

**BHAGWANT
UNIVERSITY
Sikar Road, Ajmer
Rajasthan**



Syllabus

**Institute of Engg. & Technology
M.Tech. (Energy System)**

BHAGWANT UNIVERSITY
M.TECH IN Energy System

I SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
01MES101	Energy conversion system-1	3	2	0	5
01MES102	Energy conversion system-2	3	2	0	5
01MES103	Energy instrumentation	3	2	0	5
01MES104 (01MPS101)	Power system analysis	3	2	0	5
01MES201	Energy lab-I	0	0	5	3
01MES301	Discipline & Co Curricular activities	0	0	4	1
total		12	8	4	24

II SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
02MES101	Renewable source of energy-I	3	2	0	5
02MES102	Renewable source of energy-II	3	2	0	5
02MES103	Environmental Impact of Energy Systems	3	2	0	5
02MES104	Energy Management	3	2	0	5
02MES201	Energy lab-II	0	0	5	3
02MES301	Discipline & Co Curricular activities	0	0	4	1
total		12	8	4	24

III SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
03MES101	Energy conservation-I	3	2	0	5
03MES102	Energy conservation- II	3	2	0	5
03MES201	Seminar	5		0	5
03MES202	Dissertation stage-1	5	0	0	5
03MES301	Discipline & Co Curricular activities	0	0	4	1
TOTAL		16	4	1	21

IV SEMESTER

SUBJECT CODE	NAME OF SUBJECT	HOURS/WEEK			CREDIT POINTS
		L	T	P	
04MPS201	DISSERTATION-2				
	a) Continuous Evaluation	5			5
	b) Project Report	5	0	0	5
	c) Viva Voice	6			6
04MDC301	Discipline & Co Curricular activities	0	0	4	1
TOTAL		16	0	1	17

SYLLABUS

SEMESTER-1

01MES101 ENERGY CONVERSION SYSTEM-I

UNIT-I: ENERGY CLASSIFICATION:

_Energy Classification, Principle fuels for energy conversion: Fossil fuels, nuclear fuels, conventional & Non-conventional energy sources : prospecting, extraction and resource assessment and their peculiar characteristics. Direct use of primary energy sources, conversion of primary into secondary energy sources such as Electricity, Hydrogen, And Nuclear energy etc. Energy conversion through fission and fusion, Nuclear power generation etc.

UNIT-II:THERMAL AND MECHANICAL ENERGY :

Production of Thermal energy using fossil fuels, Bio-mass and solar energy_Production of Mechanical energy using thermal energy, electric energy (electric motors)_Turbines: Steam turbines, Hydraulic turbines and wind turbines.

UNIT-III:THERMAL ENERGY UTILITY SYSTEMS:

HVAC, Refrigeration and Air conditioning: Vapor compression refrigeration cycle, refrigerants, coefficient of performance, capacity, Factors affecting refrigeration and air conditioning system performance, Vapor absorption refrigeration systems: Working principle, type and comparison with vapor compression system._Boilers-Types, combustion in boilers , performance evaluation, analysis of losses, feed water treatment, blow down. Steam systems: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system.

UNIT-IV: CO –GENERATION AND HEAT RECOVERY:

Cogeneration: Definition, need, application, advantages, classification, saving potentials
Waste heat recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices.

UNIT-V:WIND ENERGY:

Basic of wind energy conversion, wind machine, wind electric generator and wind pump

BOOKS:

1. Direct energy conversion : W.R. Corliss
2. Principles of energy conversion : A.W culp(McGraw-Hill International)

3. Energy conversion principles : Begamudre , Rakoshdas

01MES102 ENERGY CONVERSION SYSTEM-II

UNIT-1: ELECTRICAL ENERGY

Importance of Electrical energy in modern industrial society, Generation of electricity using coal, oil, natural gas, nuclear fuels and hydro- its relative advantages and disadvantages(i.e conversion of thermal, nuclear, hydro energy into electric energy).

Electricity generation using renewable energy sources : Basic principles and applications. (Conversion of electromagnetic energy and natural energy sources like solar radiation, wind, ocean waves solid waste to electricity) Conversion of chemical energy into electric energy (fuel cell) Thermal power plant, nuclear power plants and hydroelectric power plant, Transmission and distribution of electricity, Rural electrification program and problems.

