DEPARTMENT OF MECHANICAL ENGINEERING

Scheme of Instruction and Syllabi
of

M.E. (Mechanical) (Autonomous)

Specialization:

THERMAL ENGINEERING

Full time

Chaitanya Bharathi Institute of Technology
Chaitnaya Bharathi P.O., Gandipet, Hyd-500 075
Ph: 040-24193276, 24193280, Fax: 040-24193278

2013-2014

With effect from the academic year 2013- 2014

Scheme of Instruction & Examination
M.E. (Mechanical Engineering) 4 Semesters (Full Time)

Sl. No	Subject	Periods per week		Duration (Hrs)	Max. Marks		Grade
		L/T	D/P		Univ. Exam	Sessionals	
Semester - I							
1.	Core	3	--	3	80	20	
2.	Core	3	--	3	80	20	
3.	Core / Elective	3	--	3	80	20	
4.	Core / Elective	3	--	3	80	20	
5.	Core / Elective	3	--	3	80	20	
6.	Elective	3	--	3	80	20	
7.	Laboratory - I	--	3	--	--	50	
8.	Seminar - I	--	3	--	--	50	
	Total	**18**	**6**		**480**	**220**	
Semester - II							
1.	Core	3	--	3	80	20	
2.	Core	3	--	3	80	20	
3.	Core / Elective	3	--	3	80	20	
4.	Core / Elective	3	--	3	80	20	
5.	Core / Elective	3	--	3	80	20	
6.	Elective	3	--	3	80	20	
7.	Laboratory - II	--	3	--	--	50	
8.	Seminar - II	--	3	--	--	50	
	Total	**18**	**6**		**480**	**220**	
Semester - III							
1.	Dissertation and Project Seminar*	--	6	--	--	100**	
Semester - IV							
1.	Dissertation	--			Viva - Voce (Grade ***)		

Note : Six core subjects, Six elective subjects, Two Laboratory Courses and Two Seminars should normally be completed by the end of semester II.

* Project seminar presentation on the topic of Dissertation only

** 50 marks awarded by the project guide and 50 marks by the internal committee.

*** Excellent / Very Good / Good / Satisfactory / Unsatisfactory

With effect from the academic year 2013- 2014

Scheme of Instruction & Examination of Post Graduate course in Mechanical Engineering with specialization in **Thermal Engineering**

Course duration: 4 Semesters (Full Time)

Sl. No	Syllabus Ref. No.	Subject	Scheme of Instruction Periods per week		Scheme of Examination			Grade
					Duration	Max. Marks		
			L/T	D/P	in Hours	Univ. Exam	Sessional	
		CORE SUBJECTS						
1.	ME 601	Fluid Flow and Gas Dynamics	3	--	3	80	20	
2.	ME 602	Computational Fluid Dynamics	3	--	3	80	20	
3.	ME 603	Design for Thermal Systems	3	--	3	80	20	
4.	ME 604	Advanced Thermodynamics	3	--	3	80	20	
5.	ME 605	Advanced Heat & Mass Transfer	3	--	3	80	20	
6	ME 606	Advanced I.C. engines	3	--	3	80	20	
		ELECTIVES						
1.	ME 502	Finite Element Techniques	3	--	3	80	20	
2.	ME 503	Computer Aided Modeling and Design	3	--	3	80	20	
3.	ME 514	Optimization Techniques	3	--	3	80	20	
4.	ME 516	Engineering Research Methodology	3	--	3	80	20	
5.	ME 607	Fluid Power Systems	3	--	3	80	20	
6.	ME 608	Principles of Turbo machinery	3	--	3	80	20	
7.	ME 609	Design of Gas Turbines	3	--	3	80	20	
8.	ME 610	Advanced Energy Systems	3	--	3	80	20	
9.	ME 611	Fuels and Combustion	3	--	3	80	20	
10.	ME 612	Power Plant Control and Instrumentation	3	--	3	80	20	
11.	ME 613	Design of Pumps and Compressors	3	--	3	80	20	
12.	ME 614	Numerical Methods	3	--	3	80	20	
13.	ME 615	Environmental Engineering and Pollution Control	3	--	3	80	20	
14.	ME 616	Refrigeration Machinery & Components	3	--	3	80	20	
15.	ME 617	Energy Management	3	--	3	80	20	
16.	ME 618	Convective Heat Transfer	3	--	3	80	20	
17.	ME 619	Thermal & Nuclear Power Plants	3	--	3	80	20	
		DEPARTMENTAL REQUIREMENTS						
1.	ME 630	Thermal Systems Laboratory (Lab – I)	--	3	--	--	50	
2.	ME 631	CFD Laboratory (Lab –II)	--	3	--	--	50	
3.	ME 632	Seminar – I	--	3	--	--	50	
4.	ME 633	Seminar – II	--	3	--	--	50	
5.	ME 634	Project Seminar	--	3	--	--	50	
6.	ME 635	Dissertation	--	9	--	Viva-Voce (*Grade)		

*Excellent / Very Good / Good / Satisfactory / Unsatisfactory

<table>
<tr><td>CBIT</td><td colspan="8">Autonomous Regulation</td></tr>
<tr><td>Department</td><td>Mechanical Engineering</td><td colspan="3">Programme Code & Name</td><td colspan="4">M.E. Thermal Engineering</td></tr>
<tr><td colspan="9">Semester-I</td></tr>
<tr><td>Course Code</td><td rowspan="2">Course Name</td><td colspan="3">Hours/ Week</td><td>Credit</td><td colspan="3">Maximum Marks</td></tr>
<tr><td rowspan="2">ME601</td><td>L</td><td>T</td><td>P</td><td>C</td><td>E</td><td>I</td><td>Total</td></tr>
<tr><td>FLUID FLOWS & GAS DYNAMICS</td><td>3</td><td>1</td><td>0</td><td>4</td><td>80</td><td>20</td><td>100</td></tr>
<tr><td>Objective (s)</td><td colspan="8">To create the awareness of the importance of principles of gas dynamics in the design of turbojets, rockets and to make the understand the principles of hydrodynamics in design of pumps, pipes, etc,. and to study separation of flows</td></tr>
<tr><td></td><td colspan="8"></td></tr>
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<table>
<tr><td>1</td><td>VELOCITY FUNCTIONS</td><td>Total Hrs</td><td>7</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>2</td><td>LAWS OF FLUID FLOWS</td><td>Total Hrs</td><td>9</td></tr>
<tr><td colspan="4">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</td></tr>
<tr><td>3</td><td>CONCEPT OF BOUNDARY LAYER</td><td>Total Hrs</td><td>9</td></tr>
<tr><td colspan="4">Flow over an aerofoil – Lift and Drag coefficients. Boundary layer theory – laminar and turbulent boundary layers. Hydrodynamic and thermal boundary layer equations. Flow separation in boundary layers.</td></tr>
<tr><td>4</td><td>FUNDAMENTALS OF GAS DYNAMICS</td><td>Total Hrs</td><td>9</td></tr>
<tr><td colspan="4">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.</td></tr>
<tr><td>5</td><td>PRINCIPLES OF GAS DYNAMICS APPLICABLE TO SHOCKS</td><td>Total Hrs</td><td>9</td></tr>
<tr><td colspan="4">Isentropic flow through variable area passages. Design of supersonic and subsonic nozzles and diffusers. Super sonic flows. Expansion and Shock waves. Normal and Oblique Shock waves. Prandtl-Meyer and Rankine-Hugoniot Relations. Simple problems on normal and oblique shock waves.</td></tr>
<tr><td colspan="3">Total hours to be taught</td><td>43</td></tr>
<tr><td colspan="4">Text book (s)</td></tr>
<tr><td>1</td><td colspan="3">Kothandaraman, C. and Rudramoorthy, R., “Basic Fluid Mechanics”, New Age Intl. Publishers.Delhi, 2004.</td></tr>
<tr><td>2</td><td colspan="3">Shapiro, “Compressible fluid flow”. Tata McGraw Hills Publications, New York, 2004.</td></tr>
<tr><td colspan="4">Reference(s)</td></tr>
<tr><td>1</td><td colspan="3">Modi & Sethi, “ Hydraulic Machines and Systems,</td></tr>
<tr><td>2</td><td colspan="3">Yahya, S.M., “Fundamentals of Compressible Fluid Flows”, New Age International Pvt Limited, Ahmedabad, 2010.</td></tr>
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Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME602	**COMPUTATIONAL FLUID DYNAMICS**	3	1	0	4	80	20	100	
Objective (s)	To create the awareness of the importance of principles of fluid dynamics in engineering applications such as aerodynamic, heat transfer, turbo-machinery etc,.								

