SYLLABUS

2025-2026

M. Tech. (Energy Science & Technology)

(AICTE Approved and MNRE Supported)

Department of Applied Sciences and Humanities
Faculty of Engineering & Technology
Jamia Millia Islamia
New Delhi-110025

Brief About the Program

Modern civilization is completely dependent on power and energy to move ahead. Every single electrical device that we use in our daily life, as well as the production of such machines, is not able to function without power. Initially, coal was the main fuel of the eighteenth and nineteenth centuries. However, the birth of electricity, automobiles and airplanes saw oil, which is termed as a fossil fuel, comes into the picture as the dominant fuel in the twentieth century. Till now, the main contributors in power generation have been fossil fuels like oil and natural gas, coal, and nuclear resources, accounting for 86.2%. Other energy resources like hydro, solar, wind, geothermal, and wood have contributed an infinitesimal 0.9% of global energy production. In the last few years, world energy consumption has increased. This results in raising the price of oil from about $15 a barrel to above $100 a barrel, which has made everybody start thinking about the possibility of alternative energies. On the other hand, burning fossil fuels causes environmental degradation. The planet is getting hotter day by day. The ice on the mountains is melting and the existence of the planet is getting into a danger zone. The time has come to think about these serious issues in our country also and we may need dedicated manpower for both academics as well as energy-based industries to carry out research and development as well as to work as the experts in the commercial units in the energy sector. To fulfill the future demands of the experts in the energy sector, we have stared Master of Technology program in the field of Energy Science & Technology. The aim of **M. Tech. in Energy Science & Technology** is to provide advanced understanding of energy production, conversion, utilization, and conservation from conventional as well as non-conventional sources with the special emphasis on Renewable Energy. The focus is being drawn on economic, environmental and policy impact of sustainable energy practice so that the students will develop the research and communication abilities to be effective leaders in the energy industry.

Program Education Objectives (PEOs):

The objectives of the M. Tech. program (Energy Science & Technology) are to empower and enable students to develop advanced knowledge and skills in order to become leaders and managers in the energy sector. Specifically,

- ✓ Students will have a solid understanding of the sciences and technology related to energy production, conversion, utilization, and conservation.
- ✓ Students will understand the economic, environmental and policy impact of a sustainable energy practice for a sustainable society.
- ✓ Student will learn basic to advanced aspects of Renewable Energy systems and to be prepared for paradigm shift from fossil fuels to renewable sources.
- ✓ Students will develop their research and communication abilities to be effective leaders in the energy industry.
- ✓ To provide students with an academic environment aware of excellence, leadership, ethical codes and guidelines and the life-long learning needed for a successful professional career.

Programme Specific Outcomes (PSO):

On successful completion of the programme,

- ✓ Graduates will demonstrate knowledge of the sciences and technology related to energy production, conversion, utilization, and conservation.
- ✓ Graduates will demonstrate the understanding of economic, environmental and policy impact of a sustainable energy practice for a sustainable society.
- ✓ Graduate will demonstrate the knowledge of basic to advanced aspects of Renewable Energy systems and to be prepared for paradigm shift from fossil fuels to renewable sources.
- ✓ Graduates will demonstrate an ability to develop the research and communication abilities to be the effective leaders in the energy industry.
- ✓ Graduate will develop confidence for self-education and ability for life-long learning.

Programme Outcomes (POs):

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems**.**
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues, and the consequent responsibilities relevant to professional engineering practice.
7. **Environment and sustainability:** Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and

write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Total Intake: 18

COURSE STRUCTURE

M. Tech. (Energy Science & Technology)

Semester-I

S.NO.	Paper	PAPERTITLE	CREDIT	PERIOD PERWEEK			DISTRIBUTION OFMARKS			TOTAL
				L	T	P	MID SEMESTEREVALUATION		ENDSEMESTER EXAM	
							CWS	MST		
FIRSTSEMESTER										
Course Subject										
01	MEST-101	Fundamentals of Energy Science	4	3	1	-	-	40	60	100
02	MEST -102	Nanotechnology Concepts and Applications	4	3	1	-	-	40	60	100
03	MEST -103	Energy Resources: Concepts and Technologies	4	3	1	-	-	40	60	100
04	MEST -104	Energy Economics and Energy Policy	4	3	1	-	-	40	60	100
05	MEST -105	Data Driven Energy Systems	4	3	1	-	-	40	60	100
06	MEST -108	Seminar	4	4	-	-		40	60	100
Practical										
07	MEST -109	Energy Sc .& Tech. Lab-I	2	-	-	4	-	20	30	50
	Elective Subject(anyone)									
08	MEST -106	Hybrid electric vehicles and charging stations	4	3	1	-	-	40	60	100
09	MEST -107	Energy Management Systems	4	3	1	-	-	40	60	100
TOTALCREDITS			**30**	**TOTALMARKS**						**750**

Semester-II

S.NO.	Paper	PAPERTITLE	CREDIT	PERIOD PER WEEK			DISTRIBUTION OFMARKS			TOTAL
				L	T	P	MID SEMESTEREVALUATION		ENDSEM ESTEREXAM	
							CWS	MST		
SECONDSEMESTER										
THEORY										
01	MEST -201	Energy Storage Systems	4	3	1	-	-	40	60	100
02	MEST -202	Wind Energy: Resource, Engineering & Projects	4	3	1	-	-	40	60	100
03	MEST -203	Energy Audit	4	3	1	-	-	40	60	100
04	MEST -204	Solar Photovoltaic Technology	4	3	1	-	-	40	60	100
05	MEST -205	Concepts and Design of Green Building	4	3	1	-	-	40	60	100
06	MEST -208	Seminar	4	4	-	-	-	40	60	100
Practical										
07	MEST -209	Energy Sc. &Tech. Lab-II	2	-	-	4	-	20	30	50
	Elective Course(anyone)									
08	MEST -206	Hydrogen Generation and Storage	4	3	1	-	-	40	60	100
09	MEST -207	Advanced Energy Materials	4	3	1	-	-	40	60	100
TOTAL CREDITS			**30**	**TOTALMARKS**						**750**

Semester-III

S.NO.	Paper	PAPERTITLE	CREDIT	PERIOD PERWEEK			DISTRIBUTION OFMARKS			TOTAL
				L	T	P	MIDSEMESTEREVALUATION		ENDSEMESTEREXAM	
							CWS	MST		
THIRDSEMESTER										
Course on MOOC (opt any two courses of 4 credits or four course of 2 credits)										
01	MEST-301	DataScienceforEngineers https://onlinecourses.nptel.ac.in/noc23_cs97/preview	2	2	-	-	-	-	50	50
02	MEST-302	Introduction To Machine Learning https://onlinecourses.nptel.ac.in/noc23_cs87/preview	2	2	-	-	-	-	50	50
03	MEST-303	FundamentalsOfArtificialIntelligence https://onlinecourses.nptel.ac.in/noc23_ge40/preview	4	3	1	-	-	-	100	100
04	MEST-304	UnderstandingIncubationandEntrepreneurship https://onlinecourses.nptel.ac.in/noc23_de16/preview	3	2	1	-	-	-	100	100
05	MEST-305	Introduction to Embedded System Design https://onlinecourses.nptel.ac.in/noc20_ee98/preview	4	3	1	-	-	-	100	100
06	MEST-306	Power Electronics https://onlinecourses.nptel.ac.in/noc19_ee37/preview	4	3	1	-	-	-	100	100
08	MEST-308	Design, Technology and Innovation https://onlinecourses.nptel.ac.in/noc24_de14/preview	2	2	-	-	-	-	100	100
09	MEST-309	Design of Photovoltaic Systems https://onlinecourses.nptel.ac.in/noc24_ee109/preview	4	3	1	-	-	-	100	100
10	MEST-310	AdvancedMaterialsandProcesses https://onlinecourses.nptel.ac.in/noc19_mm13/preview	4	3	1	-	-	-	100	100
11	MEST-311	SmartGrid:BasicstoAdvancedTechnologies https://onlinecourses.nptel.ac.in/noc24_ee148/preview	4	3	1	-	-	-	100	100

12	MEST-312	Energy Conservation and Waste HeatRecovery https://onlinecourses.nptel.ac.in/noc20_mm20/preview	4	3	1	-	-	-	100	100
13	MEST-313	SustainableEnergyTechnology https://onlinecourses.nptel.ac.in/noc23_me138/preview	4	3	1	-	-	-	100	100
14	MEST-314	SustainablePowerGenerationSystems https://onlinecourses.nptel.ac.in/noc23_ge47/preview	4	3	1	-	-	-	100	100
15	MEST-315	Technologies for Clean and RenewableEnergyProduction https://onlinecourses.nptel.ac.in/noc19_ch26/preview	2	2	-	-	-	-	50	50
16	MEST-316	Energy Conversion Technologies(Biomassand Coal) https://onlinecourses.nptel.ac.in/noc23_ ch76/preview	2	2	-	-	-	-	50	50
17	MEST-317	Dc Microgrid and Control System https://onlinecourses.nptel.ac.in/noc20_ee84/preview	2	2	-	-	-	-	50	50
18	MEST-318	SustainableHappiness https://onlinecourses.nptel.ac.in/noc24_hs102/preview	2	2	-	-	-	-	50	50
19.	MEST-319	Architectural Approaches to Decarbonization of Buildings https://onlinecourses.nptel.ac.in/noc24_ar21/preview	4	3	1	-	-	-	100	100
MinorProject										
13	MEST-320	MinorProject(Dissertation)	4	4	-	-	-	40	60	100
TOTALCREDITS			**12**	**TOTALMARKS**						**300**

Semester-IV

S. NO.	Paper	PAPER TITLE	CREDIT	PERIOD PER WEEK			DISTRIBUTION OF MARKS			TOTAL
				L	T	P	MID SEMESTER EVALUATION		END SEMESTER EXAM	
							CWS	MST		
FOURTH SEMESTER										
Major Project										
01	MEST -401	Major Project (Dissertation)	12	-	-	-	-	120	180	300
TOTAL CREDITS			**12**	**TOTAL MARKS**						**300**

Semester	**Ist**	**IInd**	**IIIrd**	**IVth**	**Grand Total**
Total no. of Credits	30	30	12	12	84
Total no. of marks	750	750	300	300	2100

M. Tech. (Energy Science& Technology)

Semester-I

Core Subjects:

MEST-101:Fundamentalsof Energy Sciences

MEST -102: Nanotechnology Concepts and Applications

MEST -103: Energy Resources: Concepts and Technologies

MEST -104: Energy Economics and Energy Policy

MEST -105: Data Driven Energy Systems

MEST -108: Seminar

MEST -109: Energy Sc. & Tech. Lab-I

Elective Subjects:

MEST -106: Hybrid electric vehicles and charging stations.

MEST -107: Energy Management Systems

Course Structure

Semester-I

S.NO.	Paper	PAPERTITLE	CREDIT	PERIOD PERWEEK			DISTRIBUTION OFMARKS			TOTAL
				L	T	P	MID SEMESTEREVALUATION		ENDSEMESTER EXAM	
							CWS	MST		
FIRSTSEMESTER										
Course Subject										
01	MEST-101	Fundamentals of Energy Science	4	3	1	-	-	40	60	100
02	MEST -102	Nanotechnology Concepts and Applications	4	3	1	-	-	40	60	100
03	MEST -103	Energy Resources : Concepts and Technologies	4	3	1	-	-	40	60	100
04	MEST -104	Energy Economics and Energy Policy	4	3	1	-	-	40	60	100
05	MEST -105	Data Driven Energy Systems	4	3	1	-	-	40	60	100
06	MEST -108	Seminar	4	4	-	-		40	60	100
Practical										
07	MEST -109	Energy Sc .& Tech. Lab-I	2	-	-	4	-	20	30	50
	Elective Subject(anyone)									
08	MEST -106	Hybrid electric vehicles and charging stations	4	3	1	-	-	40	60	100
09	MEST -107	Energy Management Systems	4	3	1	-	-	40	60	100
TOTALCREDITS			**30**	**TOTALMARKS**						**750**

MEST-101	Fundamental of Energy Science

L	T	P	C
3	1	0	4

Course Objectives:

1. To introduce the fundamental concepts of energy resources and conversion.
2. To provide the knowledge of the basics of solar energy conversion.
3. To learn energy conservation concepts and techniques.
4. To provide an understanding of energy conservation concepts.
5. To study the impact of energy on the environment.

Course Outcomes:

1. Concept of energy resources and their classification.
2. Basic concepts of different energy conversion processes.
3. Fundamental concepts of solar energy conversion.
4. Concept of energy conservation.
5. Understanding of ecology and environment, and effect of energy conversion on the environment

Unit-1 **06Lectures**

Conventional and Non-Conventional Energy, Sources of Conventional and Non-Conventional energy, Historical, economic and Environmental Perspective, Need of Non-conventional Energy Sources, Types of Conventional and Non-conventional Energy Sources, Introduction to different energy conversion processes.

Unit-2 **08 Lectures**

Energy and development, Units and measurements, Solar spectrum – Electromagnetic spectrum. Energy balance of the earth, solar constant for earth, specialty and potential – Sun – Earth – Solar Radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications. Measurement of solar radiation – Pyranometer, Pyrheliometer, Sunshine recorder. Solar time - Local apparent time (LAT), equation of time (E), Solar radiation geometry - Earth-Sun angles – Solar angles. Calculation of angle of incidence - Surface facing due south, horizontal, inclined surface and vertical surface. Solar day length – Sun path diagram – Shadow determination. Estimation of Sunshine hours at different places in India. Calculation of total solar radiation on horizontal and tilted surfaces. Prediction of solar radiation availability, Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking.

Unit-3 **08 Lectures**

Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell, Fundamentals of solar cell, Types of solar cells, Different generations of solar cells, I-V characteristics of solar cell, maximum power point, cell efficiency, fill factor, effect of irradiation and temperature, PV module and its specifications; Basic concepts of solar thermal: Solar thermal Energy conversion, Solar

Passive Heating and Cooling, Solar Liquid and Air Heating Systems, Solar Cooling and Dehumidification.

Unit-4 **08Lectures**

Introduction to Energy conservation, Approach and modem techniques, Benefits, Trend, Energy conservation technology (Thermal Energy), Energy conservation in Energy Intensive Industries, collection, Limitation and heat and its potential applications, Waste heat survey and measurements Data collection, Limitation and heat affecting factors Heat recovery equipment and systems, Heat Exchangers, Incinerators Regenerators and Recuperates.

Unit-5 **10 Lectures**

Origin of the earth; Earth's temperature and atmosphere; Sun as the source of energy, biological processes; photosynthesis; food chains; Energy sources, Overview of world energy scenario, Fossil fuel reserves - estimates, duration, overview of India's energy scenario

Ecosystems, ecosystem theories; energy flow in the ecosystems; biodiversity.

Impact of Energy on Environment, Environment Degradation due to Energy, Control of pollution from Energy.

Reference Books:

1. The Science of Energy, Roger G Newton, World Scientific
2. Energy Recourses and Systems (Volume 1), Tushar Ghosh, Mark Prelas, Springer.
3. Energy Technology, O. P. Gupta, Khanna Publishing
4. Diamant R.M.E., "Total Energy", Pergamon, Oxford, 1970.
5. ArchieW.Culp, "Principles of Energy Conversion", McGraw-Hill Inc., Singapore, 1991.
6. Goswami D.Y., Kreider, J. F. and Francis., "Principles of Solar Engineering', Taylor and Francis, 2000.
7. Chetan Singh Solanki, "Solar Photovoltatics – Fundamentals, Technologies and Applications", PHI Learning Private limited, 2011.
8. Effective Thermodynamic Methods in Fluid Mechanics and Heat & Mass Transfer, by Henri Soumerai, Outskirts Press, 2012

MEST-102	Nanotechnology: Concepts and Applications

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the fundamentals and basics of nanotechnology.
2. To provide the knowledge of the basics and properties of semiconductor nanostructures.
3. To know the concepts, types, and properties of carbon nanotubes.
4. To provide an understanding of the multidisciplinary applications of nanotechnology.
5. To study the applications of nanomaterials for energy systems and devices.

Course Outcomes: Upon completion of this course, the students shall be able to understand.

1. Fundamentals and basics of nanotechnology.
2. Basics and properties of semiconductor nanostructures.
3. Concepts, types, and properties of carbon nanotubes.
4. Multidisciplinary applications of nanotechnology.
5. Applications of nanomaterials for energy systems and devices.

Unit-1 **08 Lectures**

Introduction to Nanotechnology

Historical Background of Nanotechnology, Quantum phenomena, Size effect, electronic confinement in 1D,2D and 3D structures, Nanomaterials, Molecular Nanotechnology, Top-down and Bottom-up approaches, Green Nanotechnology, Applications of Nanotechnology.

Unit-2 **08 Lectures**

Semiconducting Nanostructures

Metal oxide nanostructures: Background, Synthesis, Properties and Applications
Nano chalcogenides: Background, Synthesis, Properties and Applications
Organic Semiconductor Nanostructures: Background, Synthesis, Properties and Applications

Unit-3 **10 Lectures**

Carbon Nanomaterials

Introduction to Carbon allotropes and Carbon nanomaterials Fullerenes: Background, Synthesis, Properties and Applications CNTs (SWNTs and MWCNTs,): Background, Synthesis, Properties and Applications Nano-diamonds: Background, Synthesis, Properties and Applications Graphene: Background, Synthesis, Properties and Applications Carbon Nano-fibers and Carbon nano-yarns: Background, Synthesis, Properties and Applications

Unit-4 **08 Lectures**

Nanotechnology: A Multidisciplinary Approach

Nanobiotechnology; Introduction and applications, Nanomedicine; Introduction and applications. Nanotechnology for clean environment, Nanorobotics; future of robotics and applications, Nanotechnology in water desalination technologies.

Unit-5 **06 Lectures**

Nanomaterials for Energy Applications

Introduction, Nanomaterials for Photovoltaic Devices, Nanomaterials for Energy Storage Devices, Nanomaterials for Thermo-electric Devices, Nanomaterials for Hydrogen Storage, Nanogenerators

References:

1. A Handbook of Nanotechnology, U. Kumar, AGROBIOS
2. Springer Handbook of Nanotechnology, B. Bhooshan, Springer
3. Advances in Nanomaterials, Zishan Husain Khan & M. Husain, Springer
4. Recent Trends in Nanomaterials: Synthesis and Properties (Advanced Structured Materials), Zishan Husain Khan, Springer
5. Nanomaterials and Their Applications, Zishan Husain Khan, Springer
6. Charles P Poole Jr., and Frank J. Ownes, Introduction to Nanotechnology,John Wiley Sons, Inc., 2003
7. H. S. Nalwa (Ed.), "Encyclopedia of Nanoscience & Nanotechnology", American Scientific Publishers, California, 2004.
8. Garcia-Martinez J., ed. “Nanotechnology for Energy Challenge”, Wiley-VCH, Weinheim, 2010.
9. Hari Singh Nalwa, “Nanomaterials for Energy Storage Applications”, Nanomax Technologies, USA , 2009.
10. Li Quan (Ed.), “Nanomaterials for Sustainable Energy”, ISBN 978-3-319-32023-6, Springer Publications, 2016.
11. Tsakalakos L., “Nanotechnology for Photovoltaics”, CRC, 2010.
12. Vayssieres L., “On Solar Hydrogen and Nanotechnology’, Wiley, 2009.

MEST-103	Energy Resources; Concepts and Technologies

L	T	P	C
3	1	0	4

Course Objectives:

1. To provide a deep knowledge of hydro-power plants.
2. To know the concepts, types, and design of thermal power plants.
3. To provide a deep knowledge of solar photovoltaics.
4. To know the concepts, types, and design of solar thermal systems.
5. To study the concepts of tidal and ocean energy.

Course Outcomes: Upon completion of this course, the students shall be able to learn about them.

1. Concepts, working of hydro-power plants.
2. Concepts, types, and design of thermal power plants.
3. Concepts and technologies of solar photovoltaics.
4. Concepts, types, and design of solar thermal system.
5. Concepts and working of wind turbines.

Unit-1 **08 Lectures**

Hydro Power Generation

Types of hydropower plants and schemes, hydrology: runoff studies, flood estimation studies, assessment of hydropower potential of a basin, storage and pondage, load studies, elements of hydropower plants and their hydraulic design: dams, intakes, conveyance system, types of power house, hydraulic turbines and pumps, Components and design of hydraulic turbines, Standardization and selection of turbine, Components and design of hydraulic Pumps, Hydropower scenario; Global and Indian perspective, Policies, Environmental concerns, Sub classification of Hydropower projects, Conceptualization, Techno-commercial studies, Investigation & Planning, Design Principles, Project Management, Operational issues, Test cases of Hydropower Projects.

Unit-2 **08 Lectures**

Thermal Power Generation

Types of thermal power turbines, Gas turbines; Open and closed cycles, constant pressure and constant volume cycles, cycles with inter cooling, reheating and heat exchanger, compressor and turbine efficiencies, pressure losses, performance characteristics of various cycles, practical problems. Jet Propulsion: Calculation of thrust, Power, speed and efficiency, turbo - jet and turbo propulsion systems. Compressors, Combustion Systems, Steam turbines; Principle and working, type of turbines, stage to blade, speed ratio for optimum efficiency, diagram efficiency, steam s performance. Energy losses in steam turbine, turbine performance at various loads and governing of steam turbines. Constructional details and description of steam turbine, Thermal power scenario; Global and Indian perspective, Policies, Environmental concerns, Sub classification, Techno-commercial studies, Investigation & Planning, Design Principles, Project Management, Operational issues, Test cases

Unit-3 **08 Lectures**

Solar Photovoltaic Systems

Classification of PV systems and components - Central Power Station System, Distributed PV System, Stand alone PV system, Grid Interactive PV System, small system for consumer applications, Hybrid solar PV system, Concentrator solar photovoltaic. System components - PV arrays, inverters, batteries, charge controls, net power meters. PV array installation, operation, costs, reliability. Designs of solar PV systems and cost estimation. Case study of design of solar PV lantern, stand-alone PV system - Home lighting and other appliances, solar water pumping systems. Building-integrated photovoltaic units, solar cars, aircraft, space solar power satellites. Socio-economic and environmental merits of photovoltaic systems.

Unit-4 **08 Lectures**

Solar Thermal Systems

Solar thermal power plants - Solar thermal electric power plants based on parabolic trough, solar central receiver, parabolic dish-Stirling engine. Concentrated solar power using Fresnel lenses. Fundamentals of design calculations and analysis of solar power plants. Economic analysis, Design of solar water heating system and layout, Power generation – Solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio, Solar cooking – Performance and testing of solar cookers. Seawater desalination – Methods, solar still and performance calculations. Solar pond - Solar greenhouse.

Unit-5 **08 Lectures**

Tidal and Ocean Thermal Energy Conversion Systems

Introduction to Tidal Power Plants; single basin and two basis plants, Variation in generation level; Electricity generation from Waves: Shoreline and Floating wave systems, Factors affecting the suitability of the site for tidal power plant, Classification of tidal Power Plants, Working and Design of Different Tidal Power Plants, Advantages and disadvantages of Tidal Power Plants, Components of Tidal Power plants.

Ocean Thermal Energy Conversion (OTEC): concept, working principle and classification; OTEC power plant, Open loop and closed loop OTEC systems, advantages, disadvantages and applications.

.

Reference Books:

1. Handbook of Hydroelectric Engineering, P. S. Nigam, Nem Chand & Bros., Roorkee
2. Electricity generation using wind power, William Shepard & Li Zhang, World Scientific Singapore
3. Thermal Engineering, P. L. Ballany, Khanna Publishers
4. Solar Energy, by S P Sukhatme& J K Nayak, Mc Graw Hill Publishers
5. Non-Conventional Energy Resources, B. H. Khan, Mc Graw Hill Publishers
6. Yogi Goswami .D, Frank Kreith, Jan F. Kreider, “Principles of Solar Engineering”, Second Edition, Taylor & Francis, 2003.
7. Kalogirou .S.A., “Solar Energy Engineering: Processes and Systems”, Academic Press, 2009. 2. Vogel. W,Kalb .H, “Large-Scale Solar Thermal Power Technologies”, WileyVCH, 2010.
8. Sukhatme .S.P, Nayak .J.K, “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
9. G. N. Tiwari, Solar Energy, Narosa Publishing House
10. Martin A Green, “Solar cells: Operating principles, technology and system applications”, Prentice Hall Inc, Englewood Cliffs, NJ, USA, 1981.
11. Twidell.J and T. Weir, “Renewable Energy Resources”, E & F N Spon Ltd, London, 1986.

MEST-103	Energy Economics and Energy Policy

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the global scenario of energy and its impact on GDP.
2. To provide the knowledge of Indian energy scenario,consumption, and supply.
3. To know about the global and national energy policies.
4. To provide an understanding of energy policy planning.
5. To study the economics of energy.

Course Outcomes: Upon completion of this course, the students shall be able to learn about the;

1. Global scenario of energy and its impact on GDP.
2. Indian energy scenario; consumption and supply.
3. Global and national energy policies.
4. Energy policy planning.
5. Economics of energy.

Unit-1 **08 Lectures**

Global Energy Scenario

Role of energy in economic development and social transformation: Energy & GDP, GNP and its dynamics, Energy Consumption in various sectors and its changing pattern, Energy Security: Chemical and Nuclear: Non-Proliferation, Energy Security, Energy Consumption and its impact on environmental climatic change, International Energy Policies of G-8 Countries, G-20 Countries, OPEC Countries, EU Countries. International Energy Treaties (Rio, Montreal, Kyoto), INDO-US Nuclear Deal.

Unit-2 **08 Lectures**

Indian Energy Scenario

Sector wise energy consumption in India, Impact of Energy on Economy, Energy and Environmental policies, Status of Nuclear and Renewable Energy: Present Status and future promise Energy Policy Issues: Fossil Fuels, Renewable Energy, Power sector reforms, restructuring of energy supply sector, energy strategy for future. Energy Conservation Act-2001 & its features, Electricity Act-2003 & its features. Framework of Central Electricity Authority (CEA), Central & States Electricity Regulatory Commissions (CERC & ERCs)

Unit-3 **08 Lectures**

Energy Policy

Global Energy Issues, National & State Level Energy Issues, National & State Energy Policy, Industrial Energy Policy, Energy Security, Energy Vision, Energy Pricing & Impact of Global Variations, Energy Productivity (National & Sector wise productivity).

Unit-4 **08 Lectures**

Energy Policy Planning

Key Elements of Energy Policy Planning: Force Field Analysis, Energy Policy-Purpose, Perspective, Contents and Formulation, Implementation of Energy Policy: Location of Energy Manager, Top Management Support, Managerial functions, Role and responsibilities of Energy Manager,

Accountability, Motivation of employees, Requirements for Energy Action Planning, Information Systems: Designing, Barriers, Strategies, Marketing and Communicating Training and Planning.

Unit-5 **08 Lectures**

Energy Economics

Energy economics: Basic concepts, energy data, energy cost, energy balance, Energy accounting framework; Economic theory of demand, production and cost market structure; National energy map of India, Energy subsidy – National and international perspectives, Concepts of economic attributes involving renewable energy, Application of econometrics; input and output optimization; energy planning and forecasting different methods, Concepts of economic attributes involving renewable energy, Application of econometrics; input and output optimization; energy planning and forecasting different methods.

Reference Books:

1. Energy Economics, Concepts, Issues, Markets and Governance, Subhes C. Bhattacharyya, Springer
2. Energy Economics, Peter M. Schwarz, CRC Press
3. Energy Law and Policy, NawneetVibhaw, Lexis Nexis
4. Energy Economics A.V.Desai (Wieley Eastern)
5. Energy for a sustainable world: Jose Goldenberg, Thomas Johansson, A.K.N.Reddy, Robert Williams (Wiley Eastern).
6. Energy policy for :B.V.Desai (Weiley Eastern),
7. Modeling approach to long term demand and energy implication :J.K.Parikh.
8. Energy Policy and Planning :B.Bukhootsow.
9. TEDDY Year Book Published by Tata Energy Research Institute (TERI),
10. World Energy Resources : Charles E. Brown, Springer2002.
11. ‘International Energy Outlook’ EIA annual Publication
12. Heat and Thermodynamics – M.W. Zemansky (McGraw Hill Publication)
13. Principles of Energy Conversion: A.W. Culp (McGraw Hill International edition.)
14. BEE Reference book: no.1/2/3/4.
15. Fuel Economy Handbook, NIFES

MEST-105	Data-Driven Energy Systems

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand digitalization and energy transformation.
2. To provide a deep knowledge of energy network modeling and analytics.
3. To provide an understanding of the concepts of data analytics for integrated energy system.
4. To know the concepts and technologies of AI-Enhanced Data Mining in Energy Systems.
5. To study the cyber threat management in energy systems.

Course Outcomes: Upon completion of this course, the students shall be able to understand.

1. Concepts of digitalization and energy transformation.
2. About the energy network modeling and analytics.
3. Concepts of data analytics for integrated energy system.
4. Concepts and technologies of AI-Enhanced Data Mining in Energy Systems.
5. Cyber threat management in energy systems.

Unit-1 **08 Lectures**

Introduction to Digitalization and Energy Transformation

Concepts of digitalization and energy transformation, Historical perspective and drivers of the energy sector's digital transformation, smart technologies used in the energy sector, Applications of IoT, sensors, and data analytics in energy systems, Smart Cities, Digital Twins and Their Applications, Transactive Energy and Its Impact on Energy Markets, Blockchain Technology in the Energy Sector, Data Ownership Challenges, Legal and ethical aspects of data ownership.

Unit 2 **08 Lectures**

Energy Network Modeling and Analytics

Computational Methods and Power System Simulation, Numerical simulation tools and their applications, simulation types and methods, solver settings, coupling of different energy domains, uncertainty and sensitivity analysis in energy systems, modeling approaches and methods, network models, smart grid planning.

Unit 3 **08 Lectures**

Data Analytics for Integrated Energy System

Decision Support in Energy Systems, Influencing factors, Capacity Planning and Decision-Making Methods, Optimal Scheduling, Principles of modeling battery systems to support the grid, Model Parameter Variations, Decision Support Tools and Software, Sustainability Considerations and its Futuristic Outlooks.

Unit 4 **08 Lectures**

AI-Enhanced Data Mining in Energy Systems

Machine Learning Basics, Energy Forecasting with Regression, Dynamic Security Assessment with Classification and Decision Trees, Identification of customer types using k-means clustering, Anomaly

Detection using Auto-Encoders, Surrogate Modeling for Energy Optimization, Learning control actions with reinforcement learning.

Unit 5 **08 Lectures**

Cyber Threat Management in Energy Systems

Cybersecurity in Digital Energy Systems, IT-OT Network Organization in the Power Grid, Digital Substation Operations and Security, Communication Protocols, Cyber Threats and Mitigation, Blockchain in Mitigating IoT-Based Cyber Attacks, The Digital Grid Evolution.

References

1. Anthony M. Townsend, Smart Cities – Big Data, Civic Hackers, and the Quest for a New Utopia, W. W. Norton & Company (2013).
2. Antonio Gomez-Exposito, Antonio J. Conejo, Claudio Canizares, "Electric Energy Systems: Analysis and Operation", CRC (2016).
3. Vivek D. Bhise, "Decision-Making in Energy Systems", CRC (2021).
4. Andrew Ng, "Machine Learning Yearning", deeplearning.ai (2018).
5. Tyson Macaulay, Bryan L. Singer, "Cybersecurity for Industrial Control Systems: SCADA, DCS, PLC, HMI, and SIS", Auerbach Publications (2012).

MEST-106	Hybrid Electric Vehicles and Charging Stations (Elective)

L	T	P	C
3	1	0	4

Course Objectives:

1. To study the basics and introduction of electric vehicles.
2. To study components of electric vehicles.
3. To study plug-in hybrid electric vehicles
4. To study the concept of charging stations
5. To study integrations of subsystems.

Course Outcomes: Upon completion of this course, the students shall be able to learn about the.

1. Basics of electrical vehicles
2. Components of electric vehicles.
3. Plug-in hybrid electric vehicles
4. The concept of charging stations
5. Integration of subsystems.

Unit-1 **08 Lectures**

Introduction to Electric Vehicles

Fundamentals of the EV, Types of Electric Vehicles, Hybrid Electric Vehicles, Plug-In Hybrid Electric Vehicle (PHEV), Fuel Cell Vehicles (FCVs). HEV Fundamentals: Introduction, Vehicle Model, Vehicle performance, EV Power-train Component Sizing, Series Hybrid Vehicle, Parallel Hybrid Vehicle, Wheel Slip Dynamics.

Unit-2 **08 Lectures**

Components of Electric Vehicles

Electric Machines and Drives in HEVs: Introduction, BLDC motors, Induction Motor Drives, Permanent Magnet Motor Drives, Switched Reluctance Motors, Doubly Salient Permanent Magnet Machines, Design and Sizing of Traction Motors, Thermal Analysis and Modelling of Traction Motors.

Unit-3 **08 Lectures**

Plug-in Hybrid Electric Vehicles

Plug-in Hybrid Electric Vehicles: Introduction to PHEVs, PHEV Architectures, Equivalent Electric Range of Blended PHEVs, Fuel Economy of PHEVs, Power Management of PHEVs, Component Sizing of EREVs, Component Sizing of Blended PHEVs, Vehicle-to-Grid Technology, Power Electronics in HEVs: Power electronics including switching, AC-DC, DC-AC conversion, electronic devices, and circuits used for control and distribution of electric power, Thermal Management of HEV Power Electronics.

Unit-4 **08 Lectures**

Charging Stations

Need and modelling of charging stations. Batteries, Ultra capacitor, Fuel Cells, and Controls: Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.

Unit-5 **08 Lectures**

Integration of Subsystems

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems, Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicle, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy strategies.

Reference Books

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003
2. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004
3. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
4. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015
5. M. Ehsani, Y. Gao, S. E. Gay, and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
6. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016

MEST-107	Energy Management Systems (Elective)

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the definition and concept of energy efficiency.
2. To provide the knowledge of Indian transmission and distribution systems.
3. To study the SCADA and smart grids.
4. To provide an understanding of power and energy inter-change.
5. To study different regulatory frameworks for Indian power systems.

Course Outcomes: Upon completion of this course, the students shall be able to understand.

1. Definition and concept of energy efficiency.
2. Indian transmission and distribution systems.
3. SCADA and smart grids.
4. Power and energy interchange.
5. Different regulatory frameworks for Indian power systems.

Unit-1 **08 Lectures**

Energy Efficiency

Energy Efficiency, Energy Efficient Buildings, Green Buildings, Intelligent Buildings, Energy Conservation Opportunities in Public and Private Buildings Various Energy Efficiency Rating Systems for Buildings- LEEDS, BEE & GRIHA Rating Systems, Energy Conservation Building Code Energy Conservation Act 2001, Revisions and Present State of Implementation Standardization &Labelling, Electricity Act 2003, Revisions and Present Status of Implementation Energy Efficiency Projects, Evaluation of Energy Efficient Projects, Various ways of Financing Energy Efficiency Projects, Role of Financial Institutions and Corporate Banks, Deferred Payment Financing,

Unit-2 **06 Lectures**

Indian Transmission and Distribution Systems

Energy Demand and Utilization; Introduction and Historical Demand, Understanding Current Demand, Energy Markets, Energy and the rebound Effect, Residential Energy, Commercial Energy, Transportation. Architectures, Transmission and distribution systems Planning in India-Strategies, Planning Criteria: Philosophy and General Guidelines, T&D Losses, Power Factor Improvement, Harmonics and its improvement, Transformer Loss Reduction, Tr. Parallel Operation.

Unit-3 **10 Lectures**

SCADA and Smart Grid

Types of Supervisory Systems, Uses of SCADA, SCADA Hierarchy, Components of SCADA System, SCADA Functions, National Grid, Regional Grid, Energy Management System Function, Distribution Automation, Intelligent Electronics Devices (IEDs), Phasor Measurement Units (PMUs). Smart Grid Concept, components, characteristics, and technologies; AMI, Demand Side Management (DSM), Demand Response etc.

Unit-4 **08 Lectures**

Interchange of Power and Energy

Interchange of power and energy, economy interchange between interconnected utilities. Interchange evaluation. capacity interchange, Diversity Interchange, Energy Banking, Emergency Power Interchange, Power pools, Energy Broker System, transmission effects and issues; Transfer limitations, Wheeling, Calculation of Rates for transmission services in multiple utilities transactions.

Unit-5 **08 Lectures**

Regulatory Framework for Indian Power Systems Management and Control

Restructuring and Deregulations of Electric Utilities, Indian Electricity Act; Guidelines and their impact, Traditional Central Utility Model, Reform Motivations, Separation of Ownership and Operation, Central Dispatch versus Market Solution, Independent System Operator (ISO). Wholesale Electricity Market Characteristics: Central Auction, Bidding, Market Clearing and Pricing, Bilateral Trading, Scheduling, Gaming, Ancillary. Maximalist ISO, Minimalist ISO Model. Trading Arrangements: The Pool, Pool and Bilateral Trades, Multilateral Trades, Congestion Management in Open-access Transmission Systems,

Reference Books:

1. Power generation Operation & Control, Allen J. Wood and Bruce Woollenberg, John Wiley
2. Mini S. Thomas and John Douglas McDonald, “Power System SCADA and Smart Grids” CRC Press-2015.
3.]Clark W. Gellings, “The Smart Grid: Enabling Energy Efficiency and Demand Response”, CRC Press-2009.
4. Loi Lai Lai, “Power Systems Restructuring and Deregulation-Trading , Performance and Information Technologies”, John Wiley and Sons Ltd.
5. Krieder J. and Rabi A., “Heating and Cooling of buildings : Design for Efficiency”, Mc Graw Hill, 1994.
6. UrsalaEicker, “Solar Technologies for buildings”, Wiley publications, 2003.
7. Guide book for National Certification Examination for EnergyManagers and Energy Auditors (Could be downloaded from www.energymanagertraining.com
8. Energy Management: W.R.Murphy, G.Mckay (Butterworths).
9. Energy Management Principles: TEDDY year book published by TERI.
10. The Watt Committee on Energy (Reports).Energy Management Workbook

MEST-109	Energy Science & Technology Lab.-I

L	T	P	C
3	1	0	4

Course Objectives:

1. To study the properties of semiconductor materials.
2. To study the characteristics of semiconductor devices.
3. To study the solar cell characteristics.
4. To study the energy generation from wind turbines.
5. To study the energy generation from biomass/biofuel.

List of Experiments

1. To calculate the Hall co-efficient (R_H), type of majority charge carriers and number of charge carriers per unit volume (n) in a sample material.
2. By using Four probe method calculate the resistivity of semiconductors.
3. Using PN junction kit, observe the variation of current with voltage and plot the I-V characteristics of PN junction diode at room temperature.
4. To determine the value of Planck's constant 'h' by using a photocell.
5. To determine the Planck's constant by using LED.
6. To study the I-V characteristics of Zener diode and calculate the breakdown voltage of Zener diode.
7. Using solar cell kit, plot the I-V characteristics of solar cell and determine the efficiency of solar cell.
8. Using solar cell kit, study the current and voltage for different parallel and series combination of cells.
9. Using Wind Energy Kit, study the generation of energy from the given wind turbine.
10. Using Bio Energy Kit, study the generation of energy from the given biomass/biofuel.

M. Tech. (Energy Science & Technology)

Semester-II

Core Subjects:

MEST-201:	Energy Storage Systems
MEST -202:	Wind Energy: Resource, Engineering & Projects
MEST -203:	Energy Audit
MEST -204:	Solar Photovoltaic Technology
MEST -205:	Concepts and Design of Green Building
MEST -208:	Seminar
MEST -209:	Energy Sc. & Tech. Lab-II

Elective Subjects:

MEST -206:	Hydrogen Generation and Storage
MEST -207:	Advanced Energy Materials

M. Tech. (Energy Science& Technology)

Semester-II

S.NO.	Paper	PAPERTITLE	CREDIT	PERIOD PER WEEK			DISTRIBUTION OFMARKS			TOTAL
				L	T	P	MID SEMESTEREVALUATION		ENDSEMESTEREXAM	
							CWS	MST		
SECONDSEMESTER										
THEORY										
01	MEST -201	Energy Storage Systems	4	3	1	-	-	40	60	100
02	MEST -202	Wind Energy: Resource, Engineering & Projects	4	3	1	-	-	40	60	100
03	MEST -203	Energy Audit	4	3	1	-	-	40	60	100
04	MEST -204	Solar Photovoltaic Technology	4	3	1	-	-	40	60	100
05	MEST -205	Concepts and Design of Green Building	4	3	1	-	-	40	60	100
06	MEST -208	Seminar	4	4	-	-	-	40	60	100
Practical										
07	MEST -209	Energy Sc. &Tech. Lab-II	2	-	-	4	-	20	30	50
	Elective Course(anyone)									
08	MEST -206	Hydrogen Generation and Storage	4	3	1	-	-	40	60	100
09	MEST -207	Advanced Energy Materials	4	3	1	-	-	40	60	100
TOTAL CREDITS			**30**	**TOTALMARKS**						**750**

MEST-201	Energy Storage Systems

L	T	P	C
3	1	0	4

Course Objectives:

1. To study the basics of energy storage systems.
2. To study the concept and design of electrochemical batteries.
3. To study the concept and design of supercapacitor.
4. To study the concepts of fuel cells.
5. Other Emerging Energy Storage Techniques.

Course Outcomes: Upon completion of this course, the students shall be able to learn about them.

1. Basics of energy storage systems.
2. Concept and design of electrochemical batteries.
3. Concept and design of supercapacitor.
4. Basics of Fuel Cell
5. Other Emerging Energy Storage Techniques.

Unit-1 **08 Lectures**

Introduction

Importance and need of energy storage, modes of energy storage, Energy transmission methods, Electrical energy characteristics and basic load calculations, Performance characteristics of energy storage systems, Types of load curves, energy shift, Ragone plot. Importance of energy density and power density, Transmission Congestion - Demand for Portable Energy, Demand and scale requirements, Environmental and sustainability issues. Introduction to different energy storage mechanisms.

Unit-2 **08 Lectures**

Rechargeable Batteries

Primary and secondary batteries, battery potential, charge figure of merit, energy and power in battery, polarization losses, thermodynamics of battery materials, tortuosity and porosity of battery materials, reversible and irreversible interfacial reactions, battery architecture and design guidelines, Lead–acid battery, Nickel–cadmium battery (NiCd), Nickel–metal hydride battery (NiMH), Lithium-ion battery, Lithium-ion polymer battery.Energy density, power density, price, and market.Battery Management systems and System Performance.

Unit-3 **08 Lectures**

Super Capacitors

Basic components of supercapacitors like types of electrodes like high surface area activated carbons, metal oxide and conducting polymers, aqueous and organic electrolytes. The disadvantages and advantages of supercapacitors over battery systems and their applications in aspects of energy density, power density, price and market.

Unit-4 **10 Lectures**

Concepts of Fuel Cell

Introduction – working and types of fuel cell – low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells – thermodynamics and electrochemical kinetics of fuel cells, Fuel cell performance characteristics,

Unit-5 **06 Lectures**

Other Emerging Energy Storage Techniques

Superconducting Magnetic Energy Storage, Hybrid Energy Storage Systems and Flow Batteries Applications: Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.

Reference Books:

1. Detlef Stolten,"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", Wiley, 2010.
2. Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "Electrochemical Technologies for Energy Storage and Conversion", John Wiley and Sons, 2012.
3. Francois Beguin and ElzbietaFrackowiak ,"Super capacitors", Wiley, 2013.
4. Doughty Liaw, Narayan and Srinivasan, "Batteries for Renewable Energy Storage", The Electrochemical Society, New Jersy,2010.
   Linden D. and Reddy Thomas B., "Handbook of Batteries", 2001,
5. McGraw Hill Publications.
6. Larminie and A. Dicks, Fuel Cell Systems Explained, 2nd Edition, Wiley
7. (2003).
8. Xianguo Li, Principles of Fuel Cells, Taylor and Francis (2005)
9. S. Srinivasan, Fuel Cells: From Fundamentals to Applications, Springer (2006)
10. O'Hayre, S. W. Cha, W. Colella and F. B. Prinz, Fuel Cell Fundamentals,Wiley (2005)
11. A. J. Bard and L. R. Faulkner, Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley, 2000.
12. A. Faghri and Y. Zhang, Transport Phenomena in Multiphase Systems, Elsevier 2006
13. Barclay F.J., "Fuel Cells, Engines and Hydrogen", Wiley, 2009.
14. Ibrahim Dincer and Mark A. Rosen, "Thermal Energy Storage Systems and Applications", John Wiley & Sons 2002.
15. Kordesch K. and G.Simader, Fuel Cell and Their Applications, Wiley-Vch, Germany 1996.
16. Rebecca L. and Busby, Hydrogen and Fuel Cells: A Comprehensive Guide, Penn Well Corporation, Oklahoma, 2005.
17. Hoogers , "Fuel cell technology handbook", CRC Press, 2003.
18. Ru-shiliu, Leizhang and Xueliang sun, "Electrochemical technologies for energy storage and conversion", Wiley publications, 2012.

MEST-202	Wind Energy: Resource, Engineering & Projects

L	T	P	C
3	1	0	4

Course Objectives:

1. To learn about the basic introduction of wind energy.
2. To understand the basics of fluid mechanics and its application in wind energy.
3. To study the wind speeds and wind turbines.
4. To learn about wind resource tools.
5. To learn about the wind industry and wind project development.

Course Outcomes: Upon completion of this course, the students shall be able to learn about the;

1. Basic introduction of wind energy.
2. Basics of fluid mechanics and its application in wind energy.
3. Wind speeds and wind turbines.
4. Wind resource tools.
5. Wind industry and wind project development.

Unit–1 **08 Lectures**

Wind Resources Assessment

Wind Site Prospecting, Site Selection Criteria, Geomorphological Indicators, Biological Indicators, Wind atlas analysis and application programme, Re-analysis Data, Long-Term Assessments of wind speeds; Measured Data and Re-analysis, Variation in wind speeds, Long term Cycles, Windfarm Models; Boundary Layer based models, CFD Models, Wake Models, Wind Power Model, Losses from a Windfarm, Gross and Net Yield Assessment, Risks, losses, & Uncertainties; Industry norms on losses, Estimation & breakdown of losses, Sources of Uncertainty, wind mast systems, new technologies for measurement of wind, Windfarm Layout.

Unit–2 **06 Lectures**

Wind Technologies

Introduction and status of Wind Energy Technology, Vertical axis wind turbine: Working Principles, Components and Design, Horizontal axis Wind turbines: Working Principles, Components and Design, Aerodynamics of Wind Turbine, Wind Turbine Blade Manufacture, Role of Non-Crimp fabric in Blade Manufacturing, Turbine blade aerodynamics, speed-tip ratio, Drive Train Concepts of Wind Turbine, Wind Turbine Gear Box, Pitch angle and yaw control mechanism, Wind Turbine Generators, Control and Protection System in Wind Turbine, Wind Turbine Tower, Wind Turbine Foundation, Power extracted from wind,

Unit–3 **06 Lectures**

Fluid Mechanics and Wind Energy

Basic concepts; Vector Fields, Line Integral and Surface Integral, Divergence and Curl, Eulerian &Lagrangian Approach, Concept of Continuum, Control Volume, Overview of Governing Equations; Continuity Equation and its derivation, Euler's Equation, Bernoulli's Equation, Explanation Cauchy's

Equation, Explanation Navier- Stokes (NS) Equation, NS Approximations applicable to Wind, Concept of Boundary Layer, Atmospheric Boundary Layer, Overview of Aerofoil Theory; Stream function, Streamlines and Stream Tubes, Conformal Mapping, Different types of Aerofioils, Lift and Drag.

Unit–4 **12 Lectures**

Wind Speeds and Wind Turbines

Extrapolation of Wind Speeds; Laws of Vertical Extrapolation, Surface Roughness, Flow over obstacles, Slopes & Speed-up Factor, Wind Measurement Systems; Anemometers, Wind Vanes, Lidars, Wind Data Recording and Averaging Time, Calibration, Standards, Wind Data Handling; Cleaning and Filling in Missing data, Wind Speed Frequency Distribution, Mean Wind Speed, Standard Deviation, Weibull Distribution and its Estimation, Turbulence Intensity, Wind Rose, Gust, Extreme wind speeds. Different types of wind turbines; Vertical Axis and Horizontal Wind Turbine, Off-grid, On-grid and Hybrids, Onshore and Offshore wind turbines, Fixed Speed, Variable Speed, DFIG, Gearless, Permanent Magnet Gen, Electro-magnetic Gen, Modern Wind Turbine Basics; Typical Type & Specs, Wind Turbine as an Autonomous Generating Unit, Power Curve and Power Regulation, Power Curve Measurements, Wake and wake modeling, Wind turbine Classifications, Energy Yield Assessment from a Wind Turbine; Time Series Method, Frequency Distribution Method, Weibull Function Method , Actuator Disk; Power in Wind, Axial Induction factor, Momentum theory, Coefficient of Performance, Betz Limit, Power and Rotational Speed, Thrust Coefficient, Tip Speed Ratio, Wake rotation, Angular Momentum, Vortex Cylinder, Flow field, Rotor Blade Theory; Blade Element Theory, Free Mixing, Blade geometry, Rotor Design, Blade Losses, Functioning of wind turbines; Wind Turbine components, Blade Pitch, Yaw mechanism, SCADA, Availability, Predictive and Preventive maintenance.

Unit–5 **08 Lectures**

Wind Industry Overview and Wind Project Development

Wind Industry Overview**;** Industry structure and main stake holders**,** Supply Chain,Major Suppliers, Type and size of wind turbines, Quality and Certification of Wind Turbines,Wind Power Project Development; Main activities, Scheduling, Timeline,Monitoring and Supervision. Financing wind power project. Wind energy roadmap development and implementation. DPR (Detailed Project Report) of wind power project.

Reference Books:

1. Anna Mani : Wind Energy Data for India
2. C-Wet : Wind Energy Resources Survey in India VI
3. S. Rangrajan : Wind Energy Resources Survey in India V
4. SathyajithMathew : Wind Energy
5. Prepared by WISE: Wind Power in India (5000MW BY 2015)
6. B.H.Khan: Non-Conventional Energy Sources
7. Duffie A. and Beckmann W. A., “Solar Engineering of Thermal Processes, John Wiley, 1991.
8. Freris L.L., “Wind Energy Conversion Systems”, Prentice Hall, 1990.
9. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, 1996.
10. John D Sorensen and Jens N Sorensen, “Wind Energy Systems”, Woodhead Publishing
11. Ltd, 2011.
12. Kaldellis J.K., “Stand – alone and Hybrid Wind Energy Systems”, CRC Press, 2010.
13. Mario Garcia –Sanz, Constantine H. Houpis, “Wind Energy Systems”,CRC Press 2012.
14. Spera D.A., “Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering”, ASME Press, 1994.
15. Twidell J.W. and Weir A., “Renewable Energy Sources”, EFN Spon Ltd., 1983

MEST-203	Energy Audit

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the objectives of energy audit.
2. To provide the knowledge of procedures and techniques used in energy audit.
3. To study energy balance and MIS.
4. To provide an understanding of evaluation and understanding of thermal systems.
5. To study the evaluation and understanding of mechanical systems.

Course Outcomes: Upon completion of this course, the students shall be able to understand.

1. Objectives of energy audit.
2. Procedures and techniques used in energy audit.
3. Energy balance and MIS.
4. Evaluation and understanding of thermal systems.
5. Evaluation and understanding of mechanical systems.

Unit-1 **06 Lectures**

General Aspects

General Philosophy and need of Energy Audit, Definition and Objective of Energy Audit, General Principles of Energy Audit, Energy Audit Methodology, Energy Audit Approach, Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution.

Unit-2 **06 Lectures**

Procedures and Techniques-I

Basic measurements – Electrical measurements, Light, Pressure, Temperature and heat flux, Velocity and Flow rate, Vibrations, etc.Instruments Used in Energy systems: Load and power factor measuring equipment, Wattmeter, flue gas analysis, Temperature and thermal loss measurements, air quality analysis etc.Mathematical and statistical modelling and analysis.Energy Measurement & Verification, Measurement & Verification (M & V) Protocol

Unit-3 **08 Lectures**

Procedures and Techniques-II

Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy /fuel and system operations, 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: Determining the savings in Rs, Noneconomic factors, Conservation opportunities, estimating cost of implementation.

Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation,

Energy Balance & MIS: First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses, Improvements. Energy Balance sheet and Management Information System (MIS) Energy Modelling and Optimization.

Unit-4 **10 Lectures**

Thermal Systems-Evaluation and Assessment

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 refractories- 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. Integrated analysis of steam base co-gen system, Gas turbine combine cycle operation, IC engine base co-generation and tri-generation, extraction turbines and steam cycle of cogeneration.

Unit-5 **10 Lectures**

Mechanical Systems-Evaluation and Assessment

Pumps, types and application, unit's assessment, improvement option, parallel and series operating pump performance. Energy Saving in Pumps & Pumping Systems, Blomers (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 HVPC & Psychometric, vapour compression cycles & comfort cooling, refrigerants new trends, COP, Capacity assessment, Vapor absorption refrigeration's – Li Br & Ammonia Cycles, working principle and system analysis, comparison of different cooling systems, heat pump off ions for HVPC systems improvements and its analysis. Energy Saving in HVAC Systems, Water system and water analysis for power generation, water audit and its utilization, Hydro-pneumatic applications for optimization of water pumping cost.

Reference Books:

1. Handbook of Energy Audits, Albert, Terry Niehus, William J. Younger, Fairmont Press
2. Energy Audit: Thermal Power, Combined Cycle, and Cogeneration Plants, Y. P. Abbi, The Energy and Resources Institute, TERI
3. Efficient Use of Energy: I.G.C.Dryden (Butterworth Scientific)
4. Industrial Energy Conservation: D.A. Reay (Pergammon Press)
5. Hamies "Energy Auditing and Conservation; Methods Measurements,
6. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A Wiley Interscience Publication)
7. Industrial Energy Management and Utilization – L.C. Witte, P.S. Schmidt, D.R. Brown Hemisphere Publication, Washington) 8. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
8. Energy Conservation guidebook Patrick/Patrick/Fardo (Prentice Hall)
9. Handbook on Energy efficiency –
10. ASHRAEE Energy Use (4 Volumes)
11. CIBSI Guide –Users Manual (U.K.)

12. CRC Handbook of Energy Efficiency – CRC Press.
13. ECBC Code 2007 (Edition 2008) published by Bureau of Energy Efficiency, New Delhi Bureau of EnergyEfficiency Publications-Rating System, TERI PUBLICATIONS – GRIHA Rating System, LEEDS Publications
14. Industrial Furnaces (Vol I & II) and M.H. Mawhinney, (John Wiley Publications)
15. The efficient use of steam – Oliver Lyle, (HMSO London)
16. Boilers – Types, Characteristics and functions – Carl D. Shields (Mcgraw Hill book)
17. The Efficient use of steam generation – General editor – P.M.Goodall
18. Efficient use of Steam by Oliver Lylee, Amazon Publications
19. Efficient use of Steam by P M Goodall, Amazon Publications.

MEST-204	Solar Photovoltaic Technology

L	T	P	C
3	1	0	4

Course Objectives:

1. To study the concept of PV systems.
2. To study PV devices, modules and arrays and their technical parameters.
3. To study the components and working of solar power plant.
4. To study the concepts of solar power management.
5. To learn Grid Codes and Standards.

Course Outcomes: Upon completion of this course, the students shall be able to understand.

1. Concept of PV systems.
2. About the PV devices, modules and arrays and their technical parameters.
3. Components and working of solar power plant.
4. Concepts of solar power management.
5. About the learn Grid Codes and Standards.

Unit-1 **08 Lectures**

Introduction to photovoltaic (PV) systems

Review and Advancements in Solar PV Technology, Overview of Composition of Solar PV based power plants, Balance of System (BoS) components: battery, PCU (charge controller, inverter,data logger), transformer, cables and connectors, switches/circuit breakers, energymeters, bypass and blocking diodes. Overview of Government policies and standards, rooftop businessmodels – CAPEX and RESCO installation, operation and technical survey of Solar PV based power plants. Standards and Configuration of Stand Alone, Grid Connected, Hybrid SPV power plants. Canal top and floating PV system.

Unit-2 **08 Lectures**

Power Electronics Converters in Solar PV Technology

Role of Power Electronics technology in Solar PV power plant. Types of DC- DC Converter and working. Types of DC-AC Inverters and working. Control and modelling of DC-DC and DC- AC power electronics Converters.Active and Reactive Power Control, Electric vehicle charging station after integration of Solar PV based technology. Solar PV based house hold power plant.

Unit-3 **08 Lectures**

Solar PV plant- System Design

PV module technology: c-Si, Thin-film technology, response to weatherparameters, commercial module ratings, standards, module reliability

Inverter technology: Inverter technologies, types of inverters, inverterselection, voltage levels, performance, power quality

Balance of system/plant: Module mounting structure, tracking system, Cabling and electrical design, single line diagrams, metering

Safety systems: Hotspot, Blocking and bypass diodes, surge protection,PID (Potential induced degradation) and its protection, Lightning protection, anti-islanding, LVRT protection, HVRT Protection
Battery technologies: Introduction to battery, battery technologies, standalone system, and utility scale storage
Power conditioning and maximum power point tracking (MPPT) algorithms based on buckand boostconverter topologies, recent trends in MPPT, requirement and control of power electronics converters for Solar power management in Solar PV system.

Unit-4 **08 Lectures**

PV Project Development

Preliminary site survey and feasibility study, statutory clearances and permits, Different modes of project development, PPA (Power Purchase Agreement) and evacuation planning, DPR (Detailed Project Report) Project schedule, procurement schedule, civil and electrical works, installation of module and inverter Grid-synchronization and power evacuation, Testing and acceptance, Monitoring of PV plant, cleaning andmaintenance, generation data analysis and fault detection.

Unit-5 **08 Lectures**

Estimation of energy payback and environmental benefits of SPV power plant

Performance analysis and estimation of energy payback period for SPV power plant –rooftop, ground-mounted, stand alone and small-scale &large-scale power plant scenarios,assessment of carbon footprints and carbon credit calculation, estimating CO_2 mitigationpotential**,** Payback calculation of Solar PV Plant.

Reference Books:

1. Photovoltaics: Designs, Systems and Applications, Michael Stock, Larsen and Keller Education
2. Photovoltaics: Engineering and Technology for Solar Power, Catherine Waltz, Syrawood Publishing House
3. Principles of Solar Engineering, D. Goswami, CRC Press
4. Solanki S. Chetan. Solar Photovoltaics: Fundamentals, Technologies and Applications, New Delhi, PHI, 2012.
5. Gilbert M. Masters: Renewable and Efficient Electric Power Systems. John Wiley &Sons, 2004
6. Roger A. Messenger & Jerry Venter: Photovoltaic Systems Engineering. CRC Press,2004, 2nded.
7. Jha .A.R, “Solar Cell Technology and Applications”, CRC Press, 2010.
8. John R. Balfour, Michael L. Shaw, SharlaveJarosek., “Introduction to Photovoltaics”, Jones & Bartlett Publishers, Burlington, 2011.
9. Partain .L.D, Fraas L.M., “Solar Cells and Their Applications”, 2nd ed., Wiley,2010.
10. Sukhatme .S.P, Nayak .J.K, “Solar Energy”, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

MEST-205	Energy Resources; Concepts and Technologies

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the basic concepts of green building their social and economic aspects.
2. To learn the basic techniques and processes involved in Energy Efficiency and Energy Conservation through various techniques. The study and application of various software are involved in the process.
3. To understand the basic principles of Energy modelling that would be pertinent to simple and advance design building design.
4. To understand the contribution made by new materials and technology to contemporary buildings.
5. Provide students the basic concepts and thorough knowledge and operation of building services in modern, large high-rise buildings complexes.

Course Outcomes: Upon completion of this course, the students shall be able to learn about the;

1. Concepts of green building.
2. Basics techniques and process of energy efficiency and energy conservation.
3. National and international codes of the energy modeling system.
4. Study and application of various software for new building materials.
5. Study and application of various software for advanced energy materials.

Unit-1 **08 Lectures**

Introduction

Green Building, Environmental Economic & Social Benefits of Green Buildings, Sustainable features for Green Building, Case Study of Green Buildings, Energy and Resource saving through Green Buildings,Professional Accreditation, Incentive Programs, Certifications.

Unit-2 **08 Lectures**

Building Energy Efficiency

Why energy efficiency?Multiple Aspects of Building Design & Construction, Thermal Comfort, Heat exchange in buildings, Passive design (Natural Ventilation), Passive design (Building form and envelope), Passive design (Daylight), Passive design (Case Studies), Renewable energy integration, Energy Conservation Opportunities in Public and Private Buildings.

Unit-3 **08 Lectures**

National & International Codes

ECBC Code, Application of ECBC in Indian Buildings, Analysis of saving of Energyby the application of ECBC, Introduction to other codes-ECONIWAS, ASHRAE, NCC 2019.

Rating System-: IGBC (Indian Green Building Council), GRIHA(Green Rating for Integrated Habitat Assessment) Buildings, LEED (Leadership in Energy and Environmental Design).
Compliances: - ECBC Compliances, Section J.

Unit-4 **08 Lectures**

Energy Simulations

Introduction to Building Energy Simulation- Geographical Location, Building Envelope (walls, roof, floors, ceiling, windows), Interior Loads (Lighting,Internal heat gain for appliances and equipment,Internal heat gain for occupants, metabolic rate & Schedules (Occupancy, Appliances, Lighting, HVAC & others), Software Setups, Introduction to Design Builder, Application of ECBC & Simulation.

Unit-5 **08 Lectures**

Advance Energy Modelling

Energy Plus: Integrated, Simultaneous solution, Sub-hourly, user-definable time steps,
Advanced fenestration models, Standard summary, and detailed output reports.
Overview of BEE Approved Software's: Design Builder, Energy Plus, eQuest, HAP, Open Studio, IDA-ICE and others.

References:

1. Heating and Cooling of Buildings, Design for Efficiency, Revised 2nd Edition Jan_F. Kreider Curtiss Ari Rabl ECBC (Energy Conservation Building Code) 2017
2. NBC (National Building Code), ASHRAE Comprehensive HVAC Deign: A Handbook on Practical Approach to Air Conditioning, Heating and Ventilation System, by N.C. Gupta

MEST-206	Hydrogen Generation and Storage (Elective)

L	T	P	C
3	1	0	4

Course Objectives:

1. To provide the importance of hydrogen as an energy carrier.
2. To deliver the basics of the techniques of Hydrogen Production.
3. To deliver the concepts of the techniques for separation and purification of Hydrogen.
4. To provide the concepts of Hydrogen Storage.
5. To provide an understanding of the applications of Hydrogen in different energy conversion systems.

Course Outcomes: Upon completion of this course, the students shall be able to learn about the.

1. Hydrogen production and Storage
2. Use of Hydrogen as a fuel.
3. Techniques for Hydrogen separation and purification.
4. Green Hydrogen and its importance.

Unit-1 **08 Lectures**

Properties of hydrogen, global status of supply and demand, methods of hydrogen production, steam reforming, Advanced methods of steam reforming, partial oxidation, autothermal reforming, combined reforming, reforming using alternate energy sources, Hydrogen production from methane decomposition, from coal and biomass, Green Hydrogen, and its importance.

Unit-2 **08 Lectures**

Hydrogen separation and purification, thermochemical cycles for hydrogen production, fundamentals for electrolysis of water, Components of electrolytic cell, configuration of electrolyser stack, different electrolyser technologies, photoelectrochemical hydrogen production, technical and economic comparison of different production methods and global status, cost analysis.

Unit-3 **08 Lectures**

Introduction to hydrogen storage, underground hydrogen storage, fundamentals of hydrogen compression and expansionMechanical and non-mechanical hydrogen compressors; compressed hydrogen tank types and design considerations, Hydrogen liquefaction, liquid state hydrogen storage tanks, fundamentals of hydrogen storage in adsorption-based materials.

Unit-4 **08 Lectures**

Fundamentals and thermodynamics of absorption-based hydrogen storage, metal hydrides, types of metal hydrides, metal hydride-based systems design, Novel materials for solid state hydrogen storage; economics of storage; Long distance hydrogen transport via pipelines, ships and in form of LOHC; hydrogen transport via road; hydrogen refuelling stations.

Unit-5 **08 Lectures**

Use of hydrogen in internal combustion engines, fuel cells, hydrogen sensing, Properties of hydrogen associated with hazards, classification of hydrogen hazards, compressed and liquid hydrogen related

hazards, regulation, codes and standards, utilization of hydrogen in various sectors, global status, and future directions.

References:

1. Hydrogen Storage Materials by Darren P. Broom, Springer London, 2011
2. Hydrogen Fuel: Production, Transport, and Storage by R. B. Gupta, CRC Press 2008
3. The Hydrogen Revolution: A Blueprint for the Future of Clean Energy by Macro Alvera, Hodder Studio, 2021

MEST-207	Advanced Energy Materials (Elective)

L	T	P	C
3	1	0	4

Course Objectives:

1. To understand the fundamentals and basics of material science.
2. To study the basics of inorganic semiconductors.
3. To provide an understanding of organic semiconductors.
4. To know the concepts and models of polymers.
5. To provide the knowledge of materials for energy applications.
6. To provide the knowledge of energy efficient lighting and display materials.

Course Outcomes: Upon completion of this course, the students shall be able to understand.

1. Fundamentals and basics of material science.
2. Basics of polymers and their application in energy systems and devices.
3. Basics of organic semiconductors.
4. Concepts and theories of semiconductors.
5. Basics and properties of materials.
6. Basics of light emission and materials for energy efficient lighting and displays.

Unit-1 **08 Lectures**

Introduction to materials, structure of materials, classification of materials: Metals, Ceramics, Polymers, Composites and their Types, Bonding, Crystallography, Crystal Defects, Diffusion in Solids, Solid Solutions, Phase Diagrams, Electrical Conduction in Solids, Resistivities of Mixed, Solid Phases, Hall Effect; Polarization and Permittivity, Piezoelectricity, Ferroelectricity, and Pyro electricity; Magnetic properties and Superconductivity, Optical Properties of Materials.

Unit-2 **08 Lectures**

Introduction to Semiconductors, Introduction to Organic Semiconductors, Electronic Configuration and Concept of Atomic Orbital, Hybridization and Overlapping of orbitals, Molecular Orbital, LCAO theory, Bonding and Antibonding orbitals, Sigma Bonding and pi-bonding, Material Origin of bandgap in organic semiconductors, Charge transport in organic semiconductors, Types of organic semiconductors, Optical and Electrical Properties of Organic Semiconductors.

Unit-308 Lectures

Introduction to polymers, classification of polymers, Mechanism of polymerization, Degree of polymerization, Crystallization of polymer, cross linking, vulcanization of rubber, deformation of polymer, Factor affecting the properties of polymer, Advance polymers for engineering applications i.e., vinyl copolymer, composites and nanocomposites, polymer -clay Nano composite, PTFE, electro active polymers, Biodegradable polymers, High Temperature Polymers.

Unit-4 **08 Lectures**

Insulating materials for energy saving aerogels, vacuum panels; retrofitting of building, reflective/photo-thermochromic glasses; Materials for photovoltaic energy production; Materials for concentrated solar power plants, Materials for fuel cells, Materials for Energy Storage; Materials for power plants, Composite Materials for windmills, Materials for energy production from tides.

Unit-5 **08 Lectures**

Materials for Solid State Lighting, Florescence, Phosphorescence, Electroluminescence, Inorganic Luminescent Materials and Devices, Organic Luminescent Materials and OLEDs; Materials for Fiber Optics Lighting, Display Technology and Materials for Energy Efficient Displays

Reference Books:

1. Introduction to Solid State Physics, 8th Ed., C. Kittel, J. Wiley & Sons
2. Physics of Functional Materials, Hasse Fredriksson and Ulla Åkerlind, J. Wiley & Sons
3. Textbook of polymer science, Fred W Billmeyer, J. Wiley & Sons
4. Materials Chemistry, Fahlman, Bradley, Sp
5. Billmeyer F, 'Textbook of Polymer Science', Wiley Interscience, 1994
6. Anthoney Kelly, 'Concise Encyclopedia of Composite Materials', Pergamon, 1994
7. Anna Köhler, Heinz Bässler: Electronic Processes in Organic Semiconductors – An Introduction, WileyVCh, April 2015
8. Hofmann, Philip, Solid state physics : an introductionWeinheim: Wiley-Vch, 2008
9. "Solid State Physics", N. W. Ashcroft and N. D. Mermin (W. B. Saunders Company, 1976).
10. A Chemist's Perspective by, Orient Blackswan (21 November 2013)
11. C. Kittel, "Introduction to Solid State Physics" Wiley Eastern Ltd, 2005.
12. V. Raghavan, "Materials Science and Engineering: A First Course", Prentice Hall, 2006
13. A.J. Dekker, "Solid State Physics", Macmillan & Co, 2000.
14. Michael Shur, "Physics of Semiconductor Devices", Prentice Hall of India, 1995.
15. C. Kittel, "Introduction to Solid State Physics", Wiley Eastern Ltd., 2005.
16. V.R.Gowariker, "Polymer science ",New age international Publishers,1986
17. Advanced Energy Materials, Ashutosh Tiwari &SergiyValyukh, J. Wiley & Sons
18. Eco- and Renewable Energy Materials, Young Zho, Springer
19. Materials and Energy (Book Series), Leonard C Feldman (Ed. In Chief), World Scientific
20. Ginley, David S. ;Cahen, D. Fundamentals of materials for energy and environmental sustainability. Cambridge: CambridgeUniversity Press, 2011. ISBN 9781107000230.
21. S.P. Gaponenko, Optical Properties of semiconductor nanocrystals,Cambridge University Press, 1980
22. Fundamentals of Solid-State Lighting: LEDs, OLEDs, and Their Applications in Illumination and Displays, Vinod Kumar Khanna, CRC Press

MEST-209	Energy Science& Technology Lab.-II

L	T	P	C
3	1	0	4

Course Objectives:

1. To study the Solar Photovoltaic system.
2. To study different elements of photovoltaics energy systems.
3. To study the characteristics of fuel cells and their applications.
4. To study Hydro Turbine Energy Generator.

List of Experiments

1. Study of I-V characteristics of Solar Cell
2. Study of various modes of Constant Voltage Charging technique.
3. Study of Buck and Boost Converter.
4. Study of Bypass Diodes.
5. Study of Dusk to Dawn Switch.
6. Fuel Cell:
   (a) Study of Current-Voltage Characteristic of Electrolyzer's function of Reversible PEM Fuel Cell.
   (b) Study of the Application of Fuel Cell function of Reversible Fuel Cell of providing electrical energy to the loads such as buzzer, fan, and bulb.
7. To study the generation of electricity by using Bio Energy & run the different applications using generated electricity.
8. Hydro Turbine Energy Generator:
   (a) To study the Hydro Turbine (Pelton wheel Type) with Resistive Load.
   (b) To study the Hydro Turbine (Pelton wheel Type) with Motor Load.
   (c) To study the Hydro Turbine (Pelton wheel Type) with Bulb Load.
9. To demonstrate the I-V and P-V characteristics of different types of solar cells with varying radiation and temperature levels.
10. To demonstrate the impact of partial shading on solar cell performance.
11. To demonstrate the impact of tilt angle on solar cell performance.