UNIT-2: ELECTRIC ENERGY SYSTEMS

Transmission and distribution losses , pilferage, Transformer losses. Electricity Tariff , load management and maximum demand control, power factor improvement and its benefits, selection and location of capacitors etc.

Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance rewinding and motor replacement issues , Energy efficient motors.

Compressed air system: Types of air compressors, compressor efficiency, efficient compressor operations, compressed air system components, capacity assessment, and leakage test, factors affecting the performance.

Fans and blowers: Types, performance evaluation, efficient system operation, flow of control strategies.

UNIT-3 PUMPING AND LIGHTING SYSTEMS

Pumps and pumping systems: Types, performance evaluation, efficient system operation, flow of control strategies, variable speed drives.

Cooling towers: : Types, performance evaluation, efficient system operation, flow of control strategies, assessment of saving opportunities

Lightning systems: Light sources, choices of illumination, luminance requirements, electronic ballast, occupancy sensors, energy efficient lightning control.

Diesel generating systems: Factors affecting selection, energy performance assessment of diesel conservation avenues.

UNIT-4 BIO-ENERGY

Basics of Bio energy conversion: Types of bio- fuels, production process and technologies , bio-fuel applications, Ethanol as a fuel for IC engines, Relevance with Indian economy Bio based materials and chemicals : Commercial and industrial products , bio-mass feed stocks, chemicals, plastics, fibers etc. Govt. policy and status of bio-fuel technologies.

UNIT-5: ENERGY STORAGE

Basics of fusion power, Energy storage technologies, Mechanical storage , Chemical storage and Electrical storage,

BOOKS:

1. Principles of energy conversion : A.W Culp
2. Direct energy conversion : M.A. Kettani
3. Energy conversion systems : Begamudre, Rakoshdas

01MES103 ENERGY INSTRUMENTATION

UNIT-1 : ENERGY AUDIT INSTRUMENTS

Basic measurements- Electrical measurements, illumination , pressure, temperature and heat flux, velocity and flow rate, vibrations etc Instruments used in energy systems: Load & power factor measuring equipments, Wattmeter, flue gas analysis, temperature & thermal loss measurements, air quality analysis Mathematical and statistical modeling and analysis.

UNIT-2 DIGITAL INSTRUMENTS:

Introduction, Basic measurement system, Digital voltage measurements, Frequency measurements, Time measurements, digital Phase meter, Digital multimeter. Digital Displays.

UNIT -3 CONTROL SYSTEMS:

Transducer used for energy related parameter measurements_Various ways conversion and modification of signals_Analog to Digital signal conversion and advantages of digital signal Digital systems for indication and control_Microprocessor introduction and architecture Microprocessors and their use in process control_Data acquisitions systems.

UNIT4: COMPUTERISATION:

Use of computers in energy audit and management Analysis of data using numerical and statistical methods, spread sheets etc Energy optimization using computers, Energy management software and their use in industry Report writing and presentation

UNIT-5 INDUSTRIAL INSTRUMENTS:

Industrial instruments used for power measurements in thermal, Hydro and nuclear power plants & in industrial units Power line carrier principle.

BOOKS:

1. Analysis and design of energy systems- Hogde b.k(Prentice hall-1988)

01MES 201 ENERGY LAB I**PART-A- GENERAL**

1. COP for air conditioning and refrigeration system
2. Study of Heat exchangers
3. Study of variable speed drives
4. COP of cooling towers
5. Efficiency of electrical motors
6. Study of diesel generator sets
7. Measurement of load and power factor for the electrical utilities
8. Determination of efficiency of pumping system
9. Performance evaluation of blowers
10. Performance evaluation of air compressors
11. Determining efficiency of lighting system/loads.

PART-B- COMPUTERS

12. Computer programming
13. Program based on numerical and statistical methods
14. Experiments based on Micro-processors
15. . Experiments based on Energy conservation/management software and their utilization in electrical and mechanical systems

SEMESTER-II**02MES101 RENEWABLE SOURCE OF ENERGY-I****UNIT-1 NEW AND RENEWABLE ENERGY SOURCES:**

Solar, bio-mass, wind, tidal , geothermal ,microhydel etc.- their availability and potential Conversion of solar energy into various form of energy (heat , electricity, mechanical etc.) Geothermal and Tidal Energy : Basic principles , systems used in practice and applications , resource assessment criteria .

