INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

TUTORIAL QUESTION BANK

Course Name	:	EHVAC TRANSMISSION
Course Code	:	AEE504
Class	:	IV- B.Tech II Sem
Branch	:	Electrical and Electronics Engineering
Year	:	2019-2020
Course Co-ordinator	:	Ms. P. Sravani, Assistant Professor ,EEE
Course Faculty	:	Ms.P. Sravani, Assistant Professor ,EEE

OBJECTIVE:

Modern power transmission is utilizing voltages between 345 kV and 1150 kV, A.C. Distances of transmission and bulk powers handled have increased to such an extent that extra high voltages and ultra high voltages (EHV and UHV) are necessary. The problems encountered with such high voltage transmission lines exposed to nature are electrostatic fields near the lines, audible noise, radio interference, corona losses, carrier and TV interference, high voltage gradients, heavy bundled conductors, control of voltages at power frequency using shunt reactors of the switched type which inject harmonics into the system, switched capacitors, overvoltage's caused by lightning and switching operations, long air gaps with weak insulating properties for switching surges, ground-return effects, and many more.

COURSE OBJECTIVES:

The course should enable the students to:	
I	Illustrate basic concepts of extra high voltage AC transmission and understand the need for it.
II	Outline the line and ground reactive parameters and voltage gradients of conductors.
III	Describe effects of corona and methods of associated measurement.
IV	Associate the knowledge of electro static field theory and traveling wave theory.
V	Select voltage control methods for extra high voltage AC transmission system.

COURSE OUTCOMES (COs):

CO 1	Student can learn about the trends in EHV AC transmission.
CO 2	Student can calculate the line inductance and capacitance of bundle conductors
CO 3	Student understands the effect of Corona and radio interference
CO 4	Explore the concept of Electro static field and the travelling wave theory
CO 5	Student can analyze compensated devices for voltage control

COURSE LEARNING OUTCOMES (CLOs):

CLO Code	CLO's	At the end of the course, the student will have the ability to:
AEE504.01	CLO 1	Student shall learn the necessity of EHVAC Transmission.
AEE504.02	CLO 2	Student will come to know the advantages and problems in EHVAC Transmission.
AEE504.03	CLO 3	Student learns the power handling capability and line losses in EHVAC Transmission.
AEE504.04	CLO 4	Student understands the concept of bundle conductors.
AEE504.05	CLO 5	Student can calculate line inductance.
AEE504.06	CLO 6	Student can calculate line capacitance
AEE504.07	CLO 7	Student learns the concept of sequence inductance and sequence capacitance.
AEE504.08	CLO 8	Student learns the concept of sequence inductance and sequence capacitance.
AEE504.09	CLO 9	Student learns different modes of propagation and ground return.
AEE504.10	CLO 10	Student can calculate gradient of bundle conductors.
AEE504.11	CLO 11	Student can solve various design examples.
AEE504.12	CLO 12	Student learns about the concept of power loss and audible noise due to Corona.
AEE504.13	CLO 13	Student can derive the formula for corona loss .
AEE504.14	CLO 14	Student can understand the relationship between single phase and three phase audible noise levels.
AEE504.15	CLO 15	Student learns the concept of radio interference.
AEE504.16	CLO 16	Student can calculate electrostatic field of EHV transmission lines.
AEE504.17	CLO 17	Understand the effect of electrostatic field on humans ,animals and plants.
AEE504.18	CLO 18	Student can estimate the electrostatic induction in un-energized circuit of double,circuit line.
AEE504.19	CLO 19	Student can derive travelling wave expression and its solution
AEE504.20	CLO 20	Student learns about source of excitation and terminal conditions.
AEE504.21	CLO 21	Student learns about power circle diagram and its uses.
AEE504.22	CLO 22	Student understands the concept of synchronous condenser.
AEE504.23	CLO 23	Student learns the concept of static VAR compensation.

