Rajasthan Technical University (RTU)
Mechanical
(Renewable Energy Technology)

M. Tech Program in Mechanical Engineering with specialization in
Renewable Energy Technology

Courses

The theory subjects will be of maximum 125 Marks each having 25 Marks as course work and 100 Marks for University examination.

First Semester

S. No.	Code No.	***Subject***	L	T	P	Marks	Ex. Hrs.
1.	1MERET1	Renewable Energy Sources	3	1	0	125	3
2.	1MERET2	Advanced Thermodynamics	3	1	0	125	3
3.	1MERET3	Numerical Methods	3	1	0	125	3
4.	1MERET4	Advanced Heat Transfer	3	1	0	125	3
5.	1MERET5	Renewable Energy Lab - I	0	0	3	100	3
Total			12	4	3	600	

Second Semester

S. No.	Code No.	***Subject***	L	T	P	Marks	Ex. Hrs.
6.	2MERET6	Solar Energy	3	1	0	125	3
7.	2MERET7	Wind Energy Technology	3	1	0	125	3
8.	2MERET8	Fuel Cell Technology	3	1	0	125	3
9.	2MERET9	Analysis of Power plants	3	1	0	125	3
10.	2MERET10	Renewable Energy Lab - II	0	0	3	100	3
Total			12	4	3	600	

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Third Semester

S. No.	Code No.	***Subject***	L	T	Marks	Ex. Hrs.
11.	3MERET11	Elective 1	3	1	125	3
12.	3 MERET12	Elective 2	3	1	125	3
13.	3 MERET13	Seminar			150	
14.	3 MERET14	Dissertation –I			100	
Total			6	2	500	

Fourth Semester

S. No.	Code No.	***Subject***	L	T	Marks	Ex. Hrs.
15.	4 MERET15	Dissertation -II			500	
Total					500	

List of Electives (For 3MERET11 & 3MERET12):

Choose any two out of six given below.

Advanced Applications in Solar Energy Technology

Biogas/Bio diesel technology

Nuclear Power Plant

Hydrogen energy

Wind Turbine design and control

Direct Energy conversion Systems

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1MERET1: RENEWABLE ENERGY SOURCES

3L+1T **MM:125** **Ex.Hrs. 3**

Energy sources & Availability:

Conventional, Non-conventional, renewable, non renewable sources of energy, prospects & perspectives & advantages. Introduction to different types of non conventional source of energy - solar, wind, biomass, OTEC, geothermal, hydrogen energy, fuel cells, MHD, thermonic convertor, thermo-electric power.

Solar Energy :

Solar constant, solar radiation geometry, local solar time, day length, solar radiation measurement, radiation on inclined surface, solar radiation data & solar charts.

Wind Energy :

Wind as a Source of Energy, Characteristics of wind, wind data. Horizontal & Vertical axis wind Mills.

Biomass Energy :

Introduction to biomass, biofuels & their heat content, biomass conversion technologies. Aerobic & anaerobic digester, Factors affection biogestion, biogas plants - types & description. Utilisation of biogas - Gasifiers, direct thermal application of Gasifiers. Advantages & problems in development of Gasifiers, use in I.C. engines.

Other Energy Sources :

Geothermal Energy : Status & estimates, geothermal sources, geothermal systems & their characteristics.

Fuel Cells. Principle & Classification, types conversion efficiency, polarization & advantages MHD power generation - principle, types closed & open cycle system materials.

Energy form thermo nuclear fusion, OTEC, hydrogen, thermoionic generation & tidal waves.

1MERET2: ADVANCED THERMODYNAMICS (Common for 1METE2 & 1MERET2)

3L+1T **MM:125** **Ex.Hrs. 3**

Review of basic thermodynamic principles; entropy; availability; irreversibility; first and second law analysis of steady and unsteady systems;

General thermodynamics relations; Fundamentals of partial derivatives; relations for specific heats; internal energy enthalpy and entropy; Joule - Thompson coefficient; Clapeyron equation.

Multi component systems; Review of equation of state for ideal and real gases; thermodynamic surfaces; gaseous mixtures; fugacity; ideal solutions; dilute solutions; activity; non ideal liquid solutions.

Multi component phase equilibrium ; Criteria of equilibrium; stability; heterogeneous equilibrium; binary vapour liquid systems; the nucleus of condensation and the behaviour of stream with formation of large and small drops; Gibbs Phase rule; higher order phase transitions.

Thermodynamics of chemical reaction (combustion); internal energy and enthalpy - first law analysis and second law analysis; basic relations involving partial pressures; third law of thermodynamics; chemical equilibrium and chemical potential equilibrium constants; thermodynamics of low temperature.

Statistical mechanics - Maxwell - Boltzmann statistics; microstate and macrostates; thermodynamic probability; entropy and probability Bose Einstein statistics; Fermi Dirac statistics.

Elementary concepts of irreversible thermodynamics.

1MERET3: NUMERICAL METHODS (Common to IMETE3 & 1MERET3)

3L+1T **MM:125** **Ex.Hrs. 3**

Approximations: Accuracy and precision, definitions of round off and truncation errors, error propagation Algebraic equations : Formulation and solution of linear algebraic equations, Gauss elimination, LU decomposition, iteration methods (Gauss - Siedel), convergence of iteration methods, eigen values and eigen vectors. Interpolation methods: Newton's divided difference, interpolation polynomials, Lagrange interpolation polynomials. Differentiation and Integration: High accuracy differentiation formulae, extrapolation, derivatives of unequally spaced data, Gauss quadrature and integration. Introduction to optimization methods: Local and global minima, Line searches, Steepest descent method, Conjugate gradient method, Quasi Newton method, Penalty function.

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1METE 4: ADVANCED HEAT TRANSFER Common for IMETE4 & 1MERET4)

3L+1T **MM:125** **Ex.Hrs. 3**

Objective of Course :

It provides the knowledge of advanced techniques for analysis of heat transfer processes in thermal systems.

Syllabus :

Review :

Review of the basic laws of conduction, radiation and convection.

Conduction :

One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source; local heat source in non adiabatic plate.

Extended surfaces-review; optimum fin of rectangular profile; straight fins of triangular and parabolic profiles; optimum profile; circumferential fin of rectangular profile; spines; design considerations.

Two dimensional steady state conduction; semi-infinite and finite flat plates temperature field in finite cylinders and in infinite semi cylinders.

Unsteady state conduction; sudden changes in the surface temperatures of infinite plate, cylinders and spheres; solutions using Groeber's and Heisler's charts for plates, cylinders and spheres suddenly immersed in fluids.

Radiation :

Review of radiation principles; diffuse surfaces and the Lambert's Cosine law.

Radiation through non-absorbing media; Hottel's method of successive reflections.

Radiation through absorbing media; logarithmic decrement of radiation; apparent absorptivity of simple shaped gas bodies; net heat exchange between surfraces separated by absorbing medium; radiation of huminous gas flames.

Convection :

Heat transfer in laminar flow; free convection between parallel plates; forced internal flow through circular tubes, fully developed flow; velocity and thermal entry lengths solutions with constant wall temperature and with constant heat flux; forced external flow over a flat plate; the two dimensional velocity and temperature boundary layer equations. Karman Pohlhoursen approximate integral method.

1MERET5: RENEWABLE ENERGY LAB-I

3P **MM:100**

The experiments may be designed based on the course 1MERET1.

2MERET6: SOLAR ENERGY

3L+1T **MM:125** **Ex.Hrs. 3**

Solar radiation, its measurement and prediction. Flat plate collectors : liquid and air type. Theory of flat plate collectors, advanced collectors, optical design of concentrators, selective coatings, solar water heating, solar dryers, solar stills, solar cooling and refrigeration. Thermal storage. Conversion of heat into mechanical energy. Active and passive heating of buildings. Solar cells.

2MERET7: WIND ENERGY TECHNOLOGY

3L+1T **MM:125** **Ex.Hrs. 3**

Wind Energy: Wind energy potential measurement, general theories of wind machines, basic laws and concepts of aerodynamics, aerofoil design; wind mill and wind electric generator. Description and performance of the horizontal–axis wind machines. Description and performance of the vertical–axis wind machines. The generation of electricity by wind machines, case studies.

2MERET8: FUEL CELL TECHNOLOGY

3L+1T **MM:125** **Ex.Hrs. 3**

Introduction: Fuel cells- definition, relevance and importance, classification of fuel cells. Electrochemistry basis of fuel cells.
Alkaline fuel cells (AFC): Description, working principle, components, general performance characteristics, Ammonia as AFC fuel. Phosphoric Acid fuel cell.
Solid oxide fuel cell (SOFC): History, benefits and limitations, cell components, Cathode and Anode materials, fuel, configuration and performance. Environmental impact of SOFC. Application and future of SOFC.
Molten carbonate fuel cells (MCFC): General principle, cell components, mechanisms of electrode reactions, status of MCFC.
Introduction to Direct Methanol Fuel Cell and Proton Exchange Membrane Fuel Cell.
Hydrogen processing and Storage: Processing from Alcohols, Hydrocarbons and other sources. Hydrogen as an engine fuel, methods of hydrogen storage.

2MERET9: ANALYSIS OF POWER PLANTS

3L+1T **MM:125** **Ex.Hrs. 3**

Introduction to economics of power generation. Load duration curves, location of power plants, power plant economics, Indian energy scenario.

Analysis of Steam Power Plants (SPP): Components of steam power plants, Effect of variations, variation of steam condition on thermal efficiency of steam power plant. Typical layout of SPP. Efficiencies in a SPP.

Analysis of Hydroelectric Power Plants (HEPP): Components of HEPP, Types of turbine- Pelton, Francis, Kaplan, Propeller, Deriaz and Bulb turbines, Typical layout of HEPP, Performance of turbines and comparison.

Analysis of Diesel and Gas Turbine Power Plants: General layout of Diesel and Gas Turbine power plants, Performance of Diesel and Gas Turbine power plants, comparison with other types of power plants.

2MERET10: RENEWABLE ENERGY LAB-II

3P **MM:100**

The experiments may be designed based on the theoretical courses taught during the second semester.