GOVERNMENT COLLEGE OF ENGINEERING, JALGAON

Scheme for Semester I of M. Tech. (MECH) (Heat Power) - with effect from academic year 2020-21

Course Code	Name of the Course	Teaching Scheme Hrs/Week				Evaluation Scheme						Credit
						Theory			Practical		Total	
		L	T	P	Total	ISA	MSE	ESE	ICA	ESE		
ME501P	Advanced Heat Transfer	3	--	--	3	10	30	60	--	--	100	3
ME502P	Advanced Mathematics and Numerical Methods	3	--	--	3	10	30	60	--	--	100	3
ET503P	Advanced Thermodynamics and gas dynamics	3	--	--	3	10	30	60	--	--	100	3
ME504P	Advanced Fluid Mechanics	3	--	--	3	10	30	60	--	--	100	3
ME505P	Elective I	3	--	--	3	10	30	60	--	--	100	3
ME506P	Laboratory Practice-I	--	--	2	2	--	--	--	25	25	50	2
ME507P	Seminar I	--	--	2	2	--	--	--	50	--	50	1
Total		**15**	**--**	**04**	**19**	**50**	**150**	**300**	**75**	**25**	**600**	**18**

L: Lecture T: Tutorial P: Practical ISA: Internal Sessional Assessment
MSE: Mid Semester Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Note: 1. ESE (TH) duration for all theory courses is three hours.
2. MSE (TH) duration for all theory courses is two hours

Elective I

A Energy Conservation and Management
B Finite Element Analysis
C Solar Energy Technology
D Refrigeration and cryogenics

ME501P. Advanced Heat Transfer

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Heat Transfer and modes of Heat Transfer. Desirable awareness/skills: Fundamental knowledge of Physics and Engineering Thermodynamics.

Course Objectives:-
The students are expected to understand the subject of Heat Transfer in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
On completion of this course student should be able to:

1. develop knowledge of heat transfer and statistical tools used in it.
2. helped to understand the various functions of heat transfer systems along with its types.
3. understand advanced heat transfer limits
4. define mode heat transfer

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1		2		3			1					1	-	-
CO 2			2										-	-	-
CO 3	1				3								-	-	1
CO 4		2				3			2				-	-	-

1- Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

Conduction Heat Transfer :-
Introduction, Factors affecting thermal conductivity of solids, liquids & gases, General three dimensional heat conduction equation in Cartesian, Cylindrical & spherical coordinates, Initial condition and various boundary conditions. Heat source systems, Critical thickness of insulation. Different types of fins & their analysis, Two -dimensional steady state conduction. Electrical analogy ,Graphical & numerical methods. Transient heat conduction with & without temperature gradients within the system, Heat flow in semi infinite solids. Application of Heisler charts.

Convective Heat Transfer:-
Free & forced convection, Similarity & simulation of convection heat transfer, Boundary layer theory.Turbulent flow heat transfer. Analogy between momentum & heat transfer. Heat transfer with liquid metals. Heat transfer in high velocity flow. Recent development s in the theory of turbulent heat transfer. Natural convection under different situations. Empirical relations in convection heat transfer.

Boiling & condensation:-
Regimes of boiling heat transfer. Heat transfer in condensation. Drop wise & film condensation. Empirical equations.

Radiation Heat Transfer :-

Radiation heat transfer properties. Laws of thermal radiation. Shape factors. Radiation heat transfer between black, diffuse & gray surface. Electrical network method of solving radiation problems. Radiosity approach. Gas emission & absorption, Bulk radiations.

Note for paper setter/ examiners.

Use of Heat Transfer Data Book is allowed to students during examination.

Reference Books :-

1. J.P.Holman, “Heat Transfer”, McGraw Hill Book Co. Special Indian 9th Edition, 2008.
2. Oziski, M. N. “Heat Transfer – A Basic Approach”, McGraw Hill, N. Y., 2001.
3. S.P.Sukhatme, “Heat Transfer”, Orient Longman, 2001.
4. Incropera & Hewitt, “Fundamentals of Heat and Mass Transfer”, John Wiley , 2000

ME502P. Advanced Mathematics and Numerical Methods

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-

The course aims at imparting knowledge of Numerical methods and advanced mathematics. Desirable awareness/skills: Fundamental knowledge Engineering Mathematics.

Course Objectives:-

The students are expected to understand the subject of Numerical methods in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-

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

1. analyse and develop the mathematical model of thermal system.
2. analyse the reliability and maintainability of the series and parallel thermal system.
3. solve differential equations using numerical techniques.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		1		2			1					1	-	-
CO 2	1		2				3						-	-	-
CO 3		2			1								-	-	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

Ordinary Differential Equations:
First-order equations (Linear, Equi dimensional, Separable, Exact, Homogeneous,); Second-order linear differential equations (homegeneous and non homogeneous); Solution methods such as undetermined coefficients and variation of parameters.

Partial Differential Equations:
First order partial differential equations; Second order linear partial differential equations; Canonical forms; Fourier series, Second order equations (Parabolic, Elliptic and Hyperbolic) in rectangular, cylindrical polar and spherical coordinate systems; Solution techniques such as separation of variables, eigen function expansions, integral transforms (Fourier and Laplace transforms); D'Alembert's solution for the Wave equation; Maximum principle for Elliptic equations; Variational methods for approximate solutions of differential equations.

- Standard discrete and continuous distributions like Binomial, Poisson, and Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.

ANOVA:
One – way, Two – way with/without interactions, Latin Squares ANOVA technique, Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD. Some of the relevant topics required for ANOVA (sample estimates and test hypothesis) may also be included.

Reference Books

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

ME503P. Advanced Thermodynamics and gas dynamics

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of advanced thermodynamics and gas dynamics. Desirable awareness/skills: Fundamental knowledge of Physics and Engineering Thermodynamics.