TUTORIAL QUESTION BANK

UNIT – I				
INTRODUCTION				
PART – A (SHORT ANSWER QUESTIONS)				
S. No	**QUESTION**	**Blooms Taxonomy Level**	**Course Outcomes**	**Course learning outcomes**
1	Explain in detail about necessity of EHV AC transmission	Understand	CO1	AEE504.1
2	Mention advantages of EHV AC transmission and discuss problems related to EHV AC transmission.	Understand	CO1	AEE504.2
3	Give ten levels of transmission voltages that are used in the world	Understand	CO1	AEE504.2
4	Explain power loss in transmission line.	Remember	CO1	AEE504.3
5	List out the parameters on which power handling capacity depends	Remember	CO1	AEE504.3
6	What is power handling capacity and line losses	Understand	CO1	AEE504.3
7	What is the significance of power handling capacity	Understand	CO1	AEE504.3
8	What is Aeolian vibration	Understand	CO1	AEE504.3
9	What is galloping	Remember	CO1	AEE504.3
10	A power of 900 MW is to be transmitted over a length of 875 km. Estimate the cost difference when using ±400 kV dc line and 400 kV ac lines	Understand	CO1	AEE504.3
11	Explain about waked induced oscillations.	understand	CO1	AEE504.3
12	Of the following transmission voltages (given in kV) used in the world, which ones are used in India at present: 66, 132, 169, 220, 275, 345, 400, 500–525, 735–765, 1000,1150.	Understand	CO1	AEE504.3
13	Explain resistance of conductors and effect of resistance of conductance.	Understand	CO1	AEE504.4
14	What is a bundled conductor? What are the advantages of bundled conductors?	Understand	CO1	AEE504.4
15	What is bundle spacing	Understand	CO1	AEE504.4
16	Explain line inductances and capacitances	Understand	CO1	AEE504.4
17	Examples of line configuration used in various parts of the world.	Remember	CO1	AEE504.4
18	Explain the significance of mechanical aspects i n bundle conductor	Understand	CO1	AEE504.4
19	Explain the effect of resistance of conductor in EHV AC transmission system.	Understand	CO1	AEE504.4
20	Discuss why EHV AC Lines are Necessary to transmit large blocks of power over long distances.	Understand	CO1	AEE504.4

PART – B (LONG ANSWER QUESTIONS)				
1	Explain necessity of EHV AC transmission and mechanical considerations for transmission	Understand	CO1	AEE504.1
2	a) What are the merits and problems of EHVAC transmission? b)A power of 2000 MW is to be transmitted from a super thermal power station in central India over 800 Km to Delhi. Use 400 KV and 750 KV alternatives. Suggest the number of circuits required with 50% series capacitor compensation and calculate the total power loss and loss per Km	Understand	CO1	AEE504.1
3	Explain the effect of resistance of conductor in EHV AC transmission system.	Understand	CO1	AEE504.1
4	Illustrate the power handling capacity and line loss of EHVAC lines with various voltagelevels.	Understand	CO1	AEE504.2
5	Discuss why EHV AC Lines are Necessary to transmit large blocks of power over long distances.	Understand	CO1	AEE504.2
6	Obtain the sequence inductances and capacitances of EHVAC lines	Understand	CO1	AEE504.2
7	Explain sequence inductances and capacitances	Remember	CO1	AEE504.2
8	Explain Resistance and inductance of ground return	Remember	CO1	AEE504.2
9	Discuss the convenience offered by using modes of propagation and possible uses of this technique.	Understand	CO1	AEE504.3
10	a)What are the different mechanical considerations in line performance and explain in detail? b)What are the properties of Bundled conductors and explain with neat sketches?	Understand	CO1	AEE504.3
11	Explain in detail capacitances and inductances of ground return and derive necessary expressions.	Remember	CO1	AEE504.3
12	Explain in detail about bundle conductors	Understand	CO1	AEE504.3
13	a)Why he Inductance and capacitance transformation required in Sequence Quantities in EHV-AC lines? b)What are the Conductor configurations used for bundles in EHV lines and also explain properties of Bundled conductors?	Remember	CO1	AEE504.3
14	A Drake conductor of North-American manufacture has an outer diameter of 1.108 inches having an Al cross-sectional area of 795,000 circular mils. The stranding is 26Al/7 Fe. Its resistance is given as 0.0215 ohm/1000 at 20°C under dc, and 0.1284 ohm/mile at 50°C and 50/60 Hz. Calculate. (a)diameter of each strand of Al and Fe in mils, inch, and meter units; Calculation of Line and Ground Parameters (b) check the values of resistances given above taking a $\rho = 2.7 \times 10^{-8}$ ohm-meter at 20°C and temperature-resistance coefficient $\alpha = 4.46 \times 10^{-3}$/°C at 20°C. (c) find increase in resistance due to skin effect.	Understand	CO1	AEE504.4

