Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(*An Autonomous Institute affiliated to University of Pune*)

Structure and Syllabus of

M.E. (Mechanical – Heat Power Engineering)

Pattern A-13

Effective from Academic Year 2013-14

Prepared by: - Board of Studies in Mechanical Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by,

Chairman – BOS **Chairman – Academic Board**

Index

Semester – I

Title : Syllabus Format – PG Courses **FF No. : 658**

STRUCTURE – SEMESTER I

Subject Code	Subject Name	Type	Teaching scheme (Hrs./week)		Assessment scheme					Credits
					ISA#				ESA	
			Lect.	Practical	CT*	MSE	HA	CA	ESA	
Semester –I										
ME50101	Mathematical Methods in Mechanical Engineering	Theory	3	-	10	30	10		50	3
ME50107	Thermo Fluids –I	Theory	3	-	10	30	10		50	3
ME50108	Advanced Thermodynamics	Theory	3	-	10	30	10		50	3
Elective I		Theory	3	-	10	30	10	-	50	3
ME52116	Advanced Turbo Machines									
ME52117	Energy Conservation and Management									
ME50102	Advanced Stress Analysis									
Elective II		Theory	3	-	10	30	10	-	50	3
ME52118	Advanced IC engines									
ME52119	Advanced Refrigeration Systems									
ME52104	Process equipment Design									
ME50303	Thermal Engineering Lab I	Lab	-	4	-	-	-	100	-	4
HS56301	Communication and Soft Skill	Lab	-	2					100	2
ME50403	CVV-I	Oral	-	-					100	2
ME 57705	Semester Project – I	Project	-	6	-	-	-	-	100	2
Total			**15**	**12**						**25**

***** CT (Unit 1) 1 hour 30 marks converted to 10 marks + HA (minimum 3) – Total 30 marks converted to 10 marks = 20 marks

MSE – 2 hours 60 marks converted to 30 marks (Unit 2 & 3), ESE – 3 hours 100 marks converted to 50 marks (Unit 1 to 6)

ISA – In Semester Assessment, ESA – End Semester Assessment, CT- Class Test,

MSE – Mid Semester Examination, HA- Home Assignment, CA – Continuous Assessment, ESE – End Semester Examination

Title : Syllabus Format – PG Courses **FF No. : 658**

ME50101: Mathematical Methods in Mechanical Engineering

Credits: 03 Teaching Scheme: 3 hrs / Week

Course Objectives:-

i. The students will have a thorough knowledge of the mathematical methods to be applied to problems in Mechanical Engineering.

Course Outcomes:

i. Students develop an in-depth knowledge of numerical methods applicable for mechanical engineering
ii. Students develop the ability to formulate and to obtain the numerical solution of mechanical engineering problems
iii. Students will be able to compare different numerical schemes
iv. Students will be able to understand the algorithms of mechanical engineering related software packages

Unit I

Linear Algebra **(10Hrs.)**

Classical theory, Direct methods – LU, SVD, Iterative Methods- Gauss Siedel, tridiagonal systems, eigenvalues, maximum and minimum eigenvalues, applications

Unit II

Interpolation **(2 Hrs.)**

Splines – Quadratic and Cubic Splines, applications

Unit III

Nonlinear system **(3 Hrs.)**

Newton Method for nonlinear systems, applications to engineering systems

Unit IV

Ordinary Differential equations (8Hrs.)

Linear systems, classical methods, adaptive numerical methods, implicit methods for stiff systems.

Unit V

Variational Methods (5Hrs.)

Energy Methods: Rayleigh-Ritz and Galerkin methods, Introduction to FEM – application to one dimensional boundary value problems

Unit VI

Partial Differential Equations (12Hrs.)

Elliptic equations- classical and iterative methods, Parabolic Equations – classical and numerical methods; Hyperbolic Equations – analytical and numerical methods

Total Contact Hours: 40

Reference Books:

1. Numerical Methods for scientific and engineering computation: MK Jain, SRK Iyengar and RK Jain.
2. Mathematics of Physics and Engineering: IS Sokolnikoff and RM Redheffer.

Title : Syllabus Format – PG Courses **FF No. : 658**

ME50107: Thermofluids-I

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Objectives:

i. The students will have a thorough knowledge and understanding of fluid flow and convective heat transfer.

Outcomes:

i. The students will be able to understand various types of flows and hat transfer.
ii. They will be able to model various flow and thermal systems.

Unit 1 (7 Hrs)
Governing Equations: of mass, momentum and energy in differential, integral forms; flow kinematics streamlines, vorticity, strain rate etc.

Unit 2 (7 Hrs)
Conduction: steady state and transient; melting and solidification

Unit 3 (6 Hrs)
External fluids: Flow over a flat plate and heat transfer, Other External flows

Unit 4 (7 Hrs)
Internal flows: boundary layer, fully developed flows, heat transfer; introduction to turbulence

Unit 5 (7 Hrs)
Natural convection: governing equations, similarity solutions

Unit 6 (6 Hrs)
Phase-change Convection: boiling and condensation, Nusselt solution

Total Contact Hours: 40

Text Books:

1. Viscous Fluid Flow, FM White - 1991 - McGraw-Hill, Inc., New York

2. Heat conduction, MN Özisik - 1993 - Wiley, New York

3. Fundamentals of aerodynamics, JD Anderson - 2001 - McGraw-Hill, Inc., New York

4. Convective Heat and Mass Transfer, WM Kays, ME Crawford, B Weigand 2004 McGraw-Hill, Inc., New York

Reference Books:

1. Thermal Radiation Heat Transfer R Siegel, JR Howell 1992 Hemisphere Washington DC

2. Boundary Layer Theory H Schlichting, K Gersten 2000 McGraw Hill, New York

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50108: ADVANCED THERMODYNAMICS

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. Students will obtain knowledge of advance thermodynamic analysis to be applied for practical problems
ii. To study deeply and research the relations of enthalpy entropy and internal energy and their derivations
iii. To gain knowledge about mass and heat balance equations by solving practical problems

Course Outcomes:

i. Students should be able to do a thermodynamic cycle analysis using SFEE
ii. Students should be able to derive the enthalpy entropy and internal energy co-relations using Maxwell and Clayperon equations
iii. Students should be able to solve the Gas mixture problems using the properties of gases specified in the mixture

Unit 1: Entropy **(7 Hrs)**

Thermodynamic cycle analysis, Thermodynamic cycle analysis, entropy, principle of degradation of energy, increase in entropy principle, Tds relations, and entropy change of pure substance, of solids and of liquids, entropy change of Ideal gases, Available and unavailable steady flow system, practical considerations with availability, Availability in closed system

Unit 2: Pure Substance **(6 Hrs)**

Pure and impure substance, properties of pure substances, P.V. diagram, for pure substances, P-T diagram for pure substance, T-S diagram for pure substance, P-V-T surface.

Unit 3: Thermodynamic Property Relations **(7 Hrs)**

Maxwell relations, Clapeyron equation, general relations for du, dh, ds, cv and cp, Joule-Thomson coefficient, inversion curve, change of enthalpy, internal energy and entropy

for real gases. Equations of states, Generalised compressibility factor and chart, law of corresponding states, enthalpy deviation, entropy deviation of real gases

Unit 4: Gas Mixtures (6 Hrs)

Composition of gas mixtures, mass and mole fraction, Gibbs Dalton laws, p-v-t behaviour of gas mixtures, The Amgat-Ludac law, properties of gas mixtures

Unit 5: Chemical Thermodynamics and Equilibrium (7 Hrs)

Combustion reactions, enthalpy of formation, Gibbs function of formation and absolute entropy, heat of reaction and heating value, Adiabatic flame temperature. Dissociation, combustion in excess and deficient air criteria for chemical equilibrium, equilibrium constant for ideal gas mixtures, fugacity and activity

Unit 6: Statistical Thermodynamics (7 Hrs)

Probability, phase space, quantum considerations, Degeneracy, Microstates, Macrostates and thermodynamic probability, Sterlings, approximation, Bose-Einstein statistics, Fermi-Derac statistics, Classical Maxwell – Bolzmann model, equilibrium distribution, Entropy partition functions, statistical interpretations of first and second law. Statistical mechanics of ensembles, Fluctuations and equivalence of ensembles, Analysis of ideal gas system

Total Contact Hours: 40

Text Books:

1. Cenjel and Boles, Thermodynamics: An Engineering Approach, Tata McGraw Hill Co., New Delhi.
2. Van Wylen & Sontagy : Thermodynamics, John Wiley and Sons Inc., U.S.A.
3. P. K. Nag: Thermodynamics, Tata Mc Graw Hill Co., New Delhi.

Reference Books:

1. Holman: Thermodynamics, McGraw Hill Inc., New York.
2. Faires V.M. and Simmag – Thermodynamics, Macmillan Publishing Co. Inc., U.S.A.
3. Rao Y.V.C. – Postulational and Statistical Thermodynamics – Allied Publishers Inc.