UNIT-2 SOLAR THERMAL ENERGY:

Solar thermal devices: Radiation geometry, Various types of solar collectors, Flat plate and Concentrating collectors, their construction, working and applications, hot water and hot air systems, industrial hot water systems, low pressure steam generation , solar dryers, solar

pond , space heating and space conditioning, Design criteria and methodologies for solar thermal applications Solar concentrator and their applications, solar thermal power generation. Use of solar thermal systems with existing systems, economic analysis of solar thermal systems, examples of hybrid systems

UNIT-3 BIOMASS:

Biomass: Generation and Utilization, properties of biomass, Agriculture crop & Forestry residues used as fuels Biochemical and Thermo chemical conversion , combustion, gasification, biomass gasifiers and types etc. Application of gasifiers to thermal power and engines , Biomass as a decentralized power generation source for villages

UNIT-4 BIOGAS :

Importance of bio gas technology, Different type of Bio gas plants Aerobic and anaerobic bio- conversion processes, various substrates used to produce bio gas (cow dung , human and other agricultural wastes, municipal wastes etc.) Individual and community bio gas operated engines and their use.

BOOKS:

1. Renewable energy sources and conversion technology – N.K Bansal, M.K Kaleemann
2. Power generation through renewable source of energy- B.R Pai, M.S. Ramaprasad (Tata McGraw Hill)
3. Solar power Engineering – B.S Magal (Tata McGraw Hill)

02MES102 RENEWABLE SOURCE OF ENERGY-II

UNIT-I: PHOTOVOLTAIC:

Solar photovoltaic conversion: Basic principle of SPV conversion, types of solar cells , fabrication of SPV cells, modules .SPV systems: Different configurations, SPV system components and their characteristics, applications, Hybrid SPV system SPV system designing: Block diagram of general SPV system, load estimation, selection of inverter, battery sizing, array sizing, wiring of SPV system, Battery maintenance and safety precaution Case studies.

UNIT-2: WIND ENERGY

Wind energy conversion technologies , Aerodynamics of wind turbine rotor, Site selection, Wind resource assessment, various models to predict wind pattern and their analysis, concept of wind farms, various aspects of wind turbine design, Hybrid wind energy systems- wind + diesel power, wind + conventional grid, wind + photovoltaic system etc.

UNIT 3: HYDROGEN & FUEL CELL

Hydrogen as a renewable energy source, source of hydrogen , fuel for vehicles. Hydrogen production : Direct electrolysis of water, direct thermal decomposition of water, biological and biochemical methods of hydrogen production. Storage of hydrogen: Gaseous, Cryogenic and Metal hydride. Utilization of hydrogen : Fuel cell- principle of working, construction and applications

UNIT-4: HYDEL AND INTEGRATED ENERGY SYSTEMS

Mini and Microhydel power(MHP) generation : Classification of hydel plants, concepts of microhydel, merits, MHP plants : Components, design and layout, Turbines, efficiency etc Integrated energy systems & their cost benefit analysis.

BOOKS:

1. Renewable source of energy and conversion systems : N.K Bansal and M.K Kleeman
2. Principles of thermal process : Duffie- Beckman
3. Solar energy handbook : Kreith and Kreider (McGraw hill)

02MES103 ENVIRONMENTAL IMPACT OF ENERGY SYSTEMS:

UNIT-1: ENVIRONMENTAL IMPACTS

Environmental degradation due to energy emission and utilization, primary and secondary pollution, air & water pollution , depletion of ozone layer, global warming biological damage due to environmental degradation, types of emissions, correlation between emission and pollution, Methods of Environmental Impact assessment

UNIT-2: POLLUTION : THERMAL PLANTS

Pollution due to thermal power station and its control and systems.

UNIT-3 POLLUTION : NUCLEAR & HYDRO PLANTS

Pollution due to nuclear power generation, radioactive waste and its disposal, Effect of Hydro electric power station on ecology and environment.

UNIT-4 INDUSTRIAL WASTE

Industrial waste, waste and effluent treatment, waste as a source of energy: Industrial, domestic and solid waste as a source of energy, Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control, Air and water pollution controlling technologies.

UNIT-5: GLOBAL ENVIRONMENT

United nations framework convention on climate change(UNFCCC),Protocol, Conference of parties(COP),Clean development Mechanism(CDM), Prototype carbon funds, Carbon credits and its trading, Benefits to developing countries, Building a CDM project.