15	Explain in detail the line parameters for modes of propagation and derive necessary expressions.	Understand	CO1	AEE504.4
16	Explain the effect of resistance of conductor in EHV AC transmission system.	Understand	CO1	AEE504.4
17	a) What is a bundled conductor? What are the advantages of bundled conductors? b) Write short notes on positive, Negative and zero sequence impedances corresponding to E.H.V. lines.	Remember	CO1	AEE504.4
18	What are the Conductor configurations used for bundles in E.H.V. lines and also explain properties of Bundled conductors?	Remember	CO1	AEE504.4
19	Write brief descriptions of (a) Aeolian vibration, (b) Galloping (c) wake-induced oscillations. Describe the measures taken to minimize the damage due to them	Understand	CO1	AEE504.4
20	What are the Conductor configurations used for bundles in E.H.V. lines	Remember	CO1	AEE504.4
PART – C (ANALYTICAL QUESTIONS)				
1	A power of 12,000 MW is required to be transmitted over a distance of 1000 km. At voltage levels of 400 kV, 750 kV, 1000 kV, and 1200 kV, determine: (1)Possible number of circuits required with equal magnitudes for sending and receiving-end voltages with 30° phase difference; (2)The currents transmitted; and (3) The total line losses.	Understand	CO1	AEE504.1
2	A power of 2000 MW is to be transmitted from a super thermal power station in Central India over 800 km to Delhi. Use 400 kV and 750 kV alternatives. Suggest the number of circuits required with 50% series capacitor compensation, and calculate the total power loss and loss per km.	Remember	CO1	AEE504.1
3	A power of 900 MW is to be transmitted over a length of 875 km. Estimate the cost difference when using ±400 kV dc line and 400 kV ac lines	Understand	CO1	AEE504.2
4	Of the following transmission voltages (given in kV) used in the world, which ones are used in India at present: 66, 132, 169, 220, 275, 345, 400, 500–525, 735–765, 1000,1150.	Understand	CO1	AEE504.2
5	A Drake conductor of North-American manufacture has an outer diameter of 1.108 inches having an Al cross-sectional area of 795,000 circular mils. The stranding is 26Al/7 Fe. Its resistance is given as 0.0215 ohm/1000 at 20°C under dc, and 0.1284 ohm/mile at 50°C and 50/60 Hz. Calculate. (a)diameter of each strand of Al and Fe in mils, inch, and metre units; Calculation of Line and Ground Parameters (b) check the values of resistances given above taking a $\rho = 2.7 \times 10^{-8}$ ohm-metre at 20°C and temperature-resistance coefficient $\alpha = 4.46 \times 10^{-3}$/°C at 20°C. (c) find increase in resistance due to skin effect.	Understand	CO1	AEE504.2

