SREENIVASA INSTITUTE of TECHNOLOGY and MANAGEMENT STUDIES (autonomous)

Electrical Power Transmission

Question bank

II - B.TECH / IV - SEMESTER regulation: R20

Compiled by

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II B.Tech IV Semester

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20EEE243 ELECTRICAL POWER TRANSMISSION

Pre-requisites: A Course on Generation of Electrical Power

Course Educational Objectives:

1. To make students capable to understand the electrical line parameters..
2: To impart knowledge on short, medium and long transmission lines.
3: To provide the knowledge about the system transients and transmission line parameters.
4: To acquire knowledge on the concepts of corona, sag and tension calculations.
5: To provide knowledge on the issues related to overhead line insulators and underground cables.

UNIT – 1: TRANSMISSION LINE PARAMETERS

Types of conductors - calculation of resistance for solid conductors - Calculation of inductance for single phase and three phase, single and double circuit lines, concept of GMR & GMD, symmetrical and asymmetrical conductor configuration with and without transposition, Numerical Problems. Calculation of capacitance for 2 wire and 3 wire systems, effect of ground on capacitance, capacitance calculations for symmetrical and asymmetrical single and three phase, single and double circuit lines, Numerical Problems.

UNIT – 2: PERFORMANCE OF SHORT, MEDIUM AND LONG TRANSMISSION LINES

Classification of Transmission Lines - Short, medium and long line and their model - representations - Nominal-T, Nominal-Pie and A, B, C, D Constants. Numerical Problems. Mathematical Solutions to estimate regulation and efficiency of all types of lines - Numerical Problems. Long Transmission Line-Rigorous Solution, evaluation of A,B,C,D Constants, Interpretation of the Long Line Equations – Representation of Long lines – Equivalent T and Equivalent – π – surge Impedance and surge Impedance loading – Ferranti effect , Charging current.

UNIT – 3: POWER SYSTEM TRANSIENTS

Types of system transients- travelling or propagation of surges- attenuation, distortion, reflection and refraction coefficients- termination of lines with different types of conditions- open circuited line, short circuited line, T-junction (numerical problems)- Bewleys Lattice diagrams (for all cases mentioned with numerical examples)

UNIT – 4: CORONA, SAG AND TENSION CALCULATIONS

Corona - Description of the phenomenon, factors affecting corona, critical voltages and power loss, Radio Interference. Sag and Tension Calculations with equal and unequal heights of towers, Effect of Wind and Ice on weight of Conductor, Numerical Problems - Stringing chart and sag template and its applications.

UNIT – 5: OVERHEAD LINE INSULATORS & UNDERGROUND CABLES

Types of Insulators, String efficiency and Methods for improvement, Numerical Problems - voltage distribution, calculation of string efficiency, Capacitance grading and Static Shielding. Types of Cables, Construction, Types of Insulating materials, Calculations of Insulation resistance and stress in insulation, Numerical Problems. Capacitance of Single and 3-Core belted cables, Numerical Problems. Grading of Cables - Capacitance grading, Numerical Problems, Description of Inter-sheath grading.

Course Outcomes:

On successful completion of the course, students will be able to		POs related to COs
CO1	Ability to do calculation of resistance, Inductance and Capacitance of Transmission Lines.	PO1,PO2,PO4& PS01,PSO2
CO2	Ability to apply the knowledge on short, medium and long transmission lines.	PO1,PO3,&PS01, PSO2
CO3	Demonstrate knowledge on power system transients.	PO1,PO3,PO4& PS01,PSO2
CO4	Understand the concepts of corona, sag and tension calculations.	PO1,PO2,PO3,PO6 &PS01,PSO2
CO5	Able to analyze the overhead line insulators and underground cables.	PO1,PO7&PS01, PSO2

Text Books:

1. C.L.Wadwa "Electrical Power Systems",New Age International Publishers–New Delhi. 6 /e2012.
2. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', Mc Graw-Hill Publishing Company limited, New Delhi, Second Edition, 2008.

Reference Books:

1. V.K.Mehta, S.Chand "Principles of Power systems ",S.Chand Publications – New Delhi 4/e 2005
2. William D Stevenson "Elements of Power systems"–4/e 1982 - Tata McGraw – Hill Education Pvt. Ltd.. Noida
3. B.R.Gupta "Power system analysis and deign ",S.chand&co,6th revised edition
4. john j Grainger, William D Stevenson "Power system analysis",TMC Companies,4th edition

Question No.	Questions	PO Attainment
UNIT – 1: TRANSMISSION LINE PARAMETERS		
PART-A (Two Marks Questions)		
1	Write the expression for flux linkages outside the conductor producing the flux.	PO1
2	Explain the transposition of lines.	PO1
3	Define GMD for a 3 phase transmission line.	PO1
4	What is meant by transposition of overhead line conductors?	PO1
5	Explain the advantages of bundled conductors.	PO1
6	What is the difference between DC and AC resistance of transmission line?	PO1
7	Write the expression for flux linkages inside the conductor producing the flux.	PO1
8	Write expression for magnetic field intensity of a current carrying conductor.	PO1
9	Define GMR for a 3 phase transmission line.	PO1
10	Explain the advantages of transposition of conductors.	PO1
11	What is skin effect?	PO1
12	Define Proximity effect.	PO1
13	List advantages of AC over DC transmission.	PO1
14	Write the expression for capacitance of Single phase transmission line.	PO1
15	Write the expression for capacitance of Three phase single circuit transmission line.	PO1
16	Write the expression for capacitance of Three phase double circuit transmission line.	PO1
17	What is the effect of earth on capacitance of a transmission line.	PO1
18	Define inductance.	PO1
19	Define capacitance.	PO1
20	Differentiate between composite and bundled conductors.	PO1
PART-B (Ten Marks Questions)		
1	Describe about different types of transmission line conductors.	PO1, PO2
2	Show that the inductance per unit length of an overhead line due to internal flux linkages is constant and is independent of size of conductor.	PO1, PO2, PO4
3	Derive the expressions for the inductance of a 3 phase line with conductors untransposed.	PO1, PO2
4	Derive the expressions for the inductance of a 3 phase line with conductors completely transposed.	PO1, PO2, PO4
5	Explain the concept of GMR and GMD.	PO1, PO2, PO4
6	Derive an expression for inductance of composite conductors of a 1-phase line consisting of m strands in one conductor and n strands in the other conductor.	PO1, PO2, PO4
7	What are ACSR conductors? Explain the advantages of ACSR conductors when used for overhead lines.	PO1, PO2, PO4
8	What are bundled conductors? Explain the advantages of bundled conductors when used for overhead lines.	PO1, PO2, PO4
9	Explain clearly the ‘skin effect’ and ‘proximity effect’ when referred to overhead lines.	PO1, PO2, PO4
10	Derive the capacitance per km/phase of a double circuit 3-phase line.	PO1, PO2, PO4

