Prof. Ram Meghe Institute Of Technology And Research Badnera -444701

An Autonomus College Affiliated to Sant Gadge Baba Amravati University, Amravati, Maharashtra (India)

PROGRAMME SCHEME & SYLLABI

2023-2024

M. Tech.

(Thermal Engineering)

Published By
Principal
Prof. Ram Meghe Institute Of Technology And Research, Badnera - Amravati.

Department Vision :

To become a lead center in the field of Mechanical Engineering to minimize human efforts with an eye on environment

Department Mission :

1. To educate, Motivate and prepare the students to know the fundamental and technical skills in Mechanical Engineering Through effective teaching learning Methodologies
2. To impart entrepreneurship and the employability skills to the students through mentoring and healthy interaction with industry.
3. To encourage student to undertake R&D activities for the societal needs with high ethical standards.
4. To imbibe professional and ethical standards in the minds of the young engineers by continuous learning and professional activities.

Program Educational Objectives :

1. The graduates shall be capable to accept challenges in Engineering industries.
2. The graduates shall demonstrate core competency to design, analyze and evaluate various engineering systems.
3. The graduates shall be able to apply computational and professional skills in corporate world.
4. The program shall prepare the graduates for higher studies, entrepreneurship and create awareness about lifelong learning.

Program Outcomes :

Engineering Graduate will be able to :

1) **Engineering Knowledge :** Apply the knowledge of Mathematics, Science, Engineering fundamentals, and engineering specialization to the solution of complex engineering problems.
2) **Problem Analysis :** Identify, Formulate, Review research literature, and analyze complex engineering problems reaching substantiated conclusion using first principles of mathematics, natural science, and engineering sciences.

3) Design /development of solutions : Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal and environmental considerations.

4) Conduct Investigation of complex problems : Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.

5) Modern Tools Usage : Create, select and apply appropriate techniques resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6) The Engineer and society : Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7) Environment and Sustainability : Understand the impact of the professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of, and need for sustainable development.

8) Ethics : Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9) Individual and Team work : Function effectively as an a member or leader in diverse teams, and in multi disciplinary settings.

10) Communication : Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

11) Project Management and Finance : Demonstrate knowledge and understanding of the engineering and management principles and apply these to ones own work, as a member and leader in a team to manage projects and in multidisciplinary environment.

12) Life-long learning : Recognize the need for and have the preparation and ability to engage in independent and life ling learning in the broadest context technological change.

Program Specific Outcomes :

1. Graduates will stand for design, production and operations in core mechanical domain and management of interdisciplinary applications.
2. Graduates will be capable of carrying out the analysis of mechanical and allied systems and provide numerical and computer based solution.

Prof. Ram Meghe Institute of Technology and Research, Badnera-Amravati
(An Autonomous Institute)
Two Year Post Graduate Degree Program in Master of Technology
Choice Based Credit System (Semester Pattern)
Branch : Mechanical Engineering (Thermal Engineering)

SEMESTER: I

Sr. No.	Course Code	Name of the Course	Teaching Scheme					Examination Scheme										
			Hours/ Week			Total Hours/ Week	Credits	THEORY							PRACTICAL			
										Internal					Max. Marks			
			Lecture	Tutorial	P/D			Duration of paper (Hrs)	Max. Marks ESE/ ESSE	Max. Marks MSE/ MSIE	Max. Marks TA	Total	Min. Passing Marks in ESE/ ESSE	Overall Min Passing Marks	Int.	Ext.	Total	Min. Passing Marks
Theory																		
01	1MTE1	Advanced Mathematics	3	1		4	4	3	60	30	10	100	24	50				
02	1MTE2	Advanced Thermodynamics	3	1		4	4	3	60	30	10	100	24	50				
03	1MTE3	Fluid Dynamics	3	1		4	4	3	60	30	10	100	24	50				
04	1MTE4	Advanced Heat Transfer	3	1		4	4	3	60	30	10	100	24	50				
05	1MTE5	Professional Elective-I	3	1		4	4	3	60	30	10	100	24	50				
06	1MTE6	Audit Course-I	2			2												
Practical																		
07	1MTE7	Fluid Dynamics Lab			2	2	2								25	25	50	25
08	1MTE8	Advanced Heat Transfer Lab			2	2	2								25	25	50	25
		Total	**17**	**5**	**4**	**26**	**24**					**500**					**100**	
															Total		**600**	

PE - 1 : 1) Energy Conservation and power plant Economics 2) Modern Energy Sources 3) Enviormental Pollution Control
Audit Course - 1 : 1) English for research paper writing 2) Value Education
Note : Evaluation of Audit Course is based on Case study & Assignments

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SEMESTER: II

Sr. No.	Course Code	Name of the Course	Teaching Scheme					Examination Scheme										
			Hours/ Week			Total Hours/ Week	Credits	THEORY							PRACTICAL			
										Internal					Max. Marks			
			Lecture	Tutorial	P/D			Duration of paper (Hrs)	Max. Marks ESE/ ESSE	Max. Marks MSE/ MSIE	Max. Marks TA	Total	Min. Passing Marks in ESE/ ESSE	Overall Min Passing Marks	Int.	Ext.	Total	Min. Passing Marks
Theory																		
01	2MTE1	Advanced Internal Combustion Engines	3	1		4	4	3	60	30	10	100	24	50				
02	2MTE2	Advanced Refrigeration Engineering	3	1		4	4	3	60	30	10	100	24	50				
03	2MTE3	Professional Elective-II	3	1		4	4	3	60	30	10	100	24	50				
04	2MTE4	Professional Elective-III	3	1		4	4	3	60	30	10	100	24	50				
05	2MTE5	Research Methodology & IPR	2			2	2	3	60	30	10	100	24	50				
06	2MTE6	Audit Course-II	2			2												
Practical																		
07	2MCC6	Finite Element Analysis Lab			2	2	1								25	25	50	25
08	2MCC7	Robotics & Robot Application Lab			2	2	1								25	25	50	25
09	2MCC8	Mini Project			2	2	1								25	25	50	25
		Total	**16**	**4**	**6**	**26**	**21**					**500**					**150**	
															Total		**650**	

Mini-Project & Seminar -1 : Project shhould be relevant to current technology and must include innovative element,
PE - 3 1. Heat Exchanger Design 2. Advance air conditioning system 3 Gas Turbine & jet propulsion
PE : 4 1. Fuel & Combustion 2. Solar energy 3. Cryogenics
Audit Course-II: 1Problem solving with creative thinking 2. Sustainable Development 3. Economics & Enterprenurship Management
Note : Evaluation of Audit Course is based on Case study & Assignments

Exit Option after complition of First Year.: Student has to complete 10 credit online courses (NPTEL/MOOCS/SWAYAM) suitable for Mechanical Engineering (Thermal Engineering) to qualify for the **Post-Graduate Diploma in Thermal Engineering.**

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Two Year Post Graduate Degree Program in Master of Technology
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SEMESTER: III

Sr. No.	Course Code	Name of the Course	Teaching Scheme					Examination Scheme										
			Hours/ Week			Total Hours/ Week	Credits	THEORY							PRACTICAL			
										Internal					Max. Marks			
			Lecture	Tutorial	P/D			Duration of paper (Hrs)	Max. Marks ESE/ ESSE	Max. Marks MSE/ MSIE	Max. Marks TA	Total	Min. Passing Marks in ESE/ ESSE	Overall Min Passing Marks	Int.	Ext.	Total	Min. Passing Marks
Practical																		
01	3MTE1	Compulsary Internship Two months (After complition of 1st					6									200	200	50
02	3MTE2	Seminar & Dissertation Phase -I		8		8	4								100		100	**150**
		Total		**8**		**8**	**10**				..		..		**100**	**200**	**300**	
															Total		**300**	

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SEMESTER: IV

Sr. No.	Course Code	Name of the Course	Teaching Scheme					Examination Scheme										
			Hours/ Week			Total Hours/ Week	Credits	THEORY							PRACTICAL			
										Internal		Total	Min. Passing Marks in ESE/ ESSE	Overall Min Passing Marks	Max. Marks		Total	Min. Passing Marks
			Lecture	Tutorial	P/D			Duration of paper (Hrs)	Max. Marks ESE/ ESSE	Max. Marks MSE/ MSIE	Max. Marks TA				Int.	Ext.		
Practical																		
01	**4MTE**	Seminar & Dissertation Phase -II			20	20	10								100	200	300	150
		Total			**20**	**20**	**10**										**300**	
															Total		**300**	

Semester	SEM-I	SEM-II	SEM-III	SEM-IV	Total
Credits	24	21	10	10	65

SYLLABUS PRESCRIBED FOR
TWO YEAR P. G. DEGREE COURSE IN M.Tech. (Full Time)

THERMAL ENGINEERING
FIRST SEMESTER
1SMTMT01 ADVANCED MATHEMATICS

Teaching Scheme : 3(L) **Credits: 03**

Pre-requisites:
1) Elementary knowledge of differential and integral calculus.
2)) Fundamental knowledge of partial differentiation.
3) Basic idea of probability

Course Learning Objectives:
1) To investigate the solutions of certain type of differential equations and boundary value problems.
2) To express given data connecting two variables in equation form.
3) To understand the concept of differences of a function.
4) To solve differential equations by different methods.

