

GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Energy Engineering) w.e.f. (28/2/2012)

Semester – II

PROPOSED TEACHING SCHEME (SEMESTER-II)

SUBJECT CODE	NAME OF SUBJECT	TEACHING SCHEME(HOURS)			CREDITS
		THEORY	TUTORIAL	PRACTICAL	
1720001	Principles of Management	3	0	0	3
1723901	Wind Energy Engineering	3	1	0	4
1723902	Energy Audit & Management	3	0	2	4
	Major Elective - II	4	0	0	4
	Major Elective - III	3	2	0	4
	Inter Disciplinary Elective - II	3	2	0	4
1723910	Measurement of Energy efficiency	0	0	4	2
	Total	19	5	6	25

Inter Disciplinary Elective - II

1723909	Energy Efficient Buildings
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Major Elective -II

1723903	Thermal Equipment Design (Mechanical)
1723904	Nuclear and Hydrogen Energy Engineering (Chemical)
1723905	Nuclear, Hydel & OTEC Power Plants (Electrical)

Major Elective - III

1723906	Computational Fluid Dynamics(Mechanical)
1723907	Micro Fuel Cells (Chemical)
1723908	Power Quality Enhancement (Electrical)

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Semester – II

Subject Code: 1723901

Subject Name: Wind Energy Engineering

Sr. No.	Course Content
1	Wind Energy Fundamentals Wind Energy Basics, Wind Speeds and scales, Terrain, Roughness, Wind Mechanics, Power Content, Class of wind turbines, Atmospheric Boundary Layers, Turbulence.
2	Wind Measurements, Analysis and Energy Estimates Instrumentation for wind measurements, Wind data analysis, tabulation, Wind resource estimation, Betz's Limit, Turbulence Analysis.
3	Aerodynamics Theory Airfoil terminology, Blade element theory, Blade design, Rotor performance and dynamics, Balancing technique (Rotor & Blade), Types of loads; Sources of loads.
4	Wind Turbines Technology & Components of MW series WTGs. • Wind turbines types: Vertical Axis Type, Horizontal Axis, Constant Speed Constant Frequency, Variable speed Variable Frequency, Up Wind, Down Wind, Stall Control , Pitch Control, Gear Coupled Generator type, Direct Generator Drive /PMG/Rotor Excited Sync Generator. • Wind Turbine Technology & Components of WTG Gear Coupled Generator Type [Const. Speed] Direct Coupled Generator Type [Variable Speed Variable Frequency]: Multipole Synchronous / PMG Generators. • Gear Coupled Generator Wind Turbine Components and their construction Electronics Sensors /Encoder /Resolvers, Wind Measurement : Anemometer & Wind Vane, Grid Synchronization System, Soft Starter, Switchgear [ACB/VCB], Transformer, Cables and assembly, Compensation Panel, Programmable Logic Control, UPS, Yaw & Pitch System : AC Drives, Safety Chain Circuits, Generator Rotor Resistor controller (Flexi Slip), Differential Protection Relay for Generator, Battery/Super Capacitor Charger & Batteries/ Super Capacitor for Pitch System, Transient Suppressor / Lightning Arrestors, Oscillation & Vibration sensing. • Direct Rotor Coupled Generator (Multipole) [Variable Speed ,Variable Freq.] • Excited Rotor Synch. Generator / PMG Generator, Control Rectifier, Capacitor Banks, Step Up / Boost Converter (DC-DC Step Up), Grid Tied Inverter, Power Management, Grid Monitoring Unit (Voltage and Current), Transformer, Safety Chain Circuits Doubly Fed Induction Generator and Power Control

5	Modern Wind Turbine Control & Monitoring System Details of Pitch System & Control Algorithms, Protections used & Safety Consideration in Wind turbines, Wind Turbine Monitoring with Error codes, SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, Balancing technique (Rotor & Blade), FACTS control & LVRT & New trends for new Grid Codes.
6	Concept of Wind Farms and project cycle Project planning, Site selection, Project execution, Operation and maintenance Environmental concerns: Pollution free power; Noise; birds; Aesthetics; Radio waves interference; Rainfall
7	Cost Economics Wind resource assessment and R & D costs, Fixed and variable costs, Value of wind energy, Life cycle costing and cash flow of wind power projects, Wind project owners / developers, Wind energy market

Reference Books

1. Freris, L. L., Wind Energy Conversion Systems, Prentice Hall, 1990.
2. Spera, d. a., Wind Turbine Technology: Fundamental concepts of wind turbine engineering, ASME Press.
3. Johnson, G. L., Wind Energy Systems, Prentice Hall, 1985.
4. Walker, J. F., Wind Energy Technology, John Wiley, 1997.
5. Anna Mani : Wind Energy Data for India.
6. C-Wet : Wind Energy Resources Survey in India VI.
7. S. Rangrajan : Wind Energy Resources Survey in India V.
8. Sathyajith Mathew : Wind Energy Prepared by WISE: Wind Power in India (5000MW BY 2015).
9. B.H.Khan: Non-Conventional Energy Sources.

GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Energy Engineering)

Semester – II

Subject Code: **1723902**

Subject Name: **Energy Audit and Management**

Sr. No.	Course Content
1	Energy Audit Methodology and recent trends. General Philosophy and need of Energy Audit and Management. Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. Economics of implementation of energy optimization projects, it's constraints, barriers and limitations, Report-writing, preparations and presentations of energy audit reports ,Post monitoring of energy conservation projects, MIS , Case-studies / Report studies of Energy Audits. Guidelines for writing energy audit report, data presentation in report, findings recommendations, impact of renewable energy on energy audit recommendations. Case studies of implemented energy cost optimization projects in electrical utilities as well as thermal utilities. Instruments for Audit and Monitoring Energy and Energy Savings, Types and Accuracy.
2	Electrical Distribution and Utilization Electrical Systems, Transformers loss reductions, parallel operations, T & D losses, P.F. improvements, Demand Side management (DSM), Load Management, Harmonics & its improvements, Energy efficient motors and Soft starters, Automatic power factor Controllers, Variable speed drivers, Electronic Lighting ballasts for Lighting, LED Lighting, Trends and Approaches. Study of 4 to 6 cases of Electrical Energy audit and management (Power factor improvement, Electric motors, Fans and blowers, Cooling Towers, Industrial/Commercial Lighting system, etc.)
3	Thermal Systems Boilers- performance evaluation, Loss analysis, Water treatment and its impact on boiler losses, integration of different systems in boiler operation. Advances in boiler technologies, FBC and PFBC boilers, Heat recovery Boilers- it's limitations and constraints .Furnaces- Types and classifications, applications, economics and quality aspects, heat distributions, draft controls, waste heat recovering options, Furnaces refractory- types and sections. Thermic Fluid heaters, need and applications, Heat recovery and its limitations. Insulators- Hot and Cold applications, Economic thickness of insulation, Heat saving and application criteria. Steam Utilization- Properties, steam distribution and losses, steam trapping, Condensate, Flash steam recovery.

4	System Audit of Mechanical Utilities Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems. Blowers (Blowers) types & application, its performance assessment, series & parallel operation applications & advantages. Energy Saving in Blowers Compressors, types & applications, specific power consumption, compressed air system, & economic of system changes. Energy Saving in Compressors & Compressed Air Systems Cooling towers, its types and performance assessment & limitations, water loss in cooling tower. Energy Saving in Cooling Towers .Study of 4 to 6 cases of Energy Audit & Management in Industries (Boilers, Steam System, Furnaces, Insulation and Refractories, Refrigeration and Air conditioning, Cogeneration, Waste Heat recovery etc.) Study of Energy Audit reports for various Industries and Organizations
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Reference Books

1. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
2. Energy Management Principles: C.B.Smith (Pergamon Press)
3. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
4. Industrial Energy Conservation: D.A. Reay (Pergammon Press)
5. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience publication)
6. Industrial Energy Management and Utilization –L.C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988)
7. Energy Audit and Management volume-I IECC Press
8. Energy Efficiency in Electrical systems volume-II IECC Press

GUJARAT TECHNOLOGICAL UNIVERSITY

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Semester – II

Subject Code: **1723909**

Subject Name: **Energy Efficient Buildings (Interdisciplinary Elective II)**

Sr. No.	Course Content
1	Energy and buildings Introduction, Energy and the built environment - past and present, Energy and the built environment - the future.
2	Site planning and analysis Introduction , Solar radiation , Wind , Soil.
3	Building design Introduction, Energy demand and thermal response. The internal environment, Comfort, Temperature, Room air movement, ventilation and relative humidity. Size and type , Form and orientation , External and internal layout ,Construction - general Foundations and walls , Floors , Windows , Doors ,Ceilings and roofs Electrical Energy Conservation, Opportunities and Techniques for energy conservation in Buildings.
4	Passive solar design Introduction, Elements of passive solar systems, Glazing, Single and multiple glazing Insulating blinds and shutters, Shading, Radiation enhancement using reflectors, Thermal storage. Passive solar heated buildings Direct gain, Attached sun spaces, Thermal storage walls, Roof ponds, Roof-space collectors, Convective loops. Design methods for passive solar buildings Introduction, Characteristics of a perfect design model, Models approaching the desired degree of Flexibility.
5	Space heating and ventilation Introduction, Solid-fuel heating, Water-distribution systems, Forced-air systems, Heating with electricity, Heat pumps, Group schemes, Conclusion.

Reference Books

1. Sodha, M., Bansal, N.K., Bansal, P.K. Kumar, A.. and Malik, M.A.S., "Solar Passive Buildings", Pergamon Press, 1986.
2. Koenigsberger, O.H. Ingersoll, T.G. Mayhew Alan and Szokolay, S. V., "Manual of Tropical Housing and Building part 1: Climatic Design", OLBN 0 00212 0011, Orient Longman Limited, 1973.
3. Bureau of Indian Standards, I.S. 11907 –1986 Recommendations for calculation of Solar Radiation Buildings, 1986.
4. Givoni, B., "Man, Climate and Architecture", Elsevier, Amsterdam, 1986.
5. Smith, R. J., Phillips, G.M. and Sweeney, M. "Environmental Science", Longman Scientific and Technical, Essex, 1982.

GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Energy Engineering)

Semester – II

Subject Code: **1723903**

Subject Name: **Thermal Equipment Design (Major Elective-II)(Mechanical)**

Sr. No.	Course Content
1	Classification– parallel flow, counter flow, cross flow, multi pass, temperature distribution, over all heat transfer co-efficient, log mean temperature distribution – LMTD method, correction for LMTD, NTU method, methodology of heat exchanger calculation, fouling of heat exchanger.
2	Double pipe heat exchangers, applications and design parameters, types available. Shell and tube heat exchangers with single phase flow, design procedure, flow arrangement for increased heat recovery.
3	Types of condensers and their selection, design procedures, types of evaporators, shell and tube boilers, types and thermal design.
4	Compact heat exchanger, introduction, plate heat exchangers, heat transfer correlations, methods of surface area calculation, finned tube heat exchangers, application of common fin tubes, fin efficiency and temperature distribution in fin tubes, thermal rating of fin tube heat exchangers, regenerators and thermal energy storage, basic concepts and classification, calculation of regenerator thermal performance.
5	Types of cooling towers, packing region, features of natural and mechanical draft towers, thermal performance of natural and forced draft cooling towers.

Reference Books

1. Hewitt, G. F., et. al., Process Heat Transfer, CRC Press, 1994.
2. Kern, D.Q., Process Heat Transfer, Mc Graw Hill Book Co., New York 1950.
3. Schlunder, E.U., et al., Heat Exchanger Design Hand Book - Vols. 1-5, Hemisphere Publishing Corp., New York, 1983.
4. Martin, H., Heat Exchangers, Hemisphere Publishing Corporation, 1992.
5. Kakac, S., R. K. Shah, A. E. Bergles and F. Mayinger, Heat Exchangers, Hemisphere Publishing Corporation, 1983.
6. Kakac, S., R. K. Shah, and A. E. Bergles Low Reynolds Number Flow Heat Exchangers, Hemisphere Publishing Corporation, 1983.

GUJARAT TECHNOLOGICAL UNIVERSITY

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Semester – II

Subject Code: **1723904**

Subject Name: **Nuclear & Hydrogen Energy Engineering** [Major Elective – II] (Chemical)

Sr. No.	Course Content
1	Introduction: Hydrogen as a renewable energy source; Sources of Hydrogen; Fuel for Vehicles; Properties of hydrogen; Combustion methods and devices; Economics of hydrogen energy;
2	Production of hydrogen: natural resource; biological source; electrolytic process; thermal decomposition; biochemical method; photochemical method; photo-catalytic method.
3	Hydrogen Energy Storage, Transportation and Applications Selection of storage: Gaseous, liquid; Method of storage: Gaseous hydrogen, cryogenic method, metal hydrides, carbon nano-tubes, sea as a source of deuterium; Transportation: methods of transport; cryo-cooled systems; Fuel cells; Applications of hydrogen energy in land and space vehicles; Hydrogen power technologies.
4	Radioactivity; nuclear reactions; binding energy; neutron interaction; cross sections; fission; power from fission; fission chain reactions; criticality; conversion and breeding; nuclear fuel performance. Nuclear power reactors; nuclear fuel cycles; fuel enrichment; fuel assembly; fuel reprocessing; decommissioning of power plants; radioactive waste disposal and its management.
5	Neutron flux; diffusion theory applications; ficks law; solution to diffusion equation for point source; plannar source and bare slab; diffusion length; energy loss in scattering collisions; moderators.
6	One group reactor equation; one group criticality equation; thermal reactors; criticality calculations; homogeneous and heterogeneous reactor; reactor kinetics and safety; prompt neutron life time; reactor with and without delayed neutrons; prompt criticality; control rods; principles of nuclear reactor safety.
7	Heat generation in reactors; thermal constraints; heat transfer to coolants; thermal design of reactor.

Reference Books

1. Solar Hydrogen Energy Systems -T. Ohta (Ed.) (Pergamon Press)
2. Hydrogen Technology for Energy – D.A.Maths (Noyes Data Corp.)
3. Veziroglu, T. N. and Barbir, F., Hydrogen Energy Technologies, UNIDO Emerging Technologies Series, UNIDO, Vienna, 1998
4. Lamarsh, J. R., Introduction to Nuclear Engineering, Addison-Wesley, New York, 1983.
5. Marshall, W., Nuclear Power Technology - Vol. I, II & III, Clarendon Press, Oxford, 1985.
6. Samuel Glasstone, Principle of Nuclear Reactor Engineering, Van Nostrand Reinhold Co., New York, 1963.
7. Culp, Archie W., Principles of Energy Conversion, McGraw Hill Book Co., 1991.

GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering (Energy Engineering)

Semester – II

Subject Code: **1723908**

Subject Name: **Power Quality Enhancement** Major Elective-III)(Electrical)

Sr. No.	Course Content
1	Introduction to Power Quality: Definition of power Quality, Progression susceptibility Criteria, Responsibility of supplier and users of elect power, Standard, Need for monitoring Power Quality, Power quality concepts and definition (Harmonics/interharmonics/voltage sag/swell/interruption/transients etc)
2	Power Frequency disturbance: voltage sags, cures of low frequency disturbances, voltage tolerance
3	Electrical transients: Transient system model, Examples of models & response, Types and causes of transients, Examples of transient wave forms.
4	Harmonics and solutions of power Quality Problems Definition , number, odd and even harmonics, causes of harmonics, Individual & total distortion, Harmonics signatures, Effect of harmonics, Guide lines for harmonic voltage & current limitation, Harmonic current mitigation, Measurement and Analysis of PQ disturbances, Cause and effects of power quality problems, PQ standards, PQ mitigation techniques (APF/APFC/FACTS etc in brief), Case Studies

Reference Books:

1. Power quality by C.Sankaran(CRC publication).
2. Electrical Power Systems Quality by Roger C.Dugan(TMH publication).
3. Handbook of power quality, editor: Angelo Baggingi, John Wiley & Sons, 2008.
- 4 Instantaneous power theory and application to power conditioning, H. Akagi et al., IEEE Press, 2007.
- 5 Power quality enhancement using custom power devices, A. Ghosh and G. Ledwich, Kluwer Academic Publication, 2002.
- 6 Power system harmonics by J Arrilaga,Newyork,Wiley 1985
- 7 IEEE Recommended Practise for monitoring electric power Quality approved june 14 1995.

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Semester – II

Subject Code: **1723906**

Subject Name: **Computational Fluid Dynamics (Major Elective-III)**
(Mechanical)

Sr. No.	Course Content
1	Governing Equations of Fluid Flow, Finite Difference, Finite Volume, Finite Element Methods, Laplace Equation, Diffusion Equation or Wave Equation
2	Application of Finite Volume Method to Fluid Flow problems - Pressure Correction Techniques-Gauss Siedel, Gauss Jordan. Introduction to Multi grid Methods. Boundary Conditions
3	Structured and Unstructured Mesh- Introduction to CAD systems and Different Standards used for DATA Exchange.
4	Governing Equations for Turbulent Flow, Rotating Machinery, Combusting Flow, Multiphase Flow.
5	Simple Internal Flows: T-Junction, Driven Cavity, Manifold, Valves, External Flows: Flow Over Ahmed Body, Car-Reacting Flow in a Gas Burner, Multiphase Flow in an Air Lift Reactor.

Reference Books

1. Anderson, "Computational Fluid Dynamics" McGraw Hill Company, 1995.
2. D.A. Caughey and M.M.Hafez, "Frontiers of Computational Fluid Dynamics 1994" John Wiley & Sons, 1994.
3. Principles of Refrigeration R.J. Dossat ,Wiley Estern Limited.
4. Stoichiometry – Bhatt, Vora Tata Mc.Graw Hill.
5. Practical Heat Recovery – Boyen J.L. John Wiley, New York, USA1976.

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Semester – II

Subject Code: **1723907**

Subject Name **Micro Fuel Cells (Major Elective–III) (Chemical Engineering)**

Sr. No.	Course Content
1	Electrolytes for Long-Life, Ultra Low-Power Direct Methanol Fuel Cells: Introduction, Perfluorinated Polymer Proton Exchange Membranes, Non-Nafion Polymer Proton Exchange Membranes, Inorganic Membranes.
2	MEMS-Based Micro Fuel Cells as Promising Portable Power Source: Introduction, Miniaturization, Microfabricated Fuel Cells, Grafted Porous Silicon-Based Miniature Fuel Cells.
3	Advances in Microfluidic Fuel Cells: Introduction, Microfluidic Fuel Cell Fundamentals, Channel Fabrication, Electrode Patterning, and Integration, Technical Advances in Microfluidic Fuel Cells, Conclusion and challenges.
4	Development of Fabrication/Integration Technology for Micro Tubular SOFCs: Introduction, Fabrication and Characterization of Micro Tubular SOFCs, Characterization of Micro Tubular SOFCs, Bundle and Stack Design for Micro Tubular SOFCs, Concluding Remarks.
5	Enzymatic Biofuel Cells : Introduction and Background, Similarities and Differences to Traditional Fuel Cell Catalysts, Enzymatic Bioelectrocatalysis, Mediated Electron Transfer vs. Direct Electron Transfer, FAD-Dependent Enzymes, Deep Oxidation of Biofuel Cells, Biocathodes, Enzyme Immobilization, Enzymatic Fuel Cell Design, Nanomaterials in Enzymatic Biofuel Cells.

Text Book:

Micro Fuel Cells : Principles and Application by T. S. Zhao

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Master of Engineering (Energy Engineering)

Semester – II

Subject code: **1723905**

Subject Name **Nuclear Hydel and OTEC Power Plant** (Major Elective II)
(ELECTRICAL)

Sr. No.	Course Content
1	Hydro Electric power Introduction, Importance of Hydro power. .Hydro Potential in India. Some basic terms related to hydro power like Runoff, Stream flow, Hydrograph. Flow duration curve. Storage and determination of storage from hydrograph.Pondage. Environment Impacts and trends. Hydropower research and development. The future of hydropower.
2	Hydro Power Plants Introduction, Site selection of Hydro power plant. Classification of hydroelectric power plant. Types of Dams. Types of Turbines. Underground Hydro power plant. Automatic and Remote control of Hydro-Plants. Small Hydro power plants. Pumped Storage plants Advantages of hydro Power plant. Problems in hydro power plant development.
3	Nuclear Fuel Waste and their Properties Potential of Nuclear Energy. International Nuclear Energy Policies and Regulations. Nuclear Power–Radioactivity & Radioactive charge. Nuclear fuel cycle. Factors Affecting Uranium, Uranium resources, Current situation, Nuclear Fission and Fusion, Nuclear fission chain reaction. Types of nuclear waste, classification of Radioactive waste. Transport of Nuclear materials. Transportation Requirements, Packaging, Radiation Protection, Economics of Nuclear power plant.
4	Nuclear Power Plant Introduction, General Diagram, Site Selection of Nuclear Power plant, Introduction to Nuclear power reactors, Fueling of Reactors, Reactor Design, reactor control and Protection system, Reactor process Monitoring system, Basic Factors affecting choice of reactors, Advantages of Nuclear power plant, Disadvantages of Nuclear power plant, Safety and Environment aspects of power generation, Nuclear power plant accidents, The Myth of a reactor Explosion, Three Mile Island Nuclear Power Plant Explosion, Chernobyl Nuclear power plant Explosion.

5	Otec Power Plants Ocean Thermal Energy conversion -Operational problem – Ecological & environmental Impacts. Water power – Tidal power – wave power – geothermal power.
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Reference Books

1. Black and Veatch, “Power Plant Engineering”, ISBN 0-412-06401-4, CBS Publishers and Distributors, Chapter 23424.
2. “Energy Technology by S .Rao & Dr .B. B. Parulekar Third Edition, Khanna Publishers.
- 3 Modern Power Generation Practice by Bhuvnesh Oza and Vijay Makwana, Bharti Prakashan.
- 4 Electrical Power by S L Uppal khanna Publications.
- 5 A course in Electrical power by Sony,Gupta and Bhatnagar, Dhantpatrai&co publication.
- 6 Electrical power stations by M.V Deshpande,PHI Publications
- 7 Generation of Electrical Energy by B.R.Gupta.

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Master of Engineering (Energy Engineering)

Semester – II

Subject Code: **1723910**

Subject Name **Measurement of Energy Efficiency (Laboratory)**

Sr_no	List of Practical's to be performed during the semester
1.	Study of solar hot air collector/ solar dryer.
2.	Study of heat pipe
3.	Study of Lead Acid Battery as energy storage.
4.	Flue gas analysis of kerosene.
5.	Study of heat exchangers.
6.	Study of variable speed drives
7.	COP of cooling towers.
8.	Efficiency of electrical motors.
9.	Measurement of load and power factor for the electrical utilities.
10.	Performance evaluation of air compressorsx
11.	Performance evaluation of air compressors
12.	Determining efficiency of lighting system/loads
13.	Measurement of Intensity of solar radiation Energy Content in Wind. (Prototype Wind Mill of 500W)
14.	Bio-gas Production from Kitchen waste.
15.	Performance of Gasifire