K.E. Society's

Rajarambapu Institute of Technology, Rajaramnagar

(An Empowered Autonomous Institute, affiliated to Shivaji University, Kolhapur)

M. Tech. Mechanical Engineering (Thermal Engineering)

Curriculum Structure and Evaluation Scheme (NEP 2020)

To be implemented for 2025-27 & 2026-28 Batch

F. Y. M. Tech						**Semester: I**					
Course Code	**Course**	**Teaching Scheme**				**Evaluation Scheme**					
		L	**T**	**P**	**Credits**	**Scheme**	**Theory Marks**			**Practical Marks**	
							Max	**Min. % for passing**		**Max**	**Min. % for passing**
MTE1013	Classical and Statistical Thermodynamics	03	01	--	04	ISE	30	40	40	--	--
						ESE	70	40		--	--
MTE1024	Advanced Heat Transfer	03	01	--	04	ISE	30	40	40	--	--
						ESE	70	40		--	--
MTE1033	Hybrid & Electric Vehicles	03	--	--	03	ISE	30	40	40	--	--
						ESE	70	40		--	--
	Programme Elective – I	03	--	--	03	ISE	30	40	40	--	--
						ESE	70	40		--	--
	Programme Elective – II	03	--	--	03	ISE	30	40	40	--	--
						ESE	70	40		--	--
MTE1123	Modelling Lab	--	--	02	01	ISE	--	--		50	50
						ESE	--	--		50	50
MTE1133	Thermal Engineering Lab – I	--	--	02	01	ISE	--	--		50	50
						ESE	--	--		50	50
SHP5513	Technical Communication	02	--	--	01	ISE	--	--		100	50
TOTAL		**17**	**02**	**04**	**20**						

Total Contact Hours/week: 23

Total Credits: 20

ISE = In Semester Evaluation, ESE = End Semester Exam

Program Elective – I

Sr. No.	Course Code	Course
1	MTE1043	Energy Conservation and Management
2	MTE1053	Design of Pumps, Compressor and Blower
3	MTE1063	Gas Turbine and Jet Propulsion
4	MTE1073	Finite Element Method for Thermal Engineering

Program Elective – II

Sr. No.	Course Code	Course
1	MTE1083	Numerical methods and Optimization Techniques
2	MTE1093	Experimental Methods in Thermal Engineering
3	MTE1103	Alternative Fuel Technology
4	MTE1140	Design of Pressure Vessels and Piping

F. Y. M. Tech						**Semester: II**					
Course Code	**Course**	**Teaching Scheme**				**Evaluation Scheme**					
							Theory Marks			**Practical Marks**	
		L	**T**	**P**	**Credits**	**Scheme**	**Max.**	**Min. % for passing**		**Max.**	**Min. % for passing**
MTE2013	Computational Fluid Dynamics	03	01	--	04	ISE	30	40	40	--	--
						ESE	70	40		--	--
MTE2023	Design of Thermal System	03	01	--	04	ISE	30	40	40	--	--
						ESE	70	40		--	--
	Programme Elective – III	03	--	--	03	ISE	30	40	40	--	--
						ESE	70	40		--	--
	Programme Elective – IV	03	--	--	03	ISE	30	40	40	--	--
						ESE	70	40		--	--
MTE2113	Research Methodology & IPR	02	01	--	03	ISE	30	40	40	--	--
						ESE	70	40		--	--
MTE2123	Computational Fluid Dynamics Lab	--	--	02	01	ISE	--	--		50	50
						ESE	--	--		50	50
MTE2133	Thermal Engineering Lab – II	--	--	02	01	ISE	--	--		50	50
						ESE	--	--		50	50
MTE2143	Seminar	--	--	02	01	ISE	--	--		100	50
	TOTAL	**14**	**03**	**06**	**20**						

Total Contact Hours/week: 23
Total Credits: 20
ISE = In Semester Evaluation, ESE = End Semester Exam

Program Elective – III

Sr. No.	Course Code	Course
1.	MTE2033	Design of Heat Transfer Equipments
2.	MTE2043	Cryogenics Engineering
3.	MTE2053	Food Processing, Preservation and Transport
4.	MTE2063	Battery Thermal Management System

Program Elective – IV

Sr. No.	Course Code	Course
1.	MTE2073	Heating Ventilation Air Conditioning and Refrigeration Systems
2.	MTE2083	Fuel Cell Technology
3.	MTE2093	Waste Heat Management
4.	MTE2103	Advanced I. C. Engines

S. Y. M. Tech						**Semester: III**				
Course Code	**Course**	**Teaching Scheme**				**Evaluation Scheme**				
		L	**T**	**P**	**Credits**	**Scheme**	**Theory Marks**		**Practical Marks**	
							Max	**Min.% for passing**	**Max**	**Min.% for passing**
MTE3013	Industry Internship	--	--	--	01	ISE	--	--	100	50
	Open Elective	03	--	--	03	ESE	100	40	--	--
MTE3023	Dissertation Phase – I	--	--	12	06	ISE	--	--	100	50
MTE3033	Dissertation Phase – II	--	--	20	10	ISE	--	--	100	50
						ESE	--	--	100	50
	TOTAL	**03**	**--**	**32**	**20**					

Total Contact Hours/week: 35
Total Credits: 20
ISE = In Semester Evaluation, ESE = End Semester Exam

Open Elective

Sr. No.	Course Code	Course
1.	MOE2012	Artificial Intelligence and Machine Learning
2.	MOE2022	Creative Thinking: Techniques and Tools
3.	MOE2032	MOOC Course
4.	MOE2041	Energy Audit and Management
5.	MOE2062	Augmented Reality and Virtual Reality
6.	MOE2072	Industrial Instrumentation
7.	MOE2082	Advanced Mechatronics systems
8.	MOE2091	Disaster Management

Note for Open Elective

An Open Elective course is included in the curriculum of S. Y. M. Tech (Semester-III), under which students need to learn either MOOC course or courses offered by department.

Guidelines for MOOC course under Open Elective

1. If students opt for MOOC course as an Open Elective, he/she should select this course from NPTEL platform only.
2. As three credits are allotted to open elective, selected MOOC course must be of minimum 8 weeks or 30 hours.
3. Students need to solve assignments given by platform and also, give the final certification exam at allotted NPTEL exam center.
4. Student must secure certification of NPTEL platform within program duration, otherwise he/she will not be eligible for final evaluation.
5. If student fails in NPTEL certification course, he or she should re-register for the course in the next semester.

Guidelines for other courses mentioned under Open Elective:

1. Student can opt for courses mentioned in the curriculum.
2. While selecting the course, students must take care that selected course from the list is not learned in UG or PG first year curriculum.
3. Lectures of these courses will be conducted by concerned department faculty by online mode.
4. Evaluation of these courses will be as mentioned in the curriculum.

Rajarambapu Institute of Technology Mech. Engg. Dept. 415 414 Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

S. Y. M. Tech						**Semester: IV**				
Course Code	**Course**	**TeachingScheme**				**Evaluation Scheme**				
						Scheme	**TheoryMarks**		**PracticalMarks**	
		L	**T**	**P**	**Credits**		**Max**	**Min. %for passing**	**Max**	**Min. %for passing**
MTE4013	Dissertation Phase – III	--	--	16	08	ISE	--	--	100	50
MTE4023	Dissertation Stage – IV	--	--	24	12	ISE	--	--	100	50
						ESE	--	--	100	50
	TOTAL		--	**40**	**20**					

Total Contact Hours/week: 40
Total Credits: 20
ISE = In Semester Evaluation, ESE = End Semester Exam

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1013**	Course Name: **Classical and Statistical Thermodynamics**

L	T	P	Credits
03	**01**	**--**	**04**

Course Description:
This course introduces advance concepts in thermodynamics. It gives behaviour of thermodynamic gases and their relations to various mixtures and solutions. Thermodynamic equilibrium concept of the various system is compared. This course explains the Kinetic theory of gases and applies the principles of statistical thermodynamics to various processes. Effect of modification of geometric and operating parameters on thermodynamic cycle performance of systems is analysed.

Course Outcomes:
After successful completion of the course, students will be able to,
1. Explain different behaviour of gases and thermodynamic relations
2. Interpret thermodynamics property relations to various mixtures and solutions.
3. Compare thermodynamics equilibrium of system
4. Explain the kinetic theory of gases.
5. Apply the principle of statistical thermodynamics to the various processes.
6. Develop and analyze the various thermodynamic cycles.

Pre-Requisites: Engineering Thermodynamics, Engineering Mathematics and Heat Transfer.

Course Content

Unit No.	Description	Hrs.
01	**Thermodynamic Relations** Mathematical theorems, Maxwell equations, T-ds equations, energy equations, difference in heat capacities, Clapeyron relation. **Real Gases** Deviation from ideal gas behaviour, equation of state for real gases, reduced properties, Generalizes equation of state, laws of corresponding states, Generalized compressibility charts, enthalpy deviation and entropy deviation charts and their applications, P-V-T surfaces of real substances	**06**
02	**Mixtures and Solutions** Dalton Model, Amagat Model, simplified model of a mixture involving gases and a vapour, first law applied to Gas-Vapour mixtures, Adiabatic saturation process, Partial Molar properties, change in properties upon mixing, Thermodynamic properties relations for variable composition, Gibbs function and Enthalpy, Fugacity in a mixture, Ideal solution, Activity and Activity coefficient.	**06**

03	**Thermodynamic Equilibrium** Equilibrium requirements, Equilibrium between two phases of a pure substances, Equilibrium of a multi-component, Multiphase system, Gibbs phase Rule, Meta stable Equilibrium, Chemical equilibrium, Simultaneous reactions, Ionization, equation of reaction equilibrium; phase rule; chemical potential of ideal gases and fugacity	06
04	**Kinetic Theory of Gases** Postulates, concept of elastic collisions and mean free path, Derivation of ideal gas laws from kinetic theory, Distribution of molecular velocities, Maxwellion speeds and temperature, Law of equipartition of energy, Survival equation, Transport phenomenon	06
05	**Statistical Thermodynamics** Fundamental Principles, Equilibrium distribution, Significance of Lagrangian Multipliers λ & β, Partition function, Equipartition of energy, Distribution of speeds in an Ideal monotomic gas, Statistical Interpolation of Work and Heat, Entropy & Information	06
06	**Modelling of Thermodynamic Cycles** Thermodynamics cycles of various system such as IC Engine, Refrigeration, Heat pumps, solar equipment's etc. using suitable software. Effect of modification of geometric and operating parameters on these cycles performance. Efficient cycle and green cycles	06

References:

Text Books:

- V. Wylen & E. Sonntag, Fundamentals of Classical Thermodynamics, Wiley Eastern Limited, New Delhi.
- J. P. Holman, Thermodynamics, McGraw Hill, London.
- Adrian Bejan, George T., Michael Moran, Thermal Design and Optimization, John Willey and Sons.

Reference Books:

- T.J. Kotas, The Energy Method of Thermal Plant Analysis, Butterworth.
- J.L. Threlkeld, Thermal environmental engineering, Prentice Hall, Inc. New Jersy.
- M.W. Zemansky, Heat and Thermodynamics.
- M.L. Mathur& S.C. Gupta, Thermodynamics for Engineers, Dhanpatrai and Sons Ltd., New Delhi.
- Howell &Duckins, Fundamentals of Engineering Thermodynamics.
- Lee-Sears, Engineering Thermodynamics.

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1024**	Course Name: **Advanced Heat Transfer**

L	T	P	Credits
03	**01**	**--**	**04**

Course Description:
The course is planned to build necessary background for understanding the physical behaviour of various modes of heat transfer, like, conduction, convection and radiation. The course targets advances in convective heat transfer as most of heat exchange equipment are designed by considering principles of convection. Convective heat transfer has its wide horizon spreading from flow over a flat plate to thermally developing or developed flow inside a duct. Also, present course targets numerical analysis of heat transfer problems.

Course Outcomes:
After successful completion of the course, students will be able to,
1. Analyze heat conduction and Radiation
2. Develop a solution to heat convection to external laminar flow
3. Formulate heat convection to internal laminar flow.
4. Examine heat convection in turbulent flow
5. Interpret convection with phase change
6. Solve heat transfer problem numerically

Prerequisite: Fluid mechanics, Heat Transfer, Engineering Thermodynamics, Engineering Mathematics

Course Content		
Unit No	**Description**	**Hrs.**
01	**Heat Conduction and Radiation** Governing equations, steady and transient heat conduction, heat conduction with heat generation general boundary condition and initial condition for heat equation, Recapitulation of fundamentals of Radiative heat transfer, radiative properties of surfaces, methods of estimating configuration factors, heat exchange between diffusively emitting and diffusively reflecting surfaces. Electrical Network Analogy Radiant energy transfer through absorbing, emitting and scattering media. Advanced heat enhancement technique.	**07**
02	**Boundary Layer Flow Application to External Flow** Derivation of governing equations of momentum, energy and species transport, Order of magnitude analysis The boundary layer concept simplification of the governing equations, Similarity solution techniques, Blasius and Pohlhausen's solutions	**05**
03	**Boundary Layer Flow Application to Internal Flow** Concept of developing and fully developed flows. Thermally developing flows: Concept	**06**

	of thermally fully developed flow and its consequences under constant wall flux and constant wall temperature conditions. Heat flow in battery system	
04	**Convection in External and Internal Turbulent Flow** Introduction, Eddies and vorticity, conservation equation of turbulent flow, Analysis of external turbulent flow. Eddy diffusivity and Prandtl's Mixing length theory, Reynolds analogy.	06
05	**Convection with Phase Change** Condensation with change of phase, laminar and turbulent film on vertical surface, Nusselt film condensation theory, drop condensation, Pool boiling regimes, nucleate boiling and peak heat flux. Film boiling and minimum heat flux, Contact melting and lubrication.	06
06	**Numerical Analysis of Heat Transfer Problem** Solution of linear algebraic equations, unsteady one-dimensional conduction, the general descritization equation, numerical discretization methods such as finite difference forward, backward, central scheme. Numerical methods used for two and three dimensional steady and unsteady state conduction discretization of two and three-dimensional equation, implicit and explicit approach, Steady state one dimensional convection and diffusion equation, upwind scheme, exact solution, Exponential scheme, power scheme, generalized formulation, descritization of two and three dimensional equations.	06

References:

Text Books:

- Frank P Incropera, Devid P Dewit, Fundamentals of Heat and Mass Transfer, Wiley India Pvt Ltd.
- Adrian Bejan, Convection Heat Transfer, Wiley India Pvt. Ltd.
- Latif M. Jiji., Heat Convection, Springer.
- Pathankar. Numerical Heat Transfer and Fluid Flow

Reference Books:

- Essentials of Radiation Heat Transfer, by Balaji Ane books pvt. Ltd.
- David W. Hahn M. Necketi Ozisik, John Wiley, Heat Conduction.
- V.S Arpaci, Conduction Heat Transfer.
- E.M Sparrow, R.D Cess – Radiation Heat Transfer.
- R.Siegal and J.R Howell-Thermal radiation heat transfer.
- Y.A.Sengel, Heat Transfer, Tata McGrawHill.
- Krith, Fundamentals of Heat Transfer.
- Schlichting, Gersten, Boundary layer Theory, Springer.