1	**BASIC EQUATIONS IN FLUID DYNAMICS**	**Total Hrs**	**9**
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.			
2	**CLASSIFICATION OF PDEs**	**Total Hrs**	**9**
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.			
3	**GRID GENERATION**	**Total Hrs**	**9**
Grid Generation- Types of grid O,H,C. Coordinate transformation, algebraic methods. Unstructured grid generation			
4	**FINITE DIFFERENCE SOLUTIONS**	**Total Hrs**	**9**
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.			
5	**FINITE VOLUME METHOD**	**Total Hrs**	**9**
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.			
Total hours to be taught			**45**

Text book (s):	
1	Pradip Niyogi, Chakrabartty S.K, 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**.**
Reference(s):	
3	John D Anderson, 'Computational Fluid Dynamics', Mc Graw Hill, Inc., 1995**.**
4	Patankar, S.V, 'Numerical Heat transfer and Fluid flow', Hemisphere Publishing Company, New York, 1980.
5	Chung, T J, 'Computational Fluid Dynamics, Cambridge University Press, 2002.

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		L	T	P	C	E	I	Total
ME603	**DESIGN FOR THERMAL SYSTEMS**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of engineering design, economics and modeling and stress the need for dynamic behavior of thermal systems.							

1	**ENGINEERING DESIGN & ECONOMIS**	**Total Hrs**	**9**
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. .			
2	**MODELING THERMAL EQUIPMENT**	**Total Hrs**	**9**
Modeling 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.			
3	**OPTIMIZATION**	**Total Hrs**	**9**
Optimization: Levels of Optimization – Optimization procedures – Lagrange Multipliers – Search Methods			
4	**THERMODYNAMIC RELATIONS**	**Total Hrs**	**9**
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..			
5	**DYNAMIC BEHAVIOR OF THERMAL SYSTEMS**	**Total Hrs**	**9**
Calculus Methods of Optimization – Dynamic Programming – Geometric Programming, Linear Programming. Probabilistic Approaches to design.			
Total hours to be taught			**45**

Text book (s)

1	Stoecker, W.F., Design of Thermal Systems, McGraw-Hill Book Company, 1987.
2	William S. Janna, Design of Fluid Thermal Systems, Raj p.Chhabra,2011
1	Robert F.Boehm,Developments in the Design of Thermal Systems,Cambridge University press 2005
2	Yogesh Jaluria, Design and Optimization of Thermal Systems, Taylor & Francis,2007
3	Robert F. Boehm, Developments in the Design of Thermal Systems,2004

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Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME604	**ADVANCED THERMODYNAMICS**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of thermodynamic principles in engineering applications such as I.C engine combustion, psychrometry, air conditioning processes, and power cycles.							

1	**LAWS OF THERMODYNAMICS**	**Total Hrs**	**9**
Review of Thermo dynamic Laws and Corollaries – Transient Flow Analysis – Second law of thermodynamics – Entropy - Availability and unavailability – Irreversibility – Thermo dynamic Potentials – Maxwell Relations – Specific Heat Relations – Mayer's relation - Evaluation of Thermodynamic properties of working substance			
2	**PSYCHROMETRY AND AIR CONDITIONING PROCESS**	**Total Hrs**	**9**
P.V.T. surface – Equations of state – Real Gas Behaviour – Vander Waal's equation - Generalised compressibility Factor – Energy properties of Real Gases – Vapour pressure – Clausius – Clapeyron Equation – Throttling – Joule – Thompson coefficient. Non-reactive Mixture of perfect Gases – Governing Laws – Evaluation of properties – Pychrometric Mixture properties and psychrometric chart – Air conditioning processes – Cooling Towers – Real Gas Mixture			
3	**COMBUSTION REACTIONS**	**Total Hrs**	**9**
Combustion – Combustion Reactions – Enthalpy of Formation – Entropy of Formation – Reference Levels for Tables – Energy of formation – Heat of Reaction – Aiabatic flame Temperature General product – Enthalpies – Equilibrium. Chemical Equilibrium of Ideal Gases – Effects of Non-reacting Gases Equilibrium in Multiple Reactions. The van Hoff's Equation. The chemical potential and phase Equilibrium – The Gibbs phase Rule**.**			
4	**POWER CYCLES**	**Total Hrs**	**9**
Power cycles, Review Binary vapour cycle, co-generation and Combined cycles – Second law analysis of cycles – Refrigeration cycles.Thermo Dynamics off irreversible processes – Introduction – phenomenological laws – Onsagar Reciprocity Relation – Applicability of the phenomenological Relations – Heat Flux and Entropy Production – Thermo dynamic phenomena – Thermo electric circuits			
5	**DIRECT ENERGY CONVERSION**	**Total Hrs**	**9**
Introduction – Fuel Cells - Thermo electric energy – Thermo-ionic power generation -Thermodynamic devices Magneto Hydrodynamic Generations – Photo voltaic cells.			
Total hours to be taught			**45**

Text book (s)	
1	P.K. Nag, Basic and Applied Thermodynamics,TMH,2008.
2	J.P. Holman "Thermo Dynamics", Mc Graw Hill
1	Obert Edward. F. & Young Rober L, "Elements of Thermodynamics" McGraw Hills
2	Younus.A.cengel & Michael A. Boles " Thermodynamics an engineering approach sixth edition,TMH
3	Arian Bejan "Advanced Engineering Thermodynamics " 3rd Edition Wiley Publications,2006

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ME605	**ADVANCED HEAT & MASS TRANSFER**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of principles of heat transfer pertaining to conduction, convection, radiation, boiling, condensation, and mass transfer in engineering applications							

