NORTH MAHARASHTRA UNIVERSITY

JALGAON (M.S.)

MASTER OF ENGINEERING (M.E.)

(MECHANICAL ENGINEERING)

(Thermal Engineering)

W.E.F.: 2012-13

North Maharashtra University, Jalgaon
M.E. (Thermal Engineering)
Examination scheme and Structure with effect from Year 2012-13
First Year Term I

Sr No	Subject	Teaching Scheme per week		Examination Scheme				
		L	P	Paper Hr.	Paper	TW	PR	OR
1	Advanced Heat Transfer	3	-	3	100			
2	Advanced Thermodynamics and gas dynamics	3	-	3	100			
3	Energy Conservation and Management	3	-	3	100			
4	Measurement Techniques And Data Analysis	3	-	3	100			
5	Elective – I	3	-	3	100			
6	Laboratory Practice-I	-	6		-	100		50
7	Seminar-I	-	4		-	100		
	Total	15	10		500	200		50
	Grand Total	25		750				

Elective I

TE 105 INTERNAL COMBUSTION ENGINE

TE106 SOLAR ENERGY TECHNOLOGY

TE 107 FINITE ELEMENT ANALYSIS

TE 108 GAS TURBINES & JET PROPULSION

TE 109 POWER PLANT ENGINEERING

First Year Term II

Sr No	Subject	Teaching Scheme per week		Examination Scheme				
		L	P	Paper Hr.	Paper	TW	PR	OR
1	Advanced Fluid Mechanics	3	-	3	100			
2	Advanced Refrigeration	3	-	3	100			
3	Computational Fluid Dynamics	3	-	3	100			
4	Numerical Methods in Thermal and Fluid Engineering	3	-	3	100			
5	Elective – II	3	-	3	100			
6	Laboratory Practice-II	-	6		-	100		50
7	Seminar-II	-	4		-	100		
	Total	15	10		500	200		50
	Grand Total	25		750				

Elective II

TE205 NON CONVENSIONAL POWER PLANT

TE206 ADVANCED AIR CONDITIONING

TE207 CONVECTIVE HEAT TRANSFER ANALYSIS

TE208 EQUIPMENT DESIGN FOR THERMAL SYSTEMS

TE209 RESEARCH METHODOLOGY

TE210 TURBOMACHINARY

Second Year Term I

Sr No	Subject	Teaching Scheme per week		Examination Scheme				
		L	P	Paper Hr.	Paper	TW	PR	OR
1	Seminar-III	-	4	-	-	50		50
2	Project Stage-I	-	18	-	-	100		
	Total	-	22	-	-	150		50
	Grand Total	22		200				

Second Year Term II

Sr No	Subject	Teaching Scheme per week		Examination Scheme				
		L	P	Paper Hr.	Paper	TW	PR	OR
1	Progress Seminar IV	-	-	-	-	50		-
2	Project Stage-II	-	18	-	-	150		100
	Total	-	18	-	-	200		100
	Grand Total	18		300				

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I

Advanced Heat Transfer [Common with M.E (Mech.Engg. General)] TE 101

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme
Paper: 100 Marks
Paper Duration: 3 Hrs.

Modes of heat transfer.
Conduction, Factors affecting thermal conductivity of solids, liquids & gases, General three dimensional heat conduction equation in Cartesian, Cylindrical & spherical coordinates, Initial condition and various boundary conditions. Heat source systems, Critical thickness of insulation. Different types of fins & their analysis, Two -dimensional steady state conduction. Electrical analogy,

Graphical & numerical methods. Transient heat conduction with & without temperature gradients within the system, Heat flow in semi infinite solids. Application of Heisler charts.

Free & forced convection, Similarity & simulation of convection heat transfer, Boundary layer theory.

Turbulent flow heat transfer. Analogy between momentum & heat transfer. Heat transfer with liquid metals. Heat transfer in high velocity flow. Recent development s in the theory of turbulent heat transfer. Natural convection under different situations. Empirical relations in convection heat transfer.

Boiling & condensation.
Regimes of boiling heat transfer. Heat transfer in condensation. Drop wise & film condensation. Empirical equations.

Radiation heat transfer properties. Laws of thermal radiation. Shape factors. Radiation heat transfer
between black, diffuse & gray surface. Electrical network method of solving radiation problems. Radiosity approach. Gas emission & absorption, Bulk radiations.

Note for paper setter/ examiners.

Use of Heat Transfer Data Book is allowed to students during examination.

Lab. Practice-I

Assignments:
(Any Four)

1. Heat pipes
2. Numerical method in heat conduction & convection.
3. Combined heat transfer.
4. Passive heat transfer augmentation techniques.
5. Electronic cooling
6. One problem on network method (Radiation).
7. Heat transfer during melting and solidification

Reference Books

1. J.P.Holman, "Heat Transfer", McGraw Hill Book Co. Special Indian 9th Edition, 2008.
2. Oziski, M. N. "Heat Transfer – A Basic Approach", McGraw Hill, N. Y., 2001.
3. Roshenow, W., Hartnett, J., Ganic, P., "Hand Book of Heat Transfer ", Vol.1 & 2, McGraw Hill, N. Y., 2002.
4. Incropera & Hewitt, "Fundamentals of Heat and Mass Transfer", John Wiley , 2000.
5. S.P.Sukhatme, "Heat Transfer", Orient Longman, 2001.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I

Advanced Thermodynamics and Gas Dynamics (TE 102)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit 1

1. Thermodynamics Relations:- Mathematical theorems, Maxwell relations, T-ds equations, Energy Equations, General Relations involving internal energy, enthalpy & entropy, Thermodynamics Relations involving specific heat , Clapeyron equation, Joule Thomson Coefficient, Developing Tables of Thermodynamics properties from experimental data.

2. Real Gases: - Deviation from ideal gas behavior, equation of state for real gases, reduced properties, Generalizes equation of state, laws of corresponding states, Generalized compressibility charts, enthalpy deviation and entropy deviation charts and their applications, P-V-T surfaces of real substances, Fugacity and activity.

Unit 2

3. Kinetic Theory of Gases:- Postulates, concept of elastic collisions and mean free path, Derivation of ideal gas laws from kinetic theory, Distribution of molecular velocities, Maxwellion speeds and temperature, Law of equipartition of energy, Survival equation, Transport phenomenon.

4. Statistical Thermodynamics:- Fundamental Principles, Equilibrium distribution, Significance of Lagrangian Multipliers λ & β, Partition function, Equipartition of energy, Distribution of speeds in an Ideal monotomic gas, Statistical Interpolation of Work and Heat, Entropy & Information.

Unit 3

5. Mixtures and Solutions:- Dalton Model , Amagat Model, Simplified model of a mixture involving gases and a vapour, First law applied to Gas-Vapour mixtures, Adiabatic saturation process, Partial Molar properties, change in properties upon mixing, Thermodynamic properties relations for variable composition, Gibbs function and Enthalpy, Fugacity in a mixture, Ideal solution, Activity and Activity coefficient.