ME52116: Advanced Turbo Machines

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. To understand the flow and thermal analysis of turbomachines
ii. To be able to design various types of turbomachines

Course Outcomes:

i. Students are able to perform analysis and modeling of different turbomachines
ii. Students are able to design different turbomachines

Unit 1: Review of Turbomachines: - **6 Hrs**

Euler Blade equation, slip, degree of reaction, efficiencies

Unit 2: Dimensional Analysis:- **6 Hrs**

Non-dimensional numbers, Model-Prototype comparison

Unit 3: Centrifugal Machines: **8 Hrs**

Analysis and Design of Centrifugal Blowers, Compressors and Pumps

Unit 4: Axial Machines: **8 Hrs**

Design and Analysis of fans, compressors and pumps, cavitation

Unit 5: Turbines: **6 Hrs**

Water, Steam and Gas Turbines

Unit 6: Wind Turbines- **6 Hrs**

Analysis and Design

Total Contact Hours: 40

Reference Books

1. A Treatise on turbomachines, G. Gopalakrishnan and D. Prithvi Raj, SciTech Publcns, Madras 2011
2. Gas Turbines, V. Ganesan, Tata McGraw Hill, New Delhi 2003.
3. Gas Turbine Theory, HIH Saravanamuttoo, H. Cohen, GFC Rogers, Pearson Education, New Delhi 2001,

Title : Syllabus Format – PG Courses **FF No. : 658**

ME52117: Energy Conservation and Management

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

- **i.** To create awareness about energy efficiency
- **ii.** To enable students understand operational aspects of Industrial systems (Energy producing/Consuming)
- **iii.** To create awareness of National and International policies and acts.
- **iv.** To create awareness of standardization of energy appliances.
- **v.** To introduce energy economics.

Course Outcomes:

- **i.** Students should be able to understand energy efficiency and energy economics of Industrial systems.
- **ii.** Students should be able to find performance assessment of Thermal and Electrical utilities.
- **iii.** Students should be able to understand Standardisation of energy appliances, National and International policies.

UNIT 1: General Aspects of Energy Management (7 Hrs)

Energy Scenario , Energy Management & Audit ,Energy Action Planning, Financial Management, Project Management , Energy Monitoring and Targeting , Global environmental concerns

UNIT 2: Financial Management (7 Hrs)

Investment-need, appraisal and criteria, financial analysis techniques-simple pay back period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of ESCOs

UNIT 3: Industrial Thermal Systems : **(7 Hrs)**

Energy conservation in steam generation and supply system.

Boiler performance, Boiler efficiency, insulation

UNIT 4: HVAC Systems: (6 Hrs)

Energy conservation in refrigeration and air conditioning systems.

UNIT 5: Electrical and Compressed Air Systems (6 Hrs)

Energy Standards: Energy conservation in motors, energy efficient motors, power factor improvement, variable speed drive. Illumination levels, fixtures, energy-efficient illumination. Compressed Air systems.

UNIT 6: Energy Performance Assessment (7 Hrs)

Energy performance assessment and efficiency improvement of Boilers, Furnaces, Heat exchangers, Fans and blowers, pumps, Energy Performance Assessment of Power Plants, Process Industries,
Buildings and Commercial Establishments

Total Contact Hours: 40

Reference Books:

1. Handbook of Energy Audit, Albert Thumann P.E. CEM, William J. Younger CEM, The Fairmont Press Inc., 7th Edition.
2. Energy management Handbook, Wayne C. Turner, The Fairmont Press Inc., 5th Edition, Georgia.
3. Handbook on Energy Audit and Environment management, Abbi Y. A., Jain Shashank, TERI Press, New Delhi, 2006
4. Energy Performance assessment for equipment and Utility Systems.-Vol. 1,2,3.4, BEE ,Govt. of India
5. Boiler Operator, Guide Fourth Edition, Anthony L Kohan, McGraw Hill
6. Energy Hand book, Second edition,
7. www.enrgymanagertraining.com
8. www.bee-india.nic.in

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50102: ADVANCED STRESS ANALYSIS

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Objectives

i. To introduce to students the Concept of three dimensional stress and strain at a point as well stress-strain relationships for isotropic materials.

ii. To introduce to students the method of calculation of stresses in components of noncircular cross section subjected to unsymmetrical bending and torsional loading.

iii. To introduce to students the method of calculation of shear stress in thin walled sections and determination of shear center.

iv. To introduce to students the method of calculation of stresses and strains associated with thick wall cylindrical pressure vessels and rotating disks.

v. To introduce to student the methods of computing contact stresses and deflections

Outcomes:

i. Students will be able to apply the mechanics of materials methods to engineering problems to understand structural responses to various loading conditions.
ii. Students will be able to formulate solutions to solid mechanics problems.
iii. Students will be able to comprehend current research findings as reported in journals in the field of solid mechanics

Unit 1 Theory of elasticity (6 Hrs.)

Plane stress & Plane strain, Two dimensional problems in Rectangular & Polar co-ordinate system, Analysis of stresses & strains in three dimension.

Unit 2 Theory of torsion (6 Hrs.)

Torsion of general prismatic bars of solid section, Membrane Analogy, Torsion of Thin walled tubes,

Torsion of Thin walled Multiple-Cell closed sections, Torsion of rolled sections

Unit 3 Bending of Prismatic bars, Unsymmetric and Plastic bending (8 Hrs.)

Concept of shear centre in symmetrical and unsymmetrical bending, stress and deflections in beams subjected to unsymmetrical bending, shear center for thin wall beam cross section, open section with one axis of symmetry, general open section and closed section.

The plastic flow process, shape factor, springback, plastic bending with strain hardening material, plastic hinges, plastic deflection.

Unit 4 Plate Bending (6 Hrs.)

Bending of plate to cylindrical surface, Bending of a long uniformly loaded rectangular plate, pure bending in two perpendicular directions, Bending of circular plates loaded symmetrically w.r.t. center. Circular plate with circular hole at center symmetrically loaded & load distributed along inner & outer edges, Bending of circular plates of variable thickness.

Unit 5 Pressurized Cylinders & Rotating Disks (8 Hrs.)

Governing equations, stresses in thick walled cylinder under internal & external pressure, shrink fit compound cylinders, stresses in rotating flat solid disk, flat disk with central hole, disk with variable thickness, disk of uniform strength.

Unit 6 Contact Stresses (6Hrs)

Geometry of contact surfaces, methods of computing contact stresses and deflection of bodies in point contact, stress for two bodies in line contact with load normal to contact area and load normal and tangent to contact area. Introduction to analysis of low speed impact.

Total Contact Hours: 40

Text Books :

1. Advanced strength and Applied stress analysis - Richard G Budynas, McGraw Hill
2. Advanced Mechanics of solids - L S Srinath , McGraw Hill

Reference Books

1. Advanced Mechanics of Materials - Cook and Young , Prentice Hall
2. Theory of elasticity - Timoshenko and Goodier , McGraw Hill
3. Advance Strength of Materials- vol 1 & 2 – Timoshenko, CBS publisher
4. Advanced Mechanics of Materials – Boresi, Schmidt, Sidebottom, Willey
5. Mechanics of Materials - vol 1 & 2 - E J Hearn , Butterworth- Heinemann

Title: Syllabus Format – PG Courses **FF No. : 658**

ME 52118: Advanced Internal Combustion Engines

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. To understand measurement & testing of engines, engine emissions explained with modern techniques & electronic instrumentations.
ii. To understand recent research developments like engine heat transfer, electronic engine management & electronic injection systems.
iii. To understand the latest engine emission control technologies
iv. To understand the latest engine developments

Course Outcomes:

i. Students will be able to perform engine testing
ii. Students will be able analyse engine heat transfer problems
iii. Students will be able to apply different emission control strategies
iv. Students will be able to demonstrate the latest engine technologies

Unit 1: Measurement & Testing (6 Hrs)

Introduction, FP, IP, BP, Fuel & Air Consumption, Speed, Exhaust and Coolant Temperature

Unit 2: Performance Parameters and Characteristics (6 Hrs)

Engine Performance Parameters, Indicated and Brake Power and MEP, Operating Variables That Affect SI Engine Performance, Efficiency, and Emissions, Variables That Affect CI Engine Performance, Efficiency, and Emissions, Methods of improving engine performance

Unit 3: Engine Heat Transfer (7 Hrs)

Variation of Gas Temperature, Piston and Cylinder Temperature Distribution, Theory and Parameters affecting, Types of Efficient Cooling Systems

Unit 4: Engine Emission Control Technology: (7 Hrs)

SI Engine Emission Control Technology: Engine Design Parameters, Add on Treatments, Catalytic exhaust after treatment, Catalytic converter types and catalyst deactivation, Gasoline direct injection stratified charge Engines

CI Engine Emission Control Technology: Fuel Injection variables, Exhaust gas recirculation, Catalytic exhaust gas after treatment, Diesel Particulate filters

Unit 5: Electronic Injection System and Engine Electronics (7 Hrs)

Gasoline injection, EFI system, MPFI system, Electronic control system, injection timing, electronic diesel injection system and controls. EMS, Position Displacement and Speed Sensing, Pressure and Temperature Measurement, Intake Air Flow Measurement

Unit 6: Advanced Engine Technology: (7 Hrs)

HCCI Engines, HCCI operation of gasoline Engines, HCCI operation of diesel engines, Lean Burn engine, Different approaches to lean burn, LHR engine, Surface ignition concept, catalytic ignition, variable valve timing, Latest Trends in the Engine Technology.