1	**BRIEF INTRODUCTION TO DIFFERENT MODES OF HEAT TRANSFER**	**Total Hrs**	**9**
Conduction: General heat conduction equation-Initial and Boundary conditions Steady State Heat Transfer: Simplified heat transfer in 1D and 2D – Fins.Transient heat conduction; Lumped system analysis- Heisler charts-semi infinite solid-use of shape factors in conduction - 2D transient heat conduction – product solutions			
2	**FINITE DIFFERENCE METHODS FOR CONDUCTION**	**Total Hrs**	**9**
1D & 2D steady state heat conduction problems – implicit and explicit methods. Forced Convection: Equations of Fluid Flow – Concepts of Continuity, momentum equations – Derivation of Energy equation - Methods to determine heat transfer coefficient: Analytical Methods - Dimensional Analysis and concept of exact solution. Approximate Method – Integral analysis.			
3	**EXTERNAL FLOWS**	**Total Hrs**	**9**
Flow over a flat plate: Integral method for laminar heat transfer coefficient for different velocity and temperature profiles. Application of empirical relations to variation geometrics for Laminar and Turbulent flows.Internal flows: Fully developed flow: Integral analysis for laminar heat transfer coefficient – Types of flow – Constant Wall Temperature and Constant Heat Flux Boundary Conditions - Hydrodynamic & thermal entry lengths; use of empirical correlations.			
4	**FREE CONVECTION & RADIATION**	**Total Hrs**	**9**
Approximate analysis on laminar free convective heat transfer – Boussinesque Approximation - Different geometries – combined free and forced convectionBoiling and condensation: Boiling curve – Correlations-Nusselt's theory of film condensation on a vertical plate – Assumptions & correlations of film condensation for different geometrics. Radiation Heat Transfer: Radiant heat exchange in grey, non-grey bodies, with transmitting, reflecting and absorbing media, specular surfaces, gas radiation – radiation from flames			
5	**MASS TRANSFER**	**Total Hrs**	**9**
Concepts of mass transfer – Fick's Law of Diffusion, diffusion in gases, diffusion in liquids and solids , the mass transfer coefficient , evaporation processes in the atmosphere & convective mass transfer Analogies – Significance of non-dimensional numbers			
Total hours to be taught			**45**

Text book (s)	
1	Necati Ozisik "Heat Transfer" TMH 1998
2	Incropera Dewitt Fundamentals of Heat & Mass Transfer – John Wiley 2007
1	Yunus Cengel Heat Transfer: A basic approach – TMH 2008
2	R.C.Sachdeva Fundamentals of Engineering Heat & Mass Transfer" New Age International Publications 2010
3	J.P.Holman "Heat Transfer" Tata Mc Graw Hill, 2008

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Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME606	**ADVANCED I.C. ENGINES**	3	1	0	4	80	20	100	
Objective (s)	To create awareness of the importance of working principles of I.C. Engines, and familiarize various techniques to control exhaust emissions with the use of alternate fuels.								

1	**SPARK IGNITION ENGINES**	**Total Hrs**	**9**
Spark ignition engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – Factors affecting knock – Combustion chambers.			
2	**COMPRESSION IGNITION ENGINES**	**Total Hrs**	**9**
Stages of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behavior – Spray structure, Spray penetration and evaporation – Air motion – Introduction to Turbo charging.			
3	**POLLUTANT FORMATION AND CONTROL**	**Total Hrs**	**9**
Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter – Methods of controlling Emissions – Catalytic converters and Particulate Traps . Methods of measurements and Introduction to emission norms and Driving cycles.			
4	**ALTERNATIVE FUELS**	**Total Hrs**	**9**
Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.			
5	**RECENT TRENDS**	**Total Hrs**	**9**
Modification in I.C. engine to suit bio-fuels- Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition(HCCI) engines and GDI concepts– Plasma Ignition – Measurement techniques – Laser Doppler, Anemometry			
Total hours to be taught			**45**

Text book (s)	
1	Obert, E.F.Internal Computation Engines Harper & Row, Publishers N.Y3rd edition 1973.
2	GILL, P.W.and Smith (Jr,J.H, fundamentals of Internal combustion Engines, Oxford & IBH publishing Co.New Delhi, 1967.
1	Heywood, J.B, Internal Combustion engine fundamentals, McGrave Hills, Book Co, New York, 1988.
2	Taylor C.F.and Taylor, E,S,The Internal Combustion Engine in Theory and Practice, M.I.T.Press, 1968.
3	Mathur,M.L.and Sharma,R.P.,Internal Combustion Engine,Dhanpat Rai & Sons, Delhi, 5th Edition 1990.
4	Ganeshan, V., Internal Combustion engines, Tata Mc Graw Hills Publishing Co.Ltd, New Delhi 1984.

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Semester-I

Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME502	**FINITE ELEMENT TECHNIQUES**	3	1	0	4	80	20	100

Objective (s)	Identify mathematical model for solution of common engineering problems Enable the students to formulate the design problems into FEA. Enable the students to perform engineering simulations using Finite Element Analysis software

1	**FIELD PROBLMES AND MODELING**	**Total Hrs**	**9**

Introduction to Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations.

One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach : Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions.

2	**ANALYSIS OF TRUSSES AND FRAMES**	**Total Hrs**	**9**

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.

3	**TWO DIMENSIONAL STRESS ANALYSIS**	**Total Hrs**	**9**

. 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. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements.
Convergence requirements and geometric isotropy

4	**HEAT TRANSFER PROBLEMS AND DYNAMIC ANALYSIS**	**Total Hrs**	**9**

Steady state heat transfer analysis: One dimensional analysis of a fin 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 Eigen vectors.
Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.

5	**THREE DIMENSIONAL PROBLEMS IN SRESS ANALYSIS**	**Total Hrs**	**9**

Finite element formulation of three dimensional problems in stress analysis. Finite
Element formulation of an incompressible fluid. Potential flow problems
Bending of elastic plates. Introduction to non-linear problems and Finite Element analysis software.

Total hours to be taught	**45**

Text book (s)

1	Tirupathi R Chandrupatla and Ashok.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.
1	Segerland. L.J., Applied Finite Element Analysis, Wiley Publication1984.
2	Reddy J.N., An Introduction to Finite Element Methods ,Mc Graw Hill Company, 1984

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<tr><td>L</td><td>T</td><td>P</td><td>C</td><td>E</td><td>I</td><td>Total</td></tr>
<tr><td>ME503</td><td>COMPUTER AIDED MODELING AND DESIGN</td><td>3</td><td>1</td><td>0</td><td>4</td><td>80</td><td>20</td><td>100</td></tr>
<tr><td>Objective (s)</td><td colspan="8">To create awareness of the importance of various modeling techniques applicable to engineering industry.</td></tr>
</table>

1	**INTRODUCTION TO CAD**	**Total Hrs**	**9**

Criteria for selection of CAD workstations, Shigle Design Process, Design criteria, Geometric modeling, entities, 2D & 3D Primitives.

2D & 3D Geometric Transformations: Translation, Scaling, Rotation, Reflection and Shearing, conlatenation. Graphics standards: GKS IGES, PDES.

2	**MODELING**	**Total Hrs**	**9**

Wire frame modeling: Curves: Curve representation. Analytic curves – lines, Circles, Ellipse, Conis. Synthetic curves – Cubic, Bezier, B-Spline, NURBS.

3	**SURFACE MODELING**	**Total Hrs**	**9**

Surface Modeling: Surface entities, Surface Representation.