6	A 750 kV line has the details given below. Calculate the temperature rise of the conductor under given conditions. Conductor–4 × 0.03 m ACSR (area = 954,000 cir mils). Power carried 2000 MW. ra = 2.7 × 10–8 ohm-m at 20°C, a = 0.0045 ohm/°C, ambient ta = 45°C, e = 0.5, p = 1, v = 1.2 m/s, solar irradiation 1 kW/m2 , sa = 0.8.	Understand	CO1	AEE504.3
7	A single-circuit 3-phase 50 *Hz* 400 kV line has a series reactance per phase of 0.327 ohm/km. Neglect line resistance. The line is 400 km long and the receiving- end load is 600 MW at 0.9 p.f. lag. The positive-sequence line capacitance is 7.27 nF/km. In the absence of any compensating equipment connected to ends of line, calculate the sending-end voltage. Work with and without considering line capacitance. The base quantities for calculation are 400 kV, 1000 MVA.	Understand	CO1	AEE504.3
8	Derive the formulae for power handling capacity in Ehvac Transmission	Remember	CO1	AEE504.4
9	Explain in detail capacitances and inductances of ground return and derive necessary expressions.	Remember	CO1	AEE504.4
10	A 3-phase 750 kV horizontal line has minimum height of 12 m, sag at mid span = 12 m. Phase spacing *S* = 15 m. Conductors are 4 × 0.035 m with bundle spacing of *B* = 0.4572m. Calculate per kilometer: a) The matrix of Maxwell's Potential coefficients for a un transposed configuration. b) The inductance and capacitance matrices for un transposed and transposed configurations.	Understand	CO1	AEE504.4
UNIT – II				
VOLTAGE GRADIENTS OF CONDUCTORS				
PART – A (SHORT ANSWER QUESTIONS)				
1	What is electrostatics.	Understand	CO2	AEE504.5
2	Explain field of a line charges and its properties	Understand	CO2	AEE504.5
3	A point charge Q= 10^{-6}coulomb (1μC) is kept on the surface of a conducting sphere of radius r= 1 cm, which can be considered as a point charge located at the centre of the sphere. Calculate the field strength and potential at a distance of 0.5 cm from the surface of the sphere. Also find the capacitance of the sphere, εr =1.	Understand	CO2	AEE504.5
4	Determine the current drawn by the line due to corona losses	Understand	CO2	AEE504.6
5	what is shape of the between two supports, by taking sag into consideration.	Understand	CO2	AEE504.6
6	Determine the field of sphere gap in EHV AC system	Understand	CO2	AEE504.7
7	What is the effect of corona on OZONE	Remember	CO2	AEE504.7
8	What is the volume of the cable ,If K is the volume of cable conductor material required to transmit power, then for the transmission of the same power.	Understand	CO2	AEE504.7
9	What is the Maximum permissible span for wooden poles	Remember	CO2	AEE504.8

10	What is galvanizing.	Understand	CO2	AEE504.8
11	What is necessity of galvanization	Remember	CO2	AEE504.8
12	What is the abbreviation of ACSR	Remember	CO2	AEE504.9
13	A sphere gap consists of two spheres with R= 0.25 m each. The gap between their surfaces is 0.5 m. Calculate the charges and their locations to make the potentials 1 and 0. And also Calculate the voltage gradient at X= 0.25 m for the sphere gap.	Understand	CO2	AEE504.9
14	Explain 2-conductor line in brief	Understand	CO2	AEE504.10
15	Give charge potential relations for multi-conductor lines	Understand	CO2	AEE504.10
16	Give maximum charge condition on a 3-phase line	Understand	CO2	AEE504.10
17	Derive the Expression for Inductance of a Multi conductor line used in EHV AC Transmission Line.	Understand	CO2	AEE504.10
18	Give numerical values of potential coefficients and charge of lines	Understand	CO2	AEE504.11
19	Define voltage gradient	Remember	CO2	AEE504.11
20	Explain surface voltage gradient on single conductor	Understand	CO2	AEE504.11
PART – B (LONG ANSWER QUESTIONS)				
1	Explain in detail about field of sphere gap with their properties.	Understand	CO2	AEE504.5
2	Obtain the maximum charge conduction on a 3-phase EHVAC lines.	Understand	CO2	AEE504.5
2	a) Determine the field of sphere gap in EHV AC system. b) A single conductor EHV line strung above ground is used for experimental purposes to investigate high voltage effects. The conductors are of expanded ACSR with diameter of 0.06 cm and the line height is 21 m above ground. i) Find the charging current and MVAR of the single phase transformer for exciting 1Km length of the experimental line. Assume any, if necessary.	Understand	CO2	AEE504.5
3	Explain in detail about field of line charges with their properties. b) A 735-kV line has N = 4, r = 0.0176 m, B = 0.4572 m for the bundled conductor of each phase. The line height and phase spacing in horizontal configuration are H = 15, S =15 m. Calculate the maximum surface voltage gradients on the centre phase and outer phases using Mangoldt formula.	Remember	CO2	AEE504.6
4	a) Describe the charge-potential relations of a transmission line with n conductors on a tower. b) Derive an expression for Maximum Charge Condition on a 3-Phase	Understand	CO2	AEE504.6
5	Give in detail equations for potential relations for multi-conductors.	Understand	CO2	AEE504.6
6	A charge of 10 μC is placed at a distance of 2 metres from the centre of a sphere of radius 0.5 metre (1-metre diameter sphere). Calculate the magnitude, polarity, and location of a point charge Q^2which will make	Understand	CO2	AEE504.7
7	Explain in detail surface voltage gradient on conductors	Understand	CO2	AEE504.7

