UNIVERSITY OF PUNE

Structure and Syllabus

FOR

M.E. Mechanical Engineering (Heat Power Engineering) 2013-Course

UNDER FACULTY OF ENGINEERING

EFFECTIVE FROM July 2013

M.E. Mechanical Engineering (Heat Power Engineering) – (2013 Course)

SEMESTER I

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
507101	Advanced Mathematics and Numerical Methods	4	50	50	-	-	100	4
502102	Advanced Thermodynamics and Combustion Technology	4	50	50	-	-	100	4
502103	Advanced Fluid Mechanics	4	50	50	-	-	100	4
502104	Research Methodology	4	50	50	-	-	100	4
502105	Elective I**	5	50	50	-	-	100	5
502106	Lab Practice I	4			50	50	100	4
Total		**25**	**250**	**250**	**50**	**50**	**600**	**25**

SEMESTER II

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect./ Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
502107	Advanced Heat Transfer	4	50	50	-	-	100	4
502108	Air Conditioning Technology	4	50	50	-	-	100	4
502109	Measurements and Controls	4	50	50	-	-	100	4
502110	Elective II	5	50	50	-	-	100	5
502111	Lab Practice II	4	-	-	50	50	100	4
502112	Seminar I	4	-	-	50	50	100	4
Total		**25**	**200**	**200**	**100**	**100**	**600**	**25**

Elective I: Common to All M.E. Mechanical Programmes**

SEMESTER III

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
		Lect. / Pr	Paper		TW	Oral/ Presentation	Total	
			In Sem. Assessment	End Sem. Assessment				
602113	Computational Fluid Dynamics	4	50	50	-	-	100	4
602114	Design of Heat Transfer Equipments	4	50	50	-	-	100	4
602115	Elective III	5	50	50	-	-	100	5
602116	Seminar II	4	-	-	50	50	100	4
602117	Project Stage I	8	-	-	50	50	100	8
Total		**25**	**150**	**150**	**100**	**100**	**500**	**25**

SEMESTER IV

CODE	SUBJECT	TEACHING SCHEME	EXAMINATION SCHEME				CREDITS
		Lect. / Pr	Paper	TW	Oral/ Presentation	Total	
602118	Seminar III	5	-	50	50	100	5
602119	Project Work Stage II	20	-	150	50	200	20
Total		**25**	**-**	**200**	**100**	**300**	**25**

Lab Practice I & II:

The laboratory work will be based on completion of assignments confined to the courses of that semester.

SEMINAR:

The student shall deliver the seminar on a topic approved by authorities.

Seminar I: shall be on state of the art topic of student's own choice approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar II: shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

Seminar III: shall be extension of **seminar II.** The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned Guide and head of the department/institute.

PROJECT WORK:

The project work shall be based on the knowledge acquired by the student during the coursework and preferably it should meet and contribute towards the needs of the society. The project aims to provide an opportunity of designing and building complete system or subsystems based on area where the student likes to acquire specialized skills.

Project Work Stage – I

Project work Stage – I is the integral part of the project Work. In this, the student shall complete the partial work of the Project that will consist of problem statement, literature review, project overview, scheme of implementation (UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. The candidate shall deliver a presentation as a part of the progress report of Project work Stage-I, on the advancement in Technology pertaining to the selected dissertation topic.

The student shall submit the progress report of Project work Stage-I in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Project Work Stage - II

In Project Work Stage – II, the student shall complete the balance part of the Project that will consist of fabrication of set up required for the project, conducting experiments and taking results, analysis & validation of results and conclusions.

The student shall prepare the final report of Project work in standard format duly certified for satisfactory completion of the work by the concerned guide and head of the department/Institute.

Note: ***Institute must submit the list of candidates, guide and project details (title, area, problem definition, and abstract - clearly indicating objectives and scope, sponsorship details, if any) to the university within month of commencement of third semester. The guide must be approved/qualified teacher of the institute. A guide can guide at the most 8 students per year.***

Semester – I

Advanced Mathematics and Numerical Methods [507101]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
507101	4	50	50	-	-	100	4

1. Linear Algebraic Equations:

Gauss – Elimination, Gauss – Seidel, LU Decomposition, Solution of algebraic and transcendental equations : - Bisection Method, False position method, Newton – Raphson Method, Muller's method, Bairstow's Method, Convergence and stability

2. Regression Analysis:

i) Linear regression, multiple linear regressions, polynomial regression.

ii) Non linear regression – Gauss – Newton method, multiple non linear regression.

Interpolation: Newton's Divided Difference, Lagrange's Inverse, Spline, Hermite Interpolation,

Extrapolation technique of Richardson's Gaunt

3. Differentiation & Integration:

Divided difference formulae, Romberg integration, Gauss quadrature for double & triple integration.

4. Eigen Values & Eigen Vectors of Matrices:

Faddeev- Laeverrier's method, Power Method, Householder & Given's method.

5. 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.

6. 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.

Assignments:

Solve Any Three assignments based on each of the above mentioned unit with programming

Reference Books:

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

Semester - I
Advanced Thermodynamics and Combustion Technology
[502102]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502102	4	50	50	-	-	100	4

1. **Equation of State:**
   State postulate for Simple System and equation of state, Ideal gas equation, Deviation from ideal gas, Equation of state for real gases, generalized Compressibility chart, Law of corresponding states

2. **Properties of Pure Substances:**
   Phase change process of pure substances, PVT surface, P-v &P- T diagrams, Use of steam tables and charts in common use

3. **Laws of thermodynamics:**
   2^{nd} law Analysis for Engg. Systems, Entropy flow & entropy generation, Increase of entropy principle, entropy change of pure sub, T-ds relations, entropy generation, thermo electricity, Onsager equation. Exergy analysis of thermal systems, decrease of Exergy principle and Exergy destruction, Third law of thermodynamics, Nerst heat theorem and thermal death of universe.

4. **Thermodynamic Property Relations:**
   Partial Differentials, Maxwell relations, Clapeyron equation, general relations for du, dh, ds, and Cv and Cp, Joule Thomson Coefficient, Δh, Δu, Δs of real gases.

5. **Combustion Technology:**
   Chemical reaction - Fuels and combustion, Enthalpy of formation and enthalpy of combustion, First law analysis of reacting systems, adiabatic flame temperature
   Chemical and Phase equilibrium - Criterion for chemical equilibrium, equilibrium constant for ideal gas mixtures, some remarks about Kp of Ideal-gas mixtures, fugacity and activity, Simultaneous relations, Variation of Kp with Temperature, Phase equilibrium, Gibb's phase rule, Gas Mixtures – Mass & mole fractions, Dalton's law of partial pressure, Amagat's law, Kay's rule.

   Thermodynamics of Biological systems:
   Living systems, Thermodynamics of Biological cells, Energy conversion efficiency of Biological systems, Thermodynamics of Nutrition and Exercise, Thermodynamics of Aging and Death

Lab Experiments / Assignments (Any Three):

1. Computer aided energy analysis of steady flow cyclic system.
2. Study of mixture of gases, gas and vapour, estimation of properties and preparation of charts.
3. Analysis of ideal gas system using statistical thermodynamic techniques.
4. Study of behaviour of pure substance with change in pressure and temperature.
5. Preparation of computer program to study the effect of percentage of theoretical on adiabatic flame temperature and equilibrium composition for a hydrocarbon fuel. (Program to be run for variable input data.)

Reference Books:

1. Thermodynamics – An Engineering Approach, Yunus Cengel and Michael Boles,7th Ed., Tata McGraw Hill
2. Modern Engineering Thermodynamics, Robert Balmer, Elseveir.
3. Advanced Thermodynamics for Engineers, Winterbone, John Wiley
4. Advanced Thermodynamics for Engineers, Kenneth Wark, McGraw Hill
5. Thermodynamics for Engineers, Mathur, Gupta, Metropolitan Book Co. Pvt. Ltd.
6. Fundamentals of Engineering Thermodynamics, Michael Moran, Howard Shapiro, John Wiley

Semester – I

Advanced Fluid Mechanics [502103]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502103	4	50	50	-	-	100	4

1. Governing Equations:

Review of Fluid Mechanics: - Definition and properties of Fluids, Fluid as continuum, Continuum model, Flow kinematics:- Langragian and Eulerian description, Substantial or Total derivatives, Basic flow-analysis techniques, Flow Patterns: Streamlines, Streaklines, and Pathlines

Integral Relations for a Control Volume: Reynolds transport theorem, Conservation of mass, Linear momentum equation, Energy equation, Frictionless flow, Bernoulli equation

Differential Relations for a Fluid Particle: Acceleration field of a fluid, Differential equation of mass conservation, Differential Equation of linear momentum, Differential equation of Energy, Boundary Conditions for the basic equations, Velocity Potential, Stream Function, Vorticity

2. Navier-Stokes Equations:

Generalized form of NSE, Special forms: Euler equations, Bernoulli equation,

Exact solutions: fully developed flow in channel, pipe, flow between concentric rotating cylinders, Couette flow, Stokes First problem (unsteady flow), Creeping flow past a sphere, cylinder.