6. Chemical Reactions: - Combustion process, Theoretical and actual combustion processes, Enthalpy of formation, Enthalpy of combustion, First law analysis of Reacting systems, Adiabatic flame temperature Enthalpy and internal energy of combustion, Entropy change of

Reacting systems, Heat of reaction, Second law Analysis of Reacting systems, Evaluation of Actual combustion processes.

Unit 4

8. Compressible Flow: One-dimensional Flow: speed of sound, variable cross-section flow, converging diverging nozzle, effect of friction and heat transfer, normal shock relations, Introduction to oblique shocks, 2-dimensional flows(subsonic and supersonic) past slender bodies, compressible boundary layers.

Unit 5

9. Gas Dynamics: Fundamentals thermodynamic concepts; Isentropic conditions; Mach number and Area – Velocity relation; Dynamic pressure; normal shock relations for perfect gas; supersonic flow, oblique shock waves ; normal shock recovery ; detached shocks ; Aerofoil theory.

REFERANCE BOOKS

1. **V. Wylen & E. Sonntag.** "Fundamentals of Classical Thermodynamics" Wiley Eastern Limited, New Delhi,

2. **J. P. Holman,** "Thermodynamics", McGraw Hill, London.

3. **Adrian Bejan, George T., Michael Moran,** "Thermal Design and Optimization" John Willey and Sons, Inc., pp 113-127, 1996.

4. **T.J. Kotas,** "The Energy Method of Thermal Plant Analysis", Butterworth, 1985

5. **J.L. Thrdkeld,** "Thermal environmental engineering", Prentice Hall, Inc. New Jersy. 1970

6. **M.W. Zemansky,** "Heat and Thermodynamics",

7. **M.L. Mathur & S.C. Gupta,** "Thermodynamics for Engineers", Dhanpatrai and Sons Ltd., New Delhi.

8. **Howell & Duckins,** "Fundamentals of Engineering Thermodynamics".

9. **Lee-Sears,** "Engineering Thermodynamics".

10. **N.A. Chigier,** Energy Combustion and Environment –McGraw-Hill 1981

11. **A. Murthy Kanury, Gordon and Breach,** Introduction to combustion phenomena,1975

12. **S. P. Sharma and Chandra Mohan,** Fuels and combustion –Tata McGraw –Hill. 1984.
13. **F.M. White**, Fluid Mechanics, , McGraw Hill Int.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I

ENERGY CONSERVATION AND MANAGEMENT (TE 103)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks

UNIT 1

The energy market, sources of world energy, exhaustible and renewable / inexhaustible sources, energy scenario in India, energy planning, utilization pattern and future strategy, Energy conservation Act 2003.

UNIT 2

Importance of energy management. Energy auditing: methodology analysis of post trends (plant data), closing the energy balance, laws of thermodynamics, measurements, portable and online instruments.

UNIT 3

Energy economics – discount rate, payback period, and internal rate of return, life cycle costing.

Steam Systems : Boiler-efficiency testing, excess air control, steam distribution and use of steam traps, condensate recovery, flash steam utilisation, thermal insulation.

UNIT 4

Electrical Systems: Demand control, power factor correction, load scheduling / shifting, motor drives – motor efficiency testing, energy efficient motors, motor speed control. Demand side management, Electricity Act 2001.

Lighting: Lighting levels, efficient options, fixtures, day lighting, timers, energy efficient windows.

UNIT 5

Energy conservation in pumps, furnaces, fans, compressed air systems, refrigeration and air-conditioning systems. Waste heat recovery: recuperators, heat wheels, heat pipes, heat pumps.

Cogeneration: Concept options (steam / gas / turbine / diesel engine bases), selection criteria, control strategy.

TERM WORK

1) Application of energy conservation technique to one equipment such as aircompressor, air conditioning systems, furnace, etc.
2) Report based on industrial visit for study of energy audits, energy conservation methods.
3) Design of waste heat recovery system.

BOOKS :

Energy Management Hand book by W.C. Turner (Ed)

Management by H.Koontz and Cyrill O Donnell

Financial Management by S.C. Kuchhal

Energy Management by W.R.Murthy and G.Mc Kay

Energy Management Principles by CB Smith.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I

Measurement Techniques & Data Analysis[Common with M.E (Mech.Engg. General)] TE 104

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme
Paper: 100 Marks
Paper Duration: 3 Hrs.

1) Introduction to measurements for scientific and engineering application need and goal. Broad category of methods for measuring field and derived quantities.
2) Principles of measurement, parameter estimation, regression analysis, correlations, error estimation and data presentation, analysis of data.
3) Measurement of field quantities, thermometry, heat flux measurement, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration, measurement of the above by probe and non instructive techniques.
4) Measurement of derived quantities, torque, power, thermo physical properties, radiation and surface properties.
5) Analytical methods and pollution monitoring, mass spectrometry, chromatography, spectroscopy.
6) Basics of P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers, applications to machine tools, furnaces, material handling etc.

Lab. Practice –I

1) Calibration of pressure gauge
2) Computer aided experimentation for temperature measurement.
3) Design of control system for boiler/compressor/pumps/turbines
4) Problem of analysis of data and error estimation.

Reference Books

1) Doebelin E.O: Measurement Systems-Application and Design, McGraw Hill Publication Co.
2) Beckwith TG. N. Lewis Buck and Marangoni R.D: Mechanical Measurements, Narosa Publishing House, New Delhi.
3) Liptak B.G. Instrument Engineers' Handbook.
4) Bolton W, Mechatronics-Electronics Control Systems in Mechanical and Electrical Engg.
5) Modern Electronic Instrumentation and Measurement Technique by A.D. Helfrick and W.D. Cooper.
6) Johnson C.D., Process Control Instrumentation.
7) J.P.Holman: Experimental Methods For Engineers, McGraw Hill International Edition, Seventh Edition.

(* Question Paper- 50% to 60% of marks are kept for the quantitative questions)

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I
ELECTIVE – I

Internal Combustion Engine [Common with M.E (Mech.Engg. General)] (TE 105)

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme:
Paper: 100 Marks
Paper Duration: 3 Hrs.

1)Measurement & Testing: Introduction ,engine performance parameters, measurement and testing, engine operating characteristics, performance maps.
2)Engine Materials: Various engine components, cylinder head, spark plug, gaskets, cylinder block, piston ,piston rings, gudgeon pin ,connecting rod, crankshaft, bearings , crankcase ,fuel injector.
3)Engine Design: Preliminary analysis, cylinder number, size and arrangement, experimental development.
4)Electronic Injection System: Gasoline injection, EFI system, MPFI system , electronic control system ,injection timing, electronic diesel injection system and control.
5) 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, crankcase blow by.
6)Simulation Technique: Application of simulation technique for engine tuning, engine selection parameters, recent trends in IC engines.

Lab. Practice –I

(Any Four)
1. Performance trial on 4-cylinder 4-stroke petrol engine.
2. Performance trial on diesel engine.
3. Emission measurements by using gas analyzer and smoke meter.
4. Case study for engine selection.
5. Visit to research organization.

