MALLA REDDY ENGINEERING COLLEGE (AUTONOMOUS)

Course Structure for M.Tech. Thermal Engineering

MR22 Regulations - Effective from Academic Year 2022 – 23

	SEMESTER-I						
Sl. No.	**Category**	**Course Code**	**Name of the Subject**	**Contact Hours**			**Credits**
				L	**T**	**P**	
1.	PCC	C3101	Advanced Thermodynamics & Combustion	3	1	-	4
2.	PCC	C3102	Process Heat and Mass Transfer	3	-	-	3
3.	PEC- I	C3113	Advanced Finite Element Analysis	3	-	-	3
		C3114	Computational Fluids Dynamics				
		C3115	Computer Simulations in SI & CI Engines				
4.	PEC- II	C3116	PDE & Numerical Techniques	3	-	-	3
		C3117	Thermal & Nuclear Power Plant Engineering				
		C3118	Nano Fluids				
5.	HSMC	C0H18	Research Methodology and IPR	2	-	-	2
6.	PCC	C3103	Advanced Thermal Engineering lab	-	-	3	1.5
7.	PCC	C3104	Advanced Heat and Mass Transfer Lab	-	-	3	1.5
8.	AC	C0A04	English for Research Paper Writing	2	-	-	-
			Total	**16**	**1**	**6**	**18**

SEMESTER-II							
Sl. No	**Category**	**Course Code**	**Name of the Subject**	**Contact Hours**			**Credits**
				L	**T**	**P**	
1.	PCC	C3105	Advanced Refrigeration & Air Conditioning	3	-	-	3
2.	PCC	C3106	Advanced Fluid Mechanics	3	-	-	3
3.	PCC	C3107	Advanced I.C. Engines	3	-	-	3
4.	PEC- III	C3119	Energy Conservation & Management	3	-	-	3
		C3120	Jet Propulsion & Rocket Engineering				
		C3121	Turbulence Modelling				
5.	PEC- IV	C3122	Exergy Analysis of Thermal Systems	3	-	-	3
		C3123	Alternate Fuels & Pollutions				
		C3124	New & Renewable Energy Sources				
6.	PCC	C3108	Computational Methods Lab	-	-	3	1.5
7.	PCC	C3109	Advanced Refrigeration & Air Conditioning Lab	-	-	3	1.5
8.	AC	C0A05	Value Education	2	-	-	-
			Total	**17**	**-**	**6**	**18**

SEMESTER-III							
Sl. No.	**Category**	**Course Code**	**Name of the Subject**	**Contact Hours**			**Credits**
				L	**T**	**P**	
1.	PEC- V	C3125	Equipment Design for Thermal Systems	3	-	-	3
		C3126	Thermal Measurement & Process Control				
		C3127	Advanced Materials for Thermal Systems				
2.	OE-I	C3228	Industrial Safety	3	-	-	3
		C0B20	Advanced Optimization Techniques				
		C1128	Waste to Energy				
3.	PROJ	C3110	Seminar	-	-	4	2
4.	PROJ	C3111	Project / Dissertation Phase - I	-	-	16	8
			Total	**6**	**-**	**20**	**16**

SEMESTER-IV							
Sl. No.	**Category**	**Course Code**	**Name of the Subject**	**Contact Hours**			**Credits**
				L	**T**	**P**	
1.	PROJ	C3112	Project / Dissertation Phase – II	-	-	32	16
			Total	**-**	**-**	**32**	**16**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3101	ADVANCED THERMODYNAMICS AND COMBUSTION	L	T	P
Credits: 4		3	1	-

Prerequisites: Engineering Thermodynamics

Course Objectives: The objectives of this course are to understand the advances in thermodynamics, real gases& mixtures, Combustion, statistical thermodynamics and sources of pollution.

Module I: First Law of Thermodynamics and Gas Mixtures [13 Periods]

First law of Thermodynamics – Equations of State for Ideal and Real Gases – Mass and Mole Fractions for Gas Mixture – Properties of Gas Mixtures – Fuels and Combustion – Theoretical and Actual Combustion Processes – Enthalpy of Formation and Enthalpy of Combustion – First Law Analysis of Reacting Systems – Adiabatic Flame Temperature.

Module II: Second Law of Thermodynamics [13 Periods]

Second Law of Thermodynamics – Entropy Change of Reacting Systems – Second Law Analysis of Reacting Systems – Criterion for Chemical Equilibrium – Equilibrium Constant for Ideal-Gas Mixtures – Chemical Equilibrium for Simultaneous Reactions – Gibbs Free Energy for Chemical Reactions

Module III: **Statistical Thermodynamics [12 Periods]**

Part – A: Some Useful Results from Classical Thermodynamics – Energy Levels – Boltzmann Distribution Law.
Part – B: Fermi-Dirac Statistics – Bose-Einstein Statistics – Chemical Statistics

Module IV: **Fuels andCombustion [13Periods]**

Fuels – Classification on the basis of chemical structure and Properties – Alternative Fuels – Combustion – Determination of Flame Velocity and Length – Flammability Limits and their use – Burning of Solid Particles – Diffusion and Kinetically Controlled Combustion – Combustion in Fluidized Beds

Module V: **Pollution [13Periods]**

Pollutants from different Sources – Estimation of Pollutants Emissions (HC, CO and NO_x) – Emission Indices – Emission Standards – Pollution Control Measures

TEXT BOOKS

1. Brian E. Milton, **"Thermodynamics, Combustion and Engines"**, School of Mechanical and Manufacturing Engineering, University of New South Wales, 3rd Edition, 2005

2. Yunus A. Cengel & Michael A. Boles, **"Thermodynamics: An Engineering Approach"**, McGraw Hill Education, 8th Edition, 2015
3. Richard E. Sonntag, Claus B., G. J. Van Wylen, **"Fundamentals of Thermodynamics"**, John Wiley & Sons, 6th Edition, 2003

REFERENCES

1. Irvin Glassman,**"Combustion"**, 2nd Edition, Academic Press, Inc. Harcourt Brace Jovanorich Pub., Orlando, 2002
2. Norman M. Laurendeau, **"Statistical Thermodynamics – Fundamentals and Applications"**, Cambridge University Press, 1st Edition, 2015
3. S.R. de Groot, **"Non Equillibrium Thermodynamics"**, Courier corporation, 1st Edition, 2013
4. J. P. Holman, **"Thermodynamics"**, McGraw Hill, 4th Edition, 1988
5. P.L. Dhar, **"Engineering Thermodynamics"**,Elsevier**,** 2008**.**
6. Bejan, A., "**Advanced Engineering Thermodynamics"**, John Wiley and Cons, 1988

E - RESOURCES

1. http://nptel.ac.in/courses/112103016/
2. https://www.journals.elsevier.com/the-journal-of-chemical-thermodynamics
3. http://nptel.ac.in/courses/101104063/
4. http://nptel.ac.in/courses/112105123/

Course Outcomes:

At the end of the course,students should be able to:

1. Apply the fundamentals of combustion.
2. Analyse the process of combustion in the perspective of second law of thermodynamics.
3. Apply the principles of the statistical thermodynamics in research areas.
4. Examine the phenomenon of combustion of fuels
5. Evaluate the level of pollution caused from different sources

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1					
CO2	1		2		1	
CO3	1		3	1	1	2
CO4	1		2	1	1	2
CO5	1		1	1	1	3

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3102	PROCESS HEAT AND MASS TRANSFER	L	T	P
Credits: 3		3	-	-

Pre-requisites: Thermodynamics, Heat Transfer

Course Objectives: To develop the ability to use the heat transfer concepts for various applications, thermal analysis and sizing of heat exchangers and understanding of the concepts of phase change processes and mass transfer.

Module I Conduction and Radiation Heat Transfer [10Periods]

One dimensional energy equations and boundary condition - three-dimensional heat conduction equations - extended surface heat transfer - conduction with moving boundaries - radiation in gases and vapour. Gas radiation and radiation heat transfer in enclosures containing absorbing and emitting media – interaction of radiation with conduction and convection.

Module II Turbulent Convective Heat Transfer [10Periods]

Momentum and energy equations - turbulent boundary layer heat transfer - mixing lengthconcept - turbulence model – k Є model - analogy between heat and momentum transfer – Reynolds, Colburn, Prandtl turbulent flow in a tube - high speed flows.

Module III Phase Change Heat Transfer and Heat Exchanger [10 Periods]

A: Phase Change Heat Transfer: Condensation with shears edge on bank of tubes - boiling – pool and flow boiling

B: Heat Exchanger: NTU – effectiveness approach – Design procedure – Compact Heat Exchangers –Compact heat exchangers – Plate Fin and Tubular Fin.

Module IV Numerical Methods in Heat Transfer [09Periods]

Finite difference formulation of steady and transient heat conduction problems – discretization schemes – explicit - Crank Nicolson and fully implicit schemes - control volume formulation steady one-dimensional convection and diffusion problems - calculation of the flow field –SIMPLER Algorithm

Module V Mass Transfer and Engine Heat Transfer Correlation [09 Periods]

Mass transfer - vaporization of droplets - combined heat and mass transfers - heat transfer correlations in various applications like I.C. engines, compressors and turbines.

TEXT BOOKS

1. Incropera F.P. and DeWitt. D.P., “Fundamentals of Heat & Mass Transfer”, John Wiley & Sons, 2002.
2. Yunus A.Cengal., “Heat and Mass Transfer – A practical Approach”, 3rd edition, Tata McGraw - Hill, 2007

3. Oziski, M. N. “Heat Transfer – A Basic Approach”, McGraw Hill, N. Y., 2001

REFERENCES

1. Ghoshdastidar. P.S., Heat Transfer, Oxford University Press, 2004.
2. Holman.J.P., Heat Transfer, Tata Mc Graw Hill, 2008.
3. Nag.P.K., Heat Transfer, Tata McGraw-Hill, 2002.
4. Ozisik. M.N., Heat Transfer – A Basic Approach, McGraw-Hill Co., 1985.
5. Yadav, R., Heat and Mass Transfer, Central Publishing House, 1995.
6. Yunus A. Cengal., Heat and Mass Transfer – A practical Approach, 3rd edition, Tata McGraw - Hill, 2007.

Course Outcomes:

At the end of the course, students should be able to:

1. Analyse the systems involving combination of conduction and radiation heat transfer.
2. Apply the convective heat transfer correlations to turbulence models
3. Design heat exchangers using the NTU and Effectiveness methods.
4. Use the numerical methods in heat transfer analysis.
5. Formulate the mass transfer correlations.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1			1
CO2	2		3	2		1
CO3	3		3	2		1
CO4	2		1	2	1	2
CO5	1		1			1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3113	ADVANCED FINITE ELEMENT ANALYSIS [Professional Elective – I]	L	T	P
Credits:3		3	-	-

Prerequisites: Nil

Course Objectives: The objective of the course is to understand principles of finite element modelling and analysis of 1D, 2D, 3D and Scalar Field Variable Problems.

Module I: Introduction [10Periods]

Introduction to FEM - comparison of FEM with other methods – H and P methods – Variational and weighted residual methods- Rayleigh – Ritz and Galerkin methods – Coordinate system

Element types, shape function. Element equation, stiffness matrix, boundary conditions. Global stiffness matrix- solution methods – Gauss elimination – Determination of nodal solutions.

Module II: 1D Problems [10Periods]

Finite Element modelling of bar element – Stiffness matrix, load vector, temperature effects, Quadratic shape functions and problems.

Plane Truss and Space Truss –Problems Beams - Shape functions – Stiffness matrix – Load vector – Problems.

Module III: 2D and 3D Problems [10Periods]

A: CST, LST and QST Elements - Stiffness matrix and Load vectors, boundary conditions, Isoparametric elements – Quadrilateral element, shape functions – Numerical Integration.

B**:** Axi-symmetric elements -solids subjected to Axi-symmetric loading. 3D elements- Tetrahedran element – Jacobian matrix – Stiffness matrix

Module IV: Application in Heat transfer and Fluid mechanics [09Periods]

1D Heat conduction- with convection end -Slabs – fins - 2D heat conduction problems - heat generation.

Fluid mechanics governing equations, weak form, finite element model for 1D problems, penalty finite element models, problems in two dimensional flow fields, finite element models of porous.

Module V: Transient and Non linear heat conduction [09Periods]

Transientheat conduction: Transient heat conduction governing equation- formulation – Jacobian matrix- stiffness matrix – 1D problems-2D problems. Galerkin's method to nonlinear transient heat conduction.

