DEPARTMENT OF MECHANICAL ENGINEERING
BIRLA INSTITUTE OF TECHNOLOGY
MESRA, RANCHI
Courses of Studies for M.Tech. Programme in Energy Technology

		L	T	P	C
Semester - I					
Theory courses					
TET 1001	Foundation for Energy Engineering	3	0	0	3
TET 1005	Energy Systems Modeling and Analysis	3	1	0	4
TET 1009	Wind Energy Conversion Systems	3	0	0	3
Elective I - Any one					
TET 1003	Non-Conventional Energy	3	0	0	3
TET 1007	Solar Energy Technology	3	0	0	3
TET 1011	Alternative Fuel Technology	3	0	0	3
Breadth Subject – Any one		3	0	0	3
Sessional					
TET 1002	Non-Conventional Energy Laboratory	0	0	3	2
TET 1004	Elective course work	0	0	3	2
					20.00
Semester - II					
TET 2005	Energy Management	3	1	0	4
TET 2003	Waste to Energy	3	0	0	3
TET 2001	Direct Energy Conversion	3	0	0	3
TET 2007	Advanced Energy System	3	0	0	3
Breadth Subject – (Credit 03, Any one)					**03**
Sessional					
TET 2008	Energy Auditing of different Energy system.	0	0	3	2
TET 2014	SPV System Design Course work	0	0	3	2
Semester - III					
Thesis		0	0	0	15
Semester - IV					
Thesis		0	0	0	20
	Total Credits				**75**

TET 1001 Foundation for Energy Engineering

Module 1: Thermodynamics: first law and its application, second law and its application, Irreversibility and energy, basic power generation cycles. (5 periods)

Module 2: Fluid Mechanics: Properties of fluids and constitutive equations; flow through pipes. (5 periods)

Module 3: Heat Transfer: conduction, radiation and convective heat transfer. (6 periods)

Module 4: Introduction to thermal, hydel and nuclear power generation. (5 periods)

Module 5: Network analysis: simple network analysis, power factor improvement. (5 periods)

Module 6: Electrical Machines: Transformer, Induction motor and generators, Synchronous generators. (5 periods)

Module 7: Power systems: Introduction to power generation, transmission and distribution. (5 periods)

Text books:

1. M. W. Zemansky, Heat and Thermodynamics 4th Edn. McGraw Hill, 1968.
2. L. Prasuhn, Fundamentals of Fluid Mechanics, Prentice Hall, 1980
3. S. P. Sukhatme, A Text book on Heat Transfer, Orient Longman, 1979.
4. P. C. Sen, Modern Power Electronics, Wheeler, New Delhi, 1998.
5. N. Balbanian, T. A. Bickart, Electrical network theory, John Wiley, New York, 1969
6. B. L. Theraja, A. K. Theraja, Text-book of electrical technology: in S.I. units: v.2 AC and DC machines, Nirja Construction & development, New Delhi, 1988.
7. Domekundwar, Power Plant Engineering.
8. P.K. Nag, Power Plant Engineering.

TET 1005 Energy Systems Modeling and Analysis

Module 1: Modelling overview-levels of analysis, steps in model development, examples of models. Quantitative Techniques: Interpolation-polynomial, Lagrangian. Curve-fitting, regression analysis, solution of transcendental equations. (5 periods)

Module 2: Systems Simulation-information flow diagram, solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson. (5 periods)

Module 3: Examples of energy systems simulation; Optimisation: Objectives/constraints, problem formulation; Linear programming: simplex algorithm. (5 periods)

Module 4: Primal – Dual relationship; Dual simplex algorithm; sensitivity analysis. (5 periods)

Module 5: Classical optimization theory: unconstrained problems – necessary and sufficient condition; constraint problems – equality constraints, inequality constraints – Karush – Kuhn – Tucker conditions. (5 periods)

Module 6: Deterministic dynamic programming; unconstrained algorithms – direct search method, gradient method; constrained algorithms – separable programming, quadratic programming; case studies of optimization in energy systems problems. (5 periods)

Module 7: Energy- Economy Models: Scenario Generation, Input Output Model; Numerical solution of Differential equations - Overview, Convergence, Accuracy; application oriented examples. (5 periods)

Text books/ Reference books

1. W. F. Stoecker Design of Thermal Systems, Mcgraw Hill, 1981
2. Hamdy Taha, Operations Research – An introduction, 8th edition, Pearson Education, 2009.
3. Hiller and Libbermann, Operations Research, 8th edition, Tata McGraw Hill, 2009.
4. Gerald and Wheatley, Numerical Methods for Scientists and Engineers, 6th edition, Pearson Education, 2007
5. R.de Neufville, Applied Systems Analysis, Mcgraw Hill, International Edition, 1990
6. S.S.Rao Optimisation theory and applications, Wiley Eastern, 1990
7. S.S. Sastry Introductory methods of numerical analysis,Prentice Hall, 6th edition, 2007.

TET 1009 Wind Energy Conversion Systems

Module 1: Wind machine types, classification, parameters. Wind, its structure, statistics, measurements, data presentation, power in the wind. (5 periods)

Module 2: Wind turbine aerodynamics, momentum theories, basic aerodynamics, airfoils and their characteristics, Horizontal Axis Wind Turbine (HAWT) - Blade Element Theory, wake analysis, Vertical Axis Wind Turbine (VAWT) aerodynamics. (5 periods)

Module 3: HAWT rotor design considerations, number of blades, blade profile, 2/3 blades and teetering, coning, power regulation, yaw system, tower. (5 periods)

Module 4: Wind turbine loads, aerodynamic loads in steady operation, wind turbulence, static - dynamic - fatigue analysis, yawed operation and tower shadow, WECS control system, requirements and strategies. (5 periods)

Module 5: Wind Energy Conversion System (WECS): Siting and rotor selection, Annual Energy Output (AEO), Environmental consideration. (5 periods)

Module 6: Synchronous and asynchronous generators; Grid interactive and stand alone systems, storage systems. (5 periods)

Module 7: Testing of WECS. Noise. Miscellaneous topics. (5 periods)

Text 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, NY 1994.
3. Johnson, G.L., Wind Energy Systems, Prentice Hall, 1985.

TET 1003 Non-Conventional Energy

Module 1: Energy Alternatives: Solar, Nuclear, Wind, Tidal, Geothermal & Biomass Energy options. (5 periods)

Module 2: Solar Radiation, availability, measurement and estimation. (5 periods)

Module 3: Solar Thermal Conversion Devices and Storage, Applications. (5 periods)

Module 4: Solar Photovoltaic conversion. (5 periods)

Module 5: Tidal, Ocean thermal and Geothermal Energy Conversion. (5 periods)

Module 6: Wind Energy Conversion, Biomass Energy Conversion. (5 periods)

Module 7: Energy from Waste, Mini/Micro-hydel. (5 periods)

Text Books:

1. S. P. Sukhatme, Solar Energy - Principles of thermal collection and storage, second edition, Tata McGraw-Hill, New Delhi, 1996
2. J. A. Duffie and W. A. Beckman, Solar Engineering of Thermal Processes, second edition, John Wiley, New York, 1991
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Philadelphia, 2000
4. D. D. Hall and R. P. Grover, Biomass Regenerable Energy, John Wiley, New York, 1987.
5. J. Twidell and T. Weir, Renewable Energy Resources, E & F N Spon Ltd, London, 1986.

TET 1007 Solar Energy Technology

Module 1: Fundamentals of Solar Radiation: thermal radiation fundamentals, sun-earth geometric relationship, estimation of terrestrial solar radiation, models based on long term measured horizontal solar radiation, measurement of solar radiation. (5 periods)

Module 2: Methods of solar collection and thermal conversion: radiative properties and characteristics of materials, flat plat and concentrating solar collectors. (5 periods)

Module 3: Thermal Energy Storage and Transport: thermal energy storage and their types, design of storage system, energy transport subsystems. (5 periods)

Module 4: Solar Devices: solar heating systems, solar cooling and dehumidification, passive methods for heating, cooling and daylighting. (5 periods)

Module 5: Photovoltaics: semiconductors, analysis of photovoltaic cells, manufacture of solar cells and panels, design for Grid interactive and stand alone photovoltaic applications.(5 periods)

Module 6: Solar photochemical applications: photocatalytic reactions, solar reactors, kinetic models, catalyst development, system design methodology, commercial/industrial applications. (5 periods)

Module 7: Capturing solar energy through biomass: biomass feedback, thermodynamic calculations for biomass energy, conversion of biomass to gaseous and liquid fuels and electricity, overview of solar economics. (5 periods)

Text books:

1. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Sec. Ed.2000.
2. G. Rai, Non-Conventional Energy Sources, Khanna Publishers.

TET 1011 Alternative Fuel Technology

Module 1:
Alternative Fuels: Depletion of fossil fuel and potential, Alternative fuels, Alcohols, Hydrogen, Non-edible vegetable oils, Biogas, producer gas, Blast furnace gas and water gas. (5 Lectures)

Module 2:
Methods of production, properties of alternative fuels, organic substances with high calorific value and the possibility of their use as fuels, raw materials. (5 Lectures)

Module 3:
Fermentation System, Gasification of wood, Gasification and shift Conversion, Biogas, Fuel properties of biogas, utilization of biogas. (5 Lectures)

Module 4:
Biomass as a source of energy, methods of obtaining energy from biomass, thermal gasification of biomass, chemistry of gasification process. (5 Lectures)

Module 5:
Hydrogen, eco-friendly hydrogen as source of energy, production of hydrogen – electrolysis, thermo-chemical method, other methods, Storage of hydrogen gas, liquid and solid modes, transportation of hydrogen and its utilization, applications. (6 Lectures)

Module 6:
Recycling and recovery of waste energy, its potential applications, waste energy recovery systems, technological improvement. Case Study. (4 Lectures)

Module 7:
Impact of alternative fuel utilization on the environment, Decarbonization of fossil fuel by CO_2 capture. Generation of hydrogen from fossile fuels with simultaneous CO_2 sequestration. (5 Lectures)

Text Books:

1. J. Twidell and T. Weir, Renewable Energy Resources, E & FN Spon Ltd., London, 1986.
2. Fuels from Waste by Larry L, Anderson & David A.
3. Hydrogen Energy System, T. Ohta, Pergamon Press.
4. I.C. Engine & Gas Turbine –V Ganesan.
5. Energy from Solid Waste by Frederick R. Jackson.

TET 2005 Energy Management

Module 1: Energy needs and past & future estimates of energy demands; Resource base and reserves; global distribution and energy content of proven reserves; Industrial and commercial energy sources and use pattern changes with technological changes; representation of energy consumption through pie chart, Sankey diagram and load profile. Technology for improved recovery and utilization of energy and materials. (5 Periods)

Module 2: Objectives and salient features of national energy policy/strategy; essential steps in energy planning; Needs, objectives and significance of energy management; design of effective energy management program, role of energy manager and typical organization set up for energy management program and starting of an energy management program. (5 Periods)

Module 3: Energy accounting and Energy utilization index; Energy conservation, Principles, energy conservation schemes and its various aspects, Salient features of energy conservation act; Energy audit, energy audit classification, phases of energy audit and its beneficial effects. Preparation of audit report. (5 Periods)

Module 4: Load management (supply and demand side management), power factor; Economics of power generation and Tariff; Economic analysis and life cycle costing of energy projects for cost-effectiveness; energy payback period. (5 Periods)

Module 5: Common energy management opportunities in lighting systems; Heating, ventilation and refrigeration system; combustion processes; steam generation and distribution system; thermal insulation; energy systems maintenance; Process energy management and renewable energy systems management. (5 Periods)

Module 6: Energy analysis and thermodynamics, energy cost of fuel and materials, methods of energy analysis, energy analysis of real industrial system. Transportation system and energy requirement of production system. Energy and exergy analysis. (5 Periods)

Module 7: Recovery of waste energy and its potential applications, waste heat recovery systems and its optimal utilization, Technological improvement and increased efficiency. (5 Periods)

Text books:

1. W. R. Murphy and G. McKay, Energy Management, Butterworths London.
2. Paul O'Callaghan, Energy Management, McGraw Hill Book Ompany.
3. I.G.C.Dryden, Butterworths, The Efficient Use of Energy, London.
4. W.C.Turner, Wiley, Energy Management Handbook, New York.

