GUJARAT TECHNOLOGICAL UNIVERSITY
Bachelor of Engineering
Subject Code: 3150911

Subject Name: Power System II
Semester V

Type ofcourse: Engineering – Professional Core Course

Prerequisite: Fundamental knowledge of Electrical Engineering and Power System – I

Rationale: The course is aimed to provide exposure about the modeling of power systems components and transmission line, its analysis and performance including the fault analysis of power systems, brief introduction to corona and transients in power system.

Teachingand Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1.	**Basic Principles:** Power in single phase AC circuits, Complex power, Complex power balance, Complex power flow, Balanced Three Phase Circuits, Star connected loads, Delta connected loads, Delta-star transformation, Per phase analysis, Balanced three phase power.	04	05
2.	**Representation of Power System Components:** One line and impedance diagram, Per unit system, Per unit representation of transformer, Per unit impedance diagram of power system, Examples – per unit system and impedance diagram, Synchronous machine, Power factor and power control, Salient pole synchronous generator, Operating chart of a synchronous generator, Representation of loads.	08	10
3.	**Transmission Line Modeling and Performance:** Introduction, Short transmission line, Medium transmission line, Long transmission line – Rigorous solution,Evaluation of ABCD constants, Interpretation of long line equations, Ferranti effect,Tuned power lines, Power through a transmission line, Circle diagrams, Methods of voltage control, Examples.	14	25
4.	**Symmetrical Fault Analysis:** Introduction, Transient on a transmission line, Short circuit of a synchronous machine on no load, short circuit of a loaded synchronous machine, Selection of circuit breakers, Examples, Z_{BUS} formulation – by inverting Y_{BUS}, current injection technique, Z_{BUS} building algorithm (Type – 1, 2, 3, 4 modifications).	08	10
5.	**Symmetrical Components:** Symmetrical component transformation, Phase shift in star-delta transformers, Sequence impedances of transmission lines, Sequence - impedances and networks of synchronous machines, Sequence impedances and networks of transformers, Construction of sequence networks of a power system, Examples.	07	15
6.	**Unsymmetrical Fault Analysis:** Introduction, Symmetrical component analysis of unsymmetrical faults,	07	15

	Single line to ground fault, Line to line fault, Double line to ground fault, Open conductor faults.		
7.	**Corona:** Critical Disruptive Voltage, Corona Loss, Line Design based on Corona, Disadvantages of Corona, Radio Interference, Inductive interference between Power and Communication lines, Examples.	04	05
8.	**Over-voltages in Power Systems:** Causes of over-voltages, Internal causes of over-voltages, Mechanism of lightning discharge, Types of lightning strokes, Harmful effects of lightning, Protection against lightning, Earthing screen, Overhead ground wires, Lightning arresters, Surge absorber, .	05	07
9.	**Transients in Power Systems:** Travelling waves on transmission lines, Open end line, Short circuited line, Line terminated through a resistance, Line connected to a cable, Reflection and refraction at a T-junction, Line terminated through a capacitance, capacitor connection at T, Attenuation of travelling waves. Capacitance switching, Over-voltages due to arcing ground.	07	08

Reference Books:

1. Modern Power system Analysis: I. J.Nagrath, D. P. Kothari,McGraw Hill Education
2. Power System Analysis: HadiSaadat, McGraw Hill Education India Pvt Ltd.
3. Electrical Power systems: C. L .Wadhwa, New Age International Publishers
4. Principles of Power System: V. K. Mehta, Rohit Mehta, S. Chand Publications
5. Power System Analysis and Design: J. Duncan Glover, Thomas J. Overbye, Mulukutla S. Sarma, Cengage Learning India Pvt. Ltd.
6. Elements of Power Systems Analysis: W. D. Stevenson Jr., McGraw Hill Education.
7. Power System Analysis : John J. Grainger, William D. Stevenson Jr.,McGraw Hill Education

Suggested list of practical but not limited to:

1. To write computer program for plotting instantaneous voltage, current and power in a single phase ac circuit.
2. To write computer program and obtain voltage regulation and efficiency of short transmission line for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
3. To write computer program and obtain voltage regulation and efficiency of short transmission line for different specified set of sending end quantities (sending end leading, unity and lagging power factor).
4. To write computer program and obtain voltage regulation and efficiency of a Medium transmission line (using π model& T model) for different specified set of receiving end quantities (different load at leading, unity and lagging power factor).
5. To write computer program and obtain voltage regulation and efficiency of a Medium transmission line (using π model& T model) for different specified set of sending end quantities (sending end leading, unity and lagging power factor).
6. To write computer program to calculate voltage regulation and efficiency of a Long transmission line using distributed capacitance model for different specified set of receiving end quantities (different load at leading, unity and lagging power factor) and compare the results with results obtained with program for equivalent π model.
7. To write computer program to calculate voltage regulation and efficiency of a Long transmission line using distributed capacitance model for different specified set of sending end quantities (sending end leading, unity and lagging power factor) and compare the results with results obtained with program for equivalent π model.

8. To analyse the performance of long transmission line for specified load impedance.
9. To obtain voltage profile and loadability curve for a transmission line.
10. To compute shunt reactor compensation and performance of open circuited line.
11. To compute shunt capacitor compensation and performance of loaded line.
12. To compute series capacitor compensation and performance of loaded line.
13. To develop program for formulation of Z_{BUS} matrix through Z_{BUS} building algorithm.
14. To simulate transient in series R-L circuit with special attention to change in DC offset current for application of excitation at different instant.
15. Dynamic simulation of three phase fault on terminal of unloaded synchronous generator. The simulation should show the waveforms of all three line current for fault at different instant on voltage wave of phase A.
16. To develop program to transform three phase unbalanced phasor into its symmetrical components.
17. To develop program to transform symmetrical components into its original phasors.
18. To analyzeline to line fault in power system (Using program/simulation).
19. To analyze line to ground fault in power system (Using program/simulation).
20. To analyze double line to ground fault in power system (Using program/simulation).
21. To write a computer program for animation of travelling waves of a long transmission line with different operating conditions.

Suggested Specification tablewith marks(Theory):

Distribution ofTheoryMarks					
RLevel	ULevel	ALevel	NLevel	E Level	CLevel
10	20	20	25	15	10

Legends:R:Remembrance;U:Understanding, A:Application,N:Analyze, E:Evaluate C: Createand above Levels (RevisedBloom's Taxonomy)

Note: Thisspecificationtable shallbetreated as ageneralguidelineforstudents and teachers.The actual distributionofmarks in thequestionpapermay varyslightlyfromabove table.

Course Outcome (Theory):

After learning the course the students should be able to:

Sr. No.	CO Statement	Marks % Weightage
1.	Prepare the model of transmission line, generator and transformer of power system for single line diagram representation and per unit quantity calculation.	15
2.	Evaluate performance of short, medium and long transmission lines.	25
3.	Analyze symmetrical and unsymmetrical faults in power system.	40
4.	Describe various aspects of over-voltages and corona in power transmission.	12
5.	Describe travelling wave and transientsin power system.	08

Course Outcome (Laboratory):

After performing the practical, the students should be able to:

1. Evaluate transmission line parameters and operating performance using computer program and simulation.
2. Calculate fault current and voltages for three phase symmetrical and unsymmetrical faults on power systems using computer program and computer simulation.
3. Calculate important Design parameters of transmission line design and calculate ratings of circuit breakers for transmission system.

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Major software:

MATLAB, C/C++, SciLab, PowerWorld Simulator

List of Open Source Software/learning website:

1. https://www.scilab.org/
2. https://www.powerworld.com/download-purchase/demo-software/simulator-demo-download
3. https://swayam.gov.in/nd1_noc19_ee61/preview
4. https://swayam.gov.in/nd1_noc19_ee62/preview
5. http://vp-dei.vlabs.ac.in/Dreamweaver/list.html