M. TECH. MECHANICAL ENGINEERING (THERMAL SC. ENGG.) (1st Year)

Total Contact Hours = 24 **Total Marks = 600** **Total Credits = 22**

SEMESTER 1st		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MREM0-101	Research Methodology	4	0	0	40	60	100	4
MMET8-102	Advance Thermodynamics	4	0	0	40	60	100	4
MMET8-103	Advanced Fluid Mechanics	4	0	0	40	60	100	4
MMET8-104	Internal Combustion Engine	4	0	0	40	60	100	4
MMET8-105	Lab -I	0	0	4	100	-	100	2
Department Elective – I (Select any one)		4	0	0	40	60	100	4
MMET8-156	Finite Element Modelling (FEM)							
MMET8-157	Gas Dynamics							
MMET8-158	Power Plant Engineering & Industrial Utilities							
Total	**Theory = 5 Lab = 1**	**20**	**0**	**4**	**300**	**300**	**600**	**22**

Total Contact Hours = 24 **Total Marks = 600** **Total Credits = 22**

SEMESTER 2nd		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MMEE8-206	Computational Fluid Dynamics	4	0	0	40	60	100	4
MMEE8-207	Fuels and Combustions	4	0	0	40	60	100	4
MMEE8-208	Welding Technology	4	0	0	40	60	100	4
MMEE8-209	Applied Solar Energy	4	0	0	40	60	100	4
MMEE8-210	Lab-II	-	-	4	100	-	100	2
Departmental Elective – II (Select any one)		4	0	0	40	60	100	4
MMEE8-259	Refrigeration & Air Conditioning							
MMEE8-260	Statistical Methods & Algorithms							
MMEE8-261	Boundary Layer Theory							
Total	**Theory = 5 Lab = 1**	**20**	**0**	**4**	**300**	**300**	**600**	**22**

Total Contact Hours = 20 **Total Marks = 500** **Total Credits = 26**

SEMESTER 3rd		Contact Hrs			Marks			Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Int.**	**Ext.**	**Total**	
MMEE8-311	Total Quality Management	4	0	0	40	60	100	4
MMEE8-312	Maintenance & Reliability Engineering	4	0	0	40	60	100	4
MMEE8-313	Project	0	0	4	40	60	100	4
MMEE8-314	Thesis Synopsis	0	0	4	-	100	100	10
Open Elective (Select any one)		4	0	0	40	60	100	4
Total	**Theory = 3 Lab = 2**	**12**	**0**	**8**	**160**	**340**	**500**	**26**

Total Credits = 20

SEMESTER 4th		Contact Hrs			Evaluation Criteria	Credits
Subject Code	**Subject Name**	**L**	**T**	**P**	**Satisfactory/ Unsatisfactory**	
MMEE8- 415	Final Thesis	0	0	0		20

Overall

Semester	Marks	Credits
1st	600	22
2nd	600	22
3rd	500	26
4th	--	20
Total	**1700**	**90**

RESEARCH METHODOLOGY

Subject Code – MREM0-101 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT–I (11 Hrs.)

Introduction to Research: Meaning, Definition, Objective and Process
Research Design: Meaning, Types - Historical, Descriptive, Exploratory and Experimental
Research Problem: Necessity of Defined Problem, Problem Formulation, Understanding of Problem, Review of Literature
Design of Experiment: Basic Principal of Experimental Design, Randomized Block, Completely Randomized Block, Latin Square, Factorial Design.
Hypothesis: Types, Formulation of Hypothesis, Feasibility, Preparation and Presentation of Research Proposal

UNIT–II (10 Hrs.)

Sources of Data: Primary and Secondary, Validation of Data
Data Collection Methods: Questionnaire Designing, Construction
Sampling Design & Techniques – Probability Sampling and Non Probability Sampling
Scaling Techniques: Meaning & Types
Reliability: Test – Retest Reliability, Alternative Form Reliability, Internal Comparison Reliability and Scorer Reliability
Validity: Content Validity, Criterion Related Validity and Construct Validity

UNIT–III (13 Hrs.)

