Jharkhand University of Technology

Ranchi

Master of Technology in

HeatPower

Course Structure & Syllabus

Department of Mechanical Engineering

December 2021

(With effect from Academic Year 2021-22)

M.Tech.(HeatPower)
Semester I

S.No	Course code	course	Subject	Credits
1	HP1101	Core -I	Thermodynamics and Combustion	3
2	HP1102	Core II	Advance Fluid Dynamics	3
3	1. HP1104 2. HP1103 3. HP1105 4. HP1106 5. HP1107	ProgramElective -I	1. Design of solar and wind system 2. Advance mathematical methods in Engineering 3 .Theory and design of turbomachines 4. Boiler auxiliaries and performance evaluation 5. In compressible and Incompressible Flow	3
4	1. HP1108 2. HP1109 3. HP1110 4. HP1111 5. HP1112	Programme Elective -II	1. Nuclear Engineering 2. Energy Conversion and management 3. Analysis of thermal power cycle 4. Fluid mechanics of turbo machines 5. Environmental pollution and control	3
5	1. HP1113 2. HP1114 3. HP1115 4. HP1116 5. HP1117	Programme Elective -III	1. Air Conditioning System Design 2. Gas turbines 3. Advance Refrigeration and Conditioning 4. Power Plant Engineering 5. Gas turbine and Jet Propulsion	3
6	HP 1201	Lab I	Thermal Engineering Lab -I	2
7	HP 1202	Lab II	Thermal Engineering Lab -II	2
8	RM C1101	Common Paper	Research Methodology &IPR	2
9	**A10001**	Audit -I	English for research paper writing	-
	A10002		Professional ethics	
	A10003		Constitution of India	
	A10004		Stress management by yoga	
			Total Credit	**21**

M.Tech.(HeatPower)
Semester II

Sr.No	Course code	course	Subject	Credits
1	HP 1201	Core -III	Advance Heat Transfer	3
2	HP 1202	Core IV	Steam Engineering	3
3	1. HP2103 2. HP2104 3. HP2105 4. HP2106 5. HP2107	Programme Elective -IV	1. Refrigeration and Cryogenic 2. Design of Heat Exchanger 3. Renewable Source of Energy 4. Alternative Fuels 5. Jet and Rocket Propulsion	3
4	1. HP2108 2. HP2109 3. HP2110 4. HP2111 5. HP2112	Programme Elective -V	1. Computational Fluid Dynamics 2. Modelling of IC engine 3. Measurements in Thermal Engineering 4. Computer-Aided Design 5. Theory and Design of Gas Turbines	3
5	1. HP2113 2. HP2114 3. HP2115 4. HP2116 5. HP2117 6. HP2118	Open Elective -I	1. Business Analytics 2. Industrial Safety 3. Operational Research 4. Cost Management of Engineering Project 5. Composite Materials 6. Waste to energy	3
6	HP 2201	Lab III	Thermal Engineering Lab -III	2
7	HP 2202	Lab IV	Thermal Engineering Lab -IV	2
8	HP 2203	Core	Mini Project	2
9	**A20001**	**Audit -II**	Disaster management	-
	A20002		Value education	
	A20003		Soft skills	
	A20004		Personality development through life enlightenment skills	
			Total Credit	**21**

M.Tech.(HeatPower)
Semester III

Sr.No.	Course Code	Course/Subject	Credits
01	HP 3201	DISSERTATION Phase 1	10
		Total Credit	**10**

M.Tech.(HeatPower)
Semester IV

Sr.No.	Course Code	Course/Subject	Credits
01	HP 4201	DISSERTATION Phase II	16
		Total Credit	**16**

HP1101	Core-I	ThermodynamicsandCombustion	3

Course Content

Module-1. First law and State postulates, Second law and Entropy, Availability and Irreversibility, Transient flow analysis

Module-2. Non reactive Ideal-Gas Mixture,PVT Behavior of Real gases and Real Gas mixture

Module-3. Generalized Thermo dynamic Relationship

Module-4. Combustion and Thermo-chemistry, second law analysis of reacting mixture, Availabilityy analysis of reacting mixture, Chemical equilibrium

Module-5. Statistical thermo dynamics, statistical interpretations of first and second law and Entropy,Third law of thermodynamics, Nerstheat theorem.

References:

1. Cengel,"Thermodynamics",TataMcGrawHillCo.,NewDelhi,1980.
2. Howell andDedcius, "Fundamentals of Engineering Thermodynamics", McGraw Hill Inc., U.S.A.
3. VanWylen & Sonntag,"Thermodynamics",John Wiley and SonsInc.,U.S.A.
4. Jones and Hawkings, "Engineering Thermodynamics", John Wiley and Sons Inc., U.S.A,2004.
5. Holman,"Thermodynamics",McGrawHillInc.,NewYork,2002.
6. FairesV.M.andSimmag,"Thermodynamics",Macmillan PublishingCo.Inc.,U.S.A.
7. RaoY.V.C.,"Postulational and Statistical Thermodynamics",Allied PublishersInc,1994.

HP1102	**Core-II**	**AdvancedFluidDynamics**	**3**

Course Content

Module-1. Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless formof governing equations,special forms of governing equations,integral quantities.

Module-2. Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel,Couette flow,Creeping flows

Module-3. Potential Flow: Kelvin's theorem, Irrotational flow,Stream function-vorticity approach Laminar Boundarylayers: Boundary layerequations, flow overflatplate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations

Module-4. Turbulent Flow: Characteristics of turbulent flow, laminarturbulen ttransition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shearstress models,universal velocity distribution

Module-5. Experimental Techniques: Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry

References:

1. Muralidhar and Biswas,Advanced Engineering Fluid Mechanics,Alpha Science International, 2005
2. Irwin Shames, Mechanics of Fluids,,McGrawHill,2003
3. Fox R.W.,Mc Donald A.T,Introduction toFluid Mechanics,John Wiley and Sons Inc,1985
4. Pijush K.Kundu, IraM Kohenand David R.Dawaling,Fluid Mechanics, Fifth Edition,2005

HP1103	**Programme Elective-I**	**Design of Solar and Wind Systems**	**3**

Course Content

Module-1. Conventional sources of energy,Nuclear,Alternative energy sources.

Module-2. Solar Radiation-estimation,prediction & measurement,Solar energy utilization,

Module-3 Performance of Solar flat plate collectors,concentrating collectors,thermal storage.

Module-4 Windenergy, Direct Energy conversion-PV,MHD.

Module-5 Fuelcells, thermionic,thermo electric,Biomass,biogas,hydrogen,Geothermal.