Reference Books

1. The Internal Combustion Engine in Theory and Practice Volume I & II by Charles Fayette Taylor, The MIT Press.
2. Internal Combustion Engines- V Ganesan, 2nd edition, TaTa McGraw Hill.
3. Automotive Technology, Jack Erjavec,3rd edition, Delmar Thomson Learning.
4. Design and Simulation of four stroke engines, Gordon P Blair, SAE International.
5. Gasoline Engine Management, Bosch handbook,2nd edition, Professional Engineering Publication.
6. Internal Combustion Engines, C.R. Ferguson & A.R. Kirkpatrick,Delhi,2001.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I
ELECTIVE – I
SOLAR ENERGY TECHNOLOGY (TE106)

Exam Scheme:
Lectures – 03 hours/week.

Theory – 100 marks
Min passing – 40 marks
Duration – 3 Hours

Unit - 1:

Introduction – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications.

Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

Unit - 2:

Design of solar water heating system and layout

Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers.

Unit - 3:

Thermal energy storage – Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations.

Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration.

Unit - 4:

Direct energy conversion – solid-state principles – semiconductors – solar cells – performance – modular construction – applications.

Unit - 5:

Economics – Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost based analysis of water heating and photo voltaic applications.

TEXT BOOKS:

Principles of solar engineering – Kreith and Kerider

Solar energy thermal processes – Duffie and Beckman

Solar energy – S.P.Sukhatme

REFERENCE BOOKS:

Solar energy – Garg

Solar energy – Magal

Soloar energy – Tiwari and Suneja

Power plant technology – El Wakil

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I
ELECTIVE – I

Finite Element Analysis [Common withM.E (Mech.Engg. General) & M.E.CAAD] TE 107

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme
Paper: 100 Marks
Paper Duration: 3 Hrs.

Fundamental concept of finite element method
Introduction, Historical Background, Stress and equilibrium, Boundary conditions, Strain Displacement relations, Stress strain relations, Temperature effects, Potential Energy and equilibrium, Rayleigh-Ritz Method, Galerkin's Method,Saint Venant's Principle, von Mises Stress, Computer Programs.

One –Dimensional problems
Introduction, Finite Element Modeling, Coordinates and Shape Functions, The Potential- Energy Approach, The Galerkin Approach, Assembly of the Global Stiffness Matrix and Load vector, Properties of K, The Finite Element Equations; Treatment of Boundary Conditions, Quadratic Shape Functions, Temperature Effects.

Trusses
Introduction, Plane Trusses, Three-Diamensional Trusses, Assembly of Global Stiffness Matrix for the Banded and Skyline solutions.

Two-dimensional problems using constant strain triangles
Introduction, Finite Element Modeling, Constant-Strain Triangle, Problem Modeling and Boundary Conditions, Orthotropic Materials.

Axis symmetric solids subjected to axis symmetric loading
Introduction, Axis symmetric Formulation, Finite Element Modeling: Triangular Element, Problem Modeling and Boundary Conditions.

Two-dimensional isoparametric elements and numerical integration
Introduction , The Four-Node Quadrilateral, Numerical Integration, Higher Order Elements, Four-Node Quadrilateral for Axisymmetric Problems, Conjugate Gradient Implementation of the Quadrilateral Element.

Beams and frames
Introduction, Finite Element Formulation, Load Vector, Boundary Considerations, Shear Force and Bending Moment, Beams on Elastic Supports, Plane Frames, Three-Dimensional Frames, Some Components.

Three-dimensional problems in stress analysis
Introduction, Finite Element Formulation, Stress Calculation, Mesh Preparation, Hexahedral Elements, and Higher Order Elements, Problem Modeling, Frontal Method for Finite Element Matrices.

Scalar field problems
Introduction, Steady State Heat Transfer, Torsion, Potential Flow, Seepage, Electric and Magnetic Fields, and Fluids Flow in Ducts.
Dynamic considerations
Introduction, Formulation, Element Mass Matrices, Evaluation of Eigen values and Eigenvectors, Interfacing with Previous Finite Element Programs and a Program for Determining Critical Speed of Shafts, Guyan Reduction, Rigid Body Modes.

Lab. Practice –I

(Any Four)

Using analysis software like Ansys / Nastran / LS-DYNA/ Abacus / any suitable software perform the following practical

1. Analysis of 2D truss
2. Analysis of 2D frame
3. Analysis of any one machine component .
4. Analysis of composite Structure.
5. Finding analysis results for 2D truss & 2D frame using MATLAB

Reference Books:

1) J.N. Reddy, an Introduction to Nonlinear Finite Element Analysis, OUP.
2) C.S.Krishnamoorthy.,Finite element analysis TMH
3) J.N.Reddy, Finite element methods,Mc graw hill publition ltd.
4) Robert Cook, Concept an application of Finite element analysis
5) Klaus-Jurgen Bhate, finite element analysis, PHI
6) C.S. Desai and J.F.Abel.,Introduction to finite element methods ,CBS
7) Tirapati R. Chandrupatla and Belegundu, Finite element analysis by, PHI.
9) Kenneth Lt. Huebner," The FEM for Engineers", Wiley India Pvt.Ltd. New Delhi

(* Question Paper- 50% to 60% of marks are kept for the quantitative questions)

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I
ELECTIVE – I
GAS TURBINES & JET PROPULSION (TE 108)

Exam Scheme:
Lectures – 03 hours/week.

Theory – 100 marks
Min passing – 40 marks
Duration – 3 Hours

Unit 1

1. Introduction: Historical development, comparison with reciprocating I.C. Engines. Applications of gas turbine power plants.

2. Thermodynamics Cycles For Gas Turbines: Air standard Brayton cycle, Calculation of the thermal efficiency, cycle air rate, cycle work-ratio, optimum pressure ratio for maximum work output of the cycle. Simple open cycle gas turbine. Modification of gas turbine cycle with inter-cooling, reheating and regeneration and effect on thermal efficiency and specific output. Closed cycle gas turbine and semi-closed cycle gas turbine. Their comparison with open cycle, Co generative power plant(Numerical problems to be taught)

Unit 2

3. Compressors
Types commonly used for gas turbine power plants. (Numerical problems to be taught)
a. **Centrifugal Compressors:** Principal of operation, work done and pressure rise. Vane-less space, slip factor, power input factor and Mach number at intake to impeller.
b. **Axial Flow Compressors:** Working principal, work done degree of reaction, poly-tropic efficiency, overall performance of the compressors

Unit 3

4. Fuels and Combustion Chambers
Requirement of combustion chamber, combustion process, pressure loss and pressure loss factor. Combustion chamber geometry and types. Solid, liquid and gaseous fuels used for gas turbine power plants. Fuel burning arrangements and ignition

Unit 4

5. Turbines: Impulse and reaction turbines, turbine efficiencies, nozzle efficiency, blade efficiency, mechanical and overall efficiency. Theory of impulse and reaction turbines, number of stages and limitations. Constructional details of shafts, bearings, blades and casings. Cooling

of blades, Lubrication and governing of turbines. Maintenance and troubleshooting (Numerical problems to be taught)

6. Materials For Gas Turbine: Factors influencing selection of materials, materials used for different component like compressor component, combustion chamber, disc and rotors, turbine blades, nozzle guide vanes turbine casing and heat exchanges

Unit 5

7. Component Machining and Performance Evaluation
Performance characteristics, dimensionless numbers linking component Equilibrium points and procedure to find it transient operation

8. Jet Propulsion And Rocket Propulsion
Theory of jet propulsion features and types of different jet engines performance efficiencies and applications, Types of rocket power plants and their application(Numerical problems to be taught)

References Books:

1. "Gas Turbine Theory", H.Cohen, GFC Rezers and HIH Saravanamutto.