3. Potential Flows:

Elementary Plane-Flow Solutions: Circulation, Superposition of Plane-Flow Solutions**:** Irrotational vortex, Vortex flow, Doublet, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag.

4. Boundary Layers:

Boundary layer assumptions, equations, Flow over a flat plate, Similarity (Blasius) solution, Falkner-Skan equation, Momentum integral method, Flow separation.

5. Turbulent flow:

Introduction, characteristics of turbulence, laminar-turbulent transition, Correlation functions, Mean and fluctuations, Governing equations, Turbulent boundary layer, Boundary conditions, shear stress models, Prandtl's mixing length, Velocity profile over a flat plate and in pipes, Equations for free shear layers: mixing layer, plane and axisymmetric jet, and wake, two equation model (k-ε), Large Eddy Simulation, Various Turbulent Models

6. Compressible Flow:

One-dimensional flow: Speed of sound, Variable cross-section flow, Converging diverging nozzle, Fanno and Rayleigh curve, Normal shock relations, Introduction to oblique shocks, Prandtl-Meyer expansion waves

Lab Experiments / Assignments (Any Three):

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. Advanced Fluid Mechanics, G. Biswas and K. Muralidhar, Narosa Publisher
2. Viscous Fluid Flow, F. M. White, Tata McGraw Hill
3. Boundary Layer Theory, H. Schlichting, Springer
4. Fluid Mechanics, Cengel, Tata McGraw Hill
5. Fluid Mechanics, F.M. White, Tata McGraw Hill Int.
6. Mechanics of Fluid, Merle C. Potter, David C. Wiggert, Bassem Ramadan, Tom I-P. Shih, Cengage Learning**,** Publisher, Global Engineering: Christopher M. Shortt.
7. Fluid Mechanics, David Pnueli and Chaim Gutfinger, Cambridge Press

Semester – I
Research Methodology [502104]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502104	4	50	50	-	-	100	4

1. **Research Problem :**
   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

2. **Basic instrumentation :**
   Instrumentation schemes, Static and dynamic characteristics of instruments used in experimental set up, Performance under flow or motion conditions, Data collection using a digital computer system, Linear scaling for receiver and fidelity of instrument, Role of DSP in data collection in noisy environment.

3. **Applied statistics :**
   Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, Moments and response curve methods, State vector machines and uncertainty analysis, Probable errors in the research, Error analysis

4. **Modelling and prediction of performance :**
   Setting up a computing model to predict performance of experimental system, Multi-scale modelling and verifying performance of process system, Nonlinear analysis of system and asymptotic analysis, Verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity theory and applications.

5. **Developing a Research Proposal :**
   Format of research proposal, Individual research proposal, Institutional proposal, Proposal of a student – a presentation and assessment by a review committee consisting of Guide and external expert only, Other faculty members may attend and give suggestions relevant to topic of research.

Reference Books:

1. Research methodology: an Introduction for Science & Engineering students, by Stuart Melville and Wayne Goddard
2. Research Methodology: Methods and Trends, by Dr. C. R. Kothari
3. Research Methodology: An Introduction by Wayne Goddard and Stuart Melville
4. Research Methodology: A Step by Step Guide for Beginners, by Ranjit Kumar, 2nd Edition
5. Operational Research by Dr. S.D. Sharma, Kedar Nath Ram Nath & Co.
6. Software Engineering by Pressman

Semester – I
Elective – I (502105)
[Elective I Common to All M.E. Mechanical Courses]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502105	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
ME2I – M1	**Energy Audit and Management**	**ME2I – M6**	**Operation Management**
ME2I – M2	**Financial Management**	**ME2I – M7**	**Engineering Economics**
ME2I – M3	**Financial Costing**	**ME2I – M8**	**Technology Forecasting**
ME2I – M4	**Project Management**	**ME2I – M9**	**Technology Transfer**
ME2I – M5	**Energy Efficient Technologies in Electrical Systems**	**ME2I – M10**	**Human Rights**
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
ME1I – M11	**Environmental Pollution and Control**	**ME1I – M12**	**Intellectual property Rights**

Note: For e.g., ME2I-M1 indicates
ME – Common to all M.E. Mechanical Course, 2 – 2 Credits, I – Elective I, M1 – Module 1

ME2I – M1 Energy Audit and Management

Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M2 Financial Management

Investment-need, Appraisal and criteria, Financial analysis techniques- Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis, Financing options, Energy performance contracting and role of Energy Service Companies (ESCOS).

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M3 Financial Costing

Significance, Traditional absorption costing, Marginal costing, Contract costing, Activity based costing, Process costing

Ref. Books: Cost Accounting, N K Prasad, Book Syndicate Pvt. Ltd.

ME2I – M4 Project Management

Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification.

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M5 Energy Efficient Technologies in Electrical Systems

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls.

Ref. Books: Guide Books, Bureau of Energy Efficiency

ME2I – M6 Operation Management

Introduction, Importance, Operating systems models, key decisions, Planning and controlling, Strategic approach, Processes and systems, supply chain or network approach, Technology and knowledge management, Quality Management, Operations - Challenges, Opportunities, Excellence, risk management and sustainability, Case studies

Ref. Books:1) Operations Management - An Integrated Approach, Danny Samson and Prakash J. Singh, :Cambridge University Press, 2) Modern production/Operations Management, 8th Edition, E.S. Buffa and R. K. Sarin, John Wiley & Sons.

ME2I – M7 Engineering Economics

Fundamentals, Markets and Government in a Modern economy, Basic Elements of Supply and Demand, Demand and Consumer Behaviour, Analysis of Perfectly Competitive Markets, Unemployment, Inflation and Economic policy

Ref. Books: Economics, Samuelson Nordhaus, Tata McGraw Hill

ME2I – M8 Technology Forecasting

Approaches, Technology Performance Parameters, Use of Experts in Technology Forecasting, Planning, Technology Progress. Morphological Analysis of a Technology System.

Ref. Books: 1) Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M9 Technology Transfer

Definition, Source of Technology Transfer [TT], Model of TT with Public and Private Enterprises, Success and Failure Factors in Technology Transfer. The concepts of Invention and Innovation, Definition and classifications of Research and Development, New Product Development, Challenges in Commercializing Research Results.

Ref. Books: 1) Gerard H. Gaynor, Hand Book of Technology Management, Mc Graw Hill.

ME2I – M10 Human Rights

Human Rights – Concept, Development, Evolution, Philosophical, Sociological and Political debates, Benchmarks of Human Rights Movement. Human Rights and the Indian Constitution Human Rights & State Mechanisms, Police & Human Rights, Judiciary & Human Rights, Prisons & Human Rights, National and State Human Rights Commissions, Human Rights of the Different Sections and contemporary issues, Citizens' Role and Civil Society, Human Rights and the international scene Primary Information with reference to Engineering Industry

Ref. Books: 1)Study material on UNESCO,UNICEF web site, 2)HUMAN RIGHTS IN INDIA A MAPPING,Usha Ramanathan, 3)Introduction to International Humanitarian Law by Curtis F. J. Doebbler - CD Publishing , 2005 .This book is an introductory text on international humanitarian law (the laws of war) that provides the basics of law, including excerpts from some of the leading treaty texts. Perfect for a short course in the law -- one to five weeks, 4) Freedom of Information by Toby Mendel - UNESCO , 2008

ME1I – M11 Environmental and Pollution control

Pollution and Environmental Ethics, Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution, Nuclear hazards Environmental impact and economic aspects, Emission standards and regulations for Automobiles.

