DR. A P J ABDUL KALAM UNIVERSITY, INDORE

SYLLABUS

of

MASTER OF TECHNOLOGY (THERMAL POWER ENGINEERING)

Department of Mechanical Engineering

(First Year)

(Session July- December 2016)

College of Engineering

Dr. A P J Abdul Kalam University, Indore

DR. A P J ABDUL KALAM UNIVERSITY, INDORE

Syllabus for Master of Technology (Thermal Power Engineering)

Department of Mechanical Engineering

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UNIT 1: Linear Algebra

Linear transformation, vector spaces, hash function, Hermite polynomial, Heavisite's unit function and error function. Elementary concepts of Modular mathematics.

UNIT 2: Solution of Partial Differential Equation (PDE)

Solution of Partial Differential Equation (PDE) by separation of variable method, numerical solution of PDE (Laplace, Poisson's, Parabolic) using finite difference methods, Elementary properties of FT, DFT, WFT, Wavelet transform, Haar transform.

UNIT 3: Probability

Compound probability and discrete random variable, Binomial, Normal and Poisson's distributions, Sampling distribution, elementary concept of estimation and theory of hypothesis, recurred relations.

UNIT 4: Stochastic process

Markov process transition probability transition probability matrix, just and higher order Markov process, Application of Eigen value problems in Markov Process, Markov chain. Queuing system, transient and steady state, traffic intensity, distribution queuing system, concepts of queuing models (M/M/1: Infinity/ Infinity/ FC FS), (M/M/1: N/ Infinity/ FC FS), (M/M/S: Infinity/ Infinity/ FC FS).

UNIT 5: FEM

Variational functionals, Euler Lagrange's equation, Variational forms, Ritz method, Galerkin's method, descretization, finite elements method for one dimensional problems.

References:

[1] Higher Engineering Mathematics by B.V. Ramana, Tata Mc Hill.
[2] Advance Engineering Mathematics by Ervin Kreszig, Wiley Easten Edd.
[3] Applied Numerical Methods with MATLAB by Steven C Chapra, TMH.
[4] Advance Engineering Mathematics, O'Neil, Cengage (Thomson)
[5] Introductory Methods of Numerical Analysis by S.S. Shastry,
[6] Krishmurthy Finite element TMH
[7] Buchanan Finite element analysis(Schaum Outline S) TMH

Sub Code: MTTPE 102 Sub Name: Thermodynamics and Combustion 4 Credits

Unit 1: Classical Thermodynamics:

Concept of classical thermodynamics, review of zeroth, first and second law of thermodynamics. Availability analysis of thermal system and concept of energy conservation.

Unit 2: Phase and reaction equilibriums:

Equilibrium constants .calculation of equilibrium composition of multi components gaseous mixtures.

Unit 3: Equations of state:

Equations of state & calculations of thermodynamics and transport properties of substances, reaction rates of first ,second and higher order reactions, reactions in gaseous, liquid and solid phases .

Unit 4: Real substances and properties:

Equilibrium, real substances and properties, triple point, critical point, temperature entropy, entropy-enthalpy charts, Vanderwal's equation of state, Claperon's equation, Gibbs phase rule, law of corresponding states.

Unit 5: Study of fluid flow:

Compressible Fluid Flow-Velocity of Pressure Pulse, Stagnation Properties, One Dimensional Steady Isentropic flow, Critical Properties, Normal Shocks, Adiabatic Flow with Friction, Diabatic Flow without Friction.

References:

[1] Heat Power and Thermodynamics by M.W.Zemansky (McGraw Hill).
[2] Combustion, Flames and explosions of gases, B.Lewis and G.Von Elbe Academic P.
[3] Thermal Sciences, Potter, Cengage Learn (Thomson).
[4] Engineering thermodynamics by Gurdon Rogers Yon Mayhew.
[5] Concept of thermodynamics by Obert (McGraw Hill).

Unit 1: Introduction

Modes of heat flow, Basic laws of heat transfer. Combined heat transfer Mechanisms. Conduction: Steady state conduction, System with internal generation of heat, Transient Conduction, Extended surfaces (Fins), Multi-dimensional heat transfer problems, Phase change, Heat transfer with moving bodies.

Unit 2: **Convection**

Governing Equations in Laminar & Turbulent Flow, Free and Forced Convection, Tubes, Ducts and exterior surfaces, tube bundles in cross flow, Correlations,Dimensional analysis.

Unit 3: Heat Transfer

Boiling heat transfer, nature of vaporization, nucleate pool boiling and empirical correlations for pool boiling heat transfer, factors affecting pool boiling film coefficients, high heat flux boiling. Condensation: Physical Mechanisms, Laminar film condensation on a vertical plate, turbulent film condensation, drop wise condensation.