TET 2003 Waste to Energy

Module 1: Introduction to energy from waste: characterisation and classification of waste as fuel – agrobased, forest residues, industrial waste, Municipal solid waste. (5 periods)

Module 2: Waste to energy options: combustion (unprocessed and processed fuel), gasification, anaerobic digestion, fermentation, pyrolysis. (5 periods)

Module 3: Conversion devices: combustors (Spreader Stokes, Moving grate type, fluidized bed), gasifier, digesters. (5 periods)

Module 4: Briqueting technology: Production of RDF and briquetted fuel. (5 periods)

Module 5: Properties of fuels derived from waste to energy technology: Producer gas, Biogas, Ethanol and Briquettes, Comparison of properties with conventional fuels. (5 periods)

Module 6: Power generation using waste to energy technologies: Reciprocating Engines and Gas Turbines. (5 periods)

Module 7: Landfills: Gas generation and collection in land fills, Introduction to transfer stations. (5 periods)

Text Books:

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.

TET 2001 Direct Energy Conversion

Module 1: Energy conversion process, indirect and direct energy conversion. (4 periods)

Module 2: Preview of semiconductor physics: Basic ideas of quantum physics, Fermi Energy, band diagram, Intrinsic and extrinsic semiconductors, p-n junction. (6 periods)

Module 3: Introduction to irreversible thermodynamics. (4 periods)

Module 4: Thermoelectric conversion: thermoelectric effects, analysis of thermoelectric generators and coolers, figure of merit, device configuration. (5 periods)

Module 5: Photovoltaic conversion: Optical effects of p-n junction, design and analysis of PV cells. PV cell fabrication, System design. (5 periods)

Module 6: Thermionic conversion: thermionic effects, analysis of converters, application of heat pipes. Magnetohydrodynamic conversion: gaseous conductors, analysis of MHD generators. (6 periods)

Module 7: Batteries and fuel cell: Thermodynamic analysis, design and analysis of batteries and fuel cells. Other modes of direct energy conversion. (5 periods)

Text Books:

1. Kettani, M.A., Direct energy conversion, Addison-Wesley, Reading, Mass, 1970
2. Angrist S.W. ,Direct Energy Conversion. 4th Ed. Allyn And Bacon, Boston, 1982
3. Green M.A. ,Solar Cells, Prentice-Hall, Englewood Cliffs, 1982
4. Hand book Batteries and Fuel Cells. Linden, McGraw Hill, 1984.

TET 2007 Advanced Energy Systems

Module 1: Total energy system for industry, Integrated gasification combined cycle plant, combined cycle power plant with cogeneration, fuels for combined cycle power plants. (5 periods)

Module 2: Advanced energy storage systems – Mechanical energy storage, chemical energy storage, Electromagnetic energy storage, electrostatic energy storage, Thermal energy storage and biological storage. (5 periods)

Module 3: Hydrogen Energy – Properties of hydrogen; hydrogen production – Thermo-chemical methods, Electrolysis of water, thermolysis of water and biophotolysis; Storage of hydrogen, delivery, conversion, applications and safety issues, present status. (5 periods)

Module 4: Clean Coal technologies – Coal washing, gasification etc., application of coal gas in heat engines and gas turbines, Pressurized fluidized bed combustion. Coal bed methane. (5 periods)

Module 5: Fuel Cell – Principles, classification of fuel cells, working of different types of fuel cells, fuels for fuel cells, Development stages and relative performances of various fuel cells, efficincy, V-I Characteristics of fuel cell, fuel cell power plant, environmental effects. (5 periods)

Module 6: Natural gas cycles, Integrated power generation. Cogeneration principles. (4 periods)

Module 7: Energy conservation in Power plants – energy conservation opportunities in power plants, economic and environmental aspects of energy conservation in power plants, economic load sharing of power plants, waste heat utilization. (6 periods)

Text Books:

1. M.M. EL-Halwagi, Biogas Technology- Transfer and diffusion, Elsevier Applied science Publisher, New York, 1984.
2. D.O Hall and R.P. Overeed, Biomass – regenerable energy, John Willy and Sons Ltd. New York. 1987.
3. D. Y. Goswami, F. Kreith and J. F. Kreider, Principles of Solar Engineering, Taylor and Francis, Sec. Ed.2000.
4. G. Rai, Non-Conventional Energy Sources, Khanna Publishers.
1. Fuel Cells, by W. Vielstich, translated by D. J. G. Ives, Willey Interscience, 1965.
2. Microbial Fuel Cells, by B. E. Logan, John Willey & Sons, 2008.
3. I. Boustead and G. F. Hancock, Handbook of Industrial Energy Analysis, Ellis Horwood Ltd., A division of John Wiley and Sons, 1979.