Ref. Books: 1) Environmental Pollution and Control, J. Jeffrey Peirce, P Aarne Vesilind, Ruth Weiner, Butterworth-Heinemann, 2) Environmental Pollution Control Engineering, C.S. Rao, New Age International

ME1I – M12 Intellectual property Rights

Patentable and non-patentable inventions, statutory exceptions, Persons entitled to apply for patents.

Ref. Books: 1) Satyawrat Ponkshe, The Management of Intellectual Property, by, Ponkshe & Bhate Publications, Pune.

Semester – I
Lab. Practice – I [502106]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502106	4	--	--	50	50	100	4

Lab. work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects **excluding Research Methodology and Elective**. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System. (Refer University web site)

Semester - II

Advanced Heat Transfer [502107]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502107	4	50	50	-	-	100	4

1. **Introduction to Modes and Laws of Heat Transfer:**
   Simultaneous Heat Transfer Mechanism, Steady and Transient Heat Transfer, Multidimensional Heat Transfer, Thermal Conductivity, Thermal diffusivity, Various Boundary and Initial Conditions, General Heat Conduction Equation, Thermal Resistance, Generalized Thermal Resistance Networks, Thermal Contact Resistance

2. **Transient Heat Conduction:**
   Lumped capacitance and its validity, General lumped capacitance analysis, spatial effects. Problems related with conventional geometries.

3. **Principle of Fluid flow and Convective heat transfer:**
   Concept of velocity and thermal boundary layers: Laminar and Turbulent flow. Navier-stokes equations and convection equation. Boundary layer approximations and special conditions. Boundary layer similarity. The normalized convection transfer equations. Dimensionless parameters & physical significance. Reynolds analogy, Chilton-Colburn analogy.

4. **External Forced Convection:**
   Parallel flow over Flat plates, Flow across cylinders and spheres, Flow across tube banks
   Internal Forced Convection
   Entrance region, Constant surface heat flux, Constant surface temperature, Laminar and Turbulent flow in tubes

5. **Natural Convection:**
   Physical Mechanism, Equation of motion and Grashof Number, Natural Convection over surfaces, Natural convection from finned surfaces and PCBs, Natural Convection inside enclosures (Rectangular, Cylinder and Sphere), Combined Natural Convection and Radiation, Combined Natural and Forced Convection.

6. **Boiling and Condensation:**
   Boiling modes, the boiling curve, modes of pool boiling, correlations. Forced convection boiling. Two phase flow.
   Condensation: Physical mechanisms, laminar film condensation on a vertical plate. Turbulent film condensation, film condensation on radial systems, film condensation in horizontal tubes, on banks of tubes, Dropwise condensation correlations

7. Thermal Radiation:

Thermal radiation, Blackbody radiation, Radiation intensity, Radiation properties, Atmospheric and Solar radiation, Shape factor, Radiation heat transfer in two surface enclosures, Radiation shields, Radiation exchange between Emitting and Absorbing gases.

Assignments (Any Three):

1. Transient Heat Conduction using Heisler and Grober charts
2. Numerical method in heat conduction & convection.
3. Combined Natural and Forced Convection heat transfer.
4. Assignment on Boiling and Condensation
5. Radiation Heat Transfer in Two Surface Enclosures
6. Heat transfer augmentation techniques.

Reference books:

1. Fundamentals of Heat and Mass Transfer, Incropera, Dewitt, John Wiley and sons.
2. Heat and Mass Transfer, Yunus Cengel, Afshin Ghajar, Tata Mc Graw Hill.
3. Heat transfer - A basic approach, M.N. Ozisik, Mc Graw Hill Int.
4. Convective Heat transfer, A Bejan, John Wiley and sons.
5. Heat transfer, J.P. Holman, Mc Graw Hill
6. Heat transfer, S.P. Sukhatme, University Press

Semester - II

Air Conditioning Technology [502108]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502108	4	50	50	-	-	100	4

1. Psychrometry :

Composition of moist air, Important psychrometric properties, Methods for estimating moist air properties, Ideal Adiabatic saturation process, Relationship between Wet-Bulb Temperature and Thermodynamic Wet-Bulb Temperature, Sling and Aspiration psychrometers, Relations between psychrometric properties, Psychrometric chart, ASHRAE Psychrometric charts. Use of psychrometric charts and moist air tables, Goff and Gratch tables.

Psychrometric Processes, Air washer, Bypass Factor, ADP, Applied Psychrometry – RSHF, GSHF and ESHF. Numerical on Applied Psychrometry.

2. Thermal Comfort :

Thermal comfort, Heat transfer from human body by sensible and latent heat transfer. Metabolic heat generation, steady state and unsteady state model for heat transfer, effect of clothing and definition of effective temperatures. PMV and PPD. ASHRAE comfort chart

Infiltration and ventilation, Indoor Air Quality (IAQ), Sources of indoor air pollution, Methods of control of IAQ, Fresh air requirements for IAQ.

3. Heating and Cooling load calculations:

Differences between winter and summer load calculations, Inside and Outside design conditions, Various sources of the internal and external heat gains, heat losses, Solar radiation, Solar radiation through glass, SHGC and shading coefficients, Heat transfer through building structure, Methods of heat load calculations, Numerical on summer and winter load calculations.

4. Duct systems:

Frictional pressure drops in straight ducts of circular and rectangular cross-section, equivalent diameter for rectangular duct, Pressure losses in fittings, due to sudden enlargements, contractions, Sizing of ducts, Velocity Reduction method, Equal friction method, Static Regain method, Selection of fans, Fan laws and fan characteristic curves, Air distribution in rooms, Selection and location of supply and return grills, diffusers etc.

5. Air conditioning systems :

All air systems, All water systems, Air water systems, Direct Refrigerant, Unitary systems, Chilled ceilings and chilled beams, displacement ventilation, VAV Air Conditioning, Air cooled VRV (VRF) systems, Water cooled VRV (VRF), Two stage Evaporative cooling, Desiccant Dehumidification, Heat Pumps and their types

Air Conditioning applications – Supermarkets, Restaurants, Kitchen exhaust ventilation systems Hospitals, Office buildings.

6. Control systems for Refrigeration and Air conditioning applications:

Closed loop and open loop control systems, Choice of control systems, Types of control action, Energy sources, controllers and controlled devices, Control based on space temperature, Control based on outside temperature, Control based on heating and cooling medium, Control of humidity, Complete control systems

Assignments (Any Three):

1. Design of Air Conditioning system for Hospital / Restaurant / Commercial building / Supermarkets.
2. Case study on Air Conditioning Equipment Selection (Compressor, Condenser, Expansion device, Evaporator, Fan, Cooling coil, Pumps, etc)
3. To draw Psychrometric chart for a non standard Pressure
4. Case study on Desiccant Dehumidification.
5. Case study on Two stage Evaporative cooling
6. Case study on Chilled beams or Displacement Ventilation

Reference Books:

1. ASHRAE Handbooks
2. ISHRAE Handbooks.
3. Handbook of Air Conditioning System Design, Carrier Incorporation, McGraw Hill Book Co., USA.
4. Handbook of Air conditioning and Refrigeration, Shan K. Wang, McGraw Hill
5. Refrigeration and Air conditioning, R.C. Arora, PHI.
6. Air conditioning Applications and Design, Jones W. P., Edward Arnold Publishers Ltd.
7. Control System for Heating, Ventilation and Air conditioning, Hainer R. W., Van Nastrand Reinhold Co., New York, 1984.
8. Handbook of Heating,Ventilation and Air Conditioning- Jan F.Kredier- CRC
9. Refrigeration and Air conditioning, C P Arora, Tata McGraw Hill Publication
10. Fundamentals of HVAC systems, Robert McDowall, Elseveir.