8	What are gradient factors and their use.	Understand	CO2	AEE504.8
9	A conductor 5 cm diameter is strung inside an outer cylinder of 2 metre radius. Find (a)The corona-inception gradient on the conductor, kV/cm, (b)The corona-inception voltage in kV, rms, (c)The gradient factor for the electrode arrangement, (d)The capacitance of the coaxial arrangement per metre, and (e)The surge impedance.	Understand	CO2	AEE504.8
10	A sphere gap with the spheres having radii R= 0.5 m has a gap of 0.5 m between their surfaces. (a)Calculate the required charges and their locations to make the potentials 100 and 0. (b)Then calculate the voltage gradient on the surface of the high-voltage sphere. (c)If the partial breakdown of air occurs at 30 kV/cm peak, calculate the disruptive voltage between the spheres	Understand	CO2	AEE504.8
11	Derive the Expression for Inductance of a Multi conductor line used in EHV AC Transmission Line.	Understand	CO2	AEE504.8
12	Derive an expression for Maximum Charge Condition on a 3- Phase Line.	Remember	CO2	AEE504.9
13	Explain the voltage gradient distribution on Six-conductor bundle and gradient on sub-conductor.	Remember	CO2	AEE504.9
14	Discuss the convenience offered by using modes of propagation and possible uses of this technique in EHV-AC lines	Remember	CO2	AEE504.10
15	Explain the field of line charges and their properties.	Understand	CO2	AEE504.10
16	Describe the charge-potential relations of a transmission line with n conductors on a tower.	Understand	CO2	AEE504.10
17	Derive an expression for Maximum Charge Condition on a 3-Phase Line	Understand	CO2	AEE504.10
18	Explain the procedure of evaluation of voltage gradients for the phase single and double circuit lines.	Understand	CO2	AEE504.10
19	a)Among HVAC and DC Transmission which one is best transmission, also mention the advantages and disadvantages of it. b) The heights of conductors of a bipolar dc line are H = 18 m and the pole spacing P =12 m. Calculate and plot the field factors for this line for the two modes of propagation as the distance d from line centre is varied from 0 to 3.	Understand	CO2	AEE504.10
20	a)Explain in detail capacitances and inductances of ground return and derive necessary expressions. b) Why the Inductance and capacitance transformation required in Sequence Quantities in EHV-AC lines?	Understand	CO2	AEE504.10

PART – C (ANALYTICAL QUESTIONS)				
1	Explain in detail about field of line charges with their properties. b) A 735-kV line has N = 4, r = 0.0176 m, B = 0.4572 m for the bundled conductor of each phase. The line height and phase spacing in horizontal configuration are H = 15, S =15 m. Calculate the maximum surface voltage gradients on the centre phase and outer phases using Mangoldt formula.	Remember	CO2	AEE504.5
2	a) Determine the field of sphere gap in EHV AC system. b) A single conductor EHV line strung above ground is used for experimental purposes to investigate high voltage effects. The conductors are of expanded ACSR with diameter of 0.06 cm and the line height is 21 m above ground. i) Find the charging current and MVAR of the single phase transformer for exciting 1Km length of the experimental line. Assume any, if necessary.	Understand	CO2	AEE504.5
3	a)Among HVAC and DC Transmission which one is best transmission, also mention the advantages and disadvantages of it. b) The heights of conductors of a bipolar dc line are H = 18 m and the pole spacing P =12 m. Calculate and plot the field factors for this line for the two modes of propagation as the distance d from line centre is varied from 0 to 3.	Understand	CO2	AEE504.5
4	A point charge Q = 10 coulomb (1μC) is kept on the surface of a conducting sphere of radius r = 1 cm, which can be considered as a point charge located at the centre of the sphere. Calculate the field strength and potential at a distance of 0.5 cm from the surface of the sphere. Also find the capacitance of the sphere, ε_r.	Understand	CO2	AEE504.6
5	A sphere gap with the spheres having radii R= 0.5 m has a gap of 0.5 m between their surfaces. (a)Calculate the required charges and their locations to make the potentials 100 and 0. (b)Then calculate the voltage gradient on the surface of the high-voltage sphere. (c)If the partial breakdown of air occurs at 30 kV/cm peak, calculate the disruptive voltage between the spheres	Understand	CO2	AEE504.6
6	Find the charging current and MVAR of the single phase transformer for exciting 1Km length of the experimental line. Assume any, if necessary	Understand	CO2	AEE504.7
7	Describe the charge-potential relations of a transmission line with *n* conductors on a tower. A single conductor EHV line strung above ground is used for experimental purposes to investigate high voltage effects. The conductors are of expanded ACSR with diameter of 0.06cm and the line height is 21 m above ground	Understand	CO2	AEE504.8
8	If corona-inception gradient is measured in a h. v. testing laboratory at an elevation of 1000 metres and 25°C, give correction factors to be used when the equipment is used at (a) sea level at 35°C, and (b) 2000 m elevation at 15°C. Use conductor radius = r metre.	Understand	CO2	AEE504.9

9	Determine Surface voltage Gradient on conductors under i) Maximum Surface Voltage Gradients for N ≥3. ii) Mangoldt (Markt-Mengele) Formulae	Understand	CO2	AEE504.10
10	A conductor 5 cm diameter is strung inside an outer cylinder of 2 metre radius. Find (a)The corona-inception gradient on the conductor, kV/cm, (b)The corona-inception voltage in kV, rms, (c)The gradient factor for the electrode arrangement, (d)The capacitance of the coaxial arrangement per metre, and (e)The surge impedance.	Understand	CO2	AEE504.10
UNIT – III				
CORONA EFFECTS				
PART – A (SHORT ANSWER QUESTIONS)				
1	What is corona?	Understand	CO3	AEE504.11
2	Explain power loss in detail.	Understand	CO3	AEE504.11
3	Explain audible noise(AN) in detail.	Understand	CO3	AEE504.11
4	Give corona loss formulae based on voltages	Understand	CO3	AEE504.11
5	Give corona loss formulae based on voltage gradients.	Understand	CO3	AEE504.12
6	What is corona current	Understand	CO3	AEE504.12
7	Give peek's formula	Understand	CO3	AEE504.12
8	What is the effect of Increase in Effective Radius of Conductor and Coupling Factors	Understand	CO3	AEE504.12
9	Explain what are measurements of AN	Understand	CO3	AEE504.13
10	What is radio interference(RI)	Understand	CO3	AEE504.13
11	Explain generation of corona pulses.	Understand	CO3	AEE504.13
12	What is electro noise filter and why is it used	Understand	CO3	AEE504.13
13	Describe the mechanism of formation of a positive corona pulse train.	Remember	CO3	AEE504.14
14	Explain about audio noise and radio interference due to Corona in EHV lines.	Understand	CO3	AEE504.14
15	Give corona loss formulae based on voltages and voltage gradients.	Understand	CO3	AEE504.14
16	A single conductor 2.5 inch in diameter of a 525-kV line (line-to-line voltage)	Understand	CO3	AEE504.14
17	Explain Charge-Voltage Diagram with Corona.	Understand	CO3	AEE504.15