Data Process Operations: Editing, Sorting, Coding, Classification and Tabulation
Analysis of Data: Statistical Measure and Their Significance, Central Tendency, Dispersion, Correlation: Linear and Partial, Regression: Simple and Multiple Regression, Skewness, Time series Analysis, Index Number
Testing of Hypothesis: T-test, Z- test, Chi Square, F-test, ANOVA

UNIT – IV (11 Hrs.)

Multivariate Analysis: Factor Analysis, Discriminant Analysis, Cluster Analysis, Conjoint Analysis, Multi-Dimensional Scaling
Report Writing: Essentials of Report Writing, Report Format
Statistical Software: Application of Statistical Softwares like SPSS, MS Excel, Mini Tab or MATLAB Software in Data Analysis
**Each Student has to Prepare Mini Research Project on Topic/ Area of their Choice and Make Presentation. The Report Should Consists of Applications of Tests and Techniques Mentioned in The Above UNITs*

Recommended Books

1. R.I. Levin and D.S. Rubin, 'Statistics for Management', 7th Edn., Pearson Education, New Delhi.
2. N.K. Malhotra, 'Marketing Research–An Applied Orientation', 4th Edn., Pearson Education, New Delhi.
3. Donald Cooper, 'Business Research Methods', Tata McGraw Hill, New Delhi.
4. Sadhu Singh, 'Research Methodology in Social Sciences', Himalaya Publishers.
5. Darren George & Paul Mallery, 'SPSS for Windows Step by Step', Pearson Education, New Delhi.

6. C.R. Kothari, 'Research Methodology Methods & Techniques', 2nd Edn., New Age International Publishers.

ADVANCED THERMODYNAMICS

Subject Code: MMEE8-102 **L T P C** **Duration: 42 Hrs.**
4 0 0 4

UNIT-I (8 Hrs.)

Exergy Analysis: Concept of exergy, energy analysis for open and closed systems with fixed and moving boundaries, dead state and irreversibility, exergy loss due to mixing of fluids, second law efficiency, exergy analysis for power and refrigerating cycles.

UNIT-II (10 Hrs.)

Real Gases: Assumptions of real gases, equations of state for real gases, compressibility factor, compressibility chart, reduced pressure and temperature, pressure and energy equations using kinetic theory, RMS velocity, equi-partition of energy, mean free path, Maxwell distribution function.

UNIT-III (12 Hrs.)

Thermodynamic Property Relations: Maxwell relations, Clapeyron equation, Clapeyron Clausius equation, Mayer equation, thermodynamic potentials, residual property functions, Helmoholtz and Gibbs functions, Tds equations, Fugacity of gases, thermodynamic properties of homogeneous mixtures, partial molal properties.

UNIT-IV (12 Hrs.)

Reacting Systems and Chemical Equilibrium: Chemical systems, enthalpy of reaction, combustion and formation, 1st and 2nd law analysis of reacting systems, adiabatic flame temperature, fuel cells – types and applications, criteria for chemical equilibrium, Henry and Rault's law, Gibbs phase rule, Hess's law.

Recommended Books

1. A. Bejan, 'Advanced Engineering Thermodynamics', John Wiley and Sons, **2006**.
2. K. Wark, 'Advanced Thermodynamics for Engineers', McGraw Hill, **1994**.
3. O.J. Bevan, & B.J. Juliana, 'Chemical Thermodynamics: Principles and Applications', Elsevier, **2005**.
4. D. Winterbone, & A. Turan, 'Advanced Thermodynamics for Engineers', Butterworth Heinemann, **2015.**

INTERNAL COMBUSTION ENGINES

Subject Code: MMEE8-104 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-I (8 Hrs.)

Introduction: Preliminary analysis, cylinder number, size and arrangement, constructional details, thermodynamic properties of fuel-air mixture before and after combustion, deviations of actual cycle from ideal conditions, analysis using combustion charts, two stroke engine scavenging.

UNIT-II (14 Hrs.)

Fuel Supply Systems: S. I. engines: carburetion multi-jet, Carter, Zenith, Solex carburetors, MPFI, combustion, Ignition systems Gasoline injection, EFI system, MPFI system, electronic control system, injection timing, C.I. engines: in-line injection, rotary injection, electronic diesel injection system and control. Alternate Fuels for IC Engines: Liquid alternative fuels, advantages, potential, problems associated with utilization, vegetable oils, bio-diesel, emulsified fuels, effect on lubricating oils, gaseous alternative fuels, hydrogen, compressed natural gas, liquefied petroleum gas, di-methyl ether, multi-fuel engines.