Semester - II
Measurements and Controls [502109]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502109	4	50	50	-	-	100	4

1. Instrument types and performance characteristics :

Active and Passive instruments, Null type and deflection type instruments, Analogue and digital instruments, Indicating instruments and instruments with signal output, smart and non smart instruments. Static and Dynamic characteristics of instruments, Necessity of calibration

2. Measurement Uncertainty:

Sources of Systematic Error, System Disturbance due to Measurement, Errors due to Environmental Inputs, Wear in Instrument Components, Accumulation of Accepted Error, Improper Functioning of Instruments, Dual Sensitivity Errors, Other Sources of Error, Minimizing Experimental Error, Statistical Analysis of Measurements subject to Random Errors, Aggregation of Measurement System Errors, Reduction of Systematic Errors, Quantification of Systematic Errors, Sources and Treatment of Random Errors, parameter estimation, regression analysis, correlations, analysis of data

3. Measurement of field quantities:

Temperature, heat flux measurement, heat transfer coefficient, measurement of force, pressure, flow rate, velocity, humidity, noise, vibration

4. Measurement of derived quantities:

Force, Acceleration, Torque, power, thermo physical properties, radiation and surface properties, Miscellaneous Measurements - Time, Frequency, and Phase-Angle Measurement, Liquid Level, Chemical Composition, Current and Power Measurement

5. Basics of:

P, PI, PID controllers, pneumatic and hydraulic controllers, electronic controllers, applications to machine tools, furnaces, material handling etc

Lab Experiments / Assignments (Any Three)

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.
5) Signal conditioning for torque measurement using strain gauges

Reference Books:

1. Measurement Systems-Application and Design, Doebelin E.O., McGraw Hill Publication.
2. Measurement and Instrumentation – Theory and Application, Alan Morris, Reza Langari, Elseveir.
3. Instrumentation for Engineering Measurements, James Dally, William riley and Kenneth McConnell, Wiley.
4. Mechanical Measurements, S.P. Venkateshan, Ane Books Pvt. Ltd.

Semester – II
Elective – II (502110)

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502110	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
HP2II-M1	Thermal System Design	**HP2II-M8**	Jet Propulsion
HP2II-M2	Aerodynamics	**HP2II-M9**	Incompressible Flow Turbo machines
HP2II-M3	Introduction to flight	**HP2II-M10**	Cryogenic Engineering
HP2II-M4	Vacuum Technology	**HP2II-M11**	Fuel Burning Devices
HP2II-M5	Gas Dynamics	**HP2II-M12**	Adsorption Technology
HP2II-M6	Turbomachinery	**HP2II-M13**	Industrial Hydraulics
HP2II-M7	Gas Turbine		
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
HP1II-M14	Selection of Fans, Pumps and blowers	**HP1II-M18**	Turbulent Jets
HP1II-M15	HVAC Testing, Adjusting and Balancing (TAB)	**HP1II-M19**	Clean-room Technology
HP1II-M16	Nanomaterials	**HP1II-M20**	Pneumatics
HP1II-M17	Insulating Materials and Refractories		

Note: For e.g., HP2II-M1 indicates
HP – Heat Power Engineering, 2 – 2 Credits, II – Elective II, M1 – Module 1
For e.g., HP1II-M15 indicates
HP – Heat Power Engineering, 1 – 1 Credit, II – Elective II, M15 – Module 15

HP2II-M1 Thermal System Design

Designing a workable system: Workable and optimum systems, Outline of sequence of tasks and decisions for a workable design. Modeling Thermal Equipment: Using physical insight, Selection Vs Simulation, Case study on modeling thermal equipment. System Simulation: Classes of simulation, Sequential and simultaneous calculations, case study on system simulation

Ref. Books: Design of Thermal Systems, W.F. Stoecker, Tata McGraw – Hill

HP2II-M2 Aerodynamics

Fundamental principles and equations, Airfoils, wings and their nomenclature; lift, drag and pitching moment coefficients; centre of pressure and aerodynamic centre. Normal shock waves, Oblique shock waves, bow shock, expansion waves, Compressible flow through wind tunnels, introduction to Supersonic and hypersonic flows. Numerical techniques for nonlinear supersonic flow.

Ref. Books:

1) ***Fundaments of Aerodynamics, J.D. Anderson, 4th Ed. Tata McGraw Hill.***
2) ***Introduction to Flight, J.D. Anderson, 5th Ed. Tata McGraw Hill.***
3) ***Bertin, J. J., Aerodynamics for Engineers, Pearson Education, 2002.***
4) ***Houghton , E. L. and Carpenter, P. W., Aerodynamics for Engineers, Butterworth-Heinemann, 2001.***

HP2II-M3 Introduction to Flight

Aerodynamic Shapes- Airfoils and wings, Incompressible flow over Airfoils and wings, Compressible flow over airfoils, elements of Airplane performance, principles of stability and control, Space Flight, Theory on jet propulsion, Hypersonic Vehicles

Ref. Books:

1) ***Introduction to Flight, J.D. Anderson, 5th Ed. Tata McGraw Hill.***
2) ***Fundaments of Aerodynamics, J.D. Anderson, 4th Ed. Tata McGraw Hill.***
3) ***Introduction To Aircraft Performance, Selection, And Design, Francis J. Hale, Wiley India Pvt Ltd. 2011.***
4) ***Barnard,R.H., and Phillpott,D.R., Aircraft Flight, Longman, 2009.***

HP2II-M4 Vacuum Technology

Introduction ,Units for Vacuum, Vacuum Pumps, Positive Displacement Pump, Roots Pump, Diffusion Pumps, Molecular Pumps , Pumping System Design, Selection of Vacuum Pumps, Calculation of Pumping Speed ,Conductance and Pumping Speed, Baffles and Traps, Outgassing, Vacuum Pumping (Pressure–Time Relations) Calculation of Pumping Time, Measurement of Vacuum, Mechanical Gauges, Conductivity Gauges, Ionization Gauge

Ref. Book: Industrial Heating - Principles, Techniques, Materials, Applications, and Design,Yeshvant V. Deshmukh, CRC Press 2005.

HP2II-M5 Gas Dynamics

Introduction, One dimensional flow basics, Normal shock waves, Flow with heat addition – Rayleigh flow, Flow with Friction – Fanno Flow, Quasi One dimensional Flows, Oblique shock waves, Prandtl Meyer Flow

Ref. Books: 1)Fundamentals of Gas Dynamics, Robert D. Zucker, Oscar Biblarz, Wiley, 2nd Edition., 2)Fundamentals of Gas Dynamics, V. Babu, Ane Books Pvt. Ltd., 3)Elements of Gas Dynamics, Liepmann H. W. and Roshko A., Dover, 2001

HP2II-M6 Turbomachinery

Basics of turbomachinery, Analysis of Axial flow Compressors, Centrifugal flow compressors, Axial flow Turbines and Radial flow Turbines, Three-dimensional Flows in Axial Turbomachines.

Ref. Books: 1) Principles of Turbomachinery, R.K. Turton, Springer, 2nd Edition.

2) Turbomachinery Design and Theory, Rama S.R. Gorla and Aijas.A. Khan, CRC Press.

3) Fluid Mechanics and Thermodynamics of Turbomachinery, S.L. Dixon, Butterworth Heinemann.

HP2II-M7 Gas Turbine

Basics of Compressible flow, Cycle arrangements, Turbojet Engine and Turbofan Engine, Thrust calculations, Ramjet and Scramjet Engine, Parametric cycle analysis of ideal and real engine

Ref. Books: 1)Elements of Gas Turbine Propulsion – Jack D. Mattingly , Tata Mc-Graw Hill 2) Fundamentals of Propulsion, V. Babu, Ane Books Pvt. Ltd. 3) Introduction to Flight, J.D. Anderson, 5th Ed. Tata McGraw Hill.

HP2II-M8 Jet Propulsion

Ideal and Non-ideal cycle analysis, Diffusers, Nozzles, Combustors and Afterburners, Ducts and Mixers, System matching and analysis, Rocket Propellants, rocket equation, rocket staging, electric propulsion

Ref. Books: 1)Fundamentals of Jet Propulsion with Applications, Ronald D. Flack, Cambridge University , 2) Introduction to Flight, J.D. Anderson, 5th Ed. Tata McGraw Hill.

HP2II-M9 Incompressible Flow Turbomachines

Some aspects of Design, Design of impellers and runners of single and double curvature, Inlet and outlet elements, Head losses in Turbine and Pump systems, Cavitation, water hammer and Corrosion

Ref. Books: 1) Incompressible Flow Turbomachines, G. F. Round , Elsevier Publications

2) Fundamentals of Incompressible Fluid Flow, V. Babu, Ane Books Pvt. Ltd.

HP2II-M10 Cryogenic Engineering

Gas Liquefaction: Fundamentals, ideal liquefaction work, various liquefaction cycles, analysis of various cycles. Gas Separation and gas purification systems - Fundamentals of gas separation, Ideal work of gas separation, basics of gas Mixtures, distillation column, column efficiency, theoretical plate, Calculations, double columns, Plate structures, Oxygen and argon separation systems.