2. "Jet Air Craft Power Systems", Jack Casamassa, Ralph Bent.

3. "Gas Turbine", V. Ganesan

4. "Gas Turbine And Propulsion System", P.R. Khajuria and S.P. Dubey

5.Vincent "The Theory And Design Of Gas Turbines And Jet Propulsion"McGraw-Hill Publication.

6. W.W.Battic "Fundamentals of Gas Turbines" John Wily& Sons.

7. Jack D.Mattingly "Elements of Gas Turbines and Propulsion" McGraw-Hill Publication.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM I
POWER PLANT ENGINEERING (TE 109)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit 1

Analysis of Steam cycles: Rankine cycle, Carnot cycle, mean temperature of heat addition, effect of variation of steam condition on thermal efficiency of steam power plant, reheating of steam, regeneration, regenerative feed water heating, feed water heaters, carnotization of Rankine cycle, optimum degree of regeneration, Super critical pressure cycle, steam power plant appraisal, Deaerator, typical layout of steam power plant, efficiencies in a steam power plant, Cogeneration of Power and Process Heat, Numerical Problems.

Combined cycle power generation: Flaws of steam as working fluid in Power Cycle, Characteristics of ideal working fluid in vapor power cycle, Binary vapor cycles, coupled cycles , combined cycle plants, gas turbine- steam turbine power plant, MHD-steam power plant, Thermionic- Steam power plant, Numerical problems.

Unit 2

Fuels and combustion : Coal, fuel oil, natural and petroleum gas, emulsion firing, coal – oil and coal – water mixtures, synthetic fuels, bio-mass, combustion reactions, heat of combustion and enthalpy of combustion, theoretical flame temperature, free energy of formation, equilibrium constant, effect of dissociation, Numerical problems.

Combustion Mechanisms : Kinetics of combustion, mechanisms of solid fuel combustion, kinetic and diffusion control, pulverized coal firing system, fuel-bed combustion, fluidized bed combustion, coal gassifiers, combustion of fuel oil, combustion of gas, combined gas fuel oil burners, Numerical problems.

Unit 3

Steam Generators: Basic type of steam generators, fire tube boilers, water tube boilers. Economizers, superheaters, reheaters, steam generator control, air reheater, fluidized bed boilers, electrostatic precipitator, fabric filters and bag houses, ash handling system, feed water treatment, deaeration, evaporation, internal treatment, boiler blow down, steam purity, Numerical problems.

Condenser, feed water and circulating water systems: Need of condenser, direct contact condensers, feed water heaters, circulating water system, cooling towers, calculations, Numerical Problems.

Unit 4

Nuclear Power Plants: Chemical and nuclear reactions, nuclear stability and binding energy, radioactive decay and half life, nuclear fission, chain reaction, neutron energies. Neutron flux and reaction rates, moderating power and moderating ratio, variation of neutron cross sections with neutron energy, neutron life cycle. Reflectors, Types of Reactor, PWR, BWR, gas cooled reactors. Liquid metal fast breeder reactor, heavy water reactors, Fusion Power reactors, Numerical problems.

Unit 5

Hydro Electric Power Plant: Introduction, advantages and disadvantages of water power, optimization of hydro – thermal mix, hydrological cycles, storage and pondage, essential elements of hydro electric power plant, comparisons of turbines, selection of turbines, Numerical problems.

REFERENCE BOOKS:

1. Power Plant Engineering - P.K. Nag, Tata McGraw-Hill Publications.
2. Power Plant Engineering - M.M. EI-Wakil, McGraw- Hill Publications
3. An Introduction to Power plant engineering, G.D.Rai, Khanna Publishers, III edition,2001
4. Hydropower development series, Vol.1-17, Norwejian Institute of Technology,1996/2005.
5. Combined cycle Gas and Steam Turbine Power Plants, Rolf H Kohlhofer, PennWell Books, 1991
6. Standard Handbook of Power plant Engineering, Thomas C Elliot, Robert C Swanekamp, Kao Chen, McGraw Hill Professional, 1997
7. Wet steam turbines for Nuclear Power plants, Aleksander Lejzerovic, Penn Well Books, 2005.
8. TMI 25 Years Later: the Three Mile Island nuclear power plant accident and its impact, Bonnie Anne Osif, Anthony Baratta, Thomas W Conkling, Penn State Press,2004.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (THERMAL ENGINEERING)
W.E.F.: 2012-13
FIRST YEAR TERM I

LABORATORY PRACTICE – I

Exam Scheme :
Practical's – 06 hours/week. **Term-work – 100 marks**
Oral- 50 marks

Experiments/Assignments based on
Any Three subjects for Experimental work and two subjects for Assignments

1.Advanced Heat Transfer
2.Advanced Thermodynamics and gas dynamics
3.Energy Conservation and Management
4.Measurement Techniques And Data Analysis
5.Elective – I

For those subject lab. practice is not given for that, the concerned subject in-charge should frame minimum of four laboratory Experiments /Assignments.

Note: Oral will be based on the prescribed term-work presented in the form of certified journal.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (THERMAL ENGINEERING)
W.E.F.: 2012-13
FIRST YEAR TERM I
SEMINAR-I

Practical's – 06 hours/week. **Term-work – 100 marks**

Seminar-I should be based on the literature survey on any topic relevant to Thermal Engineering. It may be leading to selection of a suitable topic of dissertation. Each student has to prepare a write-up of about 25 pages.

The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department. The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II

Advanced Fluid Mechanics [Common with M.E (Mech.Engg. General)]

(TE 201)

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme
Paper: 100 Marks
Paper Duration: 3 Hrs.