UNIT-III (12 Hrs.)

Recent Trends in I.C. Engines: Dual-fuel engines, multi-fuel engines, stratified charge engine, Sterling engine, variable compression ratio engine, bench marking, combustion chamber design in SI and CI engines, swirl &inlet ports design, DI models, combustion chambers in S.I. engines, Supercharging, turbo-charging & matching of turbo-charging, friction and lubrication, Performance.

UNIT-IV (11 Hrs.)

Engine Emissions & Control: Air pollution due to IC engines, norms, engine emissions, HC, CO, NOx particulates, other emissions, Emission control methods, exhaust gas recirculation, modern methods.

Simulation Technique: Application of simulation techniques for engine tuning, engine selection parameters,

Recommended Books

1. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw Hill, **1988**.
2. R. Stone, Introduction to Internal Combustion Engines, MacMillan, **1999**.
3. W. Pulkrabek, Engineering Fundamentals of the Internal Combustion Engine, Prentice Hall, **2007**.
4. R. Ferguson Colin and Allan T. Kirkpatrick, Internal Combustion Engines: Applied Thermal Sciences, John Wiley and Sons, NY, **2000**.
5. C.F. Taylor, The Internal Combustion Engine in Theory and Practice, The MIT Press, **1985**.
6. H. Heisler, Advance Engine Technology, Butter Worth Hienemann, USA, **2000**.

LAB-I

Subject Code: MMEE8-105 **L T P C**
0 0 4 2

One lab /field/industrial oriented project /problem of duration one semester will be allocated to each student related to the subjects taught in 1st semester

FINITE ELEMENT MODELLING

Subject Code: MMET5-156 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-I (5 Hrs.)

Introduction: Historical background, basic concept of the finite element method, comparison with finite difference method.

UNIT-II (15 Hrs.)

Variation Methods: Calculus of variation, Rayleigh-Ritz and Galerkin methods; Finite Element Analysis of 1-D problems: Formulation by different approaches (direct, potential energy and Galerkin); Derivation of elemental equations and their assembly, solution and its post processing, Applications in heat transfer, fluid mechanics and solid mechanics: bending of beams analysis of truss and frame.

UNIT-III (15 Hrs.)

Finite Element Analysis of 2-D problems: Finite element modelling of single variable problems, triangular and rectangular elements; Applications in heat transfer, fluid mechanics and solid mechanics; **Axi-symmetric and 3D bodies**

UNIT-IV (5 Hrs.)

Numerical Considerations: numerical integration, error analysis, meshes refinement. Plane stress and plane strain problems; Bending of plates; Eigen value and time dependent problems.

Recommended Books

1. K. J. Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, NJ, **1982**.
2. J. N. Reddy, An introduction to the Finite Element Method, **McGraw-Hill, New York, 1993.**
3. C.S. Krishnamoorthy, Finite Element Analysis, Tata McGraw Hill.
4. Finite Element Methods by Chandupatla, Pearson Publications.

GAS DYNAMICS

Subject Code: MMEE8-157 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-I (14 Hrs.)

Fundamental Aspects of Gas Dynamics: Introduction, Isentropic flow in a stream tube, speed of sound, Mach waves; One dimensional Isentropic Flow: Governing equations, stagnation conditions, critical conditions, maximum discharge velocity, isentropic relations, Normal Shock Waves: Shock waves, stationary normal shock waves, normal shock wave relations in terms of Mach number; Oblique Shock Waves: Oblique shock wave relations, reflection of oblique shock waves, interaction of oblique shock waves, conical shock waves;

UNIT-II (11 Hrs.)

Expansion Waves: Prandtl-Meyer flow, reflection and interaction of expansion waves, flow over bodies involving shock and expansion waves; Variable Area Flow**:** Equations for variable area flow, operating characteristics of nozzles, convergent-divergent supersonic diffusers;

UNIT-III (10 Hrs.)

Adiabatic Flow in a Duct with Friction: Flow in a constant area duct, friction factor variations, the Fanno line; Flow with Heat addition or removal: One-dimensional flow in a constant area duct neglecting viscosity, variable area flow with heat addition, one-dimensional constant area flow with both heat exchanger and friction;

UNIT-III (10 Hrs.)

Generalized Quasi One-Dimensional Flow: Governing equations and influence coefficients, solution procedure for generalized flow with and without sonic point; Two-Dimensional Compressible Flow: Governing equations, vorticity considerations, the velocity potential,

linearized solutions, linearized subsonic flow, linearized supersonic flow, method of characteristics.

Recommended Books

1. L.D. Landau and E. M. Lifshitz, 'Fluid Mechanics'.
2. H.W. Liepmann, and A. Roshko, Butter worth Heinemann, **1995**.
3. 'Elements of Gas Dynamics', Dover Pub, **2001.**

POWER PLANT ENGINEERING AND INDUSTRIAL UTILITY

Subject Code: MMEE8-158 **L T P C** **Duration: 45 Hrs.**
4 0 0 4

UNIT-I (9 Hrs.)

Introduction: energy sources for generation of electric power, types of power plant-their special features and applications, present status and future trends of energy resources, overview of utility systems, project implementation stages.

UNIT-II (12 Hrs.)

Coal Fired Thermal Power Plant: site selection, plant layout, steam generators, pulverizers and coal feeding, mill rejects, combustion in furnace, coal handling, ash handling, electrostatic precipitators and bag filters, water systems, condensers, cooling towers. Nuclear Power Plant**:** Nuclear fuels, Nuclear energy, main components of nuclear power plants, nuclear reactors-types and applications, radiation shielding, radio-active waste disposal, safety aspects.

UNIT-III (13 Hrs.)

Recent Advancement in Thermal Power Systems: Fluidized Bed Combustion, CFBC, Environmental benefits, IGCC. Energy Economics: Load curves, effect of load on power plant design, methods to meet variable load, load prediction, cost of energy, system optimization, depreciation, tariff methods. Hydroelectric Power Plant**:** Hydroelectric survey, precipitation, run-off, hydrograph, flow duration curve, mass curve, reservoirs and dams and their different types and constructions. Materials Handling: Belt, chain, metallic, pneumatic and slurry conveying, hoppers and silos, feeders.

UNIT-IV (11 Hrs.)

Turbo Machines: Compressors, pumps and fan systems used in power plants, design and selection of components and systems, operating and system characteristics of dynamic machines, conventional and high concentration slurry pumps. Piping, Valves, Control and Instrumentation: Various specifications in the industry, stresses in pipes and thickness calculation criteria, pipe supports, various types of valves and application purpose of each type of valve, fittings and other pipe mounted instruments, overview of control systems.

Recommended Books

1. P.K. Nag, 'Power Plant Engineering', McGraw-Hill, **2007**.
2. A.K. Raja, A.P. Srivastava & M. Dwivedi, 'Power Plant Engineering', New Age Int., **2006**.
3. C. Elanchezhian, L. Saravankumar, B.V. Ramnath, 'Power Plant Engineering', I-K Int., **2007**.
4. T.C. Elliot, K. Chen, R. Swanekamp, 'Standard Handbook of Power Plant Engineering', McGraw Hill Education, **1998**.

COMPUTATIONAL FLUID DYNAMICS

Subject Code: MMEE8-206 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-I (5 Hrs.)

Introduction: History of CFD; Comparison of the three basic approaches in engineering problem solving – Analytical, Experimental and Computational Methods. Recent Advances in Computational Techniques.

UNIT-II (12 Hrs.)

Problem Formulation: The standard procedure for formulating a problem Physical and Mathematical classification of problems; Types of governing Differential equations and Boundary conditions. Methods of Discretization: Basics of Finite Difference Method; Finite Element Method, Finite volume Method and Spectral Method. Treatment of Boundary Condition.

UNIT-III (10 Hrs.)

Numerical Solution to Heat Conduction Problems: Steady-state Problems: (i) One-dimensional Heat Conduction Transfer through a Pin-fin (ii) Two-dimensional Conduction through a plate Unsteady-state Problem: One dimensional Transient Heat Conduction. Explicit and Implicit Methods, Stability of numerical Methods.

UNIT-IV (13 Hrs.)

