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| **Structure and syllabus of M.Tech Mechanical (Heat Power Engineering) applicable w.e.f. A. Y. 2017-18**  |
| Sr.No. | Subject Code | Title |
|  |  | Course Structure |
|  |
|  | ES551TH | Mathematical Methods in Mechanical Engineering |
|  | ME501THL | Advanced Thermodynamics  |
|  | ME502THL | Advanced Fluid Mechanics and CFD  |
|  | ME503THL | Advanced Heat Transfer and CFD |
|  | ES502TH | Research Methodology |
|  | HS551TH | Quantitative Aptitude-1 |
|  |
|  | ME506THL | Advanced Applied Thermal Engineering |
|  | ME507THL | Advance Measurement and Data Analysis |
|  | HS553TH | Engineering Economics |
|  | HS552TH | Quantitative Aptitude-2 |
|  | **Department Elective** |
|  | ME511TH | IC Engines Fuels and Combustion  |
|  | ME512TH | Heating Ventilation Air Conditioning |
|  | ME513TH | Energy Conservation and Management |
|  | **Open Elective** |
|  | ME557THL | Computer Aided Engineering |
|  | ME572TH | Optimization Technique  |
|  | ME523TH | Design of Heat Exchangers |
|  | ME524TH | Advanced Turbomachines |
|  |
|  | - | **Dept. level Open Elective** |
|  | ME611TH | Non Conventional Energy Sources |
|  | ME612TH | Electronic Cooling And Packaging  |
|  | ME613TH | Gas Turbine And Jet Propulsion  |
|  | ME614TH | Design of Experiments |
|  | - | **Inst. level Open Elective** |
|  | HS66101 | Organizational Management |
|  | HS66102 | Business Economics |
|  |  |  |
|  | ME622PS | Technical Seminar  |
|  | ME625PRJ | Dissertation Stage I |
|  |
|  | ME621INT | Industrial in plant training  |
|  |  ME623PS | Technical Seminar |
|  | ME626PRJ | Dissertation Stage I |
|  |
|  | ME627PRJ | Dissertation Stage II |

|  |  |
| --- | --- |
|  |  **Structure 2017-18 M. Tech. Mechanical (Heat Power Engineering)** |
| Subject No. | Subject Code | Subject Name | Type | Teaching scheme (Hrs./week) | Assessment scheme | Total Mark | Credits |
| ISA | ISA | MSE | ESE |  |
| Lect | Practical | Breakup |
| CA | MSA | ESA |
|  | **Semester –I** |  |  |
| S1 | ES551TH | Mathematical Methods in Engineering | TH | 4 | - | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
| S2 | ME501THL | Advanced Thermodynamics  | THL | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
| S3 | ME502THL | Advanced Fluid mechanics and CFD  | THL | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
| S4 | ME503THL | Advanced Heat Transfer and CFD | THL | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
| S5 | ES502TH | Research Methodology | TH | 2 | - |  |  |  | 10 | 20 | 70 | 100 | 2 |
| S6 | HS551TH | Quantitative Aptitude-1 | TH  | 2 |  |  |  |  | 10 | 20 | 70 | 100 | 2 |
|  |  |  |  |  |  |  |  |  |  |  |  |  | **20** |
|  |  | **Semester –II** |
| S7 | ME506THL | Advanced Applied Thermal Engineering | THL | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
| S8 | ME507THL | Advance Measurement and Data Analysis | THL | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
| S9 | HS553TH | Engineering Economics | TH | 2 |  |  |  |  | 10 | 20 | 70 | 100 | 2 |
| S10 | HS552TH | Quantitative Aptitude-2 | TH  | 2 |  |  |  |  | 10 | 20 | 70 | 100 | 2 |
| S11 | **Department Elective**  | TH | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
|  | ME511TH | IC Engines Fuels and Combustion  |  |  |  |  |  |  |  |  |  |  |  |
|  | ME512TH | Heating Ventilation Air Conditioning |  |  |  |  |  |  |  |  |  |  |  |
|  | ME513TH | Energy Conservation and Management |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| S12 | **Open Elective**  | TH | 3 | 2 | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 4 |
|  | ME557THL | Computer Aided Engineering |  |  |  |  |  |  |  |  |  |  |  |
|  | ME572TH | Optimization Technique  |  |  |  |  |  |  |  |  |  |  |  |
|  | ME523TH | Design of Heat Exchangers |  |  |  |  |  |  |  |  |  |  |  |
|  | ME524TH | Advanced Turbo-Machines |  |  |  |  |  |  |  |  |  |  | **20** |
|  |  | **Semester –III (A)** |
| S13 | - | Dept. level Open Elective | TH | 3 |  | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 3 |
| S14 | - | Inst. level Open Elective | TH | 3 |  | 30 | 20 | 50 | 30 | 35 | 35 | 100 | 3 |
|  | ME622PS | Technical Seminar |  | 2 |  |  |  |  | 10 | 20 | 70 | 100 | 2 |
| PS1 | ME625PRJ | Dissertation Stage I |  |  |  |  |  |  |  |  |  | 100 | 12 |
|  |  |  |  |  |  |  |  |  |  |  |  |  | **20** |
|  |  | **Semester –III (B)** |
| INT | ME621INT | Industrial in plant training  |  |  |  |  |  |  |  |  |  | 100 | 6 |
|  |  ME623PS | Seminar  |  | 2 |  |  |  |  | 10 | 20 | 70 | 100 | 2 |
| PS1 | ME626PRJ | Dissertation Stage I |  |  |  |  |  |  |  |  |  | 100 | 12 |
|  |  |  **Semester –IV** |
| PS2 | ME627PRJ | Dissertation Stage II |  |  |  |  |  |  |  |  |  | 100 | **20** |
|  | **Total** |  |  |  |  |  |  |  |  |  |  |  | **80** |