References:

1. D.Y.Goswami,F.KreithandJ.F.Kreider,"Principle of Solar Engineering",Taylor and Francis,2000.
2. SukhatmeS.P.,"SolarEnergy",TataMc Graw Hill Publishing Co.Ltd.,NewDelhi,1994.
3. Bansalet al,"Non-Conventional Energy Sources".
4. J.F.Kreider,F.Kreith,"Solar Energy Handbook",McGrawHill,1981
5. J.A.Duffie and W.A.Beckman,"Solar Engineering of Thermal Processes",JohnWiley,1991.

HP1104	**Programme Elective-I**	**Advanced Mathematical Methods in Engineering**	**3**

Course Content

Module 1: Introduction to Probability Theory:

Probability Theory and Sampling Distributions. Basic probability theory along with examples. Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance.Some sampling distributions like 2, t, F.

Module 2:Testing of Statistical Hypothesis:

Testing a statistical hypothesis, tests on a single sample and two samples concerning means and variances.ANOVA: One–way, Two – way with/without interactions.

Module 3:Ordinary Differential Equations:

Ordinary linear differential equations solvable by direct solution methods; solvable nonlinear ODE's;

Module 4:

Partial Differential Equations and Concepts in Solution to Boundary Value Problems:
First and second-order partial differential equations; canonical forms

Module 5:

Major Equation Types Encountered in Engineering and Physical Sciences
Solution methods for the wave equation, D'Alembert solution, potential equation, properties of harmonic functions, maximum principle, solution by the variable separation method

Reference Books:

1. Ronald E, Walpole, Sharon L. Myers, Keying Ye, Probability and Statistics for Engineers and Scientists (8th Edition), Pearson Prentice Hall, 07 (for Units I & II)
2. J. B. Doshi, Differential Equations for Scientists and Engineers, Narosa, New Delhi
3. Douglas C. Montgomery, Design and Analysis of Experiments (7th Edition), Wiley Student Edition, 09.
4. S. P. Gupta, Statistical Methods, S. Chand & Sons, 37th revised edition, 08
5. William W.Hines, Douglas C. Montgomery, David M. Goldsman, Probability and Statistics for Engineering, (4th Edition), Willey Student edition, 06.

HP1105	**ProgrammeElective-I**	**Theory and design of turbo machines**	**3**

Course Content

Module-1: Energy inter change in fluid machinery, momentum-principle, streamline theory, momentum and circulation.Theory of centrifugal impeller for incompressible fluid,velocity triangle–impeller for approach and prerotation vortex theory.

Module-2: Blower casing volute,vaned and vaneless diffuser, thermodynamics of turbo blowers. Dimensionless characteristic of turboblowers. Axial Flow Compressors.

Module-3: Two-dimensional Cascade:Theoretical analysis of performance and experimental works. Howell's and Cartter's correlations for lowspeed.

Module-4: Effect of Reynolds and Machnumbers. Pitchline design of axial flow compressor. Radial equilibrium. Calculation of losses and stage efficiencies.

Module-5: Stresses in the discs and blades-interstage traversing, measurements of total and static pressures and vane angles. Transonic and supersonic compressors. Industrial Steam Turbines.Type of Industrial SteamTurbines.

References:

1. Turbines Fans and Compressors S.M.Yahya
2. A Practical Guide to Steam Turbine Technology - Heinz P. Bloch

HP1106	**ProgrammeElective-I**	**Boiler auxiliaries and performance evaluation**	**3**

Course Content

Module-1: Boiler types- Efficiency calculation-Balance diagram–Boiler startup calculations– Boiler turbine matching–Power Plant balance diagram.

Module-2: .Fuel and Ash handling Equipment–Crushers and Mills-Druminternals- Specification and selection.

Module-3: Feedpumps–Different types, Specifications, Operation and maintenance aspects-Fans,blowers– Applications–Performancer equirements,Selection,Operation and maintenance.

Module-4: Dustcleaning equipment –Selection criteria–Design, operation and maintenance ofelectro static precipitators, Bag filters.

Module-5: Sootblowers– Various types and their constructional features– Specifications– Selection– Operation and Maintenance.

References:

1. Modern Power Station Practice, CEGB London, Pergamon Press, 1991.
2. Eck, B., Fans, Pergamon Press, 1973.
3. Shields, C.D., Boilers, Types Characteristics and Functions, McGraw-Hill, 1961.

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HP1107	**ProgrammeElective-I**	**Incompressible and compressible flows**	**3**

Course Content

Module-1 :

Introduction to Fluid Mechanics-Properties of Fluids ,Fluid Statics, Fundamental Equations Applications of Fundamental Equations, Relative Motion of Liquids

Module-2:

Kinematics of Fluids: Kinematics of Fluids-Review of basics-Velocity potential,Stream functionand Vorticity.

Theory of Stress and Rate of Strain: General theory of Stress and Rate of Strain Fundamental Equations– Integral Form-Fundamental Equations– Integral form-Reynolds Transport Theorem-Applications of the Integral Form of Equations-Numerical.

Module-3:

Fundamental Equationsin Differential Form:Fundamental:Equationsin Differential Form-One-dimensional Inviscid Incompressible Flow-Euler's Equation and Bernoulli's Equation-Applications of the Bernoulli's Equations-Numerical.

Two and Three– dimensional Inviscid Incompressible Flow:Two and Three– dimensional Inviscid Incompressible Flow-Laminar Flow- Flowbetween Parallel Flat plates-Steady Flow in Pipes- Applications of Laminar Flow-Numerical.

Module-4:

The Laminar Boundary layer: The Laminar Boundarylayer–Prandtl's Boundary Layer Equations-The Boundary layer along a Flat Plate-Solution to the Boundary Layer Equations-Momentum Integral Equation-Separation of Boundary Layer and Control-Numerical

Turbulent Flow: Introduction to Turbulent Flow – Modified N-S Equations-Semi - empirical Theories-Turbulent Boundary Layer-Numerical

Dimensional Analysis: Flow overabluff body–Lift and Drag-Dimensional Analysis and Similitude. Introduction to Compressible Flow:Introduction to Compressible Flow–review of Fundamentals- Stagnation Properties–Relations and Tables-Numerical

Module-5:

Wave Motion: Wave Motion-Propagation of Motion in Compressible Fluids-Machnumber and MachCone-Numericals Isentropic Flow: Isentropic FlowRelations-Flow through Nozzles and Diffusers-Isentropic Flow Relations and Tables-Numericals Flow across Normal Shock and Oblique Shock: Basic Equations Normal Shock–Prandtl- Meyer Equation, Oblique shock-Propertyvariation–RelationsandTables-Numericals.Flowthrougha constantareaduct with Friction:Flow through a constant areaduct with Friction- FannoLine,Fanno Flow-Variation of Properties–Relations and Tables-Numericals. Flowthrough a constant are aductwith Heat Transfer-Flow through a constant area duct with Heat Transfer-Rayleigh Line,Rayleigh Flow–Variation of Properties–Relations and Tables-Numericals.

