Government Polytechnic, Mumbai

Department of Electrical Engineering

P-16 Curriculum
[Out Come Based (OBE)]

Semester-IV
(Course Contents)

Government Polytechnic Mumbai

(Academically Autonomous Institute of Maharashtra Government)
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Programme: Electrical Engineering **Fourth Semester** **With effect from June 2017**

Teaching & Examination Scheme for the Students admitted in Second Year in 2017-18

Semester : IV

Sr. No.	Course Code	Course Title	Awards of Class	Compulsory /Optional	Teaching Scheme(Hrs./Week)				Examination Scheme (Marks)					
					L	TU	P	Total Credits	TH	TS	PR	OR	TW	Total
1	EE 16 501	Professional Practices	--	C	0	0	2	2	0	0	0	25	25	50
2	EE 16 301	Maintenance of Domestic Appliances	--	C	0	0	4	4	0	0	0	50*	50	100
3	EE 16 302	Industrial Measurement	--	C	3	0	4	7	70	30	50*	0	0	150
4	EE 16 303	Electrical Transmission & Distribution#	--	C	3	0	2	5	70#	30#	0	50*	0	150#
5	EE 16 304	Utilization of Electrical Energy	--	C	3	0	2	5	70	30	0	50*	0	150
6	EE 16 307	AC Machines	--	C	3	1	2	6	70	30	50*	0	0	150
7	EE 16 402	Renewable energy Sources	--	C	4	0	2	6	70	30	0	50*	0	150
					16	**01**	**18**		**350**	**150**	**100**	**225**	**75**	
Total Credits								**35**	**Total Marks**					**900**

Abbreviations: C- Compulsory; O- Optional; L- Theory Lecture; P-Practical; TU-Tutorial; TH- Theory Paper; TS- Term Tests (02); PR-Practical Exam; OR-Oral Exam; TW- Term Work.
***Indicates assessment by External Examiner. # Indicates on line theory exam.**

Academic Coordinator **HOD (EE)** **Principal**

Programme Code: **EE**									
Course Code: **EE 16 501**		Course Title: **Professional Practice**							
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH	TU	PR	Total	TH	TS	PR	OR	TW	Total
--	**--**	**02**	**02**	**--**	**--**	**--**	**25**	**25**	**50**

Rationale:

In the present scenario acquiring the technical knowledge is not sufficient, but every technocrat should be aware about his own professional progress to become a successful engineer in his carrier. He should know how to prepare his own CV, how to take part in group discussions, interview facing techniques, how to prepare a more interactive presentation, these all will help to improve his personality for the better success in his growing age. Industry visits, expert lectures from professionals and industry expert should really add for the job working progress.

Course Outcomes: (CO's)

EE16 501.1	Know his professional and social aim.
EE16 501.2	Prepare own bio-data and various interview techniques.
EE16 501.3	Know the importance of group discussion, presentation and latest job profiles.
EE16 501.4	Plan industry visits, expert lectures for better practical experience.

Contents:

1. **Know Yourself**
   - 1.1 My Aim
     - 1.1.1 Professional Aim
     - 1.1.2 Social Aim and Awareness
   - 1.2 C.V. (Curriculum Vitae)
     - 1.2.1 Personality
     - 1.2.2 Behavior
     - 1.2.3 Personal Bio-data
   - 1.3 Group Discussion
     - 1.3.1 Importance of Group Discussion
     - 1.3.2 Making Groups as per the strength in the class and allocating the latest topics for discussion and write the report.
       - 1.3.2.1 Technical education and society
       - 1.3.2.2 Electrical energy sources
       - 1.3.2.3 All types of pollution
       - 1.3.2.4 Government industrial policies
       - 1.3.2.5 Any other related topic
2. **Seminar Presentation**
   - 2.1 Collection of information related to our course on any topic
   - 2.2 Use books, websites, journals, magazine, field knowledge from experts etc.
   - 2.3 Present this information through PPT. (Min 5 and max 7)

3. Presentation of Professionals / Industry Experts

3.1 Why these presentations are necessary

3.2 How this will Help you to know more than your curriculum

3.3 Arrange minimum two expert lecturers for two hour session on various topics by these experts.

- 3.3.1 Role of electrical engineer in Industry
- 3.3.2 Scope and Industry culture
- 3.3.3 Electrical Safety
- 3.3.4 Industrial Drives and Control
- 3.3.5 Any latest topic related to electrical engineering

3.4 Students should prepare a report as a part of term work.

4. Industry Visits

4.1 Types of Industries and their purposes

- 4.1.1 Manufacturing and Processing
- 4.1.2 Trading and Marketing
- 4.1.3 Services to the People and Maintenance
- 4.1.4 Importing and Exporting

4.2 How small, medium and large-scale industries are different.

4.3 At least one visit should be organized to any of the following mentioned industries and write a report.

- 4.3.1 Generating Station, Substation, Load Dispatch center, Switch gear manufactures, Motor Generator manufactures Electrical sections of various industries etc.

5. Today's Job Profiles and Interview Techniques

5.1 Current Market Survey to find the Job

5.2 Your area of Interest to Apply and Preparation

5.3 Make a report on various techniques as a part of term work.

Suggested specification table with Hours and Marks (Theory)

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Know Yourself	6				
2	Seminar Presentation	6				
3	Presentation of Professionals / Industry Experts	4				
4	Industry Visits	12				
5	Today's Job Profiles and Interview Techniques	4				
	Total	32				

Legends: R- Remember; U-Understand; A- Apply and above levels (Bloom's revised Taxonomy).

Notes: *This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified.*

Suggested Implementation Strategies:

1. Lecture method
2. Improved lecture method.
3. Expert Lecturers
4. Q & A technique with Group Discussion.

5. Demonstration
6. Seminars
7. Field visit

Suggested Learning Resources:

1. Print: Text Books/Reference Books/Manuals/Journals.
2. Non Print: CDs / PPT / Transparencies / Charts / Models/ Webs

Reference Books:

Sr. No.	Name of Book	Name of Author	Publications
1	A professional practice course of EE's [electrical engineering]	Nagurney L.S. and Frochlich J.P.	IEEE
2	Teaching Professional and Ethical Aspects of Electrical Engineering to a Large Class	Kevin M. Passino	IEEE

CO's Vs PO's Matrix:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16 501.1	-	1	-	-	3	2	1	1	2	1
EE16 501.2	-	1	-	-	-	1	1	3	3	3
EE16 501.3	-	1	-	1	1	1	2	3	3	3
EE16 501.4	-	-	-	-	2	2	2	3	3	3

CO's Vs PSO's Matrix:

CO	PSO1	PSO2	PSO3
EE16 501.1	-	-	3
EE16 501.2	-	-	3
EE16 501.3	-	-	3
EE16 501.4	-	-	3

Enter correlation levels 1, 2 or 3 as defined below:
1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) *If there is no correlation, put "-"*

Academic Coordinator **Head of Department**
Electrical Engineering Dept.
Principal
Govt. Polytechnic Mumbai

Programme : **Diploma in Electrical Engineering**									
Course Code: **EE 16 301**				Course Title: **Maintenance of Domestic Appliances**					
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH	TU	PR	Total	TH	TS	PR	OR	TW	Total
--	**--**	**04**	**04**	**--**	**--**	**--**	**50***	**50**	**100**

Rationale:

Working knowledge domestic appliances should be learnt by every electrical engineer. Engineers should be well versed with installation and maintenance procedure of the domestic appliances, rating of cable/wire/fuse/mcb, power supply specification, earthing, and specific safety requirement for the particular appliance. Standard and basic electrical tools need to be practiced. This subject is intended to develop skills of maintenance, testing and fault finding of domestic appliances with following course outcomes. These outcomes will be satisfied, when students actually performs the laboratory work.

Course Outcomes:

EE16301.1	Apply safe working practices
EE16301.2	Comply environment regulation and housekeeping
EE16301.3	Interpret & use company terminology, product catalogue and technical communication
EE16301.4	Make basic electrical / electronic circuits / connections and measure Electrical parameters
EE16301.5	Carryout & test simple domestic wiring system with Earth continuity
EE16301.6	Test & Repair Domestic appliances

Unit No.	**Topics/Subtopics**
1	**Safety Practices** 1.1 Fires in electrical Circuits & Precautions 1.2 Fire Extinguishers & its Types 1.3 General Safety of Tools & equipment which are used while testing, repairing and maintenance of electrical gadgets 1.4 Environment requirement of electrical installation of domestic appliances and house keeping 1.5 Rescue of person who is in contact with live wire 1.6 Treat a person for electric shock/ injury

2	**Revision of basic electricity and electronics** 2.1 Single phase & three phase circuits 2.2 Electrical terms like Voltage, Currents, Resistance, Impedance & power factor 2.3 Familiarization with electronic components like Capacitor, Choke coil, Diode, Transistor, Thyristor, IGBT 2.4 Concept of open circuit and short circuit in the circuit diagram and installations 2.5 Series & Parallel Circuits 2.6 Direct current & Polarity testing 2.7 Alternating Current & identifying phase, neutral and earth terminals 2.8 Interpret the components as per circuits and laying components on PCB Testing of assembled PCB 2.9 Concept of earthing, purpose & types. Introduction to Pipe earthing & Plate earthing, Earthing of domestic installation, earth continuity conductors
3	**Wiring & its concepts** 3.1 Conductors, Insulators & its types 3.2 Crimping & Crimping Tools, Soldering 3.3 Joints in electrical conductor, end termination : Using glands, lugs, pin terminal and terminal connectors 3.3 Concept of gauge of wire, conductor material & its current carrying capacity 3.5 Determination of Fuse size according to the load of circuit and its location On single line diagram of domestic installation upto switch socket 3.6 Rating and specification of electrical cord, flexible cables, wires, single phase 6A/16A plug & socket. Terminal connection of switch, switch socket and Plug top, MCBs, ELCB, Fuses, resistors, inductors, capacitor 3.7 Concept of different types of switchgears used in general Electrical installations. 3.8 Use of Megger & Test lamps in fault location
4	**Domestic Appliances** 4.1 Voltage and Power requirement of all kinds of home appliances 4.2 Symbols, Diagram & Rules, Study of product catalogues Does and Don'ts related to gadget, Service log book , test certificate, Report of service 4.3 Basic construction and assembly of electric iron, heater and fan 4.4 Basic construction and assembly of mixer, grinder, blender and OTG 4.5 Basic construction and electrical parts of washing machine, microwave oven, refrigerator and dish washer 4.6 Repair and service technique of home appliances and battery Maintenance 4.7 Types/rating of batteries and their application in inverter and UPS 4.8 Construction and parts of lead acid/ maintenance free battery. Specific gravity of battery 4.9 Process of discharging and recharging of battery 4.10 Battery chargers and precautions are to be taken while charging

List of Practical : (All experiments from 1 to 10. And any six from 11.1 to 11.9)

Sr.No	Unit	Experiment/Assignment	Approx Hours
1	1	To understand signs and notices which are observed in factory and domestic electrical installation regarding electrical safety.	04
2	1	To demonstrate dousing of fire caused electrical short circuit	04
3	1	To identify proper electrical tool/equipment for general or specific purpose and practice its safe handling.	04
4	1	To demonstrate rescue of person who is in contact with live wire	04
5	1	To demonstrate first aid treatment to a person who receives electric shock/ injury	04
6	2	To set up simple electrical connections using resistance, voltmeter, ammeter & multimeter for single phase and three phase circuit.	04
7	3	To set up one board with fuse , switch and switch socket to practice of electrical joints, crimping, end termination along with test of continuity , polarity and insulation	04
8	2	To construct, solder, and test a simple circuit by using electronic components.	04
9	2	To prepare and test electronic choke & CFL assembly,led	04
10	3	To demonstrate good earthing of domestic installation and earth continuity conductors by measuring voltages between P-N, P-E and N-E	04
11	4	To understand different electrical appliances, their circuit diagrams, faults finding and repairing. Equipment are listed from 11.1 to 11.9	04
11.1	4	Electric Iron	04
11.2	4	Electric Hot Plate	04
11.3	4	Single phase invertor	04
11.4	4	Electric Room Heater	04
11.5	4	Electric Fan	04
11.6	4	Electric water Heaters	04
11.7	4	Electric Bell	04
11.8	4	Electric Mixer Grinder	04
11.9	4	Fluorescent lamp (FTL) with magnetic and electronic choke	04

Reference Books:

Sr. No.	Book Title	Author	Publication
1	Electrical Technology Volume-I	B. L. Theraja	S. Chand and Co. Ltd., New Delhi.
2	Basic Electrical Engineering	V.K. Mehta, Rohit Mehta	S. Chand and Co. Ltd., New Delhi.
3	Basic Electrical Engineering	M. L. Anwani	Dhanapat Rai and Co., New Delhi
4	How to repair small appliances Vol I & II	Jack Darr	H. W. Sams, Photofacts publications.1966
5	Electrical Safety, Fire Safety Engineering and Safety Management	S. Rao, R.K. Jain, H. L. Saluja	Khanna Publishers 1997
5	http://home.howstuffworks.com/how-to-repair-small-appliances.htm		
6	http://www.fixitclub.com/small-appliances-repairs/		

Course Curriculum Development Committee:

a. **Internal Faculty**

   i. I. N Khuspe

   ii. Mr. M. S. Narkhede

b. **External Faculty**

   i. D.D. Lulekar

Academic Coordinator **Head of Department (Electrical Engineering)** **Principal Govt. Polytechnic, Mumbai**

CO Vs PO Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16301.1	2	3	3	3	3	2	3	3	3	3
EE16301.2	2	3	3	3	3	3	3	3	3	3
EE16301.3	2	3	3	3	3	3	3	3	3	3
EE16301.4	3	3	3	3	2	3	3	3	3	3
EE16301.5	3	3	3	3	3	3	3	2	2	3
EE16301.6	2	3	3	3	3	3	3	2		3
Avg. Of COs	**2.34**	**3**	**3**	**3**	**2.84**	**2.84**	**3**	**2.67**	**2.84**	**3**

CO Vs PSO Matrix

COs	PSO1	PSO2	PSO3
EE16301.1	3	2	2
EE16301.2	3	2	2
EE16301.3	3	2	2
EE16301.4	2	2	2
EE16301.5	3	3	3
EE16301.6	3	2	3
Avg. Of PSOs	**2.84**	**2.16**	**2.34**

Programme : **Diploma in Electrical (EE) Engineering**									
Course Code: **EE 16 302**				Course Title: **Industrial Measurement**					
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH	TU	PR	Total	TH	TS	PR	OR	TW	Total
3	-	4	7	70	30	50*	-	-	150

*****Indicates assessment by Internal & External examiners.

RATIONALE:

This course is introduced with a view that the students will be exposed to various types of Transducers, signal conditioning and recording system to measure the process parameters. After completion of this course student will gain sufficient knowledge of process measurement.

Course Outcomes:

Upon completion of this course, students should be able to,

EE16302.1	Identify, list and classify different transducers.
EE16302.2	Draw the Input/output characteristics of transducers.
EE16302.3	Demonstrate and verify the transduction principles of transducers.
EE16302.4	Measure the process parameters such as Temperature, pressure, level, flow etc.
EE16302.5	Select the relevant transducers and recorders for the given application.

Course Content Details:

Unit No.	Topics / Sub-topics
1	**Introduction to Transducers:** 1.1 concept of Instrumentation 1.2 Basic block diagram of Instrumentation system & functions of each elements. 1.3 Definitions of Static and dynamic characteristics 1.4 Primary & secondary standards 1.5 Concept of Transducers 1.6 Classification of Transducers – Primary and Secondary Transducers – Analog and Digital Transducers – Active and Passive Transducers 1.7 Resistive Transducer:- Potentiometer ,Strain gauge (No derivation only formula), Types of strain gauges :- unbounded, bounded, Semiconductor, Light dependent resistor. 1.8 Inductive transducer:- Inductance principle, LVDT,RVDT 1.9 capacitive transducers:-capacitance principle, variable capacitance due to change in dielectric media, change in overlapping area, change in distance between two plates .

2	**Process Measurement Transducer** 2.1 pressure transducer:- – Manometer, Bourdon tube, bellows, diaphragm, Dead weight tester 2.2 Temperature transducer:- – Bimetallic thermometer, Thermocouple and its effect, Thermistor , RTD, pyrometer. 2.3 Flow Transducer:- – Orifice, Venturimeter, Rotameter, Coriolis flow meter. 2.4 Level Transducer:- – Capacitive type , Ultrasonic type ,Bubbler type. Working principle, application of above transducer
3.	**Signal conditioning:** 3.1 Concept of signal conditioning 3.2 Block diagram of AC and DC signal conditioning and working. 3.3 Operational Amplifiers, OP AMP – 741,Block diagram and its Electrical characteristics – Integrator, Differentiator, adder, subtractor, Inverter etc. – V to I converter, I to V converter, V to F converter A/D and D/A converters only working principle – Instrumentation Amplifier, Differential amplifier 3.4 Filters :- Types and frequency response (Only passive, active first order filters) (No derivations) 3.5 Multiplexing
4.	**Data Processors & Data transmission:** 4.1 Necessity of data processing in Instrumentation. 4.2 Generalized Data acquisition system : Block diagram & explanation 4.3 Concept of Data transmission 4.4 Block diagram of data transmission system & explanation 4.5 Advantages and disadvantages of digital data transmission over analog transmission
5	**Display Devices and Recorders:** 5.1 Digital display devices (LED, seven segment only) 5.2 Necessity of Recorder in Instrumentation 5.3 Classification of Recorders. 5.4 Block diagram and working principles of strip-chart, X-Y recorder.

Suggested Specifications Table with Hours and Marks (Theory):

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Introduction to Transducers**	08	8	6	2	16
2	**Process Measurement Transducer**	08	2	8	6	16
3	**Signal conditioning**	08	4	4	10	18
4	**Data Processors & Data transmission**	04	2	8	2	12
5	**Display Devices and Recorders**	04	2	6	---	08
Total		32	18	32	20	70

Legends: R- Remember; U-Understand; A- Apply and above levels (Bloom's revised Taxonomy).

Notes:*This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified.*

List of Experiments:

Sr. No.	Unit	Experiment/Assignment	Approx. Hours
1	**2**	To plot characteristics of Thermistor	**2**
2	**2**	To measure temperature using thermocouple	**2**
3	**2**	To plot characteristics of RTD	**2**
4	**2**	To measure pressure using pressure transducer	**6**
5	**2**	To measure liner displacement by LVDT	**2**
6	**3**	To construct signal conditioning circuit using OP – Amp 741 and Observe output, plot the adder, subtracter , Differentiator & Integrator.	**6**
7	**3**	To assemble Instrumentation amplifier circuit and find the gain of it	**4**
8	**2**	To measure and control the Liquid level using capacitive transducer	**2**
9	**3**	To study V to I converter and I to V converter using Op – Amp 741 and Observe output	**4**
10	**3**	To observe the response of first order low pass filter using OP-AMP	**4**
11	**2**	To measure of flow by orifice / venturi tube / rotameter	**4**
12	**2**	To measure angular displacement using capacitive transducer**.**	**2**

References/ Books:

Sr. No.	Name of Book	Author	Publisher
1	Electrical and Electronics Measurements and Instrumentation	A.K.Sawhney	Dhanpat Rai and Sons
2	Instrumentation Devices and Systems	Rangan, Mani Sharma	Tata McGraw Hill
3	Instrumentation and Control	S.K.Singh,	Tata McGraw Hill
4	Principle of Industrial Instrumentation	D.Patranabis	Tata McGraw Hill

Course Curriculum Development Committee:

a. **Internal Faculty**

i Dr. M.S.Narkhede
ii Mr.S.G.Thube
iii Ms. V.K.Pawar

b. **External Faculty**
   i. Mrs.S.S.Kulkarni

Academic Coordinator **Head of Department**
Electrical Engineering.
Principal
Govt. Polytechnic Mumbai

Course Name:- Industrial Measurement Course Code:-EE16302

CO Vs PO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16302.1	3	3	2					1	1	1
EE16302.2	3	3	3					2	1	1
EE16302.3	3	3	2					2	1	1
EE16302.4	3	3	3					3	1	1
EE16302.5	3	3	3					2	1	1

CO Vs PSO Matrix

CO	**PSO1**	**PSO2**	**PSO3**
EE16302.1	**3**	**1**	
EE16302.2	**3**	**1**	
EE16302.3	**3**	**2**	
EE16302.4	**3**	**2**	
EE16302.5	**3**	**2**	

Unit Number and COs

Sr. No.	**Unit No.**	**Topic Title**	**COs**
1	1	Introduction to Transducers	**EE16302.1**, **EE16302.3**
2	2	Process Measurement Transducer	**EE16302.1**, **EE16302.2**
3	3	Signal conditioning	**EE16302.4**, **EE16302.3**
4	4	Data Processors & Data transmission	**EE16302.4**
5	5	Display Devices and Recorders	**EE16302.5**

Programme : **Diploma in Electrical Engineering (EE)**									
Course Code: **EE 16 303**				Course Title: **Electrical Transmission and Distribution**					
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH	TU	PR	Total	TH	TS	PR	OR	TW	Total
03	**00**	**02**	**05**	**70 #**	**30#**	**-**	**50***	**-**	**150**

* Indicates assessment by External Examiner

#Indicates assessment by On Line examination

Rationale:

This is the subject where the principles of electrical transmission and distribution systems are studied. Knowledge of components of electrical transmission and distribution system and their functions is necessary for understanding power system performance. Study of load dispatch and HVDC transmission is also important for working in power sector or industry.

Course Outcomes:

Upon completion of this course, students should be able to,

EE16 303.1	Know various types of transmission & distribution systems.
EE16 303.2	Understand importance of load dispatch centre.
EE16 303.3	Identify various components & their functions of transmission and distribution systems.
EE16 303.4	Calculate string efficiency of insulator and transmission efficiency
EE16 303.5	Calculate the performance of transmission and distribution system.
EE16 303.6	Draw and explain the phasor diagram of short & medium transmission line.
EE16 303.7	Know about HVDC Substation and its types.

Course Content Details:

Unit No	Topics / Sub-topics
1	**Introduction to Transmission:** 1.1 A.C. and D.C. transmission. 1.2 Advantages and disadvantages. 1.3 National, Regional and State Load Dispatch Centers. 1.4 Introduction to grid and different voltage levels for HVAC and HVDC. 1.5 Compare between HVAC & HVDC
2	**Transmission line components:** 2.1 Introduction to line component. 2.2 Types of conductor- Al, ACSR, Cu and solid stranded bundle conductors. 2.3 Line supports – requirement, type. Construction of supporting structures, Towers, monopoles 2.4 Spacing between conductors. 2.6 Concept of length of span. 2.7 Sag in overhead line. 2.8 Calculations of sag: effect of wind and ice loading (Simple Numerical) 2.9 Types of insulator – Pin, Suspension, Strain, Stay, Shackle. 2.10 Safety factor, puncture and ultimate strength.

	2.11 Potential distribution over a string of suspension insulator. 2.12 Simple numerical on string efficiency.
3	**Transmission line parameters:** 3.1 Constants of transmission lines 3.2 Skin effect 3.3 Transposition of conductor and necessity. 3.4 Corona 3.4.1 Factors affecting corona. 3.4.2 Important terms 3.4.3 Advantages and disadvantages of corona. 3.4.4 Methods of reducing corona effect
4	**Performance of transmission line:** 4.1 Classification of transmission line, Important terms, regulation & efficiency of T/L 4.2 Short transmission line, eq. circuit representation & phasor diagram & analysis. (Simple Numerical) 4.3 Medium transmission line, End condenser method, Nominal T and π circuit representation & analysis, phasor diagram. 4.4 Ferranti effect. 4.5 Introduction of Long transmission line.
5	**High Voltage DC Transmission** 5.1 Principle of HVDC system 5.2 Types of DC link (Block diagram, components & description)
6	**Introduction to Distribution system:** 6.1 Components of Distribution system - distributor, feeder and service mains. 6.2 Classification of distribution system. 6.3 A.C. distribution. 6.4 Connection scheme of distribution system -radial and ring mains system. 6.5 Factors to be considered for design considerations. 6.6 Voltage drop calculation for feeder fed at one end for single phase and three phase four wire A.C. balanced system.
7	**Underground Cables:** 7.1 Introduction and requirement. 7.2 Classification of Cable. 7.3 Cable conductor. 7.4 Cable construction. 7.5 Cable insulation, metallic sheathing and mechanical protection. 7.6 Comparison with overhead lines. 7.7 Methods of cable laying. 7.8 Proximity effect. 7.9 Aerial bunch cable
8	**Tariff & Power factor improvement :** 8.1 Different types of tariffs. 8.2 Causes and disadvantages of low power factor 8.3 P.F. improvement using static capacitor. 8.4 Advantage of P.F. improvement.

Suggested Specifications Table with Hours and Marks (Theory):

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	Introduction to Transmission	04	2	4	0	06
2	Transmission line components	10	4	4	6	14
3	Transmission line parameters	04	2	4	0	06
4	Performance of transmission line	08	2	4	6	12
5	High Voltage DC Transmission	04	2	4	0	06
6	Introduction to Distribution system	08	2	4	6	12
7	Underground Cables	06	2	0	6	08
8	Tariff & Power factor improvement	04	2	4	0	06
	Total	**48**	**18**	**28**	**24**	**70**

Legends: R- Remember; U-Understand; A- Apply and above levels (Bloom's revised Taxonomy).

Notes: *This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified.*

List of experiments/Assignments:

Sr. No.	Unit	Experiment/Assignment	Approx. Hours
1	**1**	Introduction to MATLAB	**04**
2	**1,2**	Study of basic tools required for Electrical Engg.	**04**
3	**3**	Simulation of simple R,L,C of single phase circuit.	**04**
4	**3,4**	Simulation of short Transmission Line	**04**
5	**3,4**	Simulation of Numerical 'T' circuit representation of medium transmission line	**04**
6	**3,4**	Simulation of Numerical 'π' circuit representation of medium transmission line	**04**
7	**6**	Simulation of distribution system – radial/ ring mains.	**04**
8	**8**	Simulation of Power factor improvement using FACTS devices	**04**
		Total	**32**

References/ Books:

Sr. No.	Name of Book	Author	Publisher

1	Elements of Power System	V. K. Mehta and Rohit Mehta	S. Chand and Co. Ltd.
2	Electrical Power System	Dr. S. L. Uppal ,Prof. S. Rao	Khanna Publisher, New Delhi.
3	A course in Power plant Engineering	Dr. V. M. Domkundwar	Dhanpat Rai & Sons
4	A course in Electrical Power	Soni, Gupta, Bhatnagar	Dhanpat Rai & Sons
5	Transmission & Distribution	J. B. Gupta	S. K. Khanna
6	Electrical Power system Design	M.V.Deshpande	Tata Mcgraw-Hill

Course Curriculum Development Committee:

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   i. Mrs. J. D. Waghmare
   ii. Dr. P. N. Padghan
   iii. Mrs. V. U. Bhosle
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Academic Coordinator **Head of Department (Electrical Engineering)** **Principal Govt. polytechnic Mumbai**

Unit and CO mapping:

S.N.	Unit	CO
1	Introduction to Transmission	**EE16 303.1, EE16 303.2**
2	Transmission line components	**EE16 303.1, EE16 303.3, EE16 303.4**
3	Transmission line parameters	**EE16 303.3**
4	Performance of transmission line	**EE16 303.1, EE16 303.5, EE16 303.6**
5	High Voltage DC Transmission	**EE16 303.7**
6	Introduction to Distribution system	**EE16 303.1, EE16 303.3, EE16 303.5**
7	Underground Cables	**EE16 303.3**
8	Tariff & Power factor improvement	**EE16 303.1, EE16 303.3**

CO Vs PO matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16 303.1	2	3	2	3	-	1	-	-	-	-
EE16 303.2	2	3	3	3	2	1	-	3	1	2
EE16 303.3	2	3	3	2	1	1	-	-	-	-
EE16 303.4	3	3	3	3	-	-	-	-	-	-
EE16 303.5	3	3	3	3	-	-	-	-	-	-
EE16 303.6	3	3	2	2	-	-	-	-	-	-
EE16 303.7	1	1	2	1	2	1	-	3	1	2
Avg	2.29	2.71	2.57	2.43	0.71	0.57	0	0.86	0.29	0.57

CO Vs PSO matrix

CO/POs		PSO1	PSO2	PSO3
EE16 303.1	Know various types of transmission & distribution systems.	2	1	2
EE16 303.2	Understand importance of load dispatch centre.	3	3	2
EE16 303.3	Identify various components & their functions of transmission and distribution systems.	3	2	3
EE16 303.4	Calculate string efficiency of insulator and transmission efficiency	3	1	1
EE16 303.5	Calculate the performance of transmission and distribution system.	3	1	1
EE16 303.6	Draw and explain the phasor diagram of short & medium transmission line.	3	3	3
EE16 303.7	Know about HVDC Substation and its types.	2	2	3
	Avg	2.71	1.86	2.14

Programme Code: **EE**									
Course Code: **EE 16 304**			Course Title: **Utilization of Electrical Energy**						
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH	TU	PR	Total	TH	TS	PR	OR	TW	Total
03	**--**	**02**	**05**	**70**	**30**	**--**	**50***	**--**	**150**

Rationale:

The electrical supervisor / technician are expected to possess knowledge of utilization of electrical energy especially in the industry. Their main job functions are to supervise the operation & control of various electrical drives, electrical furnaces. Railway is one of the major employers of Electrical Diploma holders; therefore, Diploma holder should also study the electrical traction and Electric Traction system. This course deals with utilization of electrical energy in various industries.

Course Outcomes:

The students will be able to

EE16304.1	**Define terminologies used in illumination.**
EE16304.2	**Select suitable lighting, lighting schemes and sources of light for specific applications.**
EE16304.3	**Identify suitable methods of electric heating for specific applications.**
EE16304.4	**Choose Electric Drive for specific applications.**
EE16304.5	**Preliminaries of track Electrification systems with equipment.**

Contents:

1 : Illumination:

- Definitions of Terms used in Illumination-Light, Luminous flux, Luminous Intensity, Lumen, Illuminance or Illumination or Degree of illumination, Mean Horizontal Candle Power (M.H.C.P.), Mean Spherical Candle Power (M.S.C.P.), Mean Hemispherical Candle Power (M.H.S.C.P.), Reduction Factor, Foot candle, Lux, Nit, Stilb, Brightness.
- Laws of Illumination
  (simple numerical)
- Diffusing and Reflecting Surfaces: Globes and Reflectors
- Types of Lighting Schemes-Direct, Semi-Direct, Semi-Indirect, Indirect, General Lighting.
- Factory Lighting - General Requirement, Types of installations: General Lighting, local lighting, Emergency Lighting.
- Flood Lighting - Flood Lighting purposes, Classification of projectors, Location and mounting of projectors.
- Introduction of Street Lighting.

2 : Sources of Light:

Construction, Working and Applications of following Lamps:

- Incandescent Lamps.
- Halogen Lamps.
- Low Pressure Mercury Vapour Lamps (Fluorescent Tube).
- High Pressure Mercury Vapour Lamps.
- Sodium Vapour Lamps.

- Compact Fluorescent Lamps (C.F.L.)
- Metal Halide Lamps
- LED Lamps
- Neon Signs.
- Introduction to LASERS

3 : Electric Heating :

- Advantages of Electric Heating.
- Modes of Transfer of Heat:
- Classification of Electric Heating Methods:
- Resistance Heating: Construction & Operation, Direct Resistance Heating - Salt Bath Furnace, Indirect Resistance Heating: Resistance Ovens, Requirements of Heating Element Material, Causes of Failure of Heating Elements, Methods of Temperature Control, Applications of Resistance Heating, Design of Heating Element. (Simple Numerical problems on heating elements)
- Arc Heating - Construction & Operation, Direct Arc Furnace, Indirect Arc Furnace, Applications of Arc Heating.
- Induction Heating - Construction & Operation Core Type Induction Furnaces: Ajax Wyatt Furnace, Coreless Induction Furnace, Applications of Induction Heating, High frequency eddy current heating. Radiant & infrared heating, Estimation of Heat data. (Simple Numerical problems on rating of furnace.)
- Dielectric Heating: Principle of Dielectric Heating, Advantages of Dielectric Heating
- Limitations of Dielectric Heating, Applications of Dielectric Heating.

4 : Electric Drives:

- Introduction: What is drive?
- Drives – Mechanical Drive and Electric Drive, Advantages and Disadvantages of Electric Drive.
- Factors Governing Selection of Electric Motors, Nature of Electric Supply - 3 phase& 1 phase AC and DC, Type of Drive: Group Drive & Individual Drive.
- Nature of Load: Nature of the Mechanical Load, Matching of the Speed Torque Characteristics of the Motor with that of the Load, and Starting Conditions of the Load.
- Braking Characteristics - Plugging, Rheostatic Braking and Regenerative Braking, as Applied to DC Series and Three Phase Induction Motor.
- Mechanical Features - Type of Enclosure as per IS. Type of Bearings, Type of Transmission for Drive, Noise Level.
- Size of Motor - Load Conditions - Continuous Loads, Short Time Loads, Intermittent Loads, Continuous Operation with Short Time Loads and Continuous Operation with Intermittent Loads.
- Duty Cycles
- Standard Ratings for Motors as per ISS.
- Load Equalisation (No Calculations).

5 : Electric Traction:

- Introduction to Traction System, Requirements of an Ideal Traction System, Non-electric Traction Systems, Electric Traction Systems, Advantages and Disadvantages of Electric Traction Systems.
- Systems of Track Electrification
- Block diagram of AC locomotives with description of various equipment and accessories
- Working principal, advantages and disadvantages of Mono Rail and Metro Railways.
- Introduction of Diesel Multiple Unit (DMU), Electrical Multiple Unit (EMU) and Main Line Electrical Multiple Unit (MEMU)

List of Practical's (Any 8)

Sr. No	Unit No.	Experiment/Assignment	Approx. Hours
1	1	Measure Illumination at various places within the college premises by lux-meter.	4
2	1	Prepare a report by observing different lighting schemes at various sites / locations.	4
3	2	Prepare a survey report after collecting technical information of various lamps available in the local market.	4
4	2	Prepare an industrial visit report after visiting nearby lamp manufacturing industry.	4
5	3	Prepare a report on electrical heating furnace after visiting the industry.	4
6	4	Select the appropriate motors and justify the selection for given different load situations. (at least two)	4
7	4	Make a report by comparing various electrical drives for traction.	4
8	5	Prepare a report visiting nearby electric traction sub-station.	4
9	5	Prepare a report by comparing Metro and Mono Rail for public transport.	4
10	5	Prepare a report on various equipment's and accessories used in AC Locomotives.	4

Suggested specification table with Hours and Marks (Theory)

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Illumination**	8	4	4	4	12
2	**Sources of Light**	10	4	6	4	14
3	**Electric Heating**	12	6	4	8	18
4	**Electric Drives**	12	8	4	4	16
5	**Electric Traction**	6	6	4	---	10
		48	28	22	20	70

Legends: R- Remember; U-Understand; A- Apply and above levels (Bloom's revised Taxonomy).
Notes: *This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified*

Reference Books:

1. Electrical Power System by Dr. S. L. Uppal and Prof. S. Rao, Publisher: Khanna Publisher, New Delhi.
2. Utilization of Electric Power & Electric Traction by J. B. Gupta Publisher: S. K. Kataria & Sons.
3. Art & Science of Utilization of Electrical Energy by H. Partab Publisher: Dhanpat Rai & Sons.
4. Electric Traction by J. Upadhyay and S. N. Mahendra Publisher: Allied Publisher House Ltd.

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CO VS PO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16304.1	3	3	2	2	2	2	2	-	-	2
EE16304.2	3	3	2	3	2	2	2	-	-	2
EE16304.3	3	3	3	3	2	2	2	-	-	2
EE16304.4	3	3	3	3	2	2	2	-	-	2
EE16304.5	3	3	2	3	2	2	2	-	-	2
Avg. of POs	3	3	2	3	2	2	2	--	--	2

CO Vs PSO Matrix

CO	PSO1	PSO2	PSO3
EE16304.1	3	3	1
EE16304.2	3	3	2
EE16304.3	3	1	3
EE16304.4	3	2	2
EE16304.5	3	-	1
Avg. of PSOs	3	2	2

Unit Vs CO Matrix

Unit	**EE16304.1**	**EE16304.2**	**EE16304.3**	**EE16304.4**	**EE16304.5**
1	3	3	-	-	-
2	3	3	-	-	-
3	-	-	3	-	-
4	-	-	-	3	-
5	-	-	-	-	3
Avg. of COs	1.2	1.2	0.6	0.6	0.6

Programme Code: **Electrical Engineering**									
Course Code: **EE 16 307**		Course Title: **AC Machines**							
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH	TU	PR	Total	TH	TS	PR	OR	TW	Total
03	**01**	**02**	**06**	**70**	**30**	**50***	**--**	**--**	**150**

Rationale:

This subject is applied technology subject. It teaches students facts, concepts, principles & procedure for operations of electrical machines such as induction motor, alternator and synchronous motor. Student will be able to analyze the characteristics and qualitative parameters of these machines. The knowledge and skills obtained will be helpful in discharging technical functions such as maintenance, supervision, and controlling in the industry.

Course Outcomes:

EE16307.1	Demonstrate the constructional details & explain working principal of various types of ac machines.
EE16307.2	Solve Equivalent circuit parameters and construct the circle diagram of induction motor.
EE16307.3	Explain armature reaction, parallel operation and find voltage regulation of alternator.
EE16307.4	Examine effect of excitation and plot curves of synchronous motor.
EE16307.5	Compare Induction motor and synchronous motor.
EE16307.6	Select proper rating of motors for particular application.

Contents:

1: Introduction to AC Rotating Machines:

1.1 Introduction to AC rotating machines.
1.2 General information of three phase machines.
1.3 Difference between AC and DC Machines.

2: Three Phase Induction Motor:

2.1 Working principle of 3-phase I.M.
2.2 Construction and types of 3- phase induction motor.
2.3 Comparison between squirrel-cage and slip-ring induction motor.
2.4 Production of rotating magnetic field.
2.5 Three phase induction motor speed, slip, frequency, rotor frequency and their relations. (Simple Numerical)
2.6 Equation of rotor induced emf, current, frequency, reactance, and impedance under steady and running condition. (Simple Numerical)
2.7 Torque equation of three phase induction motor. (Simple Numerical)
2.8 Starting and running torque of squirrel cage and slip ring induction motor.
2.9 Condition for maximum and starting torque.
2.10 Torque slip characteristics of three phase induction motor.
2.11 Effect of change in rotor circuit resistance on torque-slip characteristics.
2.12 Effect of change in supply voltage on torque-slip characteristics.
2.13 Torque Ratios (Numerical)
2.13.1 Starting torque to Maximum torque
2.13.2 Full load torque to Maximum torque

3: Three Phase Induction Motor – Starters, Speed Control & Circle diagram.

3.1 Need of starters
3.2 Various starters used to start 3-phase IM
Starting of squirrel cage and slip ring induction motor.
Compare starters with DOL starter (simple numerical)
3.3 Speed control of three phase induction motor by
- Pole changing method
- Frequency control method
- By stator voltage control
- Rotor resistance control (Simple Numerical)

3.4 Applications of three phase induction motor.
3.5 Power stages of three phase induction motor.
3.6 I.M. as a generalized transformer.
3.7 Equivalent Circuit of 3-phase IM.
3.8 Construction of Circle Diagram
- Importance of circle diagram
- No load test and Blocked rotor test on 3-phase IM
- Construction of the circle diagram. (Numerical)

4: Three Phase Alternator:

4.1 Construction of three phase Alternator
- Rotor- smooth cylindrical & projected type

4.2 Advantages of stationary armature construction
4.3 Derivation of e.m.f. equation of Alternator which includes
- Chording factor
- Distribution factor
(Simple Numerical)

4.4 Factors affecting the terminal voltage of Alternator
- Armature resistive drop
- Leakage reactance drop
- Armature reaction at various power factors & concept of Synchronous impedance

4.5 Regulation of three phase Alternator by
- Synchronous impedance method
- mmf method. (Simple Numerical)

4.6 Parallel operation of three phase alternator.
- Synchronizing by 1) One dark two bright lamp method, 2) Synchroscope.

5 : Synchronous Motor:

5.1 Construction.
5.2 Characteristics of synchronous motor.
5.3 Principle of operation.
5.4 Starting of Synchronous Motor.
5.5 Synchronous Motor on load with constant excitation. (Simple Numerical)
5.6 Effect of excitation at constant load. (Simple Numerical)
5.7 Starting Methods.
Power flow within a synchronous motor.
V curve & inverted V curve. (Simple Numerical)
5.8 Applications.
5.9 Comparison between IM & Synchronous Motor.

6: Single Phase Motors:

6.1 Double field revolving theory.
6.2 Types of Single-phase IM.
6.3 Split phasing principle of starting.

6.4 Principle of working, schematic diagram and applications of following motors - Resistance start induction run - Capacitor start induction run - Capacitor start Capacitor run - Shaded pole

List of Practical:

Sr. No	Unit No.	Experiment/Assignment	Approx. Hours
1	2	To measure the slip of 3-phase induction motor by: i) Tachometer ii) Comparing rotor & stator frequency.	2
2	3	To use different types of starters to start and run 3-phase induction motor. i) D.O.L. starter, ii) Stator resistance starter, iii) Star-Delta starter, iv)Auto transformer starter, v)Rotor resistance starter.	2
3	3	To measure the performance of 3-phase induction motor by direct loading.	4
4	3	Perform no load test and block rotor test on 3-phase induction motor, to construct the circle diagram.	4
5	3	To study the Double cage IM.	2
6	4	To perform O.C.C. of the alternator	2
7	4	To determine the percentage regulation of 3-phase alternator by synchronous impedance method at Various power factors.	4
8	4	To perform parallel operation of three phase alternator.	4
9	4	To find the percentage regulation of 3-phase alternator by direct loading method at various power factors.	4
10	5	To start the synchronous motor by applying any one starting method. Plot V & inverted V curve of the same.	4

Survey Project:

1. To list the various types of 1-phase induction motor. Collect the literature for them from dealers / manufacturers of local places & compare on the following points
   i) Method of starting ii) Cost iii) Performance iv) Starting torque etc.
   and prepare a report.

Suggested specification table with Hours and Marks (Theory)

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Introduction to AC Rotating Machines.**	2	2	2	-	04
2	**Three Phase Induction Motor.**	12	4	6	6	16
3	**Three Phase Induction Motor – Starters, Speed Control & Circle diagram**	10	4	6	6	16
4	**Three Phase Alternator**	12	4	6	4	14
5	**Synchronous Motor**	08	2	6	4	12
6	**Single Phase Motors.**	04	4	4	-	08
	Total	48	20	30	20	70

Legends: R- Remember; U-Understand; A- Apply and above levels (Bloom's revised Taxonomy).
Notes: *This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified*

Reference Books:

Sr.No.	*Name of Book*	*Author*	*Publisher*
1	Electrical Machines.	P.S. Bhimbhra.	Khanna Publisher.
2	A Text Book Of Electrical Technology vol-II	B.L. Theraja A.K. Theraja	S. Chand & Co.
3	Electrical Machines.	Nagrath & Kothari	Tata McGraw-Hill Co. New Delhi
4	Electrical Technology	J.B. Gupta	S.K. Kataria & Sons.
5	Electrical Machines	S.K. Bhattacharya	Tata McGraw-Hill Co. New Delhi

Websites:
1. *www.nptel.com*
2. *www.electrical4u.com/*
3. *electrical-engineering-portal.com*
4. *www.learnerstv.com*

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CO VS PO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16307.1	3	-	-	-	-	-	-	-	-	2
EE16307.2	3	-	3	-	2	2	-	-	-	2
EE16307.3	3	3	3	3	2	3	2	-	-	2
EE16307.4	3	3	3	3	2	3	2	-	-	2
EE16307.5	3	3	3	3	2	3	2	-	-	2
EE16307.6	3	3	3	3	2	3	2	-	-	2
Avg. of POs	3	2	2.5	2	1.6	2.3	1.3	--	--	2

CO Vs PSO Matrix

CO	PSO1	PSO2	PSO3
EE16307.1	1	-	1
EE16307.2	3	2	2
EE16307.3	3	2	2
EE16307.4	3	2	2
EE16307.5	3	2	2
EE16307.6	3	2	2
Avg. of PSOs	2.6	1.6	1.8

Unit Vs CO Matrix

Unit	**EE16304.1**	**EE16304.2**	**EE16304.3**	**EE16304.4**	**EE16304.5**	**EE16307.6**
1	2	-	-	-	-	-
2	3	3	-	-	3	-
3	-	3	-	-	3	3
4	3	-	3	-	-	3
5	3	-	-	3-	3	3
6	3	-	-	-	-	3
Avg. of COs	2.3	1.0	0.5	0.5	1.5	2

Programme : **Diploma in Electrical Engineering**									
Course Code: **EE 16 406**		Course Title: **Renewable Energy Sources**							
Compulsory / Optional: **Compulsory**									
Teaching Scheme and Credits				Examination Scheme					
TH		PR	Total	TH	TS	PR	OR	TW	Total
4		**2**	**6**	**70 (3 Hrs.)**	**30**	**-**	50*	--	**150**

1. RATIONALE :

Due to the extensive use of energy the conventional energy sources like fossil fuel are depleting very fast & the thrust is to be given on renewable energy sources for power generation. An Electrical Engineer should be aware of methods of extracting energy from Non Conventional energy sources like Solar, Wind, Geothermal etc.

Energy is an important aspect in all sectors of country's economy. The energy crisis is mainly caused due to increased population and enhanced standard of living and life style of people. The conventional sources of energy are insufficient to meet these demands. Hence, alternative energy sources are utilized for power production. The use of alternate energy sources is increasing day by day. Diploma engineers are expected to develop, operate and maintain these systems. It is therefore essential to know basics of energy conversion, conservation, and energy audit and waste heat recovery techniques.

Course Outcomes:

EE16406.1	State the various methods of energy conversion from solar energy & its applications.
EE16406.2	State the various methods of energy conversion from wind energy & its applications.
EE16406.3	State the various methods of energy conversion from ocean energy, geothermal energy, biomass & other sources of renewable energy

Unit No.	Topics / Sub-topics
1	**Energy scenario and development:** 1.1 Overview of world energy scenario 1.2 Overview of India's energy scenario 1.3 Energy Sources: classification of energy sources 1.5 Need and Prospectus of Alternate Energy Sources
2	**Solar energy** 2.1Principle of conversion of solar radiation into Heat and Electricity. 2.2 Solar radiation Geometry: Declination, hour Angle, Altitude angle, incident angle, Zenith angle, solar Azimuth angle 2.3 Instruments for measuring solar radiation (explanation of only Pyranometer) 2.4 Construction and working of typical flat plate collector, solar concentrating collector and their applications, Advantages and Limitations 2.5 Space Heating and Cooling (only vapour absorption system) 2.6 Construction and working of solar cell, performance characteristic of solar cell 2.7 Solar Photo voltaic Electric Conversion (Stand alone and Grid connected

	system) 2.8 Introduction to MPPT (no details) 2.9 Solar pond, solar electric power generation (explanation of only high temperature system), Solar Distillation, Solar cooking 2.10 Solar pumping and Green House (No numerical on above content)
3	**Wind energy** 3.1 Principle of Wind energy conversion, Nature of the wind energy. 3.2 Power in wind, Power coefficient, Maximum power, Forces on the blades, Wind Energy Conversion 3.3 Selection of site for wind mill. 3.4 Classification of WEC systems. 3.5 Advantages and limitations of WECS 3.6 Basic components of WECS. 3.7 Wind energy collectors- Horizontal and Vertical axis machines, 3.8 Safety systems and Environmental aspects. (No numerical on above content)
4	**Bio-mass energy** 4.1 Biomass conversion technologies - 1) combustion 2) Thermo chemical 3) Biochemical. Wet processes, Dry processes. 4.2 Biogas generation – anaerobic digestion, 4.3 Types of Bio-gas plants, KVIC Digester, fixed dome digester, Deenbhandu, Pragati Biogas plant. 4.4 Materials used for biogas generation. Selection of site for biogas plant. Applications. Energy plantation.
5	**Energy from the oceans** 5.1 Ocean Thermal Electric Conversion-Methods of Power Generation, Open and closed cycle OTEC system 5.2 Tidal power –Basic Principle, Components of Tidal Power Plants, 5.3 Operation Methods-single basin and double basin 5.4 Advantages and limitations for tidal power Generation 5.5 Sites Requirements, Prospects of tidal energy in India.
6	**Other alternate sources of energy** 6.1 Geothermal Energy –Sources, Principle, Hydrothermal Resources ,Geothermal energy power plant, Advantages ,Limitation and application of Geothermal Energy, Geothermal occurrence in India 6.2 Small Hydroelectric Plant(Mini and Micro hydel) Nature, Classification of SHP station, Components of SHP, Design Consideration for Mini and Micro Hydel Projects, Advantages and Limitation of SHP 6.3 Fuel Cell- Principle of Operation, Classification, Advantages, Limitation and Application of Fuel cell 6.4 Magneto-Hydro Dynamic(MHD) Power Generation- Principles, MHD system, Advantages, Future Prospects

Suggested specification table with Hours and Marks (Theory)

Unit No	Topic Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1	**Energy scenario and development:**	06	06	02	00	08
2	**Solar energy**	16	04	06	04	14
3	**Wind energy**	12	04	06	04	14
4	**Bio-mass energy**	08	04	06	00	10
5	**Energy from the oceans**	08	06	04	00	10
6	**Other alternate sources of energy**	14	04	06	04	14
		64	**28**	**30**	**12**	**70**

Legends: R- Remember; U-Understand; A- Apply and above levels (Bloom's revised Taxonomy).
Notes: *This specification table shall be treated as a general guideline and actual distribution of marks may slightly vary from table. But the questions from each topic should be asked as per marks weightage. Numerical questions are to be asked only if specified.*

List of Experiments

Sr. No.	Unit No.	**Experiment/Assignment**	**Approx Hours**
1	2	Study of solar energy & solar photovoltaic systems through books, literature and internet.	4
2	3	Study of wind energy systems through books, literature and internet.	2
3	4	Study of biomass energy through books, literature and internet.	2
4	5	Study of ocean energy through books, literature and internet.	2
5	6	Study of Geo thermal energy systems through books, literature and internet.	2
6	6	Study of Fuel cells through books, literature and internet.	2
7	2	Visit to solar power plant and visit report on it.	6
8	3	Visit to wind power plant and visit report on it.	6
9	4	Visit to biogas plant and visit report on it.	6

Reference Books:

Sr.No.	***Name of Book***	***Author***	***Publisher***
1	Solar Energy - Principles of thermal collection and storage	S.P. Sukhatme	Tata McGraw-Hill Co. New Delhi
2	Non-Conventional Sources of Energy	Rai, G.D	Khanna Publishers, Delhi
3	Renewable Energy Sources &	Bansal N. K.,	Tata McGraw-Hill Co.

	Conversion technology	Kleemann M. & Michael, Meliss	New Delhi
4	Biogas systems: Priciples and Applications	Mital K.M	New Age International
5	Biogas Technology - A Practical Hand Book	K.Khendelwal & S.S. Mahdi	Tata McGraw-Hill Co. New Delhi

Websites:

i) www.mahaurja.com
ii) www.indiasolar.com
iii)www.beeindia.in

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Academic Coordinator **Head of Department (Electrical Engineering)** **Principal Govt. Polytechnic, Mumbai**

CO Vs PO Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
EE16406.1	3	3	2	3	3	3	---	2	1	3
EE16406.2	3	3	2	3	3	3	---	2	1	3
EE16406.3	3	3	2	3	3	3	--	2	1	3
Avg. of POs	3	3	2	3	3	3	--	2	1	3

CO Vs PSO matrix

CO	PSO1	PSO2	PSO3
EE16406.1	3	1	3
EE16406.2	3	1	3
EE16406.3	3	1	3
Avg. Of PSOs	3	1	3