Dept. level Open Elective **Semester –III (A)**

|  |  |
| --- | --- |
| ME611TH | Non Conventional Energy Sources |
| ME612TH | Electronic Cooling And Packaging  |
| ME613TH | Gas Turbine And Jet Propulsion  |
| ME614TH | Design of Experiments |

Inst. Level open electives: **Semester –III (A)**

|  |  |
| --- | --- |
| HS66101 | Organizational Management |
| HS66102 | Business Economics |

**Semester I**

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

**ES551TH: Mathematical Methods in Mechanical Engineering**

**Credits: 04 Teaching Scheme: 4hrs / Week**

**Course Objectives:-**

1. The students will have a thorough knowledge of the mathematical methods to be applied to problems in Mechanical Engineering.
2. The students will effectively write code and use the algorithms for mathematical analysis with the help of any of the modern softwares.

**Course Outcomes:**

Students are able to:

1. Demonstrate understanding and make use of different mathematical methods employed to solve mechanical and chemical engineering problems.
2. Apply different methods and to various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
3. Apply different methods to model and represent various mechanical and chemical engineering systems.
4. Analyse, compare and evaluate the accuracy of common numerical methods..
5. Implement the various numerical methods in commonly used softwares like Matlab / Scilab / Octave / R / Spreadsheets.
6. Write efficient, well-documented code in any of the modern languages and present numerical results in an informative way.

**Unit 1:** Linear Algebra **( 6 Hrs)**

Vector spaces, Subspaces, Basis, dimension, System of linear equations, Gauss Elimination

**Unit 2:** Eigen Values and Eigen Vectors **( 6 Hrs )**

Eigen Values, Eigen Vectors, Diagonalization, Singular Value Decomposition

**Unit 3 :** Numerical methods **( 8 Hrs )**

Solution of system of linear equations by LU decomposition, Tridiagonal method, Gauss Seidel method, Eigen values by Power method, Newton Method for nonlinear systems, Splines interpolation

**Unit 4 :** Ordinary Differential equations **( 8 Hrs )**

Linear systems, classical methods, solution by diagonalization, adaptive numerical methods, implicit methods for stiﬀ systems.

**Unit 5 :** Variational Methods **( 6 Hrs )**

Rayleigh-Ritz and Galerkin methods, Introduction to FEM

**Unit 6 :** Partial Diﬀerential equations **( 6 Hrs )**

Elliptic equations (classical, iterative methods), parabolic(classical, numerical) and hyperbolic(analytical, numerical methods).

**Total Contact Hours: 40**

**Text Books:**

1. Applied Numerical Methods for Engineers and Scientists by S. S. Rao
2. Mathematical Methods in Chemical Engineering by S. Pushpavanam

**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**

**ME501THL: ADVANCED THERMODYNAMICS**

**Credits: 04 Teaching Scheme: 3 hrs / Week**

**Lab: 2hrs/week**

**Course Objectives:**

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

 **Course Outcomes:**

**Students should be able to**

1. Do a thermodynamic analysis of SF systems using the concepts of entropy, available and unavailable energy
2. Understand relationships between various thermodynamic properties of pure substances and P-V-T surfaces
3. Derive the enthalpy entropy and internal energy co-relations using Maxwell and Clayperon equations
4. Solve the Gas mixture problems using the properties of gases specified in the mixture
5. Understand combustion reactions, enthalpy of formation, Gibbs function of formation and absolute entropy
6. Understand various models used in statistical thermodynamics

**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.

**Advanced Thermodynamics Lab:**

1. P V T surface plot using MATLAB or C
2. Trial on steam power plant and Rankine Cycle analysis
3. Exergy analysis of Steam power plant or any thermal systems
4. Adiabatic flame temperature and heat of combustion determination using applets available
5. Gibbs function and equilibrium constants relationship verification for different combustion reactions

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

**Course Code: ME502THL Course Name: Advanced Fluid Mechanics and CFD**

**Credits: 04 Teaching Scheme: 3 hrs / Week**

**Lab: 2hrs/week**

**Unit 1: Flow Kinematics** ( 6 Hours)

 Mass Conservation equations, Streamline, Vorticity, Strain Rate, Acceleration

**Unit 2: Momentum Equations**  (6 Hours)

 Euler equations, Bernoulli equation, Potential flows, Navier-Stokes Equations

**Unit 3: Viscous Flows** (6 Hours)

 Creeping flow over bodies, Boundary Layer over a Flat plate, Bluff bodies, computational Methods

**Unit 4: Turbulent Flows** (6 Hours)

 Reynolds averaged equations, algebraic models, one and two equation models, near wall behaviour, CFD Modelling

**Unit 5: High Speed Flows**  (6 Hours)

 Stagnation pressure, temperature, Converging-Diverging nozzle, Normal and Oblique shocks, numerical methods

**Unit 6: CFD** (6 Hours)

 Mesh Generation, Discretisation Schemes, Finite Volume Methods

**List of Project/Lab Experiment areas: (For THP, TLP courses)**

1. Velocity Profile measurement using Pitot tube

2. Flow through nozzles and diffusers

3. Boundary Layer on a flat plate

4. Lift and Drag forces on an airfoil

5. Flow over a cylinder

 **Text Books:**

1. ``Adv. Engg. Fluid Mechanics'', Gautam Biswas and K. Muralidhar, Alpha Science International

2. ``Viscous Fluid Flow'', Frank M. White, McGraw Hill

3. ``Adv. Fluid Mechanics'', William Graebel, Academic Press

**Reference Books:**

1. “Boundary Layer Theory'', H. Schlichting, McGraw Hill

2. ``Modern Compressible Flow'', John D. Anderson, McGraw Hill

**Course Outcomes:**

The student will be able to –

1. Understand the basic principles of flow kinematics

2. Understand the different forms of momentum equation and its applications

3. Carry out analysis of viscous flows

4. Carry out modeling of turbulent flows and near wall behaviour

5. Analyze one-dimensional high speed flows

6. Understand the basic principles of CFD

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

**Course Code: ME503THL Course Name: Advanced Heat Transfer and CFD**

**Credits: 04 Teaching Scheme: 3 hrs / Week**

**Lab: 2hrs/week**

**Unit 1: Conduction:** (8 Hours)

Basic equations (Continuity, Momentum, Energy), Conduction- 1-d and 2-d, solving conduction problem using CFD software

**Unit 2: Conduction:** (8 Hours)

Extended Surfaces, Systems with heat generation, Transient heat conduction

**Unit 3: Convection:**  (8 Hours)

Forced and Free convection for external and internal flow systems solving convection problem using CFD software

**Unit 4: Radiation:**  (8 Hours)

Radiation laws, Shape factor, Exchange between black and grey surfaces

**Unit 5: Heat Exchangers:**  (4 Hours)

LMTD approach, Effective-NTU approach, Heat Pipes

**Unit 6: Boiling and Condensation** (4 Hours)

Boiling and condensation

**Text Books:**

1. R.C. Sachdeva “Fundamentals of Engineering Heat and Mass Transfer”, Wiley Eastern Ltd., India.
2. E. M. Sparrow, R. D. Cess, “Radiation Heat Transfer” Mc Graw Hill.
3. S. P. Sukhatme, “Heat Transfer”, University Press.
4. J.P. Holman, “Heat Transfer”, McGraw Hill Book Company, New York, 1990.
5. Incropera and Dewitt, “Fundamentals of Heat and Mass Transfer”, John Wiley and Sons, NewYork, 2000.

Reference Books:

1. Frank Kreith, “Principles of Heat Transfer”, Harper and Row Publishers, New York, 1973.
2. Donald Q. Kern “Process Heat Transfer”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1975.
3. Gupta and Prakash, “Engineering Heat Transfer”, New Chand and Bros, Roorkee (U.P.) India, 1996.

**Course Outcomes:**

The student will be able to –

1. understand the basic equations and their applications. Also, to give the solutions to 2-d heat conduction problems.
2. do the analysis of fins and the unsteady state problems
3. analyse the systems with internal and external convection heat transfer
4. analyse the system of radiation heat transfer
5. apply the heat transfer knowledge for heat exchanger applications
6. understand the basic principles of boiling and condensation

List of lab Experiments:

1) Energy balance of a heat transfer setup

2) Performance trial on Plate Type heat exchanger

3) Heat Pipe

4) Analysis of variation of thermal conductivity numerically

5) Free convection (Numerically)

6)Tube in tube heat exchanger

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

**ES502TH: Research Methodology:**

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

**Course Objectives:**

1. To understand the concept and distinct types of engineering and science research
2. To understand the research process in detail in terms of ideation, concept, design and implementation of research.
3. To develop expertise in studying, writing and presenting technical documentation such as papers, thesis, etc.
4. To understand and get exposed to different tools and techniques essential for research

**Course Outcomes:**

1. Perform research in a more organized and efficient manner
2. Choose ideal method to select problem statement, design the research, collect and analyze data and test the hypothesis
3. Efficiently read and summarize technical documentation
4. Systematically write, publish and present technical documentation
5. Understand legal issue regarding research
6. Be aware of and use searching, documenting and presenting tools and technologies

**Unit1: Formulating Research Problem and Literature Review (9 Hrs)**

**Overview:** RE-Search, Definition, Research characteristics, Difference between methods and methodology, Research categories, Overview of research process.

**How to get new research ideas:** Creating thinking, Preparations for improving thinking

**Defining research problem statement:** Need, What is a research problem, Sources of research problem, research problem components

**Literature Survey Overview:** What is literature survey, Types of literature survey, Sources of information, Types of technical papers,

Publication and patent databases, How to read a scientific paper, How to write scientific paper**,** writing technical papers in English – Grammar, Punctuation, Tips for writing correct English, How to write a research proposal, How research is funded, How to give a good research talk, Presentation tools

**Research Ethics and Legal Issues**: Intellectual Property rights, Patents, Copyrights,

Plagiarism

**Unit 2: Research Design and Data Collection (6 Hrs)**

**Research Design:** What is research design, Research Design Parts, Research Design for exploratory and Descriptive Research, Principals of Research design.

**Sampling Design:** Steps in sampling Design, Different Types of Sample Design

**Unit 3: Data Collection and Analysis (6 Hrs)**

**Methods of data collection:** Data types, Data Collection Types: Observation, Interview,

Questionnaire, Schedules, Collection of Secondary Data

**Analysis and Processing of Data:** Processing operations, Types of Analysis, statistics in

Research, Measures of central Tendency, Measures of Dispersion, Measures of Asymmetry, Measures of Relationship, simple regression Analysis, Multiple correlation and regression, association in case of attributes

**Unit 4: Hypothesis testing (9 Hrs)**

**Defining Hypothesis:** What is hypothesis, Characteristics of hypothesis, Hypothesis Vs

Problem Statement

**Hypothesis Testing:** Null hypothesis, Alternative Hypothesis, Level of significance,

Type I and Type II Errors, One tailed and two tailed hypothesis, Power of hypothesis tests