Course Objectives:-
The students are expected to understand the subject of advanced thermodynamics and gas dynamics in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
On completion of this course student should be able to:

1. develop knowledge of gas dynamics and statistical tools used in it.
2. helped to understand the various functions of thermodynamics and gas systems along with its types.
3. understand concept of all important gases.
4. explain all theories related to thermodynamic

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2		1			2					1	-	-
CO 2			1				3						-	-	-
CO 3	1				3								-	-	1
CO 4		3				1			2				-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:-
Thermodynamics Relations:- Mathematical theorems, Maxwell relations, T-ds equations, Energy Equations, General Relations involving internal energy, enthalpy & entropy, Thermodynamics Relations involving specific heat , Clapeyron equation, Joule Thomson Coefficient, Developing Tables of Thermodynamics properties from experimental data. **Real Gases: -** Deviation from ideal gas behavior, equation of state for real gases, reduced properties, Generalizes equation of state, laws of corresponding states, Generalized compressibility charts, enthalpy deviation and entropy deviation charts and their applications, P-V-T surfaces of real substances, Fugacity and activity.

Kinetic Theory of Gases:- Postulates, concept of elastic collisions and mean free path, Derivation of ideal gas laws from kinetic theory, Distribution of molecular velocities, Maxwellion speeds and temperature, Law of equi partition of energy, Survival equation, Transport phenomenon. **Statistical Thermodynamics**:- Fundamental Principles, Equilibrium distribution, Significance of Lagrangian Multipliers λ & β, Partition function, Equipartition of energy, Distribution of speeds in an Ideal monatomic gas, Statistical Interpolation of Work and Heat, Entropy & Information.

Mixtures and Solutions:- Dalton Model , Amagat Model, Simplified model of a mixture involving gases and a vapour, First law applied to Gas-Vapour mixtures, Adiabatic saturation process, Partial

Molar properties, change in properties upon mixing, Thermodynamic properties relations for variable composition, Gibbs function and Enthalpy, Fugacity in a mixture, Ideal solution, Activity and Activity coefficient. **Chemical Reactions**: - Combustion process, Theoretical and actual combustion processes, Enthalpy of formation, Enthalpy of combustion, First law analysis of Reacting systems, Adiabatic flame temperature Enthalpy and internal energy of combustion, Entropy change of Reacting systems, Heat of reaction, Second law Analysis of Reacting systems, Evaluation of Actual combustion processes.

Compressible Flow: One-dimensional Flow: speed of sound, variable cross-section flow, converging diverging nozzle, effect of friction and heat transfer, normal shock relations, Introduction to oblique shocks, 2-dimensional flows(subsonic and supersonic) past slender bodies, compressible boundary layers.

Gas Dynamics: Fundamentals thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves ; normal shock recovery ; detached shocks ; Aerofoil theory.

REFERANCE BOOKS :-

1. V. Wylen & E. Sonntag. “Fundamentals of Classical Thermodynamics” Wiley Eastern Limited, New Delhi,
2. J. P. Holman, “Thermodynamics”, McGraw Hill, London.
3. Adrian Bejan, George T., Michael Moran, “Thermal Design and Optimization” John Willey and Sons, Inc., pp 113-127, 1996.
4. T.J. Kotas, “The Energy Method of Thermal Plant Analysis”, Butterworth, 1985
5. J.L. Thrdkeld, “Thermal environmental engineering”, Prentice Hall, Inc. New Jersy. 1970
6. M.W. Zemansky, “Heat and Thermodynamics”,
7. M.L. Mathur & S.C. Gupta, “Thermodynamics for Engineers”, Dhanpatrai and Sons Ltd., New Delhi.
8. Howell & Duckins, “Fundamentals of Engineering Thermodynamics”.
9. Lee-Sears, “Engineering Thermodynamics”.
10. N.A. Chigier, Energy Combustion and Environment –McGraw-Hill 1981
11. A. Murthy Kanury, Gordon and Breach, Introduction to combustion phenomena,1975
12. S. P. Sharma and Chandra Mohan, Fuels and combustion –Tata McGraw –Hill. 1984.
13. F.M. White, Fluid Mechanics, , McGraw Hill Int.

ME504P. Advanced Fluid Mechanics

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of advanced fluid mechanics. Desirable awareness/skills: Fundamental knowledge of Physics and Fluid mechanics.

Course Objectives:-
The students are expected to understand the subject of Fluid dynamics in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
On completion of this course student should be able to:

1. develop knowledge fluid dynamics and statistical tools used in it.
2. helped to understand the various functions of fluid dynamics systems along with its types.
3. understand laminar boundary layer, potential theory, turbulent flow and CFD.

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RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3					2					1	-	-
CO 2	2			1			3						-	-	-
CO 3	1				3								-	-	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:
Basic Concepts: Types of fluids and basic equations of flow, basic concepts in laminar and turbulent flows. Equations Governing Fluid Motion : Navies stokes equations, Boundary layer equations. Exact solutions of N-S equations, Flow between concentric rotating cylinders, parallel flow of a powder - law fluid.
Potential Theory: Kelvin's theorem, source, sink, vortex and doublet, development of complex potentials by super position, conformal transformation thin airfoil theory.
Laminar Boundary Layers: Blasius solution, Boundary -layers with non-zero pressure gradient, separation and vortex shedding.
Turbulent Flow : Mechanism of turbulence, derivation of governing equations for turbulent flow, K-E model of turbulence, universal velocity distribution law and friction factor, kinetic energy of the mean flow and fluctuations, re-laminarization.
Experimental Techniques: pressure tubes, thermal anemometers, laser – Doppler anemometers, P_I velocimeter.
Computational Fluid Dynamics: Philosophy of CFD, governing equations, thin derivation and physical meaning, mathematical behaviour of P.D.E. and thin impend on CFD, Finite difference scheme, grid generation and transformation. Introduction to FEM and finite volume method.

Reference Books:

1. H. Schlichting, "Boundary layer Theory", McGraw Hill, 1987.
2. Jo. Hinze, "Turbulence", McGraw Hill, 1975.
3. P. Bradshaw, "Turbulence", Springer -Verleg, 1976.
4. Anderson, Tamehill and Pletcher, "Computational Fluid Mechanics and Heat Transfer", Hemispher Pub. Co., 1984.
5. K. Muralidhar and T. Sunderajan, "Computational Fluid Flow and Heat Tra nsfer", Narosa Pub. House, New Delhi, 1997.

ME505P.A. Energy Conservation and Management

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Energy conservation and its management. Desirable awareness/skills: Fundamental knowledge of Physics and Management.