Total Contact Hours: 40

Text Books:

1. The Internal Combustion Engine in Theory and Practice Volume I & II by Charles Fayette Taylor, The MIT Press
2. John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Edition, 1998
3. Internal Combustion Engines- V Ganesan , 2nd edition, TaTa McGraw Hill
4. Internal Combustion Engines, C.R. Ferguson & A.R. Kirkpatrick, John Wiley and sons, second edtion.

Reference Books:

1. Gasoline Engine Management, Bosch handbook,2nd edition, Professional
2. Automotive Technology, Jack Erjavec, 3rd edition, Delmar Thomson Learning Engineering Publication Inc.
3. Design and Simulation of four stroke engines, Gordon P Blair, SAE International
4. B.P. Pundir, Engine Emissions, Pollution formation and advances in control Technology, Narosa Publishing House.

ME 52119: ADVANCED REFRIGERATION SYSTEMS

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. Develop the skills to analyze the multi pressure refrigeration systems
ii. Estimate the refrigeration load & design the system components
iii. Gain the knowledge of prevailing environmental laws & norms

Course Outcomes:

i. Gain the overview of various common refrigeration applications
ii. Able to design a little complex refrigeration system
iii. Exposure to legal aspects of refrigeration field

Unit 1: Vapour Compression Refrigeration (6 Hrs)

Standard cycle.; Effects of operating conditions – suction and condensing temperature, Actual cycle; Second Law Efficiency of the cycle; Liquid – Vapour regenerator., Representation on P-h & T-s Charts

Unit 2: Multipressure Systems (8 Hrs)

Multistage compression with flash inter-cooling and closed inter-cooling; Multi-evaporator systems with individual and multiple expansion valves; Cascade systems and their optimum coupling temperature;. Performance characteristics and capacity control of compressors; Compressor rating and selection; Introduction & principle of working of Screw compressor and Scroll compressor

Unit 3: System Components & Controls (8 Hrs)

Various types of refrigeration compressors, condensers, expansion devices & evaporators & their selection, type of electric motors & their controls, system components balancing, refrigerant controls

Unit 4: Refrigerants & Vapor Absorption Systems: (6 Hrs)

Refrigerants
Designation and selection of refrigerants; desirable thermodynamic, physical and chemical properties of a refrigerant; CFC/HCFC phase-out regulations, Montreal and Kyoto Protocols; Alternative eco-friendly Refrigerants; Retrofits with alternative refrigerants; Refrigeration lubricant requirements
Vapor Absorption Systems
Standard cycle; Actual cycle and its representation on enthalpy – concentration diagram; Thermodynamic analysis of vapour absorption cycle; Ammonia – water and water –

lithium bromide systems; single/double effect & single/double stage systems(Descriptive treatment only); practical absorption chiller; alternative working fluids for absorption systems; Capacity control

Unit 5: Air Refrigeration and Nonconventional Refrigeration (6 Hrs)

Bell Coleman Cycle; Aircraft refrigeration systems – simple, Boot strap, regenerative and reduced ambient; Analysis of an aircraft refrigeration cycle; Dry air rated temperature, its significance and use; Concept, introduction and working principle of Non conventional refrigeration systems.

Unit 6: Load estimation & Refrigeration Applications: (6 Hrs)

Sources of heat generation, insulating materials, design principles of cold storage, milk tankers, blood plasma storage, and refrigerant piping guidelines

Refrigeration Applications:- Refrigeration for preservation of Food, Refrigerating systems for transport by trucks and containers; Refrigerated Railway cars; Marine Refrigeration(Descriptive treatment only)

Total Contact Hours: 40

Text Books:

1. R.J.Dossat, Principles of Refrigeration, Pearson Education Asia
2. C.P.Arora, Refrigeration and Air-conditioning, Tata McGraw-Hill

Reference Books:

1. Stoecker & Jones, Refrigeration and Air-conditioning
2. J.L.Threlkeld, Thermal Environmental Engineering, Prentice Hall
3. W.F.Stoecker, Industrial Refrigeration Handbook, McGraw-Hill
4. John A.Corinchock, Technician's Guide to Refrigeration systems, McGraw–Hill
5. P.C.Koelet, Industrial Refrigeration: Principles, Design and Applications, Macmillan
6. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration

Title: Syllabus Format – PG Courses **FF No. : 658**

ME52104: Process Equipment Design

Credits: 03 Teaching Scheme: 3 hrs / Week

Course Objectives:

i. Understand the content of process flow diagrams (PFD)
ii. Understand the content of piping and instrument diagrams (P&ID)
iii. Introducing students to various design codes
iv. To enable students to apply the requirements of the relevant industry standards to the mechanical design of equipments used in the process industry and above ground atmospheric storage

Course Outcomes:

i. Students will be able to understand the calculation of line sizes and pressure drops , flow measurement sizing and develop a flow measurement process data sheet.
ii. Students will have understanding of several design codes used in the design.
ii. Students will have understanding of the principles of process equipment design, the mechanical aspects of the design and operation of process equipment, including safety considerations.
iv. Students will be able to complete detailed designs of several process equipments.

Unit 1 : Process Design Parameters (7 Hrs)

Basic concepts in process design, block diagrams for flow of processes, material flow balance. Introduction to design codes like IS-2825, ASME-SECT, EIGHT-DIV-II TEMA.API-650, BS-1500 & 1515.

B)Process Control :

Fundamentals of process measurements and control modern control devices and other controls of major unit operation and processes. Applications of CAD to process Equipment Design.

Unit 2 : Design of Cylindrical and Spherical Vessels (7 Hrs)

Thin and thick walled cylinder analysis, design of end closers, local stresses due to discontinuity or change of shape of vessel, vessel opening compensation, design of standard and non-standard flanges, design of vessels and pipes under external pressure, design of supports for process vessels.

Unit 3 : Design of Tall Vessels and Large Storage Tanks (7 Hrs)

Determination of equivalent stress under combined loadings including seismic and wind loads application of it to vertical equipment like distillation column.

Unit 4 : Process Equipment Design (7 Hrs)

Storage vessels, reaction vessels, agitation and mixers, heat exchangers, filters and driers, centrifuges. Code practices, selection and specification procedures used in design. Selection of pumps, compressors, electrical equipments and auxiliary services, safety, etc.

Unit 5 : Process Piping Design (6 Hrs)

Flow diagrams and pipe work symbols, design of layout of water, steam and compressed air pipes work, pipe fitting, linings and flanged connections. Types of valves used on pipe line. Fabrication of pipe lines, expansion joints and pipe supports.

Unit 6 : (6 Hrs)

Planning, manufacture, inspection and erection of process equipment like pressure vessels, chimneys, ducting, heat exchangers, pulverising equipment, etc. protective coatings, lining of vessels.

Total Contact Hours: 40 Hrs.

Text Books:

1) Process Equipment Design : By Dr. M.V. Joshi, Mc-Millan.

2) Process Equipment Design : By Browell and Young, John Wiley.

3) Plant Design and Economics : Max and Timasulaus Kalus – McGraw Hill.

4) Industrial Instrumentation servicing Hand Book : Cannel Grady, McGraw Hill.

Reference Books :

1) Handbook of Instrumentation and Control : Kellen Heward, McGraw Hill.

2) Chemical Engineering Handbook : Perry John, McGraw Hill.

3) Chemical Equipment Design : B.C. Bhattacharya.

4) Industrial Pipe Work : D.N.W. Kentish, McGraw Hill.

5) Chemical Engineering : J.M. Coulson, Richardson, Sinnott Vol. VII, Maxwell, McMillan.

6) Pressure Vessel Design Hand Book : H. Bedna.

7) Dryden's outlines of Chemical Technology for the 2 : By Roa M. Gopala, Sitting M., East West Press Pvt. Ltd., New Delhi.

8) Applied Process Design for Chemical and Petrochemical, Vol. I, II and III : By E.E. Ludwig, Gulf Publication Co., Houston.

9) Chemical Process Control : An Introduction to Theory and Practice : By Stephanopoulos G., Prentice Hall of India, New Delhi.

