniques and their implementations
3. To carry out the case study using optimization technique

Course Outcomes: At the end of the program the student will be able to

CO1	Enables to acquire mathematical methods and apply in engineering disciplines.
CO2	Apply methods of optimization to solve a linear,non-linear programming problem by various methods
CO3	Optimize engineering problem of nonlinear-programming with/without constraints, by using this technique
CO4	Use of dynamic programming problem in controlling in industrial managements.
CO5	Simulate Thermal engineering system problem. Understand integer programming and stochastic programming to evaluate advanced optimization techniques.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1						1		1		1
CO2	2	1	1					1				
CO3		2							1			
CO4	1				2	1				2		1
CO5			1	2	1	1	2		1	2		1

Course Contents

Unit- I

Engineering application of optimization, terminology, design variables, constraints, objective functions, variable bounds, problem formulation

Single Variable Non-Linear Unconstrained Optimizing: One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

Unit II

Multi Variable Non-Linear Unconstrained Optimization: Direct search method –Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeve's method. **Variable** metric method.

UnitIII

Geometric Programming: Polynomials – arithmetic – geometric inequality – unconstrained G.P– Constrained G.P

Dynamic Programming: Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

Unit IV

Linear Programming: Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints. **Simulation**: Introduction – Types – Steps – application – inventory – queuing – thermal system.

Unit V

Integer Programming: Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

Stochastic Programming: Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, co variance, joint probability distribution stochasticlinear, dynamic programming.

TEXT/REFERENCES:

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan& Kumar/Springar
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/Benugundu&Chandraputla/Person Asia
7. Optimization Techniques /Benugundu&Chandraputla / Pearson Asia

MHP12E3l/4l JET& ROCKET PROPULSION

MHP12E3l/4l	Jet & Rocket Propulsion	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the concept of gas dynamics
2. To familiarize the students about the Jet and rocket propulsion and its whole thermodynamics analysis
3. To understand the applications of Jet propulsion

Course Outcomes: At the end of the program the student will be able to

CO1	Apply knowledge of features and capabilities of chemical and non-chemical rocket propulsion systems.
CO2	Calculate the design thrust and overall efficiency of turbojet and turbofan engines, with and without afterburners, from given component performance.
CO3	Calculate the specific impulse and mass flow for a rocket engine with the fluid considered as an ideal gas with constant specific heats.
CO4	Estimate the specific impulse and mass flow for a rocket engine accounting for chemical reaction and non-constant specific heats.
CO5	Estimate the heat transfer rates in rocket nozzles and in aero-engine turbine components.
CO6	Design simple rocket propulsive system.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	2		2			1						
CO3	1		2	2				1		1		
CO4		2					1					
CO5	1											1
CO6	1	2	2	1	1				2			2

Course Content

Unit- I

Velocity triangles; compressor performance maps, Compressor blading; design; multi-staging, Turbines; stage characteristics; degree of reaction, mass flow limits; blade temperature. Turbine cooling; general trends and systems; internal cooling, Film cooling; thermal stresses; impingement cooling; how to do cooling design, Compressor-turbine matching; gas generators, Engine structures; centrifugal stresses; engine arrangements, Critical speeds and vibration, Combustors; afterburners.

Unit II
Jet climb & acceleration, calculation of drag and thrust, optimum exhaust velocity, Air breathing and non-air breathing engines, aircraft gas turbine engine, cycles analysis of ideal and real engines, components performance-intake, combustor, nozzle, turbomachinery, etc. limitations of jet engines, Rocket equation; optimum acceleration, Rocket staging.

UnitIII
Turbojet, turboprop, turbofan engines, ramjet and pulsejet, design parameters; performance parameters like thrust, propulsive efficiency. Models for rocket engines; Inlets or diffusers, Exhaust nozzles, Compressors and fans.

Unit IV
Modeling of thermal rocket engines; fuels, fuels arrangement, Types of nozzles; connection of flow to nozzle shape, control of mass flow, Modeling of rocket nozzles; effects of nozzle area ratio.

Unit V
Jet engine and rocket structures, Rocket casing design; structural modeling, Heat transfer and cooling arrangement, Ablative cooling, Thrust vectoring; mass estimates.

Unit VI
Chemical Rockets, types of propellants and their properties, injectors, thrust chamber, burning rate; Solid propellant gas generators; stability; grain designs; Cryogenic propellant, combustion phenomena, thrust vector control, ignition and inhibitors. Basics of Electrical and Nuclear rockets. Pollutant; motivations for control; formation; strategies for reduction, Aircraft engine noise: principles; regulations, Jet noise, turbomachinery noise, Rotordynamics of the jet engine.

References:
1. Kerrebrock, J. L. *Aircraft Engines and Gas Turbines*.2nd ed. MIT Press, 1992.
2. Sutton, G. P., and O. Biblarz. *Rocket Propulsion Elements*.7th ed. Wiley Interscience, 2000.
3. J Mattingly, Elements of Gas Turbine Propulsion, McGraw-Hill Publications, 1996.
4. G.P. Sutton and O. Biblarz, Rocket Propulsion Elements, John Wiley & Sons, 2001.
5. G.C.Oates, Aerothermodynamics of Gas Turbine and Rocket Propulsion, AIAA, New York, 1988.
6. N.A.Cumpsty, Jet Propulsion, Cambridge University Press, 2000.
7. P G Hill and C R Peterson, Mechanics and Thermodynamics of Propulsion, Addison Wesley, 1965.
8. M J Zucrow, Aircraft and Missile Propulsion (Vol.I and II), John Wiley, 1958.
9. W WBathie, Fundamentals of Gas Turbines, John Wiley, 1996.
10. H Cohen, G F C Rogers and H I H Saravanamuttoo, Gas Turbine Theory, Addison Wesley, 1998.

MOC12E5aResearch Methodology

MOC12E5a	Research Methodology	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the concept of research, paper writing, similarities, etc
2. To familiarize the students about the statistical methods, data interpretation , error analysis
3. To carry out analysis on the a published paper

Course Outcomes: At the end of the program, the student will be able to

CO1	Understand and Describe importance of research.
CO2	Classify and select appropriate resources for Research.
CO3	Analyze the contents of literature and identify further scope.
CO4	Formulate a Research Problem.
CO5	Develop effective written and oral Presentation skills.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2		3				1		3			2
CO2	2		2	1			1		1			2
CO3	2		3	3			1		1	2		2
CO4	2	3	3	2					2	2		2
CO5	2		1	3			3					3

Course Contents

Unit I

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research.

Unit II

Research process – Criteria for good research – Problems in Indian context.Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions– Field Study – Critical Analysis of Facts Generated

Unit III

Hypothetical proposals for future development and testing, selection of Research task.

Unit IV

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

Unit V

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps inreport writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

References

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York
2. Schank Fr., Theories of Engineering Experiments, Tata Mc Graw Hill Publication.
3. C. R. Kothari, Research Methodology, New Age Publishers.
4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

MOC12E5b DESIGN OF EXPERIMENTS

MOC12E5b	DESIGN OF EXPERIMENTS	PEC	3-0-0	3 Credits
Exam Scheme				
Class Test 20 Marks	Continuous Assessment 20 Marks	End-Sem Exam 60 Marks	Total 100 Marks	

Course Objectives:

1. To Understand the concept of design of experiments
2. To familiarize the students about the design of experiments techniques and their implementation
3. To design and analysis a real life problem using technique .

Course Outcomes: At the end of the program the student will be able to

CO1	Define Taguchi, factorial experiments, variability, orthogonal array, quality loss.
CO2	Plan and design the experimental investigations efficiently and effectively.
CO3	Understand strategy in planning and conducting experiments.
CO4	Evaluate variability in the experimental data using ANOVA.
CO5	Practice statistical software to achieve robust design of experiments.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1		1	1	1	1	1		1		1
CO2	2	1	1			1		1				
CO3		2	1			1			1			
CO4	1		1		2	1				2		1
CO5			1	2	3	2	2		1	2		1

Course Contents

Unit I

Introduction: Modern quality control, quality in engineering design, history of quality engineering.The Taguchi Approach to quality: Definition of quality, loss function, off-line and on-line quality control, Taguchi`s quality philosophy.

Unit II

Full Factorial Designs: Experimentation as learning process, traditional scientific experiments, three factor design, replicating experiments, factor interactions, normal plots of estimated effects, mechanical plating experiments, two factor design, four factor design, Taguchi design and western design.

Unit III
Fractional Factorial Design: Fractional factorial design based on eight run experiments, folding over an eight-run experimental design, Fractional factorial design in sixteen run, folding over a sixteen run experimental design, blocking two level designs, other two level designs.

Unit IV
Evaluating Variability: Necessity to analyze variability, measures of variability, the normal distribution, using two level designs to minimize variability, signal-to-noise ratio, minimizing variability and optimizing averages.Taguchi Inner and Arrays: Noise factors, experimental designs for control and noise factors, examples.

Unit V
Experimental Design for Factors at Three and Four level: Necessity to use more than two level, factors at four levels, factors at three levels.Analysis of Variance in Engineering Design: Hypothesis testing concepts, using estimated effects as test statistics, analysis of variance for two level designs, when to use analysis of variance.

Unit VI
Computer Software for Experimental Design: Role of computer software in experimental design, summery of statistical packages, example of use of software packages.Using Experiments to improve Processes: Engineering design and quality improvement, steps to implementing use of engineering design.

Texts / References:

1. D.C.Montgomery, *Design and Analysis of Experiments*, 5th Edition, John Wiley and Sons, NewYork, 2004.
2. R.H.Lochner and J.E.Matar, *Designing for Quality: An Introduction to the Best of Taguchi and Western Methods of Statistical Experimental Design*, Chapman and Hall, London, 1983.

MOC12E5cEnvironmental Pollution Control

MOC12E5c	Environmental Pollution Control	PEC	3-0-0	3 Credits
Exam Scheme				

Class Test	Continuous Assessment	End-Sem Exam	Total
20 Marks	20 Marks	60 Marks	100 Marks

Course Objectives:

1. To Understand the need of pollution control, its impact, control
2. To familiarize the students about the pollution control techniques
3. To carry out the real life problem

Course Outcomes: At the end of the program the student will be able to:

CO1	Identify effects of industrialization on environmental pollution in various field.
CO2	Describe photochemical smog, acidRain, Greenhouse effect, ozone depletion, global warming.
CO3	Suggest pollution control techniques for vehicles, refrigeration, industries, chemical and power plant .
CO4	Do Case study on any industry and analyze carbon exertion rate , water pollution, soil pollution etc .,
CO5	Design pollution control devices for vehicle, analyze and find out replacement CFC refrigerant with HC refrigerant.

Mapping of course outcomes with program outcomes

POs → COs↓	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	2											1
CO3				1			2	1				1
CO4	2					2			1			
CO5						1						2

Course Content

Unit I

Impact of industrialization and modernization - pollution and pollutants.. Air pollution and its effects - air pollution - sources - pollutants – organic and inorganic pollutants - gaseous pollutants– nitrogen oxides - particulate pollutants - effect of pollutants on plants – animals and human beings.

Unit II

photochemical oxidants - photochemical smog – acid Rain - Greenhouse effect - ozone depletion - global warming -Environmental pollution control techniques for air pollution - monitoring and

Control measures of air pollution - dust control equipment's - Electrostatic precipitators and scrubbers.

Unit III

Water pollution and its effects structure - water pollution - sources -Pollutants - industrial effluents - domestic wastes - agrochemicals -Heavy metals - effect of pollutants on plants - animals and human beings Bod - eutrophication - waste water treatment - indicator organisms - Oxidation pond - water pollution analysis and monitoring – drinking Water standards. Soil pollution and its effects - soil pollution - sources - solid waste Disposal and their effects - pesticides - types and effect of pollutants on Plants - animals and human beings - biomagnification - fertilizers and its Effect of pollutants on plants - animals and human beings.

UNIT IV

soil pollution Control measures - soil microbes and function - biofertilizer. Noise pollution and its effects - noise pollution - sources – noise Exposure level and standards - impacts - noise control and abatement Measures.

Unit V

Marine pollution - sources and control of marine pollution – criteria Employed for disposal of pollutants in marine system – coastal Management. Radioactive pollution and its impacts - radioactive - sources - effect of Pollutants of plants - animals and human beings - prevention and control Measures of radioactive pollution.

Unit VI

Assessment and control of pollution - environmental standards - Assessment of pollution effects due to air - water - soil and radioactive Pollution - biotechnology in pollution control - microbial role in Pollution control - biomonitoring and bioremediation - pollution control Legislations for air - water - land etc. Biotechnology in pollution control - bioremediation (organic and Inorganic pollutants) - bioleaching and biomineralization.

References

1. Environmental Pollution Analysis: Khopkar.
2. Environmental Science – A study of Inter relationships, E. D.Enger, B. E. Smith, 5th ed., W C B publication.
3. Environmental Pollution Control Engineering: C. S. Rao
4. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
5. J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.