Question No.	Questions	PO Attainment
UNIT – 2: PERFORMANCE OF SHORT, MEDIUM AND LONG TRANSMISSION LINES		
	PART-A (Two Marks Questions)	
1	Draw the phasor diagram of a medium transmission line using nominal-π method.	PO1
2	Define the regulation and efficiency of a transmission line.	PO1
3	Write the A,B,C and D parameter formulae for short transmission line	PO1
4	What are the advantages and disadvantages of Ferranti effect?	PO1
5	Define short and medium transmission lines.	PO1
6	Define surge impedance.	PO1
7	Draw the phasor diagram of a medium transmission line using nominal-T method.	PO1
8	Define A, B, C, D constants of transmission line. What are their values in short transmission lines?	PO1
9	Classify transmission lines based on length.	PO1
10	Write the equation for surge impedance loading.	PO1
11	What is the significance of charging current in transmission lines?	PO1
12	Draw the phasor diagram for a short transmission line.	PO1
13	Draw the phasor diagram of a long transmission line for equivalent T network	PO1
14	Draw the phasor diagram of a long transmission line for equivalent π network	PO1, PO3
15	Write the A,B,C and D parameter formulae for nominal T medium line	PO1
16	Write the A,B,C and D parameter formulae for nominal π medium line	PO1, PO3
17	Write the A,B,C and D parameter formulae for equivalent T long line	PO1
18	Write the A,B,C and D parameter formulae for equivalent π long line	PO1
19	Differentiate short and medium transmission lines.	PO1
20	Differentiate long and medium transmission lines.	PO1
	PART-B (Ten Marks Questions)	
1	Classify different types of transmission lines and explain their characteristics.	PO1, PO3
2	Derive expressions for voltage regulation and efficiency of a short transmission line.	PO1, PO3
3	Differentiate between a nominal-T and nominal-π representation of a transmission line.	PO1, PO3
4	Derive expressions for voltage regulation and efficiency of a nominal T type medium transmission line.	PO1, PO2, PO3
5	Explain the procedure to obtain A, B, C and D parameters of a short transmission line.	PO1, PO2, PO3
6	Explain the procedure to obtain A, B, C and D parameters of a medium transmission line.	PO1, PO2, PO3
7	A three phase 50 Hz transmission line has conductors of section 90 mm^2 and effective diameter of 1 cm and is placed at the vertices of an equilateral triangle of side 1 meter. The line is 20 km long and delivers a load of 10 MW at 33 kV and pf 0.8. Neglect capacitance and assume temperature of 20^0 C. Determine the efficiency and regulation of the line.	PO1, PO2, PO3
8	Determine the efficiency and regulation of a 3-phase, 100 km, 50 Hz transmission line delivering 20 MW at a pf of 0.8 lagging and 66 kV to a balanced load. The conductors are of copper, each having resistance 0.1 ohm	PO1, PO2, PO3

	per km, 1.5 cm outside diameter, spaced equilaterally 2 meters between centers. Neglect leakance and use (i) nominal-T and (ii) nominal-π method.	
9	Derive expressions for voltage regulation and efficiency of a nominal π type medium transmission line.	**PO1, PO2, PO3**
10	Derive expressions for voltage regulation and efficiency of a long transmission line.	**PO1, PO2, PO3**

Question No.	Questions	PO Attainment
UNIT – 3: POWER SYSTEM TRANSIENTS		
PART-A (Two Marks Questions)		
1	Explain the reflections of voltage and current wave of open ended transmission line.	**PO1**
2	Explain about propagation of surges.	**PO1**
3	Define velocity of wave propagation	**PO1**
4	Define crest and front of travelling waves	**PO1**
5	Define expression for voltage refraction coefficient for transmission line terminated by resistance.	**PO1**
6	Define attenuation constant.	**PO1**
7	What is the coefficient of reflection for current for an open ended line?	**PO1**
8	What is the coefficient of reflection for voltage for an open ended line?	**PO1**
9	What is the coefficient of reflection for current for a short circuit line?	**PO1**
10	What is the coefficient of reflection for voltage for a short circuit line?	**PO1**
11	Define distortion coefficient.	**PO1, PO3**
12	Define reflection coefficient.	**PO1**
13	Define refraction coefficient.	**PO1, PO3**
14	What is Bewleys Lattice diagram?	**PO1, PO3**
15	What is a propagation constant of travelling wave?	**PO1**
16	What are different system transients?	**PO1**
17	Why transients occur in transmission lines?	**PO1**
18	What do you mean by travelling waves?	**PO1**
19	Write down the equations for reflection coefficient of voltage for T-junction.	**PO1**
20	Write down the equations for refraction coefficient of voltage for T-junction.	**PO, PO3**
PART-B (Ten Marks Questions)		
1	A 400 m long cable is short circuited at the remote end. A pulse source having resistance of 150 ohm drives a 100 V pulse having duration of 6 μs. If the characteristic resistance of the cable is 50 ohms and the pulse velocity is 200 m/ μs, sketch the voltage profile for first 8 μs at the input of the line.	**PO1, PO3, PO4**
2	Discuss the phenomenon of reflection and refraction in travelling waves. Derive the expressions for reflection and refraction coefficients when a travelling wave is terminated through a resistance.	**PO1, PO3, PO4**
3	Derive expressions for travelling waves (Voltage and current).	**PO1, PO3, PO4**
4	Obtain refracted voltage and current equations for forked line.	**PO1, PO3, PO4**
5	A step wave of 100 kV travels on a line having a surge impedance of 400 ohms. The line is terminated by an inductance of 4000 μH. Find the voltage	**PO1, PO3, PO4**

