



**M.TECH - RENEWABLE ENERGY  
 ( Three Year Part Time)  
 CURRICULUM 2008-2011  
 SEMESTER I**

<b>Code No</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
PYRE101	Fuels and Combustion Technology	2	1	0	3
PYRE102	Hydro Power Technology	2	1	0	3
PYRE103	Solar Energy Engineering	2	0	1	3
PYRE104	Solar Energy Lab	0	0	3	2

**Total Hours:12**

**Total Credits :11**

**SEMESTER II**

<b>Code No</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
PYRE201	Bio-Energy Engineering	2	1	0	3
PYRE202	Wind Energy, Tidal Energy and OTEC	2	1	0	3
PYRE203	Electrical Energy Technology	2	1	0	3
PYRE204	Bio and Thermal Energy Lab	0	0	3	2

**Total Hours:12**

**Total Credits:11**

**SEMESTER III**

<b>Code No</b>	<b>Course Title</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
PYRE301	Computational Fluid Dynamics	2	1	0	3
PYRE302	Hydrogen and Nuclear Energy	2	1	0	3
PYRE**	Elective - I	2	1	0	3
PYRE303	Computational Fluid Dynamic Lab	0	3	0	2

**Total Hours:12**

**Total Credits :11**

### SEMESTER IV

Code No	Course Title	L	T	P	C
PYRE401	Energy Audit and Mangement	2	1	0	3
PYRE402	Statistical Tools for a Data analysis	2	1	0	3
PYRE**	Elective -II	2	1	0	3
PYRE 403	Mini Project	0	0	3	2

**Total Hours: 21**

**Total Credits:11**

### SEMESTER V

Code No	Course Title	L	T	P	C
PYRE501	Unit operations in Industries	2	1	0	3
PYRE**	Elective – III	2	1	0	3
PYRE**	Elective – IV	2	1	0	3
PYRE 502	Project work Phase - I	0	0	3	2

**Total Hours: 21**

**Total Credits:11**

### SEMESTER VI

Code No	Course Title	L	T	P	C
PYRE601	Project work Phase – II	0	0	24	12

**Total Hours:34**

**Total Credits: 17**

**Over all credits:67**

LIST OF ELECTIVES					
Code No	Course Title	L	T	P	C
PYRE71	Fluid Dynamics and Heat Transfer	2	1	0	3
PYRE72	Energy Conservation in HVAC	2	1	0	3
PYRE73	Environmental Engineering	2	1	0	3
PYRE74	Carbon Sequestration and Trading	2	1	0	3
PYRE75	Waste Management and Energy Recovery	2	1	0	3
PYRE76	Optimum Utilization of Heat and Power	2	1	0	3
PYRE77	CAD/CAM - Renewable Energy	2	1	0	3
PYRE78	Sustainable Development	2	1	0	3
PYRE79	Process Control and Instrumentation Technology	2	1	0	3
PYRE80	Energy Efficient building	2	1	0	3
PYRE81	Energy Modeling, Economics and Project Management	2	1	0	3

## SYLLABUS

**PYRE101 - FUELS AND COMBUSTION TECHNOLOGY**

**2 1 0 3**

**UNIT - I FUELS, FUEL ANALYSIS & COMBUSTION STOICHIOMETRY**

**9**

**FUELS & FUEL ANALYSIS:** Types of Fuels-Physical and Chemical characteristic of solid, liquid, and Gaseous fuels- Non conventional fuel-Producer Gas, Hydrogen, Biogas etc..-Determination of Calorific values- Ultimate and proximate analysis-Problems associated with handlings, storage and combustion.

**COMBUSTION STOICHIOMETRY:** Stoichiometry relations – conservation of mass principles – theoretical & actual combustion processes – calculation of air fuel ratio for a fuel of known combustion –calculation of flue gas composition of fuel and excess air supplied from exhaust gas analysis – combustion calculation with sub-stoichiometry air – calculation of atmospheric air moisture – Dew point temperature of the combustion products – Flue gas analysis-Boiler Performance Analysis.

**UNIT - II THERMODYNAMICS OF COMBUSTION PROCESSES**

**9**

**COMBUSTION KINETICS:** Degree of reactions – reactions equilibrium — Laws of mass action – criteria of equilibrium- heat and temperature-**Gibbs** free energy – equilibrium constant – **Vant Hoffs isotherm** – rate of reaction –factors affecting rate of reaction – calculation of equilibrium constant & composition of reacting systems.

**COMBUSTION THERMODYNAMICS:** Enthalpy of formation – First law analysis of reacting systems -Enthalpy and internal energy of combustion – calculation of heat of formation & heat of combustion — Adiabatic flame temperature calculation – Entropy change of reacting systems – Second law analysis of reacting systems

**UNIT- III FLAME, FLAME STRUCTURE, IGNITION AND IGNITORS**

**9**

Flame – flame structure – flame propagation – deflagration – detonations – flame front – Ignition – self & forced ignition – Ignition temperature & ignition limits – Factors influencing ignition – SIT – Ignition lag – limits of inflammability & its determination – factors affecting inflammability limits – calculation of inflammability limits – flame blow off, blow out & flash back – flame quenching, Flame structure – flame stability – premixed & diffused flames – velocity of flame propagation – various methods of flame stabilization – swirl number & its significance – Turndown ratio – Igniters – various types of igniters – NFPA class I, II & III igniters – Eddy plate igniter – plasma igniter – High energy Arc igniter – DIPC igniter

**UNIT- IV BASICS OF FURNACES**

**9**

Industrial furnaces – process furnaces- Steam generating furnaces – Kilns – Batch & continuous furnaces – Advantages of ceramic coating – Heat source – Distributions of head source in furnaces – Blast furnace – open hearth furnace – pot & crucible furnaces – waste heat recovery in furnaces – Recuperator – Regenerators – Furnace atmospheres – Furnace Insulation – Furnace Heat balance calculations, Pipe still Heater.

## UNIT - V COMBUSTION APPLIANCES

9

**GAS BURNERS:** Functional requirement of burners – Gas burner classification – Premix burners – Aerated gas burners – Air aspiration gas burners – Diffusion flame burners – Radiant orifice port burners – Atmospheric Gas burners – Flare Stack.

**LIQUID FUEL BURNERS:** Pressure jet atomization – Air blast atomizers – steam atomizers – rotary cup atomizers – vaporizing burners – Low NO<sub>x</sub> burners – swirl number & its significance – selection of appropriate type of burners.

### COAL BURNING EQUIPMENTS

Coal burning methods – over feed & underfeed supply of coal – Mechanical Stokers – Travelling grate & spreader stoker – vibrating grate stoker – Advantages & disadvantages of stoker firing over pulverized systems of firing – problems encountered with burning of high ash coal. Pulverized fuel burners – streamlined burner – turbulent burners – Tangential burner – cyclone burner – special type burners.

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one the combustion System and Accessories(viz.. Burner, Draught etc.,)

**L:30; T:15; Total:45**

### TEXT BOOKS:

1. Dr. Samir Sarkar, "Fuels & Combustion", Orient Longman, Second edition, 1990.
- Gupta O.P. "Elements of Fuels, Furnaces & Refractories", 3rd edition, Khanna Publishers, 1996.

### REFERENCES:

1. S.P. Sharma and Chander Mohan, "Fuels & Combustion", Tata McGraw Hill Publishing Co.Ltd., 1984.
2. J.D. Gilchrist, "Fuels, Furnaces & Refractories", Pergamon Press, ISBN-008-029430-9
3. Blokh A.G. "Heat Transmission in Steam Boiler furnaces", Hemisphere Publishing Corpn. ISBN-089-116-626-26

**UNIT - I HYDROLOGY****9**

Overview of Hydropower systems-Preliminary Investigation- Rainfall and Run of measurements- Hydrographs- flow duration graph and mass storage graphs- Determination of site selection- types hydro electric power plants- General arrangements and Layouts- Preparation of Reports and Estimates-Review of World Resources-Basic Factors in Economic Analysis of Hydropower projects-Project Feasibility-Load Prediction and Planned Development.

**UNIT- II DEVELOPMENT OF PROTO TYPE SYSTEMS****12**

Advances in Planning, Design and Construction of Hydroelectric Power Stations-Trends in Development of Generating Plant and Machinery-Plant Equipment for pumped Storage Schemes-Some aspects of Management and Operations-Updating and Refurbishing of Turbines-Case Studies

**UNIT - III SELECTION AND ANALYSIS OF TURBINES****7**

Measurement of pressure head, Velocity- Various parameters for finding out the potential of Hydro Energy- Selection of turbines based on Specific quantities- Case study

**UNIT - IV HYDRO POWER STATION OPERATION, MAINTENANCE AND TROUBLE SHOOTING****10**

Governing of Power Turbines-Functions of Turbine Governor-Condition for Governor Stability-Surge Tank Oscillation and Speed Regulative Problem of Turbine Governing in Future Planning, Design and Construction of Hydroelectric Power Stations-Remaining Lifecycle Analysis.

**UNIT - V SMALL, MINI AND MICRO HYDRO POWER PLANTS TURBINES****9**

Introduction – Analysis of Small, mini and micro hydro turbines – Economical and Electrical Aspects of Small, mini and micro hydro turbines- potential developments – Design and reliability of Small, mini and micro hydro turbines – Case Study.

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one the Small, Mini and Micro Hydro Power Plants and Components(viz.. Turbines, Controls, and Storage etc.,)

**L:30 T:15; Total: 45****TEXT BOOKS:**

- 1.P.K Nag “Powerplant Engineering”, TataMcGrawHill, NewDelhi,2004
- 2.Domkundwar and Arora” A Course in Powerplant Engineering”, Khanna Publishers, NewDelhi.

**REFERENCES:**

1. L.Monition,M.Lenir and J.Roux Micro Hydro Electric Power Station(1984)
2. AlenR. Inversin,Micro Hydro Power Source Book(1986)

## **PYRE 103 - SOLAR ENERGY ENGINEERING**

**2 1 0 3**

(Use of approved data book permitted in the examination)

### **UNIT - I SOLAR RADIATION**

**9**

Source of radiation – Sun earth relationship- extra terrestrial radiation.– Atmospheric attenuation – Terrestrial radiation-radiation on a horizontal surfaces and inclined planes- relations between horizontal radiation and inclined surfaces – relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation- pyroheliometer, pyranometer, pyro geo meter, net pyradiometer-sunshine recorder – an overview of solar radiation data in India.

### **UNIT - II SOLAR COLLECTORS – FLAT PLATE COLLECTORS**

**12**

Design considerations – classification- Flat plate collectors- air heating collectors liquid heating –Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors-for efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors analysis of concentric tube collector – testing of flat plate collectors. Solar green house.

### **UNIT - III CONCENTRIC SOLAR COLLECTORS AND THERMAL APPLICATION**

**9**

Concentric collectors-Limits to concentration – concentrator mounting – tracking mechanism - performance analysis focusing solar concentrators: Heliostats. Solar powered absorption A/C system (Ammonia/water) solar water pump, solar chimney, solar drier, solar dehumidifier, solar still, solar cooker.

### **UNIT- iv SIMULATION AND ENERGY STORAGE**

**9**

Simulation in Solar Process Design- TRANSYS- Design of active systems- f chart methods for liquid and air heaters- phi bar, of chart method - sensible, latent heat and thermo-chemical storage-pebble bed etc. materials for phase change- Glauber's salt-organic compounds -solar ponds.

### **UNIT - V SOLAR PV SYSTEM**

**6**

Photo- voltaic cell – characteristics-maximum power- tracking-cell arrays-power electric circuits for output of solar panels--inverters-batteries-charge regulators, Construction concepts.

A compulsory Seminar/ Assignment on Design/Case Study/Analysis/Application in any one the Solar thermal Energy System

**L:30; T:15; Total:45**

**TEXT BOOKS:**

1. Duffie J.A and Beckman, W.A., "Solar Engineering of Thermal Processes", 2nd Edition, John Wiley & Sons Inc., New York, -1991
2. G.N. Tiwari. "Solar Energy: Fundamentals, Design, Modelling and Applications", Third Reprint, Narosa Publishing House, New Delhi-2006

**REFERENCES:**

1. Edward E. Anderson, "Fundamentals for Solar Energy Conversion", Addison Wesley pubCO., 1983.
2. Frank Kreith, Jan F. Kreider, "Principles of solar Engg", 1978.
3. Koushika M.D., "Solar Energy Principles and Applications", IBT publications and distributors, 1988.
4. Kaushik S.C, Tiwari G.N and Nayak J.K, "Thermal control in passive solar buildings" .IBT Publishers & Distributors, 1988.

## **PYRE104 - SOLAR ENERGY LAB**

**0 0 3 2**

1. Study of direct and diffused beam solar radiation
2. Study of green house effect
3. Performance evaluation of solar flat plate collector
4. Study the effect of solar flat plate collector in parallel combination
5. Performance evaluation of concentrating solar collector
6. Performance evaluation of solar cooker
7. Performance evaluation air dryer
8. Performance evaluation distillation
9. Performance evaluation of a solar PV panel
10. Performance of PV panel in series and parallel combination
11. Charging characteristics of a battery using PV panel
12. Effect of tilt angle on solar PV panel
13. Effect of shadow on solar PV panel

**P:45; Total:45**