With effect from academic year 2021-22

DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction

and

Syllabus of

M.E. (MECHANICAL ENGG.)

TURBOMACHINERY

AICTE Model Curriculum

2021-22

UNIVERSITY COLLEGE OF ENGINEERING

(Autonomous)

Osmania University

Hyderabad – 500 007, TS, INDIA

UNIVERSITY COLLEGE OF ENGINEERING

Vision

The Vision of the Institute is to generate and disseminate knowledge through a harmonious blend of Science, Engineering and Technology and to serve the society by developing in students heightened intellectual, cultural, ethical and humane sensitivities to foster a scientific temper and to promote professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research.
- To generate, disseminate and preserve knowledge.
- To enable empowerment through knowledge and information.
- Advancement of knowledge in Engineering, Science and Technology.
- Promote learning in free thinking and innovative environment.
- Cultivate skills, attitudes to promote knowledge creation.
- Rendering socially relevant technical services for the community.
- To impart new skills of technology development.
- To inculcate entrepreneurial talents and technology appreciation programmes.
- Technology transfer and incubation.

DEPARTMENT OF MECHANICAL ENGINEERING

Vision

To generate and disseminate knowledge in Mechanical Engineering and nurture professional, technical and scientific temper for serving the needs of the industry, research organizations and society.

Mission

- Create technically competent mechanical engineers to suit the changing needs of global industry and society.
- To cultivate skills, attitudes to promote knowledge creation and technology development.
- Interact with prominent educational institutions and R&D organizations for enhancing teaching, research and consultancy services.

Programme Educational Objectives (PEOs) for ME (Turbomachinery) Programme

PEO 1

To provide the requisite fundamentals on varied subjects of Turbomachinery, and the required skill sets in various laboratory experiments and engineering tools so that they recognize, analyze and solve related technical problems.

PEO 2

To provide technical knowledge in turbomachines to analyze and solve innovatively not only thermal related technical problems, but also be able to model analyze, design the systems for varied through the modern engineering tools, be they experimental and analytical tackling engineering problems independently but also engage in generation of new ideas in Industry or Government.

PEO 3

To provide various methods to communicate (written & oral) with fellow engineers, employers and continuous learning techniques for professional challenges and the skills needed to excel their social duties and responsibilities in teamwork, collegiality and ethics.

PEO 4

To motivate them to learn on their own, think critically and creatively in order to evaluate new ideas, and provide innovative solutions, with requisite practical and managerial experience, will be able to start activities and transform into entrepreneurs.

Programme Outcomes (POs) of ME (Turbomachinery) Programme

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: Ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4: Able to use approximate numerical techniques/computational techniques and interpret the results.

PO5: Able to take up an industrial problem and function as a member of multidisciplinary team.

AICTE-Model Scheme
Scheme of Instructions & Examination
M.E.(Mechanical Engineering) 4 Semesters

S.No.	Subject	Scheme of Studies per Week			Max. Marks		Credits
		L	T	P	CIE	SEE	
Semester-I							
1.	Program Core I	3	0	0	30	70	3
2.	Program Core II	3	0	0	30	70	3
3.	Program Elective I	3	0	0	30	70	3
4.	Program Elective II	3	0	0	30	70	3
5.	Mandatory Course	3	0	0	30	70	3
6.	*Audit Course I	2	0	0	30	70	0
7.	Laboratory I	0	0	3	50	--	1.5
8.	Seminar	0	0	3	50	--	1.5
	Total	**17**	**0**	**6**	**280**	**420**	**18**
Semester-II							
1.	Program Core III	3	0	0	30	70	3
2.	Program Core IV	3	0	0	30	70	3
3.	Program Elective III	3	0	0	30	70	3
4.	Program Elective IV	3	0	0	30	70	3
5.	*Audit Course II	2	0	0	30	70	0
6.	Laboratory II	0	0	3	50	--	1.5
7.	Laboratory III	0	0	3	50	--	1.5
8.	**Mini Project	0	0	6	50	--	3
	Total	**14**	**0**	**12**	**300**	**350**	**18**
Semester-III							
1.	Program Elective V	3	0	0	30	70	3
2.	Open Elective	3	0	0	30	70	3
3.	*** Dissertation Phase I	0	0	20	100	--	10
	Total	**6**	**0**	**20**	**160**	**140**	**16**
Semester-IV							
1.	****Dissertation Phase II	0	0	32		200	16
	Total	**0**	**0**	**32**		**200**	**16**

Total Credits: 18 + 18 + 16 + 16 = 68

Note :1. L– Theory lecture, T –Tutorial; P–Lab work
CIE :Continuous Internal Evaluation SEE : Semester End Examination

2. *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% in that particular subject.
3. ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.
4. *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.
5. **** Major Project Phase II, Total marks 200 to be awarded by External Examiner

Note: 1) *For Audit Course even though the credits are Zero. It is mandatory for the students to secure 50% in that particular subject.

2) ** Mini Project total marks 50 out of which 25 marks will be awarded by Guide and 25 marks by internal committee.

3) *** Major Project Phase I total marks 100 out of which 50 marks will be awarded by Guide and 50 marks by internal committee.

4) **** Major Project Phase II, Total marks 200 to be awarded by External Examiner.

5) For Program Elective-V and Open Elective*:*

If the student is selected for Industry Internship, then he/she has to complete the required courses of Program elective V and Open Elective through ***SWAYAM-NPTEL MOOCS*** *Courses for getting the required credits. However the students are required to consult Head &CBoS (Autonomous) for due approval, before he/ she registers for the course in SWAYAM-NPTEL portal.*

M.E. (Mechanical Engineering) Specialisation: **Turbomachinery**

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	ME201	Principles of Turbomachinery	3			30	70	3
Core-II	ME202	Fluid Flow and Gas Dynamics	3			30	70	3
Program Elective-I	ME213	Experimental Techniques in Turbomachines	3			30	70	3
	ME219	Design of Thermal Systems						
	ME312	Rotor Dynamics						
Program Elective-II	ME501	Finite Element Techniques	3			30	70	3
	ME212	Design of Pumps and Compressors						
	ME216	Power Plant Steam Generators						
Audit-I	AC031	English for Research Paper Writing	2	1		30	70	0
	AC032	Disaster Management						
	AC033	Sanskrit for Technical Knowledge						
	AC034	Value Education						
Lab-I	ME251	Turbomachinery laboratory			3	50	-	1.5
Seminar	ME261	Seminar			3	50	-	1.5
Mandatory Core	ME100	Research Methodology in Mechanical Engineering	3			30	70	3
TOTAL			**17**	**1**	**6**	**280**	**420**	**18**
SEMESTER-II								
Core-III	ME203	Heat Transfer and Heat Exchangers in Power Plants	3			30	70	3
Core-IV	ME204	Design of Steam Turbines	3			30	70	3
Program Elective-III	ME217	Computational Fluid Dynamics	3			30	70	3
	ME211	Advanced Energy Systems						
	ME304	Fluid Power Systems						
Program Elective-IV	ME215	Cascade Aerodynamics	3			30	70	3
	ME218	Fuels and Combustion						
	ME313	Vibration Analysis and Condition Monitoring						
Audit-II	AC035	Stress Management by Yoga	2			30	70	0
	AC036	Personality Development						
	AC037	Constitution of India						
	AC038	Pedagogy Studies						
Core	MC070	Mini Project			6	50		3
Lab-II	ME252	Computational Fluid Dynamics Laboratory			3	50	-	1.5
Lab-III	ME253	Computational Laboratory			3	50	-	1.5
TOTAL			**14**		**12**	**300**	**350**	**18**

SEMESTER-III								
Program Elective-V			3			30	70	3
	ME220	Design of Gas Turbines						
	ME221	Flow Induced Vibrations						
	ME214	Turbulence Modelling						
	ME222	Two Phase Flow and Heat Transfer						
	ME 118	Optimization Techniques						
Open Elective	OE941	Business Analytics	3			30	70	3
	OE942	Industrial Safety						
	OE943	Operations Research						
	OE944	Cost Management of Engineering Projects						
	OE945	Composite Materials						
	OE946	Waste to Energy						
	OE947	Intellectual Property rights						
	ME281	Major Project Phase-I			20	100		10
TOTAL			**6**		**20**	**160**	**140**	**16**
SEMESTER-IV								
	ME282	Major Project Phase-II			32		200	**16**
GRAND TOTAL								**68**

*CIE : Continuous Internal Evaluation SEE : Semester End Examination

SEMISTER-I

ME201

PRINCIPLES OF TURBOMACHINERY

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Provide overview of different types of turbomachinery used for energy transformation,
- Derive governing equation designs of turbomachines
- Draw velocity triangles and calculate specific work and power for characterizing turbomachinery stages
- Determine the performance of turbomachinery stages operating at design and off design conditions

Course outcomes: After completion of the course student will be able to

1. Classify turbomachines and formulate governing equations of fluid flows and calculate efficiency of compressor and turbine.
2. Derive equation for specific work of a turbomachine and factors effecting the deviation of specific work and cavitation.
3. Examine principles of axial flow compressors, propellers and calculate performance parameters.
4. Explain working principles of centrifugal compressor and able to draw velocity diagrams, and calculate performance parameters.
5. Analyse steam turbines and able to draw velocity diagrams and calculate efficiency of steam turbines.

UNIT-I

Introduction to Turbomachines. Classification of Turbomachines. Second Law of Thermo dynamics - turbine/compressor work, Nozzle/diffuser work. Fluid equations - continuity, Euler's, Bernoulli's equation and its applications. Expansion and compression processes, Reheat Factor, Preheat Factor.

UNIT-II

Euler's Equation of Energy Transfer, vane congruent flow, influence of relative circulation, thicknessof vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor. Suction pressure and net positive suction head. Phenomena of cavitations in pumps. Concept of specific speed, Shape number. Axial, Radial and Mixed Flow Machines. Similarity laws.

UNIT–III

Flow through Axial flow fans. Principles of Axial fan and propeller. Application of fans for aircirculation and ventilation. Stage pressure rise and work done. Slip stream and Blade Element theory for propellers. Performance and characteristics of Axial fans.

UNIT-IV

Flow through Centrifugal compressors. Stage velocity triangles, specific work. forward, radial and backward swept vanes. Enthalpy entropy diagram, degree of reaction, slip factor, efficiency. Vane less and vaned diffuser systems, volute as spiral casing. Surge and stall in compressors

UNIT-V

Axial turbine stages, stage velocity triangles, work, efficiency, blade loading, flow coefficient. Single stage impulse and reaction turbines, degree of reaction, 50% reaction turbine stage, Radial equilibrium and Actuator disc approach for design of turbine blades. Partial admission problems in turbines. Losses in turbo machines.

Suggested Reading:

1. S.M. Yahya, Turbines, Compressors and Fans, Fourth Edition, Tata Mcgraw Hill, 2011
2. Gopalakrishnan G, Prithvi Raj D, A treatise on Turbomachines, Scitec Publications, Chennai, 2002.
3. D.G.Sheppard, Principles of Turbomachinery, Macmillan, 1971
4. R.K.Turton, Principles of Turbomachinery, Second Edition, Chapman & Hall, 1995
5. Balje, Turbomachinery–Theory, Design and Practice. John Wiley & Sons, 1981

ME202

FLUID FLOW AND GAS DYNAMICS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Analyze compressible flow through constant and variable area duct
- Apply Fluid mechanics principles to propulsive system
- Understand the basic characteristics of compressible flows, including wave propagation, speed of sound and the Mach number.
- Distinguish normal shock, oblique shock and Prandtl Meyer flows.