Course Objectives:-
The students are expected to understand the subject of Energy conservation and its management in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
On completion of this course student should be able to:

1. Develop knowledge Energy management and statistical tools used in it.
2. Helped to understand the various functions of Energy Conservation systems along with its types.
3. Define importance of energy management, energy economics and coversion
4. Analyse critical problem in all domain of energy.
5. Solve problem related to demand control and load scheduling

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2					1					1	-	-
CO 2			1				3						-	-	-
CO 3	1			3									-	-	1
CO 4		1				1			2				-	-	-
CO 5	1		2		3		1						-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content
The energy market, sources of world energy, exhaustible and renewable / inexhaustible sources, energy scenario in India, energy planning, utilization pattern and future strategy, Energy conservation Act 2003.

Importance of energy management. Energy auditing: methodology analysis of post trends (plant data), closing the energy balance, laws of thermodynamics, measurements, portable and online instruments.

Energy economics – discount rate, payback period, and internal rate of return, life cycle costing.
Steam Systems : Boiler-efficiency testing, excess air control, steam distribution and use of steam traps, condensate recovery, flash steam utilisation, thermal insulation.

Electrical Systems: Demand control, power factor correction, load scheduling / shifting, motor drives – motor efficiency testing, energy efficient motors, motor speed control. Demand side management, Electricity Act 2001.
Lighting: Lighting levels, efficient options, fixtures, day lighting, timers, energy efficient windows.

Energy conservation in pumps, furnaces, fans, compressed air systems, refrigeration and air-conditioning systems. Waste heat recovery: recuperators, heat wheels, heat pipes, heat pumps.
Cogeneration: Concept options (steam / gas / turbine / diesel engine bases), selection criteria, control strategy.

Reference Books :

1. Energy Management Hand book by W.C. Turner (Ed)
2. Management by H.Koontz and Cyrill O Donnell
3. Financial Management by S.C. Kuchhal
4. Energy Management by W.R.Murthy and G.Mc Kay
5. Energy Management Principles by CB Smith.

ME505P.B. Finite Element Analysis

Teaching Scheme: 03L, **Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Energy conservation and its management. Desirable awareness/skills: Fundamental knowledge of Physics and Management.

Course Objectives:-
The students are expected to understand the subject of Energy conservation and its management in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
On completion of this course student should be able to:

1) obtain an understanding of the fundamental theory of the FEA method;
2) develop the ability to generate the governing FE equations for systems governed by partial differential equations;
3) understand the use of the basic finite elements for structural applications using truss, beam,frame, and plane elements; and
4) understand the application and use of the FE method for heat transfer problems.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1		3		1			2					1	-	-
CO 2		2				1							-	-	-
CO 3	2				3								-	-	1
CO 4		1	3			2							-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

One –Dimensional problems

Introduction, Finite Element Modeling, Coordinates and Shape Functions, The Potential- Energy Approach, The Galerkin Approach, Assembly of the Global Stiffness Matrix and Load vector, Properties of K, The Finite Element Equations; Treatment of Boundary Conditions, Quadratic Shape Functions, Temperature Effects. **Trusses:** Introduction, Plane Trusses, Three-Diamensional Trusses, Assembly of Global Stiffness Matrix for the Banded and Skyline solutions.

Two-dimensional problems using constant strain triangles

Introduction, Finite Element Modeling, Constant-Strain Triangle, Problem Modeling and Boundary Conditions, Orthotropic Materials.**Axis symmetric solids subjected to axis symmetric loading**

Introduction, Axis symmetric Formulation, Finite Element Modeling: Triangular Element, Problem Modeling and Boundary Conditions.

Two-dimensional isoparametric elements and numerical integration

Introduction , The Four-Node Quadrilateral, Numerical Integration, Higher Order Elements, Four-Node Quadrilateral for Axisymmetric Problems, Conjugate Gradient Implementation of the Quadrilateral Element.

Beams and frames

Introduction, Finite Element Formulation, Load Vector, Boundary Considerations, Shear Force and Bending Moment, Beams on Elastic Supports, Plane Frames, Three-Dimensional Frames, Some Components.

Three-dimensional problems in stress analysis

Introduction, Finite Element Formulation, Stress Calculation, Mesh Preparation, Hexahedral Elements, and Higher Order Elements, Problem Modeling, Frontal Method for Finite Element Matrices.

Scalar field problems

Introduction, Steady State Heat Transfer, Torsion, Potential Flow, Seepage, Electric and Magnetic Fields, and Fluids Flow in Ducts.

Dynamic considerations

Introduction, Formulation, Element Mass Matrices, Evaluation of Eigen values and Eigenvectors, Interfacing with Previous Finite Element Programs and a Program for Determining Critical Speed of Shafts, Guyan Reduction, Rigid Body Modes.

Reference Books:

1) J.N. Reddy, an Introduction to Nonlinear Finite Element Analysis, OUP.
2) C.S.Krishnamoorthy.,Finite element analysis TMH
3) J.N.Reddy, Finite element methods,Mc graw hill publition ltd.
4) Robert Cook, Concept an application of Finite element analysis
5) Klaus-Jurgen Bhate, finite element analysis, PHI
6) C.S. Desai and J.F.Abel.,Introduction to finite element methods ,CBS
7) Tirapati R. Chandrupatla and Belegundu, Finite element analysis by, PHI.
9) Kenneth Lt. Huebner," The FEM for Engineers", Wiley India Pvt.Ltd. New Delhi

ME505P.C. SOLAR ENERGY TECHNOLOGY

Teaching Scheme: 03L, **Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-

The course aims at imparting knowledge of Solar Energy and its technological developments. Desirable awareness/skills: Fundamental knowledge of Physics.

Course Objectives:-

The students are expected to understand the subject of Solar Energy and its technological developments in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-

On completion of this course student should be able to:

1. Develop knowledge Solar Energy management and statistical tools used in it.
2. Helped to understand the various functions of Solar Energy systems along with its types.
3. Explain concept of capturing solar radiation and direct energy conversion.
4. Design of solar water heating system for particular application.
5. Understand principles of economics analysis.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1		3		1			1					1	-	-
CO 2		1				1							-	-	-
CO 3					3				2				-	-	1
CO 4			2			2							-	-	-
CO 5	2			1									-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications. **Capturing solar radiation** – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

Design of solar water heating system and layout

Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system Power cycles, working fluids and prime movers.