	across the inductance and the reflected voltage wave.	
6	Discuss the behavior of a travelling wave when it reaches (i) short circuited end and (ii) open circuited end of a transmission line.	**PO1, PO3, PO4**
7	When the transmission line is terminated by resistance and travelling wave reaches to T-junction, determine the voltage and current of reflected wave.	**PO1, PO3, PO4**
8	Explain the variation of current and voltage on an overhead line when one end of the line is (i) open circuited and (ii) short circuited and at the other end a source of e.m.f. V is switched on.	**PO1, PO3, PO4**
9	Show that a travelling wave moves with a velocity of light on the overhead line and its speed is proportional to $1/\sqrt{(\mu\varepsilon)}$ on a cable with dielectric material of permittivity ε.	**PO1, PO3, PO4**
10	A surge of 100 kV travelling in a line of natural impedance 600 ohms arrives at a junction with two lines of impedances 800 ohms and 200 ohms respectively. Find the surge voltages and currents transmitted into each branch of line.	**PO1, PO3, PO4**

Question No.	**Questions**	**PO Attainment**
UNIT – 4: CORONA, SAG AND TENSION CALCULATIONS		
PART-A (Two Marks Questions)		
1	What is visual critical voltage due to corona?	**PO1**
2	Write formula for power loss due to corona.	**PO1**
3	What is stringing chart?	**PO1**
4	Explain the methods of reducing corona loss.	**PO1, PO2**
5	Explain the radio interference due to corona.	**PO1, PO2**
6	List the factors affecting corona.	**PO1, PO2**
7	Define sag and sag template.	**PO1, PO2**
8	Describe the stringing charts.	**PO1, PO2**
9	Describe the factors affecting corona.	**PO1**
10	What is visual critical voltage due to corona?	**PO1**
11	What is stringing chart?	**PO1**
12	Write formula for sag for equal heights of towers.	**PO1**
13	Write formula for sag for unequal heights of towers.	**PO1**
14	Write sag formula including effect of wind and ice.	**PO1**
15	Describe significance of sag template.	**PO1**
16	Describe significance of stringing chart.	**PO1**
17	Describe effect of corona on radio interference.	**PO1**
18	What are the methods to reduce corona?	**PO1**
19	Describe critical disruptive voltage?	**PO1**
20	List out the disadvantages of corona.	**PO1, PO2**
PART-B (Ten Marks Questions)		
1	Derive the expression for critical disruptive voltage.	**PO1, PO2, PO3,PO6**
2	A 3 phase line has conductor 2 cm in diameter spaced equilaterally 1 m apart. If the dielectric strength of air is 30 kV (max) per cm, find the disruptive critical voltage for the line. Take air density factor δ=0.952 and irregularity	**PO1, PO2, PO3,PO6**

	factor m_0=0.9.	
3	Explain stringing chart.	PO1, PO2, PO3,PO6
4	A transmission line over a hillside where the gradient is 1:20 is supported by two 22 m high towers with a distance of 300 m between them. The lowest conductor is fixed 2 m below the top of each tower. Find the clearance of the conductor from the ground. Given that conductor weighs 1 kg/m and the allowable tension is 1500 kg.	PO1, PO2, PO3,PO6
5	Derive sag expressions for equal and unequal supports with ice and wind effects.	PO1, PO2, PO3,PO6
6	Find the disruptive critical voltage and visual corona voltage for a 3 phase 220 kV line consisting of 22.26 mm diameter conductors spaced in a 6 m delta configuration. The following data can be assumed. Temperature 25^0C, pressure 73 cm of mercury, surface factor 0.84, irregularity factor for local corona 0.72 and 0.82 for decided corona.	PO1, PO2, PO3,PO6
7	Derive critical visual voltage expression.	PO1, PO2, PO3,PO6
8	Derive the expression of sag for transmission line.	PO1, PO2, PO3,PO6
9	Find the disruptive critical and visual corona voltages of a grid line operating at 132 kV. The following data is given: conductor diameter 1.9 cm, conductor spacing=3.8 km, temperature=44^0C, barometric pressure=73.7 cm, conductor surface factor: fine weather=0.8, rough weather=0.66.	PO1, PO2, PO3,PO6
10	Derive expressions for sag and tension in a power conductor strung between two supports at equal heights taking into account the wind and ice loadings also.	PO1, PO2, PO3,PO6

Question No.	Questions	PO Attainment
	UNIT – 5: OVERHEAD LINE INSULATORS & UNDERGROUND CABLES	
	PART-A (Two Marks Questions)	
1	The insulation resistance of a cable of length 10 kM is 1 MΩ, then what is the insulation resistance for 50 kM length of cable?	PO1, PO7
2	The capacitance of a 3-phase belted cable is 1.5 μF between the two cores with the third core connected to the lead sheath. Then what is the capacitance per phase?	PO1, PO7
3	Define string efficiency.	PO1, PO7
4	List the desirable properties of insulating materials used in cables.	PO1, PO7
5	What are the advantages of inter sheath grading.	PO1
6	List the advantages of pin type insulators.	PO1, PO7
7	Classify the underground cables.	PO1
8	Classify the string efficiency improving methods.	PO1
9	List out different insulators.	PO1
10	What are the desirable properties of an insulator?	PO1
11	Write the expression for string efficiency.	PO1
12	What are the advantages of capacitance grading of insulators.	PO1
13	Differentiate between overhead line insulators and underground cables.	PO1
14	What are different parts of an underground cable?	PO1

15	What is the cause for unequal distribution of stress in insulators?	**PO1**
16	What are the advantages of static shielding of insulators?	**PO1**
17	What are different methods for improving string efficiency?	**PO1**
18	What is a belted cable?	**PO1, PO7**
19	Define insulation resistance of a cable.	**PO1**
20	List out different methods of grading underground cable.	**PO1**
	PART-B (Ten Marks Questions)	
1	What is string efficiency? Explain various methods of improving string efficiency.	**PO1, PO7**
2	A three phase transmission line is being supported by three disc insulators. The potentials across top unit and middle unit are 8 kV and 11 kV respectively. Calculate (i) the ratio of capacitance between pin and earth to the self capacitance of each unit. (ii) the line voltage and (iii) string efficiency.	**PO1, PO7**
3	What do you understand by the term grading of cables? Explain the capacitance grading?	**PO1, PO7**
4	The maximum and minimum stresses in the dielectric of a single core cable are 40 kV/cm (r.m.s) and 10 kV/cm (r.m.s) respectively. If the conductor diameter is 2 cm, Find (i) Thickness of insulation (ii) Operating voltage.	**PO1, PO7**
5	A string of 5 insulators is fitted with a guard ring. All the discs are similar and capacitance of each pin to earth is C. Find the values of line to pin capacitances so that voltage distribution is uniform.	**PO1, PO7**
6	Write short notes on string efficiency improving methods.	**PO1, PO7**
7	Describe grading of cables.	**PO1, PO7**
8	Describe the distribution of voltage over a 4-unit string of insulators.	**PO1, PO7**
9	Describe the inter sheath grading in underground cables.	**PO1, PO7**
10	A 33 kV single core cable has a conductor diameter of 1 cm and a sheath of inside diameter 4 cm. Find the maximum and minimum stress in the insulation.	**PO1, PO7**

*****ALL THE BEST*****