Course outcomes: After completion of the course student will be able to

1. Develop mathematical models for flow phenomena and understand concepts of
2. Analyse fundamental conservation equations for fluid flow.
3. Understand flow phenomena over an airfoil and boundary layer formation.
4. Apply mathematical relations for compressible fluid flow phenomena.
5. Formulate and apply mathematical relations for Supersonic fluid flow phenomena through variable flow passages.

UNIT-I

Fluid flow: Classification of fluids. Lagrangian and Eularian Methods of Study of fluid flow. Velocity and acceleration vectors. Circulation and Vorticity. Stream lines. Stream tube. Path lines. Streak lines and Time lines. Stream function and Potential function.

UNIT-II

Basic laws of fluid flow – Continuity. Euler's and Bernoulli's equations. Incompressible and Compressible flows. Potential and viscous flows. Navier – Stoke's equation and applications.

UNIT-III

Flow over an airfoil – Lift and Drag coefficients. Boundary layer theory – laminar and turbulent boundary layers. Hydrodynamic and thermal boundary layer equations. Flow separation in boundary layers.

UNIT-IV

Gas dynamics: Energy equation for flow and non flow processes. Application of Steady flow energy equation for turbines, turbo-compressors, nozzles and diffusers. Adiabatic energy equation. Acoustic velocity, Mach Number. Stagnation properties. Relationships between static and stagnation properties. Various regimes of flow – Steady flow ellipse.

UNIT-V

Isentropic flow through variable area passages. Design of supersonic and subsonic nozzles and diffusers. Supersonic flows. Expansion and Shock waves. Normal and Oblique Shock waves. Prandtl-Meyer and Rankine-Hugoniot Relations. Simple problems on normal and oblique shock waves.

Suggested Reading:

1. C P Kothandaraman, R Rudramoorthy, Basic Fluid Mechanics, New Age Intl. Publishers,1999
2. S.M. Yahya, Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion, Third Edition, New Age Intl. Publishers, 1982.
3. ZoebHussain, Gas Dynamics Though Problems, John Wiley and Sons, 1989
4. P. Balachandran, Fundamentals of compressible fluid dynamics, PHI Learning Pvt. Ltd, 2006
5. Ethirajan Rathakrishnan , Gas Dynamics, PHI Learning,2017

ME213

EXPERIMENTAL TECHNIQUES IN TURBO MACHINES

(Program Elective -I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- To develop ability to test and diagnose a new turbomachinery stage or system
- Introduces a variety of instruments and transducers available for performance, flow, and structural measurement in turbomachines.
- Understand the importance of high-quality test data, and the procedures necessary to obtain and process that data
- To design test programs to achieve practical measurements and data reduction.
- Understand fluid dynamics and structural evaluations of turbomachines.

Course outcomes: After completion of the course student will be able to

1. Familiarize to experimental design protocols and plan for design
2. Understand the calibration methods and also data acquisition systems and usage.
3. Demonstrate flow visualization techniques and flow measurement devices.
4. Design and conduct experiments, as well as to organize, analyze and interpret
5. Identify, formulate and solve complex turbomachinery problems

UNIT-I

Experiment planning, experiment design factors. Classification of measurement techniques. Conventional techniques for measurement of Flow, Pressure, Temperature and Velocity in turbomachinery passages.

UNIT-II

Temperature measuring devices – Thermo electric thermometry and pyrometry. Instantaneous pressure measurement using pressure transducers, Pitot tube, probes,. Boundary layer measurement. Calibration of probe.

UNIT-III

Wind tunnels: Schematic layout of wind tunnel with test section, subsonic, transonic and supersonic wind tunnels. Measurement of turbulence using a Hot wire anemometer and Laser Doppler anemometer.

UNIT-IV

Calibration methods and signal processing techniques. General data acquisition system Data transmission, A/D and D/A conversion, Recorders with digital display. Data collection and storage.

UNIT-V

Flow measurement instruments, Flow Visualization techniques – conventional and optical methods. Radar Doppler and Laser velocimeter. Brief description of error and uncertainty analysis.

Suggested Reading:

1. David Japikse, Advanced Experimental Techniques In Turbomachinery, Atlantic Books, 1997
2. J. P. Holman, Experimental Methods for Engineers, 8thEdition,McGraw-Hill, 2012.
3. Russell Mikel, Wind Tunnels: Models, Aerodynamics and Applications, Clanrye International, 2015
4. Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Mechanical Measurements, 6th Edition, Pearson Education, 2020
5. A.K.Tayal, Instrumentation, Mechanical Measurements and Control: 2nd Edition, Galgotia Publications Pvt Ltd 2008

ME219

DESIGN OF THERMAL SYSTEMS

(Program Elective -I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand design aspects of heat exchangers and ancillary equipment
- Apply thermoeconomic optimization techniques and provide with experience in using computer based methods to solve problems
- Revise the system design to optimize its performance
- Provide an introduction to computer-aided design of thermal systems, including performance factors, such that cost-optimized configurations can be found.
- Emphases on equipment selection, system analysis and synthesis.

Course outcomes: After completion of the course student will be able to

1. Design and conduct experiments, as well as to organize, analyze and interpret
2. Identify thermal systems, components to meet desired need within realistic constraints such as manufacturability, sustainability and safety
3. Formulate and solve complex Thermal systems
4. Apply modern engineering tools necessary for design of thermal systems
5. Evaluate optimization techniques for improving the performance of thermal systems

UNIT-I

Engineering Design: Introduction – Need – Criteria of Success – Probability of success – Market analysis– Feasibility – R&D – Iteration – Optimization of operation – Technical design. Designing a Workable System: Workable and optimum system – Design of a Food Freezing Plant – Preliminaries to the study of Optimization. Economics: Interest – lump sum, Compounded annually – lump sum Compounded more often than annually – Compound – amount factor (f/p) and present – worth factor (p/f) Future worth of a uniform series of amounts – Present worth of a uniform series of amounts – Gradient present work factor – Bonds – Shift in time of a series – Evaluating potential investments. Taxes – Depreciation – Influence of Income Tax.

UNIT-II

Modelling Thermal Equipment: Selecting Vs. Simulating a heat exchanger – Binary solutions – Temperature– Concentration – Pressure Characteristics – Developing T Vs. – x diagram – condensation of a Binary mixture Single – Stage distillation – Rectification – Pressure drop and pumping power – Turbo machinery. System Simulation : Classes of simulation – Sequential and simultaneous calculations – Simulation of a gas Turbine system.

UNIT-III

Optimization: Levels of Optimization – Optimization procedures – Lagrange Multipliers – Search Methods Dynamic Programming – Geometric Programming, Linear Programming.

UNIT-IV

Thermodynamic Properties Modeling : The form of the equation – P-V-T equations – P-T relation for saturation conditions. P/f density of liquid. The clayperon equation – Maxwells relations.

UNIT-V

Dynamic Behavior of Thermal Systems: Calculus Methods of Optimization – Calculus of variations and Dynamic Programming – Probabilistic Approaches to design.

Suggested Reading:

1. Stoecker, W.F., Design of Thermal Systems, McGraw-Hill Book Company, 1987.
2. C.Balaji, Essentials of Thermal System Design and Optimization, Ane Books Pvt. Ltd,2011
3. Steven G. Penoncello, Thermal Energy Systems: Design and Analysis , CRC Press, 2015
4. YogeshJaluria, Design and Optimization of Thermal Systems, McGraw-Hill Education, 1998
5. YogeshJaluria, Design and Optimization of Thermal Systems, CRC Press, 2007

ME312

ROTOR DYNAMICS
(Program Elective -I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the rotor dynamics phenomena with the help of simple rotor models and subsequently the modern analysis methods for real life rotor systems.
- develop modeling and analysis of rotor-bearing dynamics
- Identify and condition monitoring of rotor-bearing systems.
- Analyze rotors for the transverse and torsional vibrations.
- Understand undamped and damped natural frequencies and Forced response for steady and unsteady excitation

Course outcomes: After completion of the course student will be able to

1. Understand fluid film lubrication, boundary conditions, stiffness and damping
2. Identify different types of rotors in rotor bearing system, fluid film lubrication and stability and instability of rotors.
3. Analyse the principles of rotor dynamics for predicting the stability of the rotor.
4. Design bearings, shafts and rotor stages to predict instability
5. Analyse critical speed in rotor dynamics and different analytical methods for determining the same.

UNIT-I

Single degree of freedom system – Free vibrations. Damped vibrations and forced vibrations, Two degree of freedom systems – Undamped vibration, absorbers, Forced Damped vibrations, Vibration isolation.

UNIT-II

Close coupled systems – Eigen value problem. Orthogonality of mode shapes. Modal analysis Critical speeds.

UNIT-III

Vibrations of multi rotor systems – Matrix method, Influence coefficient methods, Transfer matrix analysis and Holzers method.

UNIT-IV

Torsional vibrations in rotating machinery – Equivalent discrete system, transient response, branched system.

UNIT-V

Out-of-rotors in rigid supports, simply supported rotor with overhangs. Gyroscopic effects. Rotor mounted on fluid film bearings – Transfer matrix analysis of turbine rotor by distributed elements, Dual rotor system analysis. Balancing of rotors.

Suggested Reading:

1. J.S. Rao, Rotor dynamics. New Age International; Third edition, 2018
2. J.S. Rao, K. Gupta, Mechanical Vibrations. John Wiley & Sons Inc,1983
3. Kicinski Jan,Rotor Dynamics: Institute Of Fluid- Flow Machinery , Techniz Books International, 2010
4. Giancarlo Genta,Dynamics of Rotating Systems, Springer; 2005
5. Michael I. Friswell, John E. T. Penny, Seamus D. Garvey, Arthur W. Lees ,Dynamics of Rotating Machines, Cambridge University Press; Illustrated edition, 2010

ME501

FINITE ELEMENT TECHNIQUES

(Program Elective -II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
- To provides a bridge between hand calculations and numerical solutions for more complex geometries and loading states.
- To study approximate nature of the finite element method and convergence of results are examined.
- It provides some experience with a commercial FEM code and some practical modeling exercises.

Course Outcomes: After completion of the course student will be able to

1. Summarize the basics of finite element formulation
2. Derive interpolation functions and characteristic matrices for different 1D, 2D and 3D elements.
3. Apply the knowledge in solving one dimension and two dimensional static stress and dynamic analysis problems.
4. Solve the steady state and transient heat transfer analysis using FEA.
5. Analyze three dimensional stress analysis and fluid flow problems.

UNIT-I

Introduction: Historical Background, General description of the finite element method, Mathematical Modeling of field problems in Engineering, Governing Equations, Discrete and continuous models, Boundary, Initial and Eigen Value problems, Weighted Residual Methods, Variational Formulation of Boundary Value Problems, Potential energy method, Rayleigh Ritz method, Galerkin's method of finite element formulation. Strain displacement relations, Stress strain relations, Interpolation models: Simplex, complex and multiplex elements, Linear interpolation polynomials in terms of local, natural and global coordinates for 1D, 2D, 3D Simplex Elements. Finite element equations, treatment of boundary conditions.

UNIT-II

One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for 1D, 2Delements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element. Torsion of Shafts: Finite element formulation of shafts, determination of stress and twists in circular shafts.