References:

1. S.W. Yuan., Foundations of Fluid Mechanics, Prentice Hall of India, 2000
2. S.M. Yahya, Fundamentals of Compressible Flow, with Aircraft and

Rocket Propulsion, 4th edition, New Age techno, 2010
3. Schlichting, H., Boundary Layer Theory, 8th edition, Springer, 2004.
4. White F.M., Viscous Fluid Flow, 3rd edition, Tata McGraw Hill BookCompany

HP1108	Programme Elective- II	Nuclear Engineering	3

Syllabus Content:

Module-1:
Basics of nuclear fission and power from fission
Radioactivity, nuclear reactions, crosssections, nuclear fission, powerfrom fission,conversion andbreeding

Module-2:
Neutrontransportanddiffusion
Neutron transport equation, diffusion theory approximation, Fick's law, solutions todiffusion equation for point source, planar source, etc., energy loss in elastic collisions, neutronslowing down

Module-3:
Multigroup,multi-regiondiffusionequation,conceptofcriticality
Solution of multigroup diffusion equations in one region and multi-region reactors, concept of criticalityofthermalreactors

Module-4:
Reactorkineticsandcontrol:
Derivation of point kinetics equations, in hour equation, solutions for simple cases of reactivity additions,fission product poison,reactivity coefficient

Module-5:
Heat removal from reactor core: Solution of heat transfer equationin reactor core, temperature distribution,critical heat flux
Reactor safety,radiation protection: Reactor safety philosophy, defense in depth, units of radioactivity exposure, radiation protection standards

References:

1. Introduction to Nuclear Engineering (3rdEdition) byJohn R.Lamarsh, Anthony J.Barrata, Prentice Hall,(2001)
2. Introduction to Nuclear Reactor Theory,by JohnR. La Marsh,Addison-Wesley,1966
3. Nuclear R e a c t o r Analysis, by J a m e s J . Degerstedt and L e w i s J. Hamilton John Wiley

HP1109	**Programme Elective- II**	**Energy Conservation and Management**	**3**

SyllabusContents:

Module-1

The energy market, energyscenario, planning, utilization patternandfuture strategy,

Module-2

Energy economics, Importance of energy management.

Module-3

Energy auditing-methodology and analysis

Module-4

Cogeneration, Combinedheatingandpowersystems.

Module-5

Energy conservationinindustries, Relevantinternational standards and laws.

References:

1. L.C.Witte,P.S.Schmidt,D.R.Brown,"IndustrialEnergyManagementandUtilization", HemisphericalPublication,1988.
2. Callaghan"EnergyConservation".
3. D.A.Reeg,"IndustrialEnergyConservation",PergamonPress,1980.
4. T.L.Boyen,"ThermalEnergyRecovery"Wiley,1980.
5. L.J.Nagrath,"SystemsModelingandAnalysis",TataMcGrawHill,1982.
6. W.C.Turner,"EnergyManagementHandbook",Wiley,NewYork,1982.

HP1110	**Programme Elective- II**	**Analysis of Thermal Power Cycles**	**3**

Syllabus

Module-1: Steam power plant cycle-Rankine cycle-Reheatcycle-Regenerative cycle with one and more feed heaters

Module-2: Types of feed heaters-Open and closed types-Steam trap stypes.

Module-3: Cogeneration-Condensing turbines-Combined heat and power-Combined cycles–Braytoncycle, Rankine cycle combinations-Binary vapour cycle

Module-4: Air standard cycles- Cycles with variable specificheat- fuel air cycle-Deviation from actual cycle. Brayton cycle-Open cycle gas turbine-Closed cycle gas turbine-Regeneration-Intercooling and reheating between stages.

Module-5: Refrigeration Cycles-Vapour compression cycles-Cascade system-Vapour absorption cycles-GAS Cycle.

References:

1.Culp,R.,PrinciplesofEnergyConversion,McGraw-Hill,2000.
2.Nag.P.K.,PowerPlantEngineering,2ndTataMcGraw-Hill,2002.
3.Nag.P.K.,EngineeringThermodynamics,3rded.,TataMcGraw-Hill,2005.
4.Arora,C.P.,RefrigerationandAirConditioning,2nded.,TataMcGraw-Hill,2004.

HP1111	**Programme Elective- II**	**Fluid Mechanics of Turbomachines**	**3**

Module-1:
Introduction and cascades-Two-dimensional cascades-Analysis of cascade forces–Energy losses–Cascade correlation–Off design performance.

Module-2:
Power generating machineI - Axial flow turbines- Stage losses and efficiency – Soderberg'scorrelation–Turbine flow characteristics

Module-3:
Power absorbing machineI-Axial flow compressors,pumps,and fans–Three-dimensional flow in axial turbo machines– theory of radial equilibrium– actuator discapproach– Secondary flows

Module-4:
Power absorbing machineII- Centrifugalpumps, fans,and compressors– slip factor– optimum design of centrifugal compressor in letchoking in a compressor stage.

Module-5:
Power generating machineII-Radial flow turbines,Loss coefficients–off design operating condition–clearance and windage losses 90deg IFR turbines.

References:
1. Dixon, S.L., Fluid*MechanicsandThermodynamicsofTurbomachinery, 5th* ed., Butter worths Heinemann,2005.
2.Csanady,G.T.,*TheoryofTurbomachines,*McGrawHill,1964.
3.Prithvi Raj,D.and Gopalakrishnan,G.,*ATreatiseonTurbomachines,*ScitechPublication,2003.

HP1112	**Programme Elective- II**	**Fluid Mechanics of Turbomachines**	**3**

Module-1:
Air pollution- Classification and properties of Airpollutants-Sampling and analysis of air pollutants, Control of airpollution.

Module-2:
Dispersion of air pollutants-Gaussian plume model-Control of gaseous pollutants–Volatileorganic compounds-Control of gaseousemission-Air pollution laws and standards.

Module-3:
Water pollution-Sampling and analysis of waste treatment –Advanced waste water treatmentsby physical,chemical,biological and thermal methods-Effluent quality standards.

Module-4:
Solid waste management-Classification and their sources-Healthhazards-Handling of toxic and radioactive wastes-Incineration and verification.

Module-5:
Pollution control in process industries namely Cement,Paper,Petroleum and petrochemical,Fertilizers and distilleries,thermal power plants and automobiles.

References:
1.Manster,G.M.,*IntroductiontoEngineeringandScience,2nd*ed.,PearsonPublishers,2004.
2.Rao,E.S.,*EnvironmentalPollutionControlEngineering,*WileyEasternLtd.,1991.
3.Mahajan,S.P.,*PollutionControlinProcessIndustries,*TataMcGraw-Hill,1985.
4.Crawford,M.,*AirPollutionControlTheory,*TMH,1976.