Thermal energy storage – Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction –

application and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration.

Direct energy conversion – solid-state principles – semiconductors – solar cells – performance – modular construction – applications.

Economics – Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

Reference Books:

1. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, New York, Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.
2. M. Stix, The Sun, An Introduction, Second Edition, Springer 2002.
3. Nelson, The Physics of Solar Cells. Imperial College Press, 2003.
4. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.
5. Sukhatme S.P., Solar Energy, Tata McGraw Hills P Co., 3rd Edition, 2008.
6. B.G. Streetman and S. Banerjee, Solid State Electronic Devices, Sixth Edition, Prentice Hall,2006.

ME505P.D. Refrigeration and Cryogenics

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Refrigeration and cryogenically developments. Desirable awareness/skills: Fundamental knowledge of Physics.

Course Objectives:-
The students are expected to understand the subject of Refrigeration and its technological developments in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
At the end of the course, students will demonstrate the ability:

1. learn the basics of refrigeration and cryogenics and its application area.
2. design the refrigeration systems for domestic and industrial applications like cold storages.
3. explain about ODP, GWP and related environment issues.
4. solve problem on VBR and single and double effect system and compressors.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1			3						1			1	-	-
CO 2		2											-	-	-
CO 3			3			1						1	-	-	1
CO 4	1				2								-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

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

References:

1. R.J.Dossat, “Principles of Refrigeration”, Pearson Education Asia, 2001.
2. C.P.Arora, “Refrigeration and Air-conditioning”, Tata McGraw-Hill, 2000.
3. Stoecker & Jones, “Refrigeration and Air-conditioning”, McGraw Hill Book Company, New York, 1982.
4. Jordan & Priester, “Refrigeration and Air-conditioning”.

5. A.R.Trott, “Refrigeration and Air-conditioning”, Butterworths, 2000.
6. J.L.Threlkeld, “Thermal Environmental Engineering”, Prentice Hall, 1970.
7. R.Barron, “Cryogenic systems”, McGraw–Hill Company, New Yourk, 1985.
8. G.G.Hasseldon. “Cryogenic Fundamentals”, Academic Press.
9. Bailey, “Advanced Cryogenics”, Plenum Press, London, 1971.
10. W.F.Stoecker, “Industrial Refrigeration Handbook”, McGraw-Hill, 1998.
11. John A.Corinchock, “Technician’s Guide to Refrigeration systems”, McGrawHill.
12. P.C.Koelet, “Industrial Refrigeration: Principles, Design and Applications”, Macmillan, 1992.
13. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration.

ME506P Laboratory Practice-I

Practical's – 02 hours/week. **Credit :2**
Examination Scheme:-ICA 50 **Total Marks: 50**

Experiments/Assignments based on sr.no 1 to 3 subjects for Experimental work and sr.no. 4 to 6 two subjects for Assignments based on syllabi of following courses:

1. ME501P: Advanced Heat Transfer

Assignments: **(Any Four)**

1. Heat pipes
2. Numerical method in heat conduction & convection.
3. Combined heat transfer.
4. Passive heat transfer augmentation techniques.
5. Electronic cooling
6. One problem on network method (Radiation).
7. Heat transfer during melting and solidification.

2. ME504P : Advanced Fluid Mechanics

*** All experiments should be performed using suitable CFD Software**

1. Flow over a cylinder/sphere at different Re. Pressure variation over the body and drag estimation.
2. Flow past an aerofoil: Pressure measurements, calculation of lift.
3. Flow through a converging-diverging nozzle: subsonic and supersonic flows.
4. Friction factor determination: incompressible flow through pipes/ducts of variable cross- section.
5. Laminar/Turbulent boundary layer over a flat plate.

3. ME505P.B. Finite Element Analysis

Using analysis software like Ansys / Nastran / LS-DYNA/ Abacus / any suitable software perform the following practical (Any four):

1. Analysis of 2D truss
2. Analysis of 2D frame
3. Analysis of any one machine component .
4. Analysis of composite Structure.
5. Finding analysis results for 2D truss & 2D frame using MATLAB

4.ME505P.A. Energy Conservation and Management

Assignment Work :

1) Application of energy conservation technique to one equipment such as aircompressor, air conditioning systems, furnace, etc.
2) Report based on industrial visit for study of energy audits, energy conservation methods.
3) Design of waste heat recovery system.

5. ME502P. Advanced Mathematics and Numerical Methods
6. ME505P.D. Refrigeration and Cryogenics

Guide lines for ICA:

Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (Journal And sheet) based on practical performed by him/her. The performance shall be assessed experiment wise on regular basis.

Guide Lines for ESE:

Oral will be based on content of syllabus and practical.

ME507P Seminar I

Practical's – 02 hours/week. **Credit :1**
Examination Scheme :-ICA 50 **Total Marks: 50**

Seminar-I should be based on the literature survey on any topic relevant to Thermal Engineering. It may be leading to selection of a suitable topic of dissertation. Each student has to prepare a write-up of about 25 pages.

The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department. The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory

GOVERNMENT COLLEGE OF ENGINEERING, JALGAON

Scheme for Semester II of M. Tech. (MECH) (Heat Power) - with effect from academic year 2020-21

Course Code	Name of the Course	Teaching Scheme Hrs/Week				Evaluation Scheme						Credit
						Theory			Practical		Total	
		L	T	P	Total	ISA	MSE	ESE	ICA	ESE		
ME551P	Design of Heat Exchanger	3	--	--	3	10	30	60	--	--	100	3
ME552P	Computational Fluid Dynamics	3	--	--	3	10	30	60	--	--	100	3
ME553P	Modelling of IC Engines	3	--	--	3	10	30	60	--	--	100	3
ME554P	Measurement Techniques And Data Analysis	3	--	--	3	10	30	60	--	--	100	3
ME555P	Elective II	3	--	--	3	10	30	60	--	--	100	3
ME556P	Laboratory Practice-II	--	--	2	2	--	--	--	25	25	50	2
ME557P	Seminar II	--	--	2	2	--	--	--	50	--	50	1
	Total	**15**	**--**	**04**	**19**	**50**	**150**	**300**	**75**	**25**	**600**	**18**

L: Lecture T: Tutorial P: Practical ISA: Internal Sessional Assessment
MSE: Mid Semester Examination ESE: End Semester Examination ICA: Internal Continuous Assessment

Note: 1. ESE (TH) duration for all theory courses is three hours.
2. MSE (TH) duration for all theory courses is two hours

Elective II

A Non conventional power plant
B Design of Solar and Wind System
C Gas Turbines
D Equipment design for thermal Systems

ME 551P Design of Heat Exchanger

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Heat exchanger developments. Desirable awareness/skills: Fundamental knowledge of Heat Transfer.

Course Objectives:-
The students are expected to understand the subject of Heat Transfer and its technological developments in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
After successful competition of this course students will be able to:

1. demonstrate a basic understanding of several types of heat exchangers that will include shell-and-tube, double pipe, plate-and-frame, finned tube, and plate-fin heat exchangers, Heat pipes.
2. design and analyses of shell-and-tube double pipe, compact, plate heat exchangers**.**
3. demonstrate the performance degradation of heat exchangers subject to fouling.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1		2		3			1					1	-	-
CO 2			2										-	-	-
CO 3	1				3								-	-	1

1- Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

1. **Heat Exchangers** – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger.

2. **Heat exchanger design methodology**, assumption for heat transfer analysis, problem formulation, e-NTU method, *P*-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling.

3. **Double Pipe Heat Exchangers:** Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop

4. **Compact Heat Exchangers:** Thermal and Hydraulic design of compact heat exchanger Shell and Tube heat exchangers – Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers

5. **Mechanical Design of Heat Exchangers** – design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such

as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

References:

1. Ramesh K. Shah and Dusan P. Sekulic, “Fundamentals of Heat Exchanger Design” John Wiley & sons Inc., 2003.
2. D.C. Kern, “Process Heat Transfer”, McGraw Hill, 1950.
3. Sadik Kakac and Hongton Liu, “Heat Exchangers: Selection, Rating and Thermal Design” CRC Press, 1998.
4. A .P. Frass and M.N. Ozisik, “Heat Exchanger Design”, McGraw Hill, 1984
5. Afgan N. and Schlinder E.V. “Heat Exchanger Design and Theory Source Book”.
6. T. Kuppan, “Book of Heat Exchanger Design”.
7. “T.E.M.A. Standard”, New Hand York, 1999.
8. G. Walkers, “Industrial Heat Exchangers-A Basic Guide”, McGraw Hill, 1982.

ME 552P. Computational Fluid Dynamics

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Fluid dynamics developments. Desirable awareness/skills: Fundamental knowledge of Heat Transfer.

Course Objectives:-
The students are expected to understand the subject of Fluid dynamics and its technological developments in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

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

1. understand the subject of Computational Fluid Dynamics and know how to use it as tool.
2. solve the Heat Transfer and Fluid Mechanics related Industrial Problems.
3. create the base and interest among the students to carry out the Future Research.
4. Provide the student with a significant level of experience in the use of modern CFD software for the analysis of complex fluid-flow systems.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2			2		3		1					1	-	-
CO 2		1									1		-	-	-
CO 3			2					1					-	-	1
CO 4	1					1			1				-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

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

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

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

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

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

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

References:

1. Computational Fluid Dynamics, The Basic with applications by John A. Anderson, Jr., McGraw Hill International editions, Mechanical Engineering series,1998.
2. Numerical Methods in Fluid Flow & Heat Transfer by Dr. Suhas Patankar,2001.
3. An Introduction to Computational Fluid Flow (Finite Volume Method), by H.K. Versteeg, W.Malalasekera, Printice Hall,2005
4. Computational Methods for Fluid Dynamics by Ferziger and Peric, Springer Publication,2001
5. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow, Wiley Publication,2004.

ME553P. Modelling of IC Engine

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-

The course aims at imparting knowledge of Fluid dynamics developments. Desirable awareness/skills: Fundamental knowledge of Heat Transfer.

Course Objectives:-

The students are expected to understand the subject of Fluid dynamics and its technological developments in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-

After successful competition of this course students will be able to:

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

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO 1	1			3		1		1					1	-	-
CO 2	2									1			-	-	-
CO 3			3			2		1					-	-	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

Fundamentals:

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

Thermodynamic Combustion Models of CI Engines:

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

Fuel spray behavior:

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

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

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

References:

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

ME554P. Measurement Techniques and Data Analysis

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Measurement techniques. Desirable awareness/skills: Fundamental knowledge of Metrology.

Course Objectives:-
The students are expected to understand the subject of Measurement and its technological developments in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
After successful competition of this course students will be able to:

1. demonstrate a basic understanding of several types of Measurement Systems .
2. develop data analysis for various systems.
3. understand critical complex nature of controller system.
4. analyse data obtained from measurements system and interpreted it.
5. explain parameter estimation, regression analysis and co-relations.

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2		1		3					1		1	-	-
CO 2	1			2			1						-	-	-
CO 3	2										1		-	-	1
CO 4		3		1									-	-	-
CO 5	3		2			1			1						

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

1) **Introduction to measurements** for scientific and engineering application need and goal. Broad category of methods for measuring field and derived quantities.

2) **Principles of measurement**, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data.

3) **Measurement of field quantities**, thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration, measurement of the above by probe and non instructive techniques.

4) **Measurement of derived quantities**, torque, power, thermo physical properties, radiation and surface properties.

5) **Analytical methods** and pollution monitoring, mass spectrometry, chromatography, spectroscopy.

6) **Basics of P, PI, PID controllers**, pneumatic and hydraulic controllers, electronic controllers, applications to machine tools, furnaces, material handling etc.

Reference books :-

1) Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
2) Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House, New Delhi.
3) Liptak B.G. Instrument Engineers' Handbook.
4) Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
5) Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper.
6) Johnson C.D., Process Control Instrumentation.
7) J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, Seventh Edition.

Note: (* Question Paper- 50% to 60% of marks are kept for the quantitative questions)

ME 555A. Non-Conventional Power Plants

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Non Conventional power plants. Desirable awareness/skills: Fundamental knowledge of Thermodynamics.

Course Objectives:-
The students are expected to understand the subject of non conventional power plants in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
After successful competition of this course students will be able to:

1. define a basic understanding of several types of non conventional power systems .
2. understand Data analysis for various systems.
3. understand difference way to produce energy by unconventional energy sources: solar energy, wind energy, tidal energy, geothermal energy, nuclear fusion.
4. apply Special methods of energy production: fuel cells, MHD power plants.
5. understand Unconventional energy, transport ,accumulation and application:

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		1			1							1	1	-	-
CO 2	1		2		2		1		1				-	-	-
CO 3				1									-	-	1
CO 4	1		3		3					1			-	-	-
CO 5		2					1					1			

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.

Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal Conversion devices, Economics and social considerations, Design considerations of component selection.

Solar Radiation - estimation, prediction & measurement, Solar energy utilization, Performance of Solar flat plate collectors, concentrating collectors, thermal storage.

Wind energy: Wind energy potential measurement, wind electric generator component design, economics and demand side management, energy wheeling, and energy banking concepts.

Biogas: properties of biogas (Calorific value and composition), biogas plant technology and status.

Other plants: Fuel cell based power plants, tidal and wave energy plant design, OTEC Power plants.

Geothermal energy: hot springs and steam ejection site selection, power plants, and economics.

Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms.

REFRENCE BOOKS:-

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

ME 555B. Design of Solar and Wind System

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Solar and wind power plants. Desirable awareness/skills: Fundamental knowledge of Thermodynamics and heat transfer.

Course Objectives:-
The students are expected to understand the subject of Solar and wind power plants in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
After successful competition of this course students will be able to:

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

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		1			1							1	1	-	-
CO 2	1		2		2		1		1				-	-	-
CO 3				1									-	-	1
CO 4	1		3		3					1			-	-	-
CO 5		2					1					1			

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

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

References:

1. D.Y. Goswami, F. Kreith and J.F. Kreider, “Principle of Solar Engineering”, Taylor and Francis, 2000.
2. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.

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

ME555C. Gas Turbine

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Gas turbine power plants. Desirable awareness/skills: Fundamental knowledge of Thermodynamics and heat transfer.

Course Objectives:-
The students are expected to understand the subject of Gas turbine power plants in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
After successful competition of this course students will be able to:

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

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		1			1							1	1	-	-
CO 2	1		2		2		1		1				-	-	-
CO 3				1									-	-	1
CO 4	1		3		3					1			-	-	-
CO 5		2					1					1			

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

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

References:

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

ME555D. Equipment Design for Thermal Systems

Teaching Scheme: 03L**, Total:** 03 **Credit:** 03
Evaluation Scheme: 30 MSE + 10 ISA + 60 ESE **Total Marks:** 100
Duration of ESE:03Hrs

Course Description:-
The course aims at imparting knowledge of Equipment design. Desirable awareness/skills: Fundamental knowledge of Thermodynamics and heat transfer.

Course Objectives:-
The students are expected to understand the subject of Equipment design in detail with capability to solve Industrial Problems. This will also create the base and interest among the students to carry out the Future Research.

Course Outcome:-
After successful competition of this course students will be able to:

1. understand construction and design features Thermal system.
2. understand various types and its adoptability in the various environment and application areas.
3. analyse various health issues
4. design seasonal energy efficient system

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		1		2							1	1	-	-
CO 2						1			1				-	-	-
CO 3		3											-	-	1
CO 4	2			3		2				1			-	-	-

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:

Classification of heat exchangers:
Introduction, Recuperation & Regeneration – Tubular heat exchangers: double pipe, shell & tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin. Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD method for heat exchanger analysis – parallel flow, counter flow, multipass, cross flow heat exchanger design calculations.

Double Pipe Heat Exchanger:
Film Coefficient for fluids in annulus, fouling factors, calorific temperature, average fluid temperature, the calculation of double pipe exchanger, Double pipe exchangers in series-parallel arrangements.Shell & Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performance of 1-2 heat exchanger, and design calculation of shell & tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

Condensation of single vapors:
Calculation of a horizontal condenser, vertical condenser, De-super heater condenser, vertical condenser – sub-cooler, horizontal condenser – subcooler, vertical reflux type condenser, condensation of steam.

Vaporizers, Evaporators and Reboilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler. Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger

Direct Contact Heat Exchanger:
Cooling towers, relation between wet bulb & dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance, heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance.

TEXT BOOKS :

1. Process Heat Transfer – D.Q. Kern, TMH.
2. Cooling Towers by J.D. Gurney
3. Heat Exchanger Design – A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York.

ME556P Laboratory Practice-II

Practical's – 02 hours/week. **Credit: 02**
Evaluation Scheme: 50 ICA **Total Marks:** 50

Experiments/Assignments based on any Three subjects for Experimental work and two subjects for Assignments

1. ME 554P: Measurement Techniques And Data Analysis

List of experiments:-

1) Calibration of pressure gauge
2) Computer aided experimentation for temperature measurement.
3) Design of control system for boiler/compressor/pumps/turbines
4) Problem of analysis of data and error estimation.

2. ME 555A. Non-Conventional Power Plants

List of experiments:-

1. Visit to a biogas plant and its report.
2. Design of photovoltaic plant for agricultural applications.
3. Trial on solar concentrator/CPC/Evacuated Tube Collector system.
4. Analysis of a wind farm system.

3. ME552P. computational fluid dynamics (CFD).

The set of tutorials designed to provide the student with the necessary tools for using sophisticated commercial Ansys fluent CFD software. A set of laboratory tasks will take the student through a series of increasingly complex flow and heat transfer simulations, requiring an understanding of the basic theory of computational fluid dynamics (CFD).

4.ME555D. Equipment Design for Thermal Systems

5.ME553P. Modelling of IC Engine

6.ME551P.Design of Heat Exchanger

Guide lines for ICA:

Internal Continuous Assessment shall support for regular performance of practical and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (Journal And sheet) based on practical performed by him/her. The performance shall be assessed experiment wise on regular basis.

Guide Lines for ESE:

Oral will be based on content of syllabus and practical.

ME557P Seminar II

Practical's – 02 hours/week. **Credit: 01**
Evaluation Scheme: 50 ICA **Total Marks:** 50

Course Content:
Seminar-II should be based on the literature survey on any topic relevant to Thermal Engineering. It may be leading to selection of a suitable topic of dissertation. Each student has to prepare a write-up of about 25 pages.

The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department. The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory.

GOVERNMENT COLLEGE OF ENGINEERING, JALGAON

Scheme for Semester III of M. Tech. (MECH) (Heat Power) - with effect from academic year 2020-21

Course Code	Name of the Course	Teaching Scheme Hrs/Week				Evaluation Scheme						Credit
						Theory			Practical		Total	
		L	T	P	Total	ISA	MSE	ESE	ICA	ESE		
ME601P	Dissertation I	--	--	--*	--	--	--	--	100	50	150	10
ME602P	Intellectual Property Rights	1	1	--	2	--	--	--	50	--	50	02
ME603P	Research Methodology	3		--	3	--	--	--	50	--	50	03
Total		**02**	**02**	**--**	**04**	**--**	**--**	**--**	**200**	**50**	**250**	**15**

* Laboratory Work: 10 hours / week and Guide Contact: 4 Hours / Week

GOVERNMENT COLLEGE OF ENGINEERING, JALGAON

Scheme for Semester IV of M. Tech. (MECH) (Heat Power) - with effect from academic year 2020-21

Course Code	Name of the Course	Teaching Scheme Hrs/Week				Evaluation Scheme						Credit
						Theory			Practical		Total	
		L	T	P	Total	ISA	MSE	ESE	ICA	ESE		
ME651P	Dissertation II	--	--	--*	--	--	--	--	100	150	250	15
Total		**--**	**--**	**--**	**--**	**--**	**--**	**--**	**100**	**150**	**250**	**15**
Grand Total		--	--	--	--	**100**	**300**	**600**	**600**	**200**	**1800**	**66**

* Laboratory Work: 16 hours / week and Guide Contact: 5 Hours / Week

ME601P. Dissertation Phase-1

Practical's – 10 hours/week. **Credit: 10**
Evaluation Scheme: ICA-100 **ESE**-50 **Total Marks: 15**0

Course Content:
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.

In Dissertation – I, the student should present the progress report of the dissertation including problem statement, literature survey, project overview and scheme of implementation. Before the end of the semester, student shall submit one copy of progress report in the prescribed format, reporting the total work completed by him/her.

Phase – I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, and a record of continuous progress.

Phase – I evaluation: A committee comprising of guides of respective specialization shall assess the progress / performance of the student based on report, presentation and depth of understanding.

i. Internal Continuous Assessment (ICA)

- The ICA shall be evaluated by guide throughout the semester and by a departmental committee before the end of the semester appointed by the Head of Department.
- Guide shall judge the student on the basis of regularity, work completed, presentation, effort taken by student, etc.
- The candidates shall give a presentation on the dissertation topic before a departmental committee along with demonstration of working model.
- The student shall be assessed on the basis of presentation/communication skill, depth of understanding, selection of dissertation topic, literature survey, work completed, result and dissertation - II report, etc.

ii. End Semester Examination (ESE)

- The ESE shall be evaluated by a panel of two examiners viz. guide and external examiner.
- The candidates shall present the work on the dissertation topic before the examiners and shall be assessed on the basis of presentation/communication skill, depth of understanding, selection of dissertation topic, literature survey, work completed, result and dissertation - II report, etc.

ME602P. Intellectual Property Rights

Teaching Scheme: 01L, **T-**01**Total:** 02 **Credits**-02
Evaluation Scheme: ICA 50 **Total Marks:** 50

COURSE DESCRIPTION

The course is designed to introduce fundamental aspects of Intellectual Property Rights to students who are going to play a major role in development and management of innovative projects in industries. The course introduces all aspects of the IPR Acts. It also includes case studies to demonstrate the application of the legal concepts in engineering, technology and creative design. The course is designed to apply knowledge for sustainable development.

Desirable awareness/skills

General awareness of science, technology, and law

Course Outcomes

On the successful completion of this course, student shall be able to

1. understand intellectual property rights and related issues
2. illustrate copyright, authors' rights, licensing and retention of rights
3. analyze the creative commons licensing system

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1		2									1	1	-	-
CO 2					2	1			1				-	-	-
CO 3		1		3									-	-	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content

Overview of intellectual property: Introduction and the need for intellectual property right (IPR), IPR in India – genesis and development, IPR in abroad, some important examples of IPR, licensing and enforcing intellectual property, commercializing inventions, infringement of intellectual property rights, enforcement measures, unfair competition, relationship between unfair competition and intellectual property laws. Patents: Definition and necessity, inventions protected by a patent, searching a patent, drafting a patent, filing a patent, the different layers of the international patent system (national, regional and international options), granting, infringement, macro-economic impact of the patent system, Rights of a patent and extensiveness of patent protection. Utility Models and Copyright: Differences between a utility model and a patent, trade secrets and know-how agreements, copyright - definition, necessity and duration, related rights, distinction between related rights and copyright, rights covered by copyright. Trademarks: Definition, necessity and rights of trademark, kind of signs used as trademarks, types of trademark, function does a trademark perform, protection of trademark, registration of trademark, extensiveness and duration of protection of registered trademark, well-known marks and their protection, domain name and its relation to trademarks.

Recommended Books

1. Karla C. Shippey, "A short course in International Intellectual Property Rights", Third Edition, World Trade Press, 2008
2. N. K. Acharya, "Intellectual Property Rights", Fifth Edition, Asia Law House, 2010
3. T. M Murray and M. J. Mehlman, "Encyclopaedia of Ethical, Legal and Policy Issues in Biotechnology", John Wiley and Sons, 2000

4. Ajit Parulekar and Sarita D'Souza, "Indian Patents Law – Legal and Business Implications", Macmillan India Ltd, 2006.
5. B. L. Wadehra, "Law Relating to Patents, Trade Marks, Copyright, Designs and Geographical Indications", Universal Law Publishing Pvt. Ltd., India , 2000
6. P. Narayanan, " Law of Copyright and Industrial Designs", Eastern Law House, Delhi, 2010

ICA – Internal Continuous Assessment (50 marks) shall include two evaluation tools viz. assignments (25 marks) and two internal written examinations (25 marks) conducted by course teacher. Assignment tool shall support for regular submission of assignments and its regular assessment. In addition; it shall be based on knowledge/skill acquired and record submitted by student (assignment). The performance shall be assessed assignment wise using internal continuous assessment format **(S 10).** First internal written examination shall be conducted at middle of semester on 50% syllabus and second internal written examination shall be conducted at end of semester on remaining 50% syllabus.

ME603P. Research Methodology

Teaching Scheme: 03L,**Total:** 03 **Credits**-03
Evaluation Scheme: ICA 50 **Total Marks:** 50

Course Description
This course is aimed at introducing the basic concepts and methods of research. The course also deals with several aspects of research such as formulating a research problem, literature review, and sampling, and data collection, statistical analysis of data, graphical representation of results, report writing, anti-plagiarism check and research ethics.

Desirable Awareness/Skills
Knowledge of statistics, general awareness of research

Course Outcomes
On the successful completion of this course, student shall be able to

1. formulate a research problem.
2. analyze research related information.
3. adapt research ethic

RELEVANCE OF COS / POS AND STRENGTH OF CO- RELATION:

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1							3						1	-	-
CO 2		1				2			3		1		-	-	-
CO 3	1							1		1			-	-	1

1-Weakly correlated 2 – Moderately correlated 3 – Strongly correlated

Course Content:
Research Concept: Concept, meaning, objectives, motivation; Types of research, approaches (descriptive research, conceptual, theoretical, applied and experimental research)
Formulation of Research Task: Literature Review: importance & methods, sources, field study, laboratory experiments, critical analysis of already generated facts, hypothetical proposal for future development and testing, selection of research task, prioritization of research, introduction to hypothesis testing.

Mathematical Modeling and Simulation: Concept of modeling, classification of mathematical models, modeling with ordinary differential equations, differential equations, partial differential equations, graphs. Simulation concept, types (quantitative, experimental, computer, statistical), process of formulation of model based on simulation.

Experimental Modeling: Definition of experimental design, examples, single factor experiments, guidelines for designing experiments. General model of process: Input factors/variables, Output parameters/variables, controllable/ uncontrollable variables, dependent/independent variables, compounding variables, extraneous variables and experimental validity.

Process optimization and designed experiments: methods for study of response surface, First order design. Determining optimum combination of factors, determination of steepest ascent, Taguchi approach to parameter design.

Analysis of Results (Parametric and Non parametric, Descriptive and Inferential Data): types of data, Methods and techniques of data collection, sampling and sample design, Non parametric test, error analysis, analysis of variance, significance of variance, analysis of co-variance, multiple regression, Introduction to Analytical hierarchical process, Factor analysis, Cluster analysis, Fuzzy logic, testing linearity/ non linearity of model, testing adequacy of model.

Report Writing: types of report, layout of research report, interpretation of results, layout and format, style of writing, typing, references, pagination, tables, figures, conclusions, appendices.
Landscape of Creativity: Convergent Vs. divergent thinking, creativity, creativity Vs intelligence, creativity abilities, determination of Creativity, increasing creativity, creative achievement, techniques of creativity, collective creativity.

Reference Books :

1. Research Methodology, C R Kothari, Wiley Eastern publishers, New Delhi, 10th edition, 2006.
2. Research in Education, John W Besr & James V Kahn, Prentice HalI of India, New Delhi.
3. Theories of Engineering Experiments, Schank Fr, Tata McGraw Hill Publishing Ltd., New Delhi.
4. Experimental design by Cochran & Cocks, John Wielly & sons, New Delhi, 2005.
5. Design of Experiments, Douglas Montgomary, 1995.
6. Formulation of Hypothesis, Willkinson K, P L Bhandarkar, Himalaya Publishing House, Mumbai, 2005.

ME651P Dissertation II

Laboratory Work : 16 hrs/Week **Credits**-15
Evaluation Scheme: ICA 100, **ESE** 150 **Total Marks:** 250

Course Description
The dissertation should be based on the knowledge acquired by the student during the course work and should contribute to the needs of the society. The dissertation aims to provide an opportunity of designing and building, complete system or subsystem in the domain area.

Desirable Awareness/Skills
Knowledge of the domain of dissertation

Course Outcomes
On the successful completion of this course, student shall be able to

1. synthesize acquired knowledge and skills and apply to solve new technical problem.
2. select a suitable technique from different methodologies, and forms of analysis to produce a suitable research design.
3. present the experimental work done in a written report.
4. present / publish the work in international/ national conference and/or reputed journals.

Dissertation will consist of a system development in Software/ Hardware.

Dissertation – II
In continuation with the work completed in semester III, student shall complete the implementation of ideas given in synopsis of dissertation, so that working model of dissertation shall be complete before the end of semester. Students shall submit final dissertation report in prescribed format which shall include the work completed in semester III also.

Dissertation report shall include -

(i) Literature review
(ii) Concepts, problem definition
(iii) Functional and technical details
(iv) Results and discussion, conclusions and contributions
(v) Comparison with contemporary techniques
(vi) Future scope
(vii) References

The candidate has to present / publish at least one paper in reputed national / international journal/ conference based on the dissertation work before submission of the dissertation report.

Phase – II deliverables: Record of continuous progress, dissertation report as per the specified format, developed system in the form of hardware and/or software.

Phase – II evaluation

i. Internal Continuous Assessment (ICA)

• The ICA shall be evaluated by guide throughout the semester and by a departmental committee before the end of the semester appointed by the Head of Department.

- Guide shall judge the student on the basis of regularity, work completed, presentation, effort taken by student, etc.
- The candidates shall give a presentation on the dissertation topic before a departmental committee along with demonstration of working model.
- The student shall be assessed on the basis of presentation/communication skill, depth of understanding, selection of dissertation topic, literature survey, work completed, result and dissertation - II report, etc.

ii. End Semester Examination (ESE)

- The ESE shall be evaluated by a panel of two examiners viz. guide and external examiner.
- The candidates shall present the work on the dissertation topic before the examiners and shall be assessed on the basis of presentation/communication skill, depth of understanding, selection of dissertation topic, literature survey, work completed, result and dissertation - II report, etc.