Unit 4: Steady State Heat Conduction

One Dimensional Heat Conduction Equation, General Heat Conduction Equation, Heat generation in a Solid, Variable Thermal Conductivity, Thermal Contact Resistance, Heat Conduction in Cylinders and Spheres, Critical Radius of Insulation Heat Transfer from Finned Surfaces.

Unit 5: Radiation

Radiation Properties & Law, Electrical analogy, Radiation exchange between surfaces, Applications to cavities & enclosures,Mass transfer: equation for convective mass transfer, boundary layer mass transfer, empirical correlation for convective mass transfer.

References:

[1] Heat Transfer, Krieth, Cengage learn (Thomson).
[2] Heat transfer by J.P. Holman.
[3] Analysis of Heat transfer E.R.G.Eckerst and R.M. Drake Jr. McGraw Hills.
[4] Heat mass and momentum transfer .W.M.Roshenow and P.Choi, Prentice Hall.

Unit 1: Reviews of basic laws

Reviews of basic laws, concept of continuum, fluid flow in Integral & differential form Ideal fluid flow: Introduction, Elementary flows in a 2-D plane, Flow nets, superposition of Elementary flows

Unit 2: Kinematics of Fluid

Description of properties in a moving fluid, Local and material derivatives, Control mass and control volume analysis, Reynolds Transport theorem and its application.

Unit 3: Viscous Incompressible Flows

Introduction, Equations of motion, N-S equations and its application. Boundary Layer Theory: Prandtl's boundary layer equations, Flat plate boundary layer, approximate solution – Integral method, Laminar and turbulent boundary layer, Separation, Lift and Drag.

Unit 4: Fundamental of Compressible flows

Introduction, Thermodynamic relations of perfect gases, Speed of sound, pressure wave propagation, Stagnation and Sonic properties, Shocks.

Unit 5: Hydraulic machines

Theory and design of hydro-turbines and centrifugal pumps, their proto-type testing.

References:

[1] Fluid Mechanics by Shames (McGraw Hill).

[2] Mechanics of Fluid by Massey (EL-BS).

[3] The Dynamics and Thermodynamics of Compressible Fluid flow A.H. Shapiro.

[4] Boundary Layer Theory H. Schlichting McGraw Hills.

[5] Thermal Sciences, Potter, Cengage Learn (Thomson)

Unit1: SI Engines

Fuels for use in S.I. Engines, Rating of S.I. Engines fuels, carburetors and carburetion, fuel injection systems; Combustion in S.I. Engines-normal and abnormal, detonation, stratification and lean mixture operations. Carburetor replacement by MPFI, Elements of MPFI System like control unit, sensors, switches, Effect on engine performance & Engine Emission.

Unit 2: Performance & testing of I.C. Engine

Introduction, breathing capacity, pumping losses, friction losses, super charging, performance parameters & their measurements for S.I.E. & C.I.E. Engine, performance maps. Air and sound pollution by engines, remedial measures.

Unit 3: Non Conventional I.C. Engines

Dual Fuel, Multi Fuel, Stratified charge lean burn variable compression ratio, Rotary Engines, Description, Working and comparison with conventional I.C. Engines.

Unit 4: Future Fuels for Ignition Engines

Introduction, Necessity for substitute Fuels. Substitute future fuels like Ethanol, Methnol, Bio gas, Hydrogen, Production, Transportation, storage of substitute fuel, performance of engines using these fuels.

Unit 5: Advance IC Engines Subsystems

Emission control and electronic management systems. Design of Supercharged engines, Advances in engine design, Modern trends in IC Engines. Engines for special applications - Mining Defence, Off-highway -Tractor, Bulldozer etc. Submarines, Race car engine systems, Flexible fueled systems.

References

[1] A.S. Khatchiian ;Theory of C.I. Engines Vol.1 and 2 IIT Bombay .

[2] C.F. Taylor and E.S. Taylor; Internal Combustion Engines ,Stanton

[3] P.G. Burman and B.Luca Fuel injection and Engines, Technical Press

[4] L.C. Litchy ,Combustion Engines Processes, McGraw-Hill

Suggested List of Experiments:

[1] Determination of LMTD and Overall Heat Transfer Coefficient of a Parallel Flow Heat Exchanger.

[2] Determination of LMTD and Overall Heat Transfer Coefficient of a Counter Flow Heat Exchanger.

[3] Determination of Overall Heat Transfer Coefficient of a Double Pass Heat Exchanger.

[4] Determination of Overall Heat Transfer Coefficient for Cross Flow Air/Water Heat Exchanger.

[5] Performance of Heat pipe as Compared with Thermal Siphon and Air Pipe.

[6] Determination of Thermal Conductivity of Metal Rod.

[7] Determination of Heat transfer in Forced Convection.

[8] Dropwise and Filmwise Condensation.

[9] Determination of Stefan Blotzman constant by Stefan Boltzman apparatus.