Analytic Surface – Plane Surface, Ruled Surface, Surface of Revolution, Tabulated Cyliner. Synthetic Surface-Cubic, Bezier, B-spline, Coons.

4	**SOLID MODELING**	**Total Hrs**	**9**

Solid Modeling Techniques: Graph Based Model, Boolean Models, Instances, Cell Decomposition & Spatial – Occupancy Enumeration, Boundary Representation (B-rep) & Constructive Solid Geometry (CSG)

5	**ADVANCED MODELING**	**Total Hrs**	**9**

Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioural Modeling, Conceptual Design & Top Down Design.

Capabilities of Modeling & Analysis Packages such as solid works, Unigraghics, Ansys, Hypermesh. Computer Aided Design of mechanical parts and Interference Detection by Motion analysis.

Total hours to be taught	**45**

Text book (s)

1	Ibrahim Zeid, "CAD/CAM, Theory and Practice", Mc Graw Hill, 1998.
2	Foley, Van Dam, Feiner and Hughes, "Computer Graphics Principles and Practice", 2nd Ed., Addison – Wesley, 2000.

1	E. Micheal, "Geometric Modelling", John Wiley & Sons, 1995.
2	Hill Jr, F.S., "Computer Graphics using open GL", Pearson Education, 2003.

CBIT	Autonomous Regulation							
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME514	**OPTIMIZATION TECHNIQUES**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of various optimization techniques and project scheduling applicable to engineering techniques.							

1	**LINEAR AND TRASPORTATION PROBLEMS**	**Total Hrs**	**9**
Statement of Optimization Problem, Linear Programming: Simplex Method, Revised Simplex Method, Sensitivity Analysis, Parametric Programming, and Transportation Problem.			
2	**NON-LINEAR PROBLEMS**	**Total Hrs**	**9**
Nonlinear Programming: Approach, Convergence and Scaling of Design variables; Unconstrained Optimization Direct Search Methods: Random Search, Univariate, Simplex Method; Indirect Search Methods: Steepest Descent, Conjugate Gradient, Newton, Quasi Newton, DFP Methods;			
3	**NON-LINEAR PROGRAMMING**	**Total Hrs**	**9**
Constrained Optimization Direct Methods: Lagrange Multipliers, Kuhn-Tucker conditions, Beal's method, Indirect Method: Penalty Function and Applications			
4	**DYNAMIC PROGRAMMING**	Total Hrs	9
Introduction to Dynamic Programming; Concept of Sub optimization and the principle of optimality; Linear and Continuous Dynamic Programming with Applications; Introduction to Integer Programming; Cutting Plane Method; Branch and Bound method; Introduction to Genetic Algorithms, particle swarm optimization			
5	**PROJECT SCHEDULING**	Total Hrs	9
Sequencing and Scheduling, Project Scheduling by PERT-CPM; Probability and cost consideration in Projectscheduling; Queuing Theory, Single and multi server models; Queues with combined arrivals and departures;Queues with priorities for service.			
Total hours to be taught			**45**

Text book (s)

1	Rao,S.S. Engineering "Optimization Theory and Practice", New Age Int. Pub., 3rd Ed., 1996.
2	Haug,E.J.and Arora, J.S., "Applied Optimal Design", Wiley Inter Science Publication, NY, 1979.

Reference (s)

1	Douglas J. Willde, "Globally Optimal Design", Jhon Wiley & Sons, New York, 1978
2	Johnson Ray C., "Optimum Design of Mechanical Elements", John Wiley & Sons, 1981.
3	S.D. Sharma, S.D. "Operations Research", Khanna Publications, 2001.
4	David Goldberg, "Genetic Algorithms", pearson publications, 2006.
5	Maurice cleric, "Particle Swarm Optimization", ISTE Publications, 2006
6	Prem Kumar Gupta, "Operations Research", S Chand publications, 2008

CBIT	Autonomous Regulation		
Department	Mechanical Engineering	Programme Code & Name	M.E. Thermal Engineering
Semester-I			

Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME516	**ENGINEERING RESEARCH METHODOLOGY**	3	1	0	4	80	20	100

Objective (s)	To create awareness of the importance of research methodology, design and possible ways of exploring data. .

1	**PREREQUISITS OF RESEARCH**	**Total Hrs**	**9**
Introduction: Scope of research, objective/motivation, characteristics and prerequisites of research. Research needs in engineering, benefits to the society in general.			
2	**REVIEW OF LITERATURE**	**Total Hrs**	**9**
Review of Literature: Role of review, search for related literature, online search, and web-based search conducting a literature search. Evaluating, Organizing, and synthesizing the literature. Identifying and describing the research. Finding the research Problem. Sources of research problem. Criteria/Characteristics of a Good research			
3	**PLANNING FOR RESEARCH DESIGN**	**Total Hrs**	**9**
The Nature and role of Data in Research. Linking Data and Research Methodology. Validity of Method. Planning for Data collection. Choosing a Research Approach. Use of Quantitative / Qualitative Research Design. Feasibility of Research Design. Establishing Research Criteria. Justification of Research Methodology. Research Proposal preparation. Characteristics of a proposal. Formatting a research proposal. Preparation of proposal. Importance of Interpretation of data and treatment of data.			
4	**EXPLORATION OF DATA**	**Total Hrs**	**9**
Exploring the data. Description and Analysis of Data. Role of Statistics for Data Analysis. Functions of Statistics, Estimates of. Population. Parameters. Parametric V/s Non Parametric methods. Descriptive Statistics, Points of Central tendency, Measures of Variability, Measures of relationship. Inferential Statistics-Estimation, 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			
5	**RESEARCH REPORT**	**Total Hrs**	**9**
Writing Format of the Research report. Style of writing report. References and Bibliography. Technical paper writing/Journal report			
Total hours to be taught			45

Text book (s)	
1	Paul D. Leedy and Jeanne E. Ormrod. "Practical Research: Planning and Design", (8th Edition)
2	"A Hand Book of Education Research" - NCTE
Reference (s)	
1	Sindhu, K.S. " Methodology of Education Research" Sidhu
2	Kothari. C.R. "Research Methodology, Methods & Technique":
3	Agarwal, Y.P. "Tests, Measurements and Research methods in Behavioral Statistical Methods".
4	Box and Jenkins; "Time Series Analysis, Forecasting and Control", Holden Day, Sanfrancisco
5	Holman, J.P. "Experimental Methods for Engineers", McGraw Hill Int., New York.

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Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME607	**FLUID POWER SYSTEMS**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of research methodology, design and possible ways of exploring data. .							

1	**HYDRAULIC FLUIDS**	**Total Hrs**	**9**
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.			
2	**HYDRAULIC PUMPS AND CONTROL VALVES**	**Total Hrs**	**9**
Hydraulic Pumps and Motors: Basic Types and constructions, ideal pump and motor analysis, Performance curves and parameters, Hydraulic Control Valves- Valve configurations, general valve analysis, critical center, open center, 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.			
3	**HYDRAULIC POWER ELEMENTS**	**Total Hrs**	**9**
Hydraulic Power Elements: Valve controlled motor, valve controlled piston, three way valve controlled piston, pump controlled motor, pressure transients in power elements.			
4	**PNEUMATICS**	**Total Hrs**	**9**
Characteristics of Pneumatics, Applications of Pneumatics, Basic Pneumatic elements, Steady flow of Ideal gases, orifice and nozzle calculations, capillary flow, flow of real gases, linearised flow equations in Orifices and Nozzles. Steady state analysis of pneumatic components: Multiple restriction and volume calculations, sensing chambers, valves, Single acting actuators.			
5	**TRANSIENTS IN ELEMENTARY PNEMATIC SYSTEMS**	**Total Hrs**	**9**
Linear dynamics-linear pneumatic spring rate, linear dynamics of a variable volume of gas, Pneumatic transmission lines, linear dynamics in single acting actuators. Applications in industrial process controls: On-Off pneumatic feedback systems, feedback control of proportional gain, derivative action, integral action, Design of a Pneumatic Pressure Regulator.			
Total hours to be taught			45

Text book (s)	
1	Herbert E. Merritt, “Hydraulic Control Systems”, John Wiley & Sons, 1967
2	W. Anderson, The Analysis and Design of Pneumatic Systems, Wiley, 1967.
Reference (s)	
1	A.B. Goodwin, Fluid Power Systems, Macmillan, 1976.
2	Anthony Esposito, “Fluid power with applications”, Prentice Hall, 7th Edition, 2002.
3	Arthur Akers, Max Gassman, Richard Smith, “Hydraulic Power System Analysis”, Taylor and Francis Group, 2006.
4	John Pippenger & Tyler Hicks, “Industrial Hydraulics”, 3rd edition McGraw Hill , 1980.

CBIT	Autonomous Regulation								
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME608	**PRINCIPLES OF TURBO MACHINERY**	3	1	0	4	80	20	100	
Objective (s)	To create awareness of the importance of principles of various turbo machines .								

1	**INTRODCUTION TO TURBO-MACHIES**	**Total Hrs**	**9**
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			
2	**CENTRIFUGAL PUIMPS**	**Total Hrs**	**9**
Euler's Equation of Energy Transfer, vane congruent flow, influence of relative circulation, thickness of 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 cavitation in pumps. Concept of specific speed, Shape number. Axial, Radial and Mixed Flow Machines. Similarity laws.			
3	**AXILA FLOW FAN**		**9**
Flow through Axial flow fans. Principles of Axial fan and propeller. Application of fans for air circulation and ventilation. Stage pressure rise and work done. Slip stream and Blade Element theory for propellers. Performance and characteristics of Axial fans.			
4	**CENTRIFUGAL COMPRESSOR**		**9**
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			
5	**STEAM TURBINES**		**9**
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.			
Total hours to be taught			45

Text book (s)	
1	S.M. Yahya, Turbines, Compreessors and Fans, Tata Mcgraw Hill.
2	Gopalakrishnan G, Prithvi Raj D, "A treatise on Turbomachines", Scitec Publications, Chennai, 2002.
Reference (s)	
1	Sheppard, Principles of Turbomachinery.
2	R.K.Turton, Principles of Turbomachinery, E & F N Spon Publishers, London
3	. Balajee, Designing of Turbomachines.

CBIT	Autonomous Regulation							
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME609	**DESIGN OF GAS TURBINES**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of principles of design of gas turbine and methods of improvement of efficiency.							

1	**THERMODYNAMIC ANALYSIS OF GAS TURBINE CYCLES**	**Total Hrs**	**9**
Joule/Brayton. Open and Closed Cycles. Methods of improving cycle efficiency – Intercooling. Reheating and Regeneration.			
2	**DESIGN OF ROTARY COMPRESSORS**	**Total Hrs**	**9**
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 vaneless and vaned diffusers. Design of multi stage axial flow compressors**.**			
3	**COMBUSTION CHAMBERS OF GAS TURBINES**		**9**
Types of combustion chambers. Combustion chamber design for modern gas turbines. Can type, annular and tube type of combustors.			
4	**DESIGN OF AXIAL FLOW TURBINES**		**9**
Matching of compressor and turbine for varying load operation. Gas turbine for super charging and cryogenic applications. Small gas turbines for space applications.			
5	**DESIGN AND CONSTRUCTION OF GAS TURBINE ROTORS AND BLADES**		**9**
Blade materials. Blade attachment techniques. Cooling methods of turbine blades. Simple analysis of turbine blade vibrations and balancing of rotors.			
Total hours to be taught			**45**

Text book (s)	
1	D.G.Wilson,The Design of High efficiency Turbomachinery and Gas Turbines,The MIT Press, Cambridge, U.K.
2	M.P.Boyce, Gas Turbine Engineering hand book, Gulf Publishing Co., New York.
Reference (s)	
1	E. Balje, Turbo machines – A guide to Selection and Theory, John Wiley & Sons, New York.
2	J.S. Rao, Rotor Dynamics, Wiley Eastern Publication, New Delhi.
3	

CBIT	Autonomous Regulation							
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME610	**ADVANCED ENERGY SYSTEMS**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of the principles of various non-conventional energy resources							

1	**SOLAR ENERGY**	**Total Hrs**	**9**
Solar energy: solar radiation – measurement, collection and storage, design of flat plate and parabolic concentrating collectors. Solar power plants. Photo voltaic power systems. Application of SPV and Solar Thermal Systems.			
2	**WIND ENRGY**	**Total Hrs**	**9**
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**.**			
3	**BIO MASS**		**9**
Bio mass energy: Sources of biomass. Energy from solid wastes. Biomass for energy production. Methane production. Bio mass energy conversion technologies. Use of Bio-gasifier. Bio mass power generation using agricultural residues. Introduction of Hybrid energy systems.			
4	**WASTE HEAT RECOVERY**		**9**
Principles of waste heat recovery and co-generation. Analysis of heat recovery systems. Regenerators and recuperators for waste heat recovery. Advantages of fluidized bed boilers. Atmospheric fluidized bed combustion (AFBC), Pressurized fluidized bed combustion (PFBC and Circulation fluidized bed combustion (CFBC).			
5	**CO-GENERATION POWER SYSTEMS**		**9**
Co-generation power systems, Condensate and back pressure steam turbines. Design of waste heat recovery boilers. Combined cycle power plants based on waste heat recovery. Integrated gasification combined cycle (IGCC) power plants. Optimization of Power plant cycle efficiency. Clean coal technologies.			
Total hours to be taught			**45**

Text book (s)	
1	D.A. Relay, Waste Heat Recovery System.
2	G.C. Drydin, The efficient Use of Energy.
Reference (s)	
1	J.A. Duffire and W.A. Beckmen, Solar Energy Thermal Processes.
2	A.B. Meinel, Applied Solar Energy.
3	V.D. Hunt, Wind Power.
	N.H Ravindranath and D O Hall, Bio Mass, Energy and Environment, Oxford University Press.
	.V Jadhav, Energy and Environment, Himalaya publishing house, Mumbai.

CBIT	Autonomous Regulation							
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME611	**FUELS & COMBUSTION**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of working principles of combustion, and familiarize the knowledge of various types of fuels .							