Ref. Books: 1) Barron R. F., Cryogenic Systems, 2nd Ed., Oxford University Press, 1985.

2) Timmerhaus K. D. and Flynn T. M., Cryogenic Process Engineering, CRC Press.

HP2III-M11 Fuel Burning Devices

Combustion of Liquid Fuels, Classification of Oil Burners, High Pressure Burners, Low Pressure Burners, Burners for Distillate Fuels, Preheating of Oils, Kinetics of Combustion of Gases, Burning Properties of Gases, Classification of Gas Burners, Flame Stabilization, Ignition and Detection, Atmospheric Gas Burners, Nozzle Mixing Gas Burners, Radiant Tubes, Immersion Tubes, Dual Fuel Burners, Packaged Burners, Combustion of Solid Waste and Garbage, Burner Auxiliaries, Burner Blocks, Ignition Devices, Flame Protection Devices

Ref. Books: Industrial Heating - Principles, Techniques, Materials, Applications, and Design, Yeshvant V. Deshmukh, CRC Press 2005.

HP2II-M12 Adsorption Technology

Adsorbents, Fundamentals of adsorption equilibria, rate of adsorption of gases and vapors by porous medium, processes and cycles, Design procedures and break through Curves, pressure swing adsorption processes, Thermal adsorption processes.

Ref. Books: 1) Adsorption Technology and Design, Barry Crittenden and W John Thomas, Butterworth Heinemann Publications
2)Diffusion Mass transfer in fluid systems (chapter 15), E L Cussler, Cambridge University Press.

HP2II-M13 Industrial Hydraulics

Vane and piston pumps, power units, accessories, accumulators, check valves, various pressure control, directional control, flow control valves, center positions, proportional valves, cartridge valves, prefill valve, linear and rotary actuators, design considerations for cylinders, various hydraulic circuits and their applications, circuit design and analysis, selection of components, troubleshooting of hydraulic components and circuits, maintenance and safety.

Ref. Books: 1) J.J.Pipenger – 'Industrial Hydraulics', McGraw Hill, 2)A. Esposito – 'Fluid Power with application', Prentice hall

HP1II-M14 Selection of Fans, Pumps and blowers

Types, Performance evaluation, efficient system operation, Flow control strategies and energy conservation opportunities and Selection of fans, pumps and blowers

Ref. Books:1) Guide Books, Bureau of Energy Efficiency, 2) Turbines, Compressors and Fans, S.M. Yahya, 3rd Ed., Tata McGraw Hill., 3)Fan Handbook, Frank P Bleier, McGraw Hill, 4) Pumps, Principles and Practice, Jaico Publishing House, Mumbai.

HP1II-M15 HVAC Testing, Adjusting and Balancing (TAB)

Need, Benefits of TAB, TAB Instruments, Standard TAB Procedures, Air Balancing, Hydronic balancing, TAB Reports.

Ref. Books: 1) HVAC Testing, Adjusting and Balancing Manual, John Gladstone and W. David Bevirt, Tata McGraw – Hill Publishing Co. Ltd., 2) Testing and Balancing HVAC Air and Water Systems, Samuel Sugarman, CRC Press.

HP1II-M16 Nanomaterials

Nanoparticles, Carbon Nanotubes, and Semiconducting Nanowires: Physics, Synthesis, Characterization and Applications.

Ref. Books:1) Nano: The Essentials, Pradeep, T., McGraw-Hill, 2007, 2) Nanoscale Science and Technology, Kelsall, R., Hamley I. and Geoghegan, M.(Eds.) Wiley, 2005.

HP1II-M17 Insulating Materials and Refractories

Need of insulation, Classification of Thermal Insulations, Properties of Thermal Insulations, Applications (Case Studies) in Refrigeration, HVAC, Cryogenic, Chemical and Process industries, Degree days and pay back periods, Refractories types and applications

Ref. Books: 1)Energy Efficiency, Estop and Croft 2) Guide Books, Bureau of Energy Efficiency, 3)Mass and Heat Transfer, T.W.Fraser Russel, Robinson,Wagner-Cambridge University Press

HP1II-M18 Turbulent Jets

Free Jets, Coflowing Jets, Multiple Free Jets, Jet Flocculator, Wall Jets

Ref. Books: Turbulent Jets, Bidya Sagar Pani, Cambridge University press.

HP1II-M19 Cleanroom Technology

Introduction to cleanrooms, types, classifications, cleanroom standards, testing and validation of clean rooms, design considerations, energy conservation in cleanrooms.

Ref. books: ASHRAE Handbook – HVAC Applications (Clean Spaces)

HP1II-M20 Pneumatics

Different pneumatic components, different pneumatic circuits, trouble shooting in pneumatics, logic valves, building circuit for a given logic, Electro pneumatic circuits, Selection criteria of pneumatic components, Installation fault finding and maintenance of pneumatic components. Microprocessor and PLC- Applications in pneumatics, Low cost Automation, case studies.

Ref. Books: 1) A. Esposito – 'Fluid Power with application', Prentice hall, 2) Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill

Semester – II
Lab. Practice – II [502111]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502111	4	-	-	50	50	100	4

Lab. work or Assignments have to be carried out at respective labs as mentioned in the syllabus of respective subjects **excluding Elective**. It is to be submitted as term work at the end of semester after continuous assessment of each by respective teacher. Assessment of term work has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

Seminar – I, II and III [502112, 602116, 602118]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Pr /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
502112	4	-	-	50	50	100	4
602116	4	-	-	50	50	100	4
602118	5	-	-	50	50	100	5

Assessment of Seminar has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR SEMINAR REPORT WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare 3 **COPIES** of your manuscript.

2. Limit your project report to preferably

   a) 15-20 manuscript pages for Seminar I
   b) 20-25 manuscript pages for Seminar II
   c) 25-30 manuscript pages for Seminar III

3. The footer must include the following:
   Institute Name, M.E. Mechanical (Heat Power Engineering) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using
   a) Letter quality computer printing.
   b) The main part of manuscript should be Times New Roman 12 pt. and justified**.**
   c) Use 1.5 line spacing.
   d) Entire report shall be one chapter. No chapters for Seminar I, II and III.
   e) Seminar I shall not have last section as Conclusions, it will be summary only.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a) Illustrations should not be more than **two** per page. One could be ideal
    b) Figure No. and Title at bottom with **12 pt**
    c) Legends below the title in **10 pt**
    d) Leave proper margin in all sides
    e) Illustrations as far as possible should not be Xeroxed.

11. **Photographs** if any should be of glossy prints

12. Please use **SI** system of units. If students would like to add the equivalent in inch-pound (British) units, they must be stated in parenthesis after the **SI** units. In case the final result comes out in any other units (say due to empirical formula etc.) covert the unit to **SI** unit.

13. Please **number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report

    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgement**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word “Abstract” should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in the Abstract)
    ix. Section: Introduction
    x. References

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books
Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions
Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings
Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.
United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent
Patent no, Country (in parenthesis), date of application, title, year.

Internet
www.(Site) [Give full length URL]

Format for front page and Certificate

A Seminar I / II / III on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name (TNR, 16pt, Centrally Aligned)

Guide (TNR, 16pt, Centrally Aligned)

Guide's Name (TNR, 16pt, Centrally Aligned)

Institute

Logo

Department of Mechanical Engineering

Name of the Institute

[2011-12](TNR, 22pt, Title Case Centrally Aligned)

Name of the Institute

Institute

Logo

C E R T I F I C A T E

This is to certify that *Mr. Lele M.M.*, has successfully completed the seminar-I/II/III entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Heat Power Engineering) of University of Pune.

Date :

Place :

Guide's Name
Guide

_____
Head
Department and
Institute Name

External Examiner

Seal

_____
Principal,
Institute Name

Semester - III

Computational Fluid Dynamics [602113]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect. /Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602113	4	50	50	-	-	100	4

1. **Introduction to CFD:**
   Governing equations: the continuity equation, momentum equation and energy equations, convective forms of the equations and general description, Reynolds transport theorem.
   Classification of partial differential equations; physical examples of elliptic, parabolic and hyperbolic equations. Mathematical nature of the flow equations& their boundary conditions.