Non linear heat conduction: Governing equation with initial and boundary conditions, one dimensional nonlinear steady-state problems and transient state problems

TEXT BOOKS

1. SS Rao"**The Finite Element Methods in Engineering"** Elsevier Publisher, 5th Edition, 2010.
2. Tirupathi R. Chandrupatla, Ashok D. Belegundu **"Introduction to Finite Elements in Engineering"** Prentice – Hall, 3rd Edition, 2002.

REFERENCES

1. J. N. Reddy **"An Introduction to Finite Element Method",** McGraw Hill, 3rd Edition, 2006
2. O.C. Zienkiewicz **"The Finite element method in engineering science",**McGraw Hill, 2nd Edition,2007
3. Robert Cook **"Concepts and applications of finite element analysis",** Wiley, 3rd Edition, 1989
4. K.J Bathe **"Finite Element Procedures in Engineering analysis",**Prentice- Hall, 1982
5. G Ram Murthy **"Applied finite element analysis"**, I.K. International, 2nd Edition, 2010
6. Alavala, **"Finite Element Methods: Basic Concepts and applications"** , PHI, 2008

E - RESOURCES

1. http://www.colorado.edu/engineering/CAS/courses.d/AFEM.d/
2. https://cosmolearning.org/courses/advanced-finite-elements-analysis/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-094-finite-element-analysis-of-solids-and-fluids-ii-spring-2011/lecture-notes/
4. http://textofvideo.nptel.iitm.ac.in/112106130/lec2.pdf
5. http://nptel.ac.in/courses/112104115/1
6. http://nptel.ac.in/courses/112104115/2
7. http://nptel.ac.in/courses/112104115/3
8. http://nptel.ac.in/courses/112104115/4
9. http://nptel.ac.in/courses/112104115/5

Course Outcomes:

At the end of the course,students will be able to:

1. Formulate the FEM equations for simple objects using fundamental principles of FEM.
2. Apply FEMto solve 1D problems.
3. Solve the 2D and 3D problems using the FEM.
4. Analyse heat transfer and fluid flow systems using FEM.
5. Evaluate transient and non-linear heat conductionby using FEM.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2		2	2		
CO2	1			1		1
CO3			1	2		2
CO4			1	1		2
CO5	2		2	2		2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3114	COMPUTATIONAL FLUID DYNAMICS [Professional Elective – I]	L	T	P
Credit: 3		3	-	-

Pre-requisites: Nil

Course Objectives: The objective of this course is to understand the methods used to solve the fluid dynamics problems using numerical methods.

Module I: Introduction & Solution methods [10 Periods]

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations - finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

Module II:Hyperbolic equations [10 Periods]

Explicit schemes and Von Neumann stability analysis, implicit schemes, multistep methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge - Kutta method.

Module III:Discretization of Navier Stokes Equation [10 Periods]

A: Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach.

B: Staggeredgrid and Collocated grid, SIMPLE Algorithm, SIMPLER Algorithm, Discretization of the Momentum Equation using unstructured grid.

Module IV:Numerical Methods for Unstructured Grids [09 Periods]

Finite Volume Method (FVM) – Some Conceptual Basics and Illustrations through 1-D Steady State Diffusion Problems: Physical consistency, Overall balance, Finite Volume discretization of convection-diffusion problem: Central difference scheme, Upwind scheme, Exponential scheme and Hybrid scheme, Power law scheme, Generalized convection-diffusion formulation, Finite volume discretization of two-dimensional convection-diffusion problem, The concept of false diffusion, QUICK scheme, Introduction of Finite Element Method (FEM).

Module V: Turbulence Models [09 Periods]

Important features of turbulent flow, Vorticity transport equation, Statistical representation of turbulent flows: Homogeneous turbulence and isotropic turbulence, General Properties of turbulent quantities, Reynolds average Navier stokes (RANS) equation, Different types of turbulence model: Eddy viscosity models, Mixing length model, Turbulent kinetic energy

and dissipation, K-ε Models, More two-equation models: RNG K-εmodel and K-ω model, Reynolds stress model (RSM), Large eddy Simulation (LES),Direct numerical simulation (DNS)

TEXT BOOKS

1. Muralidhar, K., and Sundararajan, T., "**Computational Fluid Flow and Heat Transfer**", Narosa Publishing House, New Delhi, 1995
2. T. J.Chung, **"Computational fluid dynamics",** Cambridge University press, 2002.

REFERENCES

1. Sunderajan & Muralidaran "**Computational Fluid Flow and Heat Transfer",** Narosa Publications, 2nd Edition, 2010.
2. John D. Anderson, **"Computational Fluid Dynamics: Basics with applications", Mc**Graw-Hill, 2010.
3. Tapan K. Sengupta, "**Fundamentals of Computational Fluid Dynamics",** Universities Press, 2004.
4. C. Pozrikidis, **"Introduction to Theoretical and Computational Fluid Dynamics",** Oxford University Press, 2nd Edition, 2011.
5. Suhas V. Patankar, "**Numerical heat transfer and fluid flow"**, Hemashava Publishers Corporation & McGraw Hill.
6. Frank Choritonm, **"Text book of fluid dynamics"**, CBS Publishers & distributors, 1985
7. S. V. Patankar, **Numerical Heat Transfer and Fluid Flow**, McGraw-Hill.

E - RESOURCES

1. http://topics.sae.org/computational-fluid-dynamics/magazines/
2. https://www.cfd-online.com/Forums/main/97318-cfd-journals-their-impact-factors.html
3. http://nptel.ac.in/courses/112104030/
4. http://nptel.ac.in/courses/112105045/

Course Outcomes:

At the end of the course,students will be able to:

1. Apply the principles of CFD using governing equations.
2. Adopt the implicit and explicit methods for the hyperbolic equations.
3. Apply the solution methods for the incompressible flow problems.
4. Solve and analyse the Convection Heat Transfer problems using CFD methods and FEM.
5. Analyze the Turbulence Models in CFD analysis.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1	3	1	
CO2	1	1	2	1	1	1
CO3	1	1	2	1	1	1
CO4	1	1	2	1	1	1
CO5	1	1	2	1	1	1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3115	COMPUTER SIMULATION IN SI AND CI ENGINES [Professional Elective – I]	L	T	P
Credits: 3		3	-	-

Prerequisites: Thermodynamics, Automobile Engineering

Course Objectives: The objectives of the course to understand different methods of computer simulation and analysis of IC engine performance.

Module I: Simulation Principles [10 Periods]

First and second laws of thermodynamics – Estimation of properties of gas mixtures – Structure of engine models – Open and closed cycle models – Cycle studies – Chemical reactions – First law application to combustion – Heat of combustion – Adiabatic flame temperature – Hess Law-Le chatelier's principle. Heat transfer in engines – Heat transfer models for engines – Simulation models for IC Engines. (Ideal and actual cycle simulation) – Chemical equilibrium and calculation of equilibrium composition.

Module II: Simulation of Combustion in SI Engine [10 Periods]

Combustion in SI engines – Flame propagation and velocity – Single zone models – Multi zone models Mass – Burning rate – Turbulence models. One dimensional models – Chemical kinetics modeling – Multidimensional models – Flow chart preparation.

Module III: Simulation of Combustion in CI Engine [10 Periods]

A: Combustion in CI engines single zone models – Premixed-Diffusive models – Wiebe model – Whitehouse way model – Two zone models – Multizone models –

B: Meguerdichian and Watson's model – Hiroyasu's model – Lyn's model – Introduction to multidimensional and spray modeling – Flow chart preparation.

Module IV: Simulation of Two Stroke Engine [09 Periods]

Thermodynamics of the gas exchange process – Flows in engine manifolds – One dimensional and multidimensional models. Flow around valves and through ports models for scavenging in two stroke engines – Isothermal and non-isothermal models – Heat transfer and friction.

Module V: Simulation of Gas Turbine Combustors [09 Periods]

Gas Turbine Power plants – Flame stability – Combustion models for steady flow simulation – Emission models – Flow chart preparation.

TEXT BOOKS:

1. V. Ganesan, "**Computer Simulation of Spark Ignition Engine Processes"**, Universities Press, 2000.
2. V. Ganesan, "**Computer Simulation of Compression Ignition Engine Processes"**, Universities Press, 2000.

REFERENCES:

1. Cohen H. Rogers GEC. – "**Gas Turbine Theory"** – Pearson Education India Fifth edition, 2001.
2. Bordon P. Blair, "T**he Basic Design of two-Stroke engines"**, SAE Publications, 1990.
3. Horlock and Winterbone**,** "**The Thermodynamics and Gas Dynamics of Internal Combustion Engines"**, Vol. I & II, Clarendon Press, 1986.
4. J.I.Ramos, "**Internal Combustion Engine Modeling"**, Butterworth – Heinemann ltd, 1999.
5. J.N.Mattavi and C.A. Amann, "**Combustion Modeling in Reciprocating Engines"**, Plenum Press, 1980
6. Ashley S. Campbell**,** "**Thermodynamic Analysis of Combustion Engines"**, Krieger Publication Co, 1985

E - RESOURCES

1. https://support.dce.felk.cvut.cz/mediawiki/images/1/14/Dp_2008_lansky_lukas.pdf
2. https://pdfs.semanticscholar.org/c4b5/4979aaec0acc8b563c295446a41154f040d6.pdf
3. http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1097-0363
4. http://journals.sagepub.com/home/jer

Course Outcomes:

At the end of the course,students will be able to:

1. Interpret the principles of computer simulation.
2. Examine the computer simulation of SI engines
3. Evaluate the computer simulation of CI engines.
4. Assess the computer simulation of two stroke cycle engines.
5. Formulate the computer simulation of gas turbine combustors

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1		1	1	1
CO2	2		2	2	1	2
CO3	2		2	2	1	2
CO4	2		2	2	1	2
CO5	2		2	2	1	2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech (Thermal Engg) I Semester		
Code: C3116	PDE and Numerical Techniques	L	T	P
Credits: 3	[Professional Elective – II]	3	-	-

Pre-requisite: Numerical Methods

Course Objectives: The objective of this course is to familiarize the prospective engineers with techniques inMultivariate analysis. It deals with acquainting the students with standard concepts to advanced level that will serve them well towards tackling applications that they would find useful in their profession. To understand types of partial differential equations and their applications in Engineering.

Module – I: Approximation Theory [10Periods]

Polynomial and function interpolations, Orthogonal Collocations method for solving ODE-BVPs, Orthogonal Collocations method for solving ODE-BVPs with examples, Orthogonal Collocations method for solving PDEs with examples, Necessary and sufficient conditions for unconstrained multivariate optimization, Least square approximations

Module II: Partial Differential Equations: [10Periods]

Introduction to methods for solving sparse linear systems: Thomas algorithm for tridiagonal and block tridiagonal matrices

Introduction to PDE, Formation by eliminating arbitrary constants and arbitrary functions, Linear PDE(Lagrangian Equation), Non-Linear PDE of First order (Standard forms), Charpit's Method.

Introduction to higher order PDE, Homogeneous Linear equations with constant coefficients, Rules finding Complimentary functions, Rules finding Particular Integrals, Non Homogeneous Linear equations. Equations reducible to PDEs with constant coefficients.

Module III: Applications to Partial Differential Equations: [10Periods]

A: Application to one-dimensional wave equation. Interpolation: Linear Interpolation - Higher order Interpolation - Lagrange Interpolation – Interpolating polynomials using finites differences- Hermite Interpolation -piece-wise and spline Interpolation.

B: Finite Element Analysis implicit and Explicit Methods – ADI Methods Elliptic Equations: Laplace Equation, Poisson Equation, Iterative Schemes Dirchlet's Problem, Neumann Problem, mixed boundary value problem, ADI Methods.

Module - IV: [09Periods]

Numerical Integration: Method based on interpolation-method based on undetermined coefficient – Gauss – Lagrange interpolation method- Radaua integration method- composite integration method – Double integration using Trapezoidal and Simpson's method.

Module - V: **[09Periods]**

Projections and least square solution, Function approximations and normal equation in any inner product space, Model Parameter Estimation using linear least squares method, Gauss Newton Method, Gelarkin's method and generic equation forms arising in problem discretization, Errors in Discretization, Generaic equation forms in transformed problems

TEXT BOOKS:

1. J N Reddy,**"An Introduction to Non-Linear Finite Element Analysis"**, Oxford University Press
2. S.S. Shastry, **"Introductory Methods of Numerical Analysis"**, Prentice-Hall India Pvt. Ltd., Fourth Edition, 2006

REFERENCES:

1. Applied numerical analysis by – Curtis I.Gerala- Addission Wasley – published campus.
2. Numerical methods for Engineers Stevan C.Chopra, Raymond P.Canal Mc. Graw Hill book company.
3. C Language and Numerical methods by C.Xavier – New age international publisher.
4. Computer based numerical analysis by Dr. M.Shanta Kumar, Khanna Book publishers, New Delhi.

E Resources:

1. https://www.math.cmu.edu/~wn0g/2ch6a.pdf (Differential Calculus)
2. http://www.sam.math.ethz.ch/~hiptmair/tmp/NPDE10.pdf (Numerical Solution of Partial Differential Equations)
3. http://www.nptel.ac.in/courses/122104018/node120.html
4. https://mat.iitm.ac.in/home/sryedida/public_html/caimna/pde/second/second.html (Partial Differential Equations)
5. http://www.aidic.it/cet/16/51/055.pdf (Differential Calculus)
6. www.unige.ch/~hairer/preprints/coimbra.pdf
7. http://nptel.ac.in/courses/111103021/ (Partial Differential Equations)

Course Outcomes:

At the end of the course,students will be able to:

1. Apply the concept of iteration techniques to solve system of algebraic equations.
2. Use the concept of interpolation method in order to calculate the missed data in data analysis problems..
3. Examine advanced interpolation & Extrapolation techniques to solve some real problems.
4. Validate numerical differentiation and integration to calculate areas of a given data curves.
5. Solve ordinary differential equations of the Initial value problems by using various developed methods.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**		**2**	**1**	**1**	**1**
CO2	**2**		**2**	**1**	**1**	**1**
CO3	**3**	**1**	**3**	**2**	**2**	**1**
CO4	**2**		**1**	**2**		**2**
CO5				**1**	**1**	**1**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3117	THERMAL AND NUCLEAR POWER PLANT ENGINEERING [Professional Elective – II]	L	T	P
Credits: 3		3	-	-

Prerequisite: Thermal Engineering

Course Objectives: The objective of the course is to provide detailed knowledge of steam power plants, gas turbine power plants and nuclear power plants and of different aspects of power plant economics and instrumentation.

Module-I: Introduction andSteam Power Plants [10Periods]

Sources of Energy – Types of Power Plants – Direct energy conversion system –Energy sources in India – Recent developments in power generation – Combustion of coal: Volumetric analysis, Gravimetric analysis, Flue gas analysis.

Steam Power Plant - Introduction – General Layout – Modern coal-fired steam power plants – Power plant cycles – Fuel handling – Combustion equipment – Ash handling – Dust collectors – Steam Generators Types – Accessories – Feed water heaters – Performance of boilers – Water treatment – Cooling towers – Steam turbines – Compounding of turbines – Steam condensers –Jet and Surface condensers.

Module-II: Gas Turbine Power Plant [10 Periods]

Cogeneration – Combined cycle power plants – Analysis – Waste-Heat recovery – IGCC power plants – Fluidized bed combustion: Advantages and Disadvantages.

Module-III: Nuclear Power Plants: **[10Periods]**

Fundamentals: Nuclear Physics – Nuclear Reactors – Classification – Types of Reactors – Site selection – Methods of enriching Uranium – Applications of Nuclear power plants.**Plant Safety:** By-Products of Nuclear power generation – waste disposal -Economics of Nuclear power plants – Nuclear power plants in India – Future of Nuclear power.

Module-IV: Economics of Power Generation: [09Periods]

Factors affecting the economics – Load Factor – Utilization factor – Performance and operating characteristics of power plants – Economic load sharing – Depreciation – Energy rates – Criteria for optimum loading – Specific economic energy problems.

Module- V: Power Plant Instrumentation: [09Periods]

Classification – Pressure measuring instruments – Temperature measurement and Flow measurement – Analysis of combustion gases – Pollution: Types, Methods to Control.

TEXT BOOKS:

1. P.K. Nag, "**Power Plant Engineering"**, TMH, 4th Edition, 2014.
2. R.K. Rajput, "**Power Plant Engineering"**,Lakshmi Publications, 4th Edition, 2015.

REFERENCES:

1. P.C. Sharma, "**Power Plant Engineering"**,9th Edison Kataria Publications, 2013
2. Wakil, "**Power Plant Technology"**, TMH, Edition, 2010.
3. DipakSarkar, **"Thermal Power Plant – Design and Operation"**, Elsevier, 1st Edition, 2015.
4. Robin A. Chaplin, **"Thermal Power Plant; Vol. 1 – 3"**, Encyclopedia of Life Support Systems.
5. BahmanZohuri, Patrick McDaniel, **"Thermodynamics in Nuclear Power Plant Systems"**, Springer Publications, 2015.

E Resources:

1. http://indianpowersector.com/home/power-station/thermal-power-plant/
2. Http://www.nuclear-power.net/nuclear-power plant/
3. http://www.scielo.br/pdf/ea/v21n59/en_a04v2159.pdf
4. https://link.springer.com/journal/11509
5. http://www.scitechnol.com/nuclear-energy-science-power-generation-technology.php
6. http://nuclearengineering.asmedigitalcollection.asme.org

Course Outcomes:

At the end of the course,students will be able to:

1. Analyse the different components of steam power plant.
2. Analyse the performance of the gas turbine power plant.
3. Summarize the principles of operation and safety of nuclear power plant.
4. Analyze the economic considerations of power plants.
5. Examine the instrumentation requirement of power plants

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1		2	3	
CO2	2	1	2		3	
CO3	1	1		2		2
CO4	2	2	1	3		
CO5	1			2	3	1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C3118	NANO FLUIDS [Professional Elective – II]	L	T	P
Credits: 3		3	-	-

Pre-requisite: Nil

Course Objectives: The objective of the course is to understand the types, properties, boundary layer theory, heat transfer and applications of the Nano fluids

Module-I: Nano Fluids and its Properties [10Periods]

Introduction to nanofluids, nanostructured materials, base fluids, dispersion, sonication and stable suspension. Various types of nanofluids-volumetric concentration Thermophysical properties: Density; principles of measurement and apparatus –Theoretical equations and new empirical correlations to determine the density of different nanofluids – Viscosity: principles of measurement and apparatus – Andrade's and other theoretical equations and new empirical correlations to determine the viscosity of different nanofluids. Effect of volumetric concentration and temperature.Effect of subzero temperature on nanofluid viscosity.

Module-II: Thermal Behavior of Nano Fluids [10Periods]

Thermal conductivity: principles of measurement and apparatus – Hamilton-Crosser and other theoretical equations and new empirical correlations to determine the thermal conductivity of different nanofluids – Effect of volumetric concentration and temperature. Effect of Brownian motion on enhancing the thermal conductivity – Specific heat: principles of measurement and apparatus. Buongeorno's thermal equilibrium equation and other theoretical equations and new empirical correlations to determine the specific heat of different nanofluids – Effect of volumetric concentration and temperature.

Module-III: Boundary Layer theory of Nano Fluids [11 Periods]

A: Combined effects of thermophysical properties of nanofluids on the thermal diffusivity, the Prandtl number, the Reynolds number and the Nusselt number – Basic understanding of their effects on frictional loss and Heat transfer – Convective heat transfer: Single-phase fluid equations

B: laminar flow, entry length and fully developed friction factor and heat transfer coefficient. Graetz number effect in the entry region – Correlations for friction factor and Nusselt number for nanofluids – Turbulent flow: Single phase fluid fully developed flow Dittus-Boelter and Glienilski equations – Blasius and other turbulent friction factor correlations, their comparison with nanofluids data. New correlations for turbulent friction factor and Nusselt number for nanofluids.

Module-IV: Convective Heat Transfer and Heat Exchangers [11 Periods]

Principles of measurement and apparatus for the nanofluid convective heat transfer coefficient – Recent empirical relations for convection coefficient of various types of nano fluids.Effect of particle Pecletnumber – Effect of volumetric concentration – Application of nanofluids to various types of industrial heat exchangers – Heating capacity, mass flow, heat exchanger surface area, LMTD and pumping power for nanofluids versus conventional heat transfer fluids.

Module-V: Industrial Applications [11 Periods]

Application to building heating and cooling Comparison of nanofluids performance with glycol solution in hydronic coils – Application to automobile radiators. Comparison of the performance of nanofluids under arctic and sub-arctic temperatures with glycol solutions – Introduction to electronic cooling in micro channels with nanofluids.

TEXT BOOKS:

1. Sarit K. Das, Stephen U. Choi, Wenhua Yu, T. Pradeep, "**Nanofluids: Science and Technology**", Wiley-Blackwell,2008.
2. incenzo Bianco, Oronzio Manca, Sergio Nardini, Kambiz Vafai, "**Heat Transfer Enhancement with Nanofluids",** CRC Press, 2015.

REFERENCES:

1. C. Sobhan and G. Peterson "**Microscale and Nanoscale Heat Transfer**", CRC Press, 1st Edition,2008
2. F. M. White "**Fluid Mechanic**", 8th Edition, McGraw-Hill,2016
3. Bejan "**Heat Transfer**", John Wiley, 2nd Edition, 2007
4. H.S.Nalwa "**Handbook of Nanostructured Materials and Nanotechnology**" Vol. I and II -, I edition, American Scientific Publishers,2000.
5. Bharat Bhushan "**Springer Handbook of Nanotechnology**", Springer-Verlag publications,3rd edition,2010
6. J. Dutta, H. Hofman, "**Nano materials**" , Tata Mcgraw Hill,1998
7. Mark Ratner, Danier Ratner, "**Nano Technology**", Prentice Hall, 2002

E Resources:

1.http://cordis.europa.eu/result/rcn/58596_en.html
2.https://www.diva-portal.org/smash/get/diva2:712511/FULLTEXT01.pdf
3. http://www.sciencedirect.com/science/article/pii/S1877705814034936
4.https://www.hindawi.com/journals/jnm/2012/435873/
5.https://nanoscalereslett.springeropen.com/articles/10.1186/1556-276X-6-229
6.http://nptel.ac.in/courses/103106103/1
7.http://nptel.ac.in/courses/103106103/2
8.http://nptel.ac.in/courses/103106103/3
9.http://nptel.ac.in/courses/103106103/4

Course Outcomes:

At the end of the course,students should be able to:

1. Evaluate the different types of Nano fluids and their properties
2. Analyze the thermal behaviour of the Nano fluids using theoretical and empirical relations
3. Inspect the flow properties and heat transfer rates of Nano fluids
4. Apply the Nano fluids in heat exchanger and analyse the thermal behaviours
5. Summarize the various applications of the Nano fluids

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**2**		**2**	**1**	**2**	
CO2	**1**		**1**	**2**	**1**	
CO3	**2**		**2**	**1**	**2**	**1**
CO4	**2**		**3**	**2**	**2**	**2**
CO5	**1**		**1**		**1**	**1**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech (Thermal Engg) I Semester		
Code: C0H18	RESEARCH METHODOLOGY AND IPR (HSMC)	L	T	P
Credits: 2		2	-	-

Prerequisites: NIL

Course Objectives: The objective of the course is to make students familiar with the basics of research methodology and various types of Intellectual Properties, IPR legislations and policies.

MODULE-1 Research Problem [06 Periods]

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

MODULE – II Technical Writing & Research Proposal [07 Periods]

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

MODULE – III Intellectual Property Rights [06 Periods]

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

MODULE – IV Patent Rights [06 Periods]

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

MODULE – V Case Studies [07 Periods]

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

REFERENCES:

1. Prabhuddha Ganguli: ‘ Intellectual Property Rights” Tata Mc-Graw –Hill, New Delhi
2. M.Ashok Kumar and Mohd.Iqbal Ali: “Intellectual Property Right” Serials Pub.
3. Carlos M.Correa- **‘‘Intellectual property rights , The WTO and Developing countries”**-Zed books
4. Law relating to patents, trademarks, copyright designs, Wadehra, B.L. & 2 ed. Universal Law Publishing 2000.
5. C.R.Kothari, **“Research Methodology”** New Age International Publishers, Fourth edition, 2018.

6. Donald Cooper & Pamela Schindler, **"Business Research Methods",** TMGH, 9th edition.
7. Alan Bryman & Emma Bell, **"Business Research Methods"**, Oxford University Press.

E Resources:

1. https://www.wto.org/english/tratop_e/trips_e/trips_e.htm
2. https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm7_e.htm
3. http://nptel.ac.in/courses/110999906/
4. http://nptel.ac.in/courses/109105112/

Course outcomes:

At the end of the course, students will be able to:

1. Comprehend the concepts of research methodology and its concepts.
2. Realize the concepts of literature review and developing a research proposal.
3. Outline the basic concepts of Intellectual property rights.
4. Examine the types of patents and their procedures.
5. Recognize the recent developments in IPR administration

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**3**	**3**		**2**	**1**	**3**
CO2	**3**	**3**		**1**	**3**	**1**
CO3	**2**	**3**				
CO4	**1**	**1**		**1**	**1**	**1**
CO5	**1**	**1**			**1**	

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg.) I Semester		
Code: C3103	**ADVANCED THERMAL ENGINEERING LAB**	**L**	**T**	**P**
Credits: 1.5		**-**	**-**	**3**

Pre-requisites: Nil

Course Objectives: The objective of this course is to make students learn and understand application and performance of fuels, I.C. Engines, heat exchangers, solar systems, refrigerators and air conditioners.

List of Experiments:

1. Dryness fraction estimation of steam.
2. Flame propagation analysis of gaseous fuels.
3. Performance test and analysis of exhaust gases of an I.C. Engine.
4. Heat Balance test on variable compression ratio engine
5. Performance test on variable compression ratio engine
6. Volumetric Efficiency test and air fuel ratio estimation of an I.C. Engine.
7. Performance estimation of vapour compression refrigeration test rig.
8. Performance analysis of Air conditioning unit.
9. Performance analysis of heat pipe.
10. Performance analysis of solar Flat Plate Collector
11. Performance analysis of Evacuative tube concentrator
12. Performance test on the single cylinder variable compression ratio engine.

Course Outcomes:

At the end of the course,students will be able to:

1. Apply and analyze the fundamental concepts thermodynamics
2. Evaluate the performance of an internal combustion engine
3. Assess the effects of variation of compression ratio on the performance of engine.
4. Simulate the concepts of solar energy for different practical application.
5. Apply and analyze principles of refrigeration and air conditioning system.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	1		1	1
CO2	1	2	1		1	2
CO3	2	2	2	2	1	2
CO4	2	2	2	1	1	2
CO5	1	2	1		1	1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg.) I Semester		
Code: C3104	**ADVANCED HEAT AND MASS TRANSFER LAB**	**L**	**T**	**P**
Credits: 1.5		**-**	**-**	**3**

Pre-requisites: Nil

Course Objectives: The objective of this course is to make students' learn and understand application and performance of fuels, I.C. Engines, heat exchangers, solar systems, refrigerators and air conditioners.

List of Experiments:

1. Determine Effectiveness of Concentric Double Pipe Heat Exchanger
2. Analyse the effect of cooling load on wet bulb temperature
3. To draw the Heat balance sheet.
4. To determine emissivity of radiation surface with different finishers namely polished, gray, and metal black.
5. To Verify Stefan Boltzmann Law
6. To Verify Kirchhoff's Law
7. To determine heat flux & surface heat transfer co efficient at constant pressure for Drop wise and Film wise Condensation
8. Demonstration of flow boiling within the tube of Flow Boiling Unit
9. Calibration of Thermal conductivity Unit in Cartesian Coordinate system
10. Calibration of Thermal conductivity Unit in Cylindrical Coordinate system
11. Calibration of Thermal conductivity Unit in Spherical Coordinate system
12. To determine of thermal conductivity of liquids & gases

Course Outcomes:

At the end of the course,students will be able to:

1. Apply and analyze the fundamental concepts of Heat Exchangers
2. Examine the concepts of Thermal Radiation
3. Assess the fundamental concepts of Condensation
4. Inspect the Principle of Pool Boiling and Film Boiling
5. Calibrate the thermal conductivity unit and measure the thermal conductivity

CO- PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Program Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1		1	1
CO2	1	2	1		1	2
CO3	2	2	2	2	1	2
CO4	2	2	2	1	1	2
CO5	1	2	1		1	1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) I Semester		
Code: C0A04	**ENGLISH FOR RESEARCH PAPER WRITING**	**L**	**T**	**P**
Credits: Nil		**2**	**-**	**-**

Prerequisites: Nil

Course objective: The objective of the course is to provide the knowledge on structuring paragraphs, paraphrasing and preparation of research documents related to abstract, literature review, methods and results.

Module I: **[06 Periods]**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

Module II: **[07 Periods]**

Clarifying Who Did What, Highlighting Your Findings, Hedging and criticizing, paraphrasing and plagiarism, sections of a paper, abstracts. Introduction.

Module III: **[06 Periods]**

Review of the Literature, Methods, Results, Discussion, Conclusions, the Final Check.

Module IV: **[06 Periods]**

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,

Module V: **[07 Periods]**

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. Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

REFERENCES:

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's book .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

Course outcomes:

At the end of the course, students should be able to

1. Structure the sentences and paragraphs.
2. Elaborate the various sections of research papers.
3. Explore the check list in research documents.
4. Apply the key skills to coin the title, abstract, introduction and literature review.
5. Inspect the skills required for preparing experimental results and discussions.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Programme Outcomes(POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**2**			**2**	**1**
CO2		**2**			**2**	**1**
CO3		**2**			**2**	**1**
CO4		**2**			**2**	**1**
CO5		**2**			**2**	**1**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3105	ADVANCED REFRIGERATION & AIR CONDITIONING	L	T	P
Credits: 3		3	-	-

Pre-requisites: Refrigeration and Air Conditioning

Course Objectives: Students will be able understand the components and principle of working of vapour compression and vapour absorption refrigeration system and will be able to design air conditioning systems

Module-I Vapour Compression Refrigeration [10Periods]
Performance of Complete vapor compression system. Components of Vapor Compression System: The condensing unit – Evaporators – Expansion valve –Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

Compound Compression Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems

Module-II Cascading and Vapour AbsorptionRefrigeration [10Periods]
Production of low temperature – Liquefaction system ;Cascade System – Applications. Dry ice system.

Vapor absorption system – Simple and modified aqua – ammonia system – Representation on Enthalpy –Concentration diagram. Lithium – Bromide system Three fluid system – HCOP.

Module-III Unconventional Refrigeration Systems [10Periods]
A: Air Refrigeration: Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.

B: Steam Jet refrigeration system Representation on T-s and h-s diagrams – limitations and applications – Unconventional Refrigeration system – Thermo-electric – Vortex tube & Pulse tube – working principles

Module-IV Air conditioning & Cooling Load Estimation [9 Periods]
Air –conditioning: Psychrometric properties and processes – Construction of Psychrometric chart. Summer, Winter and year round air – conditioning systems.

Cooling load Estimation: Occupants, equipments, infiltration, duet heat gain fan load, Fresh air load. Air –conditioning Systems: All Fresh air, Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP,RSHF, ESHF and GSHF for different systems.

Module-V Automotive Air Conditioning [9 Periods]
Automotive air conditioning system layout, components - Compressor components - Condenser and high pressure service ports. Thermostatic expansion value - Expansion valve calibration - Controlling evaporator temperature - Evaporator pressure regulator - Evaporator temperature regulator. Automotive heaters - Manually controlled air conditioner - Heater system - automatically controlled air conditioner and heater systems - Automatic temperature control - Air conditioning protection. Recent trends in automotive air conditioning system.

TEXT BOOKS:

1. C.P. Arora, "**Refrigeration& Air Conditioning",**Tata McGraw-Hill Education, 2001
2. Arora and Domkundwar, **"Refrigeration & Air Conditioning,** Dhanpat Rai, 3rd Edition, 1980

RERERENCES:

1. Manohar Prasad **"Refrigeration and Air Conditioning"** New Age International, 2nd Edition, 2003.
2. Stoecker **"Refrigeration and Air Conditioning"** McGraw Hill, 2nd Edition, 1982.
3. Dossat **"Principles of Refrigeration",** Pearson, 4th Edition, 2009.
4. Ananthanarayana **"Refrigeration and Air Conditioning"** TMH, 4th Edition,2013.
5. Jordan **"Refrigeration and Air Conditioning",** Prentice Hall, 2nd Edition,1982.
6. Threlkeld **"Thermal Environmental Engg**", Prentice Hall, 3rd Edition,1998.

E Resources:

1.engineeringstudymaterial.net/tag/air-conditioning-and-refrigeration-books/
2.www.engineering108.com/.../Refrigeration_and_Air_Conditioning/
3.books.mcgraw-hill.com/engineering/PDFs/Miller.pdf

Course Outcomes

At the end of the course, students will be able to:

1. Summarize the simple and complex vapour compression refrigeration systems
2. Analyze cascading and vapour absorption refrigeration system
3. Illustrate the various unconventional refrigeration systems
4. Examine the cooling load for various environments
5. Infer the automotive refrigeration systems

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	**1**		**2**	**1**		
CO2	**2**		**2**	**1**	**1**	**1**
CO3	**1**	**1**		**2**	**2**	**1**
CO4	**1**		**1**	**1**		**2**
CO5	**1**		**2**	**2**	**1**	**2**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3106	**ADVANCED FLUID MECHANICS**	**L**	**T**	**P**
Credits: 3		**3**	**-**	**-**

Pre-requisites: Fluid Mechanics

Course Objectives: To provide detailed understanding of fluid mechanics and gas dynamics principles by studying the different types of fluid flows.

Module I: Basic Concepts and Fluid Flow Characteristics: [10 Periods]
Lagrangian and Eulerain descriptions of fluid motion – Path lines – Stream lines – Streak lines – Stream tubes – Velocity of a fluid particle – Types of flows –Three dimensional continuity equation- Stream and Velocity potential functions.

Basic Laws of Fluid Flow:Condition for irrotationality – Circulation & Vorticity – Accelerations in Cartesian systems: Normal and Tangential accelerations – Euler's equation – Bernoulli's equations in 3D – Continuity and Momentum equations.

Module II: Principles of Viscous Flow: [10Periods]
Derivation of Navier-Stokes equations for viscous compressible flow – Exact solutions to certain simple cases: Plain Poiseuille flow - Couette flow with and without pressure gradient - Hagen Poiseuille flow - Blasius solution.

Module III: Boundary Layer Concepts: [10Periods]
A: Prandtl's contribution to real fluid flows – Prandtl's boundary layer theory – Boundary layer thickness for flow over a flat plate – Approximate solutions of Navier-Stokes equations.

B: Creeping motion (Stokes) – Oseen's approximation – Von-Karman momentum integral equation for laminar boundary layer – Expressions for local and mean drag coefficients for different velocity profiles.

Module IV: Introduction to Turbulent Flow and Internal Flow: [09 Periods]
Fundamental concept of turbulence – Time averaged equations – Boundary layer equations – Prandtl mixing length model – Universal velocity distribution law: Van Driest model – Approximate solutions for drag coefficients – More refined turbulence models – K-epsilon model – Boundary layer separation and form drag – Karman vortex trail – Boundary layer control – Lift on circular cylinders

Internal Flow: Smooth and rough boundaries – Equations for velocity distribution and frictional resistance in smooth and rough pipes – Roughness of commercial pipes – Moody's diagram.

Module V: Fundamentals of Compressible Fluid Flow [09 Periods]
Thermodynamic basics – Equations of continuity, momentum and energy - Acoustic velocity Derivation of equation for Mach number – Flow regimes – Mach angle – Mach cone –

Stagnation state. Area variation – Property relationships in terms of Mach number – Nozzles, Diffusers – Fanno and Rayleigh Lines, Property relations – Isothermal flow in long ducts – Normal compressible shock, Oblique shock: Expansion and compressible shocks – Supersonic wave drag.

TEXT BOOKS:

1. S. K. Som, Gautam Biswas, Suman Chakraborty, "Introduction to Fluid Mechanics and Fluid Machines", McGraw Hill Publications, 3rd Edition, 2012.
2. D. Rama Durgaiah,"**Fluid Mechanics and Machinery"**, New Age International, 1st Edition,
   2007.

REFERENCES:

1. Yuan S.W, "**Foundations of Fluid Mechanics"**,Prentice-Hall, 1967
2. Pai,"**An Introduction to Compressible Flow"**,Literary Licensing, LLC, 2013
3. William F. Hughes & John A. Brighton "**Fluid Dynamics**", McGraw-Hill, 1967
4. W.M. Kays, M.E. Crawford **"Convective Heat and Mass Transfer"**, McGrawhill,4th Edition,2005
5. Schlichting H – "**Boundary Layer Theory"** Springer Publications,8thEdition, 2003.
6. R. K. Rajput **"Fluid Mechanics and Hydraulic Machines"**, S.Chand, 1st Edition, 2011.

E - RESOURCES

1. http://nptel.ac.in/courses/105101082/
2. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-63-advanced-fluid-dynamics-of-the-environment-fall-2002/lecture-notes/
3. http://www.issp.ac.ru/ebooks/books/open/Advanced_Fluid_Dynamics.pdf
4. https://www.elsevier.com/books/advanced-fluid-mechanics/graebel/978-0-12-370885-4

Course Outcomes:

At the end of the course,students will be able to:

1. Ascertain basic concepts in fluid mechanics
2. Apply the fundamentals of kinematics and conservation laws of fluid flow systems
3. Review the concepts of boundary layer and flow in transition
4. Analyse and apply the principles of turbulent flow to systems involving different fluid flows
5. Assess the principles of compressible flow to duct systems

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1			1		2
CO2	1			1		2
CO3	1			1		1
CO4	1		2	1		1
CO5	1		1	1		2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3107	**ADVANCED IC ENGINES**	**L**	**T**	**P**
Credits: 3		**3**	**-**	**-**

Pre-requisites: Automobile Engineering

Course Objectives: The objectives of this course is to introduce the students to engine types, design and operating parameters, gas exchange processes and charge motion, combustion in CI engines, pollutants formation and control and engine heat transfer.

Module I: Combustion in SI Engines [10 Periods]

Spark ignition Engine mixture requirements – Fuel – Injection systems – Monopoint, Multipoint injection, Direct injection – Stages of combustion – Normal and abnormal combustion – knocking- factors affecting knock – Combustion chambers – Introduction to super charging

Module II: Combustion in CI Engines [10 Periods]

Stages of combustion in CI Engine – Direct and indirect injection systems – Combustion chambers – Fuel spray behaviour – spray structure, spray penetration and evaporation – types of air motion– Introduction to Turbo charging

Module III: Pollutant Formation and Control [10 Periods]

A: Emissions from SI and CI engines - Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate emissions.

B: Emissions measurement methods – Exhaust Gas Treatment, Catalytic converter, selective catalytic reduction, Particulate Traps, Lean mixture- NOx Catalysts.

Module IV: Alternative fuels [09 Periods]

Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel – availability, Properties, Suitability, Merits and Demerits - Engine Modifications required

Module V: Recent trends [09 Periods]

Lean Burn engines and Adiabatic concepts – Rotary Engines –engine modification required for Biofuels – HCCI and GDI concepts-Plasma Ignition. Common Rail Direct Injection Systems - Hybrid Vehicles – NOx Adsorbers Onboard Diagnostics— Measurement techniques – laser Doppler, Anemometry

TEXT BOOKS

1. Heywood **"I.C. Engines Fundamentals",** McGraw Hill, 1st Edition, 2011.
2. Charles Fayette Taylor **"The I.C. Engine in theory and Practice",** MIT Press,Vol. I and Vol. II, 2nd Edition, 1995.

REFERENCES

1. Edward Frederic Obert, **"I.C. Engines"** International Textbook Co., 1st Edition, 1968.

2. V.L. Maleev, **"I.C. Engines – Theory and Design"**, McGraw Hill, 2nd Edition, 1975.
3. Lester C. Lichty, **"Combustion Engine Processes"**, 7th Edition, 1967.
4. Colin R. Ferguson, Allan T. Kirkpatrick, **"Internal Combustion Engines: Applied Thermosciences"**, 3rd Edition, 2015.
5. Switzer, **"Scavenging of Two – stroke Cycle Engines"**, 2nd Edition, 1990.
6. V.Ganesan, **"Internal Combustion Engines"**,4th Edition, 2012.

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6. www.enginetechnologyinternational.com/magazine_ar
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8. nptel.ac.in/courses/112104033/
9. nptel.ac.in/courses/112104033/

Course Outcomes:

At the end of the course,students will be able to:

1. Examine the combustion in SI engines.
2. Examine the combustion in CI engines.
3. Evaluate the various pollution formations from the S.I. and C.I. engines.
4. Explore the various alternative fuels used for IC engines.
5. Summarize the modern trends in IC engine.

CO- PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Program Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1	3	
CO2	1		2	1	3	
CO3	1	1		2		3
CO4	2	1		3	2	
CO5	1		2	3	2	

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3119	ENERGY CONSERVATION & MANAGEMENT [Professional Elective – III]	L	T	P
Credits: 3		3	-	-

Pre-requisites: Nil

Course Objectives: To understand the energy principles of energy conservation, energy audit, economic analysis and energy evaluation in the projects

Module I: Energy Conservation Principles [9 Periods]

Energy scenario – Principles of energy conservation - Commercial and noncommercial energy, primary energy resources, commercial energy production, final energy consumption. Indian energy scenario, sector-wise energy consumption. Energy needs of growing economy, long term energy scenario, energy pricing, energy security, role of energy managers in industries - Energy audit questionnaire – Energy conservation Acts.

Module II: Energy Conservation in Thermal Systems [9 Periods]

Energy conservation in thermal utilities like boilers, furnaces, pumps and fans, compressors, cogeneration - steam and gas turbines. Heat exchangers, lighting system, motors, belts and drives, refrigeration system.

Module III: Energy Conservation in Electrical Systems [9 Periods]

A: Electrical Systems - Demand control, power factor correction, load scheduling and shifting, motor drives, motor efficiency testing, energy efficient motors and motor speed control.

B: Demand side management - Electricity Act, lighting efficiency options, fixtures,day lighting, timers and energy efficient windows.

Module IV: Thermal Energy Conservation [9 Periods]

Case studies of Commercial/ Industrial/ Residential thermal energy conservation systems and their economical analysis.

Module V: Energy Management [9 Periods]

Organizational background desired for energy management persuasion, motivation, publicity role, industrial energy management systems. Energy monitoring and targeting - Elements, data, information analysis and techniques – Energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS). Economics of various energy conservation schemes – Energy policy and energy labeling.

TEXT BOOKS:

1. Reay, D. A., “Industrial energy conservation”, Pergamon Press, 1st edition, 2003.

2. White, L. C., "Industrial Energy Management and Utilization", Hemisphere Publishers, 2002

REFERENCES:

1. Beggs,Clive, "Energy – Management, supply and conservation", Taylor and Francis, 2nd edition, 2009.
2. Smith, C.B., "Energy Management Principles", Pergamon Press, 2006.
3. Hamies, "Energy Auditing and Conservation; Methods, Measurements, Management and Case study", Hemisphere, 2003.
4. Trivedi, P.R. and Jolka K.R., "Energy Management", Common Wealth Publication, 2002.

Course Outcomes:

At the end of the course,students will be able to:

1. Discuss and apply the energy conservation principles
2. Apply the energy conservation principles on thermal equipment.
3. Apply the energy conservation principles on electrical equipment.
4. Conduct the case problems on the thermal related equipment.
5. Analyze the energy management concepts and methods

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		1			1	1
CO2	1	2	1	2	1	1
CO3	1	2	1	2	1	1
CO4	2	3	1	2	2	2
CO5	2	1	1	2	2	2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3120	JET PROPULSION & ROCKET ENGINEERING [Professional Elective – III]	L	T	P
Credits: 3		3	-	-

Prerequisites: Advanced Fluid Mechanics

Course Objectives: To gain insight on the working principle of rocket engines, different feed systems, propellants and their properties and dynamics of rockets

Module I Gas Dynamics [10Periods]

Wave motion - Compressible fluid flow through variable area devices – Stagnation state Mach Number and its influence and properties, Isentropic Flow, Rayleigh and Fanno Flow. Deflagration and Detonation – Normal shock and oblique shock waves.

Module II Thermodynamics of Aircraft Engines [10Periods]

Theory of Aircraft propulsion – Thrust – Various efficiencies – Different propulsion systems – Turboprop – Ram Jet – Turbojet, Turbojet with after burner, Turbo fan and Turbo shaft. Variable thrust- nozzles – vector control.

Module III Performance Characteristics of Aircraft Engines [10 Periods]

A: Aircraft Engine - Aircraft matching – Design of inlets and nozzles

B: Performance characteristics of Ramjet, Turbojet, Scramjet and Turbofan engines.

Module IV ROCKET PROPULSION [09 Periods]

Theory of rocket propulsion – Rocket equations – Escape and Orbital velocity – Multi-staging of Rockets – Space missions – Performance characteristics – Losses and efficiencies

.**Module V ROCKET THRUST CHAMBER [09Periods]**

Combustion in solid and liquid propellant classification – rockets of propellants and Propellant Injection systems – Non-equilibrium expansion and supersonic combustion – Propellant feed systems – Reaction Control Systems - Rocket heat transfer.

REFERENCES

1. Bonney E.A., Zucrow N.J,. Principles of Guided Missile Design, Van Nostranc Co., 1956.
2. Khajuria P.R. and Dubey S.P., Gas Turbines and Propulsive Systems, Dhanpat Rai
3. Publications, 2003.
4. Mattingly J.D., Elements of Gas turbine Propulsion, McGraw Hill, 1st Edition, 1997.
5. Philip G. Hill and Carl R. Peterson, Mechanics and Thermodynamics of Propulsion, Second Edition, Addition – Wesley Publishing Company, New York, 2009.

6. S.M.Yahya, Fundamentals of Compressible Flow, Third edition, New Age International Pvt Ltd, 2003.
7. Zucrow N.J., Principles of Jet Propulsion and Gas Turbines, John Wiley and Sons, New
8. York, 1970.
9. Zucrow N.J., Aircraft and Missile Propulsion, Vol. I and Vol. II, John Wiley and Sons Inc, New York, 1975.

Course Outcomes:

At the end of the course,students will be able to:

1. 1. Apply the principle of gas dynamics for solution of relevant problems
2. Examine the principle of thermodynamics of aircrafts
3. Evaluate the performance characteristics of aircrafts
4. Establish the principle of rocket propulsion for the evaluation of its performance characteristics.
5. Assess the principle of functioning of Rocket thrust chamber

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		2		1	3	
CO2		2	2	1	3	
CO3	2		1	3	2	
CO4		2	1	1	3	
CO5	1			3	2	

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3121	TURBULENCE MODELING [Professional Elective – III]	L	T	P
Credits: 3		3	-	-

Pre - requisites: Advance Fluid Mechanics

Course Objectives: To gain the knowledge on turbulence, modeling, Probability Density Function (PDF) Modelling and Turbulence Experimental Techniques.

Module-I Introduction [10Periods]
Definition of turbulence, Characterization of turbulent flows. Statistical features Scales, Intermittency, Conditional Sampling, Quadrant analysis,Direct Numerical Simulation, Definitions, description of methodology, Advantages, disadvantages, Examples

Module-II One-Point Closure Modelling [10Periods]
Turbulent viscosity modelling -assumptions, models, strengths, weaknesses, k-epsilon modelling. Reynolds stress equation modelling-development of equations, Reynolds number similarity; realizability, assumptions, models, examples, rapid distortion theory, algebraic stress models

Module-III Large-Eddy Simulations [10Periods]
A: Large-Eddy Simulations -Background, history, definitions, Basic concepts Filtering methods. Filtered equations of motion, Modelling residual (sub grid-scale) stresses,

B: Dynamic Modelling-Numerical issues, Tests of modelling performance, Additional issues

Module-IV Probability Density Function (PDF) Modelling [09 Periods]
Probability Density Function (PDF) Modelling, Definitions, Brownian motion, Application to reacting flows, Monte-Carlo solutions

Module: V Turbulence Experimental Techniques [09 Periods]
Turbulence Experimental Techniques -Hot-wire anemometry (HWA), Requirement for good response, Constant current anemometer, constant temperature anemometer and constant voltage anemometer. Calculation of turbulence quantities, Measurement using an X-probe.Laser Doppler Velocimetry (LDV)- Optical heterodyne detection, LDA modes, Fringe model of dual beam mode, Back scatter mode, Particle Image Velocimetry

TEXT BOOKS:

1. Ching Jen Chen, **Fundamentals of Turbulence Modelling**, CRC Press, 1997
2. O. M. Belotserkovskii, **Turbulence: New Approaches**, Cambridge International Science Publications, 2005

REFERENCES:

1. Paul A. Libby, **An Introduction to Turbulence**
2. J.P. Holaman**, Experimental Methods for Engineers,** Mcgraw Hill Publications, 7e.

Course Outcomes:

After completion of the course, students will be able to:

1. Summarize the basic fundamentals of turbulence
2. Apply different mathematical models for analyses of turbulent flow and stresses
3. Simulate the large eddy phenomena
4. Examine the probability density function models
5. Analyze the experimentation for turbulence evaluation

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1			**1**	**1**		**1**
CO2	**1**		**2**	**2**	**1**	**1**
CO3	**2**		**2**	**2**	**1**	**1**
CO4	**2**		**2**			**1**
CO5	**2**		**2**	**2**	**1**	**2**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3122	EXERGY ANALYSIS OF THERMAL SYSTEMS [Professional Elective – IV]	L	T	P
Credits: 3		3	-	-

Pre-requisite: Advanced Thermodynamics and Combustion

Course Objectives: The objectives of this course are to understand the fundamental concepts of exergy analysis and to apply the concept for the evaluation of exergy for different types of processes and plants.

Module– 1: Basic Exergy Concepts [10Periods]

Classification of forms of Energy – Concept of Exergy – Exergy Concepts for Control Region – Physical Exergy – Chemical Exergy – Exergy Concepts for Closed System Analysis.

Module–II: Elements of Plant Analysis [10Periods]

Control Mass Analysis – Control Region Analysis – Avoidable and Intrinsic Irreversibilities –Criteria of Performance – Pictorial Representation of Exergy Balance – Exergy Based Property Diagrams.

Module–III: Exergy Analysis of Simple Processes [10Periods]

A: Expansion Process and Compression Process: Single Stage Expansion Process – Multi-stage Expansion Process – External Irreversibility in an Expansion Process – Expansion Process in Low Temperature Systems – Adiabatic Compressors – Non-adiabatic Compressors – Minimum Work of Compression – Multi-stage Adiabatic Compression Process.

B: Heat Transfer, Mixing & Separation and Chemical Processes: Forms of Irreversibility in Heat Transfer Processes – Rational Efficiency of Separation Process – Exergy of Separation – Chemical Components of Exergy – Physical Components of Exergy.

Module–IV: Examples of Chemical and Thermal Plant Analysis [09Periods]

Linde Air Liquefaction Plant – Sulphuric Acid Plant – Gas Turbine Plant – Refrigeration Plant.

Module–V: Thermoeconomic Applications of Exergy [09Periods]

Structural Coefficients – Thermodynamic non-equivalence of Exergy and Energy Losses – Case study of a CHP Plant – Optimization of Component Geometry.

TEXT BOOKS:

1. Kotas J.J., **"The Exergy Methods of Thermal Plant Analysis"**, 2nd Ed., Krieger Publ. Corp. U.S.A., 2000

2. Larry, C.W., Schmidt, P.S., and Schmidt, P.S. and David, R.B., **"Industrial Energy Management and Utilization"**, Hemisphere Pub. Corp., Washingto n, 2001

REFERENCES:

1. Seikan, Ishigai, "Steam Power Engineering, **"Thermal and Hydraulic Design Principles"**, Cambridge Univ., Press, 2000.

2. Turner, W.C., (Ed.), **"Energy Management Handbook"**, John Wiley & Sons, N.Y., 2002.

3. Dryden, I.G.C., **"The Efficient use of Energy"**, Butterworths, London, 2000

Course Outcomes:

At the end of the course,students should be able to:

1. Interpret the forms of exergy and evaluate exergy for basic processes
2. Summarize the elements of plant exergy analysis
3. Perform the Exergy analysis for various Expansion and Compression processes
4. Apply the Exergy analysis for various Heat transfer, Mixing & Separation and Chemical Processes.
5. Analyse the Practical Working thermal and chemical plant for Exergy evaluation.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**1**			**1**	
CO2		**1**			**1**	
CO3	**1**		**1**	**2**	**1**	**1**
CO4	**2**		**2**	**1**	**1**	**1**
CO5	**3**		**3**	**2**		**2**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3123	ALTERNATE FUELS AND POLLUTIONS [Professional Elective – IV]	L	T	P
Credits: 3		3	-	-

Pre-requisites: Nil

Course Objectives: The objective of the course is to provide knowledge on the energy scenario, energy crisis, sources and availability of alternate fuels.

Module I: Introduction [10 Periods]

Estimation of petroleum reserve – World Energy Scenario – Energy survey of India – Oil industry background and history – Survey of oil consumption - Availability of petroleum products –Uses- Types - Air craft fuels. Alternate fuels –Need for alternate fuels –List and source of alternate fuels– Availability of alternate fuels.

Module II: Alcohols [10 Periods]

Introduction – Properties of alcohol as fuel – Uses of alcohol fuels – Alcohol availability – Alcohol production – Methanol – Ethanol – Impact of incremental vehicle cost – Vehicle technology. Use of low level blends – Vehicle emission – Dedicated vehicles – Fuel flexible vehicle – Variable fuelled vehicle – Air quality benefits of alcohol fuels – Methanol vehicles – Fuel characteristics – Fuel additives – Handling of methanol – Methanol: health and safety.

Module III: Natural Gas, LPG, Hydrogen and Biogas [10 Periods]

A: Availability of CNG – LPG- Automotive gasoline – Composition – Types – Properties – Additives – Effect of emissions – Modification required in engines.

B: Performance and emission characteristics of CNG, LPG and biogas in SI & CI engines — Hydrogen: Storage and handling, performance and safety aspects- Biogas –

Module IV: Vegetable and Plant Oils [09 Periods]

Introduction –types of vegetable oils for engines - availability – preparation methods - Esterification — properties - Performance and emission characteristics.

Module V: Pollutant Formation and Control [09 Periods]

Pollutant – Sources – Formation of carbon monoxide, Unburnt hydrocarbon, NOx,Smoke and Particulate matter – Methods of controlling Emissions – Catalytic convertersand Particulate Traps – Methods of measurements and Introduction to emission normsand Driving cycles.

TEXT BOOKS

1. S.S. Thipse, "**Alternative Fuels**" Jaico Publishing House, 2010
2. Erjavec Jack Et.Al, "**Alternative Fuel Technology: Electric, Hybrid, and Fuel-Cell Vehicles"**,Cengage India, 2007.

REFERENCES

1. Nagpal"**Power Plant Engineering"**, Khanna Publishers, 1991.
2. "**Alcohols and motor fuels progress in technology"**, Series No.19, SAE Publication USA 1980.
3. "**The properties and performance of modern alternate fuels"** – SAE Paper No.841210
4. Bechtold R.L., "**Alternative Fuels Guide Book"**, SAE, 1997.
5. IC engines by V. Ganesan, 4th edition, 2012.
6. IC Engines by M L Mathur & R P Sharma, DhanpatRaiPublications.2010

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2. https://www.slideshare.net/meichilo/12-alternative-fuelspdf
3. https://www.worldenergy.org
4. www.afdc.energy.gov
5. https://www.journals.elsevier.com/fuel/
6. http://www.academicjournals.org/journal/JPTAF
7. http://nptel.ac.in/courses/113104008/
8. http://nptel.ac.in/courses/112104033/39

Course Outcomes:

At the end of the course, students will be able to:

1. Interpret the need and availability of energy resources.
2. Summarize the performance evaluation of alcohol fuels.
3. Outline the availability, compositions and use of natural gas, LPG, hydrogen and biogas.
4. Identify and use vegetable oils as a fuel for IC engines.
5. Infer the principle and working of electric, solar and hybrid vehicles

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2			1	2
CO2	2		1		1	2
CO3	1	1			1	1
CO4	2	1	2	1	1	2
CO5		1			1	3

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3124	NEW & RENEWABLE ENERGY SOURCES [Professional Elective – IV]	L	T	P
Credits: 3		3	-	-

Prerequisites: Nil

Course Objectives: To explain concept of various forms and utilization of renewable energy sources and their domestic and industrial applications.

Module I: Commercial Energy [9 Periods]

Coal, Oil, Natural gas, Nuclear power and Hydro - their utilization pattern in the past, present and future projections of consumption pattern - Sector-wise energy consumption – environmental impact of fossil fuels – Energy scenario in India – Growth of energy sector and its planning in India.

Module II: Solar Energy [9 Periods]

Solar radiation at the earth's surface – solar radiation measurements – estimation of average solar radiation - solar thermal flat plate collectors - concentrating collectors – solar thermal applications - heating, cooling, desalination, drying, cooking, etc – solar thermal electric power plant - principle of photovoltaic conversion of solar energy, types of solar cells – Photovoltaic applications: battery charger, domestic lighting, street lighting, water pumping etc - solar PV power plant – Net metering concept.

Module III: Wind Energy [9 Periods]

A: Nature of the wind – power in the wind – factors influencing wind – wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection.B: Wind energy conversion devices - classification, characteristics, applications – offshore wind energy - Hybrid systems - safety and environmental aspects – wind energy potential and installation in India - Repowering concept.

Module IV Bio-Energy [9 Periods]

Biomass resources and their classification - Biomass conversion processes - Thermo chemicalconversion - direct combustion – biomass gasification - pyrolysis and liquefaction – biochemical conversion - anaerobic digestion - types of biogas Plant - applications - alcohol production from biomass – bio diesel production – Urban waste to energy conversion - Biomass energy programme in India.

Module V Other Types of Energy [9 Periods]

Ocean energy resources - principle of ocean thermal energy conversion (OTEC) - ocean thermal power plant - ocean wave energy conversion - tidal energy conversion – small hydro geothermal energy - geothermal power plant – hydrogen production and storage - Fuel cell – principle of working - various types - construction and applications.

TEXT BOOKS:

1. Sukhatme S.P., "Solar Energy", Tata McGraw Hill, 1984.
2. Twidell J.W. and Weir A., "Renewable Energy Sources", EFN Spon Ltd., 1986.
3. Kishore V.V.N., "Renewable Energy Engineering and Technology", Teri Press, New Delhi, 2012

REFERENCES:

1. Peter Gevorkian, "Sustainable Energy Systems Engineering," McGraw Hill,2007.
2. Kreith F. and Kreider J.F., "Principles of Solar Engineering", McGraw-Hill, 1978.
3. Godfrey Boyle, "Renewable Energy Power for a Sustainable Future", Oxford University Press, U.K, 1996.
4. Veziroglu T.N., Alternative Energy Sources", Vol 5 and 6, McGraw-Hill, 1990.
5. Anthony San Pietro, "Biochemical and Photosynthetic aspects of Energy Production", Academic Press, 1980.
6. Bridgurater A.V., "Thermochemical processing of Biomass", Academic Press, 1981.
7. Bent Sorensen, "Renewable Energy", Elsevier, Academic Press, 2011.

Course Outcomes:

At the end of the course, students will be able to:

1. Identify the commercial energy and renewable energy sources.
2. Summarize the various methods of harvesting the solar energy systems.
3. Examine the various methods of harvesting the wind energy systems
4. Evaluate the various methods of harvesting the bio energy systems
5. Assess the various methods of harvesting the other renewable energy systems

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**1**			**1**	**2**
CO2		**1**			**1**	**2**
CO3		**1**		**1**	**1**	**2**
CO4				**1**	**1**	**2**
CO5				**1**	**1**	**2**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3108	**COMPUTATIONAL METHODS LAB**	**L**	**T**	**P**
Credits: 1.5		**-**	**-**	**3**

Course Objectives: The objective of the course is to learn computational methods for thermal applications.

List of Experiments:

1. Write a program to solve one dimensional steady state heat conduction boundary value problem.
2. Write a program to solve one dimensional transient heat conduction equation using explicit finite difference method.
3. Write a program to solve one dimensional transient heat conduction equation using explicit finite difference method.
4. Write a program to solve one dimensional transient heat conduction equation using implicit finite difference method.
5. Write a program to solve two dimensional steady state heat conduction equation using finite difference method.
6. Write a program to solve one dimensional linear wave equation using finite difference method and also analyze the dispersion and dissipation error.
7. Determine the nodal temperature of any one composite wall using simulation software.
8. Transient thermal analysis of a steel ball using CFD software.
9. CFD analysis of flow through a diverging section using CFD software.
10. Analysis of flow through converging section using CFD software.
11. Analysis of convection heat transfer of a bar in air using CFD software.
12. Determine the flow properties after mixing of two fluids in a duct using CFD software.

