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ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION **Course Code : 313333**

Programme Name/s : **Electrical Engineering/ Electrical and Electronics Engineering/ Electrical Power System**

Programme Code : **EE/ EK/ EP**

Semester : **Third**

Course Title : **ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION**

Course Code : **313333**

I. RATIONALE

Electrical power system plays a significant role in the development of Urban, Rural, Industries and Agriculture Sector. This course aims to develop the basic knowledge and required skills to maintain the proper functioning of the power system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Maintain the functioning and operation of the electrical power generation, transmission and distribution systems.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Maintain the optimised working of the thermal power plant and hydro power plant.
- CO2 - Select the relevant power generation technology based on economic operation.
- CO3 - Interpret the normal operation and parameters of the electric transmission system.
- CO4 - Interpret the parameters of the extra high voltage transmission system.
- CO5 - Maintain the functioning and operation of electric power distribution system.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme											
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical						
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA		
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min	
313333	ELECTRICAL POWER GENERATION,TRANSMISSION AND DISTRIBUTION	GTD	DSC	4	-	2	2	8	4	3	30	70	100	40	25	10	25@	10	25	10	175

Total IKS Hrs for Sem. : 0 Hrs

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Describe the layout of the electric power generating process with a labeled block diagram of the specified power plant. TLO 1.2 State the functions of a given type of major auxiliaries of specified power plant. TLO 1.3 Distinguish between Thermal Power Plant and Hydro Power Plant. TLO 1.4 Describe the specified safe practices to be followed for a specified power plant.	**Unit - I Thermal Power Plant and Hydro Power Plant** 1.1 Classification of various energy sources (Renewable and Non-Renewable). 1.2 Site selection, Layout and working of a typical Thermal Power Plant. 1.3 Functions of the following major auxiliaries used in Thermal Power Plant: Coal fired boilers: fire tube and water tube and Heat recovery system (Super heater, Economiser and Air pre-heater). 1.4 Site selection, Layout and working of a typical Hydro power plant. 1.5 Classification of hydro power plant: Run off river Power Plant without Pondage, Run off river Power Plant with Pondage, Reservoir Power Plant and Pumped Storage Power Plant. 1.6 Comparison between Thermal Power Plant and Hydro Power Plant. 1.7 Locations of these different types of Large and Micro-Hydro Power Plants in Maharashtra. 1.8 Safe Practices of Thermal Power Plants and Hydro Power Plants (Large and Micro)	Chalk-Board Presentations Model Demonstration Demonstration Video Flipped Classroom
2	TLO 2.1 Interpret the given Load curve, Load duration curve, Integration duration curve. TLO 2.2 Interpret the given values of the demand factor, plant capacity factor, plant use factor. TLO 2.3 Interpret the given values of the diversity factor, load factor and plant load factor. TLO 2.4 State the causes and impact of the given grid system fault.	**Unit - II Economics of Power Generation and Interconnected Power System** 2.1 Base load and Peak load Plants: Load curve, Load duration curve, Integrated Load duration curve. Related terms: connected load, firm power, cold reserve, hot reserve, spinning reserve. 2.2 Cost of generation: average demand, maximum demand, demand factor, plant capacity factor, plant use factor, diversity factor, load factor and plant load factor. 2.3 Choice of size and number of Generator units, combined operation of power station. 2.4 Causes, Impact and reasons of Grid system fault: State Grid, National Grid, brownout and black out; sample blackouts at National and International level	Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
3	TLO 3.1 Classify the given Transmission Line. TLO 3.2 Describe the construction and functioning of the given Transmission Line Components. TLO 3.3 Explain the concept of the given Transmission Line parameters. TLO 3.4 Evaluate the performance of short transmission Line based on the given criteria. TLO 3.5 Explain the given method(s) for representation of Medium Transmission Line. TLO 3.6 Describe the need for Transposition of Conductors.	**Unit - III Transmission Line Components, Parameters and Performance** 3.1 Electric power transmission systems: Single line diagrams. 3.2 Classification of transmission lines: Primary and Secondary transmission; standard voltage level used in India. 3.3 Transmission line Components: Types of Line supports, Line Insulators and Overhead/ Underground Conductors with their function. 3.4 Method of construction of electric supply transmission system – 110 kV, 220 kV, 400 kV. 3.5 Transmission Line Parameters: R, L and C and types of lines. 3.6 Performance of short line: Efficiency, Regulation and its derivation, Effect of Power Factor, Vector Diagram for different Power Factor. 3.7 Representation of medium line: Nominal 'T', Nominal 'Pi' and End condenser methods. 3.8 Skin effect and Proximity Effect, Transposition of conductors and its necessity.	Chalk-Board Presentations Model Demonstration Demonstration Video Flipped Classroom
4	TLO 4.1 State the Rating and functions of the given type of transmission line. TLO 4.2 State the Rating and functions of the given High voltage Substation component(s). TLO 4.3 Explain the specified effects occurring in the given type of high voltage transmission line. TLO 4.4 Explain the importance of line compensation in High voltage transmission line. TLO 4.5 Describe the layout of the given HVDC transmission lines with sketches. TLO 4.6 Explain the concept of wireless transmission of electrical power.	**Unit - IV Extra High Voltage Transmission (HVAC and HVDC)** 4.1 Extra High Voltage AC (EHVAC) transmission line: 4.1.1 Necessity of UHV, EHV AC/ DC lines. 4.1.2 High voltage substation components: Transformers, Bus, Circuit breaker, Reactor, Lightning arrester, Relays, FACTs Devices. 4.1.3 High Temperature Low Sag (HTLS) Conductor in High voltage transmission lines: Features. 4.1.4 Ferranti and Corona effect 4.1.5 Line compensation: Need and benefits. 4.2 High Voltage DC (HVDC) Transmission Line: 4.2.1 Necessity and HVDC Lines in India. 4.2.2 HVDC Transmission lines: Components, applications, advantages, and limitations 4.2.3 Monopolar, bi-Polar and homo-polar transmission lines: Layout 4.3 EHVAC and HVDC transmission line: Features and Comparison. 4.4 Wireless transmission of electrical power.	Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom

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Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
5	TLO 5.1 Classify the given Distribution line. TLO 5.2 Describe the Distribution line erection and functioning of the given components. TLO 5.3 Explain the concept of the given Distribution line Components. TLO 5.4 Elaborate the specified Distribution schemes. TLO 5.5 Evaluate the performance of the Distribution line based on the given criteria. TLO 5.6 Describe the given distribution substation layout and components.	**Unit - V Distribution Line Components, Parameters and Performance** 5.1 Electric power Distribution systems: Single line diagrams 5.2 Classification of Distribution lines: Primary and Secondary Distribution; standard voltage level used in India. 5.3 Distribution line Components: Types of Line supports, Line Insulators and Overhead/ Underground Conductors (ACSR/ Insulated Power Cables) with their function. 5.4 Method of Distribution line erection of electric supply – 220 V, 400V, 11 kV, 33 kV 5.5 Distribution line Feeder and Distributor Schemes: Radial, Ring, and Grid. 5.6 Distribution Performance of Distributor: voltage drop, sending end and receiving end voltage. 5.7 Distribution Substation: classification, site selection, advantages, disadvantages and applications. 5.8 Single Line Diagram (layout) of 33/11kV Sub-Station, 11kV/400V substation, symbols and functions of their components.	Chalk-Board Presentations Model Demonstration Video Demonstrations Flipped Classroom

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Draw layout of the typical Thermal Power Plant LLO 1.2 Identify the different components of typical Thermal Power Plant LLO 1.3 Observe the operation of Thermal Power Plant	1	*Demonstration of a Thermal Power Plant using Visit/Animations/ Video programme.	2	CO1
LLO 2.1 Identify components of the Heat Recovery System. LLO 2.2 Describe the function of Components of the Heat Recovery System.	2	Process of Heat Recovery System in Thermal Power Plant.	2	CO1
LLO 3.1 Draw layout of the typical Hydro Power Plant. LLO 3.2 Identify the different components of typical Hydro Power Plant. LLO 3.3 Observe the operation of Hydro Power Plant.	3	*Demonstration of a Hydro Power Plant using Visit/Animations/ Video programme.	2	CO1
LLO 4.1 Draw layout of the typical Hydro Power Plant	4	Demonstration of a Pumped storage Hydro Power Plant using Visit/Animations/ Video programme.	2	CO1
LLO 5.1 Draw layout of the typical Hydro Power Plant	5	*Demonstration of Different types of Hydro Power Plant using Animations/ Video Programme.	2	CO1
LLO 6.1 Draw load curve of of Campus/ Institute building(s) LLO 6.2 Calculate various economic factors from the above load curve.	6	*Load curve of Campus/ Institute building(s) and calculation of following economical factors: Maximum demand, Average load, Load Factor, Reserve capacity, Plant capacity factor, utilization factor, Plant use factor and Diversity factor.	2	CO1 CO2

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 7.1 Select appropriate power generation technology as per variation in load demand.	7	*Selection of power generation technology as per variation in load demand of a given load curve	2	CO1 CO2
LLO 8.1 Draw Load Duration curve and Integrated load curve from a given load curve.	8	Load Duration curve and Integrated load curve.	2	CO2
LLO 9.1 List the components of the electric supply system. LLO 9.2 Prepare a single line diagram with vertical and horizontal clearances of the Electric supply system.	9	*Single line diagram of the Electric supply system.	2	CO3 CO5
LLO 10.1 Prepare single line diagram of 400 kV transmission line substation. LLO 10.2 Prepare plan and elevation diagram of 400 kV transmission line substation.	10	*Layout of 400kV transmission line substation.	2	CO3
LLO 11.1 Prepare single line diagram of 132 kV transmission line substation. LLO 11.2 Prepare plan and elevation diagram of 132 kV transmission line substation.	11	Layout of 132 kV transmission line substation.	2	CO3
LLO 12.1 Identify the components of Ultra High Voltage (UHV) Transmission lines.	12	*Demonstration of an Ultra High Voltage (UHV) Transmission lines using Animations/ Video Programme.	2	CO4
LLO 13.1 Identify the components of Extra High Voltage (EHV) Transmission lines.	13	Demonstration of Extra High Voltage (EHV) Transmission lines using Visit/Animations/ Video Programme.	2	CO4
LLO 14.1 Prepare single line diagram of HVDC transmission line. LLO 14.2 Prepare plan and elevation diagram HVDC transmission line.	14	*Layout of HVDC transmission line.	2	CO4
LLO 15.1 Prepare list of components of the distribution substation. LLO 15.2 Prepare a single line diagram of the distribution substation. LLO 15.3 Prepare plan and elevation diagram with clearances of distribution substation.	15	*Components of Distribution Substation.	2	CO5
LLO 16.1 Calculate load for Commercial and Residential Consumers. LLO 16.2 Prepare a feeder scheme for consumers.	16	*Distribution scheme for Commercial and Residential Consumers.	2	CO5

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Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 17.1 Calculate load for Industrial Consumer. LLO 17.2 Prepare a feeder scheme foIndustrial Consumer.	17	Distribution scheme for Industrial Consumer.	2	CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Visit

- Visit your Institute or nearby Distribution Substation and observe the Layout and write the technical details about Main transformer, CT, PT, Lightning arrester, Earthing System etc.
- Visit nearby Pumped Storage Hydro Power station (if any) and observe the Layout and write the technical details of Generator, working cycles of Turbine, Reservoir, Penstock etc.
- Visit nearby Hydro Power station and observe the Layout and write the technical details of Generator, working cycles of Turbine, Reservoir, Penstock etc.
- Visit nearby Thermal Power station and observe the Layout and write the technical details of Boiler, generator, Turbine, Super heater, Economiser Air Preheater, Cooling Tower etc.
- Visit nearby Transmission line and observe the Layout and write the technical details about Main transformer, CT, PT, Lightning arrester, Earthing System etc.

Assignment

- Calculate various Economical factors from the given Load Curve.
- Prepare list of material used for Transmission line.
- Calculation on Commercial and Residential Consumers Load Demand
- Prepare list of material used for Transmission line.
- Prepare list of material used for Distribution line/ substation.
- Prepare list of material used for Transmission line substation.
- Calculation on Industrial Consumers Load Demand.
- Numericals on Economics of Power generation.

Micro project

- Prepare a 3D model of Pumped storage Hydro power Station.
- Prepare a 3D model of Hydro power Station.
- Prepare a 3D model of Thermal power Station.
- Prepare a comparative chart for UHVAC and HVAC Transmission line considering their Strength, Limitations, Capital cost involvement, Running Cost, Losses, Voltage regulation, Constructional details etc.
- Prepare a comparative chart for HVAC and HVDC Transmission line on the basis of their Strength, Limitations, Capital cost involvement, Running Cost, Losses, Voltage regulation, Constructional details etc.
- Write Detail complete technical specification of all the elements of Ultra high voltage AC (UHVAC) Transmission line. Also write the functions of each element of the UHVAC Transmission line and submit the report.

Survey

- Collect information and prepare a report on Gas Insulated Substation (GIS).
- Collect information and prepare a report on Hydro Power Plants in Maharashtra/ India.
- Collect information and prepare a report on Thermal Power Plants in Maharashtra/ India.
- Collect information and prepare a report on latest technology used in Transmission Line.

- Collect information and prepare a report on latest technology used in Distribution Substation and Distribution lines.
- Collect information and prepare a report on Nearby Transmission Substation.
- Collect information and prepare a report on High Temperature Low Sag (HTLS) Conductor use in transmission lines.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	Video Programme/Animation/Demonstration Model of Thermal Power Plant.	1,2
2	Video Programme/Animation/Demonstration Model of Transmission/Distribution Substation.	10,11,15
3	Video Programme/Animation/Demonstration Model of Hydro Power Plant.	3,4,5
4	Video Programme/Animation/Demonstration Model/Chart Demonstration of Electric Power System.	9
5	Video Programme/Animation/Demonstration Model of different Supporting structures / Insulators/ Conductors of Transmission Line.	9,10,13,14,16,17

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Thermal Power Plant and Hydro Power Plant	CO1	12	2	8	6	16
2	II	Economics of Power Generation and Interconnected Power System	CO2	10	2	4	4	10
3	III	Transmission Line Components, Parameters and Performance	CO3	14	2	8	6	16
4	IV	Extra High Voltage Transmission (HVAC and HVDC)	CO4	10	2	6	4	12
5	V	Distribution Line Components, Parameters and Performance	CO5	14	2	6	8	16
Grand Total				**60**	**10**	**32**	**28**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two unit tests of 30 marks will be conducted and average of two unit tests considered.
- For formative assessment of laboratory learning 25 marks.
- Each practical will be assessed considering appropriate % weightage to process and product and other instructions of assessment.

Summative Assessment (Assessment of Learning)

- End semester summative assessment of 25 marks for laboratory learning.

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- End semester assessment of 70 marks through offline mode of examination.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	1	3	2	3	2			
CO2	3	3	3	2	2	3	2			
CO3	3	2	1	2	3	2	2			
CO4	3	2	1	2	3	2	2			
CO5	3	3	1	2	2	2	2			

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	Nag P K	Power Plant Engineering	McGraw Hill, New Delhi, 2017 ISBN: 978-9339204044
2	Gupta J.B.	A course in Electrical Power.	S. K Kataria and sons, New Delhi. 2014, ISBN: 9789350143742
3	Mehta V.K., Rohit Mehta	Principles of Power System	S.Chand & Co. New Delhi, 2005, ISBN: 9788121924962
4	Gupta B.R.	Generation of electrical Energy	S.Chand & Co. New Delhi, 2010, ISBN: 9788121901024
5	Sivanagaraju S.; Satyanarayana S.	Electrical Power Transmission and Distribution	Pearson ISBN : 8131707911, 9788131707913
6	Gupta B.R.	Power System Analysis and Design	S.Chand and Co. New Delhi ISBN : 9788121922388
7	Kamraju V.	Electrical Power Distribution System	Tata Mc.GrawHill, New Delhi ISBN : 9780070151413

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	www.ntpc.co.in	National Thermal Power Corporation is authority who control India's Thermal Power Sector.
2	https://www.powergrid.in	Power Grid Corporation of India Limited (POWERGRID), a Schedule 'A', 'Maharatna' Public Sector Enterprise of the Government of India.
3	https://www.electrical4u.com/electrical-engineering-articles/transmission/	Information about Electric Power Grid System.
4	www.meda.com	Maharashtra Energy Development Agency working under BEE for spreading Energy conservation awareness in maharashtra.

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Sr.No	Link / Portal	Description
5	https://energy.gov/sites/prod/files/2013/07/f2/Transmission_Woodall_0.pdf	Transmission Line Basics
6	https://www.electrical4u.com/performance-of-transmission-line/	Performance of Transmission Line
7	https://youtu.be/IdPTuwKEfmA?si=CfpZgHlEgrk5_YvW	Thermal Power Plant.
8	https://youtu.be/lidARL1w88Q?si=HXc3J4ISMTwHAMMw	Thermal Power Plant.

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students