10) Chemical Process Equipment Selection and Design : By Stanley M.Walas, Butterworth-Heinemann Series in Chemical Engineering.

11) Process System Analysis and Control : By D.R. Coughanowr, McGraw Hill, New York.

12) Engineering Optimsiation : Theory and Practice : By Rao S.S., New Age Publishing Co., New Delhi.

13) Optmisation of Chemical Processes : By Edgar T.F., Himmelblau D.M., McGraw Hill Book Co., New York.

14) Control Devices, Vol. I and II : Liptak

15) Analysis, synthesis and design of Chemical Processes : Richard Turton, Richard C. Bailie, Wallace B. Whiting, Josheph A. Shaewitz, Prentice Hall Int. Series in Physical and Chemical Science.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50303: Thermal Engineering Lab I

Credits: 04 Teaching Scheme: 4 hrs / Week

Course Objectives:-

i. To apply the theoretical knowledge to solve practical problems in Thermal Engineering
ii. Hands on experience through actual experimentation or simulation studies

Course Outcomes:

i. Ability to formulate and analyse practical problems in Thermal Engineering
ii. Ability to do experimentation along with calibration of the instruments
iii. Ability to make mathematical/geometrical model and simulation studies through appropriate software
iv. Ability to analyse data obtained through experimentation/simulation studies and drawing suitable technical conclusions

List of experiments:-

1. **Thermo Fluids –I**
   i. Boundary layer over a flat plate simulation
   ii. Simulation on drag of various bodies
   iii. Condensation over a vertical plate

2. **Advanced Thermodynamics**
   i. P V T surface plot using MATLAB or C
   ii. Trial on steam power plant and Rankine Cycle analysis
   iii. Exergy analysis of Steam power plant or any thermal systems
   iv. Preparation of property charts
   v. Adiabatic flame temperature and heat of combustion determination using applets available
   vi. Gibbs function and equilibrium constants relationship verification for different combustion reactions

3. **Advanced Turbo Machines**

i. Trial on centrifugal compressor
ii. Trial on steam turbine
iii. Trial on axial compressor

4. Energy Conservation and Management

i. Energy Audit of Commercial Building/Establishments.
ii. Energy Audit of Plant Industry/Utilities.

5. Advanced Stress Analysis

i. Plate bending analysis using FEA
ii. Contact Stress analysis of mechanical components
iii. Determination of shear center for thin walled cellular structure and its FEA

6. Advanced IC engines

i. Performance trial on diesel engine, with P-Theta and Emission analysis
ii. Performance trial on diesel engine, as per Bharat stage norms.
iii. Performance test on Variable compression ratio engine and data analysis
iv. Performance test on Gasoline engine

7. Advanced Refrigeration Systems

i. Thermal analysis of multipressure system using computer
ii. Design of refrigeration application
iii. Study & trial on non conventional refrigeration system
iv. Visit to a refrigeration plant

8. Process equipment design

i. Autocad assignment on process flow diagram
ii. Visit report for any process industry like sugar factory.
iii. Pipe stress analysis using Caesar software

**** Any two experiments should be conducted from each of the offered subject.**

Title: Syllabus Format – PG Courses **FF No. : 658**

HS56301: Communication and Soft Skill

Credits: 02 **Teaching Scheme: 2 hrs / Week**

This course will be conducted centrally by BOS-DESH

ME50403: CVV I

Credits: 02 **Teaching Scheme: --**

Course Objectives:

1. To ensure that the student has thorough conceptual understanding of Engineering subjects in breadth

2. To ensure that the depth of understanding of applying mathematical subjects extends to more than one subject or / and to more than one discipline.

3. To check that the student has abilities to communicate technical concepts and ideas clearly and that he /she will be able to interpret and express his/her perceptions to an elite audience confidently.

Course Outcomes:

1. The objectives mentioned broadly above will be verified as an outcome

2. The student will be able to define problems of applied interest neatly and also coherently propose methodologies to solve them in known form or in a form demanding research investigation.

3. The student will be of extensive use to an industry

SCOPE

The scope of the VIVA VOCE will include all material which the student is deemed to have assimilated during the course.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME57705: Semester Project I

Credits: 02 Teaching Scheme: 6 hrs / Week

Course Objectives:

i. To ensure that the student has thorough conceptual understanding of theory subjects.

Course Outcomes:

i. The students will be able to apply theoretical concepts taught in the class on a mechanical system.

Project should include either of the following:

1. Student should model and perform simulation of design or heat transfer problem.
2. Student should analyze a system in depth, and draw sound conclusions based on the analysis.
3. Student should model the system and conduct experiments to draw conclusions from the study.
4. Students should perform structural or thermal FE analysis of a mechanical component and discuss the results.

Semester – II

Title: Syllabus Format – PG Courses **FF No. : 658**

STRUCTURE – SEMESTER II

Subject Code	Subject Name	Type	Teaching scheme (Hrs./week)		Assessment scheme					Credits
					ISA#				ESA	
			Lect.	Practical	CT*	MSE	HA	CA	ESA	
Semester –II										
ME50109	Advanced Measurements and Data Analysis	Theory	3	-	10	30	10	-	50	3
ME50110	Thermofluids- II	Theory	3	-	10	30	10	-	50	3
ME50111	Design of Heat Exchangers	Theory	3	-	10	30	10	-	50	3
Elective III		Theory	3	-	10	30	10	-	50	3
ME52120	Advanced Air Conditioning									
ME52121	IC engine Fuels and Combustion									
ME50106	Computer Aided Engineering									
Elective IV		Theory	3	-	10	30	10	-	50	3
ME52122	Cryogenic Engineering									
ME52107	Optimization Techniques									
ME52123	Computational Fluid Dynamics									
ME50304	P G Lab-II/ Thermal Engineering Lab II	Lab	-	4	-	-	-	100	-	4
ME57704	Technical Seminar-I	Lab	-	2	-	-	-	100	-	4
ME50404	CVV-II	Oral	-	-	-	-	-	-	100	2
ME57706	Semester Project –II	Project		6	-	-	-	-	100	2
Total			**15**	**12**						**27**

***** CT (Unit 1) 1 hour 30 marks converted to 10 marks + HA (minimum 3) – Total 30 marks converted to 10 marks = 20 marks

MSE – 2 hours 60 marks converted to 30 marks (Unit 2 & 3), ESE – 3 hours 100 marks converted to 50 marks (Unit 1 to 6)

\# ISA – In Semester Assessment, ESA – End Semester Assessment, CT- Class Test,

MSE – Mid Semester Examination, HA- Home Assignment, CA – Continuous Assessment, ESE – End Semester Examination

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50109: Advanced Measurements and Data Analysis

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. To learn principles of data analysis and advanced techniques used for measuring field and derived quantities in mechanical engineering

Course Outcomes:

i. Students will learn how to measure field parameters like temperature, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration and derived parameters like torque, power, thermo physical properties, radiation and surface properties.

ii. They will learn to do regression analysis of the data and find useful correlations.

Unit 1: Introduction to advanced measurement methods (6 Hrs)

Introduction to measurements for scientific and engineering application, Broad classification of methods for measuring field and derived quantities

Unit 2: Data analysis (6 Hrs)

Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data

Unit 3: Field quantities measurement (8 Hrs)

Measurement of field quantities: thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration

Unit 4: Derived quantities measurement (8 Hrs)

Measurement of derived quantities: torque, power, thermo physical properties, radiation and surface properties

Unit 5: Analytical methods (6 Hrs)

Analytical methods and pollution monitoring, mass spectrometry, chromatography, spectroscopy

Unit 6: Types of control actions (6 Hrs)

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

Total Contact Hours: 40

Text Books:

1. Doebelin E.O., Measurement Systems-Application and Design, Mc-Graw Hill Publication Co.
2. Bolton W., Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg., Pearson
3. Beckwith TG. N. Lewis Buck and Marangoni R.D, Mechanical Measurements, Narosa Publishing House, New Delhi

Reference Books:

1. Liptak B.G. Instrument Engineers' Handbook
2. Johnson C.D., Process Control Instrumentation, Pearson
3. J. P. Holman: Experimental Methods For Engineers, Mc-Graw Hill International

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50110: Thermofluids- II

Credits: 03 Teaching Scheme: 3 hrs / Week

Course Objectives:

i. To understand the hydrodynamics and thermal characteristics of compressible and incompressible fluid flow and heat transfer

Course Outcomes:

i. Students will learn how to analyse and model thermal and flow systems

Unit: 1 **(7 Hrs)**

Compressible flows: one-dimensional flows, subsonic and supersonic flow over thin airfoils.

Unit: 2 **(6 Hrs)**

Compressible boundary layers, Introduction to hypersonic flows.

Unit: 3 **(7 Hrs)**

Radiative heat transfer : Introduction, view factor determination methods.

Unit: 4 **(6 Hrs)**

Heat transfer in enclosures with grey-diffuse surfaces.