Sub Code: MTTPE 107	Sub Name: LAB – II (IC Engine)	6 Credits

Suggested List of Experiments:

1. To Determine Volume Flow Rate for Low Speed Wind Tunnel using Pitot Tube.
2. To study Flow around Circular/Irregular Shaped Body.
3. Heat Balance Sheet for C.I./I.C Engines.
4. To find effect of compression ratio on I.C. Engine Performance.
5. Study of Experimental Facility on Steam Turbine.
6. To conduct Numerical Experiments with Software for exploration of problems related to fluid and heat transfer using the software.

Sub Code: MTTPE 201 Sub Name: Thermal Power Plant Engineering 4 Credits

UNIT 1

Conventional thermal power plants, super-critical power plants and its principles of working, performance curves and flow diagrams.

UNIT 2

Power plant components: Fuel and ash handling, pulverized fuel firing burners, dust handling, fluidized bed combustion. Radiant super heaters and re-heaters, economizer and pre-heaters, combustion and furnace design, boiler water supply and treatment. Drat and arrangement of draft fans, different types of cooling systems, open closed, mixed and dry cooling tower systems, air cooled condensers. Ejector and vacuum pumps, feed heating systems, heaters, evaporators and de-airator, feed line protection, boiler feed pumps, different type of drives for it, steam turbine driven feed pumps.

UNIT 3

Plant instrumentation for thermal power plants, need and importance, distributed and centralized, pneumatic and electro-mechanical transducers and controllers, distributed computer control. Piping and insulation: design and layout of ducting for air fuel, gases and pulverized fuels, selection of piping, pipe flexibility analysis, Various control valves and actuators. Insulation optimum thickness and costs.

UNIT 4

Installation, commissioning and operation: Preliminary performance checks and acceptance test for various components, heat balance of items and entire plant. Starting loading and normal operation checks, maintenance logging, parallel operations, droop setting, performance analysis, maintenance, safety and pollution controls.

UNIT 5

Plant Management: Preparing specifications and contract documents, guarantee. Training of power plant personnel, safety, and seismic analysis. Purchase and contract for fuel supplies.

References:

[1] Power Plant Engineering, F T Morse.
[2] Power Plant Engineering, P K Nag.
[3] Power Plant Engineering, Arora and Domkundwar.

Sub Code: MTTPE 202 **Sub Name: Design of Heat Exchangers** **4 Credits**

Unit 1

Types of Heat Exchangers, definitions & amp; quantitative relationship.

Unit 2

Analytical & Numerical solution Procedures, Fouling factors, Correction factors

Unit 3

Thermal & hydraulic design of Commonly used heat exchangers : Double pipe heat exchangers,shell and tube heat exchangers, condensers, Evaporators, Cooling and dehumidifying coils, Cooling towers, Evaporative condensers , design of air washers, desert coolers .

Unit 4

Review of mechanical Design, TEMA Codes Materials of Construction, corrosion damage, Testing and inspection .

Unit 5

Heat Pipe: Basics & its mathematical model , micro Heat Exchangers. Use of software in heat exchanger design.

References:

[1] Compact Heat Exchangers Kays and London, TMH.

[2] Heat Exchangers- Thermal Hydraulic fundamentals and design, Kokac, TM

[3] Extended Surface Heat Transfer, D Q Kern, A D Kraus, TMH.

[4] Tubular Exchanger Manufacturer Association (TEMA), and other codes.

Sub Code: MTTPE 203	Sub Name: Advance Refrigeration System	4 Credits

UNIT 1

Introduction: Thermodynamics Properties of pure and Mixed Refrigerants and their selection. Vapor Compression System, Actual Vapor Compression System, Deviation from theoretical System, Multi-pressure System with Flash Chamber and Inter Cooling, Cascade system.

UNIT 2

Refrigeration Equipments: Compressors, Analysis and Thermal Design of Reciprocating, Centrifugal and Screw Compressors, Performance Characteristics & Capacity control.

UNIT 3

Expansion Devices: Capillary, Automatic and Thermostatic Expansion Valve. Other Equipments: Liquid Receiver, Oil Separators, Liquid Line Strainers, Driers, Liquid Subcoolers.

UNIT 4

Condenser & Evaporator: Types, performance & Their Controls.

UNIT 5

Thermodynamics of Refrigerant: Absorbent Combinations, Analysis of simple and Industrial Vapor Absorption system using various working fluids Solar Powered Refrigeration & Heat Pump.

References

1. Refrigeration & Air Conditioning by W.F.Stoecker
2. Refrigeration & Air Conditioning by C.P.Arora
3. Refrigeration & Air Conditioning by Manohar Prasad

Unit 1: Steam Turbines

Principle and working of steam turbines, type of turbines, impulse and reactions, compounding for pressure and velocity. Velocity triangles for various types, stage to blade, speed ratio for optimum efficiency, diagram efficiency, steam performance. Energy losses in steam turbine, turbine performance at various loads and governing of steam turbines. Constructional details and description of steam turbine components in brief.