UNIT-III

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Plane stress, plane strain and axisymmetric problems, Body forces and temperature effects. Stress calculations, Plate and shell elements. Convergence requirements and geometric isotropy. Application to Field Problems, Thermal problems, Analysis of a uniform shaft subjected to torsion using Finite Element Analysis. Quadrilateral elements and Higher Order Elements.

UNIT-IV

Steady state heat transfer analysis: One dimensional analysis of a fin, composite walls and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod. Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigenvectors.

UNIT-V

Finite element formulation of three dimensional problems in stress analysis. Fluid Flow: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic net works. Finite Element formulation of an incompressible fluid. Potential flow problems Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Suggested Readings:

1. Tirupathi R ChandraputlaandAshok.D.Belegundu,Introduction of Finite Element in Engineering, Prentice Hall of India, 1997.
2. Rao S.S., The Finite Element Methods in Engineering, Pergamon Press,1989.
3. Segerland. L.J., Applied Finite Element Analysis, Wiley Publication,1984.
4. Reddy J.N., An Introduction to Finite Element Methods, McGraw Hill Company,1984.
5. P.Seshu, Text book of Finite Element Analysis, PHI Learning Pvt. Ltd., 2003

ME212

DESIGN OF PUMPS AND COMPRESSORS

(Program Elective -II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the principle involved in the operation of centrifugal and positive displacement pumps
- Understand the principle involved in the operation of compressors
- Identify the function of various components in pumps and compressors
- Identify the parts of pumps, compressors and mechanical drives, and troubleshoot pumps, compressors and mechanical drives.

Course Outcomes: After completion of the course student will be able to

1. Apply thermodynamic concepts to analyze pumps and compressors.
2. Design pumps and compressor components.
3. Evaluate the performance of pumps and compressors
4. Understand the Operation and maintenance of pumps and compressors
5. Evaluate the characteristics of pumps an compressors

UNIT-I

Introduction to pumps and compressors. Characteristics of working fluids, Fluid mechanics concepts and governing laws of fluid flow.

UNIT-II

Pumps – various components and their functions. Classification of pumping systems – based on the applications and working fluids. Design of pumps – data required for the design of pump and design calculations. Selection of the drive – Types of drives, their behaviour and advantages, Selection of the pumps– types of pumps. Selection of piping and other components. Development of a schematic layout of the piping system.

UNIT-III

Operation and maintenance–installation of pumping system. Testing of the pumping systems– Various methods based on the working fluid, drive and pump etc., Maintenance of the pumps – Prediction and correction methods, Factors affecting the maintenance and their evaluation.

UNIT-IV

Rotary compressor system–various components and their functions. Classification of compressors. Design of compressor – data and analysis. Characteristics of the compressors. Selection of the drive and compressors. Development of the schematic layout of the compressor system.

UNIT-V

Design of impeller, Types of impellers–centrifugal and axial. Design of a diffuser–Vane less and vaned diffuser. Types of casings, casing design. Performance characteristics of turbo compressors.

Suggested Reading:

1. S.M. Yahya, Turbines, Compressors and Fans, Tata McGraw Hill Publishing Co, 2010
2. Val.S. Lobanoff and Robert R. Ross, Centrifugal Pumps–Designs and Application, Jaico book publishing Co. 1992
3. Marc Borremans, Pumps and Compressors , Wiley-ASME Press Series, 2019
4. Maurice L. Adams, Rotating Machinery Research and Development Test Rigs, CRC Press, 2017
5. Hassan M. Badr, Wael H. Ahmed, Pumping Machinery Theory and Practice, Wiley, 2015

ME216

POWER PLANT STEAM GENERATORS

(Program Elective -II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand and know the requirements for a Thermal Power Plant, from sources to consumption
- Study and learn the processes and cycles followed in Thermal Power Plants and components used in the power plants**.**
- Gain the knowledge on steam power plants, steam generators analyses on fuel and fluidized bed combustion, ash handling systems.
- Learn the practices followed in Thermal Power Plant, to better environmental conditions and the safety measures.
- To estimate efficiencies in a steam power plant and calculate economics of power plants.

Course Outcomes: After completion of the course student will be able to

1. Understand the various sources of energy.
2. Identify Equipment, Plant layout, principle of working of various plants.
3. Understand the various combustion systems.
4. Understand the working principles of various boilers
5. Design furnaces and burners

UNIT-I

Introduction-steam generation, Nucleate & Film Boiling, circulation ratio, Natural, Assisted & Forced Circulation Boilers. Super Critical Boilers.

UNIT-II

Requirements in modern boilers, Types of steam generators and their construction and application, Fuels and Fuel Handling systems, for steam generators.

UNIT-III

Air-handling systems, Combustion in combustion systems with different types of fuels, combustion calculations, Once-thro‟ boilers, Fluidised bed combustion boilers, Cyclone furnace boilers.

UNIT-IV

Furnace sizing, Burner selection and design combined cycle power plant steam generators, Emissions from steam generators and its control.

UNIT-V

Boiler maintenance, safety regulation and inspection, Ash handling Case study of typical modern boiler systems.

Suggested Reading:

1. W.J. Kearton, Steam Turbine Theory and Practice, CBS Publishers, 2004
2. Ian Gordon Cumming Dryden, The Efficient Use of Energy, Butterworth-Heinemann Ltd; 2nd Revised edition, 1982
3. James Fay, Dan Golomb, Energy and The Environment: Scientific and Technological Principles, Oxford University Press; 2nd edition, 2011
4. Allan Bennett Gill, Power Plant Performance, Butterworth-Heinemann Ltd, 1984.
5. R.K.Hegde, Power Plant Engineering, Pearson, 2015

AC 031

ENGLISH FOR RESEARCH PAPER WRITING
(AUDIT COURSE-I)

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *Understand that how to improve your writing skills and level of readability*
- *Learn about what to write in each section*
- *Understand the skills needed when writing a Title Ensure the good quality of paper at very first-time submission*

Outcomes:

1. Able to plan and prepare paragraphs, avoiding ambiguity
2. Writing of abstracts, paraphrasing and plagiarism
3. Providing of critical and thorough review of literature, discussions and conclusions
4. Able to exhibit key skills for writing titles, introduction, abstract.
5. Able to show key and necessary skills for paper writing, phrases, results.

Unit I

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Unit II

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

Unit III

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

Unit IV

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

Unit V

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions -Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Suggested Studies:

1. Goldbort R, *Writing for Science*, Yale University Press (available on Google Books), 2006.
2. Day R, *How to Write and Publish a Scientific Paper*, Cambridge University Press, 2006.
3. Highman N *Handbook of Writing for the Mathematical Sciences*, SIAM. Highman's book. 1998
4. Adrian Wall work English *for Writing Research Papers*, Springer New York Dordrecht Heidelberg London. 2011.

AC032

DISASTER MANAGEMENT
(AUDIT COURSE-I)

Instruction: 2 periods per week | Duration of SEE: 3 hours
CIE: 30 marks | SEE: 70 marks
Credits: 0

Course Objectives:

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various natural disasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induced disasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographic, etc.

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

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

UNIT-I

Introduction

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

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT-III

Disaster Prone Areas in India

Study of Seismic Zones; Areas Prone to Floods and Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases and Epidemics.

UNIT-IV

Disaster Preparedness and Management

Preparedness: Monitoring of Phenomena Triggering A Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data From Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Risk Assessment

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival.

UNIT-VI

Disaster Mitigation

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

Suggested Readings:

1. R. Nishith, Singh AK, Disaster Management in India: Perspectives, issues and strategies, New Royal book Company, 2007
2. Sahni, Pardeep et al. (Eds.), Disaster Mitigation Experiences and Reflections, Prentice Hall of India, New Delhi, 2001
3. Goel S. L. Disaster Administration and Management Text and Case Studies, Deep & Deep Publication Pvt. Ltd., New Delhi, 2007

With effect from academic year 2021-22

AC 033

SANSKRIT FOR TECHNICAL KNOWLEDGE
(AUDIT COURSE-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Objectives:

- To get a working knowledge in illustrious Sanskrit, the scientific language in the world
- Learning of Sanskrit to improve brain functioning
- Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
- The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes:

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

UNIT-I:

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

UNIT-II:

- Order
- Introduction of roots
- Technical information about Sanskrit Literature

UNIT-III:

- Technical concepts of Engineering-Electrical,
- Mechanical,
- Architecture,
- Mathematics

References:

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

With effect from academic year 2021-22

AC034

VALUE EDUCATION
(AUDIT COURSE-I)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- Understand value of education and self- development
- Imbibe good values in students
- Let the should know about the importance of character

Course Outcomes:

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

UNIT I:

- Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism.
- Moral and non- moral valuation. Standards and principles.
- Value judgements.

UNIT II:

- Importance of cultivation of values.
- Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness.
- Honesty, Humanity. Power of faith, National Unity.
- Patriotism. Love for nature, Discipline.

UNIT III:

- Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline.
- Punctuality, Love and Kindness.
- Avoid fault Thinking.
- Free from anger, Dignity of labour.
- Universal brotherhood and religious tolerance.
- True friendship.
- Happiness Vs suffering, love for truth.
- Aware of self-destructive habits.
- Association and Cooperation.
- Doing best for saving nature

UNIT IV:

- Character and Competence –Holy books vs Blind faith.
- Self-management and Good health.
- Science of reincarnation.
- Equality, Nonviolence, Humility, Role of Women.
- All religions and same message.

- Mind your Mind, Self-control.
- Honesty, Studying effectively

References:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi, 1999

With effect from academic year 2021-22

ME251

TURBOMACHINARY LABORATORY

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits : 1.5

Course Objectives:

- To study the concepts, applications of the thermal engineering laboratory.
- To demonstrate and conduct experiments, interpret and analyze data and report results of compressors, wind tunnel testing
- To expose the students to the basic knowledge of thermal equipments and help them to develop experimental skills.

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

List of Experiments:

1) Determination of static pressure distribution on a turbine blade surface at mid span on Low speed wind tunnel.
2) To Study downstream wake profile of a turbine cascade at mid span on Low speed wind tunnel.
3) To Study downstream wake profile of a compressor cascade at mid span on Low speed wind tunnel.
4) Study on performance of Centrifugal blower with forward swept blades.
5) Study on performance of Centrifugal blower with backward swept blades.
6) Study on performance of Centrifugal blower with radial blades.
7) Unsteady state Heat Transfer.
8) Thermal Conductivity of Liquid.
9) Experiments on Convergent Divergent Subsonic Nozzle.
10) To estimate the I-V and P-V characteristics of series and parallel combination of Solar Photovoltaic modules.
11) Workout power flow calculations of standalone Solar Photovoltaic system of DC and AC load with battery.

With effect from academic year 2021-22

ME261

SEMINAR

Instruction: 3 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits : 1.5

Course Objectives:

- *Identify appropriate topic of relevance.*
- *Update literature on technical articles of selected topic and develop comprehension.*
- *Prepare a technical report.*
- *Deliver presentation on specified technical topic.*

Course outcomes: After completion of the course student will be able to

1. Identify and compare technical and practical issues related turbomachinery and related systems.
2. Study different techniques adopted to solve the problem
3. Understand usage of related techniques and softwares
4. Investigate the procedure adopted and interpret the results and conclusions
5. Document the findings

Seminar topics may be chosen by the students with advice from the faculty members and the student shall read further relevant articles in the domain.