Unit: 5 **(7 Hrs)**

Turbulence: Hydrodynamic stability, governing equations, free shear flows.

Unit: 6 **(7 Hrs)**

Wall shear flows, isotropic turbulence, one and two equation models, and large eddy simulation.

Total Contact Hours: 40

Reference Books:

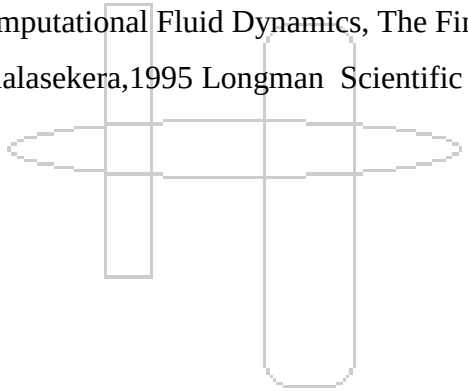
1. Viscous Fluid Flow FM White - 1991 - McGraw-Hill, Inc., New York

3. Fundamentals of aerodynamics JD Anderson - 2001 - McGraw-Hill, Inc., New York

5. Thermal Radiation Heat Transfer R Siegel, JR Howell 1992 Hemisphere Washington DC

6. Boundary Layer Theory H Schlichting, K Gersten 2000 McGraw Hill, New York

7. An Introduction to Computational Fluid Dynamics, The Finite Volume Method H.K.Versteeg & W.Malalasekera,1995 Longman Scientific & Technical, England



Title: Syllabus Format – PG Courses **FF No. : 658**

ME50111: Design of Heat Exchangers

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i Know common heat exchanger types, their advantages and limitations
ii Learn how to handle rating and sizing problems in heat exchanger design
iii Understand how to consider fouling of surfaces, incorporate fouling in designs, and handle fouling during heat exchanger operation

Course Outcomes:

i Learn how to design common types of heat exchangers; namely shell-and-tube, gasketed plate. Learn to select appropriate Heat Exchanger for the given application.
ii Will understand uses in some new engineering areas or in innovative applications
iii Become aware of and will appreciate single and multiphase heat transfer and friction coefficient correlations, and they will know how to select the appropriate ones for the case in hand

Unit 1 : Introduction **(5 hrs)**

Heat Exchangers: Meaning, Classification, Significance, Applications and Selection

Unit 2 : Basic Design Process **(8 hrs)**

Thermal Design: Thermal-Hydraulic fundamentals, Performance evaluation of Heat Exchangers. LMTD, e-NTU methods, Fouling. Rating and sizing problems, Heat Transfer and Pressure drop calculations. Standards (TEMA).

Mechanical Design: 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 etc. Flow induced vibrations.

Unit 3 : Design of Shell and Tube Heat Exchanger **(8 hrs)**

Thermal Design of Shell and Tube heat exchanger: Tinker's, Kern's and Bell Delaware's method. Introduction to automotive heat exchanger; Compact heat exchangers.

Unit 4 : Design of Plate Heat Exchanger **(7 hrs)**

Thermal Design of plate Heat Exchangers; condensers, boilers, Super heaters, cooling towers etc.

Unit 5 : Heat Transfer Enhancement and Performance Evaluation **(6 hrs)**

Enhancement of heat transfer, Performance evaluation of Heat Transfer Enhancement technique. Introduction to pinch analysis.

Unit 6 : Introduction to Simulation and Optimization **(6 hrs)**

Modeling and commercial codes. Introduction to simulation and optimization of heat exchangers.

Total Contact Hours: 40

Text Books:

4. Sadik Kakac, and Hongtan Liu, "Heat Exchangers: Selection, Rating and Thermal Design", 2nd edition, CRC Press, 2002
5. R. K. Shah, D. P. Sekulic, "Fundamentals of Heat Exchanger Design", John Wiley and Sons, Inc., 2003.
6. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
7. Frank P. Incropera and David P. De Witt, "Fundamentals of Heat Transfer", Wiley, Eastern Limited.

Reference Books:

1. T. Kuppan, "Hand Book of Heat Exchanger Design".
2. "T.E.M.A. Standard", New York, 1999.
3. Kays and London, "Compact Heat Exchanger".
4. G. Walker, "Industrial Heat Exchangers-A Basic Guide", McGraw Hill, 1982.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME52120: Advanced Air Conditioning

Credits: 03 Teaching Scheme: 3 hrs / Week

Course Objectives:

i. Develop the skills to analyze the large air conditioning systems
ii. Estimate the heating/cooling load & design the system components
iii. Gain the knowledge of contemporary air conditioning systems

Course Outcomes:

i. Gain the overview of various common & special air conditioning applications
ii. Able to design a little complex air conditioning system
iii. Exposure to duct sizing, fan selection, plant noise control

Unit 1: Advanced Psychrometrics (7 hrs.)

Lewis Number, enthalpy deviation curves, construction of psychrometric charts. Study of inside and outside design conditions, & applications,

Unit 2: Heat Gains (7 hrs.)

Physics of solar radiation, solar heat gain, study of various sources of internal and external heat gains, concept of thermal lag, cooling load calculations, RHF, GSHF, ESHF, ertc

Unit 3: Air distribution (6 hrs.)

Fundamentals of air flow in ducts, pressure drop calculations, sizing of ducts using equal friction method, Equal velocity method & static regain method, duct materials and properties, insulating materials, types of grills, diffusers, wall registers, etc.

Unit 4: Sound Control (6 hrs.)

Definition of various terms like level, pitch, attenuation, frequency, sources of noise in air conditioning plants, design procedure for noise prevention.

Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure.

Unit 5: Direct and indirect evaporative cooling: (7 hrs.)

Basic psychrometry of evaporative cooling, types of evaporative coolers, design calculations, indirect evaporative cooling for tropical countries

Heating: Heat loss calculations, heat pumps, heating coils, electric heating, warm air systems, hot water systems.

Unit 6: Air conditioning equipments and controls: (7 hrs.)

Cooling coils, humidifiers, dehumidifiers, various types of filters, air washers, thermostat, humidistats, cycling and sequence controls, modern controls for purity, odour and bacteria.

Air conditioning systems : Classification, study of central and unitary systems, typical air conditioning systems such as automobile, air planes, ships, railway coach air-conditioning systems, clean rooms (Descriptive treatment only).

Total Contact Hours: 40

Text Books:

1. Norman C. Harris: Modern Air Conditioning.
2. C.P.Arora, Refrigeration and Air-conditioning, Tata McGraw-Hill

Reference Books:

ASHRAE Handbooks.

1. Handbook of air-conditioning system design, Carrier Incorporation, McGraw Hill Book Co., U.S.A.
2. Refrigeration and air-conditioning, Anant Narayanan, Tata McGraw Hill Co.
3. Jones W.P.: 'Air Conditioning Engineering', Edward Arnold Publishers Ltd., London, 1984.
4. Hainer R.W. 'Control Systems for Heating, Ventilation and Air-Conditioning', Van Nastrand Reinhold Co., New York, 1984.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME 52121: I.C. ENGINES - FUELS AND COMBUSTION

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. To understand recent developments in combustion, flame propagation, combustion chamber, emission controls
ii. To understand recent research developments in fuels and alternative fuels
iii. To understand combustion and performance of supercharged engines
iv. To understand pollutant formation physics

Course Outcomes:

i. Student will able to demonstrate developments in fuels and alternative fuels for IC engines.
ii. Student will able to explain the physics of combustion in SI and CI engine
iii. Student will able to analyse the performance of supercharged engines
iv. Student will able to explain pollutant formation physics and their control strategies accordingly

Unit 1: Fuels for S.I., C.I. Engines and Alternate Fuels (6 Hrs)

Qualities of SI & CI engine fuels, rating of SI & CI engine fuels, fuel additives for SI & CI engines, liquid fuels, gaseous fuels, hydrogen engines, Availability and comparative properties of alternate fuels, CNG, LPG, Alcohol, Vegetable oil and Bio-gas .Engine performance and emission characteristics

Unit II Combustion and Combustion Chambers in SI Engines (7 Hrs)

Thermodynamic analysis of SI engine combustion, analysis of cylinder pressure data, flame structure and speed, stages of combustion, phenomenon of detonation, effect of engine variables on detonation, combustion chambers for SI engines, emission needs.

Unit III Combustion and Combustion Chambers in CI Engines (7 Hrs)

Phenomenological model of C I engine combustion, analysis of cylinder pressure data, Stages of combustion, factors affecting delay period, the phenomenon of knock in CI engine, combustion chambers for CI engines, emission needs

Unit IV Performance of Supercharged and Turbocharged Engines (7 Hrs)

Purpose of Supercharging, Supercharging of SI engine, Supercharging of CI engine, Modification of engine for supercharging, supercharging arrangements, Turbochargers

Unit V Fuel/Air Mixture Requirements (6 Hrs)

For steady running, Optimum fuel/Air ratios, idling and low load, normal and maximum power range, transient mixture requirements, effect of operating variables on mixture requirements, mixture requirements for CI engines, Modern trends in fuels and combustion

Unit VI Pollutant Formation and Control (7 Hrs)

Nature and extent of problem, Nitrogen oxides, Carbon monoxide, unburned hydrocarbon emissions, particulate emissions, and emission control as per standards.

Total Contact Hours: 40

Text Books:

1. John B Heywood, Internal Combustion Engine Fundamentals, McGraw Hill International Edition, 1998.
2. V.Ganesan, Internal Combustion Engine, 2nd edition, Tata McGraw Hill Ltd., 2003.
3. Obert, Edward F. *Internal Combustion Engines and Air Pollution.* New York: In text Educational Publishers, 1973 edition

Reference Books:

1. Bosch. *Automotive Handbook.* 5th ed. Published by Robert Bosch GmbH. Warrendale, PA: Distributed by SAE, 2000. A concise and useful summary of technical data on engine and vehicle components and systems.
2. Owen, K., and T. Coley. *Automotive Fuels Handbook.* Warrendale, PA: Society of Automotive Engineers, 1990. An extensive compilation of information on gasoline's and diesel fuels and their effects on engine operation.
3. Makartchouk, A. *Diesel Engine Engineering: Thermodynamics, Dynamics, Design, and Control*. New York and Basel: Marcel Dekker, Inc., 2002.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50106: COMPUTER AIDED ENGINEERING

Credits: 03 Teaching Scheme: 3 hrs / Week

Course Objectives:

i. Understand the fundamental ideas of the solid modeling.
ii. Understand the fundamental ideas of the FEM.
iii. Understand the fundamental ideas of the Computational Fluid Dynamics
iv. Can interpret and evaluate the quality of the results.
v. Learn how the finite element method is implemented (both algorithmically and numerically) by developing simple finite element computer code
vi. Develop finite element formulations of engineering problems from a variety of application areas including stress, heat transfer, and vibration analysis.
vii. Be aware of the limitations of the FEM. Learn to use Nastran® /ANSYS (Commercial finite element programs)

Course Outcomes:

i. Knowledge of the governing equations for commonly encountered mechanical engineering problems.
ii. Students will learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations
iii. Modeling and simulation of complex engineering problems by proper selection of finite element and boundary conditions.
iv. Ability to solve linear, nonlinear and dynamic analysis problems using 1D, 2D and 3D FE models.
v. Ability to think laterally and originally, conceptualise and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering all necessary factors.
vi. Usage of commercial FE softwares to solve complex engineering problems with an understanding of their limitations.
vii. Using Nastran®/ANSYS perform stress, thermal, and modal analysis

Unit 1: Solid Modeling (7 hrs.)

Geometry & Topology, Solid representation, Techniques of volume modeling, Feature based modeling: Feature representation, Parametrics, Relations, Constraints, Feature Manipulation. Mass properties calculations, Assembly modeling and Assembly analysis. Product Data Exchange.

Unit 2: One dimensional Finite Element Analysis (7 hrs.)

Linear bar element, Quadratic bar element, beam element, frame element. Development of Finite Element Models of discrete systems like Linear elastic spring, Torsion of Circular Shaft, Fluid flow through pipe, One dimensional conduction with convection.

Unit 3: Two dimensional Finite Element Analysis (7 hrs.)

Three noded triangular element, six noded triangular element, four noded quadrilateral element, eight noded quadrilateral element and nine noded quadrilateral element. Development of Finite Element Models for plane stress, plane strain, Axisymmetric stress analysis applications.

Unit 4: Dynamic Analysis Using Finite Elements (7 hrs.)

Vibration problems, Equations of motion based on weak form, Equations of motion using Lagrange's approach, consistent and lumped mass matrices, Solution of Eigenvalue problems, Transient vibration analysis.

Unit 5: Computational Flow Simulation (5 hrs.)

Meshing for flow simulation, finite volume methods, pressure-velocity coupling, numerical stability.

Unit 6: Three dimensional Finite Element Analysis (7 hrs.)

Four node tetrahedral element, six node prism element, Eight node Hexahedral element and higher order elements. Boundary conditions, Mesh Generation, Mesh Refinement and other practical considerations.

Total Contact Hours: 40

Text Books:

1. Ibrahim Zeid, 'Mastering CAD/CAM', Tata McGraw Hill Co. Ltd. 2007
2. Larry J. Segerlind, 'Applied Finite Element Analysis', John Wiley & Sons, New York, 1984.
3. T Sundararajan and K Muralidhar, 'Computational Fluid Flow and Heat Transfer', Alpha Science International, Ltd., 2003.
4. T R Chandraupatla, A D Belegundu, 'Introduction to Finite Elements in Engineering', Pearson Education, 3rd Ed. 2004.

Reference Books:

1. D F Roger, J Adams, 'Mathematical Elements for Computer Graphics', McGraw Hill Co. Ltd. New York, 1990.
2. J N Reddy, 'Introduction to Finite Element Method' , Tata McGraw Hill Co. Ltd, 2005
3. K H Huebner, D L Dewhirst, D E Smith, T G Byrom, 'The Finite Element Method for Engineers', John Wiley & Sons, New York, 2008.
4. P. Sheshu, Textbook of Finite Element Analysis, Prentice Hall of India, 2004.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME52122: Cryogenic Engineering

Credits: 03 Teaching Scheme: 3 hrs / Week

Objectives:

i. Students will obtain knowledge of various gas liquefaction, gas separation and purification systems

Outcomes:

i. Students are able to evaluate the performance of different liquefaction systems.
ii. Students are able to justify the use of different working fluids and engineering materials in cryogenic systems.
iii. Students are able to study the processes of gas separation and purification using cryogenic systems.

Unit I Introduction (6 Hrs)

Limitations of Carnot cycle, vapor compression cycle and air refrigeration cycle. Production of low temperature by reversible and irreversible adiabatic expansion of a gas; Joule Thomson effect; Joule Thomson co-efficient, Inversion curve.

Unit II Gas liquefaction systems (8 Hrs)

Linde-Hampson, Linde dual pressure, Claude, Heylandt and Kapitza systems; Systems for liquefaction of Neon, Hydrogen and Helium; Collins and Simon systems for helium liquefaction

Unit III Gas separation and purification Systems (9 Hrs)

Ideal system, Gas separation by simple condensation or evaporation, principles of rectification, Air separation systems – Linde single column and double column, Linde–Frankl, Heylandt; Argon separation system; Neon separation system; Linde – Bronn system for hydrogen separation, Hydrogen – deuterium separation system; Helium separation from natural gas; Physical adsorption for gas purification

Unit IV Gas refrigeration Systems (8 Hrs)

Joule Thomson refrigeration system, Pre cooled Joule Thomson refrigeration system, Expansion engine refrigeration system, Cold gas refrigeration system [elementary treatment only]; Stirling cryocooler

Unit V Material and fluid properties (5 Hrs)

Thermal and Mechanical properties of engineering materials at cryogenic temperatures, Properties of cryogens, Cryogenic insulations

Unit VI Cryogenic Applications (4 Hrs)

Applications in space, on-ground, medical, electronic cooling, manufacturing processes, preservation and bio-technology

Total Contact Hours: 40 Hrs.

Reference books:

1. R.Barron, Cryogenic systems, McGraw–Hill Company
2. G.G.Hasseldon. Cryogenic Fundamentals, Academic Press
3. Bailey, Advanced Cryogenics, Plenum Press
4. W.F.Stoecker, Industrial Refrigeration Handbook, McGraw-Hill
5. John A.Corinchock, Technician's Guide to Refrigeration systems, McGraw–Hill
6. P.C.Koelet, Industrial Refrigeration: Principles, Design and Applications, Macmillan
7. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration

Title : Syllabus Format – PG Courses **FF No. : 658**

ME52107: OPTIMISATION TECHNIQUES

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

To make the students o learn different methods of optimization to solve engineering problems**.**

Course Outcomes:

i. Develop the ability to obtain the optimal solution for engineering problems
ii. Are in a position to model engineering problems and pose it as an optimisation problem
iii. Apply the optimisation methods to design a thermal/flow system

Unit 1 : (7Hrs)

Review of Maths, calculus, linear algebra, function of several variables, extrema, constrained extrema

Unit 2 : (7 Hrs)

One-dimensional optimization: polynomial(quadratic, cubic) methods, golden search method, iterative methods

Unit 3 : (7 Hrs)

Gradient based methods: conjugate gradient, steepest descent, examples

Unit 4 : (7 Hrs)

Linear programming: simplex, dual simplex, case studies

Unit 5 : (7Hrs)

Constrained optimisation: Lagrange multipliers, transformation, linearisation methods

Unit 6 : (5 Hrs)

Evolutionary algorithms: Box complex methods, genetic algorithm, case studies

Total Contact Hours: (40)

Reference Books :

1. Optimization: Theory and Practice, Mohan Joshi and KannanMoudgalya, Narosa Publishing House, Bombay.
2. Optimization: concepts and application engineering, Ashok Belegundu and TirupathiChandrupatla, Pearson Education Asia, Delhi.
3. Engineering Optimization, Singiresu S. Rao, New Age International (P) Ltd., Bombay

ME53123: Computational Fluid Dynamics

Credits: 03 **Teaching Scheme: 3 hrs / Week**

Course Objectives:

i. To have a good understanding of the algorithms used in flow solvers
ii. To be able to compare different algorithms

Course Outcomes:

i. Students will understand algorithms used in flow solvers
ii. Students will be able to compare different algorithms
iii. Students will be able to prepare algorithms

Unit 1: Review of Fluid Mechanics (6Hrs)

Governing Equations, Different Flow Regimes, Simplified Equations for Special Cases

Unit 2 : Convection-Diffusion in Cartesian Domains (7 Hrs)

Convection and Diffusion in Cartesian Domains, upwind schemes, alternating direction methods

Unit 3 : Momentum and Mass Conservation Equations (7 Hrs)

Continuity and pressure correction equations, higher order pressure correction

Unit 4 : Non-Cartesian Grids (6 Hrs)

Finite volume for non-Cartesian domains, conservation equations, gradient calculation

Unit 5 : Finite Volume Convection Diffusion (7 Hrs)

Finite volume applied to convection-diffusion equation, upwind scheme, multigrid methods

Unit 6 : Finite Volume Flow Equation (7 Hrs)

Mass-conservation and pressure correction equations in finite volume, higher order pressure correction equation

Total Contact Hours: 40 Hrs.

Reference Books:

1. Principles of Computational Fluid Dynamics, P. Wesseling, Springer-Verlag, New York 2000
2. Computational Fluid Dynamics: Basics with Applications, J. D. Anderson, McGraw Hill, New York 1995.
3. Computational Methods for Fluid Dynamcis, J. H. Ferziger and M. Peric, Springer-Verlag, Berlin 1999.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50304: Thermal Engineering Lab II

Credits: 04 Teaching Scheme: 4 hrs / Week

Course Objectives:-

i. To apply the theoretical knowledge to solve practical problems in Thermal Engineering
ii. Hands on experience through actual experimentation or simulation studies

Course Outcomes:

i. Ability to formulate and analyse practical problems in Thermal Engineering
ii. Ability to do experimentation along with calibration of the instruments
iii. Ability to make mathematical/geometrical model and simulation studies through appropriate software
iv. Ability to analyse data obtained through experimentation/simulation studies and drawing suitable technical conclusions

**List of experiments:-

1. Advanced Measurements and Data Analysis

i. Calibration of pressure gauge
ii. Calibration of a thermocouple
iii. Problem on analysis of data and error estimation.

2. Thermofluids- II

i. Turbulent boundary layer over a flat plate
ii. Trial on a converging diverging nozzle
iii. Measurement of solar heat flux

3. Design of Heat Exchangers

i. Trial on shell and tube heat exchanger
ii. Trial on compact heat exchanger
iii. Simulation of shell and tube heat exchanger using commercial software

4. Advanced air conditioning

i. Solar heat gain calculations using computer
ii. load estimation of Computer laboratory/Auditorium
iii. Study & trial on a blower/fan
iv. Visit to central Air conditioning plant

5. IC engine Fuels and Combustion

i. Performance trial on diesel/petrol engine with alternative fuels and comparison with base fuel (diesel/petrol).
ii. Emission measurements by using Exhaust Gas Analyzer and Smoke meter.
iii. Properties measurements of alternative fuels.
iv. Engine simulation using software's like AVL Boost, AVL Fire, G.T. Power
v. Analysis of Carbonyl Compound from exhaust emission using HPLC.
vi. Chemical Characterization of Gasoline and Diesel Fuel.

6. Computer Aided Engineering

i. Finite Element Analysis of 2D , 3D problems using commercial FEA SW
    1. Gear tooth analysis
    2. Crane Hook analysis
    3. Plate with hole & study of stress concentration
    4. Pressure Vessel stress Analysis
    5. Connecting Rod, Crank Shaft, Cam Shaft stress Analysis.
ii. Flow Simulation: Flow through pipes, flow over bodies.
iii. Computer Implementation of 2-D Problems.

7. Cryogenic Engineering

i. Analysis of a gas liquefaction system.
ii. Design of a gas liquefaction system.
iii. Analysis of a gas refrigeration system.
iv. Design of a gas refrigeration system.

8. Optimization Technique

i. Unconstrained optimisation.
ii. Constrained optimisation.

9. Computational Fluid Dynamics

i. One dimensional heat Exchanger solver.
ii. Two dimensional conduction solver

**** Any two experiments should be conducted from each of the offered subject.**

Title: Syllabus Format – PG Courses **FF No. : 658**

ME57704: Technical Seminar - I

Credits: 04 Teaching Scheme: 2 hrs / Week

Course Objectives:

1. To empower the student to learn beyond what is taught in class by reviewing literature available at large
2. A student is expected to review research papers periodicals, magazines and review publications on the internet and in other electronic resources.
3. Student is expected to present views coherently to produce a presentation concisely with the surveyed information under the direction of the research guide.

Course Outcomes:

1. Under the influence of the project guide -To engage the student directly or indirectly in research at different levels, from advancing their course materials, professional development, to funded research projects to advance the state of practice.

SCOPE

The scope of the technical seminar will include but not restricted to the discipline of work for the final year thesis. The scope will include

Survey of patents,

Research journals books and databases

Field survey and site visit reports

Communication from experts

Title: Syllabus Format – PG Courses **FF No. : 658**

ME50404: CVV - II

Credits: 02 Teaching Scheme: --

Course Objectives:

1. To ensure that the student has thorough conceptual understanding of Engineering subjects in breadth

2. To ensure that the depth of understanding of applying mathematical subjects extends to more than one subject or / and to more than one discipline.

3. To check that the student has abilities to communicate technical concepts and ideas clearly and that he /she will be able to interpret and express his/her perceptions to an elite audience confidently.

Course Outcomes:

1. The objectives mentioned broadly above will be verified as an outcome

2. The student will be able to define problems of applied interest neatly and also coherently propose methodologies to solve them in known form or in a form demanding research investigation.

3. The student will be of extensive use to an industry

SCOPE

The scope of the VIVA VOCE will include all material which the student is deemed to have assimilated during the course.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME57706: Semester Project II

Credits: 02 Teaching Scheme: 6 hrs / Week

Course Objectives:

i. To ensure that the student has thorough conceptual understanding of theory subjects.

Course Outcomes:

i. The students will be able to apply theoretical concepts taught in the class on a mechanical system.

Project should include either of the following:

1. Design of any thermal and flow systems and its analysis
2. Analysis of thermal and flow system using commercial software's.
3. Experimentation on engine test rig/turbine test rig/ compressor test rig/pump test rig for advanced measurement and data analysis.
4. Design optimization of thermal and flow system using MATLAB. Etc.

Semester – III

STRUCTURE: SEMESTER III

Subject Code	Subject Name	Type	Teaching scheme (Hrs./week)		Assessment scheme					Credits
					ISA				ESA	
			Lect.	Practical	CT*	MSE	HA	CA	ESA	
Semester –III										
HS 66101	**Institute level Open Elective**	Theory	2	-	10	30	10	-	50	2
	Dept. level Open Elective	Theory	2	-	10	30	10	-	50	2
ME 66104	Non Conventional Energy Sources									
ME 66105	Electronic Cooling And Packaging									
ME 66106	Gas Turbine And Jet Propulsion									
ME67705	Dissertation Stage I	Lab	-	4#	-	-	-	-	100	15
ME67704	Technical Seminar-II	Lab	-	2	-	-	-	100	-	4
Total			4	**6**						**23**

***** CT (Unit 1) 1 hour 30 marks converted to 10 marks + HA (minimum 3) – Total 30 marks converted to 10 marks = 20 marks

MSE – 2 hours 60 marks converted to 30 marks (Unit 2 & 3), ESE – 3 hours 100 marks converted to 50 marks (Unit 1 to 6)

ISA – In Semester Assessment, ESA – End Semester Assessment, CT- Class Test,

MSE – Mid Semester Examination, HA- Home Assignment, CA – Continuous Assessment, ESE – End Semester Examination

- Student is expected to work around 40 hours per week as Self Study

Title: Syllabus Format – PG Courses **FF No. : 658**

HS66101: Institute Level Elective

Credits: 02 **Teaching Scheme: 2 hrs / Week**

This course will be conducted centrally by BOS DESH

Title: Syllabus Format – PG Courses **FF No. : 658**

Department Level Open Electives

ME66104: Non Conventional Energy Sources

ME66105: Electronic Cooling and Packaging

ME66106: Gas Turbine and Jet Propulsion

Title: Syllabus Format – PG Courses **FF No. : 658**

ME66104: Non Conventional Energy Sources

Credits: 02 Teaching Scheme: 2 hrs / Week

Course Objectives:-

i. The students will acquire knowledge of various techniques employed to convert energy from non-conventional sources to usable form.

Course Outcomes:

i. Students will have ability to analyse different non-conventional sources of energy.
ii. Students will be able to compare between different non-conventional sources of energy and suggest a suitable source for particular application.

Unit 1: Introduction **(3 Hrs)**

Energy scenario, Need for non-conventional sources of energy, Available alternatives

Unit 2 : Solar Thermal **(6 Hrs)**

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

Unit 3 : Wind **(3 Hrs)**

Wind energy conversion, Wind turbine

Unit 4 : Direct Energy conversion **(6 Hrs)**

Photovoltaic, MHD, Fuel cells, Thermionic, Thermoelectric

Unit 5 : Energy from gas **(4 Hrs)**

Biomass, Biogas, Hydrogen

Unit 6 : Energy from earth and ocean **(6 Hrs)**

Geothermal, OTEC, Tidal, Waves

Total Contact Hours: 28

Reference 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

Title: Syllabus Format – PG Courses **FF No. : 658**

ME66105: Electronic Cooling and Packaging

Credits: 02 Teaching Scheme: 2 hrs / Week

Course Objective:

i. This course is designed to provide a basic knowledge of the technologies and processes required for the packaging and manufacturing of electronic products.

Course Outcome:

i. Student will be able to demonstrate the technologies and processes required for the packaging and manufacturing of electronic products.

Unit 1 **Introduction:** **(5 Hrs)**

Electronics Industry – history, scope and challenges; Introduction to packaging and its role in the industry – Integrated circuits, IC packaging, Semiconductor Roadmap, Moore's Law

Unit 2 **Wafer Fabrication:** **(4 Hrs)**

Crystal growth, Czochralski growth process, CVD, Lithography, Diffusion

Unit 3 **Packaging of Electronic Systems:** **(6 Hrs)**

Different levels of packaging (substrate, PWBs, Rack systems), Interconnects, Chip carriers, Through hole components, Surface mount components, Automated Wire Bonding, Tape Automated Bonding, Flip chip technology, Printed Circuit Boards, Component placement, Routing, Lamination, Drilling and Punching of holes in PCBs, Solder Masks, Types of circuit boards.

Unit 4 **Thermal Design:** **(4 Hrs)**

Cooling systems for electronics packages – heat sinks, heat spreaders, heat pipes, microchannels, actuators, fans, cold plates; Thermo-mechanical issues in electronic packages.

Unit **5** **Mechanical Design:** **(5 Hrs)**

Effects of Vibration – vibrating systems, vibration of axially loaded components, circuit boards, Theorem of Castigliano; Mechanical design – fatigue analysis of leads, creep behaviour of solder balls, Strength of connectors

Unit 6 **Reliability:** **(4 Hrs)**

Design for reliability, Life cycle, Failure Modes and Mechanisms, Reliability Metrology and Analysis, Environmental Stress Screening.

Total Contacts Hours: 28

Reference Books:

1. Packaging of Electronic Systems – James W. Dally, McGraw Hill, New York, NY, 1990.
2. Fundamentals of Microelectronics Packaging – Ed: Rao Tummala, McGraw Hill, New York, NY, 2001.
3. Electronics Manufacturing Processes – Thomas L. Landers, William D. Browne, Earnest W. Fant, Eric M. Malstrom and Neil Schmitt, Prentice Hall, New Jersey, 1994.
4. Thermal Analysis and Control of Electronic Equipment – Allan D. Kraus and Avram Bar-Cohen, McGraw Hill, New York, NY, 1983.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME66106: Gas Turbine and Jet Propulsion

Credits: 02 **Teaching Scheme: 2 hrs / Week**

Course Objectives:

i. To understand the functioning of various components of gas turbines
ii. To be able to analyse various types of jet propulsion cycles

Course Outcomes:

i. Students are able to perform analysis and modeling of different gas turbines
ii. Students are able to analyse different jet propulsion cycles

Unit 1: Introduction **(5 Hrs)**

Cycles, Performance characteristics and improvement, Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics

Unit 2 : Gas Turbine **(4 Hrs)**

Turbine construction, Blade materials and manufacturing techniques

Unit 3 : Gas Turbine blade **(5 Hrs)**

Blade fixing, problems of high temperature operation, blade cooling, practical air cooled blades

Unit 4 : Combustion and fuel systems **(5 Hrs)**

Combustion Systems, various fuels and fuel systems

Unit 5 : Jet propulsion **(5 Hrs)**

Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation

Unit 6 : Environmental aspect **(4 Hrs)**

Environmental considerations and applications

Total Contact Hours: 28

Reference Books:

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.
5. W W Bathic, "Fundamentals of Gas Turbines", John Wiley and Sons.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME67705: Dissertation Stage I

Credits: 15 Teaching Scheme: 4 hrs/week (Practical)

Course Objectives:

1. To help the students to apply theoretical knowledge to any practical problem.
2. To develop technical report writing and presentation of the students.

Course Outcomes:

1. Student should identify problem and decide scope of his dissertation work.
2. Student should complete literature review for dissertation work.

Guidelines

Candidates are required to do project during the entire second year of the course. The work is divided into two parts, project stage-I during the third semester and project stage-II during the fourth semester.

Candidates are required to solve/analyze a mechanical engineering problem or develop any innovative concept/design in mechanical engineering during this period. The problem can be solved/ analyzed with the help of experiments which can be performed on a specially developed set ups or modified existing set up. The work can be based on analysis of components/ subsystems/systems using softwares. The work can also be based on exhaustive numerical analysis. The work can be combination of experimentation and software/numerical analysis. The results obtained need to be validated.

It is expected that, following work be completed during project stage-I.

1. Defining objectives and scope of the project work.
2. Literature review to understand the issues related to the work.
3. Development of the experimental set up, procedure for the experimentation and calibration of the instrument.
4. Study of different softwares to be used for the analysis.
5. Mathematical techniques required for the project work.
6. Sample reading or analysis of sample components needs to be done so as to become familiar with the set up/software/mathematical tools.

A mid semester review will be conducted to finalise the scope and objective of the project work. Project stage I examination will be conducted based on the work completed during this stage.

Title: Syllabus Format – PG Courses **FF No. : 658**

ME67704: Technical Seminar II

Credits: 04 Teaching Scheme: 2 hrs / Week

Course Objectives:

1. To empower the student to learn beyond what is taught in class by reviewing literature available at large
2. A student is expected to review research papers periodicals, magazines and review publications on the internet and in other electronic resources.
3. Student is expected to present views coherently to produce a presentation concisely with the surveyed information under the direction of the research guide.

Course Outcomes:

1. Under the influence of the project guide -To engage the student directly or indirectly in research at different levels, from advancing their course materials, professional development, to funded research projects to advance the state of practice.

SCOPE

The scope of the technical seminar will include but not restricted to the discipline of work for the final year thesis. The scope will include

Survey of patents,

Research journals books and databases

Field survey and site visit reports

Communication from experts

NOTE: The work done in Technical Seminar II should be different from the work done in Dissertation Stage I.

Semester – IV

STRUCTURE – SEMSTER IV

Subject Code	Subject Name	Type	Teaching scheme (Hrs./week)		Assessment scheme					Credits
					ISA				ESA	
			Lect.	Practical	CT	MSE	HA	CA	ESA	
Semester –IV										
ME67706	Dissertation Stage II	Lab	-	8#	-	-	-	-	100	25
Total				**8**						**25**

 # - Student is expected to work around 40 hours per week as Self Study

Title : Syllabus Format – PG Courses **FF No. : 658**

ME67706: Dissertation Stage II

Credits: 25 Teaching Scheme: 8 hrs/week (Practical)

Course Objectives:

i. To develop technical report writing and presentation of the students.
ii. The student should be able to construct mathematical and experimental analysis of a practical problem.
iii. The students should be able to analyze the simulation and experimental data and draw technical conclusions based on the same.

Course Outcomes:

i. Dissertation report with technical conclusions based on simulation and or experimental results.

Guidelines

Project stage II is essentially continuation of the project stage I. The objectives and scope of the project work are defined during the project stage I.

The problem is completely solved during the project stage II. The results obtained are to be validated during this stage of the project. In case of any innovative concept the work would include completely developing the component/product/ process etc. and proving the results. The project work can be presented during the examination conducted as per the institute norms. It is expected that at least one publication / presentation on any relevant platform to be made before final examination.