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1033**	Course Name: **Hybrid & Electric Vehicles**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:

This course introduces the fundamental concepts, principles, analysis and design of hybrid, electric and fuel cell vehicles. The course focuses on mechatronic system and component design of HEV based on the requirements to power flow management, power conversion and thus to vehicle dynamics and energy/fuel efficiency. The course discusses design of batteries and energy storages and vehicle power electronics and also introduces plug-in hybrid electric vehicles..

Course Outcomes:

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

1. Design and develop basic schemes of electric vehicles and hybrid electric vehicles.
2. Select suitable drive scheme for developing an electric vehicle.
3. Choose proper energy storage systems, electric machine and drive train for vehicle applications.
4. Analyse various communication protocols and technologies used in vehicle networks.

Prerequisites: Thermodynamics, Drive systems, Basic Electrical Technology

Course Content		
Unit No	**Description**	**Hrs.**
01	**Hybrid Vehicles** History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance.	**06**
02	**Electric Vehicles** Introduction, Components, vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive- train topologies, fuel efficiency analysis.	**06**
03	**Battery** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Hybridization of different energy storage devices. Basics – Types, Parameters –	**06**

	Capacity, Discharge rate, State of charge, state of Discharge, Depth of Discharge, Technical characteristics, Battery pack Design, Properties of Batteries	
04	**DC & AC Electrical Machines** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives Motor and Engine rating, Requirements, DC machines, Three phase A/c machines, Induction machines, permanent magnet machines, switched reluctance machines	06
05	**Electric Vehicle Drive Train**: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Transmission configuration, Components – gears, differential, clutch, brakes regenerative braking, motor sizing.	06
06	**Communications, Supporting Subsystems**: In vehicle networks- CAN, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies	06

References:

Text Books:

- Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, CRC Press.
- James Larminie, Electric Vehicle Technology Explained, John Wiley & Sons.

Reference Books:

- Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press.
- Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes.
- .http://nptel.ac.in/courses/108103009/

Program Elective I

Class: **F. Y. M. Tech.**	Semester-**I**
Course Code: **MTE1043**	Course Name: **Energy Conservation and Management**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course summarizes the energy scenario and need of energy conservation, this course intentionally focusses on waste heat recovery techniques and energy auditing, Explain the various measures for energy conservation and financial implications for various thermal utilities.

Course Learning Outcomes:
At the end of the course the students will be able to
1. Analyze present energy scenario and the need for energy conservation.
2. Conduct energy audit of any system
3. Illustrate various techniques of waste heat recovery and cogeneration.
4. Identify energy conservation measures for various thermal utilities.
5. Summarize different financial terms and techniques used in Energy Conservation.

Prerequisite: Engineering Thermodynamics and Engineering Mathematics.

Course Content

Unit No	Description	Hrs.
01	**Energy Scenario** Primary and Secondary Energy, Conventional and nonconventional energy, Energy Security, Energy Conservation and its importance, Energy conservation Act., Thermal Energy basics, Need of energy Audit and management, Global warming	06
02	**Energy Audit & Instruments for Energy Auditing** Energy Audit its definition & methodology, Energy Audit Instruments, Benchmarking for energy performance, Energy Action Planning, Duties and responsibilities of Energy Manager; Energy financial management, Project Management, Energy monitoring and targeting, pinch technology. Detailed energy audit Methodology, Standard guide for conducting energy audit, plant visit for preparation of energy audit phase I and Phase II considering a case study, Instrument characteristics – sensitivity, readability, accuracy, precision, hysteresis. Error and calibration. Measurement of flow, velocity, pressure, Temperature, Speed, Lux, power and humidity. Analysis of stack, water quality, power and fuel quality	06
03	**Material and Energy Balance** Facility as an energy system; Methods for preparing process flow; material and energy balance diagrams. Cogeneration and waste heat recovery.	06

04	**Energy Action Planning** Key elements; Force field analysis; Energy policy purpose, perspective, contents, formulation, ratification; Organizing the management: location of energy management, top management support, managerial function, roles and responsibilities of energy manager, accountability; Motivation of employees: Information system-designing barriers, strategies; Marketing and communicating: Training and planning. Monitoring and Targeting	06
05	**Thermal Utilities Operation and Energy Conservation** Boilers, Thermic Fluid Heaters, Furnaces, Refrigeration Systems, Thermal Storage, Fans and Blowers, Electrical system, lighting, motors	06
06	**Financial Management** Investment – need, appraisal and criteria, financial analysis techniques – break even analysis – simple payback period, return on investment, net present value, internal rate of return, cash flows, DSCR, financing options, ESCO concept	06

References:

Text Books:

- Smith, CB Energy Management Principles, Pergamon Press, New York.
- Hamies, Energy Auditing and Conservation; Methods Measurements, Management and Case study, Hemisphere, Washington.
- Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi.
- Write, Larry C, Industrial Energy Management and Utilization, Hemisphere Publishers, Washington.
- Diamant, RME, Total Energy, Pergamon, Oxford.

Reference Books:

- Handbook on Energy Efficiency, TERI, New Delhi.
- Guide book for National Certification Examination for Energy Managers and Energy Auditors (Could be downloaded from www.energymanagertraining.com).
- Handbook of Energy Engineering Albert Treemann & Paul Mehta the Fiarmout Press Inc
- G. L. Witte, Phillips S.Scbmidt and Daid R. Brown, Industrial Energy Management and Utilization, Hemisphere Publishing Corporation, Washington.
- Carig, B. Saith, Energy Management Principles, Applications, Benefit and Saving, Pern Press, New York.

Program Elective I

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1053**	Course Name: **Design of Pumps, Compressor and Blower**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:

Mechanical pumps, compressor and blowers serve in a wide range of applications such as pumping water from wells, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers_and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis. Air compressors have many uses, including: supplying high-pressure clean air to fill gas cylinders, supplying moderate-pressure clean air to a submerged surface supplied diver, supplying moderate-pressure clean air for driving some office and school building pneumatic_HVAC control system valves and to produce large volumes of moderate-pressure air for large-scale industrial processes. This course enables the student to understand the design concepts, application of pumps, compressor and blower.

Course Outcomes:

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

1. Select suitable pump, blower, fan and compressor for a given application.
2. Design pump, blower, fan or compressor for a given application.
3. Analyze the performance of compressor and pump
4. Model and simulate pump, blower, fan and compressor.

Prerequisite: Fluid Mechanics, Turbo machines and Engineering Thermodynamics.

Course Content

Unit No.	Description	Hrs.
01	**Principles of Turbo Machinery** Introduction to turbo machines - Transfer of energy to fluids - Performance characteristics - fan laws - Dimensionless parameters - Specific speed - selection of centrifugal, axial, and mixed flow machines	06
02	**Pump Performance & Testing** Pump Characteristic Curves, main characteristics curves, operating characteristic curves, constant efficiency curves, Affinity Laws, System Curves, Pumps in series and parallel operation, Factors affecting pump performance, Measuring pump performance, Measurement of the pump's NPSH.	06
03	**Centrifugal and Axial-Flow Pumps** Nomenclature and Mechanical Design, Materials of Construction, Pump Performance, Installation, Operation, Maintenance.	06

	High-vacuum pumps Installation, Vapor Contamination, Flow of Gases at Low Pressure, Applications of High-Vacuum Pumps	
04	**Reciprocating Compressors** Compressed-Air and Gas Usage, Standard Units and Conditions, Thermodynamics of Compression, Adiabatic Analysis, Polytropic Process, Real-Gas Effects, Multistaging and Intercooling, Positive-Displacement Compressors versus Dynamic Compressors Surging, Reciprocating Compressors, Compressor Valves, Piston Rings, Piston-Rod Packing, Nonlubricated Cylinders, Lubrication, Compressor Accessories, Cylinder Cooling.	**06**
05	**Other Types of Compressors** Rotary-Vane Compressors, Rolling-Piston Compressors, Rotary Twin-Screw Oil-Flooded Compressors, Rotary Single-Screw Compressors, Dry Rotary Twin-Screw Compressors, Orbiting Scroll Compressors, Dynamic Compressors, Thrust Pressures	**06**
06	**Fans** Fan Types and Nomenclature, Fan Performance and Testing, Fan and System Performance Characteristics. Model and simulate Pump, Blower, fan or compressor	**06**

References:

Text Books:

- Turbine, Compressors and Fans S. M. Yahya, Tata Mc-Graw Hill Publishing Company.
- R. K. Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand.
- R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publication.
- V. Ganeshan, Gas Turbines, Tata Mc-Graw Hill Publishing Company.
- R. Yadav, Steam and Gas Turbine, Central Publishing House, Allahabad.

ference Books:

- Shepherd, D.G., Principles of Turbomachinery, Macmillan.
- John Tuzson, Centrifugal Pump Design.
- Stepanff, A.J, Blowers and Pumps, John Wiley and Sons Inc.
- Austin H. Chruch, Centrifugal pumps and blower, John Wiley and Sons.
- Val S.Labanoff and Robert Ross, Centrifugal Pumps Design and Application, Jaico P House.
- Igori Karassik, Pump Hand Book, McGraw-Hill International Edition.
- G.K. Sahu, Pumps, New age international publishers.

Program Elective I

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1063**	Course Name: **Gas Turbine and Jet Propulsion**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
The course is intended to serve as an introduction to Jet propulsion gas turbine, engine types, performance, turbojet and turbofan engines, designs of compressor, combustor, and turbines. It also gives a basic background in combustion, one-dimensional compressible internal flows, and the thermodynamics of Brayton-cycle engines.

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

1. Describe the ideal and real thermodynamic cycles of air-breathing engines and Industrial gas turbines.
2. Design the blading, study the velocity triangles and estimate the performance of centrifugal and axial flow compressors.
3. Explain the combustion process and design the combustion chamber of a gas turbine.
4. Design the blading, study the velocity triangles and estimate the performance of axial and radial in-flow turbines.
5. Analyze off-design performance and matching of the components of a gas turbine.

Prerequisites: Thermodynamics, Heat Transfer, Fluid Mechanics.

Course Content		
Unit No.	**Description**	**Hrs.**
01	**Introduction** Classification of Turbomachines, Applications of Gas Turbines **Ideal Shaft Power Cycles and their Analysis** Assumptions for Air-Standard Cycles, Simple Brayton Cycle, Heat Exchange Cycle, Inter-cooling and Reheating Cycle, Comparison of Various Cycles. **Real Cycles and their Analysis** Methods of Accounting for Component Losses, Isentropic and Polytropic Efficiencies, Transmission and Combustion Efficiencies, Comparative Performance of Practical Cycles, Combined Cycles and Cogeneration Schemes.	**06**
02	**Jet Propulsion Cycles and their Analysis** Criteria of Performance, Simple Turbojet Engine, Simple Turbofan Engine, Simple Turboprop Engine, Turbo-shaft Engine, Thrust Augmentation Techniques.	**06**

03	**Centrifugal Compressors** Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio, The Diffuser, The Compressibility Effects, Pre-rotation and Slip Factor, Surging and Choking, Performance Characteristics.	06
04	**Axial Flow Compressors** Construction and Principle of Operation, Elementary Theory and Velocity Triangles, Factors Effecting Stage Pressure Ratio, Degree of Reaction, Work done factor, Three Dimensional Flow, Design Process, Blade Design, Stage Performance, Compressibility Effects, Off-Design Performance.	06
05	**Combustion System** Operational Requirements, Classification of Combustion Chambers, Factors Effecting Combustion Chamber Design, The Combustion Process, Flame Stabilization, Combustion Chamber Performance, Some Practical Problems Gas Turbine Emissions.	06
06	**Axial and Radial Flow Turbines** Construction and Operation, Vortex Theory, Estimation of Stage Performance, Overall Turbine Performance, Turbine Blade Cooling, The Radial Flow Turbine. **Off-Design Performance:** Off-Design Performance of Single Shaft Gas Turbine, Off-Design Performance of Free Turbine Engine, Off-Design Performance of the Jet Engine, Methods of Displacing the Equilibrium Running Line.	06

References:

Text Book:

- Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, Gas Turbine Theory, H Pearson Prentice Hall.

Reference Books:

- Dixon, S.L., Fluid Mechanics and Thermodynamics of Turbomachinery, Elsevier.
- Flack, R.D., Fundamentals of Jet Propulsion with Applications, Cambridge University Press.

Program Elective I

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1073**	Course Name: **Finite Element Method for Thermal Engineering**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course introduces finite element methods for the analysis of solid, structural, fluid, field, and heat transfer problems. Steady-state, transient, and dynamic conditions are considered. Finite element methods and solution procedures for linear and nonlinear analyses are presented using largely physical arguments. The project involves use of the general purpose finite element analysis program. Applications include finite element analyses, modeling of problems, and interpretation of numerical results.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Establish the mathematical model for the complex analysis problems and predict the nature of the solution.
2. Formulate element characteristic matrices and vectors.
3. Identify the boundary conditions and their incorporation into FE equation
4. Analyze simple geometry problems for Thermal and stress analysis.
5. Interpret the analysis results for the improvement or modification of the system.

Prerequisite: Solid Mechanics, Thermodynamics, Numerical Methods, Heat transfer

Course Content

Unit No	Description	Hrs.
01	**Approximate Methods** Introduction to FEM, brief history, general steps in FEM, principle of minimum potential energy, interpolation function, approximate methods to solve DE using Galarkin method, least square method, Reyleigh-Ritz method, Approximation in FEM, type of elements, node and element numbering	**06**
02	**2D Problems** Stepped bar, truss element, beam element, thermal rod with conduction and convection consideration, complex element in structural and thermal problems, axisymmetric approximation in 2D problems,	**06**
03	**Complex Problems** Plane stress, plane strain, triangular, rectangular, quad element, natural co-ordinates, subparametric, superparametric and isoparametric element. Conductive and convective stiffness matrix and nodal vector formation.	**06**

04	**Nonlinear Heat Conduction Analysis** Galerkin's method to nonlinear transient heat conduction; Governing equation with initial and boundary conditions, one dimensional nonlinear steady-state problems and transient state problems.	06
05	**Viscous Incompressible Flows** Governing equations, weak form, finite element model, penalty finite element models, problems in two dimensional flow fields, finite element models of porous flow	06
06	**Convective Heat Transfer** Basic equations, steady convection diffusion problems and transient convection-diffusion problems, Velocity-pressure-temperature formulation, Examples of heat transfer in a fluid flowing between parallel planes.	06

References:

Text Book:

- Reddy J.N., Gartling. D.K., The Finite Element Method in Heat Transfer and Fluid dynamics, CRC Press.

Reference Books:

- Lewis R.W. et al., The Finite Element method in Heat Transfer Analysis, John Wiley & Sons.
- Singiresu S.Rao, Finite element Method in Engineering, Elsevier.

Program Elective II

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1083**	Course Name: **Numerical Methods and Optimization Techniques**

L	T	P	Credits
03	--	--	03

Course Description:
Advanced Mathematical Methods in Engineering is a core subject introduced at Semester I of first year M. Tech. Mechanical Engineering. This course intends to build the competency in the students to apply the knowledge of mathematics to the solution of Engineering problems and to analyse it.

Course Outcomes:
After successful completion of this course students should be able to
1. Apply the methods for solving algebraic, transcendental and linear equations.
2. Solve single variable optimization problems
3. Apply the methods for curve fitting using regression and interpolation techniques.
4. Apply the methods to solve differentiation and integration numerical.
5. solve ordinary and partial differential equations
6. Analyze the variance and explain the different research designs.

Pre-requisite: Undergraduate Engineering Mathematics.

Course Content		
Unit No.	**Description**	**Hrs.**
01	**Roots of Functions and Linear Equations** Transcendental & Algebraic Equations: Bracketing & open Methods- Bisection, False Position, Newton Rapshon Method, Secant Method. Gauss Elimination, Gauss Jordon applications, Gauss Seidal, LU decomposition, Matrix Inversion.	**06**
02	**Single Variable Optimization** Single variable optimization: Optimality Criterion, Bracketing methods - Exhaustive Search Method, Bounding Phase Method, Region Elimination Method - Interval Halving Method, Fibonacci Search Method, Golden Section Search Method, Point Estimation Method - Successive quadratic estimation method, Gradient based methods - Newton - Raphson Method, Bisection Method, Secant Method, Cubic Search Method, Root Finding Method using Optimization Technique.	**06**
03	**Curve Fitting** Regression analysis – Least square method, Linear regression, Polynomial regression, Fouries regression, Non linear regression, Interpolation – Newton's forward and backward interpolation, Newton's divided difference interpolation, Lagrange's interpolation, Gauss's central difference interpolation	**06**

04	**Numerical Integration and Differentiation** Newton Cotes Integration formulas- Trapezoidal, Simpson, Romberg, Gaussian Quadrature, Numerical Differentiation-Finite Difference Method. Types of Differential equations, Picard's Series Method, Taylor Series Method, Euler's Method, Modified Euler's Method, Runge Kutta Method, Predictor Corrector Method, Milnes Method, and Application to Initial & Boundary value Problems.	06
05	**Partial Differential Equations** Introduction to PDE Elliptic, Parabolic & Hyperbolic Equation. Finite Difference Schemes, Forward, Backward, Central Difference, Application to Laplace & Poisson's Equation, Iterative & Relaxation Techniques, Laplacian Operator in Cartesian, polar and other coordinate systems. Solution of Parabolic Equations, Implicit & Explicit Schemes, Crank Nicholson, ADI scheme. Solution of Hyperbolic Equations.	06
06	**ANOVA** One-way, two-way ANOVA with/without interactions. ANOVA techniques including L9 (Taguchi orthogonal array), L27 (Taguchi orthogonal array), and other fractional factorial designs. Principles of the design of experiments: some standard designs such as Latin Square Design (LSD), Completely Randomized Design (CRD), and Randomized Block Design (RBD). Additional techniques include Factorial Design, Taguchi Methods, and Response Surface Methodology (RSM) for optimization in experimental settings.	06

References:

Text Books:

- Larry C. Andrews, Ronald L. Phillips, Mathematical Techniques for Engineers and Scientists, Prentice Hall of India Private Ltd. New Delhi.
- Numerical Mathematical analysis, James B. Scarborough, Oxford and IBH Publishing Ltd
- Optimization for Engineering Design - Algorithms and Examples, Kalyanmayi Deb, PHI Pvt. Ltd

Reference Books:

- Numerical Methods by Engineers by Steven C Chapra and Raymond P Canale, TMH Publications.
- Numerical Methods for Engineers and Scientists, J D Hoffman, Marcel Dekker.
- Numerical Methods, B. S. Garewal, Khanna Publishers

Program Elective II

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1093**	Course Name: **Experimental Methods in Thermal Engineering**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course provides the students with notions about experimental methods and measurement techniques, in the fields of Fluid Mechanics and Heat Transfer, to allow the students to choose between available methods and instruments. Data analysis and measurement uncertainties are also treated, in order to correctly represent experimental results, and to adequately plan the experiments. The aim of the course is to give students the training in experimental work, to consolidate theoretical concepts and to promote the capacity to do teamwork.

Course Outcomes:
After successful completion of the course, students will be able to,
1. Identify the suitable instrument for measuring transport parameters and estimate error
2. Analyze and apply various methods for measuring density, viscosity, and related properties
3. Distinguish different flow visualization methods and temperature measurements.
4. Determine thermal conductivity in solids, liquids and gases and radiation measurements
5. Develop transfer function of given mechanical system by using concept of control system.
6. Apply calibration techniques for various sensors and interface them with systems

Pre- requisites: Heat Transfer, Basic Material and Properties

Unit No.	Description	Hrs.
	Course Content	
01	**Instrument Characteristics and Transducers** Instrument classification, static and dynamic characteristics of instruments, experimental error analysis, systematic and random errors, statistical analysis, uncertainty, reliability of instruments, Variable resistance transducers, capacitive transducers, piezoelectric transducers, photoconductive transducers, photovoltaic cells, ionization transducers, Hall effect transducers, uncertainty analysis, validation of results.	**06**
02	**Density, Viscosity and Other Measurements** Density measurements – Strain Gauge load cell method – Buoyancy method – Air pressure balance method – Gamma ray method – Vibrating probe method. Units of Viscosity, specific gravity scales used in Petroleum Industries, Different Methods of measuring consistency and Viscosity –Two float viscorator –Industrial consistency meter. Sound-Level Meters, Microphones, Humidity Measurement.	**06**

03	**Measurements of Flow and Temperature** Flow measurement by drag effects; hot-wire anemometers, magnetic flow meters, flow visualization methods, interferometer, and Laser Doppler anemometer. Temperature measurement by mechanical effect, temperature measurement by radiation, transient response of thermal systems, thermocouple compensation, temperature measurements in high- speed flow, thermo-graphic image analysis.	06
04	**Measurements of Thermal Conductivity, Convection Coefficient, Radiation** Thermal conductivity measurement of solids, liquids, and gases, measurement of gas diffusion, convection heat transfer measurements, humidity measurements, and heat-flux meters. Detection of thermal radiation, measurement of emissivity, reflectivity and transmissivity, solar radiation measurement.	06
05	**Open Loop and Close Loop Feedback** Review of open and closed loop control systems and servo mechanisms, Transfer functions of Mechanical Systems, input and output systems.	06
06	**Calibration and Interfacing** Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density and Viscosity Sensors, Variable Frequency Drive. Open and closed loop control system with on/off control, setpoint, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems	06

References:

Text Books:

- Holman, J.P., Experimental methods for engineers, Tata McGraw- Hill.
- Prebrashensky V., Measurement and Instrumentation in Heat Engineering, MIR Publishers.

Reference Books:

- Raman C.S. Sharma G.R., Mani V.S.V., Instrumentation Devices and Systems, Tata McGraw-Hill.
- Morris A.S, Principles of Measurements and Instrumentation, Butterworth-Heinemann

Program Elective II

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1103**	Course Name: **Alternative Fuel Technology**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
In an increasingly carbon and oil constrained world, much research is given towards an environmentally friendly, domestically produced fuel that can be used by our massive transportation fleet which includes not only cars and trucks, but also aircraft, ships, and railways. Many of these technologies have already been explored but the primal obstacle is the economic production and delivery of such fuels in competition with conventional petroleum based fuels.

Course Outcomes:
After successful completion this course, students will be able to,

1. To identify the need for alternate fuels and characterize prospective alternate fuels.
2. To interpret the properties and performance characteristics of liquid fuels like gasoline, alcohol, vegetable oils in both SI and CI engines.
3. To compare the properties and performance characteristics of gaseous fuels like LPG, CNG, and Hydrogen.
4. To Judge the scope and limitation of different alternate fuels.

Prerequisites: Thermodynamics, Heat Transfer, I C Engines

Unit No.	Description	Hrs.
	Course Content	
01	**Introduction** Working process of I.C. Engine. Study of various parameters related to properties of different types of fuel (Rating of fuel, Ignition quality, volatility, calculations of Air / Fuel ratio, Calorific Value) as input and output in terms of results (Fuel efficiency, Fuel requirement, Engine efficiency and Engine life). Sources of fossil fuel, scope of availability of fossil fuel in future.	06
02	**Need for Alternative Fuels** Effects of constituents of Exhaust gas emission on environmental condition of earth (N_2, CO_2, CO, NO_x, SO_2, O_2) Pollution created by Exhaust gas emission in atmosphere. Greenhouse effect, Factors affecting greenhouse effect. Study of Global Carbon Budget, Carbon footprint and Carbon credit calculations. Emission norms as per Bharat Standard up to BS – IV and procedures for confirmation on production.	06
03	**Alcohol &Bio Diesels** Sources of Methanol and Ethanol, methods of its production. Properties of methanol	06

	& ethanol as engine fuels, Use of alcohols in S.I. and C.I. engines, performance of blending methanol with gasoline. Emulsification of alcohol and diesel. Dual fuel systems. Improvement / Change in emission characteristics with respect to % blending of Alcohol. Base materials used for production of Bio Diesel (Karanji oil, Neemoil, Sunflower oil, Soyabeen oil, Musturd oil, Palm oil, Jatropha seeds). Process of separation of Bio Diesel. Properties Diesel blended with vegetable oil, and difference in performance of Engine.	
04	**Hydrogen: Production, Storage and Utilization** Hydrogen as a substitute fuel. Study Properties, Sources and methods of Production of Hydrogen, Storage and Transportation of hydrogen. Also, the economics of Application and Advantages of hydrogen (Liquid hydrogen) as fuel for IC engine/ hydrogen car. Layout of a hydrogen car. Fuel Cells: Concept of fuel cells based on usage of Hydrogen and Methanol. Power rating, and performance. Heat dissipation, Layout of fuel cell vehicle.	06
05	**Electric and Hybrid Vehicles** Layout of an electric vehicles, advantages & limitations. Systems components, electronic controlled systems, high energy and power density batteries. Types of hybrid vehicles. Solar cells for energy collection. Storage batteries, layout of solar powered automobiles. Advantages and limitations.	06
06	**Vegetable Oils and Biogas** Various Vegetable oils for Engines – Esterification – Performance and emission characteristics. Synthetic Alternative Fuels: Di-Methyl Ether (DME), P-Series, Eco Friendly Plastic fuels (EPF). Introduction to Biogas system, Process during gas formation, Factors affecting biogas formation. Usage of Biogas in SI engine & CI engine, CBG. CNG Technology: Properties of LPG & CNG as engine fuels, fuel metering systems, combustion characteristics, effect on performance, emission, cost and safety.	06

References:

Text Books:

- Dr. S. Thipse, Alternate Fuels, Jaico Publications.
- Crouse., Anglin, Automotive Emission Control, Tata McGraw Hill.
- Ganeshan, Internal Combustion Engines, Tata McGraw Hill.
- Heywood John., Internal Combustion Engines.

Reference Books:

- The properties and performance of modern alternative fuels – SAE Paper no. 8412102.
- Bechtold R., Alternative Fuels Guidebook. SAE Paper nos. 840367, 841333, 841334
- Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press.

Program Elective – II

Class: **F. Y. M. Tech**	Semester: **II**
Course Code: **MTE1141**	Course Name: **Design of Pressure Vessels and Piping**

L	T	P	Credits
03	--	--	03

Course Description:
This course covers in-depth design & Engineering calculation of pressure vessel as per ASME Section VIII Division I including Process equipment. (Vessels, Reactors, Heat Exchangers, Distillation Columns). Overview/ detailed topic of PFD, P&ID, Process Data Sheets, Inputs required, relevant Codes and Standards used in Industry including ASME Section VIII, Materials Specifications (ASTM / ASME), Pressure Vessel Service Classification and Mechanical Properties of Steels.
The pressure vessel design course is more concentrated on Engineering and design calculations of Stresses in Pressure Vessels, Pressure Vessels Shell and Head Thickness, Dead Weight, Hydrostatic Test Weight of Pressure vessels and Calculating Nozzle Necks.
The pressure vessel design course provides a systematic development of skills and knowledge of Pressure Vessel for design, development and manufacturing process as per the International standards.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Apply the design consideration of pressure vessel.
2. Design the support of the pressure vessel.
3. Design nozzle for pressure vessel.
4. Design piping system for pressure vessel.

Prerequisite: Machine Design, Solid Mechanics

Course Content

Unit No	Description	Hrs.
01	**Stresses in Pressure Vessel** Introduction to stresses in pressure vessel and its application to shells and end closures, stresses in circular plate, Thermal stresses, Stresses in plate having the circular hole due to bi-axial loading, excessive elastic deformation, plastic instability, brittle, rupture and creep.	06
02	**Pressure Vessel Design Code** Introduction to ASME codes for pressure vessel design, Pressure vessel and related components' design using ASME codes; Supports for short vertical vessels, Stress concentration at a variable thickness transition section in a cylindrical vessel; Design of nozzles.	06

03	**Supports Design for Pressure Vessel** Design of base plate and support lugs, Types of anchor bolt, its material and allowable stresses, Design of saddle supports.	06
04	**Design Consideration in Pressure Vessel** Buckling phenomenon, Elastic Buckling of circular ring and cylinders under external pressure, collapse of thick walled cylinders or tubes under external pressure, Effect of supports on elastic buckling of cylinders, Design of circumferential stiffness, Buckling under combine External pressure and axial loading, Fatigue, shock high pressure high temperature irradiation corrosion and other hostile environments, high strength, light weight pressure vessels resistant to external high pressures found in undersea exploration.	06
05	**Buckling and Fracture Analysis in Vessels** Buckling phenomenon – Elastic Buckling of circular ring and cylinders under external pressure – collapse of thick walled cylinders or tubes under external pressure – Effect of supports on Elastic Buckling of Cylinders – Buckling under combined External pressure and axial loading.	06
06	**Piping Design** Flow diagram, piping layout and piping stress analysis; Flexibility factor and stress intensification factor; Design of piping system as per B31.1 piping code. Piping components - bends, tees, bellows and valves. Types of piping supports and their behavior; Introduction to piping Codes and Standards. Pressure Relief Valve / Pressure Safety Valve / Rupture Disc / Safety Devices.	06

References:

Text Books:

- John F. Harvey, Theory and Design of Pressure Vessels, CBS Publishers and Distributors.

Reference Books / Journals:

- Browenell L.E and Young E.D., Process equipment design, Willey Esstern Ltd. India.
- ASME, ASME Pressure Vessel and Boiler code, Section VIII Div. 1, 2, and 3.
- ASME, American standard code for pressure piping, B 31.1.
- Henry H Bednar, Pressure vessel Design Hand book, CBS publishers and distributors.
- J. Phillip Ellenberger, Pressure Vessels: ASME Code Simplified, ASME.
- Smith P, Fundamentals of Piping Design, Elsevier.
- William. J., Bees, Approximate Methods in the Design and Analysis of Pressure Vessels and Piping, Pre ASME Pressure Vessels and Piping Conference.
- Stanley, M. Wales, Chemical process equipment, selection and Design. Buterworths series in Chemical Engineering,
- Sam Kannapan, Introduction to Pipe Stress Analysis. John Wiley and Sons.

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1123**	Course Name: **Modelling Lab**

L	T	P	Credits
--	--	02	01

Course Description:
This laboratory course introduces use of computers as a tool to design equipment, analyze flow patterns, predict energy transfers, establish stress and strain patterns and to control machines and processes. The great strides in space exploration, spacecraft design, power station design, the many innovations in travel and agriculture all trace their success to the importance of Engineers being able to simulate and solve complex problems on computers. The demand for Mechanical Engineers is very high, but the demand for an Engineer with a combined Mechanical Engineering and Computer software proficiency is overwhelming. This course provides training on following software to the students for modeling the thermal parts.

Course Learning Outcomes:
After completion of this course student will be able to,
1. Model the components of thermal system using suitable software.
2. Create computational domain for selected geometry.
3. Generate mesh and refine mesh elements of given geometry.

Prerequisite: Fundamentals of Engineering Graphics, Auto CAD

List of experiments (Any 10)

Course Content		
Experiment No	**Description**	**Hrs.**
01	Development of a model for 2D Pipe junction and 3D pipe junction	**02**
02	Development of a model for Cylinder, Plate	**02**
03	Development of a model for Heat exchanger	**02**
04	Development of a model for Mixing T and Cooling chamber	**02**
05	Development of a model for Engine Block	**02**
06	Development of a model for Wing body	**02**
07	Development of a model for Stamping	**02**
08	Development of a model for Elbow junction	**02**
09	Development of a model for Engine inlet valve	**02**
10	Development of a model for Water Jacket section	**02**
11	Development of a model for battery for electric vehicles	**02**

References:

Text Books:

- ANSYS Fluent user manual.

Reference Books:

- Versteeg, H. K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics, The Finite Volume Method.
- Tannehill, J. C., Computational Fluid Mechanics and Heat Transfer, Anderson, D. A. and Pletcher, R. H., McGraw Hill.

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE1133**	Course Name: **Thermal Engineering Lab – I**

L	T	P	Credits
--	--	**02**	**01**

Course Description

This course introduces the engineering student to the thermal sciences - thermodynamics, fluid dynamics (ha)4d he(ha)t traer course labor(ha)tory experiments. The thermal engineering labor(ha)tory intentionally introduced in a curriculum to have a hands on experience for various set ups (ha)4d compare results with standard results and interpret it.

Course Outcomes:

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

1. Conduct test (ha)4d interpret the theoretical (ha)4d experimental d(ha)ta of conductionv(ha)4d c experiments.
2. Relate the theory (ha)4d the experimentation pertaining to thermal system.
3. Examine various thermal systems

Pre- requisites: Numerical Methods, He(ha)t tra4sfer, Thermodyn(ha)mics, RAC

List of experiments

Attempt any 10 experiments of the following

Experiment No.	Description	Hrs.
01	Perform experiment to fi4d out thermo physical properties of fluid (Thermal conductivity (ha)4d Viscosity) of liquids.	**02**
02	Conduct trial to estimate film wise (ha)4d drop wise condensation.	**02**
03	Verify the performance of different geometrical configuraon of fins.	**02**
04	Conduct trial on steam power plant to find performance of different device	**02**
05	Perform test (ha)4d ehassion measurement on VCR IC Engines.	**02**
06	Perform test on wind tunnel for drag (ha)4d lift force, pressure drop.	**02**
07	Performance test on air blower.	**02**
08	Perform test on sol(ha)r distillaon plant.	**02**
09	Testing of solar pa4el using sol(ha)r emula	**02**
10	Perform test on sol(ha)r pump	**02**
11	Conduct trial on heat pipe	**02**
12	Conduct trial on nanofluid forced convection test rig.	**02**
13	Visit co-generaon power plant/ steam power plant.	**02**

References:

Text Book:

- Incropera F.P. and DeWitt. D.P., Fundamentals of Heat & Mass Transfer, John Wiley & Sons.

Reference Book:

- Schlichting, Gersten, Boundary layer Theory, Springer.
- Rohsenow. W.M., Harnett. J. P. and Ganic. E.N., Handbook of Heat Transfer Applications, McGraw-Hill.

Rajarambapu Institute of Technology Mech. Engg. Dept. 415 414 Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Class: **F. Y. M. Tech**	Semester: **I**
Course Code: **SHP5513**	Course Name: **Technical Communication**

L	T	P	Credits
02	**--**	**--**	**01**

Course Description:
This course is designed to enhance students' ability to create well-structured technical documents and deliver impactful oral presentations. It emphasizes the principles of effective technical writing and explores various document types commonly used in technical fields and research. While the primary focus is on writing skills, the course also integrates oral communication skills, preparing students for professional presentations in diverse workplace settings.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Construct grammatically correct sentences in different types of technical writing, such as reports and proposals.
2. Apply technical writing skills to improve the readability of documents.
3. Demonstrate professional skills required in job interviews and at workplaces.

Prerequisite: Students enrolling in this course should have adequate LSRW abilities in English language.

Course Contents

Unit No.	Description	Hrs.
1.	**Planning and Preparation** Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness	**04**
2.	**Paraphrasing and Plagiarism** Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism	**03**
3.	**Structural Framework of Research Article** Abstract, Introduction, Review of the Literature, Methods, Results, Discussion, Conclusions, and The Final Check.	**03**
4.	**Sections of Research Article: Part- I** Key skills needed when writing a Title, key skills needed when writing an Abstract, key skills needed when writing an Introduction, skills needed when writing a Review of the Literature,	**04**
5.	**Sections of Research Article: Part- II** Skills needed when writing the Methods, skills needed when writing the Results, skills needed when writing the Discussion, skills needed when writing the	**04**

	Conclusions, useful phrases, how to ensure good quality of the paper at the time of submission	
6.	**Professional skills** Resume Writing, e-mails, Interview skills, Dos and Don'ts while Answering, FAQs, GROUP DISCUSSION: Structured and Unstructured GD, Opening and Closure, Showing Agreement and Disagreement	**06**

Reference Books:

- Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London.
- Day R, How to Write and Publish a Scientific Paper, Cambridge University Press.
- Goldbort R, Writing for Science, Yale University Press (available on Google Books).
- Jeff Butterfield, Soft Skills for Everyone, Cengage Learning India Private Limited.
- John Seely, Oxford Guide to Effective Writing and Speaking; Oxford University Press.
- Thomas N. Huckin and Leslie A. Olsen, Technical Writing and Professional Communication for Nonnative Speakers of English; Tata McGraw Hills, International Edition.

Class: **F. Y. M. Tech.**	Semester: **II**
Course Code: **MTE2013**	Course Name: **Computational Fluid Dynamics**

L	T	P	Credits
03	**01**	**--**	**04**

Course Description

An introduction to computational fluid dynamics (CFD) in Mechanical Engineering gain knowledge of use of modern CFD software to build, solve, and visualize fluid-flow models. The course is aimed to give a basic understanding to the discretization of equations of mass, momentum and energy. The course covers numerical methods for physical simulations of gas and liquid flows. The course is based on the finite difference method and the finite volume method with emphasis on fluid dynamics and includes various computational problems in fluid dynamics such as boundary conditions and meshing. This will also create the base and interest among the students to carry out the Future Research.

Course Outcomes:

At the end of the course the student will be able to

1. Derive governing equations for fluid dynamics and heat transfer.
2. Develop finite difference algorithms for fluid flow and heat transfer problems.
3. Develop finite volume algorithms for fluid dynamics equations.
4. Select appropriate grid generation methods for CFD analysis.
5. Apply different CFD Techniques to various fluid flow problems

Pre-Requisites: Fluid mechanics, Heat transfer, Numerical methods.

Course Content		
Unit No.	**Description**	**Hrs.**
01	**Conservation Laws of Fluid Dynamics and Heat Transfer** Models of fluid flow, substantial derivative, divergence of velocity, conservative and nonconservative forms of continuity, momentum and energy equations. Integral and differential analysis, physical boundary conditions	**06**
02	**Aspects of Discretization** Mathematical behaviour of partial differential equations, Classification of Elliptic, hyperbolic and parabolic equations. Finite difference approximation, difference equations. Implicit and explicit approximation, Time marching, Space marching, Error and stability analysis.	**06**
03	**CFD Techniques** Geometry discretization, Eular's FTBS, FTCS and FTBCS, Dufort-Frankel Method, Lax Wandroff technique, Macormac's technique, Relaxation technique, ADI technique, pressure correction technique.	**06**

04	**Geometry Modelling and Grid Generation** Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance, elliptic and adaptive grids. Unstructured grid structure, parabolic and hyperbolic grid generation	06
05	**Finite Volume Method** FVM for Steady state diffusion, convection diffusion problems, tridiagonal matrix algorithm, Finite volume method for two-dimensional diffusion problems, Properties of discretization schemes, Transient problems with QUICK, SIMPLE schemes, stream function-vorticity transformation	06
06	**Advanced CFD Algorithms and Application** Co-ordinate transformation, Shock capturing, Pressure - velocity coupling in steady flows: Staggered grid approach, SIMPLE algorithm, SIMPLER, SIMPLEC algorithms, worked examples of the above algorithms, cell centered scheme, nodal point scheme. Application in the field of drone technology, air taxi.	06

References:

Text Books:

- J. D. Anderson, The Basics with Applications, Computational Fluid Dynamics, McGraw Hill.
- K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House.
- K. A. Hoffmann, S. T. Chiang, Computational Fluid Dynamics for Engineers, Engineering Education System.
- O. Zikanov, Essential Computational Fluid Dynamics, Wiley India.
- Versteeg, H. K. and Malalasekera, An Introduction to Computational Fluid Dynamics, W.

Reference Books:

- The Finite Volume Method, Pearson.
- A Practical Approach, J. Tu, G. H. Yeoh and C. Liu, Computational Fluid Dynamics: Butterworth Heinemann (Indian Edition).
- S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis (Indian Edition).
- A. W. Date, Introduction to Computational Fluid Dynamics, Cambridge (Indian Edition).

Class: **F. Y. M. Tech.**	Semester: **II**
Course Code: **MTE2023**	Course Name: **Design of Thermal System**

L	T	P	Credits
03	01	--	04

Course Description

The course is designed to give students the design concepts and fundamental aspects of industrial thermal system simulation and optimization. Examination of optimum design criteria, their application and scrutiny of engineering decision. Fundamentals of design, and selection of thermal equipment and processes such as heat exchangers, evaporators, condensers, boilers, binary mixtures and turbo machinery. Mathematical modelling of thermal equipment. Simulation of thermal systems. Fundamentals of optimum system design. Optimization methods and optimization of thermal systems.

Course Outcomes:

After completion of this course student will be able to

1. Illustrate basic principles of modeling and optimization of design of thermal systems.
2. Design thermal systems.
3. Analyze thermal system.

Pre- requisites: Thermodynamics, heat transfer, Numerical Methods

Course Content		
Unit No	**Description**	**Hrs.**
01	**Design Concepts** Design Principles, Workable Systems, Optimal Systems, Matching of System Components, Economic Analysis, Depreciation, Gradient Present Worth factor. Computer aided thermal system design.	06
02	**Mathematical Modeling** Equation Fitting, Nomography, Empirical Equation, Regression Analysis, Different Modes of Mathematical Models.	06
03	**Modeling of Thermal Equipment's** Different Modes of Mathematical Models, Selection, and Computer Programs for Models. One case study type complete example for Modelling out of following: Heat Exchangers, Evaporators, Condensers, Absorption and Rectification Columns, Compressors, Pumps.	06
04	**Simulation of Thermal Systems** Uses of system simulation, classes of simulation; Information-flow diagrams; sequential and simultaneous calculations; simulation of continuous, deterministic steady-state systems, e.g., gas turbine system.	06

05	**Optimization of Thermal Systems** Optimization criteria; use of Lagrange Multipliers, search methods, dynamic programming and geometric programming for optimum design of thermal systems. Steady state Simulation, Laplace Transformation, Feedback Control Loops, Stability, Analysis.	06
06	**Thermo-Economic Analysis, Evaluation and Optimization** Fundamentals of thermo-economics, Thermo-economic variables for component evaluation; thermo-economic evaluation; additional costing considerations, design optimization for the co-generation system- a case study; thermo-economic optimization of complex systems.	06

References:

Text Books:

- Stoecker W. F., Design of Thermal Systems, McGraw Hill Edition.
- Bejan A., Thermal Design and Optimization, George Tsatsaronis, Michael J. Moran, Wiley.
- Hodge, B.K., Analysis & Design of Thermal Systems, Prentice Hall.
- Boehm, R.F., Design of Thermal Systems, John Wiley.

Reference Books:

- Kapur J. N., Mathematical Modelling, Wiley Eastern Ltd, New York.
- Yogesh Jaluria, Design and Optimization of Thermal Systems, CRC Press.
- Rao S. S., Engineering Optimization Theory and Practice, New Age Publishers.

Program Elective III

Class: **F Y M. Tech.**	Semester: **II**
Course Code: **MTE2033**	Course Name: **Design of Heat Transfer Equipments**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description

This course discusses the mechanical design requirements of different heat exchangers for various plant applications. It also highlights the primary features of air-cooled, double-pipe, and plate-and-frame exchangers and condensers and evaporators.

Course Outcomes:

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

1. Select suitable heat exchanger for particular application.
2. Design of heat exchanger.
3. Design and analyse boiler furnace.
4. Analyse different heat transfer equipments.

Prerequisites: Thermodynamics, Heat Transfer

Course Content		
Unit No.	**Content**	**Hrs.**
01	**Design Aspects, Flow and Stress Anlysis** Types of heat exchanger, Parallel flow, counter flow and cross flow; shell and tube and plate type; single pass and multipass, Heat transfer and pressure loss – flow configuration – effect of baffles – effect of deviations from ideality – design of double pipe - finned tube - shell and tube heat exchangers - simulation of heat exchangers. Effect of turbulence – friction factor – pressure loss – stress in tubes – header sheets and pressure vessels – thermal stresses, shear stresses - types of failures	**06**
02	**Thermal Design and Mechanical Design** Performance evaluation of Heat Exchangers, LMTD, e-NTU methods. Rating and sizing problems, Heat Transfer and Pressure drop calculations. Design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges etc. Flow induced vibration.	**06**
03	**Design of Shell and Tube Heat Exchanger** Thickness calculation, Tube sheet design using TEMA formula, concept of equivalent plate for analyzing perforated analysis, flow induced vibration risks including acoustic issues and remedies, tube to tube sheet joint design, buckling of tubes, thermal stresses Basic Design Methods of Heat Exchanger Fouling of Heat Exchanger, Effects of	**06**

	fouling on heat exchanger, Effects of fouling pressure drop, Types of fouling, Fundamental processes of fouling, Techniques to control fouling.	
04	**Boiler Furnace Design** Heat transfer in coal fired boiler furnace (gas side) – Estimation of furnace exit gas temperature, estimation of fin-tip temperature. Heat transfer in two phase flow- Estimation of inside heat transfer coefficient using Jens & Lottes equation and Thom's correlation. Estimation of pressure drop in two phase flow using Thom's method	06
05	**Design of Process Equipment** Design of Fuel Oil Suction Heater, Design of Fuel Oil Heater, Design of Recuperative Air Pre Heater, Design of Economizer, Design includes estimation of heat transfer area, pressure drop etc. Superheater and Reheater Design	06
06	**Design of Condensers and Evaporators** Shell and tube condensers, Air cooled condensers, Direct contact condensers, Condensers and evaporators for refrigeration and air conditioning. Darcy flow model, forced convection and natural convection boundary layer. Modeling and Simulation.	06

References:

Text Books:

- Sadik Kakac, and Hongtan Liu, Heat Exchangers: Selection, Rating and Thermal Design, CRC Press.
- R. K. Shah, D. P. Sekulic, Fundamentals of Heat Exchanger Design, John Wiley and Sons, Inc.
- D.C. Kern, Process Heat Transfer, McGraw Hill, Reprint.
- Frank P. Incropera and David P. De Witt, Fundamentals of Heat Transfer, Wiley, Eastern Limited.
- V. Ganapathy, Applied Heat Transfer Penn Well Publishing Company, Tulsa, Oklahoma.
- Sarit Kumar Das, A. R. Balakrishan, Process Heat Transfer, Alpha Science International.

Reference Books:

- T. Kuppan. Hand Book of Heat Exchanger Design.
- T.E.M.A. Standard, New York.
- Compact Heat Exchanger, Kays and London.
- G. Walker, Industrial Heat Exchangers-A Basic Guide, McGraw Hill.

Program Elective III

Class: **F. Y. M. Tech.**	Semester: **II**
Course Code: **MTE2043**	Course Name: **Cryogenics Engineering**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course provides instruction in fundamental principles of cryogenics, developing these into tools that can be utilized in laboratory and industrial applications. The topics will include a brief history of cryogenics, material properties (solids, liquids, and gases) at low temperatures, large-scale cryocooler systems for refrigeration and liquefaction, gas separation and purification, measurement techniques, and the safe storage and transfer of cryogens.

Course Outcomes:
After successful completion of this course, students will be able to,

1. Apply the basic principles of low temperature engineering.
2. Explain the behaviour of solids and liquid at low temperatures
3. Analyze cryogenic systems.
4. Discuss gas separation systems.
5. Design Heat Exchangers for Cryogenic System.

Pre-Requisites: Thermodynamics, Fluid mechanics, Heat transfer.

Course Content

Unit No.	Description	Hrs.
01	**Properties of Cryogenic Fluids and Properties of Solid at Low Temperature** Properties of fluids other than hydrogen and helium, Properties of hydrogen, helium3, helium4 Low temperature properties of materials, Mechanical properties, Thermal properties, electric and magnetic properties	06
02	**Refrigeration and Liquefaction** Refrigeration & liquefaction, Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison, Thermodynamically ideal system, System performance parameters, Liquefaction systems for gases other than neon, hydrogen and helium, Liquefaction systems for neon hydrogen and helium.(simple numerical)	06
03	**Cryogenics Measurement Systems** Heat Exchanger, compressor, expander, effect of component efficiencies, system optimization, Measurement of different parameters at low temperature like temperature, pressure level mass flow rate etc.	06

04	**Separation and Purification Systems** Ideal separation of gases, characteristics of mixture, principles of gas separation, air separation system, hydrogen separation system, helium separation system, gas purification	**06**
05	**Cryogenic Heat Exchanger** Types of Cryogenic Heat Exchanger, NTU-effectiveness design Method, Plate-fin Heat Exchanger Design, Perforated Heat Exchanger Design, Regenerators, Regenerator Design, computer programming and simulation of cryo system.	**06**
06	**Cryogenic Rocket Propulsion** Chemical rocket propulsion, Definitions and fundamentals: thrust, total impulse, specific impulse, mixture ratio, bulk density, characteristics velocity, thrust to weight ratio, exhaust velocity, mass ratio, multistaging; Types of chemical propellants: solid, liquid, hybrid, Physical properties of common earth storable propellants, semi-cryo and cryogenic propellants.	**06**

References:

Text Book:

- Randall F. Barron, Cryogenic Heat Transfer, Taylor and Francis.

Reference Books:

- A. Arkherov, Theory and design of cryogenic systems,
- Timmerchand & Flynn, Cryogenic process engineering,
- Mikulin, Theory and design of cryogenic systems, MIR Publication.

Program Elective III

Class: **F. Y. M. Tech**	Semester: **II**
Course Code: **MTE2053**	Course Name: **Food Processing, Preservation and Transportation**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
The course covers principles of food processing and preservation. Traditional and modern methods of food processing and preservation for different food categories. The effect of specific food processing and preservation techniques such as pasteurization, dehydration, thermal sterilization, freezing, chemical additives etc on storage, shelf-life, sensory and nutritional properties of different foods. Importance, opportunities and constraints of small-scale food processing in developing countries with appropriate case studies it also covers techniques to transport the food.

Course Outcomes:
After successful completion of the course, students will be able to,
1. Analyze mechanism of food spoilage.
2. Design suitable food processing and preservation system.
3. Select suitable cold storage system.
4. Design and analysis transport system of preserved foods.
5. Model the preservation system

Prerequisites: Thermodynamics, Fluid mechanics, Heat transfer.

Course Content		
Unit No.	**Description**	**Hrs.**
01	**Introduction** Microbiology of Food Products, Mechanism of food spoilage critical microbial growth requirements, Design for control of micro-organisms, The role of HACCP, Sanitation, Regulation and standards	**06**
02	**Processing & Preservation** Thermodynamic properties and Transfer properties, Water content, Initial freezing temperature, Ice fraction, Transpiration of fresh fruits & vegetables, Food processing techniques for Dairy products, Poultry, Meat, Fruits & Vegetables	**06**
03	**Freezing & Drying** Precooling, Freeze drying principles, Cold storage & freezers, Freezing drying limitations, Irradiation techniques, Cryofreezing, Numerical and analytical methods in estimating Freezing, Thawing times, Energy conservation in food industry	**06**
04	**Cold Storage Design & Instrumentation** Initial building consideration, Building design, Specialized storage facility,	**06**

	Construction methods, Refrigeration systems, Insulation techniques, Control & instrumentation, Fire protection, Inspection & maintenance.	
05	**Food Transportation** Refrigerated transportation, Refrigerated containers & trucks, Design features, Piping & Role of cryogenics in freezing & transport	**06**
06	**Modeling and Simulation** Model the simple case studies of food storage and processing. Simulation of simple case studies	**06**

References:

Text Books:

- Arora C.P. Refrigeration and Air conditioning, II Ed. McGraw-Hill, Pub.
- Alan Rodes, Principles of Industrial Microbiology, Pregmon International Pub.

Reference Books:

- Ibraham Dincer, Heat Transfer in Food Cooling Applications, Tailor & Francis Pub.
- Stanley E. Charm, Fundamentals of Food Engineering, III Ed. AVI Pub. CO.Inc.
- Clive V.I. Dellino, Cold and Chilled Storage Technology, Van Nostrand Reinhold Pub. New York.
- ASHRAE Handbook, Refrigeration, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. Atlanta.

Rajarambapu Institute of Technology Mech. Engg. Dept. 415 414 Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Program Elective III

Class: **F. Y. M. Tech**	Semester: **II**
Course Code: **MTE2063**	Course Name: **Battery Thermal Management System**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
this course, you will get a complete overview of electrochemistry, battery terminologies, battery management system, charging and discharging for EV application and thermal management. This course is especially useful to students and working professionals at a beginning stage of learning about the battery system of electric & hybrid electric vehicles. You will gain knowledge about lithium ion battery systems, chemistry, and management systems & cooling.

Course Outcomes:
After successful completion of this course, student will be able to:

1. Illustrate major functions and parts of a battery-management system.
2. Design various configurations of battery pack and recent trends in battery pack.
3. Compute stored energy in a battery pack.
4. Measure and control current, temperature, and isolation in battery-management system

Prerequisites: Thermodynamics, Heat transfer, Drive systems, Basic electrical technology

Course Content

Unit No	Description	Hrs.
01	**Energy and Electrochemistry** Sources of energy for propulsion & their comparison: Net Calorific Value, Conversion efficiency, History and background of battery technology, Electrochemistry fundamentals & terminologies, Lithium ion battery and different chemistries, Portable power applications and electrical load requirements, Factors affecting the choice of EV battery systems, Commercially available lithium ion cells, Electrical characteristics of battery: Capacity, C-rate, impedance, DOD, SOC, SOH, Life cycles, Mechanical characteristics, Form factor, Safety.	06
02	**Battery Pack Construction** Battery modules and complete battery pack system, Assembly methods, Electrical connections, Cell level protection system, battery pack level protection system, Understanding laptop battery pack system.	06
03	**Battery Management System** Introduction, Battery pack requirements: Measurement, Protection and management, Cell balancing, Battery pack electronics, Battery Management System (BMS): Functionality, technology and topology (centralized, modular, master-slave, distributed).	06

04	**Design of Battery Management System** BMS Application Specific Integrated Circuit (ASIC) selection, Analog BMS design, Digital BMS design, BMS deploying: Installing, testing and troubleshooting.	06
05	**Thermal Management** Types of temperature sensors, types of thermal management system, Thermal model of battery pack, Drive cycle simulation and vehicle range estimation, Cooling materials and methods.	06
06	**Recent Trends and Economy** Communication systems for battery pack, Review of electric car battery pack, Important considerations, Recent trends: Grid level energy storage, Solar & wind integration, Recycling and pricing.	06

References:

Text Books:

- Ibrahim Dinçer, Halil S. Hamut, Nader Javani, Thermal Management of Electric Vehicle Battery Systems, ISBN: 978-1-118-90024-6.
- James Larminie, Electric Vehicle Technology Explained, John Wiley & Sons.

ference Books:

- Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, CRC Press.
- Sandeep Dhameja, Electric Vehicle Battery Systems, Newnes,
- .http://nptel.ac.in/courses/108103009/

Program Elective IV

Class: **F. Y. M. Tech.**	Semester: **II**
Course Code: **MTE2073**	Course Name: **Heating Ventilation Air Conditioning and Refrigeration Systems**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
There is steady demand for refrigeration and HVAC (Heating, Ventilation, and Air Conditioning) specialists in commercial, industrial and institutional settings. This course is been crafted to design the Air Conditioning and ventilation system. It includes various Air Conditioning Systems, Fan and Duct systems design, Applications of Refrigeration and Air Conditioning Systems, Evaporative Cooling systems, Ventilation. More emphasis is been given on application orientation to the course.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Explain different vapor compression refrigeration system and refrigerants.
2. Design of cooling and heating components of refrigeration system
3. Explain fundamentals of air conditioning and estimate cooling load on the building by considering various heat sources
4. Illustrate various air conditioning systems.
5. Design ducting systems and select air distribution system.
6. Explain air handling units in various applications.

Prerequisite: Basic Mechanical Engineering, Applied Thermodynamics, Refrigeration, Heat and Mass Transfer.

Course Content

Unit No.	Description	Hrs.
01	**Refrigeration Systems and Advanced Refrigerents** Conventional Refrigeration Systems, Multi-evaporator system, Multi expansion system, Cascade systems, Applications of Refrigeration systems. Preservation of different products - Ice factory - Dairy plant refrigeration systems Classification of Refrigerants, Refrigerant properties, Oil Compatibility, Environmental Impact-Montreal/ Kyoto Protocols-Eco Friendly Refrigerants.	06
02	**Design and Selection of Cooling and Heating Components** Refrigeration cycles, compressors. Condensers, evaporators, Chillers, cooling towers. Heat exchangers- water heating and air heating, unit and duct heaters, terminal heating equipment. etc.	06

03	**Psychometry and cooling load calculations** Properties of moist Air, Psychometric Properties and relations, Psychrometer, Basic Processes in Conditioning of Air, Psychometric Processes in Air Conditioning Equipment Thermal exchange of body with environment, Factors affecting human comfort Effective temperature and comfort chart, Sensible heat gain and latent heat gain sources, various types of sensible heat factors (SHF) like Room SHF, Grand SHF and Effective SHF. (Numerical Treatment)	06
04	**Air Conditioning Systems** Classification of ac systems, window air conditioner, split air conditioner, package air conditioner, central air conditioning systems, all-water, all-air systems, air water systems, unitary systems. Applications of Air Conditioning Systems- Air conditioning of hotels and restaurants, Air conditioning of theatres and auditorium, Air conditioning of hospitals.	06
05	**Ventilation, Fan and Duct Systems** Ventilation for cooling of occupants and buildings, Natural ventilation, Guidelines for natural ventilation, forced ventilation using electric fans, Interior air movement. Losses in ducts, Friction losses, Dynamic Losses, design of duct, selection of fan, fan laws and fan characteristic curves, Air distribution, Selection and location of supply and return duct.	06
06	**Air Handling System Design** AHU system arrangements, package AHUs, Built-up AHU, terminal units, individual units, humidity control, control of outside air quality, effects of altitude, exhaust systems, smoke control. HVAC System in Automobiles- Automotive System layout and Components- Commonly used refrigerants- Safety devices – Climate control – Fuel efficiency aspects.	06

References:

Text Books:

- C. P. Arora, Refrigeration and Air Conditioning, Tata McGraw Hill Publication.
- Arora, Domkundwar, Refrigeration and Air Conditioning, Dhanpatrai & Sons.

Reference Books:

- Roy J. Dossat, Principles of Refrigeration, Pearson Education India.
- W. F. Stoecker, Refrigeration and Air Conditioning, McGraw Hill Publication.
- ASHRAE Handbook - Fundamentals and Equipment.
- ASHRAE Handbook – Applications.
- ISHRAE Handbook
- NPTEL Lectures by Prof. M. Ramgopal, IIT Kharagpur
- D.J. Croome and B.M. Roberts, Air conditioning and ventilation of buildings Pergamon Press
- Manohar Prasad, Refrigeration and Air Conditioning New Age International.

Program Elective IV

Class: **F Y M. Tech.**	Semester: **II**
Course Code: **MTE2083**	Course Name: **Fuel Cell Technology**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
Fuel cells directly convert the chemical energy in hydrogen to electricity, with pure water and potentially useful heat as the only by products. Hydrogen-powered fuel cells are not only pollution-free, but they can also have more than two times the efficiency of traditional combustion technologies. The course includes basic principles working of various fuel cell fuel components, fuel cell materials, applications, etc.

Course Outcomes:
After successful completion of this course students should be able to
1. Demonstrate various configuration of fuel cell.
2. Explain Low and high temperature fuel cell and modelling practices.
3. Analyse operating parameters of fuel cell.
4. Explain various fuelling technologies.
5. Illustrate fuels, processing and systems.
6. Analyse Fuel cycles and give its applications.

Pre-requisite: Engineering Mathematics, Engineering chemistry, Engineering Thermodynamics, Fluid mechanics, Heat Transfer.

Course Content

Unit No.	Description	Hrs.
01	**Fuel cell fundamentals** Relevance, Principle, various configurations (Alkaline, Acid, Proton Exchange Membrane, direct methanol, molten carbonate and solid oxide fuel cells) fuel cell applications. Basic theory of electrochemistry, electrochemical energy conversion, electrochemical techniques, Thermodynamics of fuel cells, Heat and mass transfer in fuel cells, Single cell characteristics.	06
02	**Low and High Temperature Fuel Cells and Modelling** Proton exchange membrane fuel cell (PEMFC) and direct methanol fuel cell (DMFC): their special features and characteristics. Molten carbonate fuel cell (MCFC) and solid oxide fuel cell (SOFC) for power generation, their special features and characteristics. Electrochemical model, Heat and mass transfer model, System thermodynamic model.	06
03	**Fuel Cell Components and Their Impact on Performance** Fuel cell performance characteristics – current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects – membrane	06

	electrode assembly components, fuel cell stack, bi-polar plate, humidifiers and cooling plates.	
04	**Fuelling** Hydrogen storage technology – pressure cylinders, liquid hydrogen, metal hydrides, carbon fibers – reformer technology – steam reforming, partial oxidation, auto thermal reforming – CO removal, fuel cell technology based on removal like bio-mass.	06
05	**Fuels, Processing, Systems** Hydrogen energy availability, production and characteristics of Hydrogen, fossil fuel – diverted fuels and biomass, diverted fuels. Principles of design of PEMFC, DMFC and SOFC. Materials, component, stack, interconnects, internal and external reforming, system layout, operation and performance.	06
06	**Fuel Cycle Analysis and Automotive Applications** Introduction to fuel cycle analysis – application to fuel cell and other competing technologies like battery powered vehicles, SI engine fuelled by natural gas and hydrogen and hybrid electric vehicle. Fuel cells for automotive applications – technology advances in fuel cell vehicle systems –on board hydrogen storage – liquid hydrogen and compressed hydrogen – metal hydrides, fuel cell control system – alkaline fuel cell – road map to market.	06

References:

Text Books:

- Basu, S. (Ed) Fuel Cell Science and Technology, Springer, N.Y.
- O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, Fuel Cell Fundamentals, Wiley, NY.

Reference Books:

- J., Dick A., Fuel Cell Systems Explained, Wiley.
- Liu, H., Principles of fuel cells, Taylor & Francis, N.Y.
- Bard, A. J., L. R., Faulkner, Electrochemical Methods, Wiley, N.Y. Ref Book.
- M.T.M. Koper (ed.), Fuel Cell Catalysis, Wiley, Larminie.
- J. O'M. Bockris, A.K.N. Reddy, Modern Electrochemistry, Springer.
- Fuel Cells for automotive applications – professional engineering publishing UK. ISBN 1-86058 4233, 2004.
- Fuel Cell Technology Handbook SAE International Gregor Hoogers CRC Press ISBN0-8493-0877-1-2003.

Program Elective IV

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE2093**	Course Name: **Waste Heat Management**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course provides the knowledge about upcoming concept of Cogeneration and Waste Heat Recovery Systems and also enables the students to think and analyze the techno economic viability of various energy efficient system.

Course Outcomes:
After successful completion of this course, students will be able to,
1. Estimate and quantify available waste heat.
2. Explore different waste heat recovery systems.
3. Explain economics of cogeneration and waste heat recovery systems.
4. Illustrate different cogeneration techniques.

Prerequisites: Thermodynamics, Fluid mechanics, Heat transfer

Course Content		
Unit No.	**Description**	**Hrs.**
01	**Cogeneration** Introduction, Principles of Thermodynamics Combined Cycles, Topping, Bottoming Organic Rankine Cycles Advantages of Cogeneration Technology	**06**
02	**Cogeneration Technique** Cogeneration Application, Sizing of waste heat boilers -Performance calculations, Part load characteristics-selection of Cogeneration Technologies –Financial considerations.	**06**
03	**Environmental Considerations** Environmental considerations for cogeneration and waste heat recovery Pollution	**06**
04	**Waste Heat Recovery** Introduction -Principles of Thermodynamics and Second Law -sources of Waste Heat recovery Power Plant	**06**
05	**Waste Heat Recovery Systems** Design Considerations, fluidized bed heat exchangers, heat pipe, exchangers, heat pumps, thermic fluid heaters, selection of waste heat recovery technologies	**06**
06	**Case studies of Cogeneration and Waste heat recovery** Sugar Industry, Paper Industry, Food Industry, Process Industry, Chemical Industry, Manufacturing Industries.	**06**

References:

Text Books:

- Charles H.Butler, Cogeneration, McGraw Hill Book Co.,
- Horlock JH, Cogeneration- Thermodynamics and Economics, Heat and Power, Oxford.
- Institute of Fuel, London, Waste Heat Recovery, Chapman & Hall Publishers, London.
- Sengupta Subrata, Waste Heat Utilization and Management, Lee SS EDS, Hemisphere, Washington.

Reference Books:

- De Nevers, Noel., Air Polllution Control Engineering, McGraw Hill, New York.
- I. Pilatowsky, R.J. Romero, C.A. Isaza, S.A. Gamboa, P.J. Sebastian, Cogeneration Fuel Cell-Sorption Air Conditioning Systems (Green Energy and Technology), W. Rivera, Springe
- BEE Reference Book No 2 and 4, BEE

Program Elective IV

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE2103**	Course Name: **Advanced I. C. Engines**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
Modern and advanced Otto and Diesel type engines their historical development are focused. Advanced gas exchange systems are discussed and special emphasis new engine technologies. New trends in internal combustion engines such as HCCI and PPC are explained. Simulation of engine processes and analysis of engines as well as engine control are presented. Fuel aspects with emphasis on engine performance and emissions are covered.

Course Outcomes:
After successful completion of the course, students will be able to,
1. Analyze SI and CI engines fuel system and combustion process.
2. Summarize recent engine trends
3. Compare performance and emissions of I C Engines with alternative fuels
4. Model engines flow and combustion process.

Prerequisites: Thermodynamics, Heat Transfer and I C Engines.

Course Content		
Unit No	**Description**	**Hrs.**
01	**Modified Engines** Historical Review – Engine Types – Design and operating Parameters. Cycle Analysis: Thermo-chemistry of Fuel – Air mixtures, properties – Ideal Models of Engine cycles – Real Engine cycles - differences and Factors responsible for – Computer Modeling. MPFI, Common rail fuel injection system, turbo and supercharged engine cycles and performance	**06**
02	**Alternative Fuels and Performance of Engine** Alcohols , Vegetable oils and bio-diesel, Bio-gas, hydrogen, Natural Gas , Liquefied Petroleum Gas ,Hydrogen , Properties , Suitability, Engine Modifications, Performance , Combustion and Emission Characteristics of SI and CI Engines using these alternate fuels.	**06**
03	**Pollutant Formation and Control** Indian Driving Cycles and emission norms, Nature and extent of problems – Nitrogen Oxides, Carbon monoxide, unburnt Hydrocarbon and particulate –Emissions – Measurement – Exhaust Gas Treatment, Catalytic converter, SCR, Particulate Traps, Lean, NOx, Catalysts	**06**

04	**Gas Exchange Processes** Mathematical modelling of gas exchange process, Volumetric Efficiency – Flow through ports – Charge Motion: Mean velocity and Turbulent characteristics – Swirl, Squish – Pre-chamber Engine flows. Intake and Exhaust flow models, SI and CI engine models. Combustion modeling.	06
05	**Recent Trends** Homogeneous Charge Compression Ignition Engine, Lean Burn Engine, Stratified Charge Engine, Surface Ignition Engine, Four Valve and Overhead cam Engines, Electronic Engine Management, Common Rail Direct Injection Diesel Engine, Gasoline Direct Injection Engine, Data Acquisition System –pressure pick up, charge amplifier PC for Combustion and Heat release analysis in Engines. Hybrid engine technology, Concept of hybrid engine, layout of hybrid engine	06
06	**Engine Heat Transfer** Importance of heat transfer, heat transfer and engine energy balance, Convective heat transfer, radiation heat transfer, Engine operating characteristics. Fuel supply systems for S.I. and C.I engines to use gaseous fuels like LPG, CNG and Hydrogen. Numerical analysis of engine heat transfer problems	06

References:

Text Books:

- Heinz Heisler, Advanced Engine Technology, SAE International Publications, USA.
- Ganesan V. Internal Combustion Engines, Tata McGraw-Hill

Reference Books:

- Heywood J.B., Internal Combustion Engine Fundamentals, McGraw-Hill.
- Taylor C.P., The Internal Combustion Engines in Theory and Practice, MIT press.
- Patterson D.J. and Henein N. A, Emissions from combustion engines and their control, Ann Arbor Science publishers Inc, USA,
- Gupta H.N, Fundamentals of Internal Combustion Engines, Prentice Hall of India.
- Ultrich Adler, Automotive Electric / Electronic Systems, Published by Robert Bosh GmbH.

Class: **F. Y. M. Tech**	Semester: **II**
Course Code: **MTE2113**	Course Name: **Research Methodology & IPR**

L	T	P	Credits
02	**01**	**--**	**03**

Course Description:
This course provides a first coverage of the main concepts of research process, literature review, experimental designs and the associated analysis of variance models. It introduces different types of experimental designs to students from all types of disciplines. Statistical methods useful in design and analysis of experiments in all fields of engineering. The basic idea behind introducing this course is to cultivate the research qualities within the post graduate students so that the knowledge gained in this course will prepare graduate for dissertation work. Course also covers basics about IPR which helps them to know about patents & copy rights etc.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Formulate a research problem.
2. Analyse research related information.
3. Prepare and present research proposal/paper by following research ethics.
4. Make effective use of computers and computing tools to search information, analyze information and prepare report.
5. Describe nature and processes involved in development of intellectual property rights.

Prerequisite: Basic knowledge of Engineering mathematics & statistics.

Course Content		
Unit No	**Description**	**Hrs.**
01	**Research Characteristics** Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.	**04**
02	**Effective Literature Studies Approaches** Plagiarism, Research Ethics Approaches of Investigation of solutions for Research Problems Data Collection and analysis.	**04**
03	**Technical Report Writing** Effective technical writing, how to write technical report and paper, Developing a Research Proposal, Format of research proposal, presentation and assessment by a review committee.	**04**
04	**IPR Nature of Intellectual Property** Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario:	**04**

	International cooperation on Intellectual Property, Procedure for grants of patents, Patenting under PCT.	
05	**Patent Rights** Scope of Patent Rights, Licensing and transfer of technology, Patent information and databases, Geographical Indications New Developments in IPR: Administration of Patent System.	**04**
06	**New developments in IPR** New developments in IPR; IPR of Biological Systems, Computer Software etc., Traditional knowledge Case Studies, IPR and IITs.	**04**

Reference:

Text Books:

- Stuart Melville and Wayne Goddard. Research methodology: an introduction for science & engineering students. Juta & Co Ltd.
- Ranjit Kumar. Research Methodology: A Step by Step Guide for beginners. SAGE Publication.

Reference Books:

- Wayne Goddard and Stuart Melville. Research Methodology: An Introduction. Juta Academic.
- Halbert. Resisting Intellectual Property. Taylor & Francis Ltd.
- Mayall. Industrial Design. McGraw Hill.
- Niebel. Product Design. McGraw Hill.
- Asimov. Introduction to Design. Prentice Hall.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley. Intellectual Property in New Technological Age. Wolters Kluwar.
- T. Ramappa. Intellectual Property Rights under WTO.S. Chand.

Class: **F. Y. M. Tech.**	Semester: **II**
Course Code: **MTE2123**	Course Name: **Computational Fluid Dynamics Lab**

L	T	P	Credits
-	--	**02**	**01**

Course Description

The CFD lab course is in the context of a useful design tool for industry and a vital research tool for thermo-fluid research across many disciplines. To develop students' understanding of the conservation laws applied to fluid motion and heat transfer. Familiarize students with basic computational methods including explicit, implicit methods, discretization schemes and stability analysis. Familiarize students with the basic steps and terminology associated with CFD. To develop practical expertise of solving CFD problems with a commercial. CFD code, ANSYS. To develop an awareness of the power and of limitations of CFD

Course Outcomes:

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

1. Formulate problems in fluid flow and heat transfer.
2. Apply initial and boundary conditions to solve heat transfer problems.
3. Use ANSYS-Fluent for solving real life engineering problems

Prerequisite: Students should know Programming Language C++ or MATLAB, Heat Transfer, Fluid Dynamics.

List of experiments (Any 10)

Course Content		
Experiment No	**Description**	**Hrs.**
01	Temperature distribution on plate and cylinder	**02**
02	Flow in mixing T and flow through butterfly valve	**02**
03	Flow through an automatic catalytic converter and External flow over Ahmed body	**02**
04	Flow in an axial rotor /stator arrangement	**02**
05	Transient analysis of Square plate and Cooling of electronic component with convection and radiation	**02**
06	Flow from a circular vent.	**02**
07	Multiphase flow in mixing vessel. (VOF)	**02**
08	Supersonic flow in a Laval nozzle and Flow through an engine inlet valve.	**02**
09	Conjugate heat transfer in a process-heating coil.	**02**

10	Heat transfer analysis automotive radiator and Heat and Fluid flow analysis of a room or car	**02**
11	Thermal management of battery system	**02**

References:

Text Books:

- ANSYS Fluent user Manual

Reference Books:

- J. D. Anderson, The Basics with Applications, Computational Fluid Dynamics, McGraw Hill.
- K. Muralidhar and T. Sundararajan, Computational Fluid Flow and Heat Transfer, Narosa Publishing House.
- K. A. Homann, S. T. Chiang, Computational Fluid Dynamics for Engineers Engineering Education System.
- O. Zikanov, Essential Computational Fluid Dynamics, Wiley India.
- Versteeg, H. K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics:
- The Finite Volume Method, Pearson.
- J. Tu, G. H. Yeoh and C. Liu, Computational Fluid Dynamics: A Practical Approach, Butterworth Heinemann (Indian Edition).
- S. V. Patankar, Numerical Heat Transfer and Fluid Flow, Taylor and Francis (Indian Edition).
- A. W. Date, Introduction to Computational Fluid Dynamics, Cambridge (Indian Edition).

Class: **F. Y. M. Tech**	Semester: **II**
Course Code: **MTE2133**	Course Name: **Thermal Engineering Lab – II**

L	T	P	Credits
--	--	**02**	**01**

Course Description

This course introduces the engineering student to the thermal sciences - thermodynamics, fluid dynamics and heat transfer course laboratory experiments. The thermal engineering laboratory intentionally introduced in a curriculum to have a hands on experience for various set ups and compare results with standard results and interpret it.

Course Outcomes:

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

1. Evaluate COP of different refrigeration systems.
2. Estimate cooling load needed for given space.
3. Design a refrigeration and air conditioning system for given application.
4. Calculate efficiency and effectiveness of different types of heat exchangers.

Prerequisites: Heat transfer, Thermodynamics, Refrigeration and Air conditioning

List of experiments (Any 10)

Course Content		
Experiment No.	**Description**	**Hrs.**
01	Conduct trial on Refrigeration bench and heat pumps and compare and interpret the result.	**02**
02	Perform trial refrigeration circuit with variable Load.	**02**
03	Perform testing of Refrigeration Compressor, refrigeration chamber and defrosting methods.	**02**
04	Conduct trial on ice plant.	**02**
05	Perform testing of cascade system and interpret the result.	**02**
06	Plot various psychometric processes by conducting experiment on air conditioning test rig.	**02**
07	Estimate of cooling loads of given system	**02**
08	Conduct experiment on recirculation air conditioning setup with computerized data acquisition system	**02**
09	Perform trial on variable refrigerant flow (VRF) air conditioning system.	**02**
10	Performance testing of vapor absorption system	**02**
11	Perform experiment on various types of heat exchangers	**02**
12	Industrial visit Refrigeration plant/Air conditioning plant	**02**

References:

Text Books:

- Incropera F.P. and DeWitt. D.P. Fundamentals of Heat & Mass Transfer, John Wiley & Sons.

Reference Books:

- ASHRAE Handbook, Refrigeration, American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. Atlanta.
- Rohsenow. W.M., Harnett. J. P. and Ganic. E.N., Handbook of Heat Transfer Applications, McGraw-Hill, New York.
- Sadik Kakac, and Hongtan Liu, Heat Exchangers: Selection, Rating and Thermal Design, CRC Press.

Class: **F. Y. M. Tech.**	Semester: **I**
Course Code: **MTE2143**	Course Name: **Seminar**

L	T	P	Credits
--	--	**02**	**01**

Course Description

Thermal engineering is a constituent sub-discipline of Mechanical engineering that deals with the planning and designing of heating and cooling systems as well as with the maintenance of these heating and cooling systems. This course will test the student's learning and understanding during the course of their post graduate programme. In doing so, the main objective of this course is to prepare the students to develop a solution to engineering problem.

Course Outcomes:

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

1. Review of literature related to thermal engineering.
2. Write technical reports.
3. Develop skills to present the findings.

Prerequisites: Heat transfer, Thermodynamics, RAC, IC Engines, Mathematics, Modelling and analysis Softwares.

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

Class: **S. Y. M. Tech.**	Semester: **III**
Course Code: **MTE3013**	Course Name: **Industry Internship**

L	T	P	Credits
--	--	-	**01**

Course Description:
The students have to undergo an industrial training of a minimum two weeks in an industry preferably dealing with Thermal Engineering after second semester and complete within 15 calendar days, before the start of third semester. The students have to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the department. An internal evaluation will be conducted for examining the quality and authenticity of contents of the report and award the marks at the end of the semester examination based on training quality, contents of the report and presentation. Student should include the certificate from the company regarding satisfactory completion of the field training.

Course Outcomes:
1. Identify the real applications and practices of courses studied, at industry level
2. Recognize various modelling , analysis and validation techniques adopted at industries.
3. Demonstrate the issues at design, manufacturing and assembly levels.
4. Summarize and present technical data in report format.

Prerequisites: Heat transfer, Thermodynamics, RAC, I C Engines, Mathematics

In the Industry Internship work, student is expected to get training in the industry, related to subject specialization for duration of 15 days (minimum) for at least 6 hours per day.

Open Elective

Class: **S. Y. M. Tech**	Semester- **III**
Course Code: **MOE2012**	Course Name: **Artificial Intelligence - Machine Learning**

L	T	P	Credits
03	--	--	**03**

Course Description:
Machine learning is a part of Artificial Intelligence. It uses interdisciplinary techniques such as statistics, linear algebra, optimization, and computer science to create automated systems that can sift through large volumes of data at high speed to make predictions or decisions without human intervention. Machine learning as a field is now incredibly pervasive, with applications spanning from business intelligence to homeland security, from analyzing biochemical interactions to structural monitoring of aging bridges, and from emissions to astrophysics, etc. This class will familiarize students with a broad cross-section of models and algorithms for machine learning and prepare students for research or industry application of machine learning techniques.

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Describe central machine learning methods and techniques and how they relate to artificial intelligence.
2. Differentiate between supervised and unsupervised learning techniques.
3. Apply the ML algorithms to a real-world problem.
4. Optimize the models learned and report on the expected accuracy that can be achieved by applying the models.
5. Evaluate a given problem and apply appropriate machine learning technique.

Prerequisite: Statistics, Linear Algebra, Optimization Techniques, Programming Language

Course Content

Unit No	Description	Hrs.
01	**Introduction to Artificial Intelligence and Machine Learning** Introduction: What Is AI and ML? Examples of AI and ML, Applications, Supervised Learning, Un-Supervised Learning and Reinforcement Learning, Important Elements of Machine Learning- Data formats, Learnability, Statistical learning approaches, Elements of information theory.	06
02	**Feature Selection** Scikit- Learn Dataset, creating training and test sets, managing categorical data, Managing missing features, Data scaling and normalization, Feature selection and Filtering, Principle Component Analysis(PCA)- non-negative matrix factorization, Sparse PCA, Kernel PCA. Atom Extraction and Dictionary Learning.	06

03	**Regression** Linear regression- Linear models, A bi-dimensional example, Linear Regression and higher dimensionality, Polynomial regression, Logistic regression-Linear classification, Logistic regression, Implementation and Optimizations, Stochastic gradient descendent algorithms.	06
04	**Naïve Bayes and Support Vector Machine** Bayes Theorom, Naïve Bayes Classifiers, Naïve Bayes in Scikit- learn- Bernoulli Naïve Bayes, Multinomial Naïve Bayes, and Gaussian Naïve Bayes. **Support Vector Machine(SVM)** Linear Support Vector Machines, Scikit- learn implementation, Linear Classification, Kernel based classification, Non- linear Examples. Controlled Support Vector Machines, Support Vector Regression.	06
05	**Decision Trees and Ensemble Learning** Decision Trees- Impurity measures, Feature Importance. Decision Tree Classification with Scikit learn, Ensemble Learning-Random Forest, AdaBoost, Gradient Tree Boosting, Voting Classifier. Clustering Fundamentals- Basics, K-means: Finding optimal number of clusters, DBSCAN, Spectral Clustering. Evaluation methods based on Ground Truth- Homogeneity, Completeness, Adjusted Rand Index.	04
06	**Clustering Techniques** Hierarchical Clustering, Expectation maximization clustering, Agglomerative Clustering Dendrograms, Agglomerative clustering in Scikit- learn, Connectivity Constraints. Introduction to Recommendation Systems Naïve User based systems, Content based Systems, Model free collaborative filtering-singular value decomposition, alternating least squares.	08

References:

Text Books:

- Giuseppe Bonaccorso, Machine Learning Algorithms, Packt Publishing Limited.
- Josh Patterson, Adam Gibson, Deep Learning: A Practitioners Approach, O REILLY, SPD.

Reference Books:

- Ethem Alpaydin, Introduction to Machine Learning, PHI.
- Peter Flach, Machine Learning: The Art and Science of Algorithms that Make Sense of Data, Cambridge University Press.

Open Elective

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MOE2022**	Course Name: **Creative Thinking: Techniques & Tools**

L	T	P	Credits
03	--	--	03

Course Description:

In today's ever-growing and changing world, being able to think creatively and innovatively are essential skills. It can sometimes be challenging to step back and reflect in an environment which is fast paced or when students required to assimilate large amounts of information. Making sense of or communicating new ideas in an innovative and engaging way, approaching problems from fresh angles, and producing novel solutions are all traits which are highly sought after by employers. This course will equip with a 'tool-box', introducing to a selection of behaviors and techniques that will augment innate creativity. Some of the tools are suited to use on own and others work well for a group, enabling you to leverage the power of several minds. People can pick and choose which of these tools or techniques suit needs and interests, focusing on some or all of the selected approaches and in the order that fits best.

Course Learning Outcomes:

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

1. Comprehend importance in tackling global challenges as well as in everyday problem-solving scenarios.
2. Apply different brainstorming techniques in group activities.
3. Be proficient in the application of the 6 thinking hats tool in different life scenarios.
4. Develop a systematic approach to idea generation through the use of morphological analysis.
5. Innovate on an existing product, service or situation applying the SCAMPER method.
6. Get confident with the theory of inventive problem solving, called TRIZ.

Prerequisite: There are no prerequisites to this course.

Course Content		
Unit No	**Description**	**Hrs.**
01	**Introduction to the Principles of Creativity** Basic principles of creativity and highlight its importance in tackling global challenges. Creativity is explored and applied at two different levels, lower and higher-level creativity.	**06**
02	**Creativity Tools** Augment our creativity using different methods of Brainstorming, a creativity approach that aids the generation of ideas in solving a stated problem. Particularly focus on the application of brainstorming tools in group activities, with the aim of	**06**

	enabling to understand, evaluate and apply different types of brainstorming techniques in own context.	
03	**Six Thinking Hats** Principles as well as application of the 6 Hats thinking tool both at an individual level and in a group, under various professional and personal situations, allowing students to develop competency and accelerate proficiency on the use of technique.	06
04	**Clarifying the Problem** Organizing a process, turning problems into opportunities, facts, feelings & hunches, problem as question.	06
05	**Generating Ideas** Brainstorming, scamper, forced connections, portable think tank, case studies on generating ideas.	06
06	**Developing Ideas and Planning for Action** Organizing ideas, ideas to solutions, implementing solutions, case studies of development of ideas and plan of action.	06

References -

Text Books:

- Michael Michalko, Thinkertoys: A Handbook of Creative-Thinking Techniques, second edition, Ten Speed Press.
- Michael Michalko, Cracking Creativity: The Secrets of Creative Genius, revised edition, Ten Speed Press.
- Edward de Bono, Penguin, Lateral Thinking: A Textbook of Creativity.
- Edward de Bono, Penguin, Six Thinking Hats.

Reference Books:

- New World Library, Creative Thinkering: Putting Your Imagination to Work.
- Chris Griffiths, Kogan Page, The Creative Thinking Handbook: Your Step by Step Guide to Problem Solving in Business.

Open Elective

Class: **S. Y. M. Tech.**	Semester: **III**
Course Code: **MOE2032**	Course Name: **MOOC Course**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:

Student can opt for online certification course and produce certificate.

- The students who are doing course on MOOC/NPTEL Course /Courses suggested by DPGC should select the course in consultation with supervisor and submit the details to Head of Program.
- The course should be minimum 25 hours duration and should have certification facility.
- Student should complete course and get certificate. The certificate copy should be submitted to head of program with supervisor signature.

Course Learning Outcomes:

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

1. Identify the real applications and practices of courses studied, at industry level
2. Recognize various modelling, analysis and validation techniques adopted at industries.
3. Demonstrate the issues at design, manufacturing and assembly levels.
4. Summarize and present technical data in report format.

Rajarambapu Institute of Technology Mech. Engg. Dept. 415 414 Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414

Open Elective

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MOE2041**	Course Name: **Energy Audit and Management**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course provides basic understanding of energy audit and management. Essential theoretical and practical knowledge about the concept of energy conservation, energy management, and different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in commercial and industrial sector will be achieved through this course.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Identify the important of Energy Scenario.
2. Use energy audit knowledge to carry out energy audit of a given firm.
3. Examine different rolls in energy action planning
4. Apply project finance and management skills to carry out energy audit
5. Plan for energy monitoring and targeting.

Prerequisite: Electric Machines, Thermal Systems and Finance system

Course Content		
Unit No	**Description**	**Hrs.**
01	**Energy Scenario** Energy Needs of Growing Economy, Long Term Energy Scenario, Energy Pricing, Energy Sector Reforms, Energy and Environment, Air Pollution, Climate Change, Energy Security, Energy Conservation and its Importance, Energy Strategy for the Future, Energy Conservation Act-2001 and its Features.	**06**
02	**Energy Management and Audit** Energy audit- need, Types of energy audit, Energy management (audit) approach-understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit instruments	**06**
03	**Energy Action Planning** Key elements, Force field analysis, Energy policy purpose, perspective, Contents, Formulation, Ratification, Organizing –location of energy management, Top management support, Managerial function, Roles and responsibilities of energy	**06**

	manager, Accountability. Motivating-motivation of employees: Information system-designing barriers, Strategies; Marketing and communicating-training and planning.	
04	**Financial Management** Investment-need, Appraisal and criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return, Cash flows, Risk and sensitivity analysis; Financing options, Energy performance contracts and role of ESCOs	**06**
05	**Project Management** Definition and scope of project, Technical design, Financing, Contracting, Implementation and performance monitoring. Implementation plan for top management, Planning Budget, Procurement Procedures, Construction, Measurement & Verification	**06**
06	**Energy Monitoring and Targeting** Defining monitoring & targeting, Elements of monitoring & targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences (CUSUM).	**06**

References:

Text Books:

- Amit Kumar Tyagi,Handbook on Energy Audits and Management, TERI Publication
- Wayne C. Turner, Energy Management Handbook, Wiley Inter Science Publication

Reference Books:

- P. O'Callaghan, Energy Management, McGraw - Hill Book Company
- Bureau of Energy Efficiency Study material for Energy Managers and Auditors Examination: Paper I

Open Elective

Class: **S. Y. M. Tech.**	Semester: **III**
Course Code: **MOE2062**	Course Name: **Augmented Reality and Virtual Reality**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course presents an introduction to virtual and augmented reality technologies, with an emphasis on designing and developing interactive virtual and augmented reality experiences. The course will cover the history of the area, fundamental theory, and interaction techniques. Students are provided with hands-on experience developing applications for modern virtual and augmented reality systems. In the course, students will also explore libraries and tools for creating AR/VR experiences such as Vuforia and UNITY.

Course Learning Outcomes:
After successful completion of the course, students will be able to:

1. Define the basic concepts of Virtual and Augmented Reality
2. Identify the differences in AR/VR concepts and technologies
3. Describe the fundamental concepts relating to Virtual Reality such as presence,immersion, and engagement
4. Evaluate usability of AR/VR applications and critique their use of AR/VR capabilities
5. Design and prototype effective AR/VR applications using UNITY platform for various application.

Prerequisites: Programming and Data Structures

Course Content

Unit No	Description	Hrs.
01	**Introduction to Augmented Reality** Definition and Scope, Brief History of Augmented Reality, Displays (Multimodal Displays, Spatial Display Model, and Visual Displays), Strong vs Weak, AR Applications AR Challenges in AR.	06
02	**Introduction to Virtual Reality** Definition and Scope, Types of VR Characteristics, Basic VR environments, Limitations of VR environments, Immersion Vs Presence.	06
03	**Interaction Design for AR/VR Environments** Interaction design process Identifying user needs, AR/VR design considerations Typical AR/VR Interface Metaphors, User experience (UX) guidelines for AR/VR, UX challenges for AR/VR, Prototyping for AR/VR, Evaluation of the developed AR/VR prototype.	06

04	**Introduction to UNITY** Unity Overview: Windows, Interface, Navigation, Terminology, Game Objects, Hierarchy, Parenting Objects, Asset Store, Importing Plug-ins, Creating a Terrain, Materials, Colors, Transparency, Introduction to Mono behaviours: Awake, Start, Update.	**06**
05	**Introduction to Vuforia and Physics in UNITY** Vuforia Overview: Interface, Navigation, Terminology, Image Targeting, Custom Images, Overview of Physics in Unity, Introduction to Scripting: Terminology, Creating Objects, Accessing Components, Debugging, Lists, Loops.	**06**
06	**Expanding on Scripting and Interaction** Creating Trigger Events, Manipulating Components in Scripts, Programming Interactions between Objects and Tracked Images in AR, designing a simple User Interface in AR, Introduction to colliders and their use: On Collision Enter, On Collision Exit. On Collision Stay, On Trigger vs On Collision, Rigid bodies and how Colliders report to them.	**06**

References:

Text Books:

- Vince, Virtual Reality Systems, Pearson Education.
- Grigore Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley.
- Schmalstieg, D., & Hollerer, T. Augmented reality: principles and practice.Addison-Wesley Professional.

Reference Books:

- Azuma, R.T. A survey of augmented reality. Presence: Teleoperators & Virtual Environments.
- Azuma, R., Baillot, Y., Behringer, R., Feiner, S., Julier, S., & MacIntyre, B. Recent advances in augmented reality. IEEE computer graphics and applications.
- Bhagat, K. K., Liou, W.-K., & Chang, C.-Y.A cost-effective interactive 3D virtual reality system applied to military live firing training. Virtual Reality.
- Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., & Ivkovic, M. Augmented reality technologies, systems and applications. Multimedia tools and applications.
- Raisamo, R., Rakkolainen, I., Majaranta, P., Salminen, K., Rantala, J., & Farooq, A. Human augmentation: Past, present and future. International journal of human- computer studies.
- Schuemie, M. J., Van Der Straaten, P., Krijn, M., & Van Der Mast, C. A. Research on presence in virtual reality: A survey. Cyber Psychology & Behavior.

Open Elective

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MOE2072**	Course Name: **Industrial Instrumentation**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:
This course is an overview of the principles, concepts, and applications of process transmitters found in an industrial plant. Continuous measurement and control of all the parameters will be emphasized. Also practical installation and calibration procedures of various types of sensors and transducers will be covered. Open and closed loop control systems will also be discussed, including such concepts as on/off control, set point, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems.

Course Learning Outcomes:
After successful completion of the course, students will be able to,
1. Elaborate working principal of different transducers.
2. Select suitable transducer/sensor for specific application.
3. Justify the use of specific measurement technique for specific task.
4. Evaluate the Calibration and Interfacing of the transducers.

Prerequisite: Sensor And Measurement

Course Content

Unit No	Description	Hrs
01	**Metrology** Measurement of length – Gauge blocks – Plainness – Area using Simpson's rule, Plain meter – Diameter – Roughness – Angle using Bevel protractor, sine bars and Clinometer – Mechanical, Electrical, Optical and Pneumatic Comparators. Optical Methods for length and distance measurements using Optical flats and Michelson Interferometer.	06
02	**Velocity and Acceleration Measurement** Relative velocity – Translational and Rotational velocity measurements – Revolution counters and Timers – Magnetic and Photoelectric pulse counting stroboscopic methods. Accelerometers-different types, Gyroscopes-applications.	06
03	**Force and Pressure Measurement** Force measurement – Different methods –Gyroscopic Force Measurement – Vibrating wire Force transducer. Basics of Pressure measurement –Manometer types – Force-Balance and Vibrating Cylinder Transducers – High and Low Pressure measurement – McLeod Gauge, Knudsen Gauge, Momentum Transfer Gauge, Thermal Conductivity	06

	Gauge, Ionization Gauge, Dual Gauge Techniques, Deadweight Gauges, Hydrostatic Pressure Measurement.	
04	**Flow Measurement and Level Measurement** Flow Meters- Head type, Area type (Rota meter), electromagnetic type, Positive displacement type, mass flow meter, ultrasonic type, vertex shedding type, Hotwire anemometer type, Laser Doppler Velocity-meter. Basic Level measurements – Direct, Indirect, Pressure, Buoyancy, Weight, Capacitive Probe methods.	**06**
05	**Density, Viscosity and Other Measurements** Density measurements – Strain Gauge load cell method – Buoyancy method – Air pressure balance method – Gamma ray method – Vibrating probe method. Units of Viscosity, specific gravity scales used in Petroleum Industries, Different Methods of measuring consistency and Viscosity –Two float viscorator –Industrial consistency meter. Sound-Level Meters, Microphones, Humidity Measurement.	**06**
06	**Calibration and Interfacing** Calibration using Master Sensors, Interfacing of Force, Pressure, Velocity, Acceleration, Flow, Density and Viscosity Sensors, Variable Frequency Drive. Open and closed loop control system with on/off control, setpoint, overshoot, undershoot, gain, feedback, PID loops, and reverse/direct acting systems.	**06**

References:

Text Books:

- Doeblin E.O., Measurement Systems – Applications and Design, McGraw Hill International.
- Patranabis D, Principles of Industrial Instrumentation, Tata McGraw Hill.

Reference Books:

- Considine D. M., Process Instruments and Control Handbook, McGraw Hill International.
- Jain R.K., Mechanical and Industrial Measurements, Khanna Publications.

Open Elective

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MOE2082**	Course Name: **Advanced Mechatronics Systems**

L	T	P	Credits
03	**--**	**--**	**03**

Course Description:

The course will be helpful to provide overview of mechanical and electronic systems used in industrial atmosphere. This will be helpful for upcoming automation in industry. Mechatronics is a multidisciplinary field of science that includes a combination of Mechanical Engineering, Electronics, Computer Engineering, Telecommunications Engineering and Control Engineering. Mechatronics is a multi-disciplinary study dealing with the integration of mechanical devices, actuators, sensors, electronics, intelligent controllers and computers. Mechatronics generally involves

(i) implementing electronics control in a mechanical system
(ii) enhancing existing mechanical design with intelligent control and
(iii) replacing mechanical component with an electronic solution.

This course will cover all aspects related with mechatronics such as sensors and transducers, actuators and mechanisms, signal conditioning, microprocessors and microcontrollers, modeling & system response and design of mechatronics systems.

Course Learning Outcomes:

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

1. Explain Mechatronics System.
2. Analyze the Mechatronics Based System.
3. Model, simulate, and verify the mechatronics systems.
4. Identify Electrical, Hydraulic and Pneumatic Components.

Prerequisite: Basic knowledge of research related activities.

Course Content		
Unit No.	**Description**	**Hrs.**
01	**Introduction** What is Mechatronics, Integrated Design Issues in mechatronics, Mechatronics Design Process, Mechatronics Key elements, applications in mechatronics.	**06**
02	**Modelling and Analysis of Mechatronics Systems** Block Diagram Modelling, Analogy approach, Impedance Diagrams, Electrical Systems, Mechanical systems and electromechanical systems. Mass-Spring-Oscillation and Damping system, Dynamic response of systems, Transfer function and frequency response. Labview, MATLAB, Scilab.	**06**

03	**Sensors and Actuators** Performance terminology of sensors, Displacement, Position & Proximity Sensors, Displacement, Position sensors, Force, Fluid pressure, Liquid flow sensors, temperature, light sensor, Acceleration and Vibration measurement, Electrical and Mechanical Actuation Systems.	06
04	**Signal Conditioning** Introduction to signal processing, Op-Amp as signal conditioner, Analogue to Digital Converter, Digital to Analogue Converter, Signal processing devices, relays, contactors and timers. Microcontrollers, PID controllers and PLCs.	06
05	**Hydraulic System and Pneumatic System** Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, and pumps, Pneumatic system components and graphic representations, Advantages and limitations of pneumatic systems.	06
06	**Case Study** List of various mechatronics systems, Case study of pick and place mechanism of robotic arm using pneumatic power, Hydraulic circuit for CNC Lathe machine, 3D Printer, Auto-control system for Green House Temperature and Auto-focusing in Digital Cameras.	06

References:

Text Books:

- Bradley, D. Dawson, N. C. Burd and A.J. Loader, Mechatronics: Electronics in product and process, Chapman and Hall, London.
- Devadas Shetty, Richard A. Kolkm, Mechatronics system design, PWS publishing company.
- David G. Alciatore, Michael B. Histand, Introduction to mechatronics and measurement systems Mc Graw Hill Education.

References Books:

- Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, R. Merzouki, A. K. Samantaray, P. M. Pathak, B. Ould Bouamama, Springer, London.
- Technical website: https://onlinecourses.nptel.ac.in/noc21_me27/course

Open Elective

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MOE2091**	Course Name: **Disaster Management**

L	T	P	Credits
03	--	--	03

Course Description:
This course provides a holistic understanding of disaster management, covering both natural and manmade disasters. Students will delve into the meaning, nature, and various types of disasters, exploring their effects on individuals, communities, and the environment. The course encompasses a global perspective while focusing on the disaster profile of India, considering regional and seasonal variations

Course Learning Outcomes:
After successful completion of the course, students will be able to,

1. Outline disaster and disaster management cycle.
2. Summarize disaster preparedness and response activities for various types of disaster.
3. Apply various advanced techniques for disaster management.
4. Examine role of various agencies in disaster management.
5. Dissect the disaster management scenario in India.

Prerequisite: Environmental Science

Course Content

Unit No.	Description	Hrs.
01	**Natural Disaster** Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic, eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion.	06
02	**Manmade Disasters** Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents. Disasters -A Global View, Disaster Profile of India- Regional, and Seasonal.	06
03	**Disaster Management Cycle** Introduction to Disaster Management Cycle: Mitigation, Preparedness, Response and Recovery. Disaster Mitigation, Hazard identification and vulnerability analysis, Mitigation strategies or measures	06

04	**Disaster Preparedness, Response and Recovery** Introduction to Disaster Preparedness, Disaster Risk Reduction (DRR), The Emergency Operation Plan (EOP). Introduction to Disaster Response, Aims of disaster response, Disaster Response Activities, Modern and traditional responses to disasters, Modern methods of disaster response, Disaster Recovery, The Recovery Plan, Disasters as opportunities for development initiatives.	06
05	**Role of Technology in Disaster Management** Geographic Information System (GIS) and Disaster Management. GIS applications. Global Positioning System (GPS) and Disaster Management, Applications of GPS to Disaster management. Remote Sensing and its significance in Disaster Management.	06
06	**Role of Multiple Stakeholders In Disaster Management** Role of NGO's, Community based organizations, media, Central, State, District and Local Administration, armed forces, Police and other organizations.	06

References:

Codes of Practice:

- National Disaster Management Authority (NDMA). National Disaster Management Plan 2019.
- National Disaster Management Authority (NDMA). National Disaster Management Act 2005.

Text Books:

- Coppola, D. P., Introduction to International Disaster Management, Elsevier USA.
- Singh R. B., Disaster Management, Rawat Publication.

Reference Books:

- Reiter L., Earthquake Hazard Analysis: Issues and Insight, Colombia University Press.
- Mileti D. S. Disaster by Design: A Reassessment of National Hazards in United States, The National Academic Press.

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MTE3023**	Course Name: **Dissertation Phase – I**

L	T	P	Credits
--	--	**12**	**06**

Course Description:
Dissertation Phase I consists of a) Synopsis Preparation b) Synopsis approval by DPGC committee.

Course Outcomes: -
At the end of the course the students will be able to,
1. Explain the contributions of various researchers in the field of thermal engineering after carrying out literature survey from reputed journals.
2. Recognize the gap in the research and define a problem statement.
3. Explain significance and applicability of problem statement
4. Summarize and present technical data in report format

Synopsis Preparation:
Postgraduate student should decide on the dissertation topic in consultation with their supervisor and come out with a synopsis of dissertation work, in July/August of an academic year. It is expected that student should have in-depth understanding of the selected problem, knowledge of probable solutions to the same problem and expected outcomes from the dissertation work.
The synopsis shall consist of following points
- Title
- Introduction
- Literature Review
- Objectives
- Methodology
- Gantt chart
- References

The title should be brief, accurate, descriptive, and comprehensive and clearly indicate the subject for the investigation.
The introduction part should include
1. Area of the work
2. Importance of the work

Literature review should
1. Examine the most current studies on the topic and presenting the significant aspects of these studies.
2. Compare different authors' views about the issue
3. Summarize the literature in terms of a knowledge gap identification e.g. performance

improvement of the existing system, functionality improvement of the existing, proposing an entirely new approach, etc.

4. It should be followed by the Problem statement formulated based on identified gap and objectives of the study
5. Methodology shall include information such as techniques, sample size, target populations, equipments, data analysis, etc. and explain why proposed methodology is most suitable to solve the undertaken problem.
6. It should be followed by activity chart mentioning probable duration for completion of various activities to be undertaken during dissertation work and appropriate list of references. The references should be from reputed journals such IEEE, Science direct, Elsevier etc.

Synopsis approval and evaluation by DPGC Committee:

- The student should submit the synopsis duly signed by supervisor in the prescribed format to the department office.
- The DPGC committee will conduct the Synopsis Presentation for the students of the program within the stipulated period and give approval to the synopsis with the evaluation score. The committee will find the enough complexity in the dissertation work, and all committee members should remain present at the time of the presentation.
- The objective of the presentation is to find quality of work undertaken by the student, student's understanding about basic concepts required to carry out the work, scope of the work, correctness of the methodology, consistency of proposed work with dissertations works of other students and student's ability to communicate his or her ideas and work.
- The committee can suggest modifications in the synopsis if it does not fulfil above-mentioned requirements. The student should prepare a modified synopsis by incorporating suggestions given by members and give presentation again.
- The supervisor must ensure that student have incorporated all suggestions.

Class: **S. Y. M. Tech**	Semester: **III**
Course Code: **MTE3033**	Course Name: **Dissertation Phase – II**

L	T	P	Credits
--	--	**20**	**10**

Course Description:

After synopsis approval, it is expected that student should start working on the selected problem as per activity chart given in the synopsis. It is also expected that at least 40% dissertation work should be completed by a student in this phase.

Course Outcomes:

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

1. Outline the work plan for problem statement.
2. Identify the proper modeling and analysis tool
3. Reproduce the preliminary results of problem statement
4. Summarize and present technical data in report format

Evaluation of Dissertation Phase – II:

- Evaluation (ISE) of Dissertation Phase – II shall be carried before the end of the semester-III and shall be jointly evaluated by Supervisor and Internal-examiner appointed by DPGC committee.
- The student should give presentation / demonstration of the work done. The examiners shall look at student's progress and quality of the work done. The suggestions shall be given to the student, if required. The student should keep a record of these suggestions and incorporate them in his or her work. The supervisor should ensure that suggestions given are incorporated by the student.
- The End –semester examination (ESE) of Dissertation Phase-II shall be carried out by Controller-of-Examinations at the end of Semester-III. The student should give presentation and/or demonstration of completed work in front of supervisor and external examiner appointed by CoE.

Class: **S. Y. M. Tech.**	Semester: **IV**
Course Code: **MTE4013**	Course Name: **Dissertation Phase – III**

L	T	P	Credits
--	--	**16**	**08**

Course Description:
In Dissertation Phase – III, it is expected that student should complete at least 70% of the dissertation work and prepare a draft of the paper for publication.

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

1. Explain the issues related to method adopted in solving the problem.
2. Select proper technique in solving the problem.
3. Compare the results with available literature.

Evaluation of Dissertation Phase – III:
The evaluation (ISE) of Dissertation Phase – III shall be carried out in March of the academic year by Supervisor and Internal examiner appointed by DPGC. The appointed members shall look at student's progress and quality of the work done. The suggestions shall be given to the student, if required. The student should keep a record of these suggestions and incorporate them. The supervisor should ensure that suggestions given are incorporated by the student.
If student's progress is not as per expectation, the committee member shall issue a written notice to the student about probable extension.

Class: **S. Y. M. Tech.**	Semester: **IV**
Course Code: **MTE4023**	Course Name: **Dissertation Phase – IV**

L	T	P	Credits
--	--	24	12

Course Description:

In Dissertation Phase – IV, it is expected that student should complete

- 100% implementation of the proposed system
- Simulation/ experimentation work on the proposed system
- Performance evaluation of the proposed system
- Comparison of the proposed system with existing systems
- Writing the conclusions
- Preparation of a draft-copy of the dissertation report along with Plagiarism report

Course Outcomes:

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

1. Design new methodology to address the problem.
2. Justify the results obtained from new methodology.
3. Write technical report and defend work.

Evaluation of Dissertation Phase – IV:

- The DPGC committee will evaluate the dissertation pre-submission presentation (ISE) and/or system demonstration given by the students at the end of semester –IV within the stipulated period and give approval/modifications to the work done by the student along with the evaluation score. The committee will verify work completion as per the synopsis, and all committee members should remain present for the presentation.
- The objective of the presentation/ demonstration is to understand techniques implemented by the student, student's own contribution in the development process, obtained results, comparison of results with existing systems, and deliverables of the dissertation work.
- The committee can suggest modifications if it does not fulfil above-mentioned requirements in the system/ draft copy of the report. In this case, the student should modify the work in a given time span based on suggestions given by the members and give presentation again in front of committee members. The members should ensure that student has incorporated all suggestions and gives him/her approval to submit the dissertation work for final evaluation.
- The End –semester examination (ESE) of Dissertation Phase-IV shall be carried out by Controller-of-Examinations at the end of Semester-IV. The student should give presentation and/or demonstration of completed work in front of supervisor and external examiner.

Rajarambapu Institute of Technology Mech. Engg. Dept. 415 414 Rajaramnagar

K.E.S. Rajarambapu Institute of Technology Rajaramnagar Autonomous 415414