Course Outcomes:

At the end of the course the students should be able to:

1. Evaluate heat transfer problem using software program.
2. Simulate the fluid flow problems in software.
3. Solve one dimensional linear wave equation
4. Get acquaintance with C/C++ software programming in respect of thermal related problems
5. Solve complex CFD problem using CFD software.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	1	2	1	1
CO2	3	1	1	2	1	1
CO3	3	1	1	2	1	1
CO4	3	1	1	2	1	1
CO5	3	1	1	2	1	1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C3109	**ADVANCED REFRIGERATION & AIR CONDITIONING LAB**	**L**	**T**	**P**
Credits: 1.5		**-**	**-**	**3**

Course Objectives: The objective of this course is to apply different principles and analyse phenomena of refrigeration and air conditioning

List of Experiments:

1. Determination of the refrigerating effect and work input, actual and theoretical COP of the refrigeration system
2. Determination of the compressor efficiency at varying functioning condition of given refrigeration system.
3. Determination of co-efficient of performance of the given unit when working as heat pump.
4. Determination of co-efficient of performance of the unit when working as refrigerator.
5. Determination of tower efficiency and humidification effect through the exchange of heat between air and water in a cooling tower.
6. Preparation of heat balance sheet for the given cooling tower.
7. Experiment on the air conditioning test rig for the determination of quality of air.
8. Determination of COP of the thermoelectric refrigeration system
9. Performance analysis at Temperature variations for thermoelectric refrigeration.
10. Determination of quality of air for given air conditioning system
11. Effect of properties of refrigerant on the functioning of refrigeration system
12. Load calculation for air conditioning

Course Outcomes:

At the end of the course, students should be able to:

1. Determine and analyze the COP of refrigeration systems
2. Evaluate the efficiency of refrigeration compressors
3. Estimate the COP of the heat pump
4. Examine the performance of the cooling tower
5. Inspect the quality of air at various conditions

CO- PO Mapping
(3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

COs	Program Outcomes (POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1		1	1
CO2	1	2	1		1	2
CO3	2	2	2	2	1	2
CO4	2	2	2	1	1	2
CO5	1	2	1		1	1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) II Semester		
Code: C0A05	**VALUE EDUCATION**	**L**	**T**	**P**
Credits: Nil		**2**	**-**	**-**

Pre - requisites: Nil

Course Objectives: The course deals about value of education and self- development, Imbibe good values in students and know about the importance of character.

Module -I **[06 Periods]**

Values and self-development –Social values and individual, attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements.

Module -II **[07 Periods]**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism.Love for nature ,Discipline

Module -III **[06 Periods]**

A: Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality.

B: Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Module -IV **[07 Periods]**

Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature.

Module -V **[06 Periods]**

Character and Competence – Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence ,Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively

TEXT BOOKS:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Course Outcomes:

At the end of the course, students should be able to:

1. Understand the self-development and moral values
2. Explore the importance of character, cultivation of values
3. Apply the personality development methods
4. Analyze the association and cooperation principles
5. Elaborate the principles of religions,good health science.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1					**2**	**2**
CO2					**2**	**2**
CO3					**2**	**2**
CO4					**2**	**2**
CO5					**2**	**2**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code: C3125	EQUIPMENT DESIGN FOR THERMAL SYSTEMS [Professional Elective – V]	L	T	P
Credits: 3		3	-	--

Pre Requisites: Heat Transfer

Course Objectives: The objective of the course is to understand the principle of heat exchanger design, working and parameters affecting the heat exchangers.

Module-I: **Classification& Design of Heat Exchanger [10Periods]**

Classification of Heat Exchangers:

Introduction, Recuperation & Regeneration – Tubular heat exchangers: Double pipe, Shell & tube heat exchanger – Plate heat exchangers – Gasketed plate heat exchanger – Spiral plate heat exchanger – Lamella heat exchanger – Extended surface heat exchanger: Plate fin and Tubular fin.

Design of Heat Exchangers:

Introduction – Basic equations in design – Overall heat transfer coefficient – LMTD method for heat exchanger analysis – Parallel flow, Counter flow, Multipass, Cross flow heat exchanger design calculations.

Module – II: Double Pipe and Shell & Tube Heat Exchangers [10Periods]

Double Pipe Heat Exchanger: Film coefficient for fluids in annulus – Fouling factors – Calorific temperature – Average fluid temperature – Calculation of double pipe exchanger – Double pipe exchangers in series-parallel arrangements.

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

Module-III: Condensers [10Periods]

A:Horizontal condenser, vertical condenser – De-super heater condenser – verticalcondenser-subcooler – horizontal condenser-subcooler – Vertical reflux type condenser – Condensation of steam.

B:Estimation of heat transfer coefficient, Fouling factor, Friction factor. Design procedures, Wilson plots, Designing different types of condensers, BIS Standards, Optimization studies**.**

Module–IV: Evaporators and Extended SurfacesEvaporators [09Periods]

Vaporizing processes – Forced circulation vaporizing exchangers – Natural circulation vaporizing exchangers – Calculations of a reboiler.

Extended Surfaces:Longitudinal fins – Weighted fin efficiency curve – Calculation of a double pipe fin efficiency curve – Calculation of a double pipe finned exchanger – Calculation of a longitudinal fin shell and tube exchanger.

Module- V: Direct Contact Heat Exchanger [09Periods]

Cooling towers – Relation between wet bulb & dew point temperatures – Lewis number – Classification of cooling towers – Cooling tower internals and the roll of fill – Heat balance.

Heat transfer by simultaneous diffusion and convection – Analysis of cooling tower requirements – Design of cooling towers – Determination of the number of diffusion modules – Calculation of cooling tower performance.

Text books:

1. A.P. Fraas and M.N. Ozisick "**Heat Exchanger Design",** John Wiley & sons, 2nd Edition, 1989
2. Ramesh K. Shah, Dusan P. Sekulic, **"Fundamentals of Heat Exchanger Design"**, , John Wiley & Sons, 11-Aug-2003

References:

1. J.P. Gupta, **"Fundamentals of Heat Exchanger and Pressure Vessel Technology"**, Hemisphere Publishing Company, Washington, 1986
2. F.G. Shinakey, **"Process Control Systems"**, McGraw-Hill, New York, 1979
3. S. K. Das, "**Process Heat Transfer",** Narosa Publishing House, 2005
4. Taborek.T, Hewitt.G.F and Afgan.N, **Heat Exchangers**, Theory and Practice, McGraw-Hill Book, Co. 1980.
5. Sadik Kakac and Hongtan Liu, "**Heat Exchangers Selection"**, Rating and Thermal Design, CRC Press, 2002
6. J.D. Gurney "**Cooling Towers",** Maclaren, 2007
7. D.Q. Kern "**Process Heat Transfer",** McGraw-Hill College, 1st Edition, 1950

E Resources:

1. http://nptel.ac.in/courses/103103027/pdf/mod1.pdf
2. http://www.mie.uth.gr/ekp_yliko/CEP_Plate_and_Frame_HX.pdf
3. http://www.energy.kth.se/compedu/webcompedu/ManualCopy/Steam_Boiler_Technology/Heat_exchangers/thermal_design_of_heat_exchangers.pdf
4. http://heattransfer.asmedigitalcollection.asme.org/journal.aspx
5. https://www.ijret.org/
6. http://www.ijraset.com/

Course Outcomes:

At the end of the course, students will be able to:

1. Apply the principle and design of heat exchangers
2. Analyze the performance of double pipe and shell & tube heat exchangers.
3. Assess the performance of condensers
4. Examine performance of evaporators and extended surfaces
5. Evaluate the performance of direct contact heat exchangers

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1				1	1
CO2	1		1	1		1
CO3	2		2	2	1	2
CO4	2		2	2	1	2
CO5	1		3	2	1	2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code: C3126	THERMAL MEASUREMENTS AND PROCESS CONTROLS [Professional Elective – V]	L	T	P
Credits: 3		3	-	-

Prerequisite: Instrumentation, Meterology

Course Objectives: The objective of the course is impart the knowledge on the measurement principles of pressure, flow, temperature, level, velocity and density using different methods and their application in process control.

Module-I: Measurement Principles and Pressure Measurement[10Periods]

Elements of measuring instrument – Static and dynamic characteristics – Errors in instruments – Different methods of measurement and their analysis – Sensors and transducers.

Measurement of pressure: Principles of pressure measurement – Static and dynamic pressure – Vacuum and high pressure measuring – Measurement of low pressure – Manometers – Calibration methods – Dynamic characteristics – Design principles.

Module-II:Flow Measurement [10 Periods]

Obstruction meters – Variable area meters – Pressure probes – Compressible fluid flow measurement – Thermal anemometers – Calibration of flow measuring instruments – Introduction to design of flow measuring instruments.

Module-III: **Temperature Measurement [10Periods]**

A: Principles of Temperature Measurement – Bimetallic thermometers – Mercury thermometers – Vapor pressure thermometers – Thermo-positive elements

B: Thermocouples in series and parallel – Pyrometry – Measurement of heat flux – Calibration of temperature measuring instruments – Design of temperature measuring instruments.

Module-IV: Level, Density and Velocity Measurement [09Periods]

Direct and indirect methods – Manometric methods – Float level meters – Electrical conductivity, Capacitive, Ultrasonic, and Nucleonic Methods.

Measurement of density – Hydrometer, Continuous weight method, Gamma rays, Gas impulse wheel. Velocity measurement – Coefficient of viscosity, Ostwald method, Free fall of piston under gravity, Torque method.

Measurement of moisture content and humidity – Measurement of thermal conductivity of solids, liquids and gases.

Module-V: Process Control [09Periods]

Introduction and need for process control principles – Transfer functions – Block diagrams – Signal flow graphs – Open and closed loop control systems – Analysis of First & Second order systems with examples of mechanical and thermal systems – Control system evaluation – Stability – Steady state regulations and transient regulations.

TEXT BOOKS:

1. E.O. Doebelin, **"Measurement Systems**,McGraw-Hill, 6th Edition, 2012
2. M. Gopal, **"Control Systems, Principles & Design"**, TMH, 3rd Edition, 2008.

REFERENCES:

1. R.K. Jain, "**Mechanical and Industrial Measurements"**, Khanna Publishers,11th Edition, 2013.
2. Beckwith, **"Mechanical Measurements"** Pearson, 6th Edition, 2007.
3. Norman A. Anderson, **"Instrumentation for Process Measurement and Control"**, CRC Press, 1997.
4. Thomas A. Hughes, **"Measurement and Control Basics"**, ISA Press, 3rd Edition, 2002.
5. Curtis D. Johnson, **"Process Control Instrumentation Technology"**, Pearson Education, 8th Edition, 2014.

E Resources:

1. journals.sagepub.com/doi/abs/10.1177/030641909402200404
2. https://books.google.co.in/books?isbn=1118881273
3. https://www.journals.elsevier.com/mechanical-systems-and-signal-processing
4. https://dynamicsystems.asmedigitalcollection.asme.org/
5. nptel.ac.in/courses/112106138/
6. nptel.ac.in/courses/112106140
7. www.nptelvideos.in/2012/12/principles-of-mechanical-measurements.html
8. http://nptel.ac.in/courses/112106138/

Course Outcomes:

At the end of the course, students should be able to:

1. Apply the fundamentals of measurement and the measurement of pressure
2. Infer the flow measurement techniques.
3. Apply the knowledge of the temperature measurement on various solids and fluids
4. Evaluate the knowledge on the level, velocity and density measurements.
5. Assess the measurement control methods on the feedback analysis

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1				1	
CO2	1		1	2	2	
CO3	1		1	1	1	1
CO4			2	2	2	1
CO5	2		2	2	2	2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code: C3127	ADVANCED MATERIALS FOR THERMAL SYSTEMS [Professional Elective – V]	L	T	P
Credits: 3		3	--	-

Pre-requisites: Material Science

Course Objectives: The objective of the course is to understand the mechanical properties various materials and their applications in nuclear power plant, solar cell, unconventional power generation and energy storage

Module– I: Review of Mechanical Properties [10Periods]

Fundamentals – Tensile, Hardness, and Impact Testing – Use of the stress-strain diagram – brittle materials – Hardness of materials – Strain rate effects and impact behaviour – Heat treatment of steels and cast irons and classification of steels, Simple heat treatments, Isothermal heat treatments, Quench and temper heat treatments, Surface treatments – Weldability of Steel.

Fracture mechanics – Importance of fracture mechanics – Microstructural features of fracture in metallic materials –ceramics, glasses, and composites. Fatigue – Results of the fatigue test – Application of fatigue test – Creep – Stress rupture and stress corrosion – Evaluation of creep behaviour.

Module-II: Materials for Nuclear Power Plant [10 Periods]

Nuclear reactor – Pressurised reactor – Breeder reactor. Materials for fuel, control rods, coolant, moderator, shielding. Effects of radiation on materials properties: Effects of rays on creep, fatigue, tensile, and other properties of metals, alloys, ceramics, polymers, rubbers etc. – Effects on electrical, electronic and magnetic behaviour of materials – Effects on crystal structure, grain size etc.

Module-III: Materials for Fuel Cells and Solar Cells [10Periods]

A: : Electrocatalyst materials for low temperature fuel cells – Conductive membranes for low-temperature fuel cells .

B:Materials for high temperature fuel cells – Silicon – Quantum dots for solar energy – Nanomaterials for solar thermal energy and photovoltaic.

Module-IV: Materials in Thermal Power Generation [09Periods]

Superalloys – Steels – Ceramics – TBC – Hydrogen membrane materials – Sensor and sensor materials – Biomass, coal, fly ash, etc.

Module-V: Energy storage [09Periods]

Artificial photosynthesis/solar to fuels – CO_2 separation and utilization – Safer nuclear waste disposal – Biofuels production – Biological fuel cell technologies – Reduction of energy use in manufacturing processes – Improved grid technologies – Sustainable energy economy

TEXT BOOKS:

1. D. Roddy, "**Advanced power plant materials, design and technology",** Elsevier, 2010.
2. G.S. Was, "**Fundamentals of Radiation Materials Science"**, Springer, 2007.
3. J.T.A. Roberts, **"Structural Materials in Nuclear Power Systems"**, Springer Science, 2013.

REFERENCES:

1. D.R. Olander, "**Fundamentals Aspects of Nuclear Fuel Elements"**, Technical information center, 2007.
2. Wolf Vielstich, Arnold Lamm, Hubert A. Gasteiger, and Harumi Yokokawa, **"Handbook of Fuel Cells"**, John Wiley and Sons, 2009.
3. D. Roddy, "**Advanced power plant materials, design and technology",** Elsevier, 2010.
4. C.O. Smith, "**Nuclear Reactor Materials"**, Addison-Wesley Publishing Company, 2006.
5. Joseph H. Greenberg, **"Industrial Thermal Processing Equipment Handbook"**, Asm Intl, 1994.
6. B.M. Ma, "**Nuclear Reactor Materials and Applications"**, Springer, 1982.

E Resources:

1. nptel.ac.in/courses/112108150/pdf/PPTs/MTS_01_m.pdf
2. www.vbripress.com/aml/
3. nptel.ac.in/courses/112101095/
4. nptel.ac.in/courses/113105057/
5. nptel.iitg.ernet.in/Courses(Video).php
6. www.nptelvideos.in/2012/12/physics-of-materials.html

Course Outcomes:

At the end of the course, students should be able to:

1. Summarize the fundamentals of mechanical properties of materials
2. Identify the applications of materials in nuclear power generation.
3. Outline the materials for the power generation using fuel and solar cells
4. Examine the super alloys and their applications in the thermal systems and unconventional power generation.
5. Analysis the energy storage methods for various sources of energy

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		1		2	
CO2	1		1		1	1
CO3	1		1	1		
CO4	2		2	2	2	2
CO5	1			1	2	2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code:C3228	INDUSTRIAL SAFETY (Open Elective)	L	T	P
Credits: 3		3	-	-

Prerequisite: Nil

Course Objectives: The objective of this course is to make the students aware of safety norms in industries and to make them safety conscious.

Module-I: Industrial Safety [10Periods]

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

Module -II: Fundamentals of Maintenance Engineering [10Periods]

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

Module -III: Wear and Corrosion and Their Prevention [10Periods]

A: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication.

B: Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

Module-IV: Fault Tracing [9 Periods]

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

Module -V: Periodic and Preventive Maintenance [9 Periods]

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG)

sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

TEXT BOOKS:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.

REFERENCES:

1. Pump-hydraulic Compressors, Audels, McGraw Hill Publication.
2. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Course Outcomes

At the end of the course, students will be able to:

1. Outline the basic concepts of industrial safety needs
2. Identify the various hazards in industry
3. Summarize the methods to avoid wear and tear during manufacturing process
4. Apply suitable fault finding activities
5. Examine the periodic and preventive maintenance in industry

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Programme Outcomes(POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1				**1**		
CO2	**1**	**1**		**1**	**1**	**1**
CO3	**1**		**1**	**1**		**1**
CO4	**1**			**2**		**1**
CO5				**2**		**2**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code:C0B20	ADVANCED OPTIMIZATION TECHNIQUES	L	T	P
Credits: 3	(Open Elective)	3	-	-

Pre-requisites: Nil

Course Objectives: This course objectives to understand extremely important topics under the broad umbrella of optimization, this is synonymous with efficiency which is the underlying prime rationale for all scientific and technological advances and progress.

Module - I: Linear Programming [10Periods]

Introduction and formulation of models; convexity; graphical &simplex method; Big-M Method, Two phase method; degeneracy, non-existent and unbounded solutions; duality in L.P. Dual simplex method, sensitivity analysis for cost and requirement vector; Revised simplex method; Transportation and Assignment problems.

Module - II: Integer Linear Programming [10Periods]

Gomory's cutting plane method; branch and bound algorithm; traveling salesman problem; knapsack problem; linear C-1 problem.

Module - III: Dynamic Programming, CPM & PERT [09Periods]

A: Belman's Principle of optimality; recursive relations; Solution of L.P. Problem; simple examples.

B: CPM & PERT

Module -IV: Non-Linear Programming [09Periods]

Classical optimization methods; equality and inequality constraints; Lagrange multipliers; Kuhn-tucker conditions; quadratic forms; quadratic programming and Beale's methods.

Module -V: Search Methods [10Periods]

One dimensional optimization; Fibonacci search; multi-dimensional search methods; uni-variate search; gradient methods; steepest descent/ascent methods; conjugate gradient method; Fletcher- reeves method; penalty function approach.

TEXT BOOKS

1. J.K. Sharma "Operations Resarach Theory & Applications", 4th Edition, Mc.Millan Publications
2. S.S.Rao -"Engineering Optimization theory and Practice", 4th Edition, J Wiley & Sons, Newjersey

REFERENCES

1. K.V.Mital -"Optimization methods in operations research and system analysis", 3rd Edition, Newage International (P) Ltd., publishers.
2. H.A Taha "Operations Research: An Introduction" Prentice Hall Edition, 2016 reprint
3. Raul Poler et.al "Operations Research Problems Statement and solutions" Springer, 2014 reprint.

E Resources:

1. http://www.mhhe.com/engcs/industrial/hillier/etext/PDF/chap03.pdf (LPP)
2. http://ocw.nctu.edu.tw/upload/classbfs121001503719748.pdf (Transportation Problems)
3. https://www.math.ucla.edu/~tom/GameTheory/mat.pdf (Game Theory)
4. http://www.ime.unicamp.br/~andreani/MS515/capitulo12.pdf (Inventory Models)

Course Outcomes

At the end of the course, students will be able to:

1. Find feasible solution to LPP by various methods.
2. Minimize the cost and time by using Travelling salesmen Problem.
3. Examine the various methods on Dynamic programming.
4. Assess the various concepts on Non-Linear programming.
5. Evaluate the various concepts of Search methods.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Program Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1		2			
CO2				2	1	1
CO3	2		2	2	1	1
CO4	2		2	2	2	1
CO5	1		1		2	2

2022-23 Onwards (MR-22)	MALLAREDDYENGINEERINGCOLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code:C1128	WASTETOENERGY (Open Elective)	L	T	P
Credits: 2		2	-	-

Pre- requisites: Nil

Course Objectives: This course aims to make the students aware of the energy potential in general wastes and to make them able to extract the energy from such sources.

MODULEI: Introduction to Energy From Waste [08Periods]

Classification of waste as fuel–Agro based, Forest residue, Industrial waste-MSW– Conversion devices–Incinerators, gasifiers, digestors.

MODULEII: Biomass Pyrolysis [10Periods]

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

MODULEIII: Biomass Gasification [10Periods]

A: Gasifiers–Fixed bed system–Down draft and up draft gasifiers–Fluidized bed gasifiers– Design, construction and operation

B:Gasifier burner arrangement for thermal heating–Gasifier engine arrangement and electrical power–Equilibrium and kinetic consideration in gasifier operation.

MODULEIV: Biomass Combustion [08Periods]

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

MODULEV: Biogas [12Periods]

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

TEXT BOOKS:

1. "**Non Conventional Energy**",Desai,AshokV.,WileyEasternLtd.,1990.
2. "**Biogas Technology-APractical HandBook**"-Khandelwal, K.C.and Mahdi, S.S., Vol.I&II, TataMc Graw Hill Publishing Co. Ltd.,1983.

REFERENCES

1. "**Food,FeedandFuelfromBiomass**",Challal,D.S.,IBHPublishingCo. Pvt.Ltd.,1991.
2. "**BiomassConversionandTechnology**",C.Y.WereKo-BrobbyandE.B. Hagan,JohnWiley&Sons,1996.

E–RESOURCES

1. https://www.eia.gov/energyexplained/?page=biomass_waste_to_energy
2. https://www.r-e-a.net/renewable-technologies/energy-from-waste
3. http://www.volund.dk/Waste_to_Energy/How_it_works

Course Outcomes:

At the end of the course, students should be able to:

1. Summarize the different types of waste generated in an industry
2. Identify and harvest energy from various resources
3. Convert urban waste to useful energy
4. Assess the environmental impacts of various wastes.
5. Outline the benefits of waste-to-energy conversion

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Programme Outcomes (POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		**1**			**1**	**1**
CO2	**2**	**1**	**2**	**2**	**2**	**2**
CO3	**1**			**3**	**1**	**2**
CO4		**3**	**2**	**1**	**2**	**2**
CO5	**2**			**1**	**1**	**1**

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code: C3210	**SEMINAR (PROJECT)**	**L**	**T**	**P**
Credits: 2		**-**	**-**	**4**

Course Objectives: To promote deeper understanding the basic concepts, physical mechanism behind the processes, participate in scientific analysis and comprehensive of scientific writing of verbal presentation. This course is to introduce post graduate student to ideas, methods and techniques that can improve the content and presentation of scientific seminars.

Course Outcomes:

At the end of the course, students should be able to

1. Write technical documents to the standards
2. Give oral presentation on technical and general topics
3. Express ideas clearly with examples
4. Identify the research opportunities related to their area.
5. Communicate effectively

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Programme Outcomes(POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1		3				
CO2		2				
CO3				2		
CO4						1
CO5						2

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) III Semester		
Code: C3111	**PROJECT / DISSERTATION PHASE - I**	**L**	**T**	**P**
Credits: 8		**-**	**-**	**16**

Course Objectives: Toutilize basic knowledge and advance techniques to make product/process using experimentation and/or simulation and expose to others as document and oral presentation.

Course Outcomes:

At the end of the course, students should be able to

1. Identify project goals, constraints, deliverables, performance criteria, control needs and requirements.
2. Implement concepts, tools and techniques to do quality projects.
3. Adapt projects in response to issues that arise internally and externally.
4. Interact with team and stakeholders in a professional manner, respecting differences, to ensure a collaborative project environment.
5. Utilize technology tools for communication, collaboration, information management, and decision support

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Programme Outcomes(POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2					1
CO2	2	3	1			
CO3			1	2		
CO4		3	1	1		
CO5	2					1

2022-23 Onwards (MR-22)	MALLA REDDY ENGINEERING COLLEGE (Autonomous)	M.Tech. (Thermal Engg) IV Semester		
Code: C3112	**PROJECT / DISSERTATION PHASE - II**	**L**	**T**	**P**
Credits: 16		**-**	**-**	**32**

Course Objectives: To utilize science and engineering to make product/process using innovative techniques, predict the results and prepare technical documents.

Course Outcomes:

At the end of the course, students should be able to

1. Summarize the work completed in the form of technical documents
2. Specify the techniques implemented or to be implemented
3. Explain the results obtained in Project Phase I
4. Summarize the ultimate finding of the project
5. Detailed presentation of work carried out.

CO- PO Mapping (3/2/1 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak						
COs	**Programme Outcomes(POs)**					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2					1
CO2	2	3	1			
CO3			1	2		
CO4		3	1	1		
CO5	2					1