Course Outcomes:
After the completion of course students will be able to…
1) Find the solution of linear partial differential equation with boundary conditions.
2) Apply empirical laws to the given data by graphical method connecting two variables.
3) Evaluate the functions for intermediate values by interpolation.
4) Solve differential equation by various methods.

SECTION –A

Unit-1: Partial Differential Equations: Linear partial differential equations with constant coefficients and its solution, complimentary function and particular integral.

Unit-2: Ordinary Differential Equations: Runge - Kutta methods for system of IVPs – Numerical stability of Runge - Kutta method – Adams - Bashforth multistep method, Shooting method, BVP : Finite difference method, Collocation method and orthogonal collocation method.

Unit-3: Applications of Partial Differential Equations: Method of separation of variables, solution of wave equation, one dimensional and two dimensional heat flow equation in steady state (Laplace Equation) and its solution.

SECTION – B

Unit-4: Statistics: Method of least squares, curve fitting by graphical method. Co-relation regression. **Probability:** Binomial distribution, Poisson's distribution and Normal distribution.

Unit-5: Interpolation: Newton's interpolation formulae, Newton's and Gauss's forward and backward interpolation formulae, Interpolation with unequal intervals, Lagrange's formula for unequal intervals. Newton's divided difference formula. Inverse interpolation.

Unit-6: Numerical Methods: Numerical integration, Trapezoidal rule, Simpson's one third and three eighth rule, Weddle's rule. Numerical solution of ordinary differential equations by Taylor's series method, Runge-Kutta's fourth order method, Euler's method.

TEXT BOOKS :
1. Advance Engineering Mathematics by Erwin Kreyszig, 7^{th} and 8^{th} Edition. Wiley Eastern.
2. Higher Engineering Mathematics by B. S. Grewal,

REFERENCE BOOKS :
1. Fundamentals of Statistics by S. C. Gupta.

1SMTMT02 ADVANCED THERMODYNAMICS

Teaching Scheme : 3(L) **Credits: 03**

Course Learning Objectives:

CLO 1: To impart knowledge on apply thermodynamic principles to complex systems

CLO 2: Understand and utilize thermodynamic cycles and processes

CLO 3: To elaborate and explore advanced topics in thermodynamics

Course Outcomes:

At the end of course, Learner will be able to

1. Apply the laws of thermodynamics to closed and open systems including thermodynamic cycles.
2. Discuss a range of approaches to estimate fluid phase equilibria in one and two component system.
3. Estimate the physical properties of mixtures, especially non-ideal mixtures.
4. Predict the equilibrium of chemical reactions.
5. Understand the governing equations for compressible fluid flows and normal shocks.
6. Analyze the gas power cycles and cogeneration systems.

SECTION - A

Unit-1: Review of basic thermodynamic principles, entropy, availability and irreversibility, first and second law analysis of steady and unsteady systems.

Unit-2: General thermodynamic relations, fundamentals of partial derivatives, relations for specific heat, internal energy enthalpy and entropy, Joule Thompson co-efficient, Clapeyron equation.

Unit-3: Multi component system, review of equation of state for ideal and real gases, thermodynamic surfaces, gaseous mixtures, fugacity, ideal solutions, dilute solutions, activity, non ideal liquid solution, Multi component phase equilibrium, criteria of equilibrium, stability, and heterogeneous equilibrium, binary vapour liquid systems, the nucleus of condensation and the behavior of steam with formation of large and small drops, Gibbs phase rule, higher order phase transition

SECTION - B

Unit-4: Thermodynamics of chemical reaction (combustion); internal energy and enthalpy - first law analysis and second law analysis; basic relations involving partial pressures.

Unit-5: Third law of thermodynamics; chemical equilibrium and chemical potential equilibrium constants; thermodynamics of low temperature.

Unit-6: Thermodynamic Optimization: Exergy analysis of Vapor and Gas Power Cycles, Guideline for improving Thermodynamic Effectiveness; Exergy analysis of Simple Power Plant (Steam Plant)

Text Books :

1. Engineering Thermodynamics, P.K.Nag, Tata Mc-Graw Hill Publication.
2. Engineering Thermodynamics with applications, M. David Burhardt,Harper and Row Publishers.
3. Engineering Thermodynamics, William L. Haberman and James E.A.John, Allyn and Bacon Publisher.
4. Fundamentals of Classical Thermodynamics, Gordan J Van Wylen,RichardE.Sonntag, Claus Borgnakke , Wiley Publihers.

Reference Books:

1. Thermodynamics: An Engineering Approach, Yunus A. Cengel& Michael A. Boles, Sixth Edition
2. Advanced Engineering Thermodynamics, Adrian Bejan, Wiley-Interscience Publication, Second Edition.
3. Fundamentals of Engineering Thermodynamics, Michael Moran & Howard Shapiro, Wiley & Sons, Sixth Edition.

1SMTMT03 Fluid Dynamics

Teaching Scheme: 4(L) **Credits: 4**

Pre-requisites:

1. Basic knowledge of fluid properties

Course Learning Objectives: (3 to 4)

CLO 1: To learn the fluid flow concept & its effect on various bodies.

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CLO 2: To learn the Simple transformation and inverse transformations of fluid

CLO 3: To learn the concept of Boundary layer for turbulent flow & laminar flow.

CLO 4: To learn the compressive fluid its properties & its applications.

Course Outcomes: (06)

At the end of course, Learner will be able to

1. Demonstrate basic concepts of Fluid flow
2. Apply acquired knowledge basic function of flow on various bodies.
3. Understand the simple transformation and inverse transformations of fluid
4. Understand the concept of Boundary layer for laminar flow
5. Apply the concept of turbulent flow
6. Apply the concept of compressible flow.

Section A

Unit-1:Fluid flow concepts: Euler's equations of motion, Navier stoke equation, equation of continuity, Rotational irrotational flows, potential and stream functions, and flow nets circulations. **(6Hrs)**

Unit-2: Basic Function: Uniform stream, sink, vortex, doublet, superposition of functions, flow over half bodies, Rankine bodies, circular cylinder, Magnus effect.

Unit-3: Conformal Mapping: Simple transformation and inverse transformations.

Section B

Unit-4: Boundary layer theory: Boundary layer theory for laminar and Turbulent flow, Blasius solution for flat plate, approximate methods, boundary layer separation and control, Effect of roughness.

Unit-5: Turbulent flow, Semi empirical theories of turbulence, eddy viscosity, Prandtl's mixing length theory, Karman's Similarity hypothesis, Taylor's Vorticity transfer theory.

Unit-6: Compressible Flow: Review of one dimensional compressible flow, approximation to two and three dimensional such as sonic, supersonic flows, small perturbation theory, Shock Waves, Prandtl Mayor's Equation.

BOOKS RECOMMENDED:

Text Books :

1. Foundations of Fluid Mechanics, Yuan, S.W., Prentice Hall,
2. Cengel, Y.A. and J.M. Cimbala, Fluid Mechanics, McGraw-Hill, Boston, MA
3. Mechanics of Fluids, Shames, McGraw-Hill.

Reference Books :

1 Boundary Layer Theory, Schlichting, H., McGraw-Hill,.
2. Fluid Mechanics, Kundu, P. K., and Ira M. Cohen, 4th ed., Academic Press
3. The Dynamics and Thermodynamics of Compressible Flow, Shappiro, Ronald Press.

1SMTMT04 ADVANCE HEAT TRANSFER

Teaching Scheme : 3(L) **Credits: 04**

Pre-requisites:

1. An introductory background of Maths(calculus) is needed.
2. An introductory background of Physics is needed.
3. An introductory knowledge of heat transfer is needed.

Course Learning Objectives:

CLO 1: To provide details of heat transfer involving conduction, convention and radiation mechanisms. Apply appropriate governing equation and boundary conditions to solve lD,2D steady and unsteady state conduction problems

CLO 2: To identify the non-dimensional parameters and their significance in the forced and free convection. Employ proper analogy and empirical correlations for solving convection problems.

CLO 3: To describe phenomenon and mechanisms in condensation, boiling, transpiration cooling and ablation heat transfer. Interpret the physical mechanism in heat pipes. To analyze the role of gases as participants in exchange process

Course Outcomes:

At the end of course, Learner will be able to

1. Solve lD and 2D steady and unsteady state heat conduction problems by utilizing analytical, graphical, numerical and chart solution.
2. Evaluate the performance offins having non-uniform cross section.
3. Use of non-dimensional parameters and empirical correlations to analyse convection heat transfer in external and internal, forced and free convection.
4. Determine heat transfer coefficient in condensation and boiling phenomena and illustrate the physical mechanism involved in heat pipes.
5. Estimate the radiative heat exchange between surfaces.