Numerical Solution to Fluid Flow Problems Types of fluid flow and their governing equations: Viscous Incompressible Flows Calculation of flow field using the stream function-vorticity method; Calculation of boundary layer flow over a flat plate; Numerical algorithms for solving complete NavierStokes equations- MAC method; SIMPLE algorithm; Project problem.

Recommended Books:

1. Suhas V. Patankar, 'Numerical Heat Transfer and Fluid Flow', Taylor & Francis.
2. J. Anderson, 'Computational Fluid Dynamics'.

FUELS AND COMBUSTIONS

Subject Code: MMEE8-207 **L T P C** **Duration: 39 Hrs.**
4 0 0 4

UNIT-I (10 Hrs.)

Fuels: Introduction and Classification.

Solid Fuels: Coal and its classification, composition of coal, analysis and properties of coal, natural coke, oxidation and hydrogenation of coal, processing of solid fuels: coal preparation, coal storage, coal carbonization and gasification, briquetting, gasification and liquefaction of solid fuels.

UNIT-II (11 Hrs.)

Liquid Fuels: Petroleum-origin and production, composition and classification of petroleum, processing of petroleum, properties of various petroleum products, petroleum refining, liquid fuels from sources other than petroleum.

Gaseous Fuels: Natural Gas, methane from coal mines, producer gas, water gas, coal gas, blast furnace gas, refinery gases, LPG, cleaning and purification of gaseous fuels,

biomass gasification.

UNIT-III (10 Hrs.)

Combustion: Principles of combustion, combustion of oil, coal and gas, combustion equations, stoichiometric fuel air ratio, exhaust and flue gas analysis, practical analysis of combustion products, dissociation, internal energy and enthalpy of reaction, enthalpy of formation, calorific value of fuels, air and fuel-vapour mixtures, heat balance sheet of a boiler, boiler draft, design of chimney.

UNIT-IV (08 Hrs.)

Combustion Related Pollution: Sources and effects - acid rain, smog, greenhouse gases and effect, air sampling and measurement, pollutants: classification, monitoring and control, control equipment viz. (mechanical collectors, wet scrubbers, and ESP)

Recommended Books:

1. S. Sarkar, 'Fuels and Combustion', Orient Longman, **1989**.
2. T.D. Eastop and A. McConkey, 'Applied Thermodynamics', Dorling Kingsley, **2008**.
3. I. Glassman, 'Combustion', Academic Press, **2008**.
4. L. Theodore, 'Air Pollution Control Equipment Calculations', John Wiley, **2008**.

WELDING TECHNOLOGY

Subject Code: MMEE8-208 **L T P C** **Duration: 40 Hrs.**
4 0 0 4

UNIT-I (09 Hrs.)

Introduction: Basic classification of welding processes, weldability, weld thermal cycle, metallurgy of fusion welds, solidification mechanism and microstructural products in weld metal, epitaxial, cellular and dendritic solidification, metallurgical changes in weld metal, phase transformation during cooling of weld metal in carbon and low alloy steel, prediction of microstructures and properties of weld metal. Heat affected zone, re-crystallization and grain growth of HAZ, gas metal reaction, effects of alloying elements on welding of ferrous metals.

UNIT-II (10 Hrs.)

Welding Arc: Arc efficiency, temperature distribution in the arc; arc forces, arc blow, electrical characteristics of an arc, mechanism of arc initiation and maintenance, role of electrode polarity on arc behaviour and arc stability, analysis of the arc

Coated Electrodes: Electrode coatings, classification of coatings of electrodes for SMAW, SAW fluxes, role of flux ingradients and shielding gases, classification of solid and flux code wires,

UNIT-III (11 Hrs.)

Fusion Welding reviews: Critical reviews of manual metal arc welding (MMAW) GTAW, GMAW, FCAW and CO welding processes, plasma arc, submerged arc welding, electro gas and electro slag welding, analysis of the process.

Welding power sources: Arc welding power sources basic charters tics of power sources for various arc welding processes, duty cycles, AC, DC welding power source, DC rectifiers, thyristor controlled rectifiers, transistorized units, inverter systems. Arc length regulation in mechanized welding processes,

UNIT-IV (10 Hrs.)

Metal Transfer and Melting Rate: Mechanism and types of metal transfer, forces affecting

metal transfer, modes of metal transfer, metal transfer in various welding processes, effective of polarity on metal transfer and melting rate.