HP1113	**Programme Elective -III**	**Air Conditioning SystemDesign**	**3**

Module 1
Air conditioning systems.
Module 2
Various air-conditioning processes.
Module 3
Enthalpy deviation curve, psychrometry,SHF, dehumidified air quantity, humancomfort, indoorairquality,
Module 4
Design conditions and load calculations, air distribution,pressure drop,ductdesign,fans &, blowers,
Module 5
Performance & selection of air conditioning system,noisecontrol.

References:
1.Refrigerationand air-conditioning",ARI,PrenticeHall,NewDelhi,1993.
2. NormanC.Harris,"ModernAirConditioning",NewYork,McGraw-Hill,1974.
3 JonesW.P.,"Air-ConditioningEngineering",EdwardArnoldPublishers Ltd., London,1984
4. Hainer R.W.,"Control Systems for Heating, Ventilation and Air-Conditioning",Van Nostrand
5. ReinholdCo.,NewYork,1984.7.AroraC.P.,"Refrigeration&AirConditioning", Tata McGraw Hill, 1985.

HP1114	Programme Elective -III	Gas Turbine	3

CourseContents:

Module 1:

Introduction,Cycles,Performance characteristics and improvement.

Module 2:

Gas dynamics, Centrifugal,axial and mixed flow compressor,principles and characteristics,

Module 3:

Turbineconstruction,Blademater ials,manufacturingtechniques,bladefixing,

Module 4:

Problems of high temperature operation, blade cooling, practical air- cooled blades Combustion Systems,various fuels and fuel systems,

Module 5:

Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation,environmental considerations and applications.

References:

1. H Cohen, GFC Rogers and HIH Saravanamuttoo, "Gas Turbine Theory", Pearson Education,2000.
2. V.Ganesan,"GasTurbines",Tata Mc Graw Hill,2003.
3. S.M.Yahya"Turbines,Compressors and Fans",TataMcGrawHill,1992.
4. Vincent"ThetheoryanddesignofGasTurbineandJetEngines",McGrawHill,1950.
5. WW Bathic,"Fundamentals of GasTurbines",John Wiley and Sons.

HP1115	Programme Elective -III	AdvancedRefrigerationandAirConditioning	3

Course Contents

Module 1:

Actual vapor compression system–Multipressur evapour compression system–Environment friendly refrigerants– cascade system.

Module 2:

Absorption refrigeration system ,Three fluid absorption system –comparison of absorption with compression system-Analysis of multistage systems.

Module 3:

Advanced psychrometric calculations-Cooling load calculations–Determination of U factor– short method calculation

Module 4:

Low temperature refrigeration-JouleThompson coefficient–lique faction fair–hydrogen–helium-Applications of cryogenics.

Module 5:

Room air distribution–Friction losses in ducts-Duct design,Air filters clean rooms– Aircurtain

References:

1.Arora,C.P.,*RefrigerationandAirConditioning,2nd*ed.,Tata McGraw Hill,2004.
2.Stoeker,W.P.andJones,J.W.,*RefrigerationandAirConditioning, 2nd*ed.,Tata McGraw-Hill,1982.

3.Manohar Prasad, Refrigeration and Air Conditioning, New Age International, 1996.
4. Gosney, W.B., Principles of Refrigeration, Cambridge Uni. Press, 1982

HP1116	Programme Elective -III	Power Plant Engineering	3

Course Contents:

Module 1:

Introduction: Energy resources and their availability,types of power plants,selection of the plants,Review of basic thermodynamic cycles used in powerplants.

Hydro Electric Power Plants: Rainfall and run-off measurements and plotting of various curves for estimating stream flow and size of reservoir, power plants design, construction and operation of different components of hydro-electric power plants,site selection, comparison with other types of power plants.

Module 2:

Steam Power Plants: Flow sheet and working of modern-thermal power plants,supercritical pressure steam stations,site selection,coal storage,preparation,coal handling systems,feeding and burning of pulverized fuel,ash handling systems,dust collection-mechanical dust collector and electrostatic precipitator.

Module 3:

Steam generators and their accessories: High pressure Boilers,Accessories,Fluidized bed boiler. **Condensers:** Direct Contact Condenser,Surface Condensers,Effect of various parameters on condenser performance,Design of condensers,Cooling towers and cooling ponds

Module 4:

Combined Cycles: Constant pressure gas turbine power plants,Arrangements of combined plants (steam&gas turbine power plants),re-powering systems with gas production from coal,using PFBC systems, with organic fluids,parameters affecting thermodynamic efficiency of combinedcycles. **Nuclear Power Plants:** Principles of nuclear energy,basic nuclear reactions,nuclear reactors PWR, BWR,CANDU,Sodium graphite,fast breeder,homogeneous;gas cooled.Advantages and limitations, nuclear power station,waste disposal.

Module 5

Power Plant Economics:load curve,different terms and definitions,cost of electrical energy,tariffs methods of electrical energy,performance & operating characteristics of power plants-incremental rate theory,input-output curves,efficiency,heatrate,economic load sharing, Problems

References:

1. Power plant engineering by‘Arrora&Domkundwar’,DhanpatRai &Sons,New Delhi,2008.
2. Power plant Technology by‘M.M.Ei-Wakil’,McGrawHillCom.,85.
3. Power plant engineering by‘PCSharma’,S.K.Kataria&Sons,NewDelhi,2010.

HP1117	Programme Elective -III	GasTurbinesandJetPropulsion	3

Course Contents:

Module 1: Introduction: Classification of Turbo machines, Applications of GasTurbines, Assumptions for Air-Standard Cycles, Simple Brayton Cycle Heat Exchange Cycle, Inter-cooling and Reheating Cycle, Comparison of Various Cycles.

Ideal Shaft Power Cycles and their Analysis: Assumptions for Air-Standard Cycles, Simple Brayton Cycle,Heat Exchange Cycle,Inter-cooling and Reheating Cycle,Comparison of Various Cycles.

Module 2. Real Cycles and their Analysis: Methods of Accounting for Component Losses,Isentropic and Polytropic Efficiencies, Transmission and Combustion Efficiencies, Comparative Performance of Practical Cycles,Combined Cycles and Cogeneration Schemes.

Module 3. Jet Propulsion Cycles and their Analysis: Criteria of Performance, SimpleTurbo jet Engine,Simple Turb of an Engine, Simple Turbo propEngine,Turbo-shaft Engine,Thrust Augmentation Techniques

Module 4.Fundamentals of Rotating Machines: General Fluid Dynamic Analysis, Euler's Energy Equation, Components of EnergyTransfer,Impulse and Reaction Machines.
Centrifugal Compressors: Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio,The Diffuser, The Compressibility Effects,Pre- rotation and SlipFactor,Surging and Choking, Performance Characteristics.

Module 5. Axial Flow Compressors: Construction and Principle of Operation, ElementaryTheory and Velocity Triangles, Factors Effecting Stage Pressure Ratio,Degree of Reaction,Work done factor,3-Dimensional Flow,Design Process, Blade Design, Stage Performance, Compressibility Effects, Off- Design Performance.
Axial and Radial FlowTurbines: Construction and Operation,VortexTheory,Estimation of Stage Performance,Overall Turbine Performance,Turbine Blade Cooling,The Radial FlowTurbine.

References:

1. Sarvanamuttoo,H.I.H.,Rogers,G.F.C.and Cohen,H.,*GasTurbine Theory*,6th Edition,
2. Pearson Prentice Hall, 2008
3. Dixon,S.L.,Fluid Mechanics and Thermodynamics of Turbomachinery,7thEdition,Elsevier,2014.
4. Flack,R.D.,Fundamentals of Jet Propulsion with Applications,Cambridge University Press,2011.
5. Ganesan,V.,*GasTurbines*,3rd Edition,Tata McGrawHill,2010.
6. Yahya,S.M.,Turbines,Compressors and Fans,4th Edition,Tata Mc Graw Hill,2010.Lefebvre, A.H.,Gas Turbine Combustion,CRC Press,2010.

HP1118	Core	Research Methodology and IPR	3

CourseContents:

Module1:

Meaning of research problem,Sources of research problem,Criteria Characteristics of a Good research problem,Errors in selecting a research problem,Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection,analysis, interpretation, Necessary instrumentations.

Module2:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report,Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Module4:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development:technological research,innovation, patenting, development. International Scenario:International cooperationon Intellectual Property.Procedure for grants of patents,Patenting under PCT.

Module 5:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases.Geographical Indications. New Developments in IPR:Administration of Patent System. New developments in IPR;IPR of Biological Systems,Computer Software etc.Traditional knowledge Case Studies, IPR and IITs.

References:

1 . Stuart Melville and Wayne Goddard,"Research methodology: an introduction for Science & engineering students'"
2. Wayne Goddard and Stuart Melville,"Research Methodology:An Introduction"
3. Ranjit Kumar,2nd Edition,"Research Methodology: AStep-by-Step Guide for beginners"
4. Halbert,"Resisting Intellectual Property",Taylor & Francis Ltd,2007.
5. Mayall,"Industrial Design",Mc Graw Hill,1992.

HP2101	Core -III	Advanced Heat Transfer	3

CourseContents:

Module 1

Conduction-one and 2-Dimensional, Fins conduction with heat source, unsteady state heat transfer,

Module 2

Natural and forced convection,integral equation,analysis and analogies,

Module 3

Transpiration cooling, ablation heat transfer,boiling, condensation and two-phase flow mass transfer,cooling,fluidized bed combustion,

Module 4

Heat pipes, Radiation, shape factor,analogy, shields,

Module 5

Radiation of gases & vapours.

References:

1. J.P.Holman,"Heat Transfer",McGraw HillBook Company,NewYork,1990.
2. Incropera and Dewitt, "Fundamentals of Heat and MassTransfer", JohnWiley and Sons, NewYork,2000.
3. Frank Kreith,"Principles of Heat Transfer",Harper and Row Publishers,NewYork,1973.
4. Donald Q.Kern"Process Heat Transfer",Tata McGraw Hill Publishing Company Ltd., New Delhi,1975.
5. Gupta and Prakash, "Engineering Heat Transfer",New Chand and Bros,Roorkee (U.P.) India,1996.

HP2102	Core - IV	Steam Engineering	3

Course Contents:

Module 1

Fundamentals of steam generation, Quality of steam, Use of steam table, Mollier Chart, Boilers, Types,Mountings and Accessories, Combustionin boilers, Determination of adiabatic flame temperature,quantity of fluegases,Feed Water and its quality,Blow down;IBR,Boiler standards.

Module 2

Piping & Insulation(8hrs)

Water Line,Steam line design and insulation;Insulation-types and application,Economic thickness of insulation, Heat savings and application criteria, Refractory- types, selection and application of refractory, Heat loss.

Module 3

Steam Systems (8hrs)

Assessment of steam distribution losses,Steam leakages,Steam trapping, Condensate and flash steam recovery system, Steam Engineering Practices; Steam Based Equipment's/Systems.

Module 4

Boiler Performance Assessment(8hrs)

Performance Test codes and procedure, Boiler Efficiency, Analysis of losses; Performance evaluation of accessories; factors affecting boiler performance. Energy Conservation and Wast Minimization. Energy conservation options in Boiler;waste minimization, methodology; economical Viability of waste minimization

Module 5

Instrumentation & Control(6hrs)

Process instrumentation; control and monitoring. Flow, pressure and temperature measuring and controlling instruments,its selection.

References:

1. T.D.Estop,A.McConkey,Applied Thermodynamics,Parson Publication
2. Domkundwar;ACourse in Power Plant Engineering;Dhanapat Rai and Sons
3. YunusA. Cengel and Boles,"Engineering Thermodynamics",Tata Mc Graw-Hill Publishing Co.Ltd
4. Book II-Energy EfficiencyinThermal Utilities;Bureau of Energy Efficiency
5. Book IV-Energy Performance Assessment for Equipment & Utility Systems; Bureau of Energy efficiency
6. Edited byJ.B.Kitto & SCStultz; Steam: Its Generation and Use;The Babcock And Wilcoxompany
7. P.Chatopadhyay; Boiler Operation Engineering:Questions and Answer;Tata Mc Graw Hill Education Pvt Ltd, New Delhi

HP2103	**Programme Elective -IV**	**RefrigerationandCryogenics**	**3**

CourseContents:

Module 1

Vapour compression refrigeration, actual cycle, second law efficiency, Multistage compression with inter- cooling, multi-evaporator systems,Cascade systems.

Module 2

Performance characteristics and capacity control of reciprocating and centrifugal compressors, screw compressor and scroll compressor.

Module 3

Design, selection of evaporators, condensers, control systems, motor selection,

Module 4

Refrigerants, alternative refrigerants, CFC/HCFC phase-out regulations, Refrigeration applications, food preservation, transport,

Module 5

Introduction to Vapor absorption refrigeration, single effect and double effect systems, Gasliquefaction systems-Linde-Hampson, Lindedual pressure, Claude cycle.

References:

1. R.J. Dossat,"Principles of Refrigeration",Pearson Education Asia,2001.
2. C.P.Arora,"Refrigeration and Air-conditioning",Tata McGraw-Hill,2000.
3. Stoecker & Jones, "Refrigeration and Air-conditioning", McGraw Hill Book Company, NewYork,1982.
4. Jordan & Priester,"Refrigeration and Air-conditioning".
5. A.R.Trott,"Refrigeration and Air-conditioning",Butterworths,2000.
6. J.L. Threlkeld,"Thermal Environmental Engineering",Prentice Hall,1970.

HP2104	Programme Elective -IV	DesignofHeatExchangers	3

CourseContents:

Module 1

Heat Exchangers–Classification according to transfer process, number offluids, surface compactness,and construction features.Tubular heat exchanger,plate type heat exchangers, extended surface heat exchangers, heatpipe, Regenerators. Classification according to flow arrangement: counter flow,parallel flow,cross flow exchanger.

Module 2

Heat exchanger design methodology, assumption for heat transfer analysis, problem formulation, e-NTU method, *P*-NTU method,Mean temperature difference method, fouling of heat exchanger, effects of fouling,categories of fouling,fundamental processes of fouling.

Module 3

Double Pipe Heat Exchangers: Thermaland Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop . Compact Heat Exchangers: Thermal and Hydraulic design of compact heat exchanger

Module 4

Shell and Tube heat exchangers – Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers

Module 5

Mechanical Design of Heat Exchangers – design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major componentssuch as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

References:

1. Ramesh K. Shah and DusanP.Sekulic,"Fundamentals of Heat Exchanger Design" JohnWiley & sons Inc.,2003.
2. D.C.Kern,"ProcessHeatTransfer",McGrawHill,1950.
3. Sadik Kakac and HongtonLiu, "Heat Exchangers: Selection, Rating and Thermal Design"CRCPress,1998.
4. A .P.Frass and M.N.Ozisik,"Heat Exchanger Design",Mc Graw Hill,1984
5. Afgan N. and Schlinder E.V."Heat Exchanger Design and Theory SourceBook".

HP2105	**Programme Elective -IV**	**Renewable Sources of Energy**	**3**

Course Contents

Module 1.Introduction: Overview of the course, Examination and Evaluation patterns.Classification of energyresources, energy scenario in the world and India
Basicsun-earthrelationships: Definitions.Celestialsphere,altitude-azimuth,declination-hour angle and declination-right ascension coordinate systems for finding the position of the sun, celestialtri angle and coordinates of the sun.Green wich Mean Time, Indian Standard Time, Local Solar Time,sunrise and sunset times & day length.Numerical problems

Module 2. Solar radiation: Nature of solar radiation, solar radiation spectrum, solar constant, extra-terrestrial radiation onahorizontal surface, attenuation of solar radiation, beam,diffuse and global radiation. Measurement of global,diffuse and beam radiation.Prediction of solar radiation; Angstrom model, Pagemodel,Hottel's model,Liu and Jordan model etc.Insolation onan inclined surface, angle of incidence, Illustrative problems

Module 3. Solar thermal systems: Principle of working ofsolar water heating systems, solar cookers, solar desalination systems, solarponds,solarchimney power plant,central power tower power plants etc. **Solar concentrating collectors:** Classification of solar concentrators, Basic definitions such as concentration ratio,angle of acceptance etc.,Tracking of the sun;description of different tracking modes of a solar collectors and the determination ofangle of incidence of insolation indifferent tracking modes.Illustrative problems

Photovoltaic energy conversion: Introduction. Single crystalsilicon solar cell, i-vcharacteristics, effect of insolation and temperature on the performance of silicon cells.Different types of solarcells.Modern technological methods of producing these cells. Indian and world photovoltaic energy scenario.

Module 4. Energy storage: Necessity for energy storage. Classification of methods of energy storage.Thermal energy storage; sensible heat storage, latent heatstorage. Reversible chemical reaction storage. Electromagnetic energy storage.Hydrogen energy storage. Chemical battery storage.Pumped hydel energy storage etc.
Wind energy: Origin of winds,nature of winds,wind data measurement,wind turbine types and their construction, wind-diesel hybrid system,environmental aspects,wind energy programme in India and the world.
Ocean energy : Ocean thermal energy; open cycle &closed cycle OTEC plants, environmental impacts, challenges, present status of OTECsystems.Ocean tidal energy; single basin and double basin plants, their relative merits. Ocean wave energy; basics of ocean waves, different wave energy conversion devices, relative merits.

Module 5. Fuelcells: Introduction, applications, classification, different types of fuel cells such as phosphoric acid fuelcell, alkaline fuel cell,PEM fuel cell,MC fuel cell.
Development and performance fuel cells.

Biomass: Introduction, photo synthesis, biofuels, biomass resources,biomass conversion technologies, urban waste to energy conversion,biomassto ethanol conversion, biomass energy

scenarioin India **Biogas:** Biogas production, constant pressure and constant volume biogas plants, operational parameters of the biogas plant
Geothermalenergy: Origin, applications, types of geothermal resources, relative merits.

References:
1. B.H.Khan, Non conventional Energy Resources,Tata Mc Graw Hill, NewDelhi,2012
2. S.Rao and B.B.Parulekar, Energy Technology:Non-Conventional, Renewable and Conventional, Khanna Publishers, 2010

HP2106	Programme Elective -IV	AlternateFuels	3

Course Contents

Module 1

Introduction:Estimation of petroleumreserve–Need for alternate fuels–Availability and properties of alternate fuels,ASTM standards

Module 2

Alcohols: General Use ofAlcohols –Properties as Engine fuel –Gasolene and alcohol blends – Performance in SI Engine– Methanol and Gasoleneblend– Combustion Charactersticsin engine– emission characterstics Vegetable oils: Soyabeen Oil, Jatropha, Pongamia, Ricebran, Mahuaetcasalternate fuel and their properties, Esterificationofoils

Module 3

Natural Gas, LPG: Availability of CNG, properties, modification required to use in engines – performance and emission characteristics of CNG using LPGinSI & CI engines.
Hydrogen:Hydrogen production,Hydrogenasan alternative fuel,fuel cell.

Module 4

Electric and Solar powered vehicles: Layout ofanelectric vehicle –advantage and limitations-specifications–system component–electronic controlsystem–Highenergy and power density batteries Hybrid vehicle–solar powered vehicle

Module 5

Automobile emissions & its control: Need for emission control -Classification/ categories of emissions-Major pollutants- control of emissions–Evaluating vehicle emissions–EUROI, II, III, IV standards–Indian standards

References:

1. Alternate Fuels Guide BookAuthors:Richard L.Bech hold P.E.Publisher: Society of Automotiv Engineers,1997
2. Hydrogen fuel for surface transportation Authors: Norbeck, Joseph M.Publisher: Society of Automotive Engineers,1996
3. History of the Electric Automobiles: Hybrid Electric Vehicles, Authors:Wake field,Earnest Henry
4. Engine Emissions:Pollutant formation and advancesin control Technology Authors: Norbe Pundir B.R.Publisher Narosa Publishing House
5. Air Pollution and its Control, Authors:S.C. Bhatia, Publisher: Atlantic Publications, 2007

HP2107	Programme Elective -IV	**Jet and Rocket Propulsion**	3

Course Contents :

Module 1

Motion in Space:Requirement for Orbit: Motion of Bodies in space, Parameters describing motion of bodies, Newton's Laws of motion,Universal law of gravitational force,Gravitational field, Requirements of motion in space, Geosynchronous and geostationary orbits, Eccentricity and inclination oforbits, Energy and velocity requirements to reach a particular orbit, Escape velocity, Freely falling bodies,Means of providing the required velocities.

Module 2

Theory of Rocket Propulsion: Illustration by example of motion of sledinitiallyatrest,Motion of giantsquidin deepseas, Rocket principle and rocket equation, Mass ratio of rocket, Desirable parameters of rocket,Rocket having small propellant massfraction,Propulsive efficiency of rocket, Performance parameters of rocket, Staging and clustering of rockets, Classification of rockets.

Module 3

Rocket nozzle and Performance: Expansion of gasfrom ahighpressure chamber, Shape of the nozzle, Nozzle area ratio,Performance loss inconical nozzle, Flow separation in nozzles, Contouror bell nozzles,Unconventional nozzles,Mass flow rates and characteristics velocity,Thrust developed by arocket;Thrust coefficient, Efficiencies, Specific impulse and correlation with C* and CF, General Trends.

Module 4

Chemical Propellants: Small value of molecular mass and specific heat ratio,energy release during combustion of products, Criterion for choices of propellants,Solid propellants, Liquid propellants, Hybrid propellants

Solid Propellants Rockets: Mechanism of burning and burn rate, Choice of indexn for stable operation of solid propellant rockets, Propellant grain configuration, Ignition of solid propellant rockets,Pressured ecayin chamber after propellant burnout, Action time and burntime, Factors influencing burnrate,Components of a solid propellant rocket.

Module 5

Liquid Propellant Rockets: Propellant feed system,Thrust chamber,Performance and choice of feed system cycle,Turbopumps, Gas requirements for draining of propellants from storage tanks,Draining undermicrogravity condition,Trends in development of liquid propellant rockets.

Hybrid Rockets: Working principle,Choice of fuels and oxidizer, Future of hybrid rockets.

References:

1. Barrere,M.,Rocket Propulsion, EIsevier.PubCo1990
2. Sutton,G.P.,Rocket Propulsion Element JohnWiley,NewYork, 1993.
3. Ramamurthi K.,Rocket Propulsion,Macmillan Publishers India Ltd 2010
4. Feedesiev, V.I.andSiniarev, G.B.Introduction to Rocket Technology,Academic Press, NewYork,2000.
5. Sarvanamuttoo, H.I.H.,Rogers G.F.C.andCohen,H.,GasTurbineTheory, 6th Edition, Pearson Prentice Hall,2008.

HP2108	**Programme Elective- V**	**Computational Fluid Dynamics**	**3**

SyllabusContents:

Module-1:

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison With experimental and analytical methods, Basics of PDE:Elliptic,Parabolic and Hyperbolic Equations.Governing Equations; Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis onFVM, Stability, Convergence and Accuracy.

Module-2:

Finite Volume Method: Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling,Checker board pressure field and staggered grid approach

Module-3:

Geometry Modeling and Grid Generation: Practical aspects of computational modeling of flowdomains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance.

Module-4:

Methodology of CFDHT: Objectives and importance of CFDHT, CFDHT for Diffusion Equation,Convection Equation and Convection-Diffusion Equation

Module-5:

Solution of N-S Equations for Incompressible Flows: Semi-Explicit and Semi-Implicit Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows.

References:

1. Computational Fluid Dynamics,The Basic with applications by John A. Anderson, Jr., Mc Graw Hill International editions,Mechanical Engineering series.
2. Numerical Methodsin Fluid Flow & Heat Transfer by Dr.Suhas Patankar.
3. An Introduction to Computational Fluid Flow(FiniteVolumeMethod),by H.K.Versteeg, W.Malalasekera, PrinticeHall
4. Computational Methods for Fluid Dynamics by Ferziger and Peric,Springer Publication.
5. An Introduction to Computational Fluid Mechanics by Chuen-Yen Chow,Wiley Publication.
6. Computational Fluid Flow & Heat Transfer by Murlidhar and Sundarrajan, Narosa Publication.

HP2109	**Programme Elective- V**	**Modelling of IC Engine**	**3**

SyllabusContents:

Module-1:

Fundamentals: Governing equations, Equilibrium charts of combustion chemistry, chemical reaction rates, and approaches of modeling, model building and integration methods, gas exchangethroughvalves,engineandportinggeometry,exhaustgasrecirculation,valveliftcurves.

Module-2:

Thermodynamic Combustion Models of CI Engines: Single zone models, premixed and diffusive combustion models, combustion heat release using wiebe function,wall heat transfer correlations, ignition delay, internal energy estimations, two zone model, application of heat release analysis.

Module-3:

Fuel spray behavior: Fuel injection, spray structure, fuel atomization, droplet turbulence interactions, dropletimpingementonwalls.

Module-4:

Modeling of charging system: Constant pressure and pulse turbo charging, compressor and turbine maps,charge air cooler.

Module-5:

Mathematical models of SI Engines: Simulation of Otto cycle at fullthrottle,part throttle and super charged conditions. Progressive combustion, Autoignition modeling, single zone models, mass burning rate estimation, SI Engine with stratified charge. Friction in pumping, piston assembly,bearings and valvetrain etc. friction estimation for warm and warm up engines.

References:

1. Haywood,"I.C.Engines",Mc GrawHill.
2. Ramos **J**(1989**)** Internal Combustion Engine Modeling**.** Hemisphere Publishing Company
3. C.D.Rakopoulos and E.G.Giakoumis,"Diesel Engine Transient
4. Operation Principles of Operation and Simulation Analysis",Springer,2009.
5. V.Ganeshan,"Internal Combustion Engines",Tata McGraw Hill,NewDelhi,1996.
6. P.A. Lakshminarayanan and Y.V.Aghav,"Modelling Diesel Combustion"Springer, 2010
7. Bernard Challen and Rodica Baranescu,"Diesel Engine Reference Book"Butter worth-Heinemann,1999.

HP2110	Programme Elective- V	Measurements In Thermal Engineering	3

Module-1:

Basics of Measurements: Introduction, General measurement system, Signal flow diagram of Measurement system,Inputs and their methods of correction.

Analysis of experimental data;Causes and types of errors in measurement, Propagation of errors, Uncertainty analysis, Regression analysis,Statistical analysis of Experimental data.

Module-2:

Sensing Devices : Transducers-LVDT, Capacitive, piezoelectric, photoelectric, photovoltaic, Ionization, Photoconductive,Hall-effect transducers, etc.

Pressure measurement: Different pressure measurement instruments and their comparison,Transient response of pressure transducers,dead-weight tester,low-pressure measurement.

Module-3:

Thermometry: Overview of thermometry, temperature measurement bymechanical, electrical and radiation effects.Pyrometer,Thermo couple compensation,effect of heat transfer.

Flow Measurement: Flow obstruction methods, Magnetic flowmeters, Interfero meter, LDA,flow measurement by drag effects,pressure probes,other methods.

Module-4:

Thermal and transport property measurement: Measurement of thermal conductivity,diffusivity, viscosity,humidity,gas composition, pH,heat flux, calorimetry,etc.

Nuclear, thermal radiation measurement: Measurement of reflectivity, transmissivity, emissivity, nuclear radiation,neutron detection,etc.Other measurements:Basics in measurement of torque,strain.

Module-5:

Air-Pollution: Air-Pollution standards, general air-sampling techniques, opacity measurement, sulphurdioxide measurement,particulate sampling technique,combustion products measurement.

Advanced topics: Issues in measuring thermo physical properties of micro and Nano fluids.

References:

1.Mechanical Measurements byThomas G Beck with,Pearson publications
2.Measurement systems by ErnestODoebelin, Tata Mc Graw Hill publications
3.Experimental Methods for Engineers, JPHolman,Tata McGraw Hill publications

HP2111	**Programme Elective- V**	**Computer Aided Design**	**3**

SyllabusContents:

Module-1:

CAD Hardware and Software,Types of systems and system considerations,input and output devices,hardware integration and networking, hardware trends,Software modules, Computer Communications, Principle of networking, classification networks, networkwring, methods, transmission media and interfaces,network operating systems,

Module-2:

Computer Graphics Introduction, transformation of geometric models: translation, scaling, reflection, rotation, homogeneous representation,concatenated transformations;mappings of geometric models, translational mapping rotational mapping, general mapping, mappings as changes of coordinate system;inverse transformations and mapping;

Module-3:

Projections of geometric models,ortho graphic projections, Geometric Modeling, curve representation: Parametric representation of analytic curves, parametric representation of synthetic curves,curve manipulations.Surface representation,

Module-4:

Fundamentals of solid modeling, boundary representation (B-rep), Constructive Solid Geometry (CSF),sweep representation,Analytic Solid Modeling(ASM),other representations;solid manipulations, solid modeling based applications: mass properties calculations, mechanical tolerancing,etc.

Module-5:

Finite Element Modeling and Analysis, Finite Element Analysis, finite element modeling, mesh generation mesh requirements, semiautomatic methods, fully automatic methods, design and engineering applications, System Simulation, Need of simulation, areas of applications, when simulation is appropriate tool/not appropriate,concept of a system,components of a system, discrete and continuous systems,model of a system,types of models,types of simulation approaches

References:

1. Ibrahbim Zeid,"CAD/CAM Theory and Practice".
2. Jim Browne,"Computer Aided Engineering and Design".
3. P. Radhakrishnan/V.Raju/S.Subramanyam,"CAD/CAM/CIM".
4. P.N. Rao,"CAD/ CAM principles and applications",Tata Mcraw-Hill,02.
5. Rogers/Adams,"Mathematical Elements for Computer Graphics".
6. Rooney and Steadman,"Principles of Computer Aided Design",Aug.1993.
7. Jerry Banks/John Carson/Barry Nelson/David Nicol,"Discrete-Event System Simulation"

HP2112	**Programme Elective- V**	**Theory And Design Of Gas Turbines**	**3**

Module-1:
Gas Turbine Plants, Axial Flow Compressor, Principle of operation, velocity triangles.
Module-2:
Design procedure for single and multistage compressors.Three dimensional effect compressor performance.
Module-3:
Description and problems of transonic and supersonic compressors.
Module-4:
Impulse turbine;Single and multi wheel turbine efficiency,Number of stages blade passages,Vortex design of turbine blades.Blade design & manufacture blade material and blade cooling,limiting factors in turbine design.
Module-5:
Combustion in GasTurbine andTurbine Characteristics

References:
1. GasTurbine Cohan Roger
2.GasTurbine Ganesan

HP2113	**OpenElective-I**	**Business analytic**	**3**

Syllabus:
Module 1.
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics.
Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.
Module 2.
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression.Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.
Module 3.
Organization Structures of Business analytics, Team management, Management Issues, DesigningInformation Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes.
Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.
Module 4.

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models,Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

Module 5.

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making. Recent Trends in Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

Reference Books:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G.
2. Schniederjans, Christopher M. Starkey, Pearson FT Press.
3. Business Analytics by James Evans, persons Education.

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HP2114	**OpenElective-I**	**Industrial safety**	**3**

Syllabus:

Module 1.

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

Module 2.

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

Module 3. Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv.Gravit y lubrication, v.Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Module 4. Fault tracing: Fault tracing-concept and importance, decision treeconcept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic,automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

Module 5.Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair

complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Reference Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

HP 2115	Open Elective-I	Operations research	3

Syllabus:

Module 1.

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Module 2.

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplexmethod - sensitivity analysis - parametric programming

Module 3.

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Module 4.

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Module 5.

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Reference Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
3. J.C.Pant,Introduction to Optimisation:OperationsResearch,JainBrothers,Delhi, 2008
4. Hitler Libermann Operations Research:McGrawHillPub.2009
5. Pannerselvam,OperationsResearch:Prentice Hall of India2010
6. Harvey M Wagner,Principles of Operations Research:Prentice Hall of India2010

HP2116	**Open Elective-I**	**Cost management of engineering product**	**3**

Syllabus:

Module 1

Introduction and Overview of the Strategic Cost Management Process

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Module 2

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non- technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

Module 3

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

Module 4.

Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Module 5.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Reference Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

HP2117	**Open Elective-I**	**Composite materials**	**3**

Syllabus:

Module 1.

INTRODUCTION: Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

Module 2.

REINFORCEMENTS: Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isostress conditions.

Module 3.

Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

Module 4.

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

Module 5.

Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Reference Books:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications ,Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

HP2118	**Open Elective-I**	**Waste to Energy**	**3**

Syllabus:

Module 1.

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Module 2.

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

Module 3.

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

Module 4.

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Module 5.

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Reference Books:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II,
   Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

HP 2201	**Lab III**	**Thermal Engineering Lab-III**	**2**

SyllabusContents:

The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC) namely Design of Heat Exchangers and Computational Fluid Dynamics,Modelling of IC Engine.

HP 2202	**Lab IV**	**Thermal Engineering Lab-IV**	**2**

SyllabusContents:

The lab practice consists of the tutorials and experiments as decided by the course supervisors of the Program Core Courses (PCC) namely Design of Heat Exchangers and Computational Fluid Dynamics,Modelling of IC Engine.

HP 2203	**Core**	**Mini Project**	**2**

Syllabus contents:

Students can take up small problems in the field of design engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

Guideline:

Mini Project will have mid semester presentation and end semester presentation. Mid semester presentation will include identification of the problem based on the literature review on the topic referring to latest literature available.

End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution.