POWER SYSTEM ANALYSIS **Course Code : 316331**

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

Programme Code : **EE/ EP**

Semester : **Sixth**

Course Title : **POWER SYSTEM ANALYSIS**

Course Code : **316331**

I. RATIONALE

Power system Analysis is a core subject in electrical engineering, which includes transmission line parameters calculations, Power flow analysis analytically & graphically and load flow study. The Electrical Engineering diploma pass outs working in power sector should be able to analyze transmission lines performance with the concept of 'Generalized Circuit theory'. They should also be able to control and maintain voltages and other parameters like active and reactive power flow on different buses of power system at desired level. This course is important for diploma electrical engineers who wish to work in power generation, transmission and distribution companies to handle different activities in power system.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

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

- **Analyze the performance of power system networks**.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Calculate Inductance and Capacitance for different types of transmission lines.
- CO2 - Use generalized circuit theory principles for calculations of transmission line performance
- CO3 - Estimate the power at sending and receiving ends of transmission line.
- CO4 - Analyze the performance of transmission lines graphically
- CO5 - Interpret the data required for Load flow studies

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	
316331	POWER SYSTEM ANALYSIS	PSA	DSE	3	-	2	1	6	3	3	30	70	100	40	25	10	25#	10	25	10	175

Total IKS Hrs for Sem. : 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

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 Explain the significance of analysing the given power system. . TLO 1.2 Describe role of power system engineer for analysing the given power system. TLO 1.3 Describe the impact of given parameter in transmission line performance. TLO 1.4 Develop the equation for inductance/capacitance of the given transmission line TLO 1.5 Calculate inductance / capacitance of the given single-phase line with given configuration TLO 1.6 Evaluate Self Geometric Mean Distance(GMD) and Mutual GMD for the given conductor configuration. TLO 1.7 Estimate the inductance/capacitance of three phase line for the given conductor arrangement. TLO 1.8 Estimate the capacitance of line by considering effect of earth field	**Unit - I Transmission Lines Components** 1.1 Aspects of power system analysis and Role of power system engineer. 1.2 Significance of Transmission line Components –Resistance, Inductance, Capacitance and Conductance 1.3 Inductance-Single phase line composed of solid conductors and bundled conductors. 1.4 Geometric Mean Distance (GMD) - Concept of Self GMD and Mutual GMD 1.5 Inductance of three phase line (single circuit) composed of solid conductors with symmetrical and asymmetrical spacing. 1.6 Concept of Potential difference between two conductors placed in a group of parallel conductors , Capacitance of single-phase line composed of solid Conductors and Duplex bundled conductors. 1.7 Capacitance of three phase line (single circuit) with symmetrical and asymmetrical spacing 1.8 Effect of earth field on transmission line capacitance.by method of Images	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations

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.
2	TLO 2.1 Explain the concept of generalized circuit for the given type transmission line. TLO 2.2 Calculate the Generalized Circuit Constants (GCC) for the given type transmission line. TLO 2.3 Develop resultant generalized network of the given type combination of networks. TLO 2.4 Describe the benefits of generalised circuit representation of the given type of transmission line.	**Unit - II Generalized circuit representation** 2.1 Generalized Circuit – Concept. 2.2 Generalized circuit constants (GCC) of short, medium transmission line. 2.3 Generalized circuit constants (GCC) of two networks connected in series. 2.4 Generalized circuit constants (GCC) of two networks connected in parallel. 2.5 Advantages of Generalized circuit representation.	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations
3	TLO 3.1 Explain the concept of complex power with reference to the given power system. TLO 3.2 Develop the expression for complex power at given end of the given transmission line. TLO 3.3 Calculate the real/reactive power at given end of given transmission line for the given loading condition. TLO 3.4 Derive the condition for maximum real power flow of given end of the given transmission line	**Unit - III Power flow** 3.1 Complex Power (S=V I*), Real Power and reactive Power. 3.2 Derivation for Complex power, real power, reactive power for receiving end of the transmission line using Generalized Circuit Equation (GCE). 3.3 Derivation for Complex power, real power, reactive power for sending end of the transmission line using Generalized Circuit Equation (GCE). 3.4 Condition for maximum power at receiving end of transmission line. 3.5 Condition for maximum power at sending end of transmission line	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations Video Demonstrations
4	TLO 4.1 Describe the locus of complex power flowing through transmission line at both end TLO 4.2 Draw locus of complex power at receiving end transmission line with given loading condition and evaluate performance parameters. TLO 4.3 Draw locus of complex power at Sending end transmission line with given condition and evaluate performance parameters. TLO 4.4 State the Advantages of graphical analysis by using Circle diagram.	**Unit - IV Line performance by graphical analysis** 4.1 Graphical method for Transmission line performance analysis- circle diagram , Receiving end and Sending end circle diagram 4.2 Procedure to draw circle diagram for Receiving end and derive performance parameter. 4.3 Procedure to draw circle diagram for Sending end and derive performance parameter. 4.4 Transmission line performance parameters calculations by drawing circle diagram. 4.5 Advantages of graphical analysis by using Circle diagram.	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations Video Demonstrations

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 Explain the significance of Load flow analysis for the given power system. TLO 5.2 State the data required for Load flow studies for the given power system. TLO 5.3 Interpret the Characteristics' of the given SLFE for specified power system TLO 5.4 Identify the information obtained from the given Load flow study. TLO 5.5 Identify significant features of the given Ybus matrix TLO 5.6 Develop Ybus matrix for given 3 bus system.	**Unit - V Load flow studies** 5.1 Load flow studies- Concept and its need. 5.2 Data required for Load flow studies. 5.3 Static Load Flow Equation (SLFE) for simple two bus system and definition of parameters (only equation). 5.4 Characteristics of SLFE. 5.5 Information obtained from Load Flow Studies 5.6 Formation of Ybus (for 3 bus system including reference bus).	Lecture Using Chalk-Board Flipped Classroom Case Study Presentations Video Demonstrations

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 Identify type of conductor from given sample of line conductors. LLO 1.2 Calculate self GMD.	1	*Identification of type of conductors and calculate Self GMD.	2	CO1
LLO 2.1 Evaluate Inductance for 3 ø transmission line with symmetrical and unsymmetrical spacing. LLO 2.2 Evaluate capacitance for 3 ø transmission line with symmetrical and unsymmetrical spacing.	2	*Inductance and capacitance for 3 Ø transmission line with symmetrical and unsymmetrical spacing.	2	CO1
LLO 3.1 Evaluate Inductance and capacitance for 1 ø transmission line without ground effect and with ground effect. LLO 3.2 Evaluate Inductance and capacitance for 1 ø transmission line without ground effect and with ground effect.	3	Inductance and capacitance for 1ø transmission line without ground effect and with ground effect.	2	CO1
LLO 4.1 Perform OC and SC Test and evaluate Generalized circuit constant (GCC) of given n model of transmission line.	4	*GCC of given n model of transmission line. by using OC SC test.	2	CO2
LLO 5.1 Perform OC and SC Test and evaluate Generalized circuit constant (GCC) of given T model of transmission line.	5	GCC of given T model of transmission line by using OC SC test.	2	CO2
LLO 6.1 Determine Generalized circuit constant (GCC) of given n (PI) model of transmission line by using Scilab.	6	*GCC of given n (PI) model of transmission line by using software.	2	CO2
LLO 7.1 Determine Generalized circuit constant (GCC) of given T model of transmission line by using Scilab	7	GCC of given T model of transmission line by using software.	2	CO2
LLO 8.1 Perform Load test on given n (PI) model of transmission line and determine the Efficiency and regulation.	8	n (PI) model Transmission line Efficiency and regulation by Load test.	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 9.1 Perform Load test on given T model of transmission line and determine the efficiency and regulation.	9	*T model Transmission line Efficiency and regulation by Load test.	2	CO3
LLO 10.1 Evaluate Receiving end complex power by using Scilab for given transmission line under load condition.	10	Transmission line Receiving end complex power evaluation by using software.	2	CO3
LLO 11.1 Evaluate Sending end complex power by using Scilab for given transmission line under given condition.	11	Transmission line Sending end complex power evaluation by using software.	2	CO3
LLO 12.1 Draw Circle Diagram for Receiving end or Sending end for given transmission line under load condition by using scilab / MATLAB.	12	*Transmission line Receiving end or Sending end complex power evaluation by graphical method.	2	CO4
LLO 13.1 Use Scilab / MATLAB to develop Ybus matrix for given 3- bus system-1.	13	*Development of Ybus matrix by using software- case 1.	2	CO5
LLO 14.1 Use Scilab / MATLAB to develop Ybus matrix for given 3- bus system-2.	14	Development of Ybus matrix by using software- case 2.	2	CO5
LLO 15.1 Determine the effect on SLFE for given power system using relevant software like VLAB	15	Determination of effect on SLFE during the maintenance outages for given power system using relevant software.	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)

Assignment

- Calculate inductance and capacitance / km and total loop Inductance of the given 1 ø line / 3 ø line with symmetrical/ unsymmetrical spacing with / without considering ground effect. Vary spacing / size of conductor and observe effect on line parameters.
- A 3 ø line with given equilateral spacing is to be rebuilt with horizontal/vertical spacing as D13 = 2D12 = 2D23. The conductors are to be fully transposed. Find the spacing between adjacent conductor such as that new line has the same inductance as original value.
- Determine ABCD constants, calculate sending end voltage and percentage regulation for 3 ø transmission line with given impedance and admittance and for given loading condition by Using n / T method.
- For given ABCD constants and line details with load condition, determine Sending end power / receiving end power and maximum power that can be delivered Analytically and graphically
- For given ABCD constants and for given loading condition, calculate performance of line - sending end voltage, sending end current, voltage regulation and efficiency by Using n / T method

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	Sample of transmission line conductors	1
2	AC ammeter 2.5A, 5A	4,5,8,9
3	AC voltmeter 30V, 300V	4,5,8,9
4	Single Phase Wattmeter –Lpf 2.5A,300 V and unity pf 5A ,75/300V	4,5,8,9
5	Single Phase Auto transformer 0-250 V,10A	4,5,8,9
6	Simulation n model of transmission line or trainer kit	4,8
7	Simulation T model of transmission line or trainer kit.	5,7
8	Open source software ?Scilab 5.5.2 (any other suitable software)	6,7,10,11,12,13,14,15
9	Lamp Bank 1kW, 230 V, 5A	8,9

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	Transmission Lines Components	CO1	16	4	7	7	18
2	II	Generalized circuit representation	CO2	8	2	7	4	13
3	III	Power flow	CO3	7	2	4	8	14
4	IV	Line performance by graphical analysis	CO4	8	2	6	7	15
5	V	Load flow studies	CO5	6	2	6	2	10
Grand Total				**45**	**12**	**30**	**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.
- 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.
- 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	2	3	3	2	2	2	3			
CO2	2	3	2	2	2	2	3			
CO3	3	3	2	2	2	2	3			
CO4	2	3	3	3	2	2	2			
CO5	2	2	2	2	2	2	3			

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	Mehta V. K ; Mehta Rohit	Principles of Power System	S.Chand and Co., New Delhi. . 3rd Edition ISBN-10. 9788121924962 · ISBN-13. 978-8121924962
2	Nagrath I. J. Kothari D. P.	Modern Power System Analysis	McGraw HillEducation, New Delhi 5th Edition. 14 June 2022. ISBN-13: 978-9354600968
3	Stevenson William	Elements of Power System Analysis	McGraw-Hill Book Company, New York, 2014(4th addition) ISBN 10: 0070612781 / ISBN 13: 9780070612785
4	Wadhava C. L.	Electrical Power System	New age international publishers ISBN: 13-978-1-4987-7757-5-(EPUB)
5	Gupta B.R.	Power system Analysis and Design	S. Chand and Co. Ltd., New Delhi Edition: 6 Year: 2011 ISBN: 81-219-2238-0

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://archive.nptel.ac.in/courses/117/105/117105140/	NPTEL Lecture series on power system Analysis
2	https://archive.nptel.ac.in/courses/108/105/108105067/	Lecture series on Transmission line components calculation, load flow studies & Y bus formation.
3	https://www.youtube.com/watch?v=wuT2fqdT2pE	Basics of load flow study
4	https://srmeeevlab.github.io/PSA/3_Formation_of_Bus_admittance_Matrix_(without_mutual_coupling)/simulation.html	Exercises on Y bus & Z bus matrix formation by using VLAB

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Sr.No	Link / Portal	Description

Note :

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

MSBTE Approval Dt. 04/09/2025 **Semester - 6, K Scheme**