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
# BRAC'T'S
Vishwakarma Institute of Technology, Pune – 411 037
Department of Mechanical Engineering

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* 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
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 (10 Hrs.)

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:

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 heat 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:


**Reference Books:**


Title: Syllabus Format – PG Courses

ME50108: ADVANCED THERMODYNAMICS

Credits: 03

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 correlations using Maxwell and Clapeyron 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)

**Total Contact Hours: 40**

**Text Books:**

**Reference Books:**
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: -  
Euler Blade equation, slip, degree of reaction, efficiencies  
6 Hrs

Unit 2: Dimensional Analysis:-  
Non-dimensional numbers, Model-Prototype comparison  
6 Hrs

Unit 3: Centrifugal Machines:  
Analysis and Design of Centrifugal Blowers, Compressors and Pumps  
8 Hrs

Unit 4: Axial Machines:  
Design and Analysis of fans, compressors and pumps, cavitation  
8 Hrs

Unit 5: Turbines:  
Water, Steam and Gas Turbines  
6 Hrs

Unit 6: Wind Turbines-  
Analysis and Design  
6 Hrs

Total Contact Hours: 40

Reference Books
  

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)


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)

Total Contact Hours: 40

Reference Books:
4. Energy Performance assessment for equipment and Utility Systems.-Vol. 1,2,3,4, BEE ,Govt. of India
7. www.energymanagertraining.com
8. www.bee-india.nic.in
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 students 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:


Reference Books:

1. Advanced Mechanics of Materials - Cook and Young, Prentice Hall
3. Advance Strength of Materials - vol 1 & 2 - Timoshenko, CBS publisher
ME 52118: Advanced Internal Combustion Engines

Credits: 03

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:**


**Reference Books:**

3. Design and Simulation of four stroke engines, Gordon P Blair, SAE International
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
6. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration
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:
2) Process Equipment Design : By Browell and Young, John Wiley.
4) Industrial Instrumentation servicing Hand Book : Cannel Grady, McGraw Hill.
Reference Books :

1) Handbook of Instrumentation and Control : Kellen Heward, McGraw Hill.
3) Chemical Equipment Design : B.C. Bhattacharya.
6) Pressure Vessel Design Hand Book : H. Bedna.
14) Control Devices, Vol. I and II : Liptak
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.**
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

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

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
SUBJECT – SEMESTER II

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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

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:
2. Bolton W., Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg., Pearson

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:


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)
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)

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:

Reference Books:
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, etc.

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.
Title: Syllabus Format – PG Courses  

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

Unit 1: Fuels for S.I., C.I. Engines and Alternate Fuels  

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  

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  

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  


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:**


**Reference Books:**

ME50106: COMPUTER AIDED ENGINEERING

Credits: 03

Course Objectives:
1. Understand the fundamental ideas of the solid modeling.
2. Understand the fundamental ideas of the FEM.
3. Understand the fundamental ideas of the Computational Fluid Dynamics
4. Can interpret and evaluate the quality of the results.
5. Learn how the finite element method is implemented (both algorithmically and numerically) by developing simple finite element computer code
6. Develop finite element formulations of engineering problems from a variety of application areas including stress, heat transfer, and vibration analysis.
7. Be aware of the limitations of the FEM. Learn to use Nastran® /ANSYS (Commercial finite element programs)

Course Outcomes:
1. Knowledge of the governing equations for commonly encountered mechanical engineering problems.
2. Students will learn the mathematical formulation of the finite element method and how to apply it to basic (linear) ordinary and partial differential equations
4. Ability to solve linear, nonlinear and dynamic analysis problems using 1D, 2D and 3D FE models.
5. 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.
6. Usage of commercial FE softwares to solve complex engineering problems with an understanding of their limitations.
7. Using Nastran®/ANSYS perform stress, thermal, and modal analysis

Unit 1: Solid Modeling (7 hrs.)
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.)

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:
Reference Books:

Title: Syllabus Format – PG Courses

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
7. ASHRAE HANDBOOKS (i) Fundamentals (ii) Refrigeration
ME52107: OPTIMISATION TECHNIQUES

Credits: 03  
Teaching Scheme: 3 hrs / Week

Course Objectives:

To make the students 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:  
(7 Hrs)
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:  
(7 Hrs)
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:
2. Optimization: concepts and application engineering, Ashok Belegundu and Tirupathi Chandrupatla, Pearson Education Asia, Delhi.
ME53123: Computational Fluid Dynamics

Credits: 03  
Teaching Scheme: 3 hrs / Week

Course Objectives:
1. To have a good understanding of the algorithms used in flow solvers
2. To be able to compare different algorithms

Course Outcomes:
1. Students will understand algorithms used in flow solvers
2. Students will be able to compare different algorithms
3. 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:


Title: Syllabus Format – PG Courses

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.

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.

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.**
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
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

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


**BRACC'S**  
Vishwakarma Institute of Technology, Pune – 411 037  
Department of Mechanical Engineering

**STRUCTURE: SEMESTER III**

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Type</th>
<th>Teaching scheme (Hrs./week)</th>
<th>Assessment scheme</th>
<th>Credits</th>
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<td>Non Conventional Energy Sources</td>
<td>Theory</td>
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<td>ME 66105</td>
<td>Electronic Cooling And Packaging</td>
<td>Theory</td>
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<td>ME 66106</td>
<td>Gas Turbine And Jet Propulsion</td>
<td>Theory</td>
<td>2</td>
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<td>ME67705</td>
<td>Dissertation Stage I</td>
<td>Lab</td>
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<td>ME67704</td>
<td>Technical Seminar-II</td>
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* 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

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

Department Level Open Electives

ME66104: Non Conventional Energy Sources
ME66105: Electronic Cooling and Packaging
ME66106: Gas Turbine and Jet Propulsion
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:

4. Bansal and others, “Non-Conventional Energy Sources”.
Title: Syllabus Format – PG Courses

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:**


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:

Title: Syllabus Format – PG Courses

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

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 – SEMESTER IV

<table>
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<tr>
<th>Subject Code</th>
<th>Subject Name</th>
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# - Student is expected to work around 40 hours per week as Self Study
Title: Syllabus Format – PG Courses

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.