SARVAJANIK UNIVERSITY
Sarvajanik College of Engineering and Technology
Bachelor of Technology

B.Tech. Working Professional Semester III

Subject Name: POWER SYSTEM ANALYSIS **Subject Code: BTEL13382**

Type of course: Professional core Course

Prerequisite: Fundamental knowledge of Basic Electrical Engineering & Electrical Network Analysis

Rationale: The course is aimed to provide exposure about various AC supply systems, transmission lines and their parameters, underground cables and their parameters, the modeling of power systems components and transmission line, its analysis and performance including the fault analysis of power systems and brief introduction to corona

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
4	0	2	5	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	**Electrical Supply Systems :** Electric supply system, Typical A.C. power supply scheme, Comparison of D.C. and A.C. Transmission, Advantages of high transmission voltage, Distribution System, Classification of Distribution Systems, Overhead v/s underground systems, Power in single phase AC circuits, Complex power, Power triangle, Direction of power flow, Balanced Three Phase Circuits, Star connected loads, Delta connected loads, Per phase analysis, Power in balanced three phase circuit. [1,3,6]	**05**	**05**
2.	**Inductance and Capacitance of Overhead Transmission Lines:** Introduction, Definition of Inductance, Flux Linkages of an isolated current carrying conductor, Inductance of a single phase two wire line, Conductor types, Flux Linkages of one conductor in group, Inductance of composite conductor		

	lines, Inductance of three phase lines, Double circuit three phase lines, Bundled conductors. Electric field of a long straight conductor, Potential difference between two conductors of a group of parallel conductors, Capacitance of a two wire line, Capacitance of a three phase line with equilateral spacing, Capacitance of a three phase linewith unsymmetrical spacing, Effect of earth on transmission line capacitance, Method of GMD, Bundled conductors.[2,5]	**10**	**20**
3.	**Characteristics and Performance of Power Transmission Lines:** Introduction, Short transmission line, Medium transmission line, Long transmission line – Rigorous solution, Evaluation of ABCD constants, The Equivalent Circuit of a Long Line, Interpretation of long line equations, Ferranti effect, Tuned power lines, Power through a transmission line, Circle diagrams, Reactive Compensation of Transmission Lines.[1,2,6]	**10**	**20**
4.	**Underground Cables:** Underground cables, construction of cables, classification of cables, cables for three phase services, insulation resistance of asingle core cable, capacitance of a single core cable, dielectric stresses in a single core cable, most economical conductor size in a cable, grading of cables, capacitance grading and inter- sheath grading, capacitance of three core cable and measurements of capacitances. [1.6]	**06**	**10**
5.	**Representation of Power System Components:** Single-phase Representation of Balanced Three-phase Networks, One line and impedance/reactance diagram, Per unit system, Per unit representation of transformer, Per unit impedance diagram of power system, Examples – per unit system and reactance diagram, The Steady State Model of Synchronous machine, Power factor and power control, Salient pole synchronous generator, Operating chart of a synchronous generator, Representation of loads. [2,3]	**06**	**10**
6.	**Symmetrical Components and Sequence Networks:** 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. [2,3]	**06**	**10**
7	**Fault Analysis:** Introduction, Transient on a Transmission Line, Short Circuit currents and the reactances of Synchronous machines, Internal voltages of loaded machines under Fault Condition, Algorithm	**12**	**15**

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	for Short Circuit Studies, The selection of circuit breakers. Symmetrical component analysis of unsymmetrical faults, Single line to ground fault, Line to line fault, Double line to ground fault, Bus Impedance Matrix Method for Analysis of Unsymmetrical Shunt Faults.[2,3]		
8	**Corona & Neutral Grounding:** Critical Disruptive Voltage, Corona Loss, Line Design based on Corona, Disadvantages of Corona, Radio interference, Inductive interference between Power and Communication lines [4,5] System with ungrounded neutral, Neutral grounding, Step potential, touch potential, Advantages of neutral grounding, Methods of neutral grounding – Solid grounding, Resistance grounding, Reactance grounding, Resonant grounding [1,4]	**05**	**10**

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**20**	**20**	**25**	**15**	**10**

Legends: R: Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **E:** Evaluate **C:** Create and above Levels **(Revised Bloom's Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of Publication	Publication Edition
1	Principles of Power System	V. K. Mehta, Rohit Mehta	S. Chand ISBN: 81-219-2496-0	2009	First Multicolour
2	Modern Power System Analysis	D. P. Kothari, I. J. Nagrath	TMH Publication ISBN (13): 978-0-07-107775-0	2011	Fourth
3	Power Systems Analysis	John J. Grainger W. D. Stevenson	Jr., Tata McGrawHill International ISBN (13): 978-0-07-058515-7	2011	First
4	Electric Power System	C.L.Wadhwa	New Age International Ltd. ISBN: 978-1-906574-39-0	2012	First
5	Electrical Power systems	D.Das	New Age International ISBN: 81-224-1885-6	2008	First