SECTION-A

Unit 1: Steady state conduction: Basics of heat transfer, General heat conduction equationin rectangular, cylindrical and spherical co-ordinate systems, One dimensional steady state conduction with and without heat generation,

Unit 2: Variable thermal conductivity, Critical radius of insulation. Fins of non-uniform cross section. Two dimensional heat conduction, analyical, and graphical methods, Conduction shape factor. lntroduction to finite difference numerical solution.

Unit 3: Unsteady state heat conduction: Lumped capacitance, Infinite plate of finite thickness, Semiinfinite solid, Applicability of Heisler and Crober charts, Transient numerical methods.

SECTION-B

Unit 4: Convection heat transfer: Forced convection, Conservation equations, Integral and analyical solutions, Boundary layer analogies, Internal and external flows, Laminar and turbulent flows, Flow across cylinders and tube banks, Empirical solutions. Free convection: Governing equations, Laminar and turbulent flows, Analytical and empirical solutions.

Unit 5: Boiling, Condensation and Heat pipes: Pool boiling and convective boiling. Film condensation and drop-wise condensation. Transpiration cooling, Ablation. Classification, construction and applications of heat pipe.

Unit 6: Radiation: Fundamentals, Radiation shape factor, Heat exchange between non-black bodies using network approach, Enclosure analysis. Radiation shields, gas radiation, radiation network for an absorbing and transmitting medium, Effect of radiation on temperature measurement.

BOOKS RECOMMENDED:

Text Books :

1. Heat Transfer by J.P. Holman, Tata McGraw Hill Publication, 9th ed. 2002.
2. Heat Transfer by S.P. Sukhatme, Tata McGraw Hill Publication, 1994

Reference Books :

1. Heat Transfer by P.K. Nag, Tata McGraw Hill Publication, 2005.
2. Heat and Mass Transfer Data Book Book by C P Kothandaraman, S Subramanyam, New Age International,1994
3. Heat Transfer data book Convective heat & mass transfer by Kays and Crawford, Tata
4. C. P. Kothandaraman and S.subramanyam, ,,Heat and Mass Transfer Data Book", Nerv Age International-2014
5. R.C. Sachdeva "Fundamentals of Engineering Heat and Mass Transfer,,, New Age International, 2017.

Program Elective I

1SMTMT05-1 ENERGY CONSERVATION AND POWER PLANT ECONOMICS

Teaching Scheme : 3(L) **Credits: 03**

Pre-requisites:

1. Knowledge of Energy Conservation

Course Learning Objectives:

CLO1. To study various types of Energy Sources.
CLO 2. To study energy audit of various systems
CLO 3. To study Economic analysis of power plants and targets.
CLO 4. To understand Performance and operating characteristics of power plants

Course Outcomes:

At the end of course, Learner will be able to

- Understand the importance of Energy Sources.
- Understand the auditing of various systems.
- Understand the Economic analysis of power plants and targets
- Understand the working principles of power plants.
- Understand the Performance characteristics of power plants
- Understand operating characteristics of power plants

SECTION-A

Unit 1: Energy Conservation : Energy Sources – Review of Present Status of Conventional and Renewable Energy Sources**,** Common areas of inefficiency in energy use, principles of energy conservation , energy conservation planning, energy conservation in industries, household, commercial, transport and agricultural fields, energy conservation technologies, energy conservation legislation.

Unit 2: Energy Audit: Energy flow diagram, comparison with standards, energy management team, energy audit of illumination systems and electrical systems, energy audit of various compressed air systems, buildings, steam generation and distribution systems.

Unit 3: Demand Side Management: Scope of Demand Side Management, load management as a Demand Side Management strategy, tariff options of Demand Side Management, Demand Side Management and environment, different types as a captive power plants, energy banking and wheeling,
role of private sector in energy management.

SECTION-B

Unit 4: Power Plant Economics: Economic analysis of power plants and targets, Load curves, load duration curve, different terms and definitions; Effect of fluctuating load on operation and design of the plant, methods of meeting fluctuating load, cost of electrical energy; operating costs, generation costs, depreciation cost. Cost benefit analysis, Selection of type of generation;

Unit 5: Performance and operating characteristics of power plants;
Selection of the generating equipments, Combined operation of power plants; load division between stations, effect of load factor on energy cost, different types of tariffs.

Unit 6: Environmental Aspects of Energy Generation : Well-to-Wheel Emission analysis of Energy Sources**,** Social and economical issues of the power plants, Greenhouse effect, Acid precipitation- acid rain and acid snow, dry deposition and acid fog. Thermal pollution, air pollution, Radiation from nuclear power plant effluents, clean coal technologies, hydro power plants, environmental clearances.

TEXT BOOKS :
1. Power Station Engineering and Economics **,** B G A Skrotzki , W A Vopat : Tata McGraw Hill Publishing Company Limited, New Delhi,1972.
2. Power Plant Engineering, P K Nag, Tata McGraw Hill Publishing Company Limited, New Delhi ,2006.

REFERENCE BOOKS :
1. Electrical Power Distribution , A S Pabla **,** Tata McGraw Hill Publishing Company Limited, New Delhi ,2004.
2. Generation of Electrical Energy **,** B R Gupta, Eurasia Publishing House Private Limited, New Delhi, 2007.
3. Patterns of Energy Use in Developing Countries, Ashok V Desai,al issues of the power plants, Greenhouse effect, Acid precipitation- acid rain and acid snow, dry

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1SMTMT05-2 MODERN ENERGY SOURCES

Lectures/week: 03 **Credits: 03**

Pre-requisites:

2. Knowledge of Non conventional energy sources

Course Learning Objectives:

CLO1. To study various types of collectors.
CLO 2. To study various Tidal and Ocean Energy.
CLO 3. To study Wind Energy.
CLO 4. To understand Geothermal Energy And Magneto Hydrodynamics

Course Outcomes:

At the end of course, Learner will be able to

- Understand the importance and principles of collectors.
- Understand the working & utilization of Tidal and Ocean Energy
- Understand the working principles of Wind Energy.
- Understand Magneto Hydrodynamics.
- Understand Nuclear Energy

SECTION - A

Unit 1: Solar Energy: Flat plate and concentrating collectors- design, analysis and performance, applications. Thermal Power, Photovoltaic power; Economic Analysis

Unit 2: Solar Thermal Energy Storage: Types: Sensible storage; Latent heat storage; Thermo-chemical storage. Design of storage System. Solar Thermal Energy system: Solar still; Solar cooker: Solar pond; Solar passive heating and cooling systems: Trombe wall; Greenhouse technology: Fundamentals, design, modeling and applications.

Unit 3: Tidal and Ocean Energy: Applications, Design aspects, Power generation methods, various cycles and analysis.

SECTION - B

Unit 4: Wind Energy: Atmospheric circulation, classification, factors influencing wind, wind shear, turbulence, wind speed monitoring, Betz limit, WECS: classification, characteristics, application, design aspects

Unit 5: Geothermal Energy And Magneto Hydrodynamics: Study of various components, Performance and methods of energy conversion.

Unit 6: Nuclear Energy: Fusion and fission, study of various components, Design aspects, performance and methods of power generation.

TEXT BOOKS : 1. Power Plant Technology by El- Wakil, McGraw Hill publication.
2.Solar Energy : Fundamentals and Applications (1st Revised Edition), Tata McGraw-Hill,
REFERENCES : 1.Solar Energy: Principles of thermal collection and Storage by Suhas P. Sukhatme ,Second Edition, Tata McGraw-Hill, 2006
2. Principles of Solar Thermal Engineering by F.Kreith & J .F.Kreider, McGraw Hill Publications 1978.
3. Solar Engineeering of thermal Processes by J .A.Duffie and W.A.Beckman, John Wiley & Sons publication 1999.
4.Applied Solar Energy by A.B.Meinal & F.P.Meinal, Addison Wesley

1SMTMT05-3 ENVIRONMENTAL POLLUTION CONTROL

Teaching Scheme : 4(L) **Credits: 03**

Course Learning Objectives:

CLO 1: To impart knowledge on the atmosphere and its present condition, global warming and eco legislations.
CLO 2: To detail on the sources of air, water and noise pollution and possible solutions for mitigating their degradation.
CLO 3: To elaborate on the technologies available for generating energy from waste.

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the Foundations of Environmental Pollution Control
2. Analyze and Mitigate Air Pollution
3. Evaluate Water Pollution and Remediation Techniques
4. Implement Sustainable Waste Management Practices
5. Manage Diverse Industrial Pollution Sources
6. Integrate Pollution Control Strategies Holistically

SECTION – A

Unit 1: INTRODUCTION: Global atmospheric change – green house effect – Ozone depletion - natural cycles - mass and energy transfer – material balance – environmental chemistry and biology – impacts – environmental. Legislations.
Unit 2: AIR POLLUTION: Pollutants - sources and effect – air pollution meteorology – atmospheric dispersion – indoor air quality - control methods and equipments - issues in air pollution control – air sampling and measurement.
Unit 3: WATER POLLUTION: Water resources - water pollutants - characteristics – quality - water treatment systems – waste water treatment - treatment, utilization and disposal of sludge - monitoring compliance with standards.

SECTION – B

Unit 4: WASTE MANAGEMENT: Sources and Classification – Solid waste – Hazardous waste - Characteristics – Collection and Transportation - Disposal – Processing and Energy Recovery – Waste minimization.
Unit 5: OTHER TYPES OF POLLUTION FROM INDUSTRIES: Noise pollution and its impact - oil pollution - pesticides - instrumentation for pollution control .
Unit 6: water pollution from tanneries and other industries and their control – environment impact assessment for various projects – case studies. Radiation pollution: types, sources, effects, control of radiation pollution.

REFERENCE BOOKS

1. Arcadio P Sincero and G.A. Sincero, Environmental Engineering – A Design Apporach, Prentice Hall of India Pvt Ltd, New Delhi.
2. Bishop P., Pollution Prevention: Fundamentals and Practice, McGraw-Hill International Edition, McGraw-Hill book Co, Singapore.
3. G.Masters, Introduction to Environmental Engineering and Science Prentice Hall of India Pvt Ltd, New Delhi.
4. Gilbert M. Masters, Introduction to Environmental Engineering and Science, 2nd Edition, Prentice Hall, 1998.
5. H.Ludwig, W.Evans, Manual of Environmental Technology in Developing Countries, International Book Company, Absecon Highlands N.J. (1991).
6. H.S.Peavy, D.R.Rowe and G.Tchobanoglous, Environmental Engineering McGraw- Hill Book Company, NewYork, (1985).
7. Rao C.S., Environmental Pollution Control Engineering, 2nd Edition, New Age International Publishers, 2006.

Audit Course-I

1SMTMT06-1 ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:
Students will be able to:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title Ensure the good quality of paper at very first time submission.

Section A

Units 1: Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness
Unit 2: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction
Unit 3: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

Section B

Unit 4: key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Unit 5: skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

Unit 6 : useful phrases, how to ensure paper is as good as it could possibly be the first- time submission
Suggested Studies:
1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

Audit Course-I

1SMTMT06-3 PEDAGOGY STUDIES

Course Objectives:
Students will be able to:
1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Section A

Units 1: Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.
Unit 2: Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.
Unit 3: Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Section B

Unit 4: Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies.
Unit 5: Professional development: alignment with classroom practices and follow-up support Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes
Unit 6: Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.

Suggested reading
1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.

1SMTMT07 Subject Name –FD LAB

Practical: 02 Hours/week **Credits: 1**

Course Learning Objectives (CLOs)
CLO1 To learn the fluid properties & behavior using various devices
CLO2 To learn measurement fluid flow using pumps & turbines
Course Outcome (COs)
1. Demonstrate the fluid pressure measurement
2. Apply the Bernoulli's equation
3. Apply & analyze fluid flow using pumps & turbines

Practicals: At least 5 practicals from the below list.
1 Analyze the fluid pressure measurement by various measuring devices.
2. Verification of Bernoulli's equation.
3. Determination of co-efficient discharge by Venturimeter.
4. Calculation of Reynolds number for Laminar & Turbulent flow.
5. Trial/Study of hydraulic Turbines.
6. Study & analysis of fluid flow using centrifugal & reciprocating pump.

1SMTMT08 Advance Heat Transfer–LAB

Practical: 02 Hours/week **Credits:02**

Course Learning Objectives (CLOs)
CLO 1: To provide details of heat transfer involving conduction, convention and radiation mechanisms.
CLO 2: To understand heat transfer analysis and to demonstrate different techniques used in solving a heat transfer problem.
CLO3: To evaluate basics of designing heat transfer equipment.

Course Outcome (COs)
1. Understand various modes of 1D and 2D steady and unsteady state heat transfer.
2. Evaluate various parameters of the radiation mode heat transfer process.
3. Apply the knowledge of different application of heat pipe as heat transfer.

Practicals:
1. Analysis of 3-D heat conduction with internal heat generation for a solid cylinder under unsteady state condction.
2. To determine the surface heat transfer coefficient for heated vertical cylinder in natural convection.
3. Study of radiation shape factor, their salient features and application.
4. Analysis of radiation heat exchange between non-black bodies using network analogy.
5. To determine the heat transfer coefficient in film wise and drop wise condensation.
6. Study of heat pipes.
7. To study the super thermal conducting characteristics of heat pipe.

SYLLABUS PRESCRIBED FOR
TWO YEAR P. G. DEGREE COURSE IN M.Tech. (Full Time)

THERMAL ENGINEERING
SECOND SEMESTER

2SMTMT01 ADVANCED INTERNAL COMBUSTION ENGINES

Lectures/week:04 **Credits 04**

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of IC Engines is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives: (03)

CLO 1: To understand the underlying principles of operation of different IC Engines and components.
CLO 2: To provide knowledge on pollutant formation, control, alternate fuel etc.
CLO 3: To provide knowledge on alternative fuels and Recent trends

Course Outcomes: (06)

At the end of course, Learner will be able to

1. Understand the fundamentals of combustion, thermodynamics of combustion, different combustion processes,
2. Apply knowledge to solve simple/advance numerical problem of a combustion system
3. Ability to analyze and design a combustion system such as furnace and burner
4. An understanding of pollutant formation in internal combustion engines
5. An understanding of the fundamental theory of the combustion of non-premixed and premixed flames, laminar and turbulent flames, droplets and the theory of ignition

SECTION - A

Unit 1: SPARK IGNITION ENGINES: Spark ignition engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – Factors affecting knock – Combustion chambers.

Unit 2: COMPRESSION IGNITION ENGINES: States of combustion in C.I. Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behaviour – Spray structure, Spray penetration and evaporation – Air motion – Introduction to Turbo charging.

Unit 3: POLLUTANT FORMATION: Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx, Smoke and Particulate matter

SECTION - B

Unit 4: POLLUTANT CONTROL: Methods of controlling Emissions – Catalytic converters and Particulate Traps – Methods of measurements and Introduction to emission norms and Driving cycles.

Unit 5: ALTERNATIVE FUELS: Alcohol, Hydrogen, Natural Gas and Liquefied Petroleum Gas- Properties, Suitability, Merits and Demerits as fuels, Engine Modifications.

Unit 6: RECENT TRENDS: Lean Burn Engines – Stratified charge Engines – homogeneous charge compression ignition engines – Plasma Ignition – Measurement techniques – Laser Doppler, Anemometry.

BOOKS RECOMMENDED:

TEXT BOOK :

1. K.K. Ramalingam, Internal Combustion Engine Fundamentals, Scitech Publications, 2002.
2. R.B.Mathur and R.P. Sharma, Internal combustion Engines.
3. V. Ganesan, Internal Combustion Engines, II Edition, Tata McGraw- Hill, 2002.

REFERENCE BOOKS :

1. Duffy Smith, Auto fuel Systems, The Good Heart Willox Company,Inc.
2. John B. Heywood, Internal Combustion Engine Fundamentals first edition
3. Willard W. Pulkrabek, engineering fundamentals of the Internal Combustion Engine second edition

2SMTMT02 ADVANCED REFRIGERATION ENGINEERING

Lectures/week:04 **Credits 04**

Course Learning Objectives:

CLO 1: Analyze and Design Advanced Refrigeration Systems
CLO 2: Optimize Refrigeration Processes for Energy Efficiency
CLO 3: Apply Refrigerant Component technology

Course Outcomes:

At the end of course, Learner will be able to

1. Analyze the reversed Carnot cycle and vapour compression refrigeration cycle (VCR).
2. Select the air-refrigeration systems for aircraft.
3. Study and analyze vapour absorption refrigeration system for rural and remote areas.
4. Select environmental friendly refrigerants considering the international standards.
5. Select multi pressure systems
6. Study different Non-Conventional Refrigeration systems

SECTION - A

Unit 1: Review of Basic Refrigeration Cycles: Reverse Carnot Cycle, Second Law of Thermodynamics. Vapor Compression Refrigeration. Standard and Actual Compression Cycle.

Unit 2: Multi Pressure Systems: Refrigeration Component Matching and System Integration, Thermodynamics of Vapor Absorption Refrigeration.

Unit 3: Non Conventional Refrigeration Systems with elementary analysis.

SECTION - B

Unit 4: Properties of Refrigerants: Green House Effect, Numbering and Color Coding of Refrigerants, Recent Trends in Refrigerants.

Unit 5: Air as refrigerant and air refrigeration cycles/systems.

Unit 6: Refrigerant Component Matching and Designing Refrigeration Components like Compressor, Condenser, Cap-illary, Condenser, Etc.

TEXT BOOKS :

1. Refrigeration and air conditioning, Ahmadul Ameen, Prentice Hall of India, New Delhi, 2006
2. Refrigeration and air conditioning, C P Arora, Tata McGraw-Hill, 2nd ed ,2003

REFERENCE BOOKS :

1. Refrigeration and Air Conditioning Technology, Tomczyk, J. A., Whitman, W. C., Johnson, W. M., Pub: Delmar S.Africa, 4th edition, 2000.
2. Electricity For Refrigeration, Heating, and Air Conditioning, Russell E. Smith, Delmar Cengage Learning; 7th edition, 2006 3. The ASHRAE Handbooks with CDs, 2005-2008.

Program Elective II

2SMTMT03- 1 HEAT EXCHANGER DESIGN

Lectures/week:03 **Credits:03**

Pre-requisites:

1. An introductory background of Maths(calculus) is needed.
2. An introductory background of Physics is needed.
3. Background of Thermodynamic and Heat Transfer are needed.

Course Learning Objectives:

CLO 1: It provides exposure to different kind of heat exchanger, their working and selection for a given application. To learn the thermal and stress analysis on various parts of the heat exchangers.

CLO 2 To analyze the sizing and rating of the heat exchangers for various applications. Students will come to know about different techniques of heat exchanger analysis.

CLO 3: To learn construction and thermal design methodology of shell and tube, Plate and compact heat exchanger.

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the details knowledge for heat exchanger classification & its application.
2. Analyze the design methodology of heat exchanger with reference to rating and sizing.
3. Interpret the knowledge of fouling of heat exchanger & its operational control.
4. Design and Analysis of Shell & tube Heat Exchanger performance.
5. Design and Analysis of compact heat exchanger performance.
6. Analyze an existing heat exchanger for phase change application.

SECTION-A

Unit 1: Introduction to Heat Exchangers: Mechanism of heat exchange, classification, geometrical construction of tubular, plate and compact heat exchanger, extended surface heat exchangers, regenerator's heat pipe, & its Applications and Selection. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger & its application.

Unit 2: Basic Design Methods of Heat Exchanger: Heat exchanger design methodology, problem formulation, e-NTU method, PNTU method, Mean temperature difference method(LMTD) for heat exchanger analysis for parallel, counter, and cross flow heat exchanger. Heat exchanger design calculation- heat transfer and pressure drop calculation including pumping power, Heat exchangers design methodology- rating and sizing.

Unit 3: Fouling of Heat Exchangers: Basic consideration, effect of fouling on heat transfer and pressure drop, cost of fouling, design of heat exchangers subject to fouling, fouling resistance, cleanliness factor, techniques to control fouling, Process of Fouling, Prediction of fouling, Operation of heat exchanger under fouling, Control of fouling and cleaning of heat exchanger.

SECTION-B

Unit 4: Design Of Shell & Tube and Compact Heat Exchanger: Basic components, TEMA code, J-factors & other standards, Basic design methodology – heat transfer and pressure drop calculation, Shell side calculation- KERN'S and Bell-Delaware Method. Plate fin and tube fin heat, Helical Coil Heat Exchangers and Air Cooled Heat Exchanger: Application, mechanical features, operational characteristics, flow arrangement, heat transfer and pressure drop calculation

Unit 5: Mechanical Design of Heat Exchangers.: Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

Unit 6: Heat Exchangers for Phase Change Applications: Condensers and Evaporators, Features, types, construction, working, design and operational considerations, and its thermal analysis.

BOOKS RECOMMENDED:

Text Books :

1 Fundamentals of Heat Exchanger Design by Ramesh K. Shah, Dusan P Sekulic, 1st edition, Wiley, 2002. 60 61

2. Process Heat Transfer by D.Q. Kern, Tata McGraw Hill Publication, 1999.

3. Mechanical design of heat exchanger design & Pressure vessel component, by Sing K.P. A. I.; Arcturus Publishers Cherry Hill, 2006.

4. Ramesh K. Shah and Dusan P. Sekulic, "Fundamentals of Heat Exchanger Design" John Wiley and sons Inc., 2003.

Reference Books :

1. Heat Exchanger Design by Frass & Ozisik, John Wiley and Sons, Newyork, 1997.
2. Convective Heat transfer by Kays and London, Tata McGraw Hill Publication, 1997.
3. ANSI Standards for pipe and nozzle selection, 1996.
4. ASME Section VIII Division for pressure Vessel and Boiler Design Code, 1995.
5. ASME section II, Material Specifications, 1995.
6. D.C. Kern, "Process Heat Transfer", McGraw Hill, 1950.
7. SadikKakac and Hongton Liu, "Heat Exchangers: Selection, Rating and Thermal Design" CRC Press, 1998.
8. A .P. Frass and M.N. Ozisik, "Heat Exchanger Design", McGraw Hill, 1984
9. Afgan N. and Schlinder E.V. "Heat Exchanger Design and Theory Source Book", "T.E.M.A. Standard", New York, 1999.

Program Elective II

2SMTMT03- 2 ADVANCED AIR CONDITIONING SYSTEMS

Lectures/week:04 **Credits 03**

Course Learning Objectives:

CLO 1: Design Complex Air Conditioning Systems
CLO 2: Optimize Air Conditioning Systems for Energy Efficiency
CLO 3: Implement Sustainable Cooling Solutions:

Course Outcomes:

At the end of course, Learner will be able to

1. Demonstrate Proficiency in Psychometric Air Conditioning Analysis
2. Design HVAC Systems for Optimal Comfort Conditions
3. Apply Noise and Vibration Control Techniques
4. Select Air Conditioning Components Effectively
5. Design Piping Systems for Air Conditioning
6. Understand Electrical Circuits and Components in Air Conditioners

SECTION - A

Unit 1: Properties of Air Water Mixture, Psychometric Air Conditioning Processes, Dehumidification Processes, Comfort Air Conditioning, Parameters Affects Comfort Conditions,

Unit 2: Cooling Load Calculations, Design Of Air Delivery Sys-tem To Hospital, Auditorium, Hotels Etc.

Unit 3: Noise and Vibration Control In Air Conditioning Hall.

SECTION - B

Unit 4: Air Conditioning Component Selection (Component Matching), Designing Air Ducts, Window Air Conditioner / Split Air Conditioner Performance Testing,

Unit 5: Energy calculations- Degree-Day procedure, Bin Method, Comprehensive Simulation methods method, Flow-Pump - and piping Design.

Unit 6: Electrical Circuits And Components In Air Conditioner Like Olp, Capacitor, Performance Study Of Motors Used For Fan, Blower, Compressor.

TEXT BOOKS :

1. Refrigeration and air conditioning, Ahmadul Ameen, Prentice Hall of India, New Delhi, 2006
2. Refrigeration and air conditioning, C P Arora, Tata McGraw-Hill, 2nd ed, 2003
3. Air Conditioning Principles and Systems, E G Pita, Prentice Hall of India, 4th edition, 2005.

REFERENCE BOOKS :

1. The ASHRAE Handbooks with CDs, 2015
2. Refrigeration and Air Conditioning Technology, Tomczyk, J. A., Whitman, W. C., Johnson, W. M., Pub: Delmar S. Africa, 4th edition, 2000.

Program Elective II

2SMTMT03- 3 GAS TURBINES & JET PROPULSION

Lectures/week: 03 **Credits: 03**

Pre-requisites:

1. Knowledge of gas turbine

Course Learning Objectives:

CLO1. To study various types of Turbo machinery and Aircraft Propulsion Cycles.
CLO 2. To study various Centrifugal Compressors and Axial Flow Turbines.
CLO 3. To study various types of Aircraft Jet Engines.
CLO 4. To understand Thermodynamics Of Jet Propulsion Subsystems

Course Outcomes:

At the end of course, Learner will be able to

- Understand the importance and principles of Turbo machinery.
- Understand the working & applications of Centrifugal Compressors and Axial Flow Turbines. 3. Understand the various types of Aircraft Jet Engines
- Understand the working principles of Thrust augmentations.
- Understand the working of Aircraft Jet Engines.
- Understand Thermodynamics Of Jet Propulsion Subsystems

SECTION – A

Unit 1: General Concepts related to Turbo machinery: Classification; Euler's Equation for Turbo machinery; Velocity triangle; Cascade analysis & nomenclature. Shaft Power & Aircraft Propulsion Cycles.

Unit 2: Centrifugal Compressors: Work done and pressure rise; Slip; Compressibility effects; Compressor characteris-tics. Axial Flow Compressors: Stage pressure rise; Blockage in compressor annulus;Degree of reaction; 3-D flow; Stage performance; h-s diagram & efficiency; off design performance; Performance characteristics; Design process. Combus-tion System.

Unit 3: Axial Flow Turbines: Stage performance; Degree of reaction; h-s diagram & efficiency; Vortex theory; Overall turbine performance; Performance characteristics; Blade cooling; Design process. Prediction of performance of simple gas turbines; Off Design performance; Gas turbine blade materials; matching procedure.

SECTION - B

Unit 4:Combined cycles: Differences between Single and combined Cycles, characteristics of combined cycles, Performance calculations for Combined Cycle.

Unit 5:Thermodynamics Of Aircraft Jet Engines

Theory of Jet Propulsion - Thrust and efficiency - Ram Jet - Turbojet and Turbofan engines - Turboprop and Turboshaft Engines – Thrust augmentations - Typical engine performance - Engine - Aircraft matching.

Unit 6:Aero-Thermodynamics Of Jet Propulsion Subsystems

Subsonic inlets - Supersonic inlets - Gas turbine combustors - After burners and Ramjet Combustors -Supersonic Combustion - Exhaust Nozzles.

TEXT BOOKS :

1. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition,
2. Bonney E.A. Zucrow N.J. Principles of Guided Missile Design, Van Nostranc Co., 1985.
3. S.M. Yahya, Gas Dynamics and Jet Propulsion.

REFERENCE BOOKS :

1. Addition - Wesley Publishing Company, New York, 1992.
2. Zucrow N.J. Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons Inc, New York, 1970.
3. Zucrow N.J. Aircraft and Missile Propulsion, Vol.I and Vol.II, John Wiley and Sons Inc, New York, 1975.

Professional Elective III

2SMTMT04- 1 Fules and Combustion

Lectures/week:03 **Credits 03**

Pre-requisites:

1. An introductory background of thermodynamics is needed.
2. An introductory background of IC Engines is needed.
3. An introductory background of chemistry is needed.

Course Learning Objectives: (03)

CLO 1: To study the basic concepts of thermodynamics, thermodynamic systems, work and heat
CLO 2: To study the laws of thermodynamics and their applications
CLO 3: To study the air standard cycles

Course Outcomes: (06)

At the end of course, Learner will be able to

1. Understand the basic concepts of thermodynamics, thermodynamic systems, work and heat
2. Understand the concepts of first law of thermodynamics.
3. Apply first law of thermodynamics during non-flow processes.
4. Apply first law of thermodynamics to flow processes.
5. Understand the concepts of second law of thermodynamics.
6. Understand the concept of air standard cycles

SECTION - A

Unit 1: Introduction: General, Conventional Energy Sources, Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, Tidal Power, Geothermal Energy, Energy Survey of India, Rocket Fuels

Unit 2: Solid, Liquid & Gaseous Fuels: General, Family of Coal, Origin of Coal, Gasification of Coal, Analysis and Properties of Coal, Action of Heat on Coal, Classification of Coal, Oxidation of Coal, Hydrogenation of Coal, Efficient use of Solid Fuels. Manufactured Fuels, Agro Fuels, Solid Fuel Handling, Properties Related to Combustion, Handling Storage

Unit 3: Theory Of Combustion Process: Origin and Classification of Petroleum, Refining and Other Conversion Processes, Nature of Indian Crudes & Petroleum Refining in India, Liquid Fuels from Other Sources, Storage and Handling of Liquid Fuels, Liquid Fuels Combustion Equipment. Types of Gaseous Fuels, Natural Gases, Manufactured Gases, Producer Gas, Water Gas, Carburetted Water Gas, Blast Furnace Gas Fuels, Through Non-Thermal Route - Biogas, Refinery Gas, LPG, Cleaning and Purification of Gaseous Fuels.

SECTION - B

Unit 4: Stoichiometry: Stoichiometry and Thermodynamics, Combustion Stoichiometry General, Rapid Methods of Combustion Stoichiometry, Combustion Thermodynamics, Combustion Problems with Chemical Reactions Burners Stoichiometry Relations, Theoretical Air Required for Complete Combustion,

Unit 5: Calculation of Minimum Amount of Air Required for a Fuel of known Composition, Calculation of Dry Flue Gases if Fuel Composition is Known, Calculation of the Composition of Fuel & Excess Air Supplied from Exhaust Gas Analysis, Dew Point of Products, Flue Gas Analysis (O 2, CO 2, CO, NO x, SO x).

Unit 6: Burner Design: Ignition, Concept of Ignition, Auto Ignition, Ignition Temperature. Flame Propagation, Various Methods of Flame Stabilization, Incorporation in Burner Design, Basic Features and Types of Solid, Liquid and Gaseous Fuel Burner, Design Consideration of Different Types of Coal - Oil and Gas Burners, Recuperative & Regenerative Burners

BOOKS RECOMMENDED:

TEXT BOOK :

1. Samir Sarkar, Fuels & Combustion, 2nd Edition, Orient Longman, 1990
2. Bhatt ,vora Stoichiometry, 2nd Edition, Tata Mcgraw Hill, 1984
3. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill, 1984

REFERENCE BOOKS :

1. Blokh AG, Heat Transfer in Steam Boiler Furnace, Hemisphere Publishing Corpn, 1988
2. Civil Davies, Calculations in Furnace Technology, Pergamon Press, Oxford, 1966

Professional Elective III

2SMTMT04- 2 SOLAR ENERGY

Lectures/week: 03 **Credits: 03**

Course Learning Objectives:

CLO1. To study various types of Radioactive Properties and Characteristics of Materials.
CLO 2. To study various Solar Thermal Energy Storage
CLO 3. To study various types of Solar Heating & Cooling System.
CLO 4. To understand Performances of solar collectors

Course Outcomes:

At the end of course, Learner will be able to

- Understand the Radioactive Properties and Characteristics of Materials.
- Understand the working & applications of Solar Thermal Energy Storage
- Understand the Solar Energy for Industrial Process Heat
- Understand the working principles of Solar Heating & Cooling System.
- Understand the working of solar collectors

SECTION -A

Unit 1: Radioactive Properties and Characteristics of Materials Reflection from ideal specular, ideal diffuse and real surfaces, Selective Surfaces: Ideal coating characteristics; Types and applications; Antireflective coating; Preparation and characterization. Reflecting Surfaces and transparent materials.

Unit 2: PHOTOVOLTAIC SOLAR CELL

P:N Junction - Metal - Schottky Junction, Electrolyte – Semiconductor Junction, Types of Solar Cells - their Applications - Experimental Techniques to determine the Characteristics of Solar Cells - Photovoltaic Hybrid Systems Photovoltaic Thermal Systems – Storage Battery - Solar Array and their Characteristics Evaluation - Solar Chargeable Battery.

Unit 3: Solar Energy for Industrial Process Heat

Industrial process heat: Temperature requirements, consumption pattern; Applications of solar flat plate water heater & air heater for industrial process heat; Designing thermal storage; Transport of energy.

SECTION-B

Unit 4: Solar Heating & Cooling System

Solar water heating systems, Liquid based systems for buildings, Solar air heating systems, Methods of modeling and design of Solar heating system, Cooling requirements of buildings, Vapour absorption refrigeration cycle; Water, ammonia & lithium bromide-water absorption refrigeration systems; Solar desiccant cooling.

Unit 5: Performances of solar collectors

ASHRAE code; Modeling of solar thermal system components and simulation; Design and sizing of solar heating systems: f – chart method and utilizability methods of solar thermal system evaluation; Development of computer package for solar heating and cooling applications; Energy balance for Flat Plate Collectors; Thermal analysis; Heat capacity effect; Testing methods; Types of Flat Plate Collectors: Liquid Flat Plate Collectors, Air flat-plate Collectors-Thermal analysis; Evacuated tubular
collectors.

Unit 6: Concentrating Collector Designs

Classification, design and performance parameters; Tracking systems; Compound parabolic concentrators; Parabolic trough concentrators;Concentrators with point focus; Heliostats; Comparison of various designs:
Central receiver systems, parabolic trough systems; Solar power plant; Solar furnaces

TEXT BOOKS :

1. S.P.Sukhatme-Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill
2. J.A.Duffie and W.A.Beckman-Solar Engineering of Thermal Processes-John Wiley, (1991).

REFERENCE BOOKS :

J.F.Kreider and F.Kreith-Solar Energy Handbook McGraw-Hill (1981).

Professional Elective III

2SMTMT04- 3 CRYOGENICS

Lectures/week:03 **Credits:03**

Pre-requisites:

1. An introductory background of Maths(calculus) is needed.
2. An introductory background of Physics is needed.
3. An introductory knowledge of Thermodynamics and Refrigeration & Air conditioning are needed.

Course Learning Objectives:

CLO 1: To enable the students to analyze and solve cryogenics related problems by applying principles of mathematics, science and engineering.

CLO 2: To prepare students to use modern tools, techniques and skills to fulfill industrial needs related to low temperature system and develop skills in the analysis of cryogenics systems in research or design.

CLO3: To develop a professional approach to lifelong learning in the refrigeration/air conditioning/cryogenics to include the awareness of social and environment issues associated with engineering practices

Course Outcomes:

At the end of course, Learner will be able to

1. Apply knowledge of mathematics, science, and engineering for the needs in Cryogenic.
2. Analyze different Cryogenic systems.
3. Evaluate and interpret the analysis reports in the field of Cryogenic.
4. Analyze the study of different instrumentation & safety in the field of cryogenic.
5. Understand the various applications of cryogenics.

SECTION-A

Unit 1: Introduction To Cryogenic Systems: Introduction, properties of cryogenic fluids, properties of materials used in cryogenics at lower temperature, superconductive materials, applications of cryogenics, cryogenic space technology, space simulation, cryogenics in biology & medicines.

Unit 2: Gas Liquefaction Gas Separation and Purification: Gas separation and purification – principles, Gas separation systems**:** Gas liquefaction & refrigeration systems, Basics of refrigeration & liquefaction, ideal thermodynamic cycle, Joule Thomson effect, adiabatic expansion, various liquefaction cycles, Liquefaction systems for air, Neon, Hydrogen & Helium gas, Effect of components' efficiencies on system performance for air, hydrogen, and helium.

Unit 3: Cryogenic Refrigeration Systems:: Cryogenic refrigeration systems, Ideal and practical systems, Joule-Thompson cryocoolers, Stirling Cycle Refrigerators, Gifford-McMahon Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Dilution refrigerators, Cryostat, Cryo Coolers.

SECTION-B

Unit 4: Cryogenic Fluid Storage, Handling, Insulation, Instrumentation & Vacuum Technology: Cryogenic Dewar, Cryogenic Transfer Lines, Two phase flow in cryogenic transfer system, Insulations used in Cryogenic Systems Temperature, Pressure, Flow rate and Liquid level measurement, Cryogenic storage vessels, Dewar and large tanks, Storage and transport of LNG and other liquefied industrial gases. Liquid hydrogen storage and transport for hydrogen-fueled vehicle. Special insulation requirements at low temperatures, insulating materials. Need of vacuum, various vacuum pumps.

Unit 5: Instrumentation and safety: Instrumentation in cryogenics to measure Flow, Level and Temperature, Introduction to vacuum technology, safety in cryogenics

Unit 6: Applications: Space technology, In-Flight air separation and collection of LOX, Gas industry, Biology, Medicine, Electronics.

BOOKS RECOMMENDED:

Text Books :

1. Barron. R.F. Cryogenic Systems, McGraw-Hill, 2nd edition 1985.
2. Cryogenic Engineering Intelligence T.M.Flynn, MarcelDekker CRC Press 2 nd edition, 2004
3. Cryogenics: Applications and Progress A.Bose and P.Sengupta Tata McGraw Hill 1987

Reference Books :

1. Thomas M. Flynn, "Cryogenic Engineering", Marcel Dekker. Inc New York illustrated edition 1997.
2. Marshall Sittig, D. Van Nostrand Co. "Cryogenics - Research and Applications", Princeton N.J, Van Nostrand . 1963Scott, R. B, Cryogenic Engineering, Scott, R. B. D'Van-Nostrand, 1962.
3. Vance, R. W., Applied Cryogenic Engineering, , John Wiley and sons, 1st edition 1962.
4. M. Sitting , "Cryogenic", D' Van-Nostrand company, 1st edition 1963
5. Cryogenic Systems R.Barron McGraw-Hill Inc 1967

Open Elective I

2SMTMT05- 1 Business Analytics

Course Objectives:

- In this course students will learn R. data analytics, data visualization and statistical model for data analytics.
- Students will be able to become business data analyst.

Course Outcomes:

After successful completion of this course students will be able to-

CO	Course Outcomes
1	Demonstrate skill in data management.
2	Understand the basic concept of R programming.
3	Demonstrate skills in data visualization.
4	Describe their proficiency in business statistical analysis of data.

Section A

Unit 1: Introduction to Analytics Meaning, application areas of business analytics, techniques of analytics, Statistics for Business Analytics Central tendencies and dispersion, central, limit theorem, sampling distribution, hypothesis testing, simple linear regression, categorical data analysis, analysis of variance (ANOVA), non-parametric tests.

Unit 2: Advanced Excel Proficiency Describing Numeric Data, Pivot Table Analysis, Linear Regression, Comparing Two Sample Variances, Comparing Two Sample Means, Pair T Test, One Way ANOVA, Two Way ANOVA, Generating Random Numbers, Rank and Percentile, Histogram Procedure, Exponential Smoothing and Moving Average, Sampling, Covariance and Correlation, Goal Seek and Solver.

Unit 3: Data Mining using Decision Tree Introduction to decision trees, model design and data audit, demo of decision tree development, algorithm behind decision tree and other decision tree. Understanding R Using R Studio, working with data in R, R procedures, Data Mining using clustering in R Discussion and Data mining techniques, Understanding cluster analysis using R, clustering as strategy, hierarchical clustering, non-hierarchical clustering - K means clustering, variants of hierarchical clustering, different distance and linkage functions.

Section B

Unit 4: Time Series Forecasting Time series vs causal models moving averages, exponential smoothing, trend, seasonality, cyclicity causal modelling using linear regression forecast accuracy, Predictive Modelling – Logistic Regression using R Data import and sanity check, development and validation, important categorical variable selection, important numeric variable selection, indicator variable creation, stepwise regression, dealing with multicollinearity, logistic regression score and probability, KS calculation, coefficient stability check, iterate for final model.

Unit 5: Overview of Big Data and Hadoop Big data and Hadoop and concept, application, cloud computing, generators of big-data. Data Analysis and Applications Credit risk analytics, fraud risk analytics, financial services marketing

Unit 6: Probability: Definition, Types of Probability, Mutually Exclusive events, Independent Events, Marginal Probability, Conditional Probability, Bayes Theorem. Probability Distributions – Continuous, Normal, Central Limit theorem, Discrete distribution, Poison distribution, Binomial distribution.

1. Text Books:

1. Dr. Bharti Motwani, Data Analytics with R , Wiley
2. B. Uma Maheswari (Author), R. Sujatha (Author), Introduction to Data Science: Practical Approach with R and Python, Wiley
3. W. N. Venables, D.M. Smith and the R Development Core Team: An Introduction to R, Notes on R : A Programming Environment for Data Analysis and Graphics.

Open Elective I

2SMTMT05- 2 Mechatronics

Lectures/week: 03 **Credits: 03**

Pre-requisites:

1. Knowledge of mechanical measurement systems

Course Learning Objectives:

CLO1. To study various types of switches, sensors, motors and their working.
CLO 2. To study various parts of mechatronic system.
CLO 3. To study various types of valves and their working.
CLO4. To understand and create pneumatic and hydraulic circuits for various industrial applications.

Course Outcomes:

At the end of course, Learner will be able to

1. Understand the importance and principles of various sensors,
2. Understand the working & applications of pneumatic, hydraulic & electric actuators for mechatronic systems.
3. Understand the computer processes, electronic circuits, and controllers for mechatronics systems.
4. Understand the working principles of various control valves in mechatronics systems.
5. Design pneumatic circuits for various industrial applications.
6. Design hydraulic circuits for various industrial applications

Section A

Unit 1: Introduction: Definition, Scope , Block diagram & Example. **Sensors-** selection, contact & non contact optical types, performance, Proximity Sensors & Switches, LVDT, Digital optical encoder, Temperature Sensors, Piezoelectric Transducers. **(6 Hrs.)**

Unit 2: Actuators: Principal, types of hydraulic, pneumatic, electrical actuators. Contact speed, multispeed, step and continuous variable, actuators with stepping motors. **(6 Hrs.)**

Unit 3: Computer process controls: Computer process interface, interface hardware, direct digital control, supervisory computer control. Design of mechatronics elements: Measuring system, control software and user interface, gauging, tool monitoring system, spindle drives, feed drives, servo principles, configuration CNC systems, interfacing, monitoring, diagnostics. **(6 Hrs.)**

Section B

Unit 4: Control Valves : Study of different control components and pneumatic & Hydraulic system- Construction, working and function of Directional control valve, Flow control valves, Pressure relief valve, Standard symbols for control valves. (**6 Hrs.)**

Unit 5: Pneumatic system: Different control components of pneumatic systems and there conversion valves, auxiliary devices, synchronizing, clamping, declamping, application to robotics. **(6 Hrs.)**

Unit 6: Hydraulic systems: Different control components of hydraulic systems, valves and auxiliary devices, design and analysis of hydraulic circuits sequencing, synchronizing, pneumo-hydraulic, CNC lubrication, machine tool applications. **(6 Hrs.)**

TEXT BOOKS :

1. Industrial Automation by Turgam, Mir Publication.
2. Pneumatics and Hydraulics by Stewar
3. Mechatronics – A multidisciplinary approach 4/e by W.Bolton- Pearson Publication

REFERENCE BOOKS :

1. Mechatronics by HMT
2. Introduction to Mechatronics and Measurment Systems by Michal B. Histand & David G. Aiciatore.

Open Elective I

2SMTMT05-3 COMPUTATIONAL FLUID DYNAMICS

Lectures/week: 03 **Credits:03**

Pre-requisites:

1. Basic knowledge about CAD Modeling.
2. Basic knowledge about governing equations.
3. Basic knowledge about linear differential equation.

Course Learning Objectives:

CLO 1: To numerically solve governing partial differential equations for physical problems in fluid mechanics and heat transfer.

CLO 2: To analyze different mathematical models and computational methods for transport processes.

CLO 3: To study, and apply discretization methods & schemes and analyze its effect on the accuracy of numerical solution and computational time.

CLO 4: To demonstrate the ability to use modern CFD software tools.

Course Outcomes: (05)

At the end of course, Learner will be able to

1. Numerically solve the governing partial differential equations of fluid flow and heat transfer problems.
2. Construct and solve the different mathematical models and computational methods for fluid flows.
3. Apply the discretization methods to solve fluid flow and heat transfer problems.
4. Choose and justify the CFD schemes for the respective fluid flow/transport phenomena problem.
5. Perform verification and validation of numerical model

SECTION – A

UNIT I. **Review of Governing Equations:** Governing Equations of Fluid flow and heat transfer, review of numerical methods.

UNIT II. **Discretization:** Introduction to finite differences, difference equations, explicit and implicit approaches: definition and contrasts, errors and analysis of stability.

UNIT III. **Classification of Partial Differential Equations:** Explicit and Implicit methods, solution of select model equations; Laplace heat and wave equation, laminar boundary layer solution

SECTION - B

UNIT IV. **CFD Techniques:** The lax -wendroff technique, Mac Cormack's technique, Relaxation technique and its use with low speed in viscid flows, aspects of numerical dissipation and dispersion; artificial viscosity,

UNIT V. **CFD Techniques:** Alternating Direction Implicit (ADI) technique, pressure correction technique with application to incompressible viscous flow.

UNIT VI. **Initial and Boundary Value Problems:** Free falling of a spherical.

BOOKS RECOMMENDED:

TEXT BOOKS :

1. Computational Fluid Flow and Heat Transfer, Muralidhar, K. and Sundararajan, T., Narosa Pub., 2004.
2. Computational Fluid Dynamics: The Basics with Applications, Anderson, J. D., Jr. McGraw Hill, 2002.
3. Computational Fluid Dynamics: An Introduction for Engineers, Abbot, M. B. and Basco, D. R., John Wiley & Sons, 2006.
4. Computational Fluid Dynamics: Principles and Applications, Blazek, J., Elsevier Science, 2001.

Open Elective I

2SMTMT05- 4 Cost Management of Engineering Projects

Lectures/week: 3 **Credits: 3**

Pre-requisites:

1. Knowledge of basic factors related to various types of costs.
2. Knowledge of project management.

Course Learning Objectives: (3 to 4)

CLO 1: Understand the concept of cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost.
CLO 2: Understand the Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution.
CLO 3: Understand the behaviour of profit planning, marginal costing, distinction between marginal costing and absorption costing, break-even analysis.
CLO 4: Able to analyze the linear Programming, PERT/CPM, Transportation Problems.

Course Outcomes: (06)

At the end of course, Learner will be able to

1. Understand the concepts of strategic cost management process.
2. Apply cost concepts in decision-making and cost management projects.
3. Implement various stages of project execution with a team project.
4. Analyse various decision-making problems.
5. Evaluate different qualitative techniques and cost behaviour.

SECTION A

Unit 1: **INTRODUCTION**

Introduction and Overview of the Strategic Cost Management Process.
Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

Unit 2: COST CONCEPTS

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.

Unit 3: **PROJECT MANAGEMENT**

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical 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.

SECTION B

Unit 4: **COST BEHAVIOR**

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, **(Hrs)**

Unit 5: **PROFIT PLANNING**

Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets. **(Hrs)**

Unit 6: **QUANTITATIVE TECHNIQUES**
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation Problems, Assignment problems, Simulation, Learning Curve Theory. **(Hrs)**

BOOKS RECOMMENDED:

Text Books :

1 Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting.
2 N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

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. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher.

2SMTMT05- 5 WASTE TO ENERGY

Lectures/week:04 **Credits 03**

Course Learning Objectives: (03)

CLO 1: Understand Waste-to-Energy Technologies
CLO 2: Evaluate Environmental and Economic Implications
CLO 3: Design and Implement Waste-to-Energy Solutions

Course Outcomes:

At the end of course, Learner will have

1. Comprehensive Understanding of Energy from Waste
2. Proficiency in Biomass Pyrolysis
3. Expertise in Biomass Gasification
4. Mastery of Biomass Combustion
5. Knowledge of Biogas Production
6. Competence in Biomass Conversion Processes

SECTION – A

Unit 1: Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors.
Unit 2: Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.
Unit 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.

SECTION - B

Unit 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.
Unit 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 –
Unit 6: 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.

References:

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

2SMTMT06 Research Methodology and IPR

Lectures/week: 2 **Credits: 2**

Course Learning Objectives:

CLO 1: To understand the role of research methodology, literature review process and formulation of a research problem
CLO 2: To understand data collection methods and statistical tools for data analysis
CLO 3: To learn technical writing skills required for research
CLO 4: To create awareness about intellectual property rights and research ethics

Course Outcomes:

Student will be able to:
CO 1: Understand the role of research methodology in Engineering
CO 2: Understand literature review process and formulation of a research problem
CO 3: Understand data collection methods and basic instrumentation
CO 4: Learn various statistical tools for data analysis
CO 5: Learn technical writing skills required for research
CO 6: Create awareness about intellectual property rights and patents

Section A

Unit 1: Definition of research, Characteristics of research, Types of research- Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical, Overview of research methodology in various areas, Introduction to problem solving, basic research terminology such as proof, hypothesis etc.

Unit 2: Literature review, sources of literature, various referencing procedures, Identifying the research areas from the literature review and research database, Problem Formulation, Identifying variables to be studied, determining the scope, objectives, limitations and or assumptions of the identified research problem, Justify basis for assumption, Formulate time plan for achieving targeted problem solution.

Unit 3: Important steps in research methods: Observation and Facts, Laws and Theories, Development of Models, Developing a research plan: Exploration, Description, Diagnosis and Experimentation

Section B

Unit 4: Static and dynamic characteristics of instruments, calibration of various instruments, sampling methods, methods of data collection, Basic Concepts concerning testing of hypotheses, procedures of hypothesis testing, generalization and interpretation

Unit 5: Introduction: Structure and components of scientific reports, types of report, developing research proposal. Thesis writing: different steps and software tools in the design and preparation of thesis, layout, structure and language of typical reports, Illustrations and tables, bibliography, referencing and footnotes,

Unit 6: IPR and ethics in Research: Intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of intellectual property rights Publishing: design of research paper, citation and acknowledgement, plagiarism tools, reproducibility and accountability.

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", SAGE Publications Ltd., 2011.
2. Wayne Goddard, Stuart Melville, "Research Methodology: An Introduction" JUTA and Company Ltd, 2004.
3. C.R. Kothari ,"Research Methodology: Methods and Trends", New Age International,2004
4. S.D. Sharma , "Operational Research", Kedar Nath Ram Nath & Co.,1972
5. B.L. Wadehra,"Law Relating to Patents,Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.
6. Donald Cooper, Pamela Schindler, "Business Research Methods", McGraw-Hill publication, 2005.

2SMTMT08 Advance Refrigeration Engineering LAB

Lectures/week:02 **Credits:02**

Course Learning Objectives (CLOs)

CLO 1: Identify the basic components of a refrigeration cycle. Obtain cooling capacity and coefficient of performance by conducting test on vapour compression refrigeration systems.

CLO 2: Study of various types of refrigeration systems for various applications like ice plant, water cooler etc.

CLO 3: Understand the basic air conditioning processes and study of the various equipment-operating principles, operating and safety controls employed in refrigeration air conditioning systems.

Course Outcome (COs)

1. Understand the fundamental basics of simple vapour compression system, types of refrigerants used in refrigearation.
2. Apply the knowledge different application of refrigeration and its controls.
3. Apply the concept of air conditioning system.

Practicals:

To study of analysis of actual vapour compression refrigeration system.
To study of vapour absorption refrigeration system.
Trial on cascade refrigeration system.
To study of non-conventional refrigeration system.
To study of thermodynamic properties of refrigerant.
To study of air refrigeration system.
Trial on vortex tube.
To study of various refrigeration component.