Solid State Welding: Theory and mechanism of solid state welding. Techniques and scope of friction welding, diffusion welding, cold pressure welding and ultrasonic welding. High energy rate welding. Analysis of the Process.

Recommended Books:

1. R.S. Parmar, 'Welding Processes & Technology', Khanna Publishers.
2. R.S. Parmar, 'Welding Engineering & Technology', Khanna Publishers.
3. S.V. Nandkarni, 'Modern Arc Welding Technology', Oxford & IDH Publishing Co.

APPLIED SOLAR ENERGY

Subject Code: MMEE8-209 **L T P C** **Duration: 41 Hrs.**
4 0 0 4

UNIT-I (10 Hrs.)

Solar Radiation: Solar constant, solar angles and basic definitions, extraterrestrial and terrestrial solar radiation, solar time, local standard time, equation of time.

Solar Radiation Measurement and Estimation: Measurement of solar radiation using pyranometer and pyrheliometer, sunshine recorder, atmospheric attenuation of solar radiation, estimation of average solar radiation using empirical equations.

UNIT-II (11 Hrs.)

Radiation Transmission through Glazing: Reflection and absorption by glazing, optical properties of glass cover system, transmittance for diffuse radiation, transmittance-absorbance product, effects of surface layers on transmittance.

Flat Plate Collectors: Description of flat plate collectors, liquid heating collectors, air heating collectors, collector overall heat loss coefficient, collector efficiency factor, collector heat removal factor, flow factor, thermal and thermohydraulic performance of flat plate collector.

UNIT-III (10 Hrs.)

Concentrating Collectors: Types of concentrating collectors, geometry of concentrating collectors, concentration ratio, thermal performance of concentrating collectors.

Evacuated Tube Collector (ETC): Description and working principle of ETC systems. construction details of ETC, selection and installation of ETC systems, performance parameter tests of ETC systems.

UNIT-IV (10 Hrs.)

Solar Still: Basics of solar still and solar distillation, types of solar stills, single effect and multiple effect solar stills, design of solar still, heat and mass transfer analysis for basin type solar still.

Solar Energy Storage: Packed bed storage, phase change energy storage, chemical energy storage, solar ponds.

Recommended Books:

1. J.A. Duffie and W.A. Beckmann, 'Solar Engineering of Thermal Processes', John Wiley & Sons, **2006**.
2. D.Y. Goswami, F. Kreith and J. Kreider, 'Principles of Solar Energy', Taylor & Francis, **2003**.

3. A.S. Kalogirou, 'Solar Energy Engineering: Processes and Systems', Academic Press Inc., **2014**.
4. S. Sukhatma and J. Nayak, 'Solar Energy Principle of Thermal Collection and Storage', McGraw-Hill, **2009**.
5. H.P. Garg and J. Prakash, 'Solar Energy: Fundamentals and Applications', Tata McGraw Hill, **2000**.

LAB-II

Subject Code: MMEE8-210 **L T P C**
0 0 2 1

One lab /field/industrial oriented project /problem will be allocated to each student related to the subjects related to the subjects taught in 2nd Semester.

REFRIGERATION & AIR CONDITIONING

Subject Code: MMEE8-259 **L T P C** **Duration: 42 Hrs.**
4 0 0 4

UNIT-I (10 Hrs.)

Refrigerants: Classification of refrigerants, refrigerant properties, secondary refrigerants, ozone depletion potential and global warming potential of CFC refrigerants, eco-friendly refrigerants, azeotropic and zeotropic refrigerants.
Vapour Compression System: Multiple evaporator and compressor systems, cascade systems, manufacture of solid carbon oxide (Dry Ice).

UNIT-II (11 Hrs.)

System Components and Accessories: Types of evaporators, compressors, condensers, expansion devices, driers/ filters, receiver, accumulator, functional aspects of the above components & accessories, System equilibrium and cycling controls, capacity control in compressors.
Vapor Absorption System: Aqua ammonia & Li-Br systems, temperature-concentration diagram and enthalpy-concentration diagram for binary mixtures, thermodynamic analysis of aqua ammonia & Li-Br systems using enthalpy-concentration charts.

UNIT-III (10 Hrs.)

Steam Jet Refrigeration System: Principle and working of steam jet refrigeration system, performance analysis of steam jet refrigeration system.
Air Conditioning: Applied psychrometry, psychometric processes using chart.
Ventilation and Infiltration: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load.

UNIT-IV (11 Hrs.)

Load Estimation: Inside and outside design conditions, study of various sources of the internal and external heat gains, heat losses, equivalent temperature difference method for heat load calculations, RSHF, GSHF, ESHF, etc.
Air Distribution: Fundamentals of air flow in ducts, pressure drop calculations, design of ducts by velocity reduction method, equal friction method and static regain method, duct materials and properties, insulating materials, types of grills, diffusers.

Recommended Books:
1. R.J. Dossat, 'Principles of Refrigeration', Dorling Kingsley, **2008**.
2. W.F. Stoecker, 'Refrigeration and Air Conditioning', McGraw Hill, **1986**.
3. W.B. Goshnay, 'Principles and Refrigeration', 'Cambridge University Press', **1982.**
4. B.C. Langley, 'Solid State Electronic Controls for HVACR', Prentice Hall, **1989**.
5. S.C. Arora and S. Domkundwar, 'A Course in Refrigeration and Air Conditioning', **1997**.

STATISTICAL METHODS & ALGORITHMS

Subject Code: MMEE8-260 **L T P C** **Duration: 41 Hrs.**
4 0 0 4

UNIT-I (10 Hrs.)

Introduction: Nature and objectives of research, Study and formulation of research problem. Scope and formulation of hypothesis. Preparation and presentation of research proposal using statistical package.

Review of Probability: Appraisal of axiomatic approach of probability, Conditional probability, Baye's rule, Conditional distributions, and conditional expectations.

UNIT-II (11 Hrs.)

Markov Chains: Basics of markov chains, Finite state space, Markov chains, Transition and stationary markov chains. Continuous time markov process: continuous time branching processes, Kolmogorov, Forward and backward equations, Pure birth, Pure death, Birth and death process.

Analysis of Variance: One Way Classification: ANOVA for fixed effect model, ANOVA for Random Effect Model, Two-way Classification (one observation per cell): ANOVA for fixed effect model, ANOVA for Random Effect Model.

UNIT-III (11 Hrs.)

Design of Experiments: Completely Randomized Design, Randomized Block Design, Latin Square Design, their statistical analysis and variance of estimates, Analysis of Covariance.

Multivariate Data Analysis: Introduction, multivariate normal distributions, Mean vector, Variance-covariance matrix, Correlation matrix and their estimation for multivariate data., Step wise regression, Selection of best set of variables, Classification and discrimination problems. Factor analysis and principal component analysis. Illustrative examples and Multivariate data analysis using statistical package.

UNIT-IV (09 Hrs.)

Time Series and Forecasting: Components of time series, Analysis of time series, Measurement of trend, Measurement of seasonal variations, Measurement of cyclic variations, Auto-Regression Analysis, Auto-correlation, Random component in time series

Recommended Books:
1. J. Medhi, 'Stochastic Processes', New Age International, **2005**.
2. Montgomery, 'Introduction to Statistical Quality Control', John Wiley and Sons.

BOUNDARY LAYER THEORY

Subject Code: MMEE8-261 **L T P C** **Duration: 39 Hrs.**
4 0 0 4

UNIT-I (10 Hrs.)

BASIC CONCEPTS OF VISCOUS FLOWS: Viscous flow characteristics, introduction to hydrodynamic and thermal boundary layer theory, governing equations with effect of viscosity, flow over the flat plate at zero incidences, boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer equation and their general properties.

UNIT-II (11 Hrs.)

THERMAL BOUNDARY LAYERS: Heat transfer from heated surface. Heat transfer from cold surface, thermal boundary layer growth over the hot and cold surface, flow over the flat plate with different flow conditions with heat transfer, exact and approximate solutions to thermal boundary layer flows, relation between thermal and hydrodynamic boundary layer theories, Reynolds analogy and Colburn analogy, non-dimensional numbers governing boundary layer flows,

UNIT-III (09 Hrs.)

TRANSITION: Pipe flow and flow over a flat plate, critical Reynolds number, turbulent spots, principles of theory of stability of Laminar flows, Summerfield equation, factors effecting transition, Laminar aero foils.

UNIT-IV (09 Hrs.)

BOUNDARY LAYER CONTROL: Need of boundary layer control, causes of boundary layer separation, flow over the cylinder and aerofoil for different flow conditions leads separation

Recommended Books:

1. Bansal, 'Fluid Mechanics'.
2. R.K. Rajput, 'Heat Transfer'.
3. Deward Shaughnessy, 'Introduction to Fluid Mechanics'.
4. H. Schlichting, 'Boundary Layer Theory'.

TOTAL QUALITY MANAGEMENT

Subject Code: MMEE8-311 **L T P C** **Duration: 44 Hrs.**
4 0 0 4

UNIT-I (8 Hrs.)

Quality Concepts

Evolution of Quality control, concept change, TQM Modern concept, Quality concept in design, Review off design, Evolution of proto type. Control on Purchased Product Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure.

UNIT-II (12 Hrs.)

Manufacturing Quality

Methods and Techniques for manufacture, Inspection and control of product, Quality in sales and services, Guarantee, analysis of claims. Quality Management, Organization structure and design, Quality function, decentralization, Designing and fitting organization for different types products

and company, Economics of quality value and contribution, Quality cost, optimizing quality cost, seduction programme.

UNIT-III (12 Hrs.)

Human Factor in Quality

Attitude of top management, co-operation, of groups, operator's attitude, responsibility, causes of operator's error and corrective methods. Control Charts Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts.

Attributes of Control Charts

Defects, construction and analysis off-chart, improvement by control chart, variable sample size, construction and analysis of C-chart.

UNIT-IV (12 Hrs.)

Defects Diagnosis and Prevention

Defect study, identification and analysis of defects, corrective measure, factors affecting reliability, MTTF, calculation of reliability, Building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

IS0-9000 and its concept of Quality Management:

ISO 9000 series, Taguchi method, JIT in some details

Recommended Books:

1. H. LaI, 'Total Quality Management', Wiley Eastern Ltd., **1990**.
2. Greg Bounds, 'Beyond Total Quality Management'. McGraw Hill, **1994**.
3. H.G, 'TQM in New Product Manufacturing', McGraw Hill.

MAINTENANCE & RELIABILITY ENGINEERING

Subject Code: MMEE8-312 **L T P C** **Duration: 41 Hrs.**
4 0 0 4

UNIT I (10 Hrs.)

Evolution of maintenance, objective of maintenance, maintenance policies and philosophies, maintenance concept, maintenance management & terotechnology, relationship with functional areas, importance of maintenance, elements of good maintenance, Economics of maintenance, training and safety aspects in maintenance.

UNIT II (08 Hrs.)

Classification of maintenance programs, corrective preventive and predictive maintenance, comparison of maintenance programs, preventive maintenance- concepts, functions, benefits, limitations.

UNIT III (11 Hrs.)

Spare and Inventory planning, Manpower planning, Maintenance performance and Maintenance Auditing. Reliability centered maintenance (RCM) RCM logic, benefits of RCM, introduction to Total productive maintenance (TPM), Objectives, key supporting elements of TPM, methodology, evaluation and benefits.

UNIT IV (12 Hrs.)

Introduction to Reliability systems - series, parallel and hybrid systems, Techniques for improvement of operational reliability, Reliability calculations, and availability of machines and

production systems, maintainability criteria, checklist to assess the maintainability of a system, maintainability programs, objectives, key issues in availability improvements program, fault diagnosis, Pareto principle Ishikawa diagram, Failure Distribution-Constant failure rate, Weiball analysis etc.

Recommended Books:

1. S.O. Duffuaa and A. Raouf, 'Planning and Control of Maintenance Systems: Modeling and Analysis', John Wiley Inc.,**1999**.
2. L.R. Higgin, 'Maintenance Planning and Control', McGraw- Hill Book Co., **1990**.
3. Kelly Anthony, 'Maintenance Planning and Control', East West Press Private Ltd., New Delhi, **1991**.
4. B.S. Blanchard and E.E. Lowey, 'Maintainability Principle and Practices', McGraw Hill Book.
5. Niebel Benjamin W. 'Engineering Maintenance Management', Marcel Dekker, **1994**.