The seminar must be clearly structured and the power point presentation shall include following aspects:

1. Introduction to the field
2. Literature survey
3. Consolidation of available information
4. Objectives and Methodology
5. Results and Discussions& Summary
6. Conclusions
7. References

Each student is required to:

1. Deliver the seminar for a maximum duration of 30 minutes, where the presentation should be for 20 minutes in PowerPoint, followed by Question and Answers session for 10 minutes.
2. Submit the detailed report of the seminar in spiral bound in a précised format as suggested by the Department.

Guidelines for awarding marks		
S. No.	**Description**	**Max. Marks**
1	Contents and relevance	10
2	Presentation skills	10
3	Preparation of PPT slides	05
4	Questions and answers	05
5	Report in a prescribed format	20

Note:

1. The seminar presentation should be a gist of at few research papers from Peer-reviewed or UGC recognised journals.
2. The seminar report should be in the following order: Background of work, literature review, techniques used, prospective deliverables, discussion on results, conclusions, critical appraisal and reference.
3. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.
4. Attendance of all the students for weekly seminar presentations is compulsory.

With effect from academic year 2021-22

ME 100

RESEARCH METHODOLOGY IN MECHANICAL ENGINEERING

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Learn to focus on research related activities.
- Learn methods to devise and develop the various research designs
- Learn basic principles of data collection and analysis techniques
- Learn the style and format of writing a report for technical papers

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

1. Motivate the orientation towards research related activities
2. Formulate the research problem, analyze research related information
3. Identify various sources for literature review and design an experimentation set-up
4. Apply the basic principles of data collection and analysis techniques
5. Improve the style and format of writing a report for technical / Journal articles

UNIT - I

Research Methodology: Objectives and Motivation of Research, Types of Research, Research Approaches, Significance of Research, Research Methods verses Methodology, Research and Scientific Method, Important of Research Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general.

Defining the Research Problem: Definition of Research Problem, Problem Formulation, Necessity of Defining the Problem, Technique involved in Defining a Problem.

UNIT - II

Literature Survey: Importance of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Information through Internet. **Literature Review**: Need of Review, Guidelines for Review, Record of Research Review.

UNIT - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Design of Experimental Set-up, Use of Standards and Codes.

UNIT - IV

Data Collection: Collection of primary data, Secondary data, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Sample Design, Need for sampling, some important sampling definitions, Estimation of population, Role of Statistics for Data Analysis, Parametric V/s Non Parametric methods, Descriptive Statistics, Measures of central tendency and Dispersion, Hypothesis testing, Use of Statistical software.

Data Analysis: Deterministic and random data, Uncertainty analysis, Tests for significance: Chi-square, student's t-test, Regression modeling, Direct and Interaction effects, ANOVA, F-test, Time Series analysis, Autocorrelation and Autoregressive modeling.

UNIT - V

Research Report Writing: Format of the Research report, Synopsis, Dissertation, Thesis its Differentiation, References/Bibliography/Webliography, Technical paper writing/Journal report writing, making presentation, Use of visual aids. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research Grant Proposal.

Suggested Reading:

1. C.R Kothari, Research Methodology, Methods & Technique; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers, MJP Publishers, 2011
3. Ratan Khananabis and Suvasis Saha, Research Methodology, Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs., Pvt., Ltd., New Delhi, 2004
5. Vijay Upagade and Aravind Shende, Research Methodology, S. Chand & Company Ltd., New Delhi, 2009
6. G. Nageswara Rao, Research Methodology and Quantitative methods, BS Publications, Hyderabad, 2012.

With effect from academic year 2021-22

SEMESTER-II

ME203

HEAT TRANSFER AND HEAT EXCHANGERS IN POWER PLANTS

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Account for the consequence of heat transfer in thermal analyses of engineering systems.
- Develop solutions for transient heat and Obtain numerical solutions for conduction and radiation heat transfer problems.
- Evaluate heat transfer coefficients for natural convection and forced convection.
- Analyze heat exchanger performance
- Analyze heat exchanger performance by using the method of heat exchanger effectiveness and Calculate radiation heat exchange

Course Outcomes: After completion of the course student will be able to

1. Formulate 2D heat conduction problems in rectangular, cylindrical and spherical coordinate system by transforming the physical system into a mathematical model.
2. Compute boundary layer for laminar and turbulent flows and convective heat transfer coefficients
3. Solve problem in radiation heat transfer and numerical methods.
4. Analyse the mechanism which is involved in boiling and condensation
5. Compute different types of heat exchangers used in an Industries and that leads to design heat exchanges

UNIT-I

Conduction: Two dimensional steady state problems – Cartesian and cylindrical geometries. General unsteady state heat conduction equation in cylindrical and spherical co-ordinates. Periodic and non periodic temperature variations within a semi-infinite solid within infinite wall. Extended Surfaces (Fins): Heat transfer from a straight fin (Plate) of a uniform cross section, Error in measurement of temperature in a thermometer well, Fin efficiency, Applications.

UNIT-II

Convection: Approximate integral boundary layer analysis. Heat transfer in the laminar flow inside smooth tubes. Analogy between momentum and heat transfer in turbulent flow over a plane surface and turbulent flow in a tube. Empirical correlations – free convection (vertical and horizontal plates).

UNIT-III

Radiation: Enclosures with black surfaces, Enclosures with gray surfaces. Numerical Methods–finite difference techniques. Gas radiation.

UNIT-IV

Boiling and condensation: Boiling: Boiling phenomenon, Boiling curve, Mechanism of nucleateboiling, Stable film boiling, Forced convection boiling. Condensation: Condensation phenomenon, Film Condensation on a vertical surface, Condensation outside a horizontal tube or a tube bank, Condensation inside a horizontal tube. Drop wise Condensation. Introduction to two-phase flow: Simple momentum and energy equations.

UNIT-V

Heat Exchangers: Parallel flow, counter flow and cross flow heat exchangers, multi-pass shell and tube heat exchangers and design. Plate type of heat exchangers, and Compact Heat Exchangers. Power plant heat exchangers: Condensers, Feed Water Heaters, Evaporators, Dearators, Economizer, Air Pre heaters, and their design considerations. Principles of simultaneous heat and mass transfer. Analysis of cooling towers. Case studies of heat transfer related problems in Power Plant Boilers and Turbines.

Suggested Reading:

1. Frank Kreith and S. Bohn, Principles of Heat Transfer, Harper and Roks Publishers, New York 1986.
2. Glen Myers, Analytical Method in Conduction Heat Transfer, McGraw Hill co., 1971.
3. W.M. Kays, Convective Heat and Mass Transfer, Tata McGraw Hill Publishing Co. Ltd., 1979.
4. J.P. Holman, Heat Transfer, McGraw – Hill Book Co., 1992.
5. Binay K. Dutta, Heat Transfer, Prentice Hall of India, 2001.

With effect from academic year 2021-22

ME204

DESIGN OF STEAM TURBINES

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand and know the requirements for a Thermal Power Plant
- Study and learn the processes and cycles followed in Thermal Power Plants
- Gain the knowledge on steam power plants, steam generators
- Learn the practices followed in Thermal Power Plant and functioning of Turbines

Course Outcomes: After completion of the course student will be able to

1. Apply thermodynamic concepts to analyze turbo machines.
2. Analyze power plant and propulsion cycles.
3. Analyze impulse and reaction turbo machines for energy transfer.
4. Design gas turbine and steam turbine components.
5. Evaluate the performance of turbo machine components

UNIT-I

Introduction. Working principles of steam turbines. Flow through impulse and reaction steam turbine stage. Theoretical steam turbine cycle and methods of improving cycle efficiency.

UNIT-II

Flow analysis in steam nozzles and effect of back pressure. Design and testing of converging–diverging nozzle. Effect of area ratio on the performance of the nozzle.

UNIT-III

Optimum blade speed ratio and two stage impulse wheel. Blade and stage efficiencies for multistage steam turbines. Vortex flow and mixed flow turbines. Losses in steam turbines. Design of steam turbine blade and performance at varying loads.

UNIT-IV

Design and construction of steam turbine rotor. Disc of constant strength. Stress in steam turbine rotors and blades. Material for rotor and blades.

UNIT-V

Blade attachment techniques. Critical speeds and balancing of rotors, speed regulation of turbines. Static and dynamic balancing of turbogenerator sets.

Suggested Reading:

1. W.J. Kearton, Steam Turbine Theory And Practice, Seventh Edition, CBS Publishers, 2004
2. P Shlyakhin, Steam Turbines: Theory and Design, University Press of the Pacific 2005
3. Heinz P. Bloch, Murari Singh, Steam Turbines: Design, Application, and Re-Rating, Second Edition, McGraw Hill Professional, 2008

4. Murari Singh, Blade Design and Analysis for Steam Turbines, McGraw-Hill Education, 2011
5. Hermann Wilda, Charles Salter, Steam Turbines: Their Theory and Construction, Merchant Books, 2007
6. H H Harrison, Model Steam Turbines; How to Design and Build Them, Franklin Classics, 2018

With effect from academic year 2021-22

ME217

COMPUTATIONAL FLUID DYNAMICS
(Program Elective -III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the major theories, approaches and methodologies used in CFD
- Build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modeling etc.) in using commercial CFD codes
- Gain experience in the application of CFD analysis to real engineering designs.

Course outcomes: After completion of the course student will be able to

1. Understand the governing equations of different types of fluid flow systems, averaging procedure of turbulent flow properties
2. Classify second order partial differential equations, formulate finite difference equations based on accuracy, type of differencing and should be able to analyse their stability
3. Discretise the problem domain
4. Apply FDM and solve equations using numerical methods
5. Apply Finite volume method for basic equations of heat transfer and fluid flow problems.

UNIT-I

Review of basic equations of fluid dynamics: Continuity, Momentum and Energy equations, Navier Stokes equations, Reynolds and Favre averaged N – S equations. Differential equations for steady and unsteady state heat conduction. Differential equations for diffusion. Introduction to turbulence, Turbulence models-mixing length model, k-ε turbulence Model.

UNIT-II

Classification of PDEs – Elliptic, parabolic and hyperbolic equations. Initial and boundary value problems. Concepts of Finite difference methods – forward, backward and central difference. Errors, Consistency, Stability analysis by von Neumann. Convergence criteria.

UNIT-III

Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation.

UNIT-IV

Finite difference solutions-Parabolic PDEs – Euler, Crank Nicholson, Implicit methods, Elliptic PDEs –Jacobi, Gauss Seidel, ADI, methods. FD- solution for Viscous incompressible flow using Stream function –Vorticity method & MAC method.

UNIT- V

Introduction to Finite volume method. Finite volume formulations for diffusion equation, convection diffusion equation. Solution algorithm for pressure velocity coupling in steady flows. Use of Staggered grids SIMPLE Algorithm.

Suggested Reading:

1. Pradip Niyogi, Chakrabartty SK, Laha M.K., "Introduction to Computational Fluid Dynamics", Pearson Education, 2005.
2. Muralidhar K, Sundararajan T, "Computational Fluid flow and Heat transfer", Narosa Publishing House,2003.
3. Chung, T J, "Computational Fluid Dynamics", Cambridge University Press, 2002.
4. John D Anderson, "Computational Fluid Dynamics", McGraw Hill, Inc., 1995.
5. Patankar, S.V, "Numerical Heat transfer and Fluid flow", Hemisphere Publishing Company, New York,1980.

With effect from academic year 2021-22

ME211

ADVANCED ENERGY SYSTEMS
(Program Elective -III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- To acquaint with energy systems and their basic principles.
- To acquire knowledge on various advanced energy conversion equipments
- To understand the principles of renewable energy technologies.
- To study the working principle, construction of power generation from non-conventional sources of energy.

Course Outcomes: After completion of the course student will be able to

1. Identify the need and promise of simultaneously alternative and "clean" energy
2. Expose to the diversity of beneficial applications currently utilizing renewable energy
3. Introduce societal catalysts and challenges regarding renewable energy Implementation
4. Evaluate the performance of thermal systems using of energy management
5. Explore the utilization of renewable energy within developing or developed regions

UNIT-I

Solar Energy: Solar radiation–measurement, collection and storage, Solar Thermal Systems, Design of flat plate and parabolic concentrating collectors, Solar power plants. Photo voltaic power systems. Application of SPV.

UNIT-II

Wind Energy: Estimation of wind energy potential. Horizontal and Vertical axis wind turbine rotors. Aerodynamic design considerations for wind rotor blades. Wind electric generators-operation and control. Aero generators for battery charging.

UNIT-III

Biomass Energy: Sources of biomass. Biomass for Energy production. Methane production. Biomass energy conversion technologies. Use of Biomass gasifier, Types of gasifiers. Biomass Power generation using agricultural residues. Introduction of Hybrid energy systems.

UNIT-IV

Waste Heat Recovery: Principles and Devices - Regenerators and Recuperators. Analysis of heat recovery systems. Design of waste heat recovery boilers. Combined cycle power plants based on waste heat recovery.

UNIT-V

Fuel Cell Technology: Introduction, Classification of fuel cells, Operating principles, Thermodynamic Aspects of Electrochemical Energy Conversion, Electrochemical kinetics, Performance of fuel cells, fuel cell components - Alkaline Fuel Cells, (AFC), Solid Oxide Fuel Cells (SOFC), Proton Exchange Membrane Fuel Cells (PEMFC), Characteristics of fuel cells.

Suggested Reading:

1. J.A. Duffire and W.A. Beckmen, Solar Energy Thermal Processes, John Wiley & Sons Inc, New York, 2006
2. Paul Gipe, Wind Energy Comes of Age, John Wiley & Sons Inc, New York, 1995
3. N.H Ravindranath and D O Hall, Bio Mass, Energy and Environment, Oxford University Press, 1995
4. Robert Goldstick, Principles of waste heat recovery, Fairmont Press,1986
5. J. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley, 2003

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With effect from academic year 2021-22

ME304

FLUID POWER SYSTEMS
(Program Elective - III)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- The course will develop the students' knowledge and understanding of hydraulic and pneumatic devices and systems.
- The students should be able to understand the principles of operation and the design details of hydraulic pumps, motors, valves, actuators, and systems.
- The student should be able to analyze both the steady-state and the dynamic performance of individual hydraulic components and systems.
- The student should also be able to relate the theory with the practical applications of these principles

Course outcomes: After completion of the course student will be able to

1. Differentiate between Hydraulic and Pneumatic systems and Identify various hydraulic and pneumatic elements with their symbols
2. Classify various hydraulic, pneumatic fluids with their properties & applications and Illustrate the working principles of various positive displacement pumps and motors.
3. Generate and solve mathematical models for various hydraulic & pneumatic components like valves, pumps and motors
4. Integrate all hydraulic & pneumatic components and solve the corresponding mathematical models for generating various fluidic circuits
5. Apply the concept of fluidics in developing various fluidic circuits

UNIT - I

Advantages and Disadvantages of Fluid control, Types of Hydraulic Fluids, physical, chemical and thermal properties of hydraulic fluids, selection of hydraulic fluid, fluid flow fundamentals. Hydraulic Pumps and Motors: Basic Types and constructions, ideal pump and motor analysis, Performance curves and parameters

UNIT - II

Hydraulic Control Valves- Valve configurations, general valve analysis, critical centre, open centre, three way spool valve analysis and Flapper valve analysis, pressure control valves, single and two stage pressure control valves, flow control valves, introduction to electro hydraulic valves.

UNIT - III

Hydraulic Power Elements: Valve controlled motor, valve controlled piston, three way valve controlled piston, pump controlled motor, pressure transients in power elements.

UNIT - IV

Characteristics of Pneumatics, Applications of Pneumatics, Basic Pneumatic elements, Pneumatic servomechanisms, pneumatic servo, ram equations, load sensitivity, method of stabilization, stabilization using auxiliary tanks. Some practical aspects of servo testing and design

UNIT - V

Control of pressure and speed in Hydraulic and Pneumatic Systems, Fluidics: proportional amplifier, bistable amplifier, vortex amplifier, turbulence amplifier, impact modulator, Boolean algebra, fluid logics, manipulation of logic expressions, special circuits and sequential circuits.

Suggested Reading:

1. Herbert E. Merritt, "Hydraulic Control Systems", John Wiley & Sons, 1991
2. D McCloy& H R Martin," The control of fluid power" Longman publications.1980
3. Anthony Esposito, "Fluid power with applications", Prentice Hall, 7th Edition, 2002.
4. Arthur Akers, Max Gassman, Richard Smith, "Hydraulic Power System Analysis", Taylor and Francis Group, 2006.
5. John Pippenger& Tyler Hicks, "Industrial Hydraulics", 3rd edition McGraw Hill, 1980
6. Patrick J. Klette, Fluid Power Systems, Amer Technical Pub; 2nd edition, 2014

With effect from academic year 2021-22

ME215

CASCADE AERODYNAMICS
(Program Elective -IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- To provide information regarding the behavior of compressible fluid flow
- To impart knowledge regarding the difference between subsonic and supersonic flow
- To Estimate flow over flying vehicles at subsonic and supersonic speeds
- Understand the influence of compressibility and to distinguish between the flow regime
- Apply compressibility corrections for flow in C-D passages and analyze the compressible flow field over an airfoil and finite wings

Course outcomes: After completion of the course student will be able to

1. Understand turbine and compressor airfoil blades nomenclature.
2. Analyze the flow over airfoil and Calculate airfoil profile coordinates for NACA Series blades.
3. Evaluate forces acting on turbine airfoil blades and understand loss mechanisms leading to their estimation using correlations.
4. Evaluate forces acting on compressor airfoil blades and understand loss
5. Application of Finite Difference Techniques for studying flow through variable area flow passages in turbomachines.

UNIT-I

Airfoil blade geometry. Blade terminology – leading and trailing edges, flow angles, blade angles, camber line, chord line, solidity, space to chord ratio, aspect ratio, Comparison of turbine and compressor blade/ cascade profiles.

UNIT-II

Fundamental Theory of Airfoils - flow around an aerofoil, pressure distribution around airfoil and lift generation. NACA series of airfoils –Calculation of coordinates of airfoils for NACA Four-Digit Series and NACA Five-Digit Series- Advantages and Disadvantages of NACA Series Airfoils and their Applications.

UNIT-III

Turbine cascade analysis – evaluation of axial, tangential, lift and drag forces. Relations for lift, drag and pressure coefficients. Losses in turbine cascade/blade passages – profile, annulus, secondary and tip clearance losses. Correlations for estimation of losses.

UNIT-IV

Compressor cascade analysis – evaluation of axial, tangential, lift and drag forces. Relations for lift, drag and pressure coefficients. Losses in compressor cascade/blade passages – profile, annulus, secondary and tip clearance losses. Correlations for estimation of losses. Effects of flow and geometrical parameters on cascade performance.

UNIT-V

Application of finite difference techniques for study of flow phenomena – first & second order accuracy relations for forward, rearward & central difference relations. Two dimensional supersonic flow through a turbo machine passage – transformation of physical plane into computational plane, governing equations, primitive variables, flux variables, application of Mack Cormack's finite difference method, predictor – corrector approach for obtaining numerical solutions.

Suggested Reading:

1. J.P.Gostelow, Cascade Theory, Pergamon Press, New York,1984
2. Charles E. Dole & James E. Lewis, Flight Theory and Aerodynamics, John Wiley and Sons 2000
3. J.H. Horlock, Axial Flow Compressors and Turbines, Krieger Publishing Company,1973
4. Peter Jonathan Baddoo, Analytic Solutions for Flows Through Cascades, Springer, 2020
5. O. C. Zienkiewicz, R. L. Taylor, The Finite Element Method: Fluid Dynamics, John Wiley & Sons Inc,2000

With effect from academic year 2021-22

ME218

FUELS AND COMBUSTION
(Program Elective -IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand solid, liquid and gaseous fuel properties,
- Analyse process and handling of fuels
- Estimate stoichiometry relations in the combustion process
- Understand the features of different types of burners and emissions
- Analyse exhaust and flue gases

Course outcomes: After completion of the course student will be able to

1. Analyse combustion stability and the formation of pollutants in practical
2. Understand the fundamental theory of the combustion of non-premixed and premixed flames, laminar and turbulent flames, droplets and the theory of
3. Analyse the role of detailed chemical kinetics in combustion and the ability to calculate the equilibrium compositions of reacting systems.
4. Understand pollution formation in practical devices such as internal
5. Design gasification techniques and equipment for solid and liquid fuels

UNIT-I

Introduction: General, Conventional energy resources, Solar energy, Nuclear power, Energy from biomass, Wind power, Tidal power, Geothermal energy, Energy survey for India, Rocket Fuels, Definitions, Units, Measures.

UNIT-II

Solid Fuels: General, Biomass, Peat, Lignite or Brown Coal, Sub-bituminous Coal or Black Lignite, Bituminous Coal, Semi-anthracite, Anthracite, Cannel coal and Boghead coal, Natural coke (Jhama)/SLV fuel, Origin of coal, Composition of coal, Analysis and properties of coal, Action of heat on coal, Oxidation of coal, Hydrogenation of coal, Classification of coal. Processing of Solid Fuels: General Coal preparation, Storage of coal, Coal carbonization, Briquetting of solid fuels, Liquefaction of solid fuels.

UNIT-III

Liquid Fuels : General, Petroleum, Origin of Petroleum, Petroleum production, Composition of petroleum, Classification of petroleum, Nature of Indian crude‟s, Petroleum processing, Important petroleum products, Properties and testing of petroleum and petroleum products, Petroleum refining in India, Liquid fuels from sources other than petroleum, Gasification of liquid fuels, Storage and handling of liquid fuels.

UNIT-IV

Gaseous fuels: General, Types of gaseous fuels, Natural gas, Methane from coal mines, Producer gas, Water gas, Carburetted water gas, Complete gasification of coal, Underground gasification of coal, Coal gas, Blast furnace gas, Gases from biomass, Refinery gases, Liquefied petroleum gases (LPG), Oil gasification, Cleaning and purification of gaseous fuels.

UNIT-V

Combustion Process (Stoichiometry and Thermodynamics):Combustion Stoichiometry: General, Examples, Rapid methods of combustion stoichiometry. Combustion Thermodynamics: General Combustion Process (Kinetics): Nature of combustion process, Types of combustion processes, Mechanism of combustion reaction, Spontaneous Ignition Temperature (SIT), Velocity of flame propagation, Limits of inflammability, Structure of flame, Flame stability, Kinetics of liquid fuel combustion, Kinetics of solid fuel combustion. Combustion Applications: General, Gas burners, Oil burners, Coal burning equipment.

