

ENERGY DEPARTMENT

M.TECH. GREEN TECHNOLOGY

**Course of Study & Scheme of Examination
2016-17**



**Maulana Azad National Institute of Technology,
Bhopal**

SCHEME**M.Tech. in Green Technology*****First Semester***

Course Number	Subject	Scheme of Studies Periods per week			Credits
		L	T	P	
GT511	Advance Mathematics	3	-	-	3
GT512	Small Hydro Power Development	3	-	-	3
GT513	Energy from waste	3	-	-	3
	Elective – 1	3	-	-	3
	Elective - 2	3	-	-	3
	Open elective-1	3	-	-	3
GT514	Environment Laboratory	-	-	2	2
GT515	Seminar-I & Mini Project	-	2	-	2
Total credit 22					

Second Semester

Course Number	Subject	Scheme of Studies Periods per week			Total Credits
		L	T	P	
GT521	Environment Policy & Planning	3	-	-	3
GT522	Green Buildings	3	-	-	3
GT523	Carbon Sequestration & Sustainable Development	3	-	-	3
	Elective - 3	3	-	-	3
	Elective - 4	3	-	-	3
	Open elective-2	3	-	-	3
GT524	Bio-Energy Laboratory	-	-	2	2
GT525	Seminar-II & Mini Project	-	2	-	2
Total credit 22					

Electives are common for both the courses (M.Tech. Green Technology & M.Tech. Renewable Energy)

DEPARTMENTAL ELECTIVES

S.No	CODE	SUBJECT
1.	RE/GT532	Energy Storage Technology
2.	RE/GT 533	Super Critical Technology
3.	RE/GT 534	Geothermal & Ocean Energy
4.	RE/GT 535	Energy policy and planning
5.	RE/GT 536	Power Conversion Techniques
6.	RE/GT 537	Hydrogen Energy and Fuel cell
7.	RE/GT 538	Environment and Ecology
8.	RE/GT 539	Solid Waste Management
9.	RE/GT 540	Cogeneration

OPEN ELECTIVES

S.No	CODE	SUBJECT
1.	RE/GT 551	Energy Modeling and Simulation
2.	RE/GT 552	Integrated Energy Systems
3.	RE/GT 553	Energy Efficient Materials
4.	RE/GT 554	Pollution Control Technology
5.	RE/GT 555	Fuel Efficient IC Engines

SYLLABUS

M.Tech. GREEN TECHNOLOGY

Course Objective: Green Technologies is a highly interdisciplinary degree program that emphasizes green systems and the environment, energy technology and efficiency, and sustainability and society.

GT 511ADVANCE MATHEMATICS

Mathematical modeling: introduction, development of models, model evaluation, modeling approaches: Analytical, deterministic, Stochastic and numerical. High speed computing and error analysis. Interpolation. Numerical differentiation and integration. Statistical techniques: Sampling design and theory .sampling distributions, common probability functions, confidence intervals, tolerance limits .hypothesis testing, Curve fitting: correlation and regression analysis, regression analysis of non-linear models.

Fundamentals of simulation.

Reference books:

1. Numerical Methods for Scientific & Engg. Computation Jain, Iyenge and Jain
2. Numerical Methods for Mathematics, Science and Engineering John H Mathews
3. Applied Numerical Analysis CF Gerld and PO Wheatley
4. Fundamentals of Applied Statistics S.C. Gupta and V. K. Kapoor,
5. Numerical methods for Engineers Chapra, S.C. and Canale, R.P. Tata McGraw Hill, New Delhi.
6. Advanced Engineering Mathematics. Kreyszig, E. John Wiley & Sons, India
7. Introductory Probability and Statistical Applications. Meyer, P.L. (1970). Oxford & IBH Publishing Co. Ltd, New Delhi.

