MOTHERHOOD
UNIVERSITY, Roorkee
ENLIGHTENING WORLD

DIPLOMA IN ENGINEERING

(ELECTRICAL ENGINEERING)

II Year / 3rd SEMESTER

[Academic Session 2022-2023 onwards]

EVALUATION SCHEME – SEMESTER III – Electrical Engineering

Sr. No.	Subject Code	Subject Name	Effective Teaching			Credits	Evaluation Scheme		
			L	T	P		Internal Assessment	End Term	Total Marks
			Hours/Week						
ETHEORY									
1	MDEEE22-301T	Introduction to Electric Generation Systems	3	0	0	3	30	70	100
2	MDEEE22-302T	Electrical Circuits	2	1	0	3	30	70	100
3	MDEEE22-303T	Electrical and Electronic Measurements	2	1	0	3	30	70	100
4	MDEEE22-304T	Electric Motors and Transformers	2	1	0	3	30	70	100
5	MDEEE22-305T	Renewable Energy Power Plants	3	0	0	3	30	70	100
	TOTAL		**12**	**3**	**-**	**15**	**150**	**350**	**500**
PRACTICAL/PROJECT									
6	MDEEE22-351P	Introduction to Electric Generation Systems Laboratory	0	0	2	1	20	30	50
7	MDEEE22-352P	Electrical Circuits Laboratory	0	0	2	1	20	30	50
8	MDEEE22-353P	Electrical and Electronic Measurements Laboratory	0	0	2	1	20	30	50
9	MDEEE22-354P	Electric Motors and Transformers Laboratory	0	0	2	1	20	30	50
10	MDEEE22-357I	Summer Internship-I	0	0	0	2	40	60	100
		TOTAL	**-**	**-**	**8**	**6**	**120**	**180**	**300**

MDEEE22-301T	Introduction to Electric Generation Systems	3L:0T:2P	3T + 1P Credits

COURSE OBJECTIVES

The objectives of the course are:

- To make students aware about the functioning of different power plants both renewable and non-renewable.
- To develop an understanding of the interconnection of these plants for effective production of electricity.

COURSE OUTCOMES

At the end of the Course, Student will be able:		Bloom's Level
CO1	To understand the working of major conventional power plants based on coal, gas, diesel and nuclear energy	**K2**
CO2	To analyze the different components of large and micro hydro power plants and understand the overall working of the plant.	**K3**
CO3	To design and understand the layout and working of a solar and biomass plant.	**K2**
CO4	To understand the construction and working of a wind-based power plant.	**K2**
CO5	To select an appropriate mix of power generation based on economic operation.	**K3**

K1 – Remember K2- Understand K3-Apply K4-Analyze K5 – Evaluate K6 – Create

SYLLABUS

Unit – I Thermal Power Plants: Coal, Gas/ Diesel and Nuclear-based

Layout and working of a typical thermal power plant with steam turbines and electric generators. Properties of conventional fuels used in the energy conversion equipment used in thermal power plants: Coal, Gas/ diesel, nuclear fuels –fusion and fission action Safe Practices and working of various thermal power plants: coal-based, gas-based, diesel-based, and nuclear-based. Functions of the following types of thermal power plants and their major auxiliaries: Coal fired boilers: fire tube and water tube. Gas/diesel-based combustion engines Types of nuclear reactors: Disposal of nuclear waste and nuclear shielding. Thermal power plants in Maharashtra.

Unit – II Large and Micro-Hydro Power Plants

Energy conversion process of hydro power plant. Classification of hydro power plant: High, medium and low head. Construction and working of hydro turbines used in different types of hydro powerplant:

a. High head – Pelton turbine
b. Medium head – Francis's turbine
c. Low head – Kaplan turbine.

Safe Practices for hydro power plants. Different types of micro- hydro turbines for different heads: Pelton, Francis and Kaplan turbines Locations of these different types of large and micro-hydro power plants in Maharashtra Potential locations of micro-hydro power plants in Maharashtra.

Unit– III Solar and Biomass based Power Plants

Solar Map of India: Global solar power radiation. Solar Power Technology, Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors

Solar Photovoltaic (PV) power plant: layout, construction, working.

Biomass-based Power Plants

a. Layout of a Bio-chemical based (e.g., biogas) power plant:
b. Layout of a Thermo-chemical based (e.g., Municipal waste) power plant
c. Layout of an Agro-chemical based (e.g., bio-diesel) power plant

Features of the solid, liquid and gas biomasses as fuel for biomass power plant.

Unit– IV Wind Power Plants

Wind Map of India**:** Wind power density in watts per square meter. Layout of Horizontal axis large wind power plant: Geared wind power plant. Direct-drive wind power plant. Salient features of electric generators used in large wind power plants: Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG), Wound Rotor Induction Generator (WRIG) Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG)

Unit– V Economics of Power Generation and Interconnected Power System

Connected load, firm power, cold reserve, hot reserve, spinning reserve. Base load and peak load plants; Load curve, load duration curve, integrated duration curve Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. Choice of size and number of generator units, combined operation of power station. Causes and Impact and reasons of Grid system fault: State grid, national grid, brownout and black out; sample blackouts at national and international level.

RECOMMENDED BOOKS

1. Nag. P. K.Power Plant Engineering, McGraw Hill, New Delhi, ISBN: 978-9339204044
2. Tanmoy Deb, Electrical Power Generation, Khanna Publishing House, Delhi (Ed. 2018)
3. Gupta, B.R., Generation of Electrical Energy, S. Chand& Co. New Delhi.

PRACTICAL LIST

1. Identify the routine maintenance parts of the coal fired thermal power plant after watching a video program
2. Identify the routine maintenance parts of the gas fired thermal power plant after watching a video program
3. Identify the routine maintenance parts of the nuclear fired thermal power plant after watching a video program.
4. Identify the routine maintenance parts of the large hydro power plant after watching a video program
5. Identify the routine maintenance parts of the micro hydro power plant after watching a video program.
6. Identify the routine maintenance parts of the large wind power plant after watching a video.
7. Identify the routine maintenance parts of the horizontal axis small wind turbine after watching a video
8. Identify the routine maintenance parts of the vertical axis small wind turbine after watching a video

MDEEE22-302T	Electrical Circuits	2L:1T:2P	3T + 1P Credits

COURSE OBJECTIVES

The objectives of the course are:

- To make students understand the principles of different AC series and parallel circuits.
- To develop an understanding amongst students to solve circuits using the available network theorems and fundamentals.

COURSE OUTCOMES

At the end of the Course, Student will be able:		Bloom's Level
CO1	To understand the phenomena of Circuits and solve numerical interpretation based on Single Phase AC Series Circuits.	**K2**
CO2	To apply the fundamental principles of circuits on various combinations of R,L and C for Single Phase AC Parallel circuits.	**K3**
CO3	To understand the concept of three phase power with respect to their representation as well as different conditions of the load.	**K2**
CO4	To solve circuits based on Transformation as well as mesh and nodal analysis.	**K3**
CO5	To verify different network theorems like Superposition, Norton's, Thevenin's on different circuits.	**K2**

K1 – Remember K2- Understand K3-Apply K4-Analyze K5 – Evaluate K6 – Create

SYLLABUS

Unit – I Single Phase A.C Series Circuits

Generation of alternating voltage, Phasor representation of sinusoidal quantities R, L, C circuit elements its voltage and current response R-L, R-C, R-L-C combination of A.C series circuit, impedance, reactance, impedance triangle, Power factor, active power, reactive power, apparent power, power triangle and vector diagram Resonance, Bandwidth, Quality factor and voltage magnification in series R-L, R-C, R- L-C circuit

Unit – II Single Phase A.C Parallel Circuits

R-L, R-C and R-L-C parallel combination of A.C. circuits. Impedance, reactance, phasor diagram, impedance triangle

R-L, R-C, R-L-C parallel A.C. circuits power factor, active power, apparent power, reactive power, power triangle

Resonance in parallel R-L, R-C, R-L-C circuit, Bandwidth, Quality factor and voltage magnification

Unit– III Three Phase Circuits

Phasor and complex representation of three phase supply. Phase sequence and polarity. Types of three-phase connections, Phase and line quantities in three phase star and delta system. Balanced and unbalanced load, neutral shift in unbalanced load. Three phase power, active, reactive and apparent power in star and delta system.

Unit– IV Network Reduction and Principles of Circuit Analysis

Source transformation, Star/delta and delta/star transformation, Mesh Analysis, Node Analysis

Unit–V Network Theorems

Superposition theorem. Thevenin's theorem. Norton's theorem, Maximum power transfer theorem, Reciprocity theorem Duality in electric circuits.

RECOMMENDED BOOKS

1. Ashfaq Husain, Networks & Systems, Khanna Book Publishing, New Delhi.
2. Gupta, B. R; Singhal, Vandana; Fundamentals of Electrical Network, S.Chand and Co., New Delhi, ISBN : 978-81-219-2318-7
3. Saxena, S.B Lal; Dasgupta, K; Fundamentals of Electrical Engineering, Cambridge University Press Pvt. Ltd., New Delhi, ISBN: 978-11-0746-435-3
4. Theraja, B. L.: Theraja, A. K;, A Text Book of Electrical Technology Vol-I, S. Chand & Co. Ramnagar, New Delhi, ISBN : 9788121924405
5. Sudhakar, A.; Shyammohan, S. Palli; Circuit and network, McGraw Hill Education, New Delhi, ISBN : 978-93-3921-960-4
6. Bell, David A., Electric Circuits, Oxford University Press New Delhi, ISBN: 978-01-954-2524-6

PRACTICAL LIST

1. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L series circuit. Draw phasor diagram.
2. Use voltmeter, ammeter to determine active, reactive and apparent power consumed in given R-C series circuit. Draw phasor diagram.
3. Use voltmeter, ammeter, wattmeter to determine active, reactive and apparent power consumed in given R-L-C series circuit. Draw phasor diagram.
4. Use variable frequency supply to create resonance in given series R-L-C circuit or by using variable inductor or variable capacitor.
5. Use voltmeter, ammeter, wattmeter to determine current, p.f, active, reactive and apparent power

in R-C parallel A.C. circuit.

6. Use voltmeter, ammeter, wattmeter, p.f meter to determine current, p.f., active, reactive and apparent power for given R-L-C parallel circuit with series connection of resistor and inductor in parallel with capacitor.
7. Use variable frequency supply create resonance in given parallel R-L-C circuit or by using variable inductor or capacitor.
8. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of volt-age and current for balanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram.
9. Use voltmeter, ammeter, wattmeter, p.f meter to determine line and phase quantities of volt-age and current for unbalanced three phase star and delta connected load and calculate active, reactive, and apparent power. Draw phasor diagram.
10. Use voltmeter, ammeter to determine current through the given branch of an electric network by applying mesh analysis.
11. Use voltmeter, ammeter to determine current through the given branch of an electric network by applying node analysis.
12. Use voltmeter, ammeter to determine current through the given branch and voltage across the given element of circuit by applying superposition theorem.

MDEEE22-303T	**Electrical and Electronic Measurements**	**2L:1T:2P**	**3T + 1P Credits**

COURSE OBJECTIVES

The objectives of the course are:

- To make students aware on the fundamentals of measurement of different electrical parameters for different electrical devices.
- To develop an understanding on the working as well as calibrating different equipment's.

COURSE OUTCOMES

At the end of the Course, Student will be able:		Bloom's Level
CO1	To understand the fundamentals of measurements for different categories of instruments.	**K2**
CO2	To develop an understanding of different types of voltage and current measuring devices.	**K2**
CO3	To understand the different meters for measuring the power and observe the effect of power factor on meter readings.	**K2**
CO4	To study the construction features and working principle of different types of energy meters for measuring single phase energy.	**K2**
CO5	To measure different circuit parameters like Resistance, Inductance and Capacitance using different methods.	**K3**

K1 – Remember K2- Understand K3-Apply K4-Analyze K5 – Evaluate K6 – Create

SYLLABUS

Unit – I Fundamentals of Measurements

Measurement: Significance, units, fundamental quantities and standards Classification of Instrument Systems: Null and deflection type instruments Absolute and secondary instruments Analog and digital instruments. Static and dynamic characteristics, types of errors Calibration: need and procedure. Classification of measuring instruments: indicating, recording and integrating instruments. Essential requirements of an indicating instruments

Unit – II Measurement of voltage and current

DC Ammeter: Basic, Multi range, Universal shunt,
DC Voltmeter: Basic, Multi-range, concept of loading effect and sensitivity

AC voltmeter: Rectifier type (half wave and full wave)
CT and PT: construction, working and applications.
Clamp-on meter.

Unit– III Measurement of Electric Power

Analog meters: Permanent magnet moving coil (PMMC) and Permanent magnet moving iron(PMMI) meter, their construction, working, salient features, merits and demerits. Dynamometer type wattmeter: Construction and working Range: Multiplying factor and extension of range using CT and PTErrors and compensations. Active and reactive power measurement: One, two and three wattmetermethod. Effect of Power factor on wattmeter reading in two wattmeter method. Maximum Demand indicator

Unit– IV Measurement of Electric Energy

Single and three phase electronic energy meter: Constructional features andworking principle. Errors and their compensations. Calibration of single phase electronic energy meter using direct loading.

Unit– V Circuit Parameter Measurement, CRO and Other Meters

Measurement of resistance: Low resistance: Kelvin's double bridge, Medium Resistance: Voltmeter and ammeter method. High resistance: Megger and Ohm meter: Series and shunt. Measurement of inductance using Anderson bridge (no derivation and phasor diagram) Measurement of capacitance using Schering bridge (no derivation and phasor diagram) Single beam/single trace CRO, Digital storage Oscilloscope**:** Basic block diagram, working, Cathode ray tube, electrostatic deflection, vertical amplifier, time base generator, horizontalamplifier, measurement of voltage/ amplitude/ time period/ frequency/ phase angle delay line, specifications. Other meters: Earth tester, Digital Multimeter; L-C-R meter, Frequency meter (Ferromagnetic and Weston type), Phase sequence indicator, power factor meter (single phase and three phase dynamometer type), Synchro scope, Tri-vector meter. Signal generator: need, working and basic block diagram. Function generator: need, working and basic block diagram, function of symmetry.

RECOMMENDED BOOKS

1. Theraja B. L., Theraja A. K., A Text Book of Electrical Technology Vol-I(Basic Electrical Engg.),S.Chand and Co. New Delhi, ISBN: 9788121924405
2. Mittle V. N., Basic Electrical Engineering, McGraw-Hill New Delhi, ISBN : 978-0-07-0088572-5,
3. Edward Hughes, Electrical Technology, Pearson Education, New Delhi, ISBN-13: 978-0582405196
4. Rajput R.K., Electrical and Electronic Measurement and Instrumentation, S.Chand and Co. New Delhi, ISBN : 9789385676017
5. Sawhney A.K., Electrical and Electronics Measurements and Instrumentation., Dhanpai Rai and Sons,New Delhi, ISBN : 9780000279744
6. Suryanarayna N.V., Electrical Measurements and Measuring Instruments, S.Chand and Co. New Delhi , ISBN :8121920116

PRACTICAL LIST

1. Identify measuring instruments on the basis of symbols on dial, type, accuracy, class position and scale.
2. Identify the components of PMMC and MI instruments.
3. Troubleshoot PMMC and MI instruments.
4. Measure AC and DC quantities in a working circuit.
5. Extend range of ammeter and voltmeter by using (i) shunt and multiplier (ii) CT and PT.
6. Use Clamp-on meter for measurement of AC/DC current, AC/DC voltage.
7. Use electro-dynamic watt-meter for measurement of power in a single phase circuit
8. Troubleshoot electrodynamic watt-meter for measurement of power in a single phase circuit
9. Use single wattmeter for measurement of active and reactive power of three phase balanced load.
10. Use two watt-meters for measuring active power of three-phase balanced load.
11. Calibrate single phase electronic energy meter by direct loading.
12. Troubleshoot single phase electronic energy meter.
13. Use digital multi-meter for measurement of AC/DC current, AC/DC voltage.
14. Use Kelvin's double bridge for measurement of low resistance.
15. Use voltmeter and ammeter method for measurement of medium resistance.
16. Use Megger for insulation resistance measurements.
17. Use earth tester for measurement of earth resistance.
18. Use CRO for the Measurement of supply frequency in single-phase circuit.
19. Use Tri-vector meter for measuring kW, kVAr and kVA of a power line.

MDEEE22-304T	**Electric Motors and Transformers**	**2L:1T:2P**	**3T + 1P Credits**

COURSE OBJECTIVES

The objectives of the course are:

- To make students aware about the working and constructional details of Static and Dynamic Machines like Transformers, DC Motors and Generators.
- To develop an understanding of different applications of the Static and Dynamic machines in power industry.

COURSE OUTCOMES

At the end of the Course, Student will be able:		Bloom's Level
CO1	To understand the construction and working principle of DC Generators.	**K2**
CO2	To understand the working of DC Motors along with the applications and characteristics.	**K2**
CO3	To develop an understanding of constructional details and working of single-phase transformer.	**K2**
CO4	To describe the specifications as well as constructional details of three phase transformer along with the applications.	**K3**
CO5	To understand the working principle of special purpose transformers like the current, potential and instrument transformers.	**K2**

K1 – Remember K2- Understand K3-Apply K4-Analyze K5 – Evaluate K6 – Create

SYLLABUS

Unit – I DC Generators

DC generator: construction, parts, materials and their functions. Principle of operation of DC generator: Fleming's right-hand rule, schematic diagrams, E.M.F. equation of generator, armature reaction, commutation and applications of DC generators. Classification of measuring instruments: indicating, recording and integrating instruments.

Unit – II D.C. Motors

DC motor: Types of DC motors. Fleming's left-hand rule, Principle of operation of DC Motors, Back E.M.F. and its significance, Voltage equation of DC motor. Torque and Speed; Armature torque, Shaft torque, BHP, Brake test, losses, efficiency. DC motor starters: Necessity, two point and three point

starters. Speed control of DC shunt and series motor: Flux and Armature control. Brushless DC Motor: Construction and working.

Unit– III Single Phase Transformers

Types of transformers: Shell type and core type; Construction: Parts and functions, materialsused for different parts: CRGO, CRNGO, HRGO, amorphous cores, Transformer: Principle of operation of single phase transformers, EMF equation of transformer: Derivation, Voltage trans-formation ratio, Significance of transformer ratings Transformer No-load and on-load phasor diagram, Leakage reactance,Equivalent circuit of transformer: Equivalent resistance and reactance. Voltage regulation and Efficiency: Direct loading, OC/SC method, All day efficiency.

Unit– IV Three Phase Transformers

Bank of three single phase transformers, Single unit of three phase transformer. Distribution and Power transformers. Construction, cooling, Three phase transformers connections as per IS:2026 (part IV)-1977, Three phase to two phase conversion (Scott Connection), Selection of transformer as per IS: 10028 (Part I)-1985, Criteria for selection of distribution transformer, and power transformer, Amorphous Core type Distribution Transformer, Specifications of three-phase distribution transformers as per IS:1180 (part I)-1989.Need of parallel operation of three phase transformer, Conditions for parallel operation. Polarity tests on mutually inductive coils and single-phase transformers, Polarity test, Phasing out test on Three-phase transformer.

Unit– V Special Purpose Transformers

Single phase and three phase auto transformers: Construction, working and applications. Instrument Transformers: Construction, working and applications of Current transformer andPotential transformer. Isolation transformer: Constructional Features and applications. Single phase welding transformer: constructional features and applications. Pulse transformer: constructional features and applications. 'K' factor of transformers: overheating due to non-linear loads and harmonics.

RECOMMENDED BOOKS

1. G.C. Garg & P.S. Bimbhra, Electrical Machines, Vol-I, II, Khanna Book Publishing House (ISBN:978-9386173-447, 978-93-86173-607), New Delhi
2. Mittle, V.N. and Mittle, Arvind., Basic Electrical Engineering, McGraw Hill Education, New Delhi,ISBN: 9780070593572
3. Kothari, D. P. and Nagrath, I. J., Electrical Machines, McGraw Hill Education. New Delhi,ISBN:9780070699670
4. Bhattacharya, S. K., Electrical Machines, McGraw Hill Education, New Delhi, ISBN: 9789332902855
5. Mehta, V. K. and Mehta, Rohit, Principles of Electrical Machines, S. Chand and Co. Ltd., New Delhi,ISBN: 9788121930888
6. Theraja, B.L., Electrical Technology Vol-II (AC and DC machines), S. Chand and Co. Ltd., New Del-hi, ISBN: 9788121924375
7. Murugesh Kumar, K., DC Machines and Transformers, ISBN: 9788125916055

PRACTICAL LIST

1. Dismantle a DC machine.
2. Reverse the direction of rotation of the DC shunt motor.
3. Perform brake test on DC shunt motor.
4. Control the speed of DC shunt motor by different methods.
5. Control the speed of DC series motor by different methods.
6. Perform the brake test on DC series motor.
7. Check the functioning of single-phase transformer.
8. Determine regulation and efficiency of single-phase transformer by direct loading.
9. Perform open circuit and short circuit test on single phase transformer to determine equivalent circuit constants, voltage regulation and efficiency.
10. Perform parallel operation of two single phase transformers to determine the load currentsharing.
11. Perform parallel operation of two single phase transformers and determine the apparent andreal power load sharing.
12. Perform polarity test on a single-phase transformer whose polarity markings are masked.
13. Perform phasing out test on a three-phase transformer whose phase markings are masked.
14. Connect the auto-transformer in step-up and step-down modes noting the input/output readings.
15. Check the functioning of the CT, PT and isolation transformer.

MDEEE22-305T	Renewable Energy Power Plants	3L:0T:0P	3T Credits

COURSE OBJECTIVES

The objectives of the course are:

- To make students aware about the different types of renewable based power plants.
- To make students understand the different components of various wind, solar and biomass based power plants.

COURSE OUTCOMES

At the end of the Course, Student will be able:		Bloom's Level
CO1	To understand the layout, the construction and working details of Solar Power Plant.	**K2**
CO2	To discuss the various speed control mechanism for a wind-based power plant.	**K2**
CO3	To differentiate between the horizontal and Vertical Axis wind turbines based on the construction and working.	**K2**
CO4	To understand the construction and working of hydro power plants based on different heads – High, Medium and Low Heads.	**K2**
CO5	To develop an understanding of Bio Chemical and Thermo Chemical based power plants.	**K2**

K1 – Remember K2- Understand K3-Apply K4-Analyze K5 – Evaluate K6 – Create

SYLLABUS

Unit – I Solar PV and Concentrated Solar Power Plants

Solar Map of India: Global solar power radiation, Solar PV. Concentrated Solar Power (CSP) plants, construction and working of: Power Tower, Parabolic Trough, Parabolic Dish, Fresnel Reflectors. Solar Photovoltaic (PV) power plant: components layout, construction, working. Rooftop solar PV power system

Unit – II Large Wind Power Plants

Wind Map of India: Wind power density in watts per square meter Lift and drag principle; long path theory. Geared type wind power plants: components, layout and working. Direct drive type wind power

plants: components, layout and working. Constant Speed Electric Generators: Squirrel Cage Induction Generators (SCIG),Wound Rotor Induction Generator (WRIG); Variable Speed Electric Generators: Doubly-fed induction generator (DFIG), wound rotor synchronous generator (WRSG), permanent magnet synchronous generator (PMSG).

Unit– III Small Wind Turbines

Horizontal axis small wind turbine: direct drive type, components and workingHorizontal axis small wind turbine: geared type, components and working. Vertical axis small wind turbine: direct drive and geared, components and working Types of towers and installation of small wind turbines on roof tops and open fields.Electric generators used in small wind power plants

Unit– IV Micro-hydro Power Plants

Energy conversion process of hydro power plant. Classification of hydro power plant: High, medium and low head. Layouts of micro-hydro power plants. Construction and working of hydro turbines used in different types of hydro power plant:

- High head – Pelton turbine
- Medium head – Francis turbine
- Low head – Kaplan turbine.

Safe Practices for micro hydro power plants

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Unit– V Biomass-based Power Plants

Properties of solid fuel for biomass power plants: bagasse, wood chips, rice husk,municipal waste. Properties of liquid and gaseous fuel for biomass power plants: Jatropha, bio-diesel gobar gas. Layout of a Bio-chemical based (e.g., biogas) power plant: Layout of a Thermo-chemical based (e.g. Municipal waste) power plant. Layout of a Agro-chemical based (e.g., bio-diesel) power plant.

RECOMMENDED BOOKS

1. Deambi, Suneel: From Sunlight to Electricity: a practical handbook on solar photovoltaic application; TERI, New Delhi ISBN:9788179935736
2. David M. Buchla, Thomas E. Kissell, Thomas L. Floyd - Renewable Energy Systems, Pearson Education New Delhi , ISBN: 9789332586826,
3. Rachel, Sthuthi; Earnest, Joshua – Wind Power Technologies, PHI Learning, New Delhi, ISBN: 978-93-88028-49- 3; E-book 978-93-88028-50-9
4. Khoiyangbam, R S Navindu; Gupta and Sushil Kumar; Biogas Technology: Towards Sustainable Development; TERI, New Delhi; ISBN: 9788179934043
5. Gipe, Paul: Wind Energy Basics, Chelsea Green Publishing Co; ISBN: 978-1603580304
6. Wizelius, Tore &Earnest, Joshua -PHI Learning, New Delhi, ISBN: 978-8120351660
7. Kothari, D.P. et al: Renewable Energy Sources and Emerging Technologies, PHI Learning, New Delhi, ISBN: -978-81-203-4470-9
8. Bhadra, S.N., Kastha, D., Banerjee, S, Wind Electrical Systems installation; Oxford University Press, New Delhi, ISBN: 9780195670936.
9. O.P. Gupta, Energy Technology, Khanna Publishing House, New Delhi (ISBN: 978-9386173-683)