2. **Discretization:**
   Basic discretization techniques applied to model equations and systems of equations: finite difference, finite volume and finite element methods.
   Finite difference methods: Taylor series expansion, different means for formulating finite difference equation; accuracy of finite difference method.
   Finite Volume Methods: Finite volume methods; approximation of surface and volume integrals; interpolation methods; central, upwind and hybrid formulations and comparison for convection-diffusion problem.
   Analysis of numerical schemes: concept of consistency, accuracy, stability and convergence; Error and stability analysis; some applications.

3. **Numerical Grid Generation:**
   Introduction, Structured and Unstructured mesh generation techniques
   - Structured grid generation: a)Algebraic method, b) Elliptic generation systems.
   - Unstructured grid generation: a)Voronoi diagram and Delaunay triangulation; b) Advancing front grid generation.

4. **Solution to Eulers equations:**
   Formulations of Euler equations, Discretization methods for Euler equations. High resolution schemes and TVD.

5. **Navier-Stokes Equations:**
   Governing equations, Properties of Navier-Stokes equations; Discretization of NS equations;Boundry conditions; Convergence acceleration techniques.

6. **Turbulence Modeling:**
   Introduction, Statistical representation of turbulent flows: General Properties of turbulent quantities, Closure problem: Necessity of turbulence modeling, Reynolds average Navier stokes (RANS) equation,
   Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy and dissipation, The κ-ε model, Advantages and disadvantages of κ-ε model, Two-equation models: κ-ε model and κ-ω model, Reynolds stress equation model (RSM).

Reference Books:

1. T. J. Chung, Computational Fluid Dynamics, Cambridge University Press.
2. Anderson, J.D. Computational Fluid Dynamics, McGraw Hill, 1995.
3. Hirsch,C. Numerical Computation of Internal and External Flows, Vol.I, John Wiley, 1990.
4. Jiyuan Tu, Guan – Heng Yeoh, Chaoqun Liu, Computational Fluid Dynamics – A practica approach, Butterworth Heinemann.
5. Leveque, R.J., Numerical Methods for Conservation Laws, BirkhauserVerlag, 1990.
6. Anderson,D.A., Tannehill,J.C. and Pletcher,R.H., Computational Fluid Dynamics and Heat Transfer, McGraw Hill, 1984.
7. Pradip Niyogi, S.K. Chakraborty, M.K. Laha, Introduction to Computational Fluid Dynamics, Pearson
8. Oleg Zikanov, Essential Computational Fluid Dynamics, John Wiley
9. Pieter Wesseling, Principles of Computational Fluid Dynamics, Springer, 2004.
10. S. V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill.
11. John C. Tannehill, Dale A. Anderson and Richard H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor &Francis.
12. Versteeg, H. K. and Malalasekara, W. (2008). Introduction to Computational Fluid Dynamics: The Finite Volume Method. Second Edition (Indian Reprint) Pearson Education.
13. David C. Wilcox Turbulence Modeling for CFD, Publisher: D C W Industries, Nov 1, 2006

Semester – III

Design of Heat Transfer Equipments [602114]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602114	4	50	50	-	-	100	4

1. Classification of Heat Exchangers:

Introduction, Classification, Overview of Heat Exchanger Design Methodology, Process and Design Specifications, Thermal and Hydraulic Design, Mechanical Design, Optimum Design , Heat Exchanger Variables and Thermal Circuit, Assumptions, Basic Definitions, ε - NTU Method , The P-NTU Method , TEMA , Multi-pass Exchangers, LMTD, Heat Exchanger Arrays and Multi-passing, Sizing and Rating Problems, Kern Method, Bell Delaware Method, Numerical on Shell and tube HEX.

2. Solution Methods for Determining Exchanger Effectiveness:

Exact Analytical Methods, Approximate Methods, Numerical Methods, Matrix Formalism, Chain Rule Methodology , Flow-Reversal Symmetry, Design Problems, Longitudinal Wall Heat Conduction Effects, Multipass Exchangers, Non-uniform Overall Heat Transfer Coefficients, Temperature - Length - Combined Effect

3. Heat Exchanger Pressure Drop Analysis:

Importance of Pressure Drop, Devices, Extended Surface Heat Exchanger Pressure Drop, Tubular Heat Exchanger Pressure Drop, Tube Banks, Shell-and-Tube Exchangers, Plate Heat Exchanger Pressure Drop, Pipe Losses, Non-dimensional Presentation of Pressure Drop Data

4. Heat Transfer Characteristics:

Dimensionless Surface Characteristics, Experimental Techniques for Determining Surface Characteristics, Steady-State Kays and London Technique, Wilson Plot Technique, Transient Test Techniques, Friction Factor Determination, Hydrodynamic ally Developing Flows, Thermally Developing Flows, Extended Reynolds Analogy, Heat Exchanger Surface Geometrical Characteristics, Selection of Heat Exchangers and Their Components, Temperature Difference Distributions

5. Cooling tower fundamentals:

Types, Nomenclature, material for construction, Structural components in details, Mechanical components (Fan, Speed reducer, Valves, Safety), Electrical components, Thermal performance testing – conduction and evaluation.

6. Furnace:

Furnace, Types, Parts used in furnace, Nozzles used, Heat transfer related design of systems, Insulations, Applications in process industries.

7. Thermal Devices:

Heat pipe, Thermal interface material, use of nano particle in heat transfer equipments, Steam Trap, Electronics cooling systems, Thermal interface materials, Heat transfer augmentation techniques

Assignments (Any three)

1 Visit to study heat exchanger manufacturing
2 Study of Instrumentation used related to Heat exchanger
3 Study of plate heat exchanger
4 Experimentation on any one Heat exchanger
5 Experimentation on Heat pipe
6 Study of any one advanced/similar topic from Topic 7

Reference Books:

1. Cooling Tower, Fundamentals- John C. Hensley, SPX Cooling Technologies
2. Heat exchangers Selection, Rating and Thermal Design – Sadik Kakac,Hongtan Liu,Anchasa Pramunjanaroenkij, CRC Press
3. Process Heat Transfer – Donald Q. Kern, Tata McGraw-Hill
4. Process Heat Transfer – Hewitt ,Shires & Bott, CRC Press
5. Heat Pipes Theory, Design & Applications – D.A. Reay, P.D.Dunn, Pergamon
6. Cooling Techniques for Electronic Equipment– Dave S. Steinberg, Wiley-InterScience Publication
7. Fundamentals of Heat Exchanger Design -Ramesh K. Shah, Dusan P. Sekulic,Wiley-India

Semester – III
Elective – III [602115]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602115	5	50	50	-	-	100	5

Modules of 2 Credits (Select any Two)			
Code No.	**Title**	**Code No.**	**Title**
HP2III-M1	Solar Energy	**HP2III-M8**	Modern Sensors
HP2III-M2	Wind Power	**HP2III-M9**	Microfluidics
HP2III-M3	Nuclear Reactors and Nuclear Power	**HP2III-M10**	Boilers
HP2III-M4	Waste Heat Recovery and Cogeneration	**HP2III-M11**	Introduction to Composites
HP2III-M5	Fluidized Bed Technology	**HP2III-M12**	Piping Technology
HP2III-M6	Convective Heat & Mass Transfer	**HP2III-M13**	I.C. Engines- Design
HP2III-M7	Fuel Cell Technology		
Modules of 1 Credit (Select any One)			
Code No.	**Title**	**Code No.**	**Title**
HP1III-M14	Thermal Energy Storage (TES)	**HP1III-M18**	Geothermal Technology
HP1III-M15	Biomass Technology	**HP1III-M19**	Alternative Fuels for I.C. Engines
HP1III-M16	Combustion Applications	**HP1III-M20**	I.C. Engines- Emissions and control
HP1III-M17	Fluid Sealing Technology		

Note: For e.g., HP2III-M1 indicates
HP – Heat Power Engineering, 2 – 2 Credits, III – Elective III, M1 – Module 1
For e.g., HP1III-M14 indicates
HP – Heat Power Engineering, 1 – 1 Credit, III – Elective III, M14 – Module 14

HP2III-M1 Solar Energy

The Solar spectrum, Semiconductors, p-n junction, Solar photocells, Efficiency of solar cells, Commercial solar cells, Solar panels, economics of photovoltaic, environmental impact of photovoltaic, Solar thermal power plants

Ref. Book: Energy Science – Principles, Technologies and Impacts, John Andrews and Nick Jelley, OXFORD University Press.