**Parametric Tests:** z-test, t-test, chi-square test, F-test, ANOVA

**Total Contact Hours: 30**

**Text Books:**

1. ‘Research Methodology: Methods and Trends’, , by Dr. C. R. Kothari, 2nd revised edition, New Age International Limited Publishers, ISBN: 978-81-224-1522-3

2. ‘Research Methodology: An Introduction’ by Wayne Goddard and Stuart Melville, 2nd

 Edition, Juta and Co. Ltd, ISBN: 0-70215660-4

**Reference Books:**

1. ‘Research Methodology: A Step by Step Guide for Beginners’, by Ranjit Kumar, 2nd

 Edition, APH Publishing Corporation

2. ‘Research methodology: an introduction for science & engineering students’, by Stuart

 Melville and Wayne Goddard

3. ‘Research Methodology’ by Dr. Jayant Tatke, 2009, Symbiosis Centre for Distance

 Learning

4. ‘Operational Research’ by Dr. S.D. Sharma, Kedar Nath Ram Nath & Co

5. Online material provided by the faculty

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

**HS551TH: Quantitative Aptitude-I**

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

|  |  |
| --- | --- |
| **Unit 1: Numbers, Surds and Indices & Logarithms** | **(7 Hours)** |
| Numbers, Average, Decimal fractions, Problem on ages, Simplification, Problems on numbers, Square roots & cube roots, Logarithms, Surds and Indices, HCF and LCM of Numbers. |
|  |
| **Unit 2: Time ,distance and work** | **(7 Hours)** |
| Time and distance, Problems on trains, Boats and Streams, Time and Work , Pipes and Cisterns, Alligation or mixture |
|  |
| **Unit 3: Measures of Statistical Data** | **(7 Hours)** |
| Percentage, Profit and loss, Ratio and Proportion, Simple interest, Compound interest, Partnership, Chain Rule. |
|  |
| **Unit 4: Logical Reasoning**  | **(7Hours)** |
| Race and Games , Odd Man Out and Series, Number Series, Analogies, Logical Problems, Letter and Symbol Series, Statement and Conclusion, Artificial Language |
|  |
|  |
| **Text Books** 1. Quantitative Aptitude For Competitive Examinations”, Dr. R. S. Aggarwal, S. Chand.
2. “How to Prepare for Quantitative Aptitude”, Arun Sharma, Tata Mcgraw-Hill.

**Reference Books** 1. Quantitative Aptitude Quantum Cat Common Admission Test”, K. Sarvesh Verma., Arihant.
2. “Quantitative Aptitude for Competitive Examinations”, Abhijit Guha, Fourth Quarter.
 |

**Course Outcomes**

The students will be able to:

1. improve their employability skills
2. improve aptitude, problem solving skills and reasoning ability
3. critically evaluate various real life situations by resorting to analysis of key issues and factors.
4. demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions

**Semester II**

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

**ME506THL: Advanced Applied Thermal Engineering**

**Credits: 04 Teaching Scheme: 3 hrs / Week**

**Lab: 2hrs/week**

**Course Objectives:**

1. To understand the Analysis of Internal Combustion Engines
2. To understand the Analysis of Refrigeration System

**Course Outcomes:**

**Students will be able to**

1. Perform Analysis for performance, combustion and emission characteristics of Engine
2. Students must develop skill to understand engine based on environment pollution and methods to control the same.
3. Demonstrate modern techniques of engine management and electronic injection system and the Latest Trends in the Engine Technology
4. Analyse multistage vapour compression refrigeration cycle
5. Compare various refrigerants and evaluate the performance of multistage vapour absorption refrigeration system
6. Estimate refrigeration load and design a refrigeration system for an application

**Unit 1: Engine Performance analysis: (6 Hrs)**

Analysis of Performance Characteristics, Combustion Characteristic and Emission characteristics of SI and CI Engine

**Unit 2: Engine Emission Control Technology: (6 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 3: Electronic Injection Systems and Advanced Engine Technology: (8 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 MeasurementHCCI 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.

**Unit 4: Multi pressure Refrigeration 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, Hermetically sealed compressor and its selection

**Unit 5: 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 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)

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

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

**List of Experiments:**

1. Performance trial on diesel engine, with P-Theta and Emission analysis
2. Performance test on Variable compression ratio engine and data analysis
3. Performance test on Gasoline engine
4. Engine performance simulation using any commercial software
5. Thermal analysis of multipressure system using computer
6. Design of refrigeration application
7. Study & trial on non conventional refrigeration system
8. Visit to a refrigeration plant

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

 **ME507THL: Advanced Measurements and Data Analysis**

**Credits: 04 Teaching Scheme: 3 hrs / Week**

**Lab: 2hrs/week**

**Course Objectives:**

* 1. To learn principles of data analysis and advanced techniques used for measuring field and derived quantities in mechanical engineering
	2. To learn the various controllers

**Course Outcomes:**

1. Students will be able to do mathematical analysis for the dynamic characteristics of the instruments.
2. Students will be able to do uncertainty analysis, regression analysis for the experimental data
3. Students will be able to demonstrate and analyze various advanced measurements techniques for the field quantities
4. Students will be able to demonstrate and analyze various advanced measurements techniques for the derived quantities
5. Students will be having the knowledge of analytical methods of advanced measurements
6. Students will be able to perform analysis for various controllers

**Unit 1: Introduction to advanced measurement methods (8 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.

1. Bolton W., Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg., Pearson
2. Beckwith TG. N. Lewis Buck and Marangoni R.D, Mechanical Measurements,

 Narosa Publishing House, New Delhi

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|  |

**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

**Labs:**

1. Calibration of pressure gauge
2. Calibration of a thermocouple
3. Calibration of rotameter and flow measurement
4. Hot Guarded plate experiment
5. Thermo physical properties measurement
6. Radiation measurement
7. Pollution measurement
8. Torque measurement

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

**HS553TH: Engineering Economics:**

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

**HS552TH: Quantitative Aptitude-II**

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

|  |  |
| --- | --- |
| **Unit 1: Area, Volume, Permutation and Combinations** | **(7 Hours)** |
| Area, Volume and Surface Areas, Calendar, Clocks, Permutations and Combinations, Probability, Heights and Distances. |
|  |
| **Unit 2: Data Interpretation** | **(7 Hours)** |
| Tabulations: Tabulations of Imports and Exports of Data, Analysis of Tabulated Data, Bar Graphs: Vertical or Horizontal Bars, Pie Charts: Pie Graphs, Central angle, Line Graphs. |
| **Unit 3: Probability** | **(7 Hours)** |
|  Introduction to probability, Structure of probability, Results of probability, Revision of probability: BAYES’ RULE, and examples; Random variable and probability distribution: Discrete and Continuous distribution, Expected value and variance of a distribution. |
|  |
| **Unit 4: Correlation & Regression Analysis** | **(7 Hours)** |
| Regression analysis (Linear only), Correlation analysis, Karl Pearson’s correlation coefficient, Spearman’s Rank correlation coefficient |
|  |
|  |
| **Text Books** 1. Quantitative Aptitude For Competitive Examinations”, Dr. R. S. Aggarwal, S. Chand. 2. “How to Prepare for Quantitative Aptitude”, Arun Sharma, Tata Mcgraw-Hill. 3. Probability & Statistics for Engineers- Richard Johnson – Prentice Hall of India, 4. Statistics for Management- Richard Levin , Rubin - Prentice Hall of India, **Reference Books** 1. Quantitative Aptitude Quantum Cat Common Admission Test”, K. Sarvesh Verma., Arihant.
2. “Quantitative Aptitude for Competitive Examinations”, Abhijit Guha, Fourth Quarter.
 |

**Course Outcomes**

The students will be able to:

1. improve their employability skills
2. improve aptitude, problem solving skills and reasoning ability
3. critically evaluate various real life situations by resorting to analysis of key issues and factors.
4. demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions

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

**ME511TH: I.C. ENGINES - FUELS AND COMBUSTION**

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

**Course Objectives:**

1. To understand recent developments in combustion, flame propagation, combustion chamber, emission controls
2. To understand recent research developments in fuels and alternative fuels
3. To understand combustion and performance of supercharged engines
4. To understand pollutant formation physics

**Course Outcomes:**

1. Students must understand details of characteristics of fuel used in engine in detail as it affect the design, efficiency and performance of engine and also developments in alternative fuels.
2. Students must understand theory of combustion, flame propagation and various factors affecting the SI Engine.
3. Students must understand theory of combustion, delay period and various factors affecting the CI Engine.
4. Students must develop skill to understand purpose of supercharger and turbocharger with their effects on engine performance.
5. Student must understand influence of fuel-air ratio on engine power output and thermal efficiency with the various operating conditions.
6. Student must understand recent research developments in the field of engine emissions and scavenging techniques.

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

Qualities of SI & CI engine fuels, ASTM distillation curve, rating of SI & CI engine fuels, fuel additives for SI & CI engines, liquid fuels, gaseous fuels, and hydrogen engines

**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 and its control (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 Alternate Fuels and Pollutant Control (7 Hrs)**

Availability and comparative properties of alternate fuels, CNG, LPG, Alcohol, Vegetable oil, Biodiesel, Bio-gas and hydrogen. Engine Performance and emission characteristics using alternative fuels and its comparison with base fuels

**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**

 **ME512TH: Heating, Ventilation and Air Conditioning**

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

**Course Objectives:**

1. Develop an ability to analyze air conditioning systems
2. Estimate the air-conditioning load & design the system components
3. Select suitable controls for contemporary air conditioning systems

**Course Outcomes:**

Students will be able to

1. Apply the concepts of psychrometry to air-conditioning systems
2. Estimate the air-conditioning load required to design an air-conditioning system
3. Design an air distribution system for air-conditioning application
4. Select appropriate system components for an air-conditioning system
5. Design an evaporative cooling system
6. Compare different air-conditioning systems

**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**

**ME513TH: Energy Conservation and Management**

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

**Course Objectives:**

* 1. To create awareness about energy efficiency
	2. To enable students understand operational aspects of Industrial systems (Energy producing/Consuming)
	3. To create awareness of National and International policies and acts.
	4. To create awareness of standardization of energy appliances.
	5. To introduce energy economics.

**Course Outcomes:**

1. Students should be able tounderstand global energy scenario , need of energy management and environmental concerns
2. Students should be able to use the financial analysis techniques like simple pay back period, return on investment, net present value for an industry
3. Students should be able to find performance assessment of Thermal and Electrical utilities
4. Students should be able to understand energy conservation in HVAC systems
5. Students should be able to understand energy conservation in electrical and compressed air systems
6. Students should be able to find energy performance of process equipment like Furnaces, Heat exchangers and methods to improve it

**UNIT 1: General Aspects of Energy Management   (6 Hrs)**

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

**UNIT 2: Financial Management**: 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** : **(6 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**  **(6 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

**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**

**ME557THL: Computer Aided Engineering**

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

Course Objectives:

1. Understand the fundamental ideas of the solid modeling.
2. Understand the fundamental ideas of the FEM and Computational Fluid Dynamics
3. To interpret and evaluate the quality of the results. Be aware of the limitations of the FEM.
4. Learn how the finite element method is implemented (both algorithmically and numerically) by developing simple finite element computer code
5. Develop finite element formulations of engineering problems from a variety of application areas including stress, heat transfer, and vibration analysis.

Course Outcomes:

1. Students will be able to understand the mathematical formulation of the finite element and to apply it to basic (linear) ordinary and partial differential equations
2. Students will be able to model and simulate complex engineering problems by proper selection of finite element and boundary conditions.
3. Students will be able to solve linear, nonlinear and dynamic analysis problems using 1D, 2D and 3D FE models.
4. Students will be able to solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering all necessary factors.

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

Geometry & Topology, Solid representation, Techniques of volume modeling, Feature based modeling: Feature representation, Parametrics, Relations, Constraints, Feature Manipulation. Assembly modeling and 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**

**ME572TH: OPTIMISATION TECHNIQUES**

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

**Course Objectives:**

* 1. To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems
	2. To develop and promote research interest in applying optimization techniques in problems of Engineering and Technology
	3. To apply the mathematical results and numerical techniques of optimization theory to concrete Engineering problems.

**Course Outcomes:**

**The students are able to**

1. Gain the knowledge of various optimization techniques
2. Develop the ability to obtain the optimal solution for engineering problems
3. Understand the concepts of one-dimensional optimization, gradient based methods, linear programming, constrained optimization and evolutionary algorithms
4. Model engineering problems and pose it as an optimisation problem
5. Apply the optimisation methods to design a mechanical system
6. Select and implement proper optimization technique as per the required application

**Unit 1: ( 7Hrs )**

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

**Unit 2: ( 7 Hrs )**

 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

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

**ME523TH: Design of Heat Exchangers**

**Credits: 03 Teaching Scheme: 3hrs / 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:** |
|  |
|  |
| 1. Students will understand commonly used and some innovative applications of heat exchangers
2. Students will be able to formulate a procedure for thermal and mechanical design of a heat exchangers and use of standards for the same
3. Students will study different methods employed for designing Shell and Tube heat exchanger such as Kern’s method
4. Students will learn to do thermal design of plate heat exchanger
5. Students will learn different heat transfer enhancement techniques used in heat exchangers
6. Students will be able to understand the concepts of modeling and simulation used for optimization of heat exchangers
 |
| **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** | **(9 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** | **(8 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: 42**

**Text Books:**

1. Sadik Kakac, and Hongtan Liu, “Heat Exchangers: Selection, Rating and Thermal Design”, 2nd edition, CRC Press, 2002
2. R. K. Shah, D. P. Sekulic, “Fundamentals of Heat Exchanger Design”, John Wiley and Sons, Inc., 2003.
3. D.C. Kern, “Process Heat Transfer”, McGraw Hill, 1950.
4. 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**

**ME524TH: Advanced Turbo Machines**

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

**Course Objectives:**

1. To understand the flow and thermal analysis of turbo machines
2. To be able to design various types of turbo machines

**Course Outcomes:**

**Students are able to**

1. Predict the performance of full scale prototype, using the results from a test model.
2. Design and analyse centrifugal machines
3. Design point and off-design performance of axial machines
4. Design and cavitation analysis of Hydraulic turbines
5. Analysis of Gas and Wind turbines

**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

## A Treatise on turbomachines, G. Gopalakrishnan and D. Prithvi Raj, SciTech Publcns, Madras 2011

* 1. Gas Turbines, V. Ganesan, Tata McGraw Hill, New Delhi 2003.
	2. Gas Turbine Theory, HIH Saravanamuttoo, H. Cohen, GFC Rogers, Pearson Education, New Delhi 2001,

**SEMESTER III (A)**

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

**ME611TH: Non Conventional Energy Sources**

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

**Course Objectives:**

1. The students will acquire knowledge of various techniques employed to convert energy from non-conventional sources to usable form.
2. The students will develop an ability to analyse these energy conversion techniques and design appropriate systems for the same

**Course Outcomes:**

Students will be able to

1. Recognize the importance of non-conventional energy sources in the current energy scenario
2. Analyse the performance of and design a solar thermal system
3. Conduct performance analysis of wind energy conversion system
4. Recommend a direct energy conversion system for an application
5. Analyse an energy conversion system working on biogas
6. Identify the applications for use of ocean and geothermal energy forms

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

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

**Unit 2 :** Solar Thermal  **( 10 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  **( 8 Hrs )**

Photovoltaic, MHD, Fuel cells, Thermionic, Thermoelectric

**Unit 5 :** Energy from gas **( 6 Hrs )**

Biomass, Biogas, Hydrogen

**Unit 6 :** Energy from earth and ocean **( 10 Hrs )**

Geothermal, OTEC, Tidal, Waves

**Total Contact Hours: 40**

**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”.
	1. J.F. Kreider, F. Kreith, “Solar Energy Handbook”, McGraw Hill, 1981

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

**ME612TH: Electronic Cooling and Packaging**

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

**Course Objective:**

1. 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:**

1. Students will gain knowledge of various technologies involved in electronic cooling and packaging
2. Students will gain knowledge of packaging and its role in the industry
3. Students will understand concept of wafer fabrication
4. Student will be able to demonstrate the technologies and processes required for the packaging and manufacturing of electronic products.
5. Students will understand concept of thermal design and mechanical design related to electronic packaging
6. Student will be able to design reliable electronic packages

Unit 1 **Introduction:**

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:**

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

Unit 3 **Packaging of Electronic Systems:**

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:**

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:**

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:**

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

**Total Contacts Hours: 40**

**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**

**ME613TH: Gas Turbine and Jet Propulsion**

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

**Course Objectives:-**

1. This course is designed to provide a basic knowledge of the technologies related to gas turbine and jet propulsion

**Course Outcomes:**

1. Students will be able to understand principles and characteristics of gas dynamics, centrifugal, axial and mixed flow compressor
2. Students will be able to understand turbine construction, blade materials and manufacturing techniques
3. Students will be able to understand blade fixing, problems of high temperature operation
4. Students will get knowledge regarding combustion and fuel systems in gas turbine.
5. Students will be able to understand and analyse jet propulsion cycles
6. Students will be able to understand environmental aspect of gas turbine and jet propulsion

**Unit 1:** Introduction  **( 8 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 **(8 Hrs)**

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

**Unit 4:** Combustion and fuel systems **(6 Hrs)**

Combustion Systems, various fuels and fuel systems

**Unit 5:** Jet propulsion **(10 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: 40**

**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**

**ME614TH: Design of Experiments**

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

**Course Objectives:**

1. To design and conduct experiments, as well as to analyze and interpret data.
2. To cover the statistical design of experiments for systematically examining functioning of the system

**Course Outcomes:**

Students will be able to-

1. An ability to design a system, component, or process to meet desired needs within realistic constraints
2. Plan, design and conduct experiments efficiently and effectively, and analyze the resulting data to obtain objective conclusions.
3. To utilize standard statistical software packages for computational purposes.
4. Design/apply fractional factorial experiments for simple experimental case studies and analyze data collected for such experiments.

**Unit I: Overview and Basic Principles (5 Hrs)**

The Experimenter's Problem and Statistical Methods, Experimental units, treatments, factors, and other terms. Randomizing to eliminate bias and confounding; randomizing run-orders and other things; randomization as a basis for statistical inference; paired and 2-sample t-tests.

**Unit II: Completely Randomized Design (5 Hrs)**

Random variables; probability distributions; means, variances, and covariances; models; summary statistics; transforming to normality. The fixed effects model; the ANOVA decomposition and why ANOVA works; post hoc mean comparisons; contrasts; residual analysis for validating assumptions.

**Unit III: Factorial Designs (5 Hrs)**

The analysis of experiments with two or more fixed treatment factors. Fixed effects models; main effects versus interactions; characterizing interactions; interpretation of F-ratios; contrasts and post hoc mean comparisons; unreplicated designs.

**Unit IV: Random, Mixed, and Nested Effects (5 Hrs)**

Random effects models; ANOVA for random effects; variance components; expected mean square algorithm; exact and approximate F-tests for random factors; Mixed effects models; the expected mean square algorithm; exact and approximate F-tests;

**Unit V: Designs with Restrictions on Randomization (4 Hrs)**

Blocking; the randomized complete block design; Latin squares and Graeco-Latin squares; cross-over designs. Whole plot, sub-plot, and sub-sub-plot structure and restricted randomization; split-plot, split-split plot, and split-block designs

**Unit VI: Response Surface Methodology and Robust Product Design (4 Hrs)**

Introduction to Response Surface Methodology, The Method of Steepest Ascent, First-Order Models, First-Order Designs, Analyzing First-Order Data,

Environmental Robustness, Robust parameter design, Robustness to Component Variation, Mathematical Formulation for Environmental Robustness.

**Total Contact Hours: 28 Hrs.**

**Text books:**

1. Box, GEP, Hunter, WG, and Hunter, JS, 1978, Statistics for Experimenters, Wiley.
2. Box, GEP and Draper, NR 1987, Empirical Model-Building and Response Surfaces, Wiley.

**Reference Books:**

1. Cochran, W.G and Cox, G.M, 1957, Experimental Designs, Wiley.
2. Fisher, R A, 1966, The Design of Experiments, 8th ed., Hafner.

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

**HS66102: Organizational Management**

Outcomes of the course on Organizational Management

An engineering graduate student about to enter Industry will be able to learn

1. Use of EFQM Model of Business Excellence
2. Introduction to Quality Management System as per ISO 9001, Environmental Management System as per ISO 14001, Operational Health and Safety Assessment Specifications OHSAS 18000 and Information Security Management System as per ISO 17799
3. Problem Solving Techniques
4. Introduction to Six Sigma concept

5) Introduction to Toyota Production System

6) Introduction to statistical terminologies, their use in calculations for practical applications

7) Statistical Quality Control tools

8) Introduction to TQM, Kaizen, and concepts of Just in time, Kanban, 5”S”, Quality Circles

9) Concepts of Cost of Quality, Total Productive Maintenance

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Course Outcomes/Units |  I |  II |  III |  IV |  V |
| 1 |  **\*** |  |  |   |  \* |
| 2 |   |  \* |  \* |  \* |   |
| 3 |  |  |  |  \* |  |
| 4 |  |  |  \* |  \* |   |
| 5 |  |   |  |  \* |  |
| 6 |  |  |  \* |  \* |  |
| 7 |  |  |  \* |  \* |  |
| 8 |  \* |  \* |  \* |  \* |   |
| 9 |  \* |  \* |  \* |  \* |  **\***  |
| Outcome attainmentthrough | Internal Class testCase Study | Mid semTestCase Study | Mid semTestCase Study | End sem testCase Study | Internal Class test,Case Study |

Topics to be covered

1. EFQM model of Business Excellence
2. Statistics and SQC
3. TQM, Kaizen, 5 “S”, Cost of Quality, TPM
4. Problem Solving Techniques
5. JIT, KANBAN
6. Six Sigma, Toyota Production System
7. QMS ISO 9000, EMS ISO 14000
8. OHSAS 18000, ISMS ISO 17799
9. Contributions by Deming, Taguchi, Henry Ford
10. Malcolm Baldrige Award

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

**HS66102: Business Economics**

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

**Course Objectives:**

1. To understand the concept and distinct types of engineering and science research
2. To understand the research process in detail in terms of ideation, concept, design and implementation of research.
3. To develop expertise in studying, writing and presenting technical documentation such as papers, thesis, etc.
4. To understand and get exposed to different tools and techniques essential for research

**Course Outcomes:**

1. Get familiar with basic concepts of economics, acquire basic knowledge of Micro, Macro Economics, inflation, taxation and money.
2. Gain information and knowledge on Laws of demand and supply, in depth study of elasticity f dem and supply with numerical problems.
3. Understand Production functions, Laws of variable proportions, Laws of diminishing returns and Learning curve
4. Analysis of competition, and other business environments

**Unit 1: (6 Hrs)**

Definition, Nature and Scope of Managerial Economics. Introduction to Microeconomic and Macroeconomics. Managerial Economics and decision-making. Interest, taxes, inflation, currency fluctuations, depreciation and their effects on decision making.

**Unit 2: (6 Hrs)**

Law of Demand & Supply: Meaning and Determinants of Demand. Demand Function. Law of Demand, Market Demand, Elasticity of demand. Types of elasticity. Measurement of elasticity. Significance and uses of the elasticity. Meaning and Determinants of Supply, Law of supply. Equilibrium of demand and supply i.e. price determination.

**Unit 3: (6 Hrs)**

Production Function. Law of Variable Proportions. Costs of production. Accounting Costs and Economic costs, Short run and Long Run costs, Relevant (Future) and Irrelevant Costs (Past or Sunk Costs), Direct (Prime) Cost and Indirect Cost (Overheads), Economies of scale: Relevance to Mfg and Services, Learning Curve

**Unit 4: (6 Hrs)**

Types of Competition: Monopoly, Monopolistic competition, Duopoly, Oligopoly. Perfect Competition Need for Government Intervention in Markets. Price Controls. Support Price. Preventions and Control of Monopolies. System of Dual Price.

**Total Contact Hours: 24**

**Text Books:**

1. Engineering Economic Analysis, Theusen H.G., Prentice Hall of India
2. Engineering Economic Principles, Henry M. Steiner, McGraw Hill
3. Engineering Economics, S.M. Mahajan, Everest Publishing House, Pune
4. Managerial Economics – Analysis**,** Problems and Cases, P.L. Mehta, Sultan Chand Sons, New Delhi.
5. Managerial Economics – Varshney and Maheshwari, Sultan Chand and Sons, New Delhi.
6. Managerial Economics – G.S. Gupta, T M H, New Delhi.
7. Managerial Economics – Mote, Paul and Gupta, T M H, New Delhi.

 **Reference Books:**

1. Managerial Economics –Joel Dean, Prentice Hall, USA.
2. Managerial Economics – Pearson and Lewis, Prentice Hall, New Delhi
3. Managerial Economics – D. Salvatore, McGraw Hill, New Delhi.
4. Economics ,PA Samuelson, WD Nordhaus, Tata McGraw Hill

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

**ME622PS: Technical Seminar**

**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. Students are able to develop research skills like literature survey and data analysis
2. 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.
3. Students are able to develop their own writing and presentation skills.

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 should be different from the work done in Dissertation Stage I.**

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

**ME625PRJ: Dissertation Stage I**

**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. Students will be able to formulate a problem for the dissertation.
2. Students will be able do literature review to understand work done by other researchers in the field of project work.
3. Students will be able to decide the methodology to obtain solution of the problem.
4. Students will be able to plan activities and resources pertaining to the solution of the problem.

**Guidelines**

Candidates are required to do project during the entire second year of the course. The work is divided into two parts, Dissertation Stage I during the third semester and Dissertation 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 Dissertation 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. Dissertation Stage I examination will be conducted based on the work completed during this stage.

**SEMESTER III (B)**

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

**ME621INT: Industrial in Plant Training**

**Credits: 06 Teaching Scheme: hrs / Week**

Semester long (minimum 14 weeks) industrial training in Mechanical Industries

**Course Outcomes:**

1. Students will be able to correlate the theoretical and practical concepts
2. Students will be able to understand various processes of product developments and services

3. Students will be able to understand industrial works and management

4 .Students will be able to demonstrate verbal, written and graphical communication skills.

5. Students will be able to undertake technical discussions.

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

**ME623PS: Technical Seminar**

**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. Students are able to develop research skills like literature survey and data analysis
2. 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.
3. Students are able to develop their own writing and presentation skills.

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 should be different from the work done in Dissertation Stage I.**

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

**ME626PRJ: Dissertation Stage I**

**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. Students will be able to formulate a problem for the dissertation.
2. Students will be able do literature review to understand work done by other researchers in the field of project work.
3. Students will be able to decide the methodology to obtain solution of the problem.
4. Students will be able to plan activities and resources pertaining to the solution of the problem.

**Guidelines**

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

**Semester IV**

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

**ME627PRJ: Dissertation Stage II**

**Course Objectives:**

* + - 1. To develop technical report writing and presentation of the students.
			2. The student should be able to construct mathematical and experimental analysis of a practical problem.
			3. The students should be able to analyze the simulation and experimental data and draw technical conclusions based on the same.

**Course Outcomes:**

1. Students will be able to formulate different solutions and arrive at most suitable solution systematically.
2. Students will be able to develop experimental test setups.
3. Students will be able to use analysis tools for practical problems.
4. Students will be able to analyze data to help draw conclusions.
5. Students will be able to independently learn different engineering aspects pertaining to the project work.
6. Students will be able to communicate effectively both in written and verbal forms.
7. Students will be able to approve knowledge in the field of work.
8. Students will be able to perform collaborative work.
9. Students will be able to sustain in the competitive environment in the future engineering career

**Guidelines**

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

The problem is completely solved during the Dissertation 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 on any relevant platform to be made before final examination.