1. Basic Concepts : Types of fluids and basic equations of flow, basic concepts in laminar and turbulent flows.
2. Equations Governing Fluid Motion : Navier stokes equations, Boundary layer equations. Exact solutions of N-S equations, Flow between concentric rotating cylinders, parallel flow of a powder - law fluid.
3. Potential Theory : Kelvin's theorem, source, sink, vortex and doublet, development of complex potentials by super position, conformal transformation thin airfoil theory.
4. Laminar Boundary Layers : Blasius solution, Boundary -layers with non-zero pressure gradient, separation and vortex shedding.
5. Turbulent Flow : Mechanism of turbulence, derivation of governing equations for turbulent flow, K-E model of turbulence, universal velocity distribution law and friction factor, kinetic energy of the mean flow and fluctuations, relaminarization.
6. Experimental Techniques : pressure tubes, thermal anemometers, laser – Doppler anemometers, P_I velocimeter.
7. Computational Fluid Dynamics : Philosophy of CFD, governing equations, thin derivation and physical meaning, mathematical behavior of P.D.E. and thin impent on CFD, Finite difference scheme, grid generation and transformation. Introduction to FEM and finite volume method.

Lab Practice –II

(Any four)
*** All experiments should be performed using suitable CFD Software**

1. Flow over a cylinder/sphere at different Re. Pressure variation over the body and drag estimation.
2. Flow past an aerofoil: Pressure measurements, calculation of lift.
3. Flow through a converging-diverging nozzle: subsonic and supersonic flows.
4. Friction factor determination: incompressible flow through pipes/ducts.
of variable cross-section.
5. Laminar/Turbulent boundary layer over a flat plate.

Reference Books:

1. H. Schlichting, "Boundary layer Theory", McGraw Hill, 1987.

2. Jo. Hinze, "Turbulence", McGraw Hill, 1975.
3. P. Bradshaw, "Turbulence", Springer -Verleg, 1976.
4. Anderson, Tamehill and Pletcher, "Computational Fluid Mechanics and Heat Transfer", Hemispher Pub. Co., 1984.
5. K. Muralidhar and T. Sunderajan, "Computational Fluid Flow and Heat Tra nsfer", Narosa Pub. House, New Delhi, 1997.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II
ADVENCED REFRIGERATION (TE 202)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

UNIT 1

1. **Vapour Compression refrigeration:** Multi-evaporator system; Multi expansion system; Cascade systems; Study of P-h; T-s; h-s and T-h charts for various refrigerants, Concept of Heat Pump

2. **Refrigerant**: Designation, selection, desirable properties, refrigerant blends, secondary refrigerants, refrigerant recycling, reclaim and charging, alternative refrigerants, refrigerant-lubricant mixture behavior, ODP, GWP concepts

UNIT 2

3. **Vapour absorption refrigeration**: Standard cycle and actual cycle, thermodynamic analysis, Li-Br-water, NH3-water systems, Three fluid absorption systems, half effect, single effect, single-double effect, double effect, and triple effect system

4. **Non-convention refrigeration system** (Principle and thermodynamic analysis only): Thermoelectric refrigeration, thermo-acoustic refrigeration, adsorption refrigeration, steam jet refrigeration, vortex tube refrigeration, and magnetic refrigeration.

UNIT 3

5. **Compressor rating and selection**- reciprocating, screw, Scroll and centrifugal compressors based on applications

6. **Evaporators**: types, thermal design, effect of lubricants accumulation, draining of lubricants, selection and capacity control

UNIT 4

7. **Condenser**: types, thermal design, purging, selection and capacity control

8. **Selection of expansion devices**, Design of refrigerant piping refrigeration system controls and safety devices, Solenoid valves, suction and evaporator pressure regulators, Thermal Insulation

UNIT 5

9. **Motor selection**: Single phase, Three phase, Starters, Constant speed and Variable

speed drive
10. **Associated devices**: high pressure receiver thermal design of low pressure receiver, accumulator, Filters, driers, oil separators, relief valves, safety valves, high and low pressure cut out, thermostats, water regulators etc.

TEXT BOOKS:

1. Refrigeration & Air Conditioning – C.P. Arora(TMH)

Refrigeration & Air Conditioning – Arora & Domkundwar – Dhanpat Rai

REFERENCE BOOKS:

1) Refrigeration and Air Conditioning :Manohar Prasad

2) Refrigeration and Air Conditioning: Stoecker – Mc Graw Hill

3) Principles of Refrigeration – Dossat (Pearson)

4) Refrigeration and Air Conditioning : Ananthanarayana (TMH)

5) Refrigeration and Air Conditioning: Jordan and – Prentice Hall, Preister

6) Refrigeration and Air Conditioning: Dossat – Mc Graw Hill

7) Thermal Environmental Engg. : Threlkeld – Van Nostrand

8) Refrigeration and Air Conditioning: Ballany – Khanna

9) Refrigeration and Air Conditioning : Arora – Tata Mc Graw Hill

10) Refrigeration and Air Conditioning: Domkundwar – Dhanpatrai

11) Refrigeration and Air Conditioning: SC Jain S.Chand and Co.

12) Ashrae Hand Book: 2 Vols.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II

Computational Fluid Dynamics [Common with M.E (Mech.Engg. General)&M.E.CAAD] TE 203

Teaching Scheme
Lectures: 3 Hrs per week

Examination Scheme
Paper: 100 Marks
Paper Duration: 3 Hrs.

Review of Governing Equations Fluid Flo w and Heat Transfer
Conservation of Mass, Newton's Second Law of Motion, Expanded Forms of Navier stokes equations, Conservation of Energy Principle, Special Forms of the Navier Stokes Equations, Classification of Second order Partial Differential Equation s, Initial and Boundary Conditions, Governing Equations in Generalized Coordinates.

Finite Difference, Discretizatison, Consistency, Stability and Fundamental ofFluid Flow Modeling.
Elementary Finite Difference Quotients, Basic Aspects of Finite Differen ce Equations, Errors and Stability Analysis, Some Nontrivial Problems with Discretized Equations, Applications to Heat Conduction and Convection.

Solution of Viscous Incompressible Flows by Stream Function –Vorticity Formulation
Two Dimensional Incompressible Viscous Flow, Incorporation of Upwind Scheme, Estimation of Discretization Error, Application to Curvilinear Geometries, Derivation of Surface Pressure and Drag.

Solution of Navier -Stokes Equations for Incompressible Flows Using MACand SIMPLE Algorithms
Staggered Grid, Solution of the Unsteady Navier -Stokes Equations, Solutions of Energy Equation, Formulation of the Flow Problems, SIMPLE Algorithm. Introduction to FVM: Integral Approach, discretization & Higher order scheme

Reference Books:

1. Anderson D.A., Tannehill J.C., Pletcher R.H., Computational Fluid Mechanics and Heat Transfer, Hemisphere Publishing Corporation, New York, U.S.A. 1984.
2. Murlidhar K. Sunderarajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 2003.
3. Anderson J.D., Jr., Computational Fluid Dynamics McGraw Hill, Inc New York, 1996.
4. Ankar S.V., "Numerical Heat Transfer and Flow" Hemisphere Publ.,Corporation, 1985.
5. Anderson J.D., Jr., Computational Fluid Dynamics" McGraw Hill, Inc New York, 1995.
6. Anderson D.A., Tannehill J.C. Pletcher R.H., "Computational Fluid Mechanics and Heat Transfer" Hemisphere Publ. Corp. N.Y. 1984.
7. Sturt P.A., "Introduction to Numerical Methods", The Macmillan Company, London, 1985.
8. Pratap R., "Getting Started with MATLAB", Sounders Coll ege Publ. 1995.
9. H.K.Versteag and W.Malalsekara, "An Introduction to Computational Fluid Dynamics", Longman, 1995.