1	**CONVENTIONAL AND NON-CONVENTIONAL ENERGY RESOURCES**	**Total Hrs**	**9**
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.			
2	**SOLID FUEL-COAL**	Total Hrs	9
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.			
3	**LIQUID FUELS**	**Total Hrs**	**9**
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.			
4	**GASEOUS FUELS**	**Total Hrs**	**9**
Gaseous fuels: General, Types of gaseous fuels, Natural gas, Methane from coal mines, Producer gas, Water gas, Carbureted 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.			
5	**COMBUSTION PROCESS**	**Total Hrs**	**9**
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			
Total hours to be taught			45

Text book (s)	
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.
1	"Gas Engineers Handbook", New York : Industrial Press, 1966.
2	Williams, D.A. and G. James, "Liquid Fuels", London Pergamon, 1963
3	Minkoff, G.J., and C.F.H. Tipper, "Chemistry of Combustion Reaction", London Butterworths, 1962.
4	Samir Sarkar, "Fuels & Combustion", Orient Long man 1996.

<table>
<tr><td>CBIT</td><td colspan="9">Autonomous Regulation</td></tr>
<tr><td>Department</td><td>Mechanical Engineering</td><td colspan="4">Programme Code & Name</td><td colspan="4">M.E. Thermal Engineering</td></tr>
<tr><td colspan="10">Semester-I</td></tr>
<tr><td>Course Code</td><td>Course Name</td><td colspan="3">Hours/ Week</td><td>Credit</td><td colspan="3">Maximum Marks</td><td></td></tr>
<tr><td></td><td></td><td>L</td><td>T</td><td>P</td><td>C</td><td>E</td><td>I</td><td>Total</td><td></td></tr>
<tr><td>ME612</td><td>POWER PLANT CONTROL AND INSTRUMENTATION</td><td>3</td><td>1</td><td>0</td><td>4</td><td>80</td><td>20</td><td>100</td><td></td></tr>
<tr><td>Objective (s)</td><td colspan="9">To create awareness of the importance of working principles of various measuring instruments and their applications in engineering industry. .</td></tr>
<tr><td></td><td colspan="9"></td></tr>
<tr><td>1</td><td colspan="5">STATIC & DYNAMIC CHARACTERISTICS OF INSTRUMENTS</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="10">Static & dynamic characteristics of instruments, sensors, signal processing & data transmission elements, indicating & recording elements.</td></tr>
<tr><td>2</td><td colspan="5">DATA ACQUISITION</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="10">Use of computers for data acquisition & instrumentation for measuring temperature, pressure flow, speed, vibration & noise.</td></tr>
<tr><td>3</td><td colspan="5">ELECTRICAL PARAMETERS</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="10">On-line process instruments. Automatic process control systems Representation. Feedback control concepts. Transient & Frequency response. Types of controllers</td></tr>
<tr><td>4</td><td colspan="5">STABILITY OF INSTRUMENTS</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="10">Stability, Digital Control System Modern Control theory. Boiler Control, Governing & Control of turbo-machines.</td></tr>
<tr><td>5</td><td colspan="5">COMPUTER AIDED POWER SYSTEMS ANALYSIS</td><td colspan="2">Total Hrs</td><td colspan="2">9</td></tr>
<tr><td colspan="10">Modeling of power system, components, Formation of bus admittance and impedance matrices, Power flow solution Gauss-Seidel, Newton Raphson, and fast de-coupled load flow, Short Circuit studies, Static equivalents of power system, Basic concepts of security analysis and state estimation.</td></tr>
<tr><td colspan="8">Total hours to be taught</td><td colspan="2">45</td></tr>
<tr><td colspan="10">Text book (s)</td></tr>
<tr><td>1</td><td colspan="9">Beckwith and Buck, Mechanical Measurements.</td></tr>
<tr><td>2</td><td colspan="9">A.K.Tayal, Instruments and Mechanical Measurements, Galgotia Publication</td></tr>
<tr><td colspan="10"></td></tr>
<tr><td>1</td><td colspan="9">“McCloy and Martin H.R., The Control of Fluid Power, Longman Publication, 1973.</td></tr>
<tr><td>2</td><td colspan="9">Williams, D.A. and G. James, “Liquid Fuels”, London Pergamon, 1963</td></tr>
<tr><td>3</td><td colspan="9">David Lindsley “Power-Plant Control and Instrumentation “IEE Control Engineering Series 585.</td></tr>
<tr><td>4</td><td colspan="9">W.Bolton “Instrumentation and Control Systems”, 1st Edition Elsevier, 2004</td></tr>
</table>

CBIT	Autonomous Regulation								
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME613	**DESIGN OF PUMPS AND COMPRESSORS**	3	1	0	4	80	20	100	
Objective (s)	To create awareness of the importance of working principles of design of rotary pumps and rotary compressors .								

1	**INTRODUCTION TO PUMPS AND COMPRESSORS**	**Total Hrs**	**9**
Characteristics of working fluids, Fluid mechanics concepts and governing laws of fluid flow.			
2	**DESIGN OF PUMPS**	**Total Hrs**	**9**
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 behavior and advantages, Selection of the pumps – types of pumps. Selection of piping and other components. Development of a schematic layout of the piping system			
3	**OPERATION AND MAINTANANCE OF PUMPS**	**Total Hrs**	**9**
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.			
4	**ROTARY COMPRESSORS**	**Total Hrs**	**9**
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.**.**			
5	**DESIGN OF IMPELLORS**	**Total Hrs**	**9**
Design of impeller, Types of impellers – centrifugal and axial. Design of a diffuser – Vaneless and vaned diffuser. Types of casings, casing design. Performance characteristics of turbo compressors.			
Total hours to be taught			**45**

Text book (s)	
1	S.M. Yahya, Turbines, Compressors and Fans, Tata McGraw Hill Publishing Co.
2	Val.S. Lobanoff and Robert R. Ross, Centrifugal Pumps – Designs and Application, Jaico book publishing Co
1	Igor J. Karassik and Joseph P. Messina “Pump Handbook 1986
2	Kovats, Andre, Design and performance of centrifugal and axial flow pumps and compressors, Oxford, New York, Pergamon Press, 1964.

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Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME614	**NUMERICAL METHODS**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of working principles of numerical analysis and its applications in engineering .							

1	**LINEAR SETS OF EQUATIONS**	**Total Hrs**	**9**
Gauss Elimination, LV Decomposition, Matrix Inversion, Scalar Tridiagonal Matrix, Thomas Algorithm, Gauss Seidel Method, Secant Method			
2	**NON-LINEAR SETS OF EQUATIONS**	**Total Hrs**	**9**
Solving nonlinear sets of equations Minimization of function, Newton's Method, Quasi-Newton Method, Steepest Descent Method, Eigen Values & Vectors.			
3	**INTERPOLATION**	**Total Hrs**	**9**
Interpolation & Polynomial Approximation Least Squares Method, Lagrange Interpolation, Hermite Interpolation, Cubic Spline Interpolation, Chebeshev Polynomials & Series			
4	**NUMERICAL DIFFERENTIATION**	**Total Hrs**	**9**
Numerical Differentiation & Integration Numerical Differentiation, Richardson's Extrapolation, Definite & Indefinite Integrals, Simpson's Rule, Trapezoid Rule, Gaussian Quadrature			
5	**ORDINARY DIFFERNENTIAL EQUATIONS**	**Total Hrs**	**9**
First and Higher Order Taylor Series, First order Runge-kutta Method, Fourth order Runge-kutta Method, Stiff Equations, Errors, Convergence Criteria			
Total hours to be taught			**45**

