

**Government of Karnataka
Department of Collegiate and Technical Education
Board of Technical Examinations, Bangalore**

Course Code	20EE11T	Semester	I
Course Title	BASICS OF ELECTRICAL POWER SYSTEM	Course Group	Core
No. of Credits	4	Type of Course	Lecturing, Student Activity and Assignment
Course Category	ES	Total Contact Hours	4Hrs Per Week
			52Hrs Per Semester
Prerequisites	Basic Science	Teaching Scheme	(L:T:P)= 4:0:0
CIE Marks	50	SEE Marks	50

1. RATIONALE

A power system comprises of the various subsystems that include generation, transmission, and distribution and Load. Basic knowledge of Electrical Power System **is essential for student of diploma in electrical Engineering** to work in Generation, transmission and distribution field. An electrical engineering diploma student must be knowledgeable about various sources of energy, construction and operation of conventional and non-conventional power plants, economics of power generation and techniques of transmission and distribution. The study of basic concepts of electrical power generation will help the student to understand various issues associated with Generation, transmission and Distribution.

2. COURSE SKILL SET

The aim of the course is to help the student to attain the following industry identified competency through various teaching -learning experiences

- **Select the site** for Hydroelectric, Thermal, Nuclear, Wind and Solar power plants.
- **Construction and operation** of conventional and non-conventional power plants.

3. COURSE OUT COMES

On successful completion of the course, the students will be able to:

CO1	Describe the Non-renewable energy methods of Generation.
CO2	Describe the Renewable energy methods of Generation.
CO3	Analyze the economic operation of power generation.
CO4	Describe basic elements of the electric transmission and distribution systems.

4. COURSE TOPICS:

Unit No	Unit Name	Hours
1	Hydroelectric and Thermal Power plants	08
2	Nuclear power plant, Diesel power plant and Gas turbine power plant.	06
3	Solar photovoltaic system and Wind Power plant	10
4	Biomass Power, Fuel cell and Hybrid PV systems	7
5	Economics of Power Generation	06
6	Basics of Transmission and Distribution	15
Total		52

5. DETAILS OF COURSE CONTENT

The following topics/sub topics is to be taught and assessed in order to develop Unit Skill sets for achieving CO to attain identified skill sets

Session No.	Contents	Class Hour L:T:P
Unit-I	Hydroelectric and Thermal power plants	08 hrs
1	Power sector scenario including generation, transmission, and distribution scenario of India	1:0:0
2	Introduction -Importance of electrical power generation. Sources of energy available in nature. Conventional and non-conventional sources.	1:0:0
3	Hydro power plant -Factors to be considered for selection of site and Classify hydroelectric power plants based on the available head of water, plant capacity, load and construction.	1:0:0
4	General layout of hydro power plant and explain of its components. Meaning of water hammer and its effect.	1:0:0
5	Advantages and Disadvantages of Hydroelectric power plant. Environmental Impact of Hydel power plant	1:0:0
6	Thermal power plant - Factors to be considered for selection of site. General layout of thermal (steam) power plant.	1:0:0
7	Working of thermal power plant. Advantages and disadvantages of Thermal power plant. Environmental Impact of Thermal power plants	1:0:0
8	Activity based Learning on Hydroelectric and Thermal power plant	1:0:0
Unit-II	Nuclear, Diesel and Gas turbine power plants	06hrs
9	Nuclear power plant -Factors to be considered for selection of site and Schematic diagram of nuclear power plant.	1:0:0

Session No.	Contents	Class Hour L:T:P
10	Construction and working of Nuclear power plant.	1:0:0
11	Nuclear power plant impacts such as Health physics, nuclear wastes and nuclear waste disposal. Comparison between thermal power plant with nuclear power plant.	1:0:0
12	Diesel power plant -Schematic diagram of a Diesel generator unit and main components. Advantages and Disadvantages of Diesel power plant	1:0:0
13	Gas turbine power plant - Schematic diagram of a Gas turbine power plant. Advantages and Disadvantages of Gas turbine plant	1:0:0
14	Activity based Learning on Nuclear, Diesel and Gas turbine power plants	1:0:0
Unit-III	Solar photovoltaic system and Wind Power plant	10 hrs
15	Photovoltaic effect, solar power, Construction of solar cell, solar photovoltaic module with block diagrams.	1:0:0
16	Construction of photovoltaic panel and PV array with block diagrams. Materials used in solar cells and Solar cells Applications.	1:0:0
17	Classification of solar photovoltaic systems.	1:0:0
18	Stand-alone and grid interactive solar PV system with block diagram	1:0:0
19	Advantages and dis-advantages of PV systems and environmental impacts of solar PV system on environment.	1:0:0
20	Importance of Wind Energy. Explain the origin of Global and local winds.	1:0:0
21	Factors affecting distribution of wind energy on surface of the earth. Factors to be considered for site selection.	1:0:0
22	Nature of winds with neat sketches.	1:0:0
23	Classification of wind turbine generator, Comparison between horizontal axis and vertical axis wind turbine generator Environmental Impact of wind plants.	1:0:0
24	Activity based Learning on Solar PV system and Wind Power plant	1:0:0
Unit-IV	Biomass Power, Fuel cell and Hybrid PV systems	07hrs
25	Urban waste to energy conversion - Block diagram of municipal solid waste (MSW) to energy incineration plant.	1:0:0
26	Bio Energy -Describe biomass and sources, conversion process. Importance of biomass energy and its scope. Factors to be considered for site selection. Line diagram of biomass power plant. Benefits of biomass. Biomass briquetting	1:0:0

Session No.	Contents	Class Hour L:T:P
27	Bio fuels, electricity generation using biomass. Biogas plants, mention types of biogas plants.	1:0:0
28	Chemical Energy source: fuel cells, working of fuel cells, classification, applications	1:0:0
29	Hybrid PV systems-Types of hybrid PV systems.	1:0:0
30	Block diagram PV-Wind hybrid system and, PV-fuel cell hybrid system.	1:0:0
31	Activity based Learning on Biomass Power, Fuel cell and Hybrid PV systems	1:0:0
Unit-V	Economics of Power Generation	6 Hrs
32	Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve.	1:0:0
33	Base load and peak load plants; Load curve, load duration curve, integrated duration curve	1:0:0
34	Cost of generation: Average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor.	1:0:0
35	Simple problems on Cost of generation	1:0:0
36	Choice of size and number of generator units, combined operation of power station.	1:0:0
37	Activity based Learning on Economics of Power Generation	1:0:0
Unit-VI	Basics of Transmission and Distribution	15 Hrs
38	Transmission: AC transmission and distribution system with typical Single line diagrams with components of the electric supply transmission and distribution systems.	1:0:0
39	Classification of transmission lines: Primary and secondary transmission; standard voltage level used in India	1:0:0
40	Classification of transmission lines: based on type of voltage, voltage level, length and others, Characteristics of high voltage for power transmission.	1:0:0
41	HVDC transmission lines-block diagram, list and explain the functions of main components of HVDC transmission system	1:0:0
42	AC Distribution: Components classification, requirements of an ideal distribution system, primary and secondary distribution system.	1:0:0
43	Connection schemes of distribution system- radial, ring main and interconnected systems. Distinguish between Feeder, distributor and service main.	1:0:0
44	Substation and receiving station and their functions, Classification of substations.	1:0:0
45	Single Line diagram (layout) of 66/11KV Substation, Symbols and functions of their components.	1:0:0
46	Single Line diagram (layout) of 11KV/400V Sub-Station Symbols and functions of their components.	1:0:0

Session No.	Contents	Class Hour L:T:P
47	Causes and Impact and reasons of Grid system fault: State grid, national grid, brownout and black out, Sample blackouts at national and international level	1:0:0
48	Explain Black start Restoration	1:0:0
49	Explain Demand side Management	1:0:0
50	Functions of Load Dispatch Centre	1:0:0
51	Functions of Power Generation and Distribution Companies Different electric distribution companies and their functions (BESCOM, MSCOM, HESCOM etc.)	1:0:0
52	Activity based Learning on Basics of Transmission and Distribution	1:0:0
TOTAL		52 Hrs

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

UnitNo .	Unit Title	CO	Teachin g Hours	Distribution of Theory Marks			
				R Level	U Level	A Level	Total
I.	Hydroelectric and Thermal Power plants.	1	08	12	20	0	32
II.	Nuclear power plant, Diesel power plant and Gas turbine power plant.		06	8	20	0	28
III.	Solar photovoltaic system and Wind Power plant.	2	10	12	28	0	40
IV.	Biomass Power, Fuel cell and Hybrid PV systems.		7	8	20	0	28
V	Economics of Power Generation and Interconnected Power System.	3	06	0	0	24	24
VI	Basics of Transmission and Distribution.	4	15	30	18	0	48
Total			52	70	106	24	200

7. INSTRUCTIONAL STRATEGY

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving station and substations.
3. Show Video/animation films /games to explain functioning of various power plants.
4. Encourage **collaborative** (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes **critical thinking**

6. Adopt Game based Learning (GBL), which helps student to improve **critical thinking, planning and Problem-Solving skills**
7. Adopt Problem Based Learning (PBL) ,which fosters students **Analytical skills**, develop **thinking skills** such as the ability to evaluate, generalize, and analyze information rather than simply recall it.

8. SUGGESTED LEARNING RESOURCES

Reference Books:

Principles of power system by V.K.Mehta and Rohit Mehta S.CHAND
Generation of Electrical Energy, by B.R.Gupta, publisher S.chand& company LTD, New Delhi
Electrical Power Generation, Transmission and Distribution. - S.N.Singh. PHI Publications.
Elements of power station design-M V Deshpande-PHI Publications
Power Plant Engineering - A. K. Raja, New Age International Publisher
Generation Distribution and Utilisation of electric energy by C.L. Wadwa, -New-Age International Publisher
Non-conventional Energy Resources - G.S.Sawhney, PHI publications, second Printing-2014, Delhi-110092.
Non-conventional Energy Resources-B.H.Khan 2 ^d Edition Tata McGraw hill PVT, New-Delhi.
Solar photovoltaic Technology and systems, - Chetan Singh Solanki, PHI, Delhi-110092.
Generation of Electrical Energy, by B.R.Gupta, publisher S.chand& company LTD, New Delhi
Transmission, distribution and utilization – vol 3 B.L Thereja and A.K.Theraja.
Transmission and Distribution of Electric Power by J.B Gupta Katsons Publications.
Energy Management by Dr. Umesh Rathod, Katson publications

E-resources:

1. https://en.wikipedia.org/wiki/Electricity_generation.
2. <https://www.google.com/phindia.com//solarphotovoltaics>.
3. <https://www.schandgroup.com>.
4. <https://www.tatamcgrawhill.com>
5. <https://www.youtube.com/watch?v=daeyoS-PCUA> (Generation, distribution and transmission of electrical power)
6. <https://www.youtube.com/watch?v=IdPTuwKEfma> (Thermal power plant)
7. <https://www.youtube.com/watch?v=zcWkEKNvqCA> (Gas turbine power plant)
8. <https://www.youtube.com/watch?v=-hoofWJ1jY> (Hydroelectric power plant)
9. <https://www.youtube.com/watch?v=bQ23kCvokAc> (Nuclear power plant)
10. https://www.youtube.com/watch?v=eAX_fK_c8Mc (Diesel power plant)
11. <https://www.youtube.com/watch?v=ZLgQoMSIS3Y> (Solar)
12. https://www.youtube.com/watch?v=qSWm_nprfqE (wind)
13. <https://www.youtube.com/watch?v=VkTRcTyDSyk> (Tidal)
14. <https://www.youtube.com/watch?v=sZuc4LMtHoY> (Wave)
15. <https://www.youtube.com/watch?v=OL26yYFmDHU> (Ocean thermal)
16. <https://www.youtube.com/watch?v=3UafRz3QeO8> (Biogas)
17. https://www.youtube.com/watch?v=nVl17JLn_u0 (Biomass)
18. <https://www.youtube.com/watch?v=bXHwnKMchkk> (Fuel cell)
19. <https://www.youtube.com/watch?v=qjY31x0m3d8> (Transmission lines)
20. <https://www.youtube.com/watch?v=WUHcVXjfsxs> (Transmission and distribution)

21. https://www.youtube.com/watch?v=R_HGnc63QKU (Power blackout)
22. <https://www.pbs.org/wgbh/nova/labs/lab/energy/1/1/> (Alternative energy)

9.MAPPING OF CO WITH PO

CO	Course Outcome	PO Mapped	UNIT Linked	Cognitive Level R/U/A	Theory Session In Hrs.
CO1	Describe the Non-renewable energy methods of Generation.	PO1	1-2	R/U	14
CO2	Describe the Renewable energy methods of Generation.	PO1	3-4	R/U	17
CO3	Analyze the economic operation of power generation.	PO1	5	A	06
CO4	Describe basic elements of the electric transmission and distribution systems	PO1	6	R/U	15
					52

Course	CO's	Programme Outcomes (PO's)						
		1	2	3	4	5	6	7
BASICS OF ELECTRICAL POWER SYSTEM	CO1	3	-	-	-			
	CO2	3						
	CO3	3						
	CO4	3						
Level 3- Highly Mapped, Level 2-Moderately Mapped, Level 1-Low Mapped, Level 0- Not Mapped								

10. ACTIVITY BASED LEARNING:

1. We have to create interest among the students through Activity-Based Learning (ABL)
2. Classroom activities will give simultaneous benefits to both students as well as for teachers (students can overcome the difficulty in learning typical course, teachers can deliver a topic in a variety of approaches effectively).
3. Collaborative learning among students will create a healthy learning environment and also emphasize student's performance, teamwork.
4. Any student tries to identify a solution for a given problem but, through collaborative learning with a group of people will give an **optimized** solution to the same **problem**.

In order to develop **higher order thinking skills**, it is important to conduct lessons using **activity-based teaching**.

Activity Based Learning Suggested Activities in Class
<p>1. Identification of Topic (IOT):</p> <ul style="list-style-type: none"> • The objective of this activity is to identify, recollect the technical words. • Identification of topic names /part name, parts of an apparatus, a mistake in the content in given image.
<p>2. Word search: place technical words, components names of in the 12 x 12 table in various directions (left to right, right to left, top to bottom, bottom to top, diagonally from top to bottom and diagonally bottom to top from both sides (left, right)). The objective of this activity is to search technical words in the course.</p>
<p>3. Mind map: Students have to draw a variety of mind maps by interfacing power system topics with aspects of societal, environment, etc. By these mind maps students elevated power system concepts in a different approach, so that they can remember the concepts for a long time.</p> <ul style="list-style-type: none"> • https://creately.com/diagram/example/i08rf3b52/Mind%20Map%20of%20Hydroelectric%20Dam. • https://durofy.com/mind-map-energy-resources • https://www.brighthubengineering.com/power-plants/17353-electricity-generation-in-power-plants/
<p>4. Mapping/Scratch Cards: Prepare various quiz questions cards, answers cards, and scratch cards. Separate, question cards on the left side, answer cards on the right side and asked batch-wise to map question cards with answer cards.</p> <p>https://www.essentialenergy.com.au/ext/electricity-and-safety-unit/assets/documents/Lesson%204%20-%20Practical%20-%20Generation%20and%20movement%2011.pdf</p>
<p>5. Crossword: create a cross on any of the topics of the course using online resources : https://wordmint.com/public_puzzles/182138 Students have to draw various types of power plants that are exploring their creativity</p>
<p>6. Preparing Posters/ chart: students have to prepare posters/ charts on various topics of power system and present in the class.</p>
<p>7. Energy games</p> <p>Energy Island game http://siemens.zincmediadev.com/energy/island/index.html</p> <p>Game on wind and Solar Power Generation https://climatekids.nasa.gov/power-up/</p> <p>Game on Solar Power Generation https://wonderville.org/asset/solarenergydefenders</p> <p>Game on wind , Solar Power, Hydel and Geothermal Generation https://wonderville.org/asset/save-the-world</p> <p>Game on Generation, Transmission and Distribution http://www.hydroquebec.com/games/network/flash.html</p> <p>Mange Virtual power Plant and prevent blackout https://www.next-kraftwerke.com/virtual-power-plant-vpp-simulation/?lang=en</p> <p>Game on Power GRID https://gamejolt.com/games/powerthegrid/306616</p> <p>Game on Design Renewable future https://www.pbs.org/wgbh/nova/labs//lab/energy/research</p> <p>Game on Energy City https://assets.jason.org/resource_assets/8239/3733/popup.html</p>

8. Case Studies: Through this activity, students will get to know about problems/issues which are happening/happened in the Power System sector.

11. SUGGESTED LIST OF STUDENT ACTIVITY for CIE

Sl. No	Activity
1	<p>Problem Based Learning Activity for CIE</p> <p>Task is to organize the energy technology for a farm. This should provide the farm with energy to carry out various functions, such as keeping the lights on (when it's dark), powering the equipment (such as the milking parlor) and keeping the house warm.</p> <ul style="list-style-type: none"> • student have a budget of 20 tokens to set the system up. Each piece of equipment has a price, so student need to make decisions about what to spend the tokens on. • Once student set the system up, then run it for a (simulated) week. At the end of the week student can then see how well it has worked. <p>http://siemens.zincmediadev.com/energy/island/index.html https://new.siemens.com/uk/en/company/education/students/interactives.html#AdditionalResources https://assets.new.siemens.com/siemens/assets/api/uuid:692addfc-d92c-4397-b8b1-c0a3d9a32601/version:1570547738/energy-farm-ks3-student-worksheets-25sept2019.pdf</p> <p>Assessing success</p> <p>There are three sets of criteria students will be judged against:</p> <ol style="list-style-type: none"> 1. Did student get through the week without the lights going out? 2. What were running costs? 3. Did student manage to minimize the negative impact on the environment? <p>Teacher will brief student</p> <ul style="list-style-type: none"> • on the use of the interactive resource, explaining the decisions student need to make • and showing the feedback, student will get on how well the system has performed • . Student can then modify the system to try and improve its performance <p>From student best performance:</p> <p>Did student manage to keep the lights on all week?</p> <p>What did the system cost to run?</p> <p>What was the environmental impact of the system?</p> <p>Now think about how student managed to set up an effective system:</p> <p>What hints would student give to someone trying to set up an effective system and get a good score?</p> <p>What would student say about whether (and, if appropriate, how many) to use of:</p> <ul style="list-style-type: none"> Solar cells Wind turbines Biogas generators

	Batteries National Grid link Petrol generators Teacher will then show you the feedback screens from some other people's attempts at setting up a system. Have a look at them and comment on how good a job they've done.
2	Visit to solar PV plant/ windmill /bio-gas plants and submit the report
3	Visit to hydroelectric power plant/thermal power plants/D.G. power plant and submit the report
4	Design calculations for establishing a Solar panel/ system for a lighting purpose using Inverter, battery,
5	Design and establish solar operated application to 1) pump 2) Street lamp 3) fan 4) traffic signal control. 4) Rural electrification 5) Rooftop lighting any ONE
6	1.Visit http://www.nhpcindia.com/ collect the following information a) installed capacity b) Total capacity and Design energy of Different Hydroelectric power electric stations in India 2. Visit NTPC website https://www.ntpc.co.in/ collect information on a) Coal based Power stations b) Gas based Power stations c) Renewable Energy d) Hydro based power stations e) career opportunities for Diploma engineers
7	Visit http://karnatakapower.com/ collect information on a) Hydro-electric power plant in Karnataka b) Thermal electric power plant in Karnataka c) Renewable electric power plant in Karnataka d) Daily Generation in MU E) Consumption in MU
8	Visit https://www.powergridindia.com/ collect information on overview of company

12. COURSE ASSESSMENT AND EVALUATION CHART

Sl.No	Assessment	Duration	Max marks	Conversion
1.	CIE Assessment 1 (Written Test -1) At the end of 3 rd week	80 minutes	30	Average of three written tests 30
2.	CIE Assessment 2 (Written Test -2) At the end of 7 week	80 minutes	30	
3.	CIE Assessment 3 (Written Test -3) At the end of 13 week	80 minutes	30	
4	CIE Assessment 4 (MCQ/Quiz) At the end of 5 week	60 minutes	20	Average of three 20
5	CIE Assessment 5 (Open book Test) At the end of 9 week	60 minutes	20	
6	CIE Assessment 6 (Student activity/Assignment)- At the end of 11 week	60 minutes	20	

7.	Total Continuous Internal Evaluation (CIE) Assessment				50
8.	Semester End Examination (SEE) Assessment	3 Hours	100	50	
Total Marks					100

13. RUBRICS

Dimension	RUBRICS FOR ACTIVITY Appropriate rubrics as per the activity to be developed by the faculty					
	Beginning	Developing	Satisfactory	Good	Exemplary	Student Score
1	2	3	4	5		
Collection of data	Does not collect any information relating to the topic	Collects very limited information; some relate to the topic	Collects much information; but very limited relate to the topic	Collects some basic information; most refer to the topic	Collects a great deal of information; all refer to the topic	
Fulfil team's roles & duties	Does not perform any duties assigned to the team role	Performs very little duties but unreliable.	Performs very little duties	Performs nearly all duties	Performs all duties of assigned team roles	
Shares work equally	Always relies on others to do the work	Rarely does the assigned work; often needs reminding	Usually does the assigned work; rarely needs reminding	Normally does the assigned work	Always does the assigned work without having to be reminded.	
Listen to other Team mates	Is always talking; never allows anyone else to speak	Usually does most of the talking; rarely allows others to speak	Talks good; but never show interest in listening others	Listens, but sometimes talk too much	Listens and speaks a fair amount	
Total marks						

**Model Question Paper
I A Test (CIE)**

Programme	:	Semester: I			
Course	:	Max Marks : 30			
Course Code	:	Duration : 1 Hr 20 minutes			
Name of the course coordinator:					
Note: Answer one full question from each section. One full question carries 10 marks.					
Qn.No	Question	CL	CO	PO	Marks
Section-1					
1.a)					
b)					
c)					
2.a)					
b)					
c)					
Section-2					
3.a)					
b)					
c)					
4.a)					
b)					
c)					
Section-3					
5.a)					
b)					
c)					
6.a)					
b)					
c)					

Model Question Paper
Semester End Examination

Programme:	Semester: I
Course :	Max Marks: 100
Course Code:	Duration: 3 Hrs

Instruction to the Candidate:

Answer one full question from each section. One full question carries 20 marks.

Qn.No	Question	CL	CO	Marks
Section-1				
1.a)				
b)				
2.a)				
b)				
Section-2				
3.a)				
b)				
4.a)				
b)				
Section- 3				
5.a)				
b)				
6.a)				
b)				
Section-4				
7.a)				
b)				
8.a)				
b)				
Section-5				
9.a)				
b)				
10.a)				
b)				