10. Carnahan B., “Applied Numerical Methods”, John Wiley & Sons 1969.
11. Lewis R.W., “Numerical Methods in Thermal Problem”, Vol Vi Part -II, Pine Ridge Press Ltd., 1989.
12. Jain M.k., “Numerical Methods for Scientific and Engineering”, 3 rd Edi., New Edge International, 1995.
13. Mathews J.H. “Numerical Methods for Mathematics, Science & Engineering,” 2 nd Ed. Prentice Hall of India Pvt. Ltd., New Delhi, 1994.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II

Numerical Methods in Thermal and Fluid Engineering (TE 204)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit 1

1. **Linear Algebraic Equations**:- Gauss – Elimination, Gauss – Seidel, LU Decomposition.

2. **Roots of equations**: - Bisection Method, False position method, Newton – Raphson Method, Muller's method, Bairstow's Method.

Unit 2

3. **Curve fitting – Least square regression**:-

i) Linear regression, multiple linear regressions, polynomial regression.
ii) Non linear regression – Gauss – Newton method, multiple non linear regression.

4. **Interpolation**: - Newton's Divided Difference, Lagrange's Inverse, Spline, Hermite Interpolation, Extrapolation technique of Richardson's Gaunt.

Unit 3

5. **Differentiation & Integration**:- Divided difference formulae, Romberg integration, Gauss quadrature for double & triple integration.

6. **Eigen Values & Eigen Vectors of Matrices** – Faddeev- Laeverrier's method, Power Method, Householder & Given's method.

Unit 4

7. **Ordinary differential equations**:- Euler's method, Heun's method, Mid – point method, Runge – Kutta methods, Multi step Methods - explicit Adams – Bashforth technique & Implicit Adams – Moulton Technique, Adaptive RK method, Embedded RK method, step size control. Higher order ODE – Shooting method. Non linear ODE – Collocation technique.

Unit 5

8. **Partial Differential Equations**:- Solution of Parabolic and Hyperbolic equations – Implicit & Explicit Schemes, ADI methods, Non linear parabolic equations-Iteration method. Solution of elliptic equation – Jacobi method, Gauss – Seidel & SOR method. Richardson method.

References:-

1. Numerical Methods for Engineers, Steven C Chapra & Raymond P Canale, TMH, Fifth Edition
2. Applied Numerical Methods, Alkis Constantinides, McGraw Hill
3. Numerical Solution of Differential Equations, M.K. Jain, 2nd Edition, Wiley Eastern.
4. Numerical methods for scientific and engineering computation, Jain, Iyangar, Jain, New Age International Publishers.
5. Numerical methods in Engineering and Science, Dr. B.S. Garewal, Khanna Publishers.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II
ELECTIVE – II
Non Conventional Power Plants (TE 205)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

UNIT 1:

Potential of renewable energy sources, renewable electricity and key elements, Global climate change, CO2 reduction potential of renewable energy.

UNIT 2:

Solar thermal power plants (Concentrators, solar chimney etc.), Solar thermal Conversion devices, Economics and social considerations, Design considerations of component selection.
Solar Radiation - estimation, prediction & measurement, Solar energy utilization, Performance of Solar flat plate collectors, concentrating collectors, thermal storage.

UNIT 3:

Wind energy: Wind energy potential measurement, wind electric generator component design, economics and demand side management, energy wheeling, and energy banking concepts.
Biogas: properties of biogas (Calorific value and composition), biogas plant technology and status

UNIT 4:

Other plants: Fuel cell based power plants, tidal and wave energy plant design, OTEC Power plants.

UNIT 5:

Geothermal energy: hot springs and steam ejection site selection, power plants, and economics.
Environmental impacts, Economic and social considerations, Financing mechanisms, Carbon credits, clean development mechanisms

BOOKS:

1. J.A. Duffie and W.A. Beckman, “Solar Engineering of Thermal Processes”, John Wiley, 1991.
2. D.Y. Goswami, F. Kreith and J.F. Kreider, “Principle of Solar Engineering”, Taylor and Francis, 2000.
3. Sukhatme S.P., “Solar Energy”, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
4. Bansal and othes, “Non-Conventional Energy Sources”.
5. J.F. Kreider, F. Kreith, “Solar Energy Handbook”, McGraw Hill, 1981

TERM WORK

1. Visit to a biogas plant and its report.
2. Design of photovoltaic plant for agricultural applications.
3. Trial on solar concentrator/CPC/Evacuated Tube Collector system.
4. Analysis of a wind farm system.

REFERENCES

1. S.P.Sukhatme, Solar Energy – Principles of thermal collection and storage, II edition, Tata McGraw Hill, New Delhi, 1996.
2. J.A.Duffie and W.A.Beckman, Solar engineering of Thermal processes, II edition, John Wiley, New York, 1991.
3. D.Y.Goswami, F.Kreith and J.F.Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000.
4. D.D.Hall and R.P.Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II
ELECTIVE – II
Advanced Air Conditioning (TE 206)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit 1

1. Applied Psychrometry, Psychrometric processes using chart

2. **Load Estimation**: solar heat gain, study of various sources of the internal and external heat gains, heat losses, etc. Methods of heat load calculations: Equivalent Temperature Difference Method, Cooling Load Temperature Difference, and Radiance Method, RSHF, GSHF, ESHF, etc. Inside and outside design conditions.

Unit 2

3. **Air Distribution**: Fundamentals of air flow in ducts, pressure drop calculations, Design ducts by velocity reduction method, equal friction method and static regain Method, duct materials and properties, insulating materials, types of grills, diffusers, Wall registers, etc. VAV.

4. **Sound Control**: Definitions of various terms like level, pitch, attenuation, frequency, sources of noise in air conditioning plants, design procedure for noise prevention, noise and vibration study and elimination techniques (description only).

Unit 3

5. **Ventilation and Infiltration**: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load.
Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure.

6. Direct and Indirect Evaporative Cooling: Basic psychometric of evaporative cooling, types of evaporative coolers, design calculations, indirect evaporative cooling for tropical countries.

Unit 4

7. **Air Conditioning Equipments and Controls**: Chillers, Condensing units, Cooling coils, bypass factors, humidifiers, dehumidifiers, various types of filters, air washers,

thermostat, humidistat, cycling and sequence controls, modern control of parity, odour and bacteria, Air filtration- Study of different types of filters, BMS applications. Cooling Towers

Unit 5

8. **Air conditioning systems**: Classification, design of central and unitary systems, Typical air conditioning systems such as automobile, air plane, ships, railway coach Air-conditioning, warm air system, hot water systems, heat pump, clean rooms (descriptive treatments only). VRF.
9. **Standards and Codes**: ASHRAE/ARI, BIS standards study and interpretation, ECBC, NBC codes

Recommended Books:

1. ASHRAE Handbooks
2. ISHRAE Handbook.
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Trane air conditioning manual,
5. Refrigeration and Air conditioning, ARI Prentice Hall, New Delhi.
6. Norman C. Harris, Modern air conditioning
7. Jones W. P., Air conditioning Engineering, Edward Arnold Publishers Ltd, London, 1984.
8. Jones W. P., Air conditioning Engineering - Applications, Edward Arnold Publishers Ltd, London, 1984
9. Hainer R. W., Control System for Heating, Ventilation and Air conditioning, Van Nastrand Reinhold Co., New York, 1984.
10. Refrigeration and Air conditioning- C P Arora, Tata McGraw Hill Publication, New Delhi.
11. McQuiston, Faye; Parker, Jerald; Spitler, Jeffrey 2000, Heating, Ventilating and Air Conditioning-Analysis and Design, 5th ed. John Wiley & Sons

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II
ELECTIVE – II
Convective Heat Transfer Analysis (TE 207)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit 1

1. Introduction

2. The Equations of Convective Heat Transfer

3. Some Solutions for External Laminar Forced Convection
Exact and Numerical Solutions.

Unit 2

4. Internal Laminar Flows
Fully developed and thermally developing flows.

5. Introduction to Turbulent Flows
Various models and Governing Equations.

Unit 3

6. External Turbulent Flows

7. Internal Turbulent Flows

Unit 4

8. Natural Convection
Similarity solutions and Numerical solutions for Natural Convective Boundary Layer Equations.

9. Combined Convection

Unit 5

10. Convective Heat Transfer through Porous Media.

11. Condensation

Recommended Books:

Patrick H. Oosthuizen, David Naylor, "Convective Heat Transfer Analysis", Mcgraw Hill. Inc.[1999]

W. M. Kays, M. E. Crawford," Convective Heat and Mass Transfer", Mcgraw Hill. Inc. Third Edition [1993]

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II
ELECTIVE – II
EQUIPMENT DESIGN FOR THERMAL SYSTEMS (TE208)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit - 1: Classification of heat exchangers: Introduction, Recuperation & Regeneration – Tubular heat exchangers: double pipe, shell & tube heat exchanger, Plate heat exchangers, Gasketed plate heat exchanger, spiral plate heat exchanger, Lamella heat exchanger, extended surface heat exchanger, Plate fin, and Tubular fin.

Basic Design Methods of Heat Exchanger: Introduction, Basic equations in design, Overall heat transfer coefficient – LMTD method for heat exchanger analysis – parallel flow, counter flow, multipass, cross flow heat exchanger design calculations.

Unit - 2: Double Pipe Heat Exchanger: Film Coefficient for fluids in annulus, fouling factors, calorific temperature, average fluid temperature, the calculation of double pipe exchanger, Double pipe exchangers in series-parallel arrangements.

Shell & Tube Heat Exchangers: Tube layouts for exchangers, baffle Heat exchangers, calculation of shell and tube heat exchangers – shell side film coefficients, Shell side equivalent diameter, the true temperature difference in a 1-2 heat exchanger, influence of approach temperature on correction factor, shell side pressure drop, tube side pressure drop, Analysis of performance of 1-2 heat exchanger, and design calculation of shell & tube heat exchangers. Flow arrangements for increased heat recovery, the calculations of 2-4 exchangers.

Unit - 3: Condensation of single vapors: Calculation of a horizontal condenser, vertical condenser, De-super heater condenser, vertical condenser – sub-cooler, horizontal condenser – subcooler, vertical reflux type condenser, condensation of steam.

Unit – 4: Vaporizers, Evaporators and Reboilers: Vaporizing processes, forced circulation vaporizing exchangers, natural circulation vaporizing exchangers, calculations of a reboiler.

Extended Surfaces: Longitudinal fins, weighted fin efficiency curve, calculation of a double pipe fin efficiency curve, calculation of a double pipe finned exchanger, calculation of a longitudinal fin shell and tube exchanger.

Unit - 5: Direct Contact Heat Exchanger: Cooling towers, relation between wet bulb & dew point temperatures, the Lewis number, and classification of cooling towers, cooling tower internals and the roll of fill, Heat balance, heat transfer by simultaneous diffusion and convection. Analysis of cooling tower requirements, Design of cooling towers, Determination of the number of diffusion units, calculation of cooling tower performance.

TEXT BOOKS :

1. Process Heat Transfer – D.Q. Kern, TMH.

2. Cooling Towers by J.D. Gurney

3. Heat Exchanger Design – A.P.Fraas and M.N. Ozisick. John Wiely & sons, New York.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II

RESEARCH METHODOLOGY (TE 209)

Exam Scheme:
Lectures – 03 hours/week.

Theory – 100 marks
Min passing – 40 marks
Duration – 3 Hours

Unit – 1:

Research Concept: Concept, meaning, objectives, motivation; Types of research, approaches (descriptive research, conceptual, theoretical, applied and experimental research)

Formulation of Research Task: Literature Review: importance & methods, sources, field study, laboratory experiments, critical analysis of already generated facts, hypothetical proposal for future development and testing, selection of research task, prioritization of research, introduction to hypothesis testing.

Unit –2:

Mathematical Modeling and Simulation: Concept of modeling, classification of mathematical models, modeling with ordinary differential equations, differential equations, partial differential equations, graphs. Simulation concept, types (quantitative, experimental, computer, statistical), process of formulation of model based on simulation.

Unit – 3:

Experimental Modeling: Definition of experimental design, examples, single factor experiments, guidelines for designing experiments.

General model of process: Input factors/variables, Output parameters/variables, controllable/ uncontrollable variables, dependent/independent variables, compounding variables, extraneous variables and experimental validity.

.**Unit – 4:**

Process optimization and designed experiments: methods for study of response surface, First

order design. Determining optimum combination of factors, determination of steepest ascent, Taguchi approach to parameter design.

Analysis of Results (Parametric and Non parametric, Descriptive and Inferential Data): types of data, Methods and techniques of data collection, sampling and sample design, Non parametric test, error analysis, analysis of variance, significance of variance, analysis of co-variance, multiple regression, Introduction to Analytical hierarchical process, Factor analysis, Cluster analysis, Fuzzy logic, testing linearity/ non linearity of model, testing adequacy of model.

Unit – 5:

Report Writing: types of report, layout of research report, interpretation of results, layout and format, style of writing, typing, references, pagination, tables, figures, conclusions, appendices.

Landscape of Creativity: Convergent Vs. divergent thinking, creativity, creativity Vs intelligence, creativity abilities, determination of Creativity, increasing creativity, creative achievement, techniques of creativity, collective creativity.

Books Recommended:

1. Research Methodology, C R Kothari, Wiley Eastern publishers, New Delhi, 10^{th} edition, 2006.
2. Research in Education, John W Besr & James V Kahn, Prentice HalI of India, New Delhi.
3. Theories of Engineering Experiments, Schank Fr, Tata McGraw Hill Publishing Ltd., New Delhi.
4. Experimental design by Cochran & Cocks, John Wielly & sons, New Delhi, 2005.
5. Design of Experiments, Douglas Montgomary, 1995.
6. Formulation of Hypothesis, Willkinson K, P L Bhandarkar, Himalaya Publishing House, Mumbai, 2005.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
FIRST YEAR TERM II
TURBO MACHINERY (TE 210)

Exam Scheme:
Lectures – 03 hours/week. **Theory – 100 marks**
Min passing – 40 marks
Duration – 3 Hours

Unit – 1:

Fundamentals of Turbo machines: Classification, Applications Thermodynamic analysis; Isentropic flow, Energy transfer; Efficiencies; static and Stagnation conditions; continuity equation; Euler's flow through variable cross sectional area; unsteady flow in turbo machines.

Unit –2:

Steam Nozzles: Convergent and Convergent – Divergent nozzles; Energy balance; effect of back – pressure on the analysis; Design of nozzles.

Steam Turbines :Impulse Turbines: Compounding; work done and velocity triangles; Efficiencies; Constant Reaction Blading; Design of blade passages, angles and height; Secondary flow; leakage losses; Thermodynamic analysis of steam turbines.

Unit – 3:

Centrifugal Compressor: Types; Velocity triangles and efficiencies; Blade passage design; Diffuser and pressure recovery; slip factor; stanitz and stodolas formulae; Effect of inlet mach number; Prewirl; performance.

Unit – 4:

Axial Flow Compressors: Flow analysis, work and velocity triangles ; Efficiencies; Thermodynamic analysis; stage pressure rise ; Degree of reaction ; stage loading ; general design, effect of velocity incidence ; performance.

Cascade Analysis: Geometry and Terminology; Blade forces, Efficiency; losses; free and forced vortex blades.

Unit – 5:

Axial Flow Gas Turbines: Work done; velocity triangles and efficiencies; thermodynamic flow analysis; degree of reaction; Zweifels relation; Design cascade analysis – Soderberg – Hawthrone – ainley-correlations; secondary flow; Free-vortex blades; Blade angles for variable degree of reaction; Actuator disc theory; stresses in blades; Blade assembling; materials and cooling of blades; performance; Matching of compressor and turbine; off-design performance.

REFERENCE BOOKS :

1) Fundamentals of Turbo machines – Shephard

2) Practise on Turbomachines – G. Gopalakrishnan & D. Prithviraj, SciTech Publishers, Chennai.

3) Theory and practice of steam turbines – Kearton

4) Gas Turbines – Theory and practice – Zucrow

5) Elements of Gas Dynamics – Liepman and Roshkow

6) Elements of Gas Dynamics – Yahya

7) Turbines, Pumps, Compressors – Yahya

8) Axial Flow Compressors – Horlock.

9) Gas Turbines- Cohen, Roger & Sarvanamuttu

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (THERMAL ENGINEERING)
W.E.F.: 2012-13
FIRST YEAR TERM II
LABORATORY PRACTICE – II

Exam Scheme :
Practical's – 06 hours/week. **Term-work – 100 marks**
Oral- 50 marks

Experiments/Assignments based on
Any Three subjects for Experimental work and two subjects for Assignments

1.Advanced Fluid Mechanics
2.Advanced Refrigeration
3.Computational Fluid Dynamics
4.Numerical Methods in Thermal and Fluid Engineering
5.Elective – II

For those subject lab. practice is not given, for that the concerned subject in-charge should frame minimum of four laboratory Experiments / Assignments.

Note: Oral will be based on the prescribed term-work presented in the form of certified journal.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (THERMAL ENGINEERING)
W.E.F.: 2012-13
FIRST YEAR TERM II
SEMINAR-II

Practical's – 06 hours/week. **Term-work – 100 marks**

Seminar-II should be based on the literature survey on any topic relevant to Thermal Engineering. It may be leading to selection of a suitable topic of dissertation. Each student has to prepare a write-up of about 25 pages.

The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department. The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall do an assessment of the seminar.

The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
SECOND YEAR TERM I
SEMINAR-III

Exam Scheme:

Practical's – 04 hours/week. Term-work – 50 marks
Oral – 50 marks

Seminar-II should be based on the literature survey on any topic relevant to Thermal Engineering. It may be leading to selection of a suitable topic of dissertation. Each student has to prepare a write-up of about 25 pages.

The report typed on A4 sized sheets and bound in the necessary format should be submitted after approved by the guide and endorsement of the Head of Department. The student has to deliver a seminar talk in front of the teachers of the department and his classmates. The Guide based on the quality of work and preparation and understanding of the candidate shall Do an assessment of the seminar.

The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
SECOND YEAR TERM I
PROJECT STAGE - I

Exam Scheme:
Practical's – 18 hours/week. Term-work – 100 marks

The candidate shall submit the synopsis of the dissertation work to the evaluation committee at the starting of FIRST YEAR TERM III. It shall include the problem definition, literature survey, approaches for handling the problem, finalizing the methodology for the dissertation work and design calculations / experimental design etc.

A report of the work shall be submitted at the end of Semester III after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work, by the evaluation committee appointed by the Head of the Department, for appropriateness, sufficiency of contents and offer suggestions if any.

The candidate shall prepare a report of about 50 pages. The report typed on A4 sized sheets and bound in the prescribed format shall be submitted after approval by the Guide and endorsement of the Head of Department. It will be assessed for term work by the evaluation committee appointed by the Head of the Department.
The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
SECOND YEAR TERM II
PROGRESS SEMINAR-IV

Exam Scheme:
Practical's – 04 hours/week. Term-work – 50 marks

Progress Seminar shall be based on topic of the Dissertation Work. It may include literature review, required theoretical input, study and comparison of various approaches for the proposed dissertation work. The candidate shall prepare a report of
about 25 pages. The report typed on A4 sized sheets and bound in the prescribed format shall be submitted after approval by the Guide and endorsement of the Head of
Department. It will be assessed for term work by the evaluation committee appointed by
the Head of the Department.

The report copies must be duly signed by the guide and Head of department (one copy for institute, one copy for guide and one copy for the candidate for certification). Attendance of all students for all seminars is compulsory.

NORTH MAHARASHTRA UNIVERSITY, JALGAON
M.E. (Thermal Engineering)
W.E.F.: 2012-13
SECOND YEAR TERM II
PROJECT STAGE - II

Exam Scheme:
Practical's – 18 hours/week. Term-work – 100 marks

The candidate shall submit the detailed report as per the synopsis approved by the evaluation committee, of the dissertation work in the prescribed format after approval by the Guide and endorsement by the Head of the Department. It will be assessed for term Work by the evaluation committee appointed by the Head of the Department, for Completion of the proposed work.

Note: - The evaluation committee shall consist of the Guide, one senior expert faculty member and the Head of the Department or his/her representative.