BOOKS:

1. Management of energy environment system- W.K Foell
2. Environmental impact analysis handbook- J.G Rau, D.C Wood (McGraw Hill)
3. Energy and environment -J.M Fowler (McGraw Hill)

02MES104 ENERGY MANAGEMENT

UNIT-1: GENERAL ASPECTS

Fundamental of energy conservation, Energy Audit and Management, Definition , General principles and types of energy audit, Energy management approach- understanding energy costs, bench marking, energy performance, matching use to requirement , maximizing system efficiencies. Optimizing the energy requirements, fuel and energy substitution. Energy audit instruments.

UNIT-2: PROCEDURES AND TECHNIQUES

Data gathering: Level of responsibilities , energy sources , control of energy and uses of energy- get facts, figures and impression about energy/fuel and system operation , Past and Present operating data, Special tests, Questionnaire for data gathering. Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation. Evaluation of saving opportunities: Determine the saving in Rs., Non- economic factors ,conservation opportunities estimation cost of implementation

UNIT-3: ENERGY POLICY PLANNING AND IMPLEMENTATION

Key elements, force field analysis , Energy policy purpose , perspective , contents, formulation , ratification, organizing- location of energy management , top management support , managerial functions, role and responsibilities of every manager, accountability. Motivating- motivation of employees, Information system designing barriers, strategies, Marketing and communicating training and planning

UNIT-4: ENERGY BALANCE & MIS

First law efficiency and second law efficiency, Facility as an Energy system, methods for preparing process flow, materials and energy balance diagram, identifying losses,

improvements. Energy balance sheet and management information system (MIS) Energy modeling and optimization, Energy analysis Technique for energy optimization.

UNIT-5:ENERGY MONITORING, TARGETING REVIEW AND EVALUATION/ CASE STUDIES

Definition – monitoring and targeting, elements of monitoring and targeting, data and information analysis, techniques- energy consumption, production, commutative sum of difference(CUSUM), review and evaluation.

Case studies- 1- Study of 4 to 6 cases of thermal energy audit and management (boilers, steam system, furnaces, insulation and refractories, refrigeration and air conditioning, co-generation, waste heat recovery etc.)

2- Study of 4 to 6 cases of electrical energy audit and management (power factor improvement, electric motors, compressed air system, pumping systems, fans and blowers, cooling towers industrial/commercial lighting system, diesel based power generation system etc.)

3- Study of energy audit reports for various industries and organization.

BOOKS:

1. Energy management : W.R Murphy, G. Mckay(Butterworths)
2. Energy management principles : C.B.Smith(Pergamon Press)
3. Industrial energy conservation : D.A Reay(Pergamon Press)

02 MES 201 ENERGY LAB-2

Thermal

- 1- Study of solar collector – efficiency V/s delta T/ I
- 2- Study of hot water system.
- 3- Determination of heat loss coefficients in flat plate collector.
- 4- Study of solar hot air collector/ solar dryer.
- 5- Study of solar still.
- 6- Study of vacuum tube collectors.
- 7- Performance evaluation of box type and concentrating type solar cooker.
- 8- Study of heat pipe.

Electrical & Other

- 9- Power Vs load characteristics of SPV system.
- 10- Variation of power output with intensity of solar radiation and load.
- 11- Determination of efficiency of SPV water pump.
- 12- Determination of efficiency of DC/ AC inverter.
- 13- Variation of diesel replacement with load in gasifiers.
- 14- Study of storage battery – charging, discharging characteristics and maintenance.
- 15- Wind power and annual energy estimation from wind data.
- 16- Energy audit of 3 of the following installation :
(1) Workshop

- (2) Ice factory
- (3) Small chemical plant
- (4) Electronic industry
- (5) Printing press.

SEMESTER III

03 MES 101 ENERGY CONSERVATION-I

UNIT-1 : GENERAL ASPECTS

Introduction to energy conservation, approach and modern techniques, benefits and trends. Energy conservation technologies (Thermal energy)- conservation in energy intensive industries. Economic evaluation of energy conservation technologies. Energy conservation in Thermal utilities: Boilers, steam system, Furnaces, Refractories etc.

UNIT-2 : WASTE HEAT RECOVERY

Sources of waste heat and its potential applications, waste heat survey and measurements, Heat recovery equipment and systems, Incinerators, Regenerators and Recuperates ,Waste Heat boilers

UNIT-3: ENERGY STORAGE

Need and importance of Energy storage in conventional and Non- conventional energy systems, Various forms of energy storage : Thermal, Chemical, Mechanical, Electrical and Nuclear energy storage, Energy storage devices and systems, Thermal insulation

UNIT-4 ENERGY CONSERVATIONS IN BUILDINGS

Introduction, Definition and concepts, Heat loss and heat gain and its evaluation, Methods of improving thermal quality, Optimum performance, Thermal comforts in building, Electrical energy conservation, Opportunities techniques for energy conservation in buildings.

UNIT-5 : CASE STUDY : THERMAL ENERGY CONSERVATION

4-6 Case studies of commercial/ Industrial/Residential thermal energy conservation systems and their economic analysis.

BOOKS:

- 1: Energy management W.R Murphy, G.Mckay (Butterworths)
- 2. Energy management principles: C.B Smith(Pergamon Press)

03 MES 102PT ENERGY CONSERVATION-II

UNIT-1 : GENERAL ASPECTS

Energy conservation in Electrical system and Utilities, Economic aspects of energy conservation in electrical systems, Energy conservation in Electrical Utilities : Motors , pumps , fans and blowers, Air conditioning and refrigeration systems, DG sets etc

UNIT-2 : ILLUMINATION

Introduction , illumination requirements, system elements , Day lighting. Illumination system controls, system maintenance , Operating schedules. Psychology of change over , Tips for conservation. Products for energy conservation-in Illumination sources

UNIT-3: ELECTRICAL SYSTEMS

Various techniques for energy conservation in electrical utilities, Power factor improvement, Improvement in Transformer losses , T&D losses etc, Conservation through load management, demand site management(DSM), Devices for energy conservation- Electrical : Energy efficient motors, Automatic cut off timers, Demand monitors etc. Automatic power factor controllers, soft starters with energy savers , variable speed drives, electronic ballast, energy efficient transformers etc

UNIT-4: CASE STUDIES: ELECTRIAL ENERGY CONSERVATION

4-6 Case studies of commercial/ Industrial/Residential thermal energy conservation systems and their economic analysis.

BOOKS:

1. Energy management : W.R Murphy, G. Mckay(Butterworths)
2. Energy Economics- A.V Desai
3. Energy Management Handbook- W.C Turner(John Wiley and Sons, A Wiley-Interscience publication)

03MES-201 SEMINAR

OBJECTIVE:

The students are to select one technical topic related its branch for Seminar. The student is to submit the synopsis for assessment and approval. Progress for preparation of the seminar topic would be continuously assessed from time to time. Two periods per week are to be allotted and students are expected to present the seminar Progress. A faculty guide is to be allotted and he / she will guide and monitor the progress of the student and maintain the attendance.

Students have to give a final presentation for 15 minutes on his topic. Students are encouraged to use various teaching aids such as over head projectors, power point presentation and demonstrative models. This will enable them to gain confidence in facing the placement interviews

03MES-202 DISSERTATION STAGE I

The student will submit a synopsis at the beginning of the semester for the approval from the University project committee in a specified format. Synopsis must be submitted within two weeks. The first defense, for the dissertation work, should be held with in a one month. Dissertation Report must be submitted in a specified format to the University for evaluation purpose.

OBJECTIVE:

The objective of the project work is to enable the students in convenient groups of not more than 3 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution.

The student should select any one of the topics offered from the department or select one on his own duly approved from the department. Candidate is required to submit the detailed synopsis of the work that he would complete in the part-II

Each student shall finally produce a comprehensive report covering back ground information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines.

SEMESTER- IV

04MPS201:

DISSERTATION STAGE-2

The student will submit a synopsis at the beginning of the semester for the approval from the University project committee in a specified format. Synopsis must be submitted within two weeks. The first defense, for the dissertation work, should be held within a one month. Dissertation Report must be submitted in a specified format to the University for evaluation purpose.

OBJECTIVE:

The objective of the project work is to enable the students in convenient groups of not more than 3 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution.

The student should select any one of the topics offered from the department or select one on his own duly approved from the department. Candidate is required to submit the detailed synopsis of the work that he would complete in the part-II

Each student shall finally produce a comprehensive report covering back ground information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines.