DEPARTMENT OF MECHANICAL ENGINEERING

Y23 M.TECH THERMAL ENGINEERING HANDBOOK

i. COMPUTATIONAL TECHNIQUES IN ENGINEERING OPTIMIZATION (CTEO)

COURSE CODE	23MT5102	MODE		LTPS	2-2-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the fundamental concepts of optimization, including types of problems, mathematical formulation, and programming implementation.	2	PO1, PO2, PO3
CO2	Apply mathematical optimization techniques, both unconstrained and constrained, to solve engineering problems using programming languages like Matlab/Python/R.	3	PO1, PO4, PO5
CO3	Analyze and solve multi-objective optimization problems, considering trade-offs and conflicting objectives, using appropriate algorithms and methodologies.	4	PO1, PO4, PO5
CO4	Apply optimization techniques to solve application-specific problems in Machine Design and Thermal Engineering domains, demonstrating domain-specific knowledge and skills.	3	PO1, PO4, PO5

Syllabus

Module 1	Introduction to Engineering Optimization: Basics of optimization, mathematical formulations, and algorithms. Applications in mechanical and machine design.
Module 2	Unconstrained Optimization Techniques: Newton's method, gradient descent, conjugate gradient. Implementation in MATLAB/Python.
Module 3	Constrained Optimization Techniques: Linear and nonlinear constraints, Lagrange multipliers, penalty and barrier methods. Application in mechanical design.
Module 4	Multi-objective Optimization: Pareto optimality, weighted sum, epsilon-constraint methods. Implementing multi-objective optimization using Python.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	"Engineering Optimization: Methods and Applications"	Ravindran, R., Ragsdell, K. M., & Reklaitis, G. V.	Wiley	2006
2	"Introduction to Optimization"	Chong, E. K. P., & Zak, S. H.	Wiley	2013
3	"Optimization Concepts and Applications in Engineering"	Belegundu, A. D., & Chandrupatla, T. R.	Pearson	2011
4	"Optimization in Practice with MATLAB®: For Engineering Students and Professionals"	Achanta, S., & Darby-Dowman, K.	Cambridge University Press	2015

5	"Applied Optimization: Formulation and Algorithms for Engineering Systems"	Ross, I. J.	Cambridge University Press	1999

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Certified Optimization Engineer (COE)	INFORMS	Y	Online	INFORMS	COE Certification
2	Professional Engineering Optimization Certification	Optimization Firm	Y	Online	Optimization Firm	PE Optimization Certification

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MATLAB	Software	Commercial
2	Python with NumPy/SciPy	Software	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	24
	Tutorial	8	
	Home Assignment and Book. (Min. 4 Assignments etc.)	8	
In-Sem Summative	In-Sem Exam-I	18	36
	In-Sem Exam-II	18	
End-Sem Summative	End Semester Exam	40	40

ii. SIMULATION OF ENERGY MANAGEMENT SYSTEM (SEMS)

COURSE CODE		MODE	Offline	LTPS	0-0-4-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Design of renewable energy power plants by optimum sizing of components	6	PO1,PO2
CO2	Perform financial analysis of different RE technologies	3	PO1, PO2

Syllabus

Module 1	RET Screen (i) Design and sizing RET Projects (ii) Greenhouse Gas (GHG) Emission Reduction Analysis (ii) Financial Analysis for various case studies listed below a. Photovoltaic Project Model for on-grid (central-grid and micro- grid PV systems);

	off-grid (stand-alone (PV-battery) and hybrid (PV-battery-genset) systems; and water pumping applications
Module 2	b. Solar Water Heating Project Model for domestic hot water, industrial process heat and swimming pools, ranging in size from small residential systems to large scale commercial, institutional and industrial systems.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Clean Energy Project Analysis: RETScreen Engineering & Cases Textbook-Photovoltaic Project Analysis	Leng, G., Meloche, N., Monarque, A., Painchaud, G., Thevenard, D., Ross, M., & Hosette, P.	*CANMET Energy Technology Center*	2004
2	PVSYST user's manual	Mermoud, A., & Wittmer, B.	*Switzerland.*	2014
3	U.S. Department of Energy	EnergyPlus Documentation https://energyplus.net/documentation		2017

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	RetScreen Software	Government of Canada	Commercial

Evaluation Components:

Evaluation	Component		Weightage	Total
In-Sem Formative	Lab Weekly Exercise/continuous evaluation		12.5	25
	Project continuous evaluation		12.5	
In-Sem Summative	Sem in 1		17.5	35
	Sem in 2		17.5	
End-Sem Summative	Lab End sem Exam	Viva	7	40
		Exercise	20	
		Report	5	
	External Review		8	

iii. DESIGN OF THERMAL SYSTEMS> <(DTS)>

COURSE CODE	23TE5102	MODE		LTPS	2-0-2-4	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the modelling concepts to the design of thermal systems	3	PO1,PO2,PSO1
CO2	Analyse the design of thermal systems by considering its economic viability	4	PO1,PO2,PSO1
CO3	Analyse about the problem formulation for optimization and its search methods and understanding Lagrange multiplier	4	PO1,PO2,PSO1
CO4	Analyse about the Geometric, linear and dynamic Programming and modelling of thermal equipment	4	PO1,PO2,PSO1

Syllabus

Module 1	Modeling of Thermal Systems: types of models, mathematical modelling, curve fitting, linear algebraic systems, numerical model for a system, system simulation, methods for numericalsimulation;Acceptable Design of thermal System: initial design, designstrategies,designofsystemsfromdifferentapplicationareas,additionalconsiderationsforlargepracticalsystem
Module 2	Economic Considerations: calculation of interest, worth of money as a function of time, series of payments, raising capital, taxes, economic factor in design, application to thermal systems;
Module 3	Problem Formulation for Optimization: optimization methods, optimization of thermal systems, practical aspects in optimal design, Lagrange multipliers, optimization of constrained and unconstrained problems, applicability to thermal systems; search methods: single-variable problem, multivariable constrained optimization, examples of thermal systems; geometric, linear, and dynami cprogramming and other methods for optimization, knowledge-baseddesign and additional considerations, professional ethics.
Module 4	Optimization, Objective function formulation, Constrainte quations, Mathematicalformulation,Calculusmethod,Dynamicprogramming,Geometricprogramming,linearprogrammingmethods, solution procedures. Equation fitting, Empirical equation, best fit method, method of leastsquares. Modelingofthermalequipmentssuchasturbines, compressors,pumps,heatexchangers, evaporatorsandcondensers

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Thermal Design and Optimization	Bejan,G.Tsatsaronis, M.J.Moran	Wiley	
2	N.V.Suryanarayana	Design&SimulationofThermalSystems	MGH	
3	Developments in the Design of Thermal Systems	R.F.Boehm	CambridgeUniversityPress.	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	MAT LAB	MAT LAB	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	CONTINUOUS LAB EXERCISE	7	
	HOME ASSIGNMENT AND TEXT BOOK	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	24	40
	LAB IN ENDEXAM	16	

iv. ADVANCED THERMODYNAMICS<(ATD)>

COURSE CODE	22TE5103	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply thermodynamics concepts for various applications like availability analysis and thermodynamic relations.	3	PO1, PSO1
CO2	Analyze Phase transition, types of equilibrium and stability, multi-component and multi-phase systems.	4	PO2, PSO1
CO3	Analyze the basic concepts of Statistical and Irreversible thermodynamics.	4	PO2, PSO1
CO4	Analyze the behaviour of real gas behaviour, availability analysis, statistical and irreversible thermodynamics	4	PO2, PSO1
CO5	Practice the case study problems solve the with help of learned concepts.	4	PO2, PSO1

Syllabus

Module 1	Review of first and second law of thermodynamics, Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis, phase transition, types of equilibrium and stability, multi-component and multi-phase systems,

	equations of state, chemical thermodynamics, combustion. Third law of thermodynamics.
Module 2	Kinetic theory of gases introduction, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equi-partition of energy, classical theory of specific heat capacity. Transport phenomena-intermolecular forces, The Vander Waals equation of state, collision cross section, mean free path.
Module 3	Statistical thermodynamics- introduction, energy states and energy levels, macro and micro-scales, thermodynamic probability, Bose-Einstein, Fermi-Dirac, Maxwell-Boltzmann statistics.
Module 4	distribution function, partition energy, statistical interpretation of entropy, application of statistics to gases-mono-atomic ideal gas.
Module 5	Practice the case study problems in Simulation.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Advanced Thermodynamics for Engineers	Kenneth Wark	McGraw-Hill	
2	Thermodynamics, Kinetic theory, and Statistical thermodynamics.	F. W. Searsand G. L. Salinger	Narosa Publishing House	1998
3	Fundamentals of Engineering thermodynamics	M. J. Moron, and H. N. Shapiro	JohnWiley& Sons.	
4	Heat and thermodynamics	M. W. Zemansky, and R. H. Dittman	McGraw Hill International	2007
5	Advanced Engineering Thermodynamics	A. Bejan	Wiley and sons	2006
6	Thermodynamics	J. P. Holman	McGraw-Hill Inc.	1998

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Advanced Thermodynamics	yes		Objective	yes	https://nptel.ac.in/courses/112/103/112103016/
2	Advanced Engineering Thermodynamics	yes		objective	yes	https://booksonweb.files.wordpress.com/2011/09/2-advanced-thermodynamics-engineering.pdf

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys	Simulation	Open Source
2	MATLAB	SimBiology	Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	**ALM**	8	
	LAB WEEKLY EXERCISE	7	
	Home Assignment and Textbook	7	22
In-Sem Summative	**Semester in Exam-I**	15	38
	Semester in Exam-II	15	
	IN SEM LAB EXAM	8	

v. COMPUTATIONAL FLUID DYNAMICS <(CFD)>

COURSE CODE	23TE5104	MODE	Offline	LTPS	3-0-2-0	PRE-REQUISITE	

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Derive Governing equations of fluid flow and heat transfer and apply finite difference formulation to discretize the governing equations	3	PO1,PO3
CO2	Analyze heat transfer characteristics in case of steady diffusion problems using finite volume discretization technique.	4	PO1,PO3
CO3	Analyze fluid flow and heat transfer characteristics in case of steady advection diffusion	4	PO1,PO3
CO4	Formulate explicit and implicit algorithms to solve N-S Equations and to understand the turbulence modelling	4	PO1,PO3
CO5	Analyze various fluid flow and heat transfer characteristics using a simulation software (Ansys-Fluent)>	4	PO2,PO3,PO4

Syllabus

Module 1	Introduction: Conservation equation; mass; momentum and energy equations; convective forms of the equations and general description, Classification and Overview of Numerical Methods: Classification into various types of equation; parabolic elliptic and hyperbolic; boundary and initial conditions; over view of numerical methods, Finite Difference Technique: Finite difference methods; different means for formulating finite difference equation; Taylor series expansion
Module 2	Finite Volume Technique: Finite volume methods; different types of finite volume grids; approximation of surface and volume integrals; interpolation methods, Methods of Solution: Solution of finite difference equations; matrix inversion methods
Module 3	central, upwind and hybrid formulations and comparison for convection-diffusion problem, Solution of finite difference equations – Iterative methods
Module 4	Time integration Methods: Single and multilevel methods; predictor-corrector methods; stability analysis; Applications to transient conduction and advection-diffusion problems, Numerical Grid Generation: Numerical grid generation; basic ideas; transformation and mapping, Navier-Stokes Equations: Explicit and implicit methods; SIMPLE type methods; fractional step methods, Turbulence modeling: Reynolds averaged Navier-Stokes equations, RANS modeling, DNS and LES.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	An Introduction to Computational Fluid Dynamics	H. K. Versteeg & W. Malalasekera	Longman Scientific & Technical	2005
2	Computational Fluid Mechanics and Heat Transfer	J. C. Anderson, D. A. Tannehil and R. H. Pletcher,	Taylor & Francis publications	
3	Computational Methods for Fluid Dynamics	J. H. Ferziger and M. Peric	Springer	
4	Fundamentals of CFD	T. K. Sengupta	Universities Press	

Global Certifications:

Mapped Global Certifications:						
S. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Basics of Fluid Dynamics	Ansys	Yes	Online	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys - Fluent	Ansys	Commercial

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

vi. ADVANCED HEAT AND MASS TRANSFER <(AHMT)>

COURSE CODE	23TE5205	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze 1D steady and unsteady state state heat conduction in various heat transfer applications	4	PO1, PO2
CO2	Analyze Multidimensional and transient heat conduction and heat transfer characteristics in various various heat transfer applications	4	PO1, PO2
CO3	Design heat exchangers by applying the basic heat transfer principles and analyze the radiation heat transfer characteristics	4	PO1, PO2
CO4	Analyze the Diffusion and convective mass transfer in plate and pipes	4	PO1, PO2
CO5	Analyze various the heat transfer characteristics in fins and heat exchangers using Ansys software	4	PO2,PO3,PO4

Syllabus

Module 1	Introduction - review of heat transfer Fundamentals - transient conduction and extended surface Heat Transfer, Unsteady heat conduction. Lumped capacity model, awareness of one-dimensional unsteady results (charts; Biot and Fourier numbers)
Module 2	Brief review of Steady Laminar and Turbulent Heat Transfer in External and Internal Flows - Heat Transfer at High Speeds - Unsteady Laminar and Turbulent Forced Convection in Ducts and on Plates - Convection with body forces, Boundary layers and internal flows. Awareness of these configurations, some knowledge of internal flow energy balances, Convection correlations. Finding heat transfer coefficients from Reynolds numbers and Rayleigh numbers
Module 3	Heat Exchangers. Typical configurations and epsilon-NTU analysis, phase-change heat transfer. General awareness of processes of condensation and boiling in a pure substance, some use of correlations, Quenching of metals, Leidenfrost problem, heat transfer of sprays, jets and films, Radiation basics -Radiation in Enclosures - Gas Radiation
Module 4	Diffusion and Convective Mass Transfer - Combined Heat andMass Transfer from Plates and in Pipes.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Heat Transfer	A. Bejan	John Wiley & Sons	1993
2	Advanced Heat and Mass Transfer	A.Faghri, Y. Zhang, J. Howell,	Global Digital Press	2010
3	Heat Transfer	P.S.Ghoshdatidar	Oxford University Press	
4	Heat Transfer – A practical approach	Y. A. Cengel	Tata McGraw-Hill	2002

Global Certifications:

Mapped Global Certifications:						
S. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Basics of Fluid Dynamics	Ansys	Yes	Online	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys - Fluent	Ansys	Commercial

Evaluation Components:

Evaluation	**Component**	**Weightage**	**Total**
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

vii. MEASUREMENTS IN THERMAL ENGINEERING > <(MTE)>

COURSE CODE	23TE5206	MODE		LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply scientific and engineering methods for the measurement of field and derived quantities	3	PO1, PSO1
CO2	Analyze principles of presentation, estimation and data analysis	4	PO2, PSO1
CO3	Apply various experimental measurement techniques for the measurement of field quantities with probe and non-instructive techniques	3	PO1, PSO1
CO4	Evaluate the measurement of derived quantities and analytical methods and design and conduct the experiments, as well as to organize, analyze and interpret data to produce meaningful conclusions and recommendations	4	PO3, PSO1

Syllabus

Module 1	Introduction to measurements for scientific and engineering applications- need and goal - broad category of methods for measuring field and derived quantities
Module 2	Principlesofmeasurement-parameterestimation-regressionanalysis-correlations-errorestimation and data presentation - analysis of data;
Module 3	Measurement of field quantities -thermometry-heat flux measurement-measurement of force, pressure, flowrate, velocity, humidity, noise, vibration- measurement of the above by probe and nonintrusive techniques
Module 4	Measurement of derived quantities-torque,power,thermo-physical properties - radiation and surface properties; Analytical methods and pollutionmonitoring-massspectrometry-chromatography-spectroscopy.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fluid mechanics and measurements	,R.J.Goldstein	Taylor Francis	
2	Hand book of experimental fluid mechanics	C.Tropea,Y.Alexander,J.F.Foss	SPRINGER	
3	Thermal and flow measurements	,T.W.Lee,	CRCPress.	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA	NA	NA	NA	NA	NA

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial

1	NA (For practical, instruments available in the laboratory will be used)	NA	NA

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	22
	CONTINUOUS LAB EXERCISE	7	
	HOME ASSIGNMENT AND TEXT BOOK	7	
In-Sem Summative	IN SEM EXAMINATION-I	15	38
	IN SEM EXAMINATION-II	15	
	LAB IN SEM EXAM	8	
End-Sem Summative	END SEMESTER EXAM	24	40
	LAB IN END EXAM	16	

viii. ESSENTIALS OF RESEARCH DESIGN> <(ERD)>

COURSE CODE	23IE5201	MODE		LTPS	1-1-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Illustrate Research objects, steps involved in research and articulate appropriate Research Questions	3	PO4,PSO1
CO2	Perform Literature Review in a Scholarly style and apply appropriate methods for Data collection	3	PO4,PSO1
CO3	Represent the data in tabular/Graphical form and prepare data for analysis	3	PO1,PSO1
CO4	Perform statistical modelling and analysis to optimize the data, prepare the data for publishing.	4	PO1,PSO1

Syllabus

Module 1	Definition and objectives of Research-Types of research, Various Steps in Research process, Applied Mathematical tools for analysis, developing a research question-Choice of a problem, Literature review, Surveying, Synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code.
Module 2	Literature Review (LR)-Meaning and its Types-Narrative and Systematic, LR using Web of Science, Google and Google Scholar, Citations-Types, referencing in academic writing, Citation vs Referencing Vs Bibliography, Citation tools- Zotero, Qualitative Research and its methods, Quantitative Research, and its Methods. Data Collection-Primary data collection using Questionnaire, Google forms, survey monkey, Testing the validity and Reliability of Questionnaire using Factor Analysis and Cronbach's Alpha respectively, Secondary data-sources
Module 3	Diagrammatic and graphical presentation of data: Diagrams and Graphs of frequency data of one variable- histogram, barcharts-simple, sub-divided and multiple; line charts, Diagrams and Graphs of frequency data of two variables -scatter plot,

	preparing data for analysis. Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Error Analysis.
Module 4	Analyzing data using one-dimensional statistics, two-dimensional statistics and multi-dimensional statistics. Technical Writing and Publishing, Conference presentations, Poster Presentations, Plagiarism-check and tools, Self-Plagiarism. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, Design Thinking for Contextualized Problem-Solving and Empathetic Research.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Research Methodology Methods and Techniques	C.R. Kothari	New Age International	2019
2	Business Research Methods,	Donald R.Cooper, Pamela S. Schhindler	TMH	2018
3	Research Methods for Engineers	David V Thiel	Cambridge University Press	2015
4	Engineering Research Methodology	Krishnan Nallaperumal	Manonmaniam Sundaranar University.	2013
5	Business Research Methods	William G Zikmund	South West Cengage Learning	2013

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Research Design and Methodology Certification	Global Association of Research Methodology Education and Training (GARMET)	Proctored	Online Multiple Choice Questions	GARMET	https://www.garment.org/certifications/research-design-methodology
2	Certified Research Methodologist (CRM)	International Institute for Applied Knowledge Sciences (IIAKS)	Proctored	Online Exam	IIAKS	https://www.iiaks.org/certifications/certified-research-methodologist

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	24
	HOME ASSIGNMENT AND TEXT BOOK	8	
	TUTORIALS	8	

In-Sem Summative	IN SEM EXAMINATION-I	18	36
	IN SEM EXAMINATION-II	18	
End-Sem Summative	END SEMESTER EXAM	40	40

ix. MACHINE LEARNING WITH PYTHON (MLWP)

COURSE CODE	VAC-2	MODE	R	LTPS	2-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO/PSO Mapping
CO1	Apply machine learning techniques	3	PO1, PO5, PSO1
CO2	Apply Computational techniques to solve supervised learning problems	3	PO1, PO3, PSO1
CO3	Apply Statistical learning techniques to solve unsupervised learning problems	3	PO1, PO5, PSO1
CO4	Apply support vector machine method to solve classification problems.	3	PO1, PO5, PSO1

Syllabus

Module 1	Towards Intelligent Machines Well posed Problems, Example of Applications in diverse fields, Data Representation, Domain Knowledge for Productive use of Machine Learning, Diversity of Data: Structured / Unstructured, Forms of Learning, Machine Learning and Data Mining, Basic Linear Algebra in Machine Learning Techniques
Module 2	Supervised Learning: Rationale and Basics: Learning from Observations, Bias and Why Learning Works: Computational Learning Theory, Occam's Razor Principle and Over fitting Avoidance Heuristic Search in inductive Learning, Estimating Generalization Errors, Metrics for assessing regression, Metris for assessing classification.
Module 3	Statistical Learning: Machine Learning and Inferential Statistical Analysis, Descriptive Statistics in learning techniques, Bayesian Reasoning: A probabilistic approach to inference, K-Nearest Neighbor Classifier. Discriminant functions and regression functions, Linear Regression with Least Square Error Criterion, Logistic Regression for Classification Tasks, Fisher's Linear Discriminant and Thresholding for Classification, Minimum Description Length Principle.
Module 4	Support Vector Machines (SVM): Introduction, Linear Discriminant Functions for Binary Classification, Perceptron Algorithm, Large Margin Classifier for linearly seperable data, Linear Soft Margin Classifier for Overlapping Classes, Kernel Induced Feature Spaces, Nonlinear Classifier, and Regression by Support vector Machines.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Applied Machine Learning	M.Gopal	TMH	2018
2	Machine Learning: An Algorithmic Perspective	Stephen Marsland	Taylor & Francis (CRC) 1st Edition	2014

3	Machine Learning Methods in the Environmental Sciences, Neural Networks,	William WHsieh,	Cambridge Univ Press. 1 edition	2009
4	pattern classification	Richard o. Duda, Peter E. Hart and David G. Stork,	Wiley &Sons	2001
5	Machine Learning	Peter Flach	Cambridge	2012

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Machine learning	IBM	Y	Online	IBM	Supervised Machine Learning: Regression | Coursera
2	Machine Learning	AWS	Y	On line	AWS	AWS Certified Machine Learning - Specialty Certification | AWS Certification | AWS (amazon.com)

Tools used in Practical / Skill: N A

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1			
2			

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	10	20
	Home Assignments	10	
In-Sem Summative	In-Sem 1	20	40
	In-Sem 2	20	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40

x. GAS TURBINE ENGINEERING > <(GTE)>

COURSE CODE	23TE51A1	MODE		LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply the concepts of air standard cycle to analyse the performance of ideal and actual gas turbine cycles	3	PO1, PSO1
CO2	Apply gas turbine theory to jet propulsion and understand fabrication techniques of components	3	PO1, PSO1
CO3	Analyze the Performance of compressors and combustion chambers.	4	PO2, PSO1
CO4	Analyze the Performance of gas turbine and cogeneration systems.	4	PO2, PSO1

Syllabus

Module 1	Thermodynamicsofgasturbines:Cycleanalysis;GasTurbineComponents:compressor,combustor,heatexchangers,turbine-description:analyticalconsiderations, performance
Module 2	Matching of compressor and turbine: cooling of turbine blades. Compressor and turbine impeller construction, blade fixing details, sealing; Material selection for components
Module 3	, Protective coating for hot turbine parts, Components fabrication techniques, Gas turbine turbocharger, gas turbine power generation, turbo expander, gas turbine application, Closed cycle gas turbines
Module 4	Co-generation-Introduction, Thermodynamics of co-generation, Criteria for component performance, Some practical schemes.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Aircraft Propulsion and Gas Turbine Engines;	AhmedF.El-Sayed	CRCpress,2008.	
2	Turbine, Compressors and Fans	Turbine, Compressors and Fan		

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Nill	Nill	Nill

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

xi. ELECTRIC VEHICLE ENGINEERING<(EVE)>

COURSE CODE	23TE51A2	MODE		LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand Hybrid /EV Vehicles and study of vehicle dynamics	3	PO1, PO2
CO2	Apply Architecture of Hybrid/EV Vehicles, components andBattery EV	3	PO1, PO2, PO3
CO3	Apply and analyse Fuel Cell, DC/AC Drives and SRM	3	PO1, PO3, PO4
CO4	Apply EV Controls, Controller, and control strategies	4	PO1, PO2, PO4
CO5	Analyze and apply theoretical concepts to develop mathematicalmodels and simulate the Combustion and EV Vehicles	5	PO2, PO3, PO5

Syllabus

Module 1	Introduction: Electric Vehicle History, Components of Electric Vehicle, Comparison with Internal combustion, Engine: Technology, Comparison with Internal combustion Engine: Benefits and Challenges, EV classification and their electrification levels, EV Terminology Motor Torque Calculations for Electric Vehicle: Calculating the Rolling Resistance, calculating the grade resistance, Calculating the Acceleration Force, Finding the Total Tractive Effort, Torque Required On The Drive Wheel.
Module 2	Electric Vehicle Architecture Design: Types of Electric Vehicle and components, Electrical protection and system requirement, Photovoltaic solar based EV design, Battery Electric vehicle (BEV), Hybrid electric vehicle (HEV),
Module 3	Plug-in hybrid vehicle(PHEV), Fuel cell electric vehicle (FCEV), Electrification Level of EV, Comparison of fuel vs Electric and solar power, Solar Power operated Electric vehicles.
Module 4	Electric Drive and controller: Types of Motors, Selection and sizing of Motor, RPM and Torque calculation of motor, Motor Controllers, Component sizing, Physical locations, Mechanical connection of motor, Electrical connection of motor.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	1. Electric and Hybrid Vehicles: Design Fundamentals.	Iqbal Husain	CRC Press	
2	Modern Electric Hybrid Electric and Fuel Vehicles	Mehrdad Ehsani, Yimin Gao, Stefane Longo, Kambiz Ebrahimi.	CRC Press, 3rd Edition	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Mat Lab, Diesel RK		Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

xii. ENERGY CONSERVATION & AUDIT<(ECA)>

COURSE CODE	23TE51A3	MODE		LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze the present energy scenario and understand the need of energy conservation	PO2	4
CO2	Apply various instruments in energy audit	PO1	3

CO3	Apply various measures of energy conservation and financial implications for various thermal utilities.	PO1	3
CO4	Audit the power plants, the various measures for energy conservation and financial implications for various thermal utilities.	PO1	4
CO5	Analyse the energy performance of power plants numerically using MAT lab	PO2	4

Syllabus

Module 1	Energy Scenario - Basics of Energy and its various forms - Energy Management and - Audit - Material and Energy Balance - Energy Action Planning - Financial Management –Project Management - Energy Monitoring and Targeting - Global Environmental Concerns
Module 2	Energy Efficiency in Thermal Utilities - Fuels and Combustion – Boilers - Steam System - Furnaces - Insulation and Refractory - FBC Boilers -Cogeneration - Waste heat recovery. Energy Efficiency in Electrical Utilities - Electrical Systems - Electric Motors - Compressed Air System - HVAC and Refrigeration System - Fans and Blowers - Pumps and Pumping System - Cooling Tower - Lighting System - Diesel Generating System - Energy Efficient Technologies in Electrical Systems.
Module 3	. Energy Performance Assessment for Equipment and Utility systems – Boilers – Furnaces - Cogeneration, Turbines (Gas, Steam) - Heat Exchangers - Electric Motors andVariable Speed Drives - Fans and Blowers - Water Pumps – Compressors
Module 4	HVACSystems - Lighting Systems - Performing Financial Analysis - Applications of Non - Conventional and Renewable Energy Sources - Waste Minimization and Resource Conservation

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Energy Management Principles	CB Smith	Pergamon Press, NewYork	1981
2	Energy Auditing and Conservation; Methods, Measurements,Management & Case study	Hamies	Hemisphere, Washington	1980

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial

1	MAT Lab		Open Source

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

xiii. ADVANCED ENERGY STORAGE TECHNOLOGIES > <(AEST)>

COURSE CODE	23TE52B1	MODE		LTPS	2-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand various thermal storage systems and storage materials	2	PO1
CO2	Analyse the sensible and latent heat concepts and develop a heat storage units	4	PO2
CO3	Apply the basics of storage systems to understand the various thermal storage systems	3	PO1
CO4	Apply the principles of heat storage systems on regenerators and its applications	3	PO1

Syllabus

Module 1	Necessity of thermal storage – types-energy storage devices – comparison of energy storage technologies - seasonal thermal energy storage - storage
Module 2	Basic concepts and modelling of heat storage units - modelling of simple water and rock bed storage system – use of TRNSYS – pressurized water storage system for power plant applications
Module 3	Modelling of phase change problems – temperature based model - enthalpy model – porous medium approach - conduction dominated phase change – convection dominated phase change
Module 4	Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Energy Production and Storage	Crabtree R.H.,	Wiley	2010
2	, Energy Storage Fundamentals, Materials and Applications	Huggins & Robert,	Springer	2016
3	Thermal Energy Storage Systems and Applications	. Ibrahim Dincer and Mark A. Rosen	Wiley & Sons	2002

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Nil	Nil	Nil

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

xiv. FOOD PROCESSING PRESERVATION AND TRANSPORT > <(FPPT)>

COURSE CODE	23TE52B2	MODE		LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping

CO1	Apply food preservation methods and understand the factors effecting food deterioration	3	PO1, PSO1
CO2	Analyse the different types of drying and food concentration methods	4	PO1, PSO1
CO3	Analyse the role of natural, chemical preservatives and recent preservation techniques	4	PO2, PSO1
CO4	Analyse the effect of molecules in transport mechanisms	4	PO2, PSO1

Syllabus

Module 1	Food and its preservation Food preservation - Need, importance, principals and methods. Perishable and non perishable foods, concept of shelf life- definition and factors affecting water activity in food and its significance in food preservation, factors affecting food deterioration – physical factors, chemical factors and microbiological factors.
Module 2	Drying- Theory and Mechansim, drying characteristics of materials, preliminary processing, Sun drying vs dehydration, Driers - Air convection driers and types, Drum /Roller Drier, Vacuum drier, Belt drier, tunnel drier, spray drier, rotary drier, fluidized bed drier, Freeze drying and microwave drying. Food Concentration- purpose, methods of concentration, changes during concentration, Intermediate moisture foods (IMF).
Module 3	Use of high temperature- principle and equipments: Methods - pasteurization, blanching, sterilization , canning- procedure, canning of acid foods and nonacid foods, aseptic canning nutritive value of canned foods, types of spoilage in canned foods, storage of canned foods, influence of canning on the quality of food,.
Module 4	Introduction to transport phenomena – Molecular transport mechanism, transport properties and their proportionality constants in momentum, energy and mass transfer. Mass transfer -- Fick's law of diffusion, diffusion of gases and liquids through solids, equimodal diffusion, isothermal evaporation of water into air, mass transfer coefficients

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Food Microbiology	William C Frazier & Dennis C Westhoff	Tata McGraw Hill Publications	2013
2	Food Scienc	Norman N Potter Joseph H Hotchkiss	CBS Publishers	2005
3	The Technology of Food Preservation	Norman W Desrosier James N Desrosier	CBS Publishers	2006
4	Food Processing and Preservation	B. Sivasankar P	PHI Learning Pvt Ltd	2002
5	Introduction to Food Science and Technology	Stewart GP and Amerine MA	Elsevier	2012

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil		Nil		Nil	

		Nil		Nil		Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Nil	Nill	Nil

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	8	
	Home Assignment and Book	7	22
	Lab In sem	7	
In-Sem Summative	Sem -1	15	
	Sem -2	15	38
	Lab Weekly exercise	8	
End-Sem Summative	End sem exam	24	24
	Lab end exam	16	40

xv. CONVECTION AND TWO PHASE FLOW <(CTPF)>

COURSE CODE	23TE52B3	MODE	Offline	LTPS	2-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the basics of two phase flow, Interfacial phenomena and Phase transitions	2	PO1
CO2	Apply mathematical models to understand hydrodynamics of two phase flows without phase change.	3	PO1,PO3
CO3	Derive and apply various correlations to analyse boiling and condensation phenomena	3	PO1,PO3
CO4	Apply two phase flows for thermal management of electronic components	3	PO1,PO3
CO5	Analyze various two phase flows (with and without phase change) using a commercial software Ansys-Fluent	4	PO2,PO3,PO4

Syllabus

Module 1	Introduction to two-phase flow and heat transfer technology, Liquid-vapor phase change phenomena, Interfacial tension, Wetting phenomenon, Contact angles, Transport effects, Dynamic behaviour of interfaces, Phase stability and nucleation
Module 2	Two- phase flow fundamentals, Flow patterns and map representation, Development of homogeneous, separated flow and drift flux models, Flooding mechanisms
Module 3	Boiling Fundamentals, Homogeneous and heterogeneous nucleation, Pool boiling and convective flow boiling, Heat transfer and CFH mechanisms, Enhancement techniques, Condensation fundamentals, External and internal condensation, Film condensation theory, Drop-wise condensation theory, Enhancement techniques
Module 4	Application of two- phase flow and heat transfer, Electronics thermal management, Latent heat storage devices, Gravity assisted thermo-siphons/Vapor chambers, Theory and operation of Conventional heat pipes, Micro heat pipes, Pulsating heat pipes, Capillary pumped loops/ Loop heat pipes, Micro two-phase heat exchangers

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Liquid Vapor Phase Change Phenomena	Van P. Carey	Taylor & Francis	2005
2	Two-phase Flow and Heat Transfer	P. B. Whalley	Oxford Engineering Science	
3	One Dimensional Two-Phase Flow	G. B. Wallis	McGraw Hill	
4	Convective Boiling And Condensation	Collier John	Oxford Engineering Science	

Global Certifications:

Mapped Global Certifications:						
S. No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Basics of Fluid Dynamics	Ansys	Yes	Online	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys - Fluent	Ansys	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

xvi. Renewable Energy Sources and Technology> <(REST)>

COURSE CODE	23TE52C1	MODE		LTPS	3-0-2-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand concept of various forms of Non-renewable and renewable energy	4	PO1, PSO1
CO2	outline division aspects and utilization of renewable energy sources for both domestics and industrial applications	3	PO1, PSO1
CO3	study the environmental and cost economics of using renewable energy sources compared to fossil fuels	3	PO1, PSO1
CO4	Understand the commercial energy and renewable energy sources. Know the working principle of various energy systems	4	PO1, PSO1
CO5	Apply RET Screen software in feasibility analysis for the installation of Solar PV and water heater	4	PO1, PSO1

Syllabus

Module 1	Renewable Energy Sources in India - Potential sites, availability. Solar Energy:Measurement and collection, flat plate collectors, concentrating collectors, solar ponds
Module 2	photovoltaic conversion, Thermal energy storage. Ocean Energy: Principles of OTEC; wave energy, tidal energy, energy conversion systems. Wind Energy: Principle, potential and status; Wind Characteristics; National Wind Atlas; Theory of wind turbine blades; Types of wind turbines and their characteristics.

Module 3	Biofuels: Sources and potential, properties and characterization; Biogas generation through aerobic and anaerobic digestion; Thermochemical methods of biofuel utilization: Combustion and gasification; Status of biofuel technology
Module 4	Geothermal Energy-Nature, types and utilization. Applications: Applications of renewable energy sources-Typical examples.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Renewable Energy Resources	Twidell &Wier	CRC Press	2000
2	Renewable Energy, Power for a Sustainable Future,	Godfrey Boyle,	Oxford University Press	2000
3	Wind Energy Conversion systems	L.L.Freris	Prentice Hall	1990
4	Renewable energy resources	Tiwari and Ghosal	Narosa	2002

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Wind Turbine Technician Certification	Pinnacle career institute		Online		https://www.pcitraining.edu/wind-turbine-technician

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	RET Screen software		Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	08	22
	Home Assignments	07	
	Practical Continuous Evaluation	07	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	08	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xvii. Principles of Turbo Machinery (PTM)

COURSE CODE	22TE52C2	MODE		LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyse the design principles of turbomachinery to improve and optimize its performance	4	PO2, PSO1
CO2	Design the performance of Turbo machines for engineering applications	5	PO3, PSO1
CO3	Analyse the energy transfer process in Turbomachines and governing equations of various forms.	4	PO2, PSO1
CO4	Design various Turbomachines for power plant and aircraft applications	5	PO3, PSO1
CO5	Design and Maintain Turbomachinery Using Ansys Simulation Solutions	5	PO3, PSO1

Syllabus

Module 1	Classification - Specific work - Representation of specific work in T-s and h-s diagrams - Internal and external losses
Module 2	Euler's equation of turbo-machinery - Ideal and actual velocity triangles-Slip and its estimation-Impulse and reaction type machines
Module 3	Degree of reaction - Effect of outlet blade angle on blade shape - Model laws, specific speed and shape number-Special features of hydro, steam and gas turbines
Module 4	Performance characteristics of turbo-machines-Cavitation, Surge and Stall-Thin aerofoil theory - Cascade mechanics. Use of CFD for Turbo-machinery analysis and design.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Fundamentals of Turbomachinery	WilliamW.Peng	JohnWiley&Sons	
2	Principles of turbomachinery	D.G.Shepherd	Macmilan	1969
3	Aircraft Propulsion and Gas Turbine Engines	AhmedF.El-Sayed	CRCpress	2008
4	Hydraulic and Compressible Flow Turbo machines	A.T.Sayers	Mc-GrawHill	

Mapped Global Certifications:						
Sl No	Title	Certification	Proctored (Y/N)	Format of	Exam	URL of the Certification

		Provider		the Exam	Provider	
1	Condition Monitoring and Machinery Diagnostics Certification	The Mobius Institute		online		https://www.mobiusinstitute.com/professional-growth/condition-monitoring-training-and-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys		Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	08	22
	Home Assignments	07	
	Practical Continuous Evaluation	07	
In-Sem Summative	In-Sem 1	15	38
	In-Sem 2	15	
	Practical In-Sem	08	
End-Sem Summative	End-Sem Exam (Paper Based)	24	40
	Lab End-Sem Exam	16	

xviii. Heat Exchanger Design (HED)

COURSE CODE	23TE52C3	MODE	R	LTPS	3-0-2-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Classify heat exchangers and understand thermo-hydraulic fundamentals of the exchangers.	PO1	2
CO2	Apply LMTD and ε-NTU methods for the design of different types of shell and tube heat exchangers.	PO3	3
CO3	Apply different methods in the design of shell and tube heat exchangers	PO3	3
CO4	Design of Compact heat exchangers and study of fouling control techniques	PO3	3
CO5	Design and analyse various heat exchangers using Ansys Fluent	PO3, PSO1	5

Syllabus

Module 1	Heat Exchangers: Introduction, Classification, and Selection. Heat Exchanger: Thermo-Hydraulic Fundamentals. Heat Exchanger Design. Compact Heat Exchangers
Module 2	Shell and Tube Heat Exchanger Design. Regenerators. Plate Heat Exchangers and Spiral Plate Heat Exchangers. Heat-Transfer Augmentation

Module 3	Fouling; Flow-Induced Vibration of Shell and Tube Heat Exchangers. Mechanical Design of Shell and Tube Heat Exchangers.
Module 4	Corrosion; Material Selection and Fabrication. Quality Control and Quality Assurance and Non-destructive Testing. Heat Exchanger Fabrication

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Heat Exchangers: Selection, Design and Construction	E. A. Saunders	Longman Scientific and Technical	1988
2	Fundamentals of Heat Exchanger Design	Ramesh K. Shah, Dusan P. Sekulic,	Wiley	2002

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	NA					

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys		Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALMs	8	22
	Home assignments	7	
	Continuous Evaluation - Lab Exercise	7	
In-Sem Summative	Sem in 1	15	38
	Sem in 2	15	
	Lab In Semester Exam	8	
End-Sem Summative	End Semester Exam	24	40
	Lab End Semester Exam	16	

xix. REFRIGERATION AND CRYOGENICS<(R & C)>

COURSE CODE	23TE52D1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply basic thermodynamic principles to produce low temperatures and to the liquefaction systems.	3	PO2

CO2	Analyse different types of cryogenic refrigerators and insulation and their applications.	4	PO2
CO3	Examine the properties of matter at low temperature and their measurement.	2	PO3
CO4	Understand the principle of superconductivity, adiabatic demagnetization, and dilution refrigeration etc. to produce low temperatures	2	PO2

Syllabus

Module 1	Review of Basic Thermodynamics, Properties of Cryogenic fluids, First and Second Law approaches to the study of thermodynamic cycles, Isothermal, Adiabatic, and Isenthal pic processes. Production of Low Temperatures: Liquefaction systems, ideal, Cascade, LindeHampson, and Claude cycles and their derivatives; Refrigerators: Stirling, Gifford-McMahoncycles and their derivatives.
Module 2	Cryogenic Insulations: Foam, Fibre, powder, and Multi-layer.Applications of Cryogenics in Industry, Space Technology, Nuclear Technology, Biology, and Medicine. The matter at low temperatures: specific heat, thermal conductivity, electrical conductivity, magnetic and mechanical properties.
Module 3	Properties of liquid 4He and 3He; and their measurements. Review of a free electron and band theory of solids: Basic properties of Superconductors; outlines of Ginzbarg Landau and Bardeen-Cooper-Schrieffer theories of superconductivity.
Module 4	superconducting tunnelling phenomena; Introduction to type IIsuperconductivity including flux flow and critical current density: High-temperature superconductivity. Production of very low temperatures by adiabatic demagnetization, dilution refrigeration, and nuclear demagnetization.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	A Textbook of Cryogenics	V V Kostionk	Discovery Publishing house	2003
2	Cryogenic Fundamentals	Haselden.G.G	Academic Press-Newyork	
3	Principles of Refrigeration	Dossat Thomas	J.Horan Books	
4	Refrigeration and Air conditioning	Stoecker and Jones	McGraw Hill	
5	Cryogenic Systems	RFBarron	Oxford University press	1985
6	Cryogenics-Theory, Process, and applications	Allyson E Hayes	Nova science Incorporated	2010

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification

1	Cryogenic Engineering	yes		objective	nptel	https://nptel.ac.in/courses/112101004/
2	Cryogenic Engineering	yes		objective	nptel	https://nptel.ac.in/courses/112101004/

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	HOME ASSIGNMENT AND TEXT BOOKS	10	
In-Sem Summative	IN SEM EXAMINATIONS-1	20	40
	IN SEM EXAMINATION-II	20	
End-Sem Summative	END SEMESTER EXAM	40	40

xx. AIR CONDITIONING SYSTEMS > <(ACS)>

COURSE CODE	23TE52D2	MODE		LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Apply Psychrometric process in air conditioning equipment.	3	PO1, PSO1
CO2	Analyse the effect of cooling and dehumidification.	4	PO1, PSO1
CO3	Analyse air conditioning processes in various seasons.	4	PO2, PSO1
CO4	Analyse the factors governing optimum effective temperature, Design consideration in comfort air conditioning systems.	4	PO2, PSO1

Syllabus

Module 1	PSYCHROMETRY: Properties of moist air. Important Psychrometry properties, Dry bulb temperature, Humidity ratio, degree of saturation, Dew point temperature and Enthalpy, Psychometric chart and ASHRAE chart. Psychrometric process in air conditioning equipment, Bypass factor and sensible heat factor
Module 2	APPLIED PSYCHROMETRY: Use of Effective and grand sensible heat factor, Selection of air conditioning equipment for cooling and dehumidification. High latent cooling load applications, All outdoor air applications.

Module 3	AIR CONDITIONING PROCESSES: Mixing process- Summer, winter and year round air Conditioning system, Hot and dry outdoor conditions. Hot and humid outdoor conditions. Winter air conditioning system. Year round air conditioning system.
Module 4	COMFORT AIR CONDITIONING: Thermodynamics of human body. Body regulation process against heat and cold. Comfort & Comfort chart, Effective temperature, Factors governing optimum effective temperature, Design consideration. Selection of outside and inside design conditions, Air conditioning control systems, basic elements of the control system, Temperature, Humidity & Pressure controls, Refrigeration, Room thermostat.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Refrigeration & Air Conditioning	CP Arora	Tata McGraw Hill Publications	2013
2	Refrigeration & Air Conditioning	Arora and Domkundwar	Dhanpat Rai &Co	2005
3	Refrigeration & Air Conditioning	RC Arora	PHI Learning Pvt Ltd	2012
4	Refrigeration & Air Conditioning	SC Jain	Chand & Co	2002
5	Hand Book of Air Conditioning System Design	Carrier	Carrier	2012

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Nill	Nill	Nill

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	20
	HOME ASSIGNMENT AND TEXT BOOK	10	
In-Sem Summative	IN SEM EXAMINATION-I	20	40
	IN SEM EXAMINATION-II	20	
End-Sem Summative	END SEMESTER EXAM	40	40

xxi. SOLAR ENERGY & SYSTEMS> <SES)>

COURSE CODE	23TE52D3	MODE		LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Expose to Solar energy and its applications,	4	PO1, PSO1
CO2	Demonstrate the importance of renewable energy source and various applications of solar energy systems	3	PO1, PSO1
CO3	Do the preliminary analysis related to solar energy systems and design of solar PV and solar thermal systems	3	PO1, PSO1
CO4	Identify the power electronic converters for solar PV energy systems	4	PO1, PSO1

Syllabus

Module 1	Availability - Measurement and Estimation - Isotropic and an IsotropicModels – Introduction to Solar Collectors (Liquid Flat - Plate Collector, Air Heater andConcentrating Collector) and Thermal Storage - Steady State Transient Analysis - SolarPond - Solar Refrigeration
Module 2	**Modeling of Solar Thermal Systems and Simulations inProcess Design:** Design of Active Systems by f-chart and Utilizability Methods – Water HeatingSystems-Activeand Passive-Passive Heating and Coolingof Buildings-SolarDistillation-SolarDrying
Module 3	**PhotovoltaicSolarCell** P-N Junction-Metal-Schottky Junction, Electrolyte - Semiconductor Junction, Types of Solar Cells – their Applications
Module 4	Experimental Techniques to determine the Characteristics of Solar Cells -Photovoltaic Hybrid Systems Photovoltaic Thermal Systems – Storage Battery - SolarArrayandtheirCharacteristicsEvaluation-SolarChargeableBattery

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Solar Energy: principles of Thermal Collection and Storage,	S.P.Sukhatme	Tata McGraw-Hill	
2	Solar Energy Handbook	J.F.Kreider and F.Kreith	McGraw-Hill	2016

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	

						Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	
	Home Assignment and Book	10	20
In-Sem Summative	Sem -1	20	
	Sem -2	20	40
End-Sem Summative	End sem exam	40	40

xxii. HYDROGEN AND FUEL CELLS <HFC)>

COURSE CODE	23TE53E1	MODE	R	LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand various properties of hydrogen and various production methods	2	PO1, PO2 & PSO2
CO2	Understand hydrogen storage methods and employing hydrogen as fuel for IC engine	2	PO1, PO2 & PSO2
CO3	Apply fuel cell basics and Fuel cell thermodynamics	3	PO1, PO2 & PSO2
CO4	Apply fuel cell reaction kinetics	3	PO1, PO2 & PSO2

Syllabus

Module 1	Hydrogen basics and Production methods: Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation – direct thermal or catalytic splitting of water	
Module 2	Hydrogen storage methods: Hydrogen storage options – compressed gas – liquid hydrogen – Hydride – chemical Storage – comparisons. Safety and management of hydrogen, Transportation of hydrogen. Applications of Hydrogen. Hydrogen as a fuel for automobiles – Combustive properties of Hydrogen, Problems caused by hydrogen by employing fuel for automobiles, Design modifications required for the engine, Performance parameters of hydrogen fuelled IC engines	
Module 3	Fuel cell: Overview of Fuel Cells, low and high temperature fuel cells. Fuel Cell performance, Polymer electrolyte fuel cells, Alkaline fuel cells, Phosphoric fuel cells, Molten carbonate fuel cells, Solid oxide fuel cells, Fuel cell systems and Sample	

	calculations. Fuel cell thermodynamics - heat, work potentials, prediction of reversible voltage, fuel cell efficiency.	
Module 4	Fuel cell reaction kinetics - electrode kinetics, over voltages, Tafel equation, charge transfer reaction, exchange currents, electro catalyses - design, activation kinetics, Fuel cell charge and mass transport - flow field, transport in electrode and electrolyte	

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Hydrogen and Fuel Cells: A Comprehensive Guide	Rebecca L. and Busby	2005	Penn WellCorporation, Oklahoma
2	Fuel Cell Handbook	Mark C. Williams and H. Quedenfeld	2004	EG&GTechnical Services, Inc
3	Fuel Cells – Principles andApplications	Viswanathan, B and M Aulice Scibioh	2006	Universities Press
4	Non Conventional Energy Sources	G.D Rai	2017	Khanna Publishers

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Improving Fuel Cell Designs for FCEVs Using Simulation	Ansys	Y	Online		https://www.ansys.com/en-in/resource-center/webinar/improving-fuel-cell-designs-for-fcevs-using-simulation

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	COMSOL multiphysics Software		Commercial
2	Ansys		Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
	ALM	10	

In-Sem Formative	Home Assignment and Book	10	20
In-Sem Summative	Sem -1	20	
	Sem -2	20	40
End-Sem Summative	End sem exam	40	40

xxiii. AIRCRAFT & JET PROPULSION SYSTEMS > <AJPS)>

COURSE CODE	23TE52E2	MODE		LTPS	3-0-0-0	PRE-REQUISITE	Nil

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Analyze the Air craft and jet propulsion systems and its applications,	4	PO1, PSO1
CO2	Applying the One Dimensional Flows and shock waves	3	PO1, PSO1
CO3	Applying the Propulsive Engines For Aircraft	3	PO1, PSO1
CO4	Analyze the Shaft Power and Gas Turbine Cycles	4	PO1, PSO1

Syllabus

Module 1	Basic Principles of Propulsion, Historical background, how the jet engines make thrust: conceptual basis; Jet engine: Turbo-jet, Turbo-fans, Turbo prop, Turbo-shaft, Ramjet. Scramjets
Module 2	Compressible flow; Quasi One dimensional flow, Normal shock, Oblique shock, , Air intake, Nozzle flow, Boundary layer flow, Rayleigh flow, Fanno flow, Effect of frictional duct length in subsonic flow and supersonic flow, numerical problems in 1D flow
Module 3	The Otto cycles; IC engines for aircraft application Reciprocating engine performance; Supercharging and Performance enhancement Propeller fundamentals & Theories.
Module 4	Reheat cycle, cycle with heat and heat exchange, Methods of accounting for components losses, stagnation properties, compressor and turbine efficiencies, isentropic and polytropic, pressure losses, heat exchanger effectiveness, Mechanical losses, bleed flows, design point calculations, comparative performance of practical cycles.

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Elements of Gas Turbine Propulsion",	Mattingly J.D	", McGraw Hill	
2	Aerothermodynamics of Aircraft Engine Components	G.C (r) Oates,	AIAA	

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Nil	Nil	Nil	Nil	Nil	Nil
2	Nil	Nil	Nil	Nil	Nil	Nil

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	NA		

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	ALM	10	
	Home Assignment and Book	10	20
In-Sem Summative	Sem -1	20	
	Sem -2	20	40
End-Sem Summative	End sem exam	40	40

xxiv. BATTERY AND THERMAL MANAGEMENT SYSTEMS> <BTMS>

COURSE CODE	23TE52E3	MODE	MOOCS	LTPS	3-0-0-0	PRE-REQUISITE	NIL

Course Outcomes

CO#	CO Description	BTL	PO Mapping
CO1	Understand the construction and fabrication methods of various kinds of batteries	2	PO1, PSO1
CO2	Apply laws of thermodynamics to analyze battery performance	4	PO1,PO2, PSO1
CO3	Analyze various battery thermal management systems	4	PO1,PO2, PSO1
CO4	Simulate and analyze liquid cooled and air cooled battery pack	4	PO1,PO2, PSO1

Syllabus

Module 1	Introduction to Battery Technology and Electrochemical Modelling – working of electrochemical cell, li ion cell make up, manufacturing of electrodes, Assembling the cell, Failure modes.
Module 2	Equivalent Circuit Modelling of Cell and Thermodynamic of Cell - Open Circuit Voltage (OCV), SOC, OCV Testing, Coulombic Efficiency, Thermal Logic and Algorithms, Li-ion Aging, Butler Volmer Model

Module 3	Battery Thermal Management - Air Cooling and Heating, Liquid Cooling and Heating, PCM, Thermoelectric Module, Heat Pipe
Module 4	Thermal and Flow Modelling of Battery Pack - Pressure Drop Study, 3D Modelling of Liquid-cooled Thermal Systems using Fluent, 3D Thermal Modelling of an Air-cooled Battery Pack

Reference Books:

Sl No	Title	Author(s)	Publisher	Year
1	Thermal Management of Electric Vehicle Battery Systems	Ibrahim Dinçer, Halil S. Hamut, Nader Javani	John Wiley & Sons	2017
2	Handbook of Thermal Management Systems	Fethi Aloui, Edwin Geo Varuvel, Ankit Sonthalia	Elsevier	2023

Global Certifications:

Mapped Global Certifications:						
Sl No	Title	Certification Provider	Proctored (Y/N)	Format of the Exam	Exam Provider	URL of the Certification
1	Ansys Associate certification	Ansys	Y	MCQs	Ansys	https://certifications.ansys.com/courses/basics-of-fluid-dynamics-associate-certification/

Tools used in Practical / Skill:

Sl No	Tool Name	Parent Industry	Open Source/ Commercial
1	Ansys Fluent	Ansys	Commercial
2	Matlab	Mathworks	Commercial

Evaluation Components:

Evaluation	Component	Weightage	Total
In-Sem Formative	Active Learning	12	22
	Home Assignments	10	
In-Sem Summative	In Sem -1	19	38
	In Sem-2	19	
End-Sem Summative	End-Sem Exam (Paper Based)	40	40