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6	Electric Power Transmission and Distribution	S. Sivanagaraju, S. Satyanarayana	Pearson Education ISBN: 978-81-317-0791-3	2009	First
7	Principles of Power System	V.K.Mehta Rohit Mehta	S. Chand ISBN: 81-219-2496-0	2009	First Multi colour
8	Power System Analysis	Hadi Saadat	McGraw Hill Education India Pvt Ltd. ISBN: 0-07-116758-7	1999	First
9	Power System Analysis and Design	J. Duncan Glover, Thomas J. Overbye, Mulukutla S. Sarma	Cengage Learning India Pvt. Ltd. ISBN: 978-81-315-0362-1	2009	Third

LIST OF PRACTICALS:

1. To write a computer program for plotting instantaneous voltage, current and power in a single phase ac circuit.
2. To write a computer program to obtain voltage regulation and efficiency of Short transmission line for different
   a) Specified set of receiving end quantities (load at leading, unity and lagging power factor).
   b) Specified set of sending end quantities (load at leading, unity and lagging power factor).
3. To write a computer program to obtain voltage regulation and efficiency of a Medium transmission line (using End condenser method, T model & π model) for different
   a) Specified set of receiving end quantities (load at leading, unity and lagging power factor).
   b) Specified set of sending end quantities (load at leading, unity and lagging power factor).
4. To write a computer program to obtain voltage regulation and efficiency of a Long transmission line using rigorous method, equivalent T model & equivalent π model for different
   a) Specified set of receiving end quantities (load at leading, unity and lagging power factor).
   b) Specified set of sending end quantities (load at leading, unity and lagging power factor).
5. To analyse the performance of long transmission line for specified load impedance.
6. To obtain voltage profile and loadability curve for a transmission line.
7. To write a computer program to obtain receiving end power circle diagram of a transmission line.
8. To simulate transient in series R-L circuit to change in DC offset current for application of excitation at different instant.
9. To study phase shifting in star- delta transformer with emphasis on the labelling on HV and LV sides for positive sequence and negative sequence.
10. To write a computer program for obtaining symmetrical components for a given set of unbalanced phasors.
11. To write a computer program to obtain fault current, bus voltages & line flow for a three phase fault in a small power system.
12. To write a computer program for L-G fault of a small system (containing generator, transformer and lines) using interconnection of sequence networks.

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13. To write a computer program for L-L fault of a small system (containing generators, transformers and lines) using interconnection of sequence network.
14. To write a computer program for L-L-G fault of a small system (containing generators, transformers and lines) using interconnection of sequence network.
15. To write a computer program to obtain corona losses of transmission line.

Major Equipment:

1. Computer LAB equipped with MATLAB, PowerWorld Simulator, MiPower software

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Describe supply systems and distribution systems.	05
CO-2	Compute transmission line parameters.	20
CO-3	Evaluate the performance of Short, Medium & long transmission line.	20
CO-4	Describe underground cables.	10
CO-5	Describe the representation of different power system components and loading capability of a generator.	10
CO-6	Describe the symmetrical components and its applications.	10
CO-7	Analyze Symmetrical and Unsymmetrical faults in power systems.	15
CO-8	Describe Corona effect & Neutral grounding in power systems.	10

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO-1	3	3	2	-	-	-	2	2	1	2	2	3	2	-	2
CO-2	3	3	3	1	2	-	2	-	1	-	1	3	3	1	-
CO-3	3	3	3	3	2	3	2	2	2	2	3	3	3	3	2
CO-4	2	3	3	2	2	2	1	-		2	1	3	2	2	-
CO-5	3	3	2	1	-	-	1	-	2	2	3	3	3	2	2
CO-6	3	3	2	3	2	1	2	-	2	1	2	3	3	3	-
CO-7	3	3	3	3	3	3	3	3	3	3	3	3	3	3	-
CO-8	2	1	3	3	2	3	3	3	2	2	2	3	2	2	3
Rationale*	22	22	21	16	13	12	16	10	13	14	17	24	21	16	09

***Rationale:** Explaining why it is matching this particular program outcome

List of Open Source/learning website:

1. https://nptel.ac.in/courses/108/105/108105104/
2. https://swayam.gov.in/nd1_noc19_ee61/preview
3. https://swayam.gov.in/nd1_noc19_ee62/preview
4. https://nptel.ac.in/courses/108/102/108102047/
5. https://nptel.ac.in/courses/108/104/108104051/
6. https://nptel.ac.in/courses/108/105/108105067/

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7. http://vp-dei.vlabs.ac.in/Dreamweaver/list.htmlhttps://www.powerworld.com/download-purchase/demo-software/simulator-demodownload