Unit 2: Regenerative feed heating cycles

Introduction : Most Ideal Regenerative f eed heating cycle. Regenerative feed heating cycles and their representation on T-s and h-s Diagram. Representation of actual process on T-s and h-s Diagram Regenerative cycles. Other types of feed heating arrangements. Optimum feed water temperature and saving in Heat Rate. Feed Heaters, Direct Contact Heaters, Surface Heaters, Deaerators .

Unit 3: Reheating – Regenerative and Regenerative water – Extraction Cycles

Reheating of steam, Practical reheating and Non- reheating cycles, advantage & disadvantages of reheating, regenerative water extraction cycles, practical feed heating arrangements. Feed heating system for 120MW, 200MW, 350MW, 500MW & 66 MW units.

Unit 4: Mixed Pressure Turbines

Low- pressure Turbines, Mixed pressure Turbines, Heat Accumulators.

Unit 5 Gas Turbines

Open and closed cycles, constant pressure and constant volume cycles, cycles with inter cooling, reheating and heat exchanger, compressor and turbine efficiencies, pressure losses, performance characteristics of various cycles, practical problems. Jet Propulsion: Calculation of thrust, Power, speed and efficiency, turbo – jet and turbo propulsion systems.

References:

[1] Fluid dynamics and heat transfer of turbo-machinery, Budugur Lakshmi narayana.

[2] Cohen H Rogers, Sarvanmutto, Gas Turbine Theory, Longman Pub.

[3] Mathur, Sharma, Gas turbine, Standard Pub And Distributors Delhi.

Unit1: Maintenance Management

Emergency maintenance produces maintenance strategies spare part management, inventory control purchase procedure and storage, Warning systems, organization of maintenance department, human consideration.

Unit 2 Diagnostic Maintenance and Machine Health Monitoring

Introduction to maintenance techniques, preventive and predictive maintenance, signature analysis, observational and estimation techniques, online techniques specially dealing with instrumentation system, off-line techniques, non-destructive testing, practical application of diagnostic maintenance to specific industrial machinery and plants. Various techniques of condition monitoring wear analysis, vibration and noise signature, thermography etc.

Unit 3: Mechanism of Lubrication & Lubricants

Lubrication regimes, analysis and modes of lubrication in different bearings, squeeze films, fluid film, elasto-hydrodynamic and boundary lubrications theories and applications, environmental effects on lubrications, types of lubricant and properties, non-conventional lubricants and applications.

Unit 4: Failure Mechanisms and Analysis

Material failure due to environmental effects, Introduction; Importance of failure analysis, common causes of failure in metals & alloys. Failure due to faulty heat treatment, embrittlement of metals, Residual stresses in metals, and their effects. Defects in production and manufacture. Design faults, analysis of engineering failures, failure due to abuse of machinery, failure of seals & packing, failure of bearings, failure of gears, fatigue failure, failure due to time-temperature effects(creep) corrosion etc.

Unit 5: Maintenance of Power Plant Machinery

Predictive and preventive maintenance of steam turbine and its components, Erosion of blades and its prevention. Lubrication of bearings,valves, Maintenance scheduling, methods of detection of leaking and its prevention in the condensers. Condenser fault systems and its cases. On load and off load cleaning of condenser tubes, Maintenance scheduling of cooling water plants, cooling towers, Life enhancement techniques, case studies.

References

[1] Maintenance & Spare Parts & Management -by Gopal Krishnan & Bannergee
[2] Maintenance Engg. Handbook - by Lindley & Higgins
[3] Industrial Maintenance Management - by Neibel
[4] Reliability Centered Maintenance - by Moubray
[5] Maintenance Engg. & Management - by R.C. Mishra

Sub Code: MTTPE 206 Lab – III (Maintenance of Thermal Power Plant) 6 Credits

Suggested List of Experiments:

[1] Study of Turbine (High intermediate and low pressure).

[2] Maintenance of Steam Turbine.

[3] Study & Maintenance of Turbine driven generator.

[4] Maintenance of Heat Exchanger shell and tube type .

[5] Study & Maintenance of Heat Exchanger Procedure.

[6] Study & Maintenance of Cooling Tower.

[7] Study & Maintenance of Condenser.

Suggested List of Experiments:

[1] General Study of vapor compression refrigeration system.

[2] General Study of window Air Conditioner.

[3] General Study and working of cold storage.

[4] General Study Trane Air Condition.

[5] General Study One tone Thermax refrigeration unit.

[6] General Study of Water cooler.

[7] General Study of Psychrometers. (Absorption type).

[8] General Study of Leak Detectors (Halide Torch).

[9] General Study and working of Gas charging.