GT 512 SMALL HYDRO POWER DEVELOPMENT

Overview of micro mini and small hydro, Site selection and civil works, Penstocks and turbines, Speed and voltage regulation, Estimation of available power, Investment issues, load management and tariff collection, Wind and hydro based stand-alone / hybrid power systems.

Reference books:

1. Micro-Hydro Design Manual: A Guide to Small-Scale Water Power Schemes by Adam Harvey, Andy Brown and Priyantha Hettiarachi.

GT 553 ENERGY FROM WASTE

Waste as a Renewable Energy Source, Waste-to-Energy Conversion: Thermochemical Conversion, Biochemical Conversion, Physico-chemical Conversion, Factors affecting Energy Recovery from waste, Agricultural Residues, Animal Waste, Industrial Wastes, Forestry Residues, Municipal Solid Waste (MSW), Converting Waste Heat to Electricity, Bio energy as by product of waste processing, Environmental significance, Introduction to anaerobic digestion, Process fundamentals and design considerations, Process analysis and reactor configurations, Methane production, Energy assessment, Bio-methanation from sludge digestion, Types of reactors

Reference books:

1. Handbook of Solid Waste Management and Waste Minimization Technologies by Nicholas P. Cheremisinoff.
2. Solid Waste Engineering by P. Aarne Vesilind, William A. Worrell and Debra R. Reinhart.

GT 514 Environment Laboratory

1. Solar resource assessment using simulation software
2. Wind resource assessment using simulation software
3. Simulation of Green Building
4. Study of various phase change materials for energy storage , charging and discharging characteristics of batteries, ultra capacitors and super capacitors
5. Characterization of Biomass briquettes and pellets
6. Ambient Air quality monitoring and dust concentration
7. Performance evaluation of Evacuated Solar collector.
8. Biodiesel production from various non edible seeds and it's characteristics.
9. Performance evaluation of Solar Power plant.

GT 521 ENVIRONMENT POLICY AND PLANNING

Concepts of Environmental Planning, History of Environmental Planning, Development of habitat patterns, settlement structure and form in response to environmental challenges. • Concepts of Ecology and Ecosystem • Resource analysis for various ecosystems and development imperatives (land, geology, soil, climate, water, vegetation) characteristics, exploitation, causative factors for degradation, analytical techniques. • Urban Ecosystem. • Environmental Zones (Hill, coastal, arid, characteristics, resources, settlements pattern, problems and potentials, regulating mechanisms for development. • Environmental Policies and initiatives including policies, strategies, protocols, treaties and agreements

GT 522 GREEN BUILDINGS

Need of energy in buildings. Role of building design and building services to evaluate the energy performance in buildings. Study of Climate and its influence in building design for energy requirement, Principles of energy conscious design of buildings, Building Envelope, Orientation, Building Configuration, Passive Cooling, Basic Principles of Day-lighting, Embodied Energy of Building Materials, design guidelines, Commercial Buildings, Industrial buildings, Residential buildings, integration of emerging technologies. Study of Thermal environment and visual environment. Energy rating of buildings and case studies.

Reference Books:

1. Energy Efficient building in India by Mili Majumdar
2. Handbook on Energy Conscious Buildings by J.K. Nayak & J.A. Prajapati

GT 523 CARBON SEQUESTRATION AND SUSTAINABLE DEVELOPMENT

Greenhouse emissions .Climate Change: Causes and effects .Diagnostics and baseline determination, Climate change Mitigation and adaptation strategy. Risk assessments & mitigation. Carbon accounting, Carbon Market .Carbon capture and storage .Potential Carbon sequestration (forest sinks), Oceanic, Terrestrial, Biological, geological. Clean Coal Technology,IGCC,Coal blending and gasification.Precombustion and Post Combustion Capture .Energy efficiency opportunities, Kyoto Protocol and Clean development Mechanism ,CDM project activities in Industries; Emission benchmarks; Governments policies for mitigation and adaptation. Technology Perspective: Strategies for technology innovation and transformation.National Action Plan on Climate Change .Carbon credits. Case studies.

Reference Books:

1. Carbon Capture and storage: R&D Technology for Sustainable Energy future By Malti Goel
2. IPCC (Intergovernmental for Climate Change). Climate Change: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change

GT 524 BIOENERGY LABORATORY

1. Study of various water quality parameters of available water resources
2. Combustion efficiency evaluation of Improved Biomass cooks stoves
3. Experiment on Artificial photosynthesis
4. Experiments on various natural dyes/pigments and their characterization
5. Experiment on Biomass dryer.
6. Determination of Calorific value of Biomass sample using Automatic calorimeter
7. Determination of Moisture content of Biomass sample using Hot air oven
8. Determination of Ash content of Biomass sample using muffle furnace
9. Experiment on Microbial and plant fuel cell.

DEPARTMENTAL ELECTIVES

GT 532 ENERGY STORAGE TECHNOLOGY

Introduction, Need of Energy storage, Different modes of energy storage, Technology Types– Mechanical energy storage: flywheels, compressed air, and pumped hydro; Electrical and Magnetic Energy storage: Batteries, Capacitors, electromagnets, Chemical energy storage. Basics of Sensible heat storage, Stratified storage, Rock bed storage, Thermal storage in buildings, Earthstorage, Aquifers storage. Basics of Latent heat storage, Phase change materials (PCM), Stefan problem. Brief description of the technologies and the differences between them; State-of-the-art – Past demonstrations, existing hurdles and performance targets for commercialization;

Reference books:

1. Energy Storage Science & Technology by Pendse
2. Energy Storage by Mullick and Garg

GT 533 SUPER CRITICAL TECHNOLOGY

Introduction to super critical technology, history, advantages, environmental impact
Interpretation of phase diagrams in supercritical fluids, equipment and safety issues,
fundamentals about solubility of small molecules, and fundamentals and applications of
extraction, chromatography, polymer processing, particle formation processes, reactions and
biocatalysis. supercritical steam generator. Supercritical technology in thermal power plants.

Reference books:

- 1 Introduction to Supercritical Fluids by Richard Smith, Hiroshi Inomata & Cor Peters
2. Supercritical Fluids and Organometallic Compounds by Can Erk

GT 534 GEO THERMAL AND OCEAN ENERGY

Introduction of Geothermal Energy, Geothermal resources; definition and classification, Hydrothermal system, Hot dry rock systems, Geopressured reservoirs, Magma energy, Dry rock and hot aquifer analysis Utilization of geothermal resources, Direct utilization; Swimming bathing & balneology, space conditioning, district heating, Geothermal heat pump; basic concept of heat pump, air conditioner, heating and cooling mode in heat pump, Heat pump with geothermal resources; typical GHP loop configuration Ocean Thermal: Introduction, OTEC history and technology progress, working principle, resources & site requirement

Reference books:

1. Renewable Energy Resources: basic principle & application by Tiwari and Ghosal.
2. Renewable Energy Sources by Boyle

GT 535 ENERGY POLICY & PLANNING

Energy and Environment Basic Issues: Criteria for Economic Growth; Energy-Economy-Environment Linkages; Emissions Inventories: Assessment and Policy Relevance. Issues for Developing Countries: Energy and Environment Policies from Urban and Rural perspectives. Analysis Methodologies: Scenarios and Models, Global and Local Environmental Issues: Climate Change Negotiations Technological Options: Energy-Efficiency and New Energy Technologies; Renewable Energy: Issues, Prospects and Policies.

Reference books :

1. Energy Economic by Parag Diwan
2. Energy Sources & Policies in India by Rishi Muni Dwivedi

GT 536 POWER CONVERSION TECHNIQUES

Introduction to power electronic devices: SCRs, Triacs, GTOs, Power-MOSFETS, IGBT and other devices. Typical gate and triggering circuits, Opto-couplers. Converters: A.C. to D.C. convertors- single phase & three phase. Commutation circuits, Choppers- types and application Inverters: single phase and three phase bridge inverters. Voltage control, frequency control, PWM inverter. Application of power controller in grid connected and stand alone renewable energy systems

Books:

1. Power Electronics by PS Bhimbra
2. Power Electronics by MD Singh

GT 537 HYDROGEN ENERGY & FUEL CELL

Hydrogen Energy – introduction and application, General introduction to infrastructure requirement for hydrogen production, storage, dispensing & utilization. Electrochemical: Electrolysis, Photo electro chemical. Biological: Photo Biological, Anaerobic Digestion Fermentative Micro- organisms. Physics and chemical properties: General storage methods, compressed storage, Glass micro sphere storage, Zeolites, Metal hydride storage, chemical hydride storage and cryogenic storage. Overview of hydrogen utilization: I.C. Engines, gas turbines, hydrogen burners, power plant, Principles of fuel cells, types of fuel cells, fuels for fuel cells, low, medium and high temperature fuel cells, power generation by fuel cells, applications of fuel cells, future potential of fuel cells.

Reference books:

1. Hydrogen and Fuel Cells by Sorensen, B.
2. The Hydrogen Economy Opportunities and Challenges by Michael Ball and Martin Wietschel.

GT 538 ENVIRONMENT AND ECOLOGY

Origin of the earth. Earth's temperature and atmosphere. Sun as a source of energy, nature of its radiation. Biological processes, photosynthesis. Food chains Marine ecosystem. Ecosystem theories. Autecology, sources of energy, classification, quality and concentration of an energy source, characteristics temperature. Environmental degradation, primary and secondary pollutants. Thermal and radioactive pollution, air and water pollution. Micro climatic effects of pollution. Pollution abatement methods. Global initiatives Kyoto Protocol, Clean development mechanism case studies.

Reference books:

1. Energy and the Environment by Robert A. Ristinen and Jack J. Kraushaav
2. Energy Ecology and the Environment by Richard Wilson and William J. Jones.

GT 539 SOLID WASTE MANAGEMENT

Introducing Municipal Solid Waste Management; Overview process of collection, transport, processing, recycling or disposal, managing and monitoring of waste materials. Waste Generation and characterization, Aspects ; Waste Collection, Storage and Transport Waste Disposal ; Waste Processing Techniques ; Source Reduction, Product Recovery and Recycling Recovery of Biological Conversion Products: Compost and Biogas, Incineration pyrolysis and Energy Recovery ; Hazardous Waste: Management and Treatment; landfill designs

Reference Books:

1. Diaz, L.F., G.M. Savage, L.L. Eggerth, and C.G. Golueke, *Composting and Recycling Municipal Solid Waste*, Lewis Publishers, Ann Arbor, Michigan, USA, 1993.
2. George Tchobanoglous; Integrated Solid Waste management ,McGraw-Hill Publishers,1993

GT 540 COGENERATION

The concept of cogeneration, main design parameters for cogeneration, cogeneration alternatives, Bottoming and topping cycles, Steam turbine plants, Gas turbine plant, Diesel and gas engine plants, Thermodynamic evaluation, Combined cycle applications, Sterling engine, Industry / utility cogeneration, Trigeration, Techno economic and Environ-mental aspects, Cogeneration in sugar, textile, paper and steel industry.

Reference Books:

1. Energy Cogeneration Hand Book for Central Plant Design by George Polimeros.
2. Power Plant Technology by M.M.El- Wakil.

OPEN ELECTIVES

GT 551 ENERGY MODELING AND SIMULATION

Energy Models. Surveys, Steady-State Computer Models, Dynamic Models: advantages and disadvantages, Interdependence of energy-economy-environment; Modeling concept, and application. Network analysis: PERT, CPM, Gantt Chart. Quantitative methods. Basic concept of econometrics and statistical analysis, Two variable regression model, The multiple regression model, Tests of regression coefficients and regression equation, Forecasting Techniques : Moving Average, Method of Least squares, Parabolic trend. Analysis of Variance: ANOVA (one way & two way). usage of MATLAB .Econometric techniques used for energy analysis with case studies. Input-output analysis, Energy multiplier and implication of energy multiplier for analysis of regional and national energy policy.

Reference Books:

1. Energy Planning and Economics by A.V. Desai.
2. Energy Policy Analysis and Modeling by Munasinghe M. and P. Meier.

GT 552 INTEGRATED ENERGY SYSTEMS

System Aspects of Integration: voltage effects, thermal effects, fault level. Islanding. Stand Alone Systems: Network voltage and system efficiency, Case studies of standalone system. Hybrid Energy Systems and its economic evaluation. Mathematical modeling of Integrated Energy Systems. Technological aspects of power electronic systems connection to the grid. Hybrid and integrated energy systems, Total energy concept and waste heat utilization, Energy modeling to optimize different systems.

Reference books:

1. Renewable Energy Sources for fuels and Electricity by Laurie Barrtom.
2. Wind-Diesel Systems by R. Hunter and G. Elliot, Cambridge University Press.

GT 553 ENERGY EFFICIENT MATERIALS

Need of Alternative materials, Green Materials, Biomaterials, Natural and synthetic Polymers ., Photovoltaic (PV) thin films for solar cells; Organic Solar Cells; dye sensitized solar cells; Thermo photovoltaic (TPV) devices Fuel cells, The role of the fuel in the operation, performance and degradation of fuel cells; Membrane electrode assemblies for polymer electrolyte membrane fuel cells; Developments in membranes, catalysts and novel cathode and anode materials; Membranes, adsorbent materials and solvent-based materials for syngas and hydrogen production fuel cells , Batteries, Ultra capacitor; Super capacitors. Thermoelectrics, Novel illumination sources for efficient lighting, Energy saving in buildings. Materials and techniques for energy harvesting; Lithium batteries: Current technologies and future trends. Thermoelectric materials for conversion of heat to electricity. Materials issues for future nuclear energy; Radiation damage, recovery mechanisms, and creep-rupture, modeling and theoretical aspects

Reference

1. Materials for Renewable and Sustainable Energy(Springer)

GT 554 POLLUTION CONTROL TECHNOLOGIES

Classification of Pollution and Pollutants, Causes, Effects and Sources of Pollution air pollution: primary and secondary pollutants, automobile pollution, industrial pollution, ambient air quality standards, meteorological aspects of air pollution---temperature lapse rates and water pollution: point and non-point source of pollution, major pollutants of water, water quality requirement for different uses, global water crisis issues. marine and nuclear pollution: misuse of international water for dumping of hazardous waste, coastal pollution due to land/soil pollution: Effects of urbanization on land degradation, Impact of Modern Agriculture on Soil, Effect on Environment and Life sustenance, Abatement measures.

Reference Books:

1. Text book of Environmental Science and Technology by Dr. M. Anji Reddy.
2. Environmental Science- Towards a sustainable future by Richard T. Wright.

GT 555 FUEL EFFICIENT IC ENGINES

Working of I.C. Engines, Combustion in IC Engines; Engine parameters affecting combustion, Homogeneous Charge Compression Ignition Engine, Ultra Lean Burn Engines, Fuel Injection in SI Engines, Multi valve engines, Variable valve timing. Direct and Indirect injection systems, Combustion chambers, Turbo charging, Formation and control of NOX , HC/CO and Particulate emissions, Alternative fuels; Combustion and Emission Characteristics of SI and CI Engines using alternate fuels.

Reference books:

1. John B Heywood, "Internal Combustion Engine Fundamentals", Tata McGraw-Hill 1988
2. Gupta H.N, "Fundamentals of Internal Combustion Engines" ,Prentice Hall of India, 2006