HP2III-M2 Wind Power

Source of wind energy, Global wind patterns, Principles of wind turbine, Modern wind turbines, Wind turbine blade design, Turbine control and operation, Power output of wind turbine, environmental impact and public acceptance, Economics of wind power

Ref. Book: Energy Science – Principles, Technologies and Impacts, John Andrews and Nick Jelley, OXFORD University Press

HP2III-M3 Nuclear Reactors and Nuclear Power

Components of Nuclear Reactors, Power Reactors and Nuclear Steam Supply systems, Nuclear cycles, Fuel Reprocessing, Radioactive Waste disposal, heat generation in reactors, heat removal from reactors, thermal design of a reactor.

Ref. Books: Introduction to Nuclear Technology, John R. Lamarsh, Anthony J.Baratta, Prentice Hall, 3rd Edition.

HP2III-M4 Waste Heat Recovery and Cogeneration

a) Waste Heat Recovery: Classification, Advantages and applications, commercially viable waste heat recovery devices, Saving potential

b) Cogeneration: Definition, Need, Application, Advantages, Classification, Saving potentials

Ref. Books: Guide Books, Bureau of Energy Efficiency

HP2III-M5 Fluidized Bed Technology

Principal of Fluidized bed combustion, Advantages of fluidized bed combustion, Circulating fluidizing bed (CFB) and Bubbling Fluidized bed (BFB) combustion, Categories of FBC, Fuel requirements of FBC. Fluidized bed Boilers, Applications, Advantages of Fluidized bed Boilers, Regimes of fluidization, Fast Fluidized bed, Hydrodynamic structures of Fast fluidized beds, axial voidage profile, lateral Distribution of voidage on fast bed, Gas Solid mixing, gas solid slip velocity, dispersion, stages of combustion, Factors affecting on Combustion Efficiency, Combustion in CFB and BFB, Biomass combustion. Emission of FBC equipments.

Ref. Books: 1)Prabir Basu, Combustion and gasification in Fluidized bed, CRC press, Taylor and Francis, 2) Black and Veatch, Power Plant Engineering, CBS Publication and distribution.

HP2III-M6 Convective Heat & MassTransfer

Fundamental Principles, Laminar Boundary layer flow, Laminar duct flow, External and internal natural convection, Transition to turbulence, Turbulent boundary layer flow, Turbulent duct flow, convection with change of phase, Mass transfer, convection in porous media

Ref. Books: 1)Convective Heat Transfer Analysis, Patrick H. Oosthuizen, David Naylor, Mcgraw Hill.2) Convective Heat and Mass Transfer, W. M. Kays, M. E. Crawford, McGraw Hill, 3)Convective Heat and Mass Transfer, S. Mostafa Ghiaasiaan, Cambridge University Press.,4) Convection Heat Transfer, Adrian Bejan, John Wiley.

HP2III-M7 Fuel Cell Technology

Principle of Fuel Cell, Efficiency, Types – Polymer Electrolyte Membrane, Alkaline, Molten Carbonate, Solid oxide, Regenerative, Performance Limiting factors of Fuel Cell, losses, advantages and limitations, applications, Microbial Fuel Cells.

Ref. Books: 1) Fuel Cell Technology, N. Sammes, Springer

2) Non Conventional Energy Resources, G.S. Sawhney, PHI.

HP2III-M8 Modern Sensors

Senor Characteristics, Types of sensors- Position, displacement, level, velocity, acceleration, force strain, Pressure, Flow, Acoustic, Humidity and moisture, Temperature. Applications, Sensor Material and technologies.

Ref. Books: 1) Handbook of Modern Sensors- physics, Designs and applications, J. Fraden, Springer

HP2III-M9 Microfluidics

Introduction: Scaling issues, Applications, Derivation of Navier-Stokes equations
Two-phase flows: Flow regimes and their modeling. Heat Transfer: Forced convection with slip, Thermal effects at microscales, Heat transfer with liquids.
Mixing: Introduction to mixing, Challenges at microscales, Chaotic mixing, acoustic and electrically induced mixing.

Ref. Books: 1) Karniadakis G. E. and Beskok A., Microflows and Nanoflows: Fundamentals and Simulation, Springer.

2) Panton R.L., Incompressible Flow, John Wiley

HP2III-M10 Boilers

Types, Combustion in boilers, Performances evaluation, Analysis of losses, Feed water treatment, Blow down, Energy conservation opportunities, Design for high temperature - Combined cycles with heat recovery boiler – Combined cycles with multi-pressure steam - STAG combined cycle power plant - Influence of component efficiencies on cycle performance

Ref. Books:1) Guide Books, Bureau of Energy Efficiency, 2) Boilers and Burners:Design and Theory, Prabir Basu, Kefa Cen, Louis Jestin, Springer,3) Process Heat Transfer – Hewitt ,Shires & Bott, CRC Press

HP2III-M11 Introduction to Composites

Fibers, matrices and fillers, Manufacturing of composites, Unidirectional and short-fiber composite behavior, Orthotropic laminates, Laminated composites, Failure of composites, Hygrothermal effects, and residual stresses

Ref. Books:1) Analysis and Performance of Fiber Composites, Agarwal, B.D. and Broutman, L. J., John Wiley & Sons.2)Mechanics of Composite Materials, Jones, R. M., Mc-Graw Hill. 3)Engineering Mechanics of Composite Materials, Daniel, I. M. and Ishai, O., Oxford University Press.

HP2III-M12 Piping Technology

Pipe Sizing Techniques, Mechanical Design of Pipes, Codes and Standards, Piping Elements,
Transient Flow in Piping Systems, Piping Network Design, Various Stresses in Pipes, Pipe Support Selection and Design, Thermal Stresses in Pipes, Stress Analysis of Piping Systems Expansion Joints, Case Study

Ref. books: 1) ASHRAE Handbooks, 2) Piping Handbook, Nayyar, McGraw Hill

HP2III-M13 I.C. Engines- Design

Materials for Various engine components, cylinder head, spark plug, gaskets, cylinder block, piston ,piston rings, gudgeon pin ,etc. Engine Design- Preliminary analysis, cylinder number, size and arrangement, design of piston, connecting rod, crankshaft and valve mechanism. Combustion in SI engine, stages of combustion, phenomenon of detonation, effect of engine, variables on detonation, design of combustion chambers for SI engines Combustion in CI engine, Stages of combustion, factors affecting delay period, the phenomenon of knock in CI engine , design of combustion chambers for CI engines. Application of simulation technique for engine tuning, engine selection parameters, recent trends in IC engines

Ref. books: 1) The Internal Combustion Engine in Theory and Practice Volume I & II by Charles Fayette Taylor, The MIT Press., 2) Automotive Technology, Jack Erjavec,3rd edition, Delmar Thomson Learning, 3)Design and Simulation of four stroke engines, Gordon P Blair, SAE International,4) Internal Combustion Engines, C.R. Ferguson & A.R. Kirkpatrick, Delhi,2001

HP1III-M 14 Thermal Energy Storage (TES)

Basic Principle, Benefits, Criteria for TES Evaluation, TES Market Considerations, TES Heating and Cooling Applications, TES Operating Characteristics, ASHRAE TES Standards, Sensible and Latent TES, Energy Conservation with TES: Planning and Implementation, Recent Advances in TES Methods

Ref. books: 1) ASHRAE Handbook – Applications

2) Ibrahim Dincer and Marc A. Rosen, Thermal Energy Storage – Systems and Applications, Wiley Publication.

HP1III-M15 Biomass Technology

Photosynthesis and crop yields, Biomass potential and Use, Biomass Energy Production, Environmental impact of biomass, Economics and potential of biomass.

Ref. Book: Energy Science – Principles, Technologies and Impacts, John Andrews and Nick Jelley, OXFORD University Press

HP1III-M16 Combustion Applications

Wood Burning Cookstove – Modeling considerations, reference stove specifications, effect of parametric variations, Vertical Shaft Brick Kiln – Modeling assumptions, parametric studies, Gas turbine combustion chamber – Combustor designs.

Ref. Books: Analytic Combustion, Anil W. Date, Cambridge University Press

HP1III- M17 Fluid Sealing Technology

Introduction, Rotary Seals, Reciprocating Seals, Flexible packings, Mechanical seals, Noncontact shaft seals, Static Seals, Bellows and Diaphragms.

Ref. Books: Fluid Sealing Technology – Principles and Applications, H.K. Muller & B.S. Nau, Marcel Dekker Inc.

HP1III- M18 Geothermal Technology

Resources of Geothermal Energy, Hydrothermal resources, Hot dry rock resource, High enthalpy Geothermal Aquifers, Low enthalpy reserves, Wet and dry steam systems. Comparison with conventional plant, Advantages and disadvantages/limitations, Materials for Geothermal plants, Environmental problems

Ref. Books: 1) Renewable Energy Sources, Tasneem Abbasi, S.A.Abbasi, PHI

2) Non Conventional Energy Resources, G.S. Sawhney, PHI

3)Renewable energy Resources –John Twidell and Tony Weir, Taylor & Francis

HP1III-M19 Alternative Fuels for I.C. Engines

Solid fuels, liquid fuels, gaseous fuels, Properties and specifications, Material Compatibility, Storage and Dispensing, Refueling Facility, Safety and Protection norms, Fuels For S.I. and C.I. Engines, rating of SI & CI engine fuels, fuel additives for SI & CI engines

Ref. Books: 1) Alternate fuels Guidebook, Richard L. Bechtold, SAE International,

2) Automotive fuels and fuel systems, Vol. I & II, T. K. Garret, SAE International

HP1III-M20 I.C. Engines- Emissions and control

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

Ref. Books: 1) Alternate fuels Guidebook, Richard L. Bechtold, SAE International,

2) Automotive fuels and fuel systems, Vol. I & II, T. K. Garret, SAE International, 3)Engineering Fundamentals of The Internal Combustion Engine, Willard W. Pulkrabek, Pearson Education

Project Stage – I and II [602117 & 602119]

CODE	TEACHING SCHEME	EXAMINATION SCHEME					CREDITS
	Lect/Week	Paper		TW	Oral/ Presentation	Total	
		In Semester Assessment	End Semester Assessment				
602117	8	-	-	50	50	100	8
602119	20	-	-	150	50	200	20

Assessment of Project stage-I has to be carried out as per R-1.4 and R-1.5 of PG Rules and Regulations of Credit System.

INSTRUCTIONS FOR DISSERTATION WRITING

It is important that the procedures listed below be carefully followed by all the students of M.E. (Mechanical Engineering).

1. Prepare **Three Hard Bound Copies** of your manuscript.

2. Limit your Dissertation report to 80 – 120 pages (preferably)

3. The footer must include the following:
   Institute Name, M.E. Mechanical (Heat Power Engineering) Times New Roman 10 pt. and centrally aligned.

4. Page number as second line of footer, Times New Roman 10 Pt, centrally aligned.

5. Print the manuscript using
   a. Letter quality computer printing.
   b. The main part of manuscript should be Times New Roman 12 pt. with alignment - justified**.**
   c. Use 1.5 line spacing.
   d. Entire report shall be of 5- 7 chapters.

6. Use the paper size **8.5'' × 11''** or **A4 (210 × 197 mm).** Please follow the margins given below.

Margin Location	Paper 8.5'' × 11''	Paper A4 (210 × 197 mm)
Top	1''	25.4 mm
Left	1.5''	37 mm
Bottom	1.25''	32 mm
Right	1''	25.4 mm

7. All paragraphs will be 1.5 line spaced with a one blank line between each paragraph. Each paragraph will begin with without any indentation.

8. Section titles should be bold with 14 pt typed in all capital letters and should be left aligned.

9. Sub-Section headings should be aligning at the left with 12 pt, bold and Title Case (the first letter of each word is to be capitalized).

10. Illustrations (charts, drawings, photographs, figures) are to be in the text. Use only illustrations really pertinent to the text. Illustrations must be sharp, clear, **black and white. Illustrations downloaded from internet are not acceptable.**
    a. Illustrations should not be more than **two** per page. One could be ideal
    b. Figure No. and Title at bottom with **12 pt**
    c. Legends below the title in **10 pt**
    d. Leave proper margin in all sides
    e. Illustrations as far as possible should not be photo copied.

11. **Photographs** if any should of glossy prints

12. Please use **SI** system of units only.

13. Please **number the pages** on the front side, centrally below the footer

14. **References** should be either in order as they appear in the thesis or in alphabetical order by last name of first author

15. **Symbols** and **notations** if any should be included in nomenclature section only

16. Following will be the order of report
    i. **Cover page** and **Front page** as per the specimen on separate sheet
    ii. **Certificate** from the Institute as per the specimen on separate sheet
    iii. **Acknowledgements**
    iv. **List of Figures**
    v. **List of Tables**
    vi. **Nomenclature**
    vii. **Contents**
    viii. **Abstract** (A brief abstract of the report not more than **150 words**. The heading of abstract i.e. word "Abstract" should be **bold, Times New Roman, 12 pt** and should be typed at the **centre.** The contents of abstract should be typed on new line without space between heading and contents. Try to include one or two sentences each on **motive, method, key-results** and **conclusions** in Abstract

1 Introduction (2-3 pages) (TNR – 14 Bold)
1.1 Problem statement (TNR – 12)
1.2 Objectives
1.3 Scope
1.4 Methodology
1.5 Organization of Dissertation

2 Literature Review (20-30 pages)

Discuss the work done so far by researchers in the domain area and their significant conclusions. No derivations, figures, tables, graphs are expected.

3 This chapter shall be based on your own simulation work (Analytical/ Numerical/FEM/CFD) (15- 20 pages)

4 Experimental Validation - This chapter shall be based on your own experimental work (15-20 pages)

5 Concluding Remarks and Scope for the Future Work (2-3 pages)

References

ANNEXURE (if any)

(Put all mathematical derivations, Simulation program as Annexure)

17. All section headings and subheadings should be numbered. For sections use numbers **1, 2, 3, ….** and for subheadings **1.1**, **1.2**, **….** etc and section subheadings **2.1.1**, **2.1.2, ….** etc.

18. **References** should be given in the body of the text and well spread. No verbatim copy or excessive text from only one or two references. If **figures** and **tables** are taken from any reference then indicate source of it. Please follow the following procedure for references

Reference Books

Collier, G. J. and Thome, J. R., Convective boiling and condensation, 3rd ed., Oxford University Press, UK, 1996, pp. 110 – 112.

Papers from Journal or Transactions

Jung, D. S. and Radermacher, R., Transport properties and surface tension of pure and mixed refrigerants, *ASHRAE Trans*, 1991, 97 (1), pp. 90 – 98.

Bansal, P. K., Rupasinghe, A. S. and Jain, A. S., An empirical correction for sizing capillary tubes, *Int. Journal of Refrigeration*, 1996, 19 (8), pp.497 – 505.

Papers from Conference Proceedings

Colbourne, D. and Ritter, T. J., *Quantitative assessment of flammable refrigerants in room air conditioners*, Proc. of the Sixteenth International Compressor Engineering Conference and Ninth International Refrigeration and Air Conditioning Conference, Purdue University, West Lafayette, Indiana, USA, 2002, pp. 34 – 40.

Reports, Handbooks etc.

United Nations Environmental Programme, Report of the Refrigeration, Air Conditioning and Heat Pumps, Technical Option Committee, 2002, Assessment - 2002.

ASHRAE Handbook: Refrigeration, 1994 (Chapter 44)

Patent

Patent no, Country (in parenthesis), date of application, title, year.

Internet

www.(Site) [Give full length URL]

A Project Stage-I Report on (TNR, 16pt, centrally aligned)

Title (TNR, 27pt, Bold, Centrally Aligned, Title Case)

By (TNR, 16pt, Centrally Aligned)

Mr. Student's Name(TNR, 16pt, Centrally Aligned)

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C E R T I F I C A T E

This is to certify that *Mr. Lele M.M.*, has successfully completed the Project Stage – I entitled "Performance analysis of……." under my supervision, in the partial fulfilment of Master of Engineering - Mechanical Engineering (Heat Power Engineering) of University of Pune.

Date :

Place :

Guide's Name
Guide

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Head
Department and
Institute Name

External Examiner

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Mr. Student's Name(TNR, 16pt, Centrally Aligned)

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Guide's Name
Guide

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Head
Department and
Institute Name

External Examiner

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