Suggested Reading:

1. Loftness, R.L., Energy hand book, New York, Van Nostrand 1998.
2. Wilson, P.J. and J.H. Wells, Coal, Coke and Coal Chemicals, New York : McGraw-Hill, 1960.
3. Williams, D.A. and G. James, Liquid Fuels, London Pergamon, 1963.
4. Gas Engineers Handbook, New York : Industrial Press, 1966.
5. Minkoff, G.J., and C.F.H. Tipper, Chemistry of Combustion Reaction, London Butterworths
6. Samir Sarkar, Fuels & Combustion, Orient Long man 1996

With effect from academic year 2021-22

ME313

VIBRATION ANALYSIS & CONDITION MONITORING

(Program Elective -IV)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the theoretical basis for single and multi-degree freedom systems
- Learn to derive the mathematical models for free and forced vibration systems
- Understand the importance of various methods to solve multi degree freedom systems
- Know the working principles of various condition monitoring equipment
- Learn various methods of recording and displaying data

Course Outcomes: After completion of the course student will be able to

1. Fully understand importance of vibrations in mechanical design of machine parts that operate under vibratory conditions.
2. Write differential equation of motion of vibratory system and understand free and forced modes of vibration
3. Obtain linear vibratory models of dynamic systems of varying complexity (SDOF,MDOF)
4. Apply various condition monitoring techniques available in the literature.
5. Classify and use various devices available to record interpret and understand the vibration data.

UNIT-I

Causes and effects of vibration. Vibrations of Single Degree of freedom systems. Free, Damped and Forced vibrations

UNIT-II

Two Degree of freedom systems. Bending vibrations of two degree of freedom systems, Steady state and transient characteristics of vibration, vibration absorber and vibration isolation.

UNIT-III

Multi degree of freedom systems: Dunkerley method, Rayleigh method, stodola method and holzers method. Modal analysis.

UNIT-IV

Introduction to Condition Monitoring, Failure types, investigation and occurrences. Causes of failure, Vibration measuring instruments, vibration transducers, signal conditioning elements. Display and recording elements. Vibration meters and analyzers. Condition Monitoring through vibration analysis. Frequency analysis, Filters, Vibration signature of active systems, vibration limits and standards.

UNIT-V

Contaminant analysis, SOAP and other contaminant monitoring techniques. Special vibration measuring techniques - Change in sound method, Ultrasonic measurement method, Shock pulse measurement, Kurtosis, Acoustic emission monitoring, Cepstrum analysis, Modal analysis, critical speed analysis, Shaft –orbit & position analysis.

Suggested Readings:

1. Rao S .S Mechanical Vibrations , 5th Edition, Prentice Hall, 2011
2. V.P.Singh, Mechanical vibrations, Dhanpat Rai Publications, 2015
3. Collacott, R.A., Mechanical Fault Diagnosis and Condition Monitoring, Chapman & Hall, London,1982.
4. John S. Mitchell, Introduction to Machinery Analysis and Monitoring, Penn Well Books, Penn Well Publishing Company, Tulsa, Oklahoma, 1993.
5. J S Rao, Vibration condition monitoring of machines, CRC Press, 2000
6. Nakra, B.C. Yadava, G.S. and Thuested, L., Vibration Measurement and Analysis, National Productivity Council, New Delhi, 1989.

With effect from academic year 2021-22

AC 035

STRESS MANAGEMENT BY YOGA
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *Creating awareness about different types of stress and the role of yoga in the management of stress.*
- *Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).*
- *Prevention of stress related health problems by yoga practice.*

Course Outcomes: *Students will be able to*

1. *To understand yoga and its benefits.*
2. *Enhance Physical strength and flexibility.*
3. *Learn to relax and focus.*
4. *Relieve physical and mental tension through Asanas*
5. *Improve work performance and efficiency.*

UNIT-I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga by Patanjali.

UNIT–II

Meaning and definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT-III

Concept of Stress according to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress.

UNIT-IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas– Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar

UNIT-V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama – Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation techniques: Om Meditation - Cyclic meditation : Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT).

Suggested Reading:

1. "Yogic Asanas for Group Training - Part-I": Janardhan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or Conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
3. Nagendra H.R nadNagaratna R, "Yoga Perspective in Stress Management", Bangalore, Swami Vivekananda Yoga Prakashan

Online Resources:

https://onlinecourses.nptel.ac.in/noc16_ge04/preview

https://freevideolectures.com/course/3539/indian-philosophy/11

With effect from academic year 2021-22

AC 036

PERSONALITY DEVELOPMENT THROUGH LIFE ENHANCEMENT SKILLS
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives :

- *To learn to achieve the highest goalhappily*
- *To become a person with stable mind, pleasing personality and determination*
- *To awaken wisdom in students*

Course Outcomes: *Upon completing this course, students will be able to:*

1. *Develop their personality and achieve their highest goal of life.*
2. *Lead the nation and mankind to peace and prosperity.*
3. *To practice emotional self regulation.*
4. *Develop a positive approach to work and duties.*
5. *Develop a versatile personality.*

UNIT-I

Neetisatakam – Holistic development of personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT-II

Neetisatakam – Holistic development of personality (cont'd) - Verses 52, 53, 59 (dont's) - Verses 71,73,75& 78 (do's) - Approach to day to day works and duties.

UNIT-III

Introduction to Bhagavad Geetha for Personality Development – Shrimad Bhagawad Geeta: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 – Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT-IV

Statements of basic knowledge – Shrimad Bahgavadgeeta: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bahgavadgeeta.

UNIT-V

Role of Bahgavadgeeta in the present scenario - Chapter 2 – Verses 17 – Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Reading:

1.. "Srimad Bahgavadgeeta" by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata 2007

2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi 2010

Web resource:

1. NTPEL:http://nptel.ac.in/downloads/109104115/

With effect from academic year 2021-22

AC 037

CONSTITUTION OF INDIA
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 00

Objectives:

- *The history of Indian Constitution and its role in the Indian democracy.*
- *Address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.*
- *Have knowledge of the various Organs of Governance and Local Administration.*

Course Outcomes: Upon completing this course, students will be able to:

1. Understand the making of the Indian Constitution and its features.
2. Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
3. Have an insight into various Organs of Governance - composition and functions.
4. Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
5. Understand Electoral Process, special provisions.

UNIT-I

History of making of the Indian constitutions: History, Drafting Committee(Composition & Working).**Philosophy of the Indian Constitution**: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights and Duties Fundamental Rights, Right toEquality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance": Parliament: Composition, Qualifications, Powers and Functions, Union executives : President, Governor, Council of Ministers, Judiciary, appointment and transfer of judges, qualifications, powers and functions.

UNIT-IV

Local Administration - District's Administration head: Role and importance. Municipalities: Introduction, ayor and role of Elected Representative, CEO ofMunicipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions and role. Block level: Organizational Hierarchy (Different departments) Village level: role of elected and appointed officials. Importance of grass root democracy.

UNIT-V

Election commission: Election Commission: Role and functioning, Chief Election Commissioner and Election Commissioners, State Election Commission :Role and functioning. Institute and Bodies for the welfare of SC/ST/OBC and women**.**

Suggested Reading:

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

Web Resource:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

With effect from academic year 2021-22

AC038

PEDAGOGY STUDIES
(AUDIT COURSE-II)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 0

Course Objectives:

- Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

Course Outcomes:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in Developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

UNIT-I

Introduction and Methodology:

- Aims and rationale, Policy background, Conceptual framework and terminology
- Theories of learning, Curriculum, Teacher education.
- Conceptual framework, Research questions.
- Overview of methodology and Searching.

UNIT-II

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

UNIT-III

- Evidence on the effectiveness of pedagogical practices
  Methodology for the in depth stage: quality assessment of included studies.
- How can teacher education (curriculum and practicum) and the school
- Curriculum and guidance materials best support effective pedagogy?
- Theory of change.
- Strength and nature of the body of evidence for effective pedagogical practices.
- Pedagogic theory and pedagogical approaches.
- Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT-IV

- Professional development: alignment with classroom practices and follow up support
- Peer support

- Support from the head teacher and the community.
- Curriculum and assessment
- Barriers to learning: limited resources and large class sizes

UNIT-V

- Research gaps and future directions
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact

Suggested reading:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of
   Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher educationresearch project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal
   Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
7. ww.pratham.org/images/resource%20working%20paper%202.pdf.

With effect from academic year 2021-22

MC070

MINI PROJECT

Instruction: 6 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits : 3

Course Objectives:

- *Understand the purpose of doing mini project*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to select appropriate software and procedure*
- *Learn to document results and arrive at required conclusions*

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

1. Identify engineering problems reviewing available literature
2. Study different techniques used to analyze complex systems.
3. Use related techniques and software's for solving the problem
4. Interpret the results and arrive at the relevant conclusions.
5. Document the findings as a technical report with proper references

Guidelines

1. Guide allocation will be done at the beginning of the semester. Identification of Mini project work will be done with Guides consultation

2. Mini project presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.

3. Evaluation of Mini project will be done by the Departmental Committee. Half of the marks are awarded by the Guide and the remaining half of the marks will be awarded by Departmental Committee.

With effect from academic year 2021-22

ME252

COMPUTATIONAL FLUID DYNAMICS LABORATORY

Instruction: 4 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits : 1.5

Course objectives:

- To provide students with the necessary skills to use commercial CFD packages
- To carry out research in the area of Computational Fluid Dynamics.
- To solve a variety of flow situations and heat transfer tutorials.

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

List of Experiments:

1. Introduction to CFD – Pre Processor, Solver, Post Processor
2. Ansys Work bench – Modelling tools
3. Ansys Work Bench – Grid Generation
4. Ansys CFX pre – Properties of fluids, Boundary Conditions
5. Ansys Solver, Post processor
6. Exercise 1 : Flow through a Nozzle – Modeling, Grid generation
7. Exercise 1 : Flow through a Nozzle – Pre, Solver, Post Processor
8. Exercise 2: Flow past a cylinder – Modeling, Grid generation
9. Exercise 2: Flow past a cylinder – Pre, Solver, Post Processor
10. Exercise 3 : Static Mixer – Modeling, Grid generation
11. Exercise 3 : Static Mixer – Pre, Solver, Post Processor
12. Exercise 4 : Flow Mixing in a pipe bend – Modeling, Grid generation
13. Exercise 4 : Flow Mixing in a pipe bend - Pre, Solver, Post Processor

With effect from academic year 2021-22

ME 253

COMPUTATION LABORATORY

Instruction: 4 periods per week *Duration of SEE: --*
CIE: 50 marks *SEE: --*
Credits : 1.5

Course objectives

- Understanding the MATLAB environment
- To introduce to the software MATLAB for numerical computations
- To do simple calculations using MATLAB
- Carry out simple numerical computations and analyses using MATLAB

Course Outcomes: After completion of the course student will be able to

1. Ability to perform simulations/ experiment and understand the phenomenon
2. Critically evaluate and interpret the results
3. Prepare a well-organized record

MATLAB programs

1. Evaluate the mathematical expressions in Matlab
2. Write scripts to make the following single-index arrays
3. Basic syntax and command-line exercises, Basic array exercises, Relational and logical operations
4. Control of flow: if-blocks , Loop constructs: for and while
5. Problems on generating various kinds of 2D & 3D Plots
6. Solving ordinary differential equations
7. Solving algebraic equations
8. Applications of Curve fitting and interpolation
9. Usage of Data Analysis and statistics
10. Modeling of problems related to turbomachinery

With effect from academic year 2021-22

ME220

DESIGN OF GAS TURBINES
(Program Elective -V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the thermodynamics of each component of a turbine engine which include inlets, fans, compressors, burners, turbines, afterburners and nozzles
- Know the design variables for each components
- Understand the connected system performance of all components in the engine and performance trends
- Understand the basis for off-design performance

Course outcomes: After completion of the course student will be able to

1. Understand various gas turbine cycles.
2. Analyse laws pertaining to gas turbines and compressors
3. Identify, formulate and solve problems related to gas turbines
4. Estimate the performance of turbines
5. Design turbine components and combustion chambers

UNIT-I

Thermodynamic analysis of Gas turbine power cycles – Joule/Brayton. Open and Closed Cycles. Methods of improving cycle efficiency – Inter cooling. Reheating and Regeneration.

UNIT-II

Applications of Turbo Compressors (Centrifugal and axial flow) in Gas turbine power plant. Euler equation of energy transfer in a turbomachine. Design of two stage centrifugal compressor with vane less and vaned diffusers. Design of multi stage axial flow compressors.

UNIT-III

Types of combustion chambers. Combustion chamber design for modern gas turbines. Can type, annular and tube type of combustors.

UNIT-IV

Analysis and design of 2-D and 3-D flow for axial flow turbines. Matching of compressor and turbine for varying load operation. Gas turbine for super charging and cryogenic applications. Small gas turbines for space applications.

UNIT-V

Design and construction of Gas turbine rotors and blades. Blade materials. Blade attachment techniques. Cooling methods of turbine blades. Simple analysis of turbine blade vibrations and balancing of rotors.

Suggested Reading:

1. D.G.Wilson, The Design of High efficiency Turbomachinery and Gas Turbines, The MIT Press, Cambridge, U.K. 2014
2. M.P.Boyce, Gas Turbine Engineering hand book, Gulf Publishing Co., New York. 2002
3. O.E. Balje, Turbo machines–A guide to Selection and Theory, John Wiley & Sons, New York. 1981
4. J.S. Rao, Rotor Dynamics, Wiley Eastern Publication, New Delhi,2005
5. Meinhard T. Schobeiri, Gas Turbine Design, Components and System Design Integration, Springer, 1st Edition, 2017

With effect from academic year 2021-22

ME221

FLOW INDUCED VIBRATIONS
(Program Elective -V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the problems that coupling with a fluid for both quiescent and flowing flow.
- Understand the current state-of-the-art in the area of flow induced vibrations
- Classify the mechanisms for flow-induced vibration and explain the qualitative differences between these mechanisms
- Analyse theoretically a single and multidegree of freedom aeroelastic systems
- Assess the impact of FSI and FIV to a particular problem.

Course outcomes: After completion of the course student will be able to

1. Understand problems coupling with a fluid
2. Analyses non-dimensional variables and induced vibrations.
3. Understand the mechanisms for flow-induced vibration and explain the qualitative differences between these mechanisms
4. Analyse theoretically a single and multidegree of freedom aeroelastic systems
5. Assess the impact of FIV to a particular problem.

UNIT-I

Single degree system with external excitation. Two degree System, Modal analysis, Principal coordinates.

UNIT-II

Non dimensional variables, Vortex induced vibrations, Vortex wake of a stationary cylinder, Strouhal's number, Wake oscillatory model, Correlation model, Reduction of vortex induced vibrations.

UNIT-III

Stall flutter, Stability of one degree and two degree freedom systems. Response of one degree and two degree of freedom systems, Galloping of a beam and cable and reduction of galloping vibrations.

UNIT-IV

Vibrations induced by oscillatory flow, solution of linearised equations, Oscillatory flow with mean zero flow and with mean flow, Sound induced by vortex shedding.

UNIT-V

Vibrations of pipe containing fluid flow, Vibrations of cantilever and pinned-pinned pipe, Pipe whip.

Suggested Reading:

1. Robert D. Blevines, Flow Induced Vibration, Krieger Publishing Company, 2006
2. Tomomichi Nakamura, Flow Induced Vibrations: Classifications and Lessons from Practical Experiences, Elsevier Science,2008
3. A. Zukowskus, Fluid Dynamics and Flow-induced Vibrations of Tube Banks, Taylor & Francis Inc, 1988
4. E. Naudascher, Flow-Induced Vibrations: An Engineering Guide, Dover Publications Inc, 2005
5. M.K. Au-Yang, Flow-Induced Vibration of Power and Process Plant Components: A Practical Workbook, ASME, 2001

With effect from academic year 2021-22

ME214

TURBULENCE MODELLING

(Program Elective -V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Understand the fundamental concepts of turbo machines
- Apply concepts of fluid mechanics in turbo machines.
- Understand the thermodynamic analysis of steam nozzles and turbines.
- Understand the different types of compressors and evaluating their performances in the form of velocity triangles.
- Familiarize the basic concepts of gas dynamics and analyze the performance of axial flow gas Turbines

Course outcomes: After completion of the course student will be able to

1. Design and analyze the performance of Turbo machines for engineering applications
2. Understand the energy transfer process in Turbo machines and governing equations of various forms.
3. Design various Turbo machines for power plant and aircraft applications
4. Evaluate the design principles of the turbo machines
5. Analyze the turbo machines to improve and optimize their performance

UNIT-I:

Introduction and Origin of Turbulence: Properties of laminar flow, Properties of turbulent flow. Boundary Layer: Boundary Layer, Growth rate of Boundary layer for Laminar and Turbulent Flows. Characteristics of Turbulent Flow: The Origin of Turbulence, Nature of Turbulence, Swirling Structure, Mean Motion and Fluctuations, Consequences of Turbulence, Homogeneous Isotropic Turbulence.

Correlation Functions, Kolmogorov Hypothesis and Probability Density Function: Correlation

Functions, Ideas about eddy size, Intensity of Turbulence or Degree of Turbulence. Kolmogorov Hypothesis and Energy Cascade: Kolmogorov Universal Law for the Fine Structure, Energy Cascade, Kolmogorov Length Scale, Kolmogorov's First Hypothesis, Kolmogorov's Second Hypothesis. Probability Density Functions and Averaging: Introduction, Probability density function, averaging used in the analysis of turbulent flows.

UNIT -II:

Reynolds Averaged Navier-Stokes Equations and Classical Idealization of Turbulent Flows: Reynolds' Decomposition, Examples of Turbulent Fluctuations, some Measurements

on Fluctuating Components. Measurements on Fluctuating Components: Shear Stress due to the Fluctuations, Theboundary layer measurements of Klebanoff. Turbulent Boundary Layer Equations: Turbulent Boundary Layer Equations for a two-dimensional flow. Classical Idealization of Turbulent Stresses: Introduction, The boussines or eddy viscosity model, Eddy viscosity.

UNIT-III:

Vorticity Dynamics: Introduction, Vorticity and the equations of motion, Reynolds stress and vorticity. Vortex Stretching. The Vorticity Equation, Vorticity in Turbulent Flows.

Dynamics of Turbulent Kinetic Energy and Important Scaling Relations: Kinetic Energy of the Mean Flow. Kinetic Energy of Fluctuations. Scaling Relations.

UNIT-IV:

Wall Bounded Flows and Free Shear Flows: The Law of the Wall for Wall Bounded Flows, The Universal Velocity Profile. Free Shear Flows, Turbulent Jets, Uniform Eddy Viscosity model.

Spectral Dynamics: Correlation Functions and Spectra. Correlation Functions and Spectra.

Large - Eddy Simulation of Turbulent Flows: RANS Equations and Eddy Viscosity: Introduction Reynolds Averaged Navier-Stokes (RANS) Equations, Eddy Viscosity Models, Zero-Equation Models. One-Equation Model: One-Equation Model, Two-Equation Model. Two Equation Models: k - ω Model, SST (Shear Stress Transport) Turbulence Model. Discussion on Applicability

UNIT-V:

Large - Eddy Simulation of Turbulent Flows: Low Reynolds number k - ε model: Special Features of Near Wall Flow, Near Wall Treatment in Transport Equation based Models, Wall Function Approach, Low Reynolds number version of k - ε model: Asymptotic Consistency, Damping Functions.RNG k - ε Model and Kato-Launder Model. The Realizable k - ε Model, Reynolds Stress Models(RSM), Large Eddy Simulation (LES). Mathematical Modeling of Turbulent Flows: The Filtered Navier-Stokes Equations, Subgrid Scale Closure, Standard Subgrid-Scale Model. Dynamic Model of LES. Direct Numerical Simulation.

Suggested Reading:

1. A First Course in Turbulence by H. Tennekes and J.L. Lumley, The MIT Press, Cambridge, Massachusetts, and London, England, 1987
2. Fluid Mechanics by P.K. Kundu and I.M. Cohen, Academic Press (An Imprint of Elsevier Science, USA, 2002
3. Turbulent Flows by S.B. Pope, Cambridge University Press, UK, 2000
4. Turbulent Flows: Fundamentals, Experiments and Modeling by G. Biswas and V. Eswaran, Narosa Publishing House, New Delhi, India, 2002
5. Sal Rodriguez, Applied Computational Fluid Dynamics And Turbulence Modeling Practical Tools Tips And Techniques, Springer, 2021

With effect from academic year 2021-22

ME222

TWO PHASE FLOW AND HEAT TRANSFER
(Program Elective -V)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits : 3

Course Objectives:

- Introduce and describe the processes in two-phase
- Understand and model the behaviour of two-phase thermal-hydraulic system components**.**
- Demonstrate the ability to model multiphase flows
- Perform fundamental analysis of multiphase flow system
- Demonstrate linkage between mass transfer and heat flow

Course outcomes: After completion of the course student will be able to

1. Demonstrate the ability to model multiphase flows
2. Perform fundamental analysis of multiphase flow system
3. Link between mass transfer and heat flow
4. Understand the physical phenomena and specific models that can be used as an aid in two phase flow and heat transfer
5. Design and analyse the combustion systems, nuclear and other reactors, and heat transfer in industrial processes commonly found in plants

UNIT-I

Introduction: Fundamentals of heat and mass transfer. Generating phase diagrams in Engineering Equation Solver (EES) software. Introduction to mass transport. Gas-Liquid interfacial phenomena. Interfacial waves on thin films, jets, jet breakup and bubble growth

UNIT-II

Two-phase mixtures: Particles and films, Homogeneous vs. separated flow model. Two-phase flow regimes. Two-phase modelling – one-dimensional. Flow regime-based pressure drop prediction. Two-phase modelling – multi-dimensional

UNIT-III

Drift Flux Model : Drift Flux model and void fraction prediction. Flow regimes and interfacial area . Pressure drop comparison of macro- and micro-scale heat exchangers. Two-phase flow in small passages

UNIT-IV

Nucleate boiling: Electronics cooling via immersion. Film boiling, Flow boiling, Flow regime-based heat transfer model, Flow regimes and impact on flow boiling. **CHF and post-CHF heat transfer:** Analysis of the physical basis for CHF hypotheses. Flow boiling in small passages, CHF in small passages. Two-phase microchannel cold plate for electronics thermal management

UNIT-V

Fundamentals of condensation: Internal flow condensation. Condensation on jets and droplets. Choking in two-phase flow. **Atomizer:** Critical two-phase flow models**.** Spray formation and Spray evaporation rate. Single droplet behavior. Instabilities - droplet breakup Atomization of the jet in cross-flow. Instabilities - droplet breakup . Spray/Wall impingement Spray cooling thermal management of high heat flux sources. Spray/wall impingement

Suggested books:

1. Mostafa Ghiaasiaan S, Two-Phase Flow, Boiling, and Condensation 1st Edition, Cambridge University Press, Cambridge, 2008
2. Nellis G. F. and Klein S. A., Heat Transfer 1st Edition, Cambridge University Press, Cambridge, 2008
3. P B Whalley, Two-Phase flow and heat transfer, Atlantic, 2008
4. John G Collier, Two- Phase Flow and Heat Transfer in the Power and Process Industries McGraw-Hill Companies, 1999
5. Graham B Wallis , One-Dimensional Two-Phase Flow, Dover Publications Inc ,2020

With effect from academic year 2021-22

OE 941

BUSINESS ANALYTICS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Understanding the basic concepts of business analytics and applications*
- *Study various business analytics methods including predictive, prescriptive and prescriptive analytics*
- *Prepare the students to model business data using various data mining, decision making methods*

Course Outcomes: Upon completing this course, students will be able to:

1. To understand the basic concepts of business analytics
2. Identify the application of business analytics and use tools to analyze business data
3. Become familiar with various metrics, measures used in business analytics
4. Illustrate various descriptive, predictive and prescriptive methods and techniques
5. Model the business data using various business analytical methods and techniques

UNIT-I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics**- Linear Programming(LP) and LP model building,

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Suggested Reading:

1. Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015
3. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

With effect from academic year 2021-22

OE942

INDUSTRIAL SAFETY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives:

- *Causes for industrial accidents and preventive steps to be taken.*
- *Fundamental concepts of Maintenance Engineering.*
- *About wear and corrosion along with preventive steps to be taken*
- *The basic concepts and importance of fault tracing.*
- *The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry*

Course Outcomes:

1. *Identify the causes for industrial accidents and suggest preventive measures.*
2. *Identify the basic tools and requirements of different maintenance procedures.*
3. *Apply different techniques to reduce and prevent Wear and corrosion in Industry.*
4. *Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.*
5. *Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc*

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes, Fire prevention and firefighting, equipment and methods.

UNIT–II

Fundamentals of Maintenance Engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT–III

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

UNIT–IV

Fault Tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, Electrical motors, Types of faults in machine tools and their general causes.

UNIT–V

Periodic and Preventive Maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Suggested Reading:

1. H. P. Garg, Maintenance Engineering, S. Chand and Company, 1987
2. Audels, Pump-hydraulic Compressors, Mcgraw Hill Publication
3. Higgins & Morrow, Maintenance Engineering Handbook, McGraw Hill Higher Education, 3rd edition, 1977
4. Winterkorn, Hans, Foundation Engineering Handbook, Van Nostrand Reinhold, 2016
5. Mishra, R. C. & Pathak K,Maintenance Engineering And Management , Second Edition, PHI, 2012

With effect from academic year 2021-22

OE 943

OPERATIONS RESEARCH
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Course Objectives

- *To understand the dynamic programming to solve problems of discrete and continuous variables*
- *To apply the concept of non-linear programming and carry out sensitivity analysis*
- *To understand deterministic and probabilistic inventory control models.*

Course Outcomes

After the completion of this course, the students shall be able to:

1. To understand the basics of OR, including mathematical modeling, feasible solutions and optimization
2. Able to carry out sensitivity analysis
3. Apply PERT/CPM in project management
4. Select appropriate inventory control model
5. Able to apply dynamic programming and understand the concept of non-linear programming

UNIT I

Development, Different Phases, Characteristics, Operations Research models and applications.

Linear Programming Problem:

Introduction, Basic Assumptions, Formulation, graphical method, simplex method :Big M and Two Phase method.

UNIT II

DUALITY: duality theory, primal-dual relationships, Economic interpretation, Dual simplex method, Post optimal or sensitivity analysis,

UNIT III

Project Management:

Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.

Inventory models – Economic order quantity models – Quantity discount models – Stochastic inventory models – Multi product models – Inventory control models in practice.

UNIT IV

Sequencing Models : Introduction, General assumptions, processing n jobs through 2 machines, processing 'n' jobs through m machines

Game Theory:

Introduction, Characteristics of Game Theory, Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods

Nonlinear programming problem: - Kuhn-Tucker conditions

UNIT V

Queueing models - Queueing systems and structures – Notation parameter – Single server and multi server models – Poisson arrivals – Exponential service times – with finite population – Infinite population .

Dynamic Programming: Characteristics, principle of optimality, deterministic problems.

Suggested Reading:

1. Hamdy, A. Taha, Operations Research – An Introduction, Seventh Edition, Prentice Hall of India Pvt. Ltd., 2002.
2. Ronald L. Rardin, Optimization in Operations Research, First Indian Reprint, Pearson Education Asia, 2002
3. R. Paneerselvam, Operations Research, Prentice Hall of India Private Ltd., 2002.
4. Singiresu S. Rao, Engineering Optimization Theory of Practice, 3rd edition, New Age
5. International (P) Ltd. Publishers, 2013
6. S.C. Sharma, Operations Research, Discovery Publishing House, 2006
7. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008

With effect from academic year 2021-22

OE 944

COST MANAGEMENT OF ENGINEERING PROJECTS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- Introduce the concepts of cost management, inventory valuation , decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Course Outcomes:

1. Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
2. Ability to appreciative detailed engineering activities of the project and execution of projects
3. Preparation of project report and network diagram
4. Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
5. Applications of various quantitative techniques for cost management

UNIT I

Introduction and Overview of the Strategic Cost Management Process-Cost concepts in decision-making; relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System- Inventory valuation- Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

UNIT III

Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems- Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector-Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints- Activity-Based Cost Management,

Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets- Performance budgets- Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V

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

Suggested Reading :

1. Charles T. Horngren, Srikant M. Datar, Madhav V. Rajan, Cost Accounting A Managerial Emphasis, Prentice Hall, 2012
2. Robert S. Kaplan, Anthony A. Atkinson , Advanced Management Accounting, Pearson; 3rd edition 1998
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, Pearson Education, 1994
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting, PHI, 2012
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co.Ltd,2008

With effect from academic year 2021-22

OE 945

COMPOSITE MATERIALS
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *Study the concepts of composite construction.*
- *Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.*
- *Apply the concepts for design of multi-storey composite buildings.*
- *Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.*

Course Outcomes:

1. *Understand the fundamentals of composite construction, and analysis and designs of composite beams.*
2. *Analyse and design the composite floors*
3. *Select suitable materials for composite columns,*
4. *Analyse composite trusses and understand connection details.*
5. *Analyse and design the multi-storey composite buildings*

UNIT-I

Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.

Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

UNIT-II

Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

UNIT-III

Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

UNIT-IV

Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

UNIT-V

Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1. R.P. Johnson, "Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings", Blackwell Publishing, Malden, USA, 2004.
2. "INSDAG Teaching Resources for Structural Steel Design", Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3. "INSDAG Handbook on Composite Construction – Multi-Storey Buildings", Institute for Steel Development and Growth Publishers, Calcutta, India.
4. "INSDAG Design of Composite Truss for Building", Institute for Steel Development and Growth Publishers, Calcutta, India.
5. "INSDAG Handbook on Composite Construction – Bridges and Flyovers", Institute for Steel Development and Growth Publishers, Calcutta, India.
6. IS: 11384-1985, "Code of Practice for Composite Construction in Structural Steel and Concrete", Bureau of Indian Standards, New Delhi, 1985.

With effect from academic year 2021-22

OE 946

WASTE TO ENERGY
(OPEN ELECTIVE)

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

- *To know the various forms of waste*
- *To understand the processes of Biomass Pyrolysis.*
- *To learn the technique of Biomass Combustion*.

Course Outcomes: *Upon completing this course, students will be able to:*

1. *Understand the concept of conservation of waste.*
2. *Identify the different forms of wastage.*
3. *Chose the best way for conservation to produce energy from waste.*
4. *Explore the ways and means of combustion of biomass.*
5. *Develop a healthy environment for the mankind.*

UNIT-I:

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

UNIT-II:

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

UNIT-III:

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-IV:

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT-V:

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion

anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading:

1. Desai, Ashok V, Non-Conventional Energy, Wiley Eastern Ltd., 1990
2. Khandelwal, K. C. and Mahdi, S. S, Biogas Technology - A Practical Hand Book, Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983
3. Challal, D. S., Food, Feed and Fuel from Biomass, IBH Publishing Co. Pvt. Ltd., 1991
4. C. Y. WereKo-Brobby and E. B. Hagan, Biomass Conversion and Technology, John Wiley & Sons, 1996
5. JingzhengRen, Waste-to-Energy, Elsevierm 2020

With effect from academic year 2021-22

ME281

MAJOR PROJECT PHASE-I

Instruction: 20 periods per week *Duration of SEE: --*
CIE: 100 marks *SEE: --*
Credits : 10

Objectives:

- Understand the purpose of Project work
- Learn the resources available at the college and outside for pursuing project
- Importance of literature review
- Learn to select appropriate software and procedure
- Learn to document results and arrive at required conclusions

Course outcomes: After completion of the course student will be able to

1. Identify suitable engineering problems reviewing available literature.
2. Study different techniques used to analyze complex systems.
3. Use related techniques and software's for solving the problem
4. Interpret the results and arrive at the relevant conclusions and defend work in front of technically qualified audience
5. Document the findings as a technical report with proper references

Guidelines

1. The Major Project Phase I Work 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.
2. Seminar should be based on the area in which the candidate has undertaken the dissertation work as per the common instructions for all branches of M.E..
3. The examination shall consist of the preparation of report consisting of a detailed problem statement and a literature review.
4. The preliminary results (if available) of the problem may also be discussed in the report.
5. The work has to be presented in front of the examiners panel set by Head and Faculty Advisor.
6. 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.

With effect from academic year 2021-22

SEMESTER- IV

ME282

MAJOR PROJECT PHASE - II

Instruction: 32 periods per week *SEE: 200 marks*

Credits : 16

Course Objectives:

- *Understand the purpose of doing project work*
- *Learn the resources available at the college and outside for pursuing project*
- *Importance of literature review*
- *Learn to select appropriate software and procedure*
- *Learn to document results and arrive at required conclusions*

Course outcomes: After completion of the course student will be able to

1. Use different experimental techniques & software/ computational/analytical tools
2. Design and develop an experimental set up/ equipment/test rig.
3. Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analyzing them.
4. Work in either in research environment or in an industrial environment and Conversant with technical report writing.
5. Present and defend their choice of topic of study to the evaluation committee.

Guidelines

1. It is a continuation of Major Project Phase I work started in semester III.
2. The dissertation should be presented in standard format as provided by the department.
3. 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) adopted & Result analysis.
4. The report must bring out the conclusions of the work and future scope for the study and also should be properly referenced.
5. Student has to submit the report in prescribed format and also present a seminar.
6. Student should present a Seminar in front of Internal committee consisting of Head, CBoS, Guide, Subject expert, Faculty Advisor. Further the suggestions of the committee have to be incorporated in the final Report.
7. The final work has to be presented in front of the examiners panel consisting of an approved external examiner, an internal examiner and a guide, co-guide etc. as decided by the Head and Faculty Advisor.
8. The candidate has to be in regular contact with his/her guide.