GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-III

Course Title: Electrical Power Generation and Transmission
(Course Code: 4330903)

Diploma programmer in which this course is offered	Semester in which offered
Electrical Engineering	Third

1. RATIONALE

Generation of Electric Power is most important activity in power system. With growing demand for electric power, it has become more necessary to generate electric power more efficiently. It is possible with advanced technology. This course deals in detail about generation of electric power using thermal (coal) hydro and nuclear sources. These types of power plants need highly skilled technocrats who are capable of operating and maintaining various equipment and auxiliaries to generate uninterrupted power.

The bulk electrical power is generated at power plants which are quite away from load center, transmitted to different load center by transmission system and then supplied to consumers through distribution system. This course deals in detail with elements & performance of overhead transmission line and HVDC transmission systems. The skilled technocrats are required to operate and maintain power transmission system so that uninterrupted electrical power supply is made available at consumer end. Essential efforts are made in this course to develop basic skills required to maintain power generation and transmission system.

2. COMPETENCY

The purpose of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Operate and maintain various types of electrical power generating plants and transmission systems.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Supervise functioning of Thermal power plant, Hydro power plant and Nuclear power plant.
b) Solve problems related to load curve and load duration curve.
c) Apply mechanical and electrical design aspects of various types of conductor, support and insulator to maintain overhead line.
d) Analyze performance of transmission line.

e) Differentiate various types of HVDC transmission system.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
4	0	2	6	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

***Legends: L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** - End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked **'*'** are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Sketch and interpret the schematic diagram of thermal power station (T.P.S.) and its main cycles.	I	4*
2	Prepare technical report of visit to a nearby T.P.S.	I	2
3	Sketch and interpret the various schemes of hydro power plant(H.P.S.)	I	2*
4	Prepare technical report of visit to a nearby H.P.S.	I	2
5	Sketch and interpret the schematic diagram of nuclear power station (N.P.S.)	I	2*
6	Prepare and interpret load curve for given data/data collected from nearby power station	II	4*
7	Demonstrate various types of conductors used in overhead transmission lines.	III	2*
8	Demonstrate different types of line supports employed in transmission system and distribution system.	III	4*
9	Demonstrate different types of insulators used in overhead transmission and distribution system	III	4*
10	Calculate sag in overhead transmission line for given data.	III	2
11	Determine string efficiency of suspension type insulator for given data.	III	2

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
12	Determine voltage regulation and transmission efficiency of short transmission line.	IV	4
13	Determine voltage regulation and transmission efficiency of medium transmission line.	IV	4
14	Prepare technical report on load dispatch center.	IV	2*
15	Prepare report on HVDC transmission systems.	V	2*
	Minimum 10 Practical Exercises		28

Note

*i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

*ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.*

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Understanding of concepts	20
2	Explanation of conclusion	20
3	Student attitude towards learning	20
4	Quality of term work	20
5	Timely completion of term work	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Demonstration piece of ACSR conductors, Bundle Conductor etc	7
2	Demonstration piece of Pin insulator, Disc of suspension insulator, Shackle insulator, Silicon rubber insulator	9
3	Transmission line trainer kit	12,13

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

a) Work as a leader/a team member(while doing a micro-project)
b) Follow safety practices while usingElectrical supply and electrical equipment.
c) Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit -I Generation of Electrical Power	1a. Explain energy conversion process in thermal, hydro and nuclear power plant. 1b. Identify appropriate site for thermal, hydro and nuclear power plant. 1c. Describe schematic diagram, major equipment, accessories used in thermal, hydro and nuclear power station. 1d. State the critical safe practices, and precautions to be followed while operation and maintenance of thermal, hydro and nuclear power plant.	1.1 Energy conversion process of thermal, hydro and nuclear power plant 1.2 Factors of site selection for thermal, hydro and nuclear power plant 1.3 Schematic diagram of thermal, hydro and nuclear power plant. 1.4 Schematic diagram of different cycles of thermal power plant. 1.5 Major equipment, accessories used in thermal power plant. 1.6 Classification of hydro power plant 1.7 Different schemes and elements of Hydro Power Plant 1.8 Nuclear fission, nuclear fusion and chain reaction 1.9 Nuclear reactor and fuels used 1.10 Nuclear waste in its disposal 1.11 Advantages and disadvantages of thermal, hydro and nuclear power plant. 1.12 Safe practices, environmental effect and precautions for thermal, hydro and nuclear

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
		power plant 1.13 Major thermal, hydro and nuclear power plant of Gujarat-state
Unit-II Variable Load on Power Station	2a. Distinguish between load curve and load duration curve. 2b. Differentiate between base load and peak load power plants. 2c. Solve numerical related to load curve and load duration curve.	2.1 Types of loads 2.2 Types and importance of load curve 2.3 Terms and factors regarding load curve 2.4 Load duration curve 2.5 Base load and peak load power plants
Unit-III Elements of Overhead Transmission Lines	3a. Compare features of different transmission systems. 3b. State effect of system voltage and load power factor 3c. Differentiate features of various types of line conductors, line supports and line insulators. 3d. Explain voltage distribution across string of suspension insulator and method of improving string efficiency. 3g Describe factors to be considered while erecting lines and factors affecting sag of lines. 3h Solve numerical based on string efficiency and sag.	3.1 Single line diagram of typical power supply system. 3.2 Classification of transmission lines 3.3 Comparison between AC & DC and overhead & underground system. 3.4 Effect of system voltage and load power factor and Selection of voltage of transmission. 3.5 Line Conductors: requirements, materials & types of conductors for overhead lines, types of ACSR conductors and features of optical fiber ground wire. 3.6 Line Supports: requirements & types of line supports and classification of transmissions line towers Line 3.7 Line Insulators: requirements, materials, types & failure of line insulators and features of silicon rubber insulators. 3.8 String efficiency and methods of improving string efficiency. 3.9 Sag calculation , spacing between conductors and ground clearance
Unit-IV Performance of Transmission Lines	4a. Explain effect of line parameters (constants) and their representation in short & medium transmission line. 4b. Differentiate the features of	4.1 Transmission line parameters: effect and representation of line parameters 4.2 Transposition of line conductors 4.3 Classification of transmission lines 4.4 Skin effect, proximity effect,

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
	short, medium and long transmission lines. 4c.Discriminate between skin effect, proximity effect, Ferranti effect and corona effect. 4d.Explain effect of load power factor on performance of short transmissions lines. 4e.Differentiate various methods of determining performance of medium transmissions lines. 4f.Describes importance and functions of LDC. 4g.Solve numerical based on line parameters and performance of short & medium transmission lines.	ferranti effect and corona effects 4.5 Voltage regulation and transmission efficiency 4.6 Performances of short transmission lines. 4.7 Performances of medium transmission lines 4.8 Load dispatch center; grid system in India and it's hierarchy
Unit-IV HVDC Transmission System	5a.State need for EHV transmission. 5b.Compare features of HVAC and HVDC transmission system. 5c.Explain concepts and types of HVDC transmission system. 5d. State application of HVDC transmission system.	5.1 Requirements of EHV transmission system. 5.2 Advantage and limitations of EHV AC transmission system 5.3 Single diagram of HVDC transmission 5.4 Types of HVDC transmission systems 5.5 Merits, demerits and application of HVDC transmission system 5.6 Comparison between HVDC and HVAC transmission systems

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Generation of Electrical Power	24	8	14	6	28
II	Variable load on Power Station	04	2	2	4	08
III	Elements of Overhead	14	4	6	4	14

	Transmission System					
IV	Performance of Transmission System	10	4	4	4	12
V	HVDC Transmission System	04	2	4	2	08
Total		56	20	30	20	70

Legends: *R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)*
Note*: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***co-curricular*** activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should perform following activities in group (or individual) and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

a) Present seminar on various topics from course content
b) Present seminar on recent technologies used for power generation and transmission
c) Solve numerical problems regarding course contents.

The student should be encouraged to get their work assessed by the concerned teacher progressively during the term and at the end of the term the whole work should be submitted to the concerned teacher.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L' in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) Show animation/ video related to course content.
e) Visit to a nearby power plant and load dispatch center.
f) Co-relating the importance of content of this course with other courses and practical applications.
g) Introduce methods to reduce pollution in Thermal power plant.
h) Introduce E-waste recycling technology among the students.
i) Guide students on how to address issues on environment and sustainability.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should ***not exceed three.***

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16** ***(fourteen to sixteen) student engagement hours*** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

a) Build model to demonstrate layout of Thermal Power Plant.
b) Build working model to demonstrate working or Hydro Power Plant.
c) Prepare charts of various cycles of Thermal Power Plant.
d) Prepare charts of various schemes of Hydro Power Plant.
e) Prepare chart of schematic diagram of Nuclear Power Plant.
f) Prepare chart of single line diagram of Electrical power system.
g) Prepare chart of various types of line insulators,
h) Prepare chart of various types of line conductors.
i) Prepare chart of various types of line supports.
j) Prepare chart of various types of HVDC systems.
k) Prepare chart of representation of line parameters of medium transmission line.
l) Prepare chart of equivalent circuit and vector diagram of short transmission line.
m) Prepare a report on various power plants in Gujarat by collecting data from internet.
n) Prepare a report on disasters occurred in Thermal, Hydro or Nuclear Power Plant.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Principles of Power system	Mehta, V.K.	S. Chand & Co., New Delhi, 2020 ISBN: 978-8121924962
2	Power plant Engineering	Nag, P K	Tata McGraw Hill, New Delhi, 2011 ISBN:978-0-07-064815-9
3	Electrical Power Systems	Uppal S.L.	Khanna publication, New Delhi, 2011 ISBN:978-8174092380
4	Generation and Utilization of Electrical Energy	S. Sivanagaraju	Pearson, New Delhi, 2011 ISBN:978-81-317-33325
5	A course in Power Systems	J.B.Gupta	S K Kataria & sons,2013 ISBN:978-9350143735

6	Electrical Power Systems	C.L.Wadhwa	New Age, New Delhi, sixth edition ISBN:978-8122424683
7	A Textbook on Power System Engineering	P.V. Gupta, M.L. Soni, U.S. Bhatnagar, A. Chakrabarti	Dhanpat Rai & Co., New Delhi, Latest edition

14. SOFTWARE/LEARNING WEBSITES

- https://nptel.ac.in/courses/108/105/108105112/
- https://nptel.ac.in/courses/108/105/108105053/
- https://lectures.gtu.ac.in/(related to course content)
- https://www.electrical4u.com/electrical-engineering-articles/basic-electrical/
- https://www.electricaltechnology.org/
- www.vlab.co.in
- www.khanacademy.org
- https://ndl.iitkgp.ac
- http:www.nhpcindia.com/hydro-technology.htm
- http://www.mnre.gov.in/
- http://www.ntpc.co.in/index.php?option=com_content&view=article&id=64&Itemid=34&lang=en
- https://www.youtube.com/user/EnergyShouldBe

15. PO-COMPETENCY-CO MAPPING:

Semester III	Electrical Power Generation and Transmission (Course Code: 4330903)						
	POs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solution	PO4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Operate and maintain various types of Electrical power generating plants and transmission systems.						
Course Outcomes CO1 Supervise functioning of Thermal power plant, Hydro power plant and Nuclear power plant.	3	2	2	--	2	--	--
CO2 Solve problems related to load curve and load duration curve.	2	3	--	--	--	--	--
CO3 Apply mechanical and electrical design aspects of various types of conductors, supports and insulators to	3	3	2	--	--	--	--

maintain overhead lines.							
CO4 Analyze performance of transmission lines	3	3	2	--	--	--	--
CO4 Differentiate various types of HVDC transmission systems	3	2	--	--	--	--	--

*Legend: '**3**' for high, '**2**' for medium, **'1'** for low and **'-'** for no correlation of each CO with PO.*

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

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