Text book (s)	
1	Cheney E. Ward, Kincaid D.R., Numerical Methods and Applications, 2008, Cengage Learning
2	Gerald C.F., Wheatley P.O., Applied Numerical Analysis, 7th Ed, Pearson Education.
1	Burden R.L., Faires J.D., Numerical Analysis: Theory and Applications, 2005, Cengage Learning.
2	Chapra S.C., Canale R.P., Numerical Methods for Engineers, 4th Ed,Tata McGraw Hill.
3	Mathews J.H., Fink K.D., Numerical Methods using MA TLAB, 4th Ed, Pearson Education
4	6. Press W.H., Taukolsky S.A., Vetterling W.T., Flannery B.P., Numerical Recipes in C++, 2nd Ed, Cambridge University Press

CBIT	Autonomous Regulation							
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering		
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME615	**ENVIRONMENTAL ENGINEERING AND POLLUTION CONTROL**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of the harmful effects of different types of pollution and its effects on human beings and environment							
1	**AIR POLLUTION**							
Sources and Effect - Acid Rain - Air Sampling and Measurement - Analysis of Air Pollutants - Air Pollution Control Methods and Equipments - Issues in Air Pollution control.								
2	**SOLID WASTE MANAGEMENT**							
Sources and Classification - Characteristics of solid waste-Potential methods of solid waste Disposal – Process and Equipments for Energy Recovery from Municipal Solid Waste and Industrial Solid Waste								
3	**WATER POLLUTION**							
Sources and Classification of Water Pollutants - Characteristics - Waste Water Sampling Analysis - Waste Water Treatment - Monitoring compliance with Standards - Treatment, Utilization and Disposal of Sludge								
4	**OTHER TYPES OF POLLUTION**							
Noise Pollution and its impact - Oil Pollution - Pesticides - Radioactivity Pollution Prevention and Control								
5	**POLLUTION FROM THERMAL POWER PLANTS AND CONTROL METHODS:**							
Instrumentation for pollution control - Water Pollution from Tanneries and other Industries and their control								
Total hours to be taught								**45**
Text book (s)								
	G.Masters" Introduction to Environmental Engineering and Science, Prentice -Hall 1998 International Editions.							
	S.Peavy, D.R..Rowe, G.Tchobanoglous "Environmental Engineering" - McGraw- Hill Book Company,NewYork.1985.							
References								
	H.Ludwig, W.Evans :" Manual of Environmental Technology in Developing Countries, 1991							
	Environmental Considerations in Energy Development, Asian Development Bank (ADB), Manilla 1991							

CBIT	Autonomous Regulation							
Department	Mechanical Engineering	Programme Code & Name			M.E. Thermal Engineering			
Semester-I								
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks		
		L	T	P	C	E	I	Total
ME616	**REFRIGERATION MACHINERY & COMPONENTS**	3	1	0	4	80	20	100
Objective (s)	To create awareness of the importance of the refrigeration and its application in daily today life and design of various components of refrigerator.							

1 REFRIGERANT COMPRESSORS

Hermetic compressors - Reciprocating, Rotary, Scroll Compressors, Open type compressors- Reciprocating, Centrifugal, Screw Compressors. Semi hermetic compressors – Construction , working and Energy Efficiency aspects. Applications of each type.

2 DESIGN OF CONDENSERS

: Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Designing different types of condensers, BIS Standards, Optimization studies.

3 DESIGN OF EVAPORATORS

: Different types of evaporators, Design procedure, Selection procedure, Thermal Stress calculations, matching of components, Design of evaporative condensers.

4 REFRIGERATION SYSTEM COMPONENTS

Evaporators and condensers - Different types, capacity control, circuitry, Oil return, Oil separators - Different types Refrigerant driers strainers, Receivers, Accumulators, Low pressure receivers, Air Washers, Spray ponds.

5 SYSTEM ACCESSORIES AND CONTROLS

Refrigerant Pumps, Cooling Tower fans, Compressor Motor protection devices, Oil equalizing in multiple evaporators, Different Defrosting and capacity control methods and their implications -Testing of Air conditioners, Refrigerators, Visicoolers, Cold rooms, Calorimetric tests.

Total hours to be taught	**45**

Text book (s)

1	Chlumsky, “Reciprocating & Rotary compressors”, SNTL Publishers for Technical literaure, 1965.
2	Hains, J.B, “Automatic Control of Heating & Airconditioning” Mc Graw Hill, 1981.

References

1	Althose, A.D. & Turnquist, C.H. “Modern Refrigeration and Air conditioning” Good Heart -Wilcox Co. Inc., 1985.
2	Recent release of BIS Code for relevant testing practice.
3	ASHRAE Hand book: Equipments, 1998
4	Cooper &Williams, B. “Commercial, Industrial, Institutional Refrigeration, Design, Installation and Trouble Shooting “ Eagle Wood Cliffs (NT) Prentice Hall, 1989.

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Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME617	**ENERGY MANAGEMENT**	3	1	0	4	80	20	100	
Objective (s)	To create awareness of the importance of the energy auditing and determination of evaluation methods of engineering projects .								

1	**PRINCIPLES OF ENERGY MANAGEMENT**		
Managerial Organization – Functional Areas for i. Manufacturing Industry ii. Process Industry iii. Commerce iv. Government. Role of Energy Manager in each of these organizations. Initiating, Organising and Managing Energy Management Programs			
2	**ENERGY AUDITING**		
Energy Audit: Definition and Concepts, Types of Energy Audits – Basic Energy Concepts – Resources for Plant Energy Studies – Data Gathering – Analytical Techniques. Energy Conservation: Technologies for Energy Conservation , Design for Conservation of Energy materials – energy flow networks – critical assessment of energy usage – formulation of objectives and constraints – synthesis of alternative options and technical analysis of options – process integration.			
3	**ECONOMIC ANALYSIS**		
Economic Analysis: Scope, Characterization of an Investment Project – Types of Deprecication – Time Value of money – budget considerations, Risk Analysis.			
4	**METHODS OF EVALUATION OF PROJECTS**		
Methods of Evaluation of Projects : Payback – Annualised Costs – Investor's Rate of return – Present worth – Internal Rate of Return – Pros and Cons of the common methods of analysis – replacement analysis. Energy Consultant: Need of Energy Consultant – Consultant Selection Criteria.			
5	**ALTERNATIVE ENERGY SOURCES**		
Alternative Energy Sources : Solar Energy – Types of devices for Solar Energy Collection – Thermal Storage System – Control Systems-Wind Energy – Availability – Wind Devices – Wind Characteristics – Performance of Turbines and systems.			
Total hours to be taught			**45**

Text book (s)	
1	W.C. Turner "Energy Management Hand book" 5th edition, the Fair Mount Press
2	W.R.Murphy and G.Mc Kay "Energy Management", Butterworth Publications
References	
1	C.B.Smith "Energy Management Principles" Pergamon Press
2	Stephen W.Fardo, Dile, R.Patric, "Energy conservation Guide Book" Fair Mount Press
3	Frank Krieth, D.Yogi Goswamy "Energy management & conservation hand book" CRC Press 2008

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Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME618	**CONVECTIVE HEAT TRANSFER**	3	1	0	4	80	20	100	
Objective (s)	To create the awareness of the importance of principles of heat transfer by convection and its applications in engineering along with solution. .								

1 INTRODUCTION TO CONVECTIVE HEAT TRANSFER

Forced, free & combined convection – convective heat transfer coefficient – Application of dimensional analysis to convection – Physical interpretation of dimensionless numbers. Equations of Convective Heat Transfer: Continuity, Navier-Strokes equation & energy equation for steady state flows – similarity – Equations for turbulent convective heat transfer – Boundary layer equations for laminar, turbulent flows – Boundary layer integral equations.

2 FORCED CONVECTION

External Laminar Forced Convection: Similarity solution for flow over an isothermal plate – integral equation solutions – Numerical solutions – Viscous dissipation effects on flow over a flat plate. External Turbulent Flows: Analogy solutions for boundary layer flows – Integral equation solutions – Effects of dissipation on flow over a flat plate.

Internal Laminar Flows: Fully developed laminar flow in pipe, plane duct & ducts with other cross-sectional shapes – Pipe flow & plane duct flow with developing temperature field – Pipe flows & plane duct flow with developing velocity & temperature fields. Internal Turbulent Flows: Analogy solutions for fully developed pipe flow –Thermally developing pipe & plane duct flow.

3 NATURAL CONVECTION

Boussineq approximation – Governing equations – Similarity – Boundary layer equations for free convective laminar flows – Numerical solution of boundary layer equations. Free Convective flows through a vertical channel across a rectangular enclosure – Horizontal enclosure – Turbulent natural convection.

4 COMBINED CONVECTION

Governing parameters & equations – laminar boundary layer flow over an isothermal vertical plate – combined convection over a horizontal plate – correlations for mixed convection – effect of boundary forces on turbulent flows – internal flows - internal mixed convective flows – Fully developed mixed convective flow in a vertical plane channel & in a horizontal duct.

5 HEAT TRANSFER THROUGH POROUS MEDIA

Area weighted velocity – Darcy flow model – energy equation – boundary layer solutions for 2-D forced convection – Fully developed duct flow – Natural convection in porous media – filled enclosures – stability of horizontal porous layers.

Total hours to be taught	**45**

Text book (s)

1	Patrick H. Oosthuigen & David Naylor “Introduction to Convective Heat Transfer Analysis” (TMH)
2	Kays & Crawford “Convective Heat & Mass Transfer” TMH, 2000

References

1	Oosthigen, “Convective Heat and Mass Transfer” McGrawhill, 1998
2	Adrian Bejan “Convection Heat Transfer”, 2nd Edition John Wiley,1984

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Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME619	**THERMAL AND NUCLEAR POWER PLANTS**	3	1	0	4	80	20	100	
Objective (s)	To create the awareness of working of thermal and nuclear power plants along with economics								

1	**STEAM POWER PLANTS**
	Sources of Energy, types of Power Plants, Direct Energy Conversion System, Energy Sources in India, Recent developments in Power Generation. Combustion of Coal, Volumetric Analysis, Gravimetric Analysis, Flue gas Analysis. Steam Power Plants: Introduction – General Layout of Steam Power Plant, Modern Coal-fired Steam Power Plants, Power Plant cycles, Fuel handling, Combustion Equipment, Ash handling, Dust Collectors. Steam Generators: Types, Accessories, Feed water heaters, Performance of Boilers, Water Treatment, Cooling Towers, Steam Turbines, Compounding of Turbines, Steam Condensers, Jet & Surface Condensers.
2	**GAS TURBINE POWR PLANTS**
	Cogeneration, Combined cycle Power Plants, Analysis, Waste-Heat Recovery, IGCC Power Plants, Fluidized Bed Combustion – Advantages & Disadvantages.
3	**NUCLEAR POWR PLANTS**
	Nuclear Physics, Nuclear Reactors, Classification – Types of Reactors, Site Selection, Methods of enriching Uranium, Applications of Nuclear Power Plants. Nuclear Power Plants Safety: By-Products of Nuclear Power Generation, Economics of Nuclear Power Plants, Nuclear Power Plants in India, Future of Nuclear Power.
4	**ECONOMICS OF POWER GENERATION**
	Economics of Power Generation: Factors affecting the economics, Load Factor, Utilization factor, Performance and Operating Characteristics of Power Plants. Economic Load Sharing, Depreciation, Energy Rates, Criteria for Optimum Loading, Specific Economic energy problems.
5	**POWER PLANT INSTRUMENTATION**
	Classification, Pressure measuring instruments, Temperature measurement and Flow measurement. Analysis of Combustion gases, Pollution – Types, Methods to Control.
Total hours to be taught	**45**

Text book (s)

1	EL- Wakil, M.M., “Power Plant Technology “ Mc Graw Hill, New York, 1985.
2	Weis Man, J.and Eckert, R, “Modern Power Plant Engineering”, PHI, New Delhi, 1983

References

1	Arora and Domkundwar, “A course in Power Plant Engineering”, Dhanpat Rai & sons 2002.
2	P.K. Nag, “Power Plant Engineering,” TMH, 2003
	P.C.Sharma, “Power Plant Engineering” Kotaria Publications. 2007

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Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
		L	T	P	C	E	I	Total	
ME630	**THERMAL SYSTEMS LABORATORY**	3	1	0	4	50	25	100	
Objective (s)	To demonstrate basic knowledge by determining various parameters and conducting experiments using the principles of thermal engineering.								

1. Performance Evaluation on single cylinder 4-stroke SI Engine with alternate fuels with computer interfacing.
2. Performance Evaluation on single cylinder 4 stroke CI Engine with alternate fuels with computer interfacing.
3. Determination of heat transfer coefficient in Film wise and Drop wise condensation
4. Cross flow Heat Exchanger.
5. Heat Pipe Demonstration
6. Performance text on Axial flow compressor.
7. Performance test on solar collector
8. Determination of coefficient of thermal expansion of Solids, Liquids and Gases .
9. Determination of thermal capacity of Solids
10. Determination of isentropic coefficient of air by Clement-Desormes method
11. Measure of enthalpy of fusion and solidification
12. Measurement of Temperature Distribution in the interior and external Surface of an electric water heater with thermometers and thermo-camera

CBIT	Autonomous Regulation								
Department	Mechanical Engineering	Programme Code & Name				M.E. Thermal Engineering			
Semester-I									
Course Code	Course Name	Hours/ Week			Credit	Maximum Marks			
ME631		L	T	P	C	E	I	Total	
	CFD LABORATORY	3	1	0	4	80	20	100	
Objective (s)	To demonstrate basic knowledge of governing equations, pertaining to CFD with application to mechanical engineering practice								

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 : Static Mixer – Modeling, Grid generation
9. Exercise 2 : Static Mixer – Pre, Solver, Post Processor
10. Exercise 3 : Flow Mixing in a pipe bend – Modeling, Grid generation
11. Exercise 3 : Flow Mixing in a pipe bend - Pre, Solver, Post Processor
12. Exercise 4 : Aerodynamic analysis over a body – Modeling, Grid generation
13. Exercise 5 : Cascade Analysis – Modeling, Grid generation
14. Exercise 5 : Cascade Analysis - Pre, Solver, Post Processor