18	An overhead conductor of 1.6 cm radius is 10 m above ground. The normal voltage is 133 kV r.m.s. to ground (230 kV, line-to-line). The switching surge experienced is 3.5p.u. Taking K= 0.7, calculate the energy loss per km of line. Assume smooth conductor.	Understand	CO3	AEE504.15
19	Explain generation and characteristics of audible noise	Understand	CO3	AEE504.15
20	Give limits for audible noise.	Understand	CO3	AEE504.15
PART – B (LONG ANSWER QUESTIONS)				
1	Explain about audio noise and radio interference due to Corona in EHV lines.	Understand	CO3	AEE504.11
2	Give corona loss formulae based on voltages and voltage gradients.	Understand	CO3	AEE504.11
3	A single conductor 2.5 inch in diameter of a 525-kV line (line-to-line voltage) is strung 13 m above ground. Calculate (a) the corona-inception voltage and (b) the effective radius of conductor at an overvoltage of 2.5 p.u. Consider a stranding factor m= 1.25 for roughness. (c) Calculate the capacitance of conductor to ground with and without corona. (d) If a second conductor is strung 10 m away at the same height, calculate the coupling factors in the two cases. Take δ=1.	Understand	CO3	AEE504.11
4	Explain Charge-Voltage Diagram with Corona.	Understand	CO3	AEE504.11
5	An overhead conductor of 1.6 cm radius is 10 m above ground. The normal voltage is 133 kV r.m.s. to ground (230 kV, line-to-line). The switching surge experienced is 3.5p.u. Taking K= 0.7, calculate the energy loss per km of line. Assume smooth conductor.	Understand	CO3	AEE504.12
6	Explain generation and characteristics of audible noise	Understand	CO3	AEE504.12
7	Give limits for audible noise.	Understand	CO3	AEE504.12
8	Draw the block diagram of AN Measuring Circuit.	Remember	CO3	AEE504.12
9	Explain Octave band AN meter circuit.	Understand	CO3	AEE504.13
10	Give relation between single-phase and 3-phase AN levels	Understand	CO3	AEE504.13
11	Describe the difference between a line spectrum and band spectrum for noise. What is the difference between a pure tone and broad-band spectrum?	Understand	CO3	AEE504.13
12	Explain generation of corona pulses and give their properties	Understand	CO3	AEE504.13
13	Give some properties of corona losses.	Understand	CO3	AEE504.14
14	Give equations for frequency spectrum of the RI field of line	Remember	CO3	AEE504.14

15	Explain RI Excitation Function	Understand	CO3	AEE504.14
16	Draw the circuit diagram for measurement of radio influence voltage	Understand	CO3	AEE504.14
17	A test object for 400 kV is undergoing an RIV test. The coupling capacitor has 1000 pF and the voltage across the measuring system is to be 1 volt. Calculate the value of inductance required if V=243.5 kv	Understand	CO3	AEE504.15
18	Explain cage setups for measuring excitation function	Understand	CO3	AEE504.15
19	Calculate and plot the field factors for the 3 modes of propagation for a line with H=15 m, S= 12 m as the distance from the line centre is varied from 0 to 3 H	Understand	CO3	AEE504.15
20	Why does line-generated corona noise not interfere with TV reception or FM radio reception? What causes interference at these frequencies?	Understand	CO3	AEE504.15
PART – C (ANALYTICAL QUESTIONS)				
1	What is the effect of Increase in Effective Radius of Conductor and Coupling Factors	Understand	CO3	AEE504.11
2	Explain what are measurements of AN	Understand	CO3	AEE504.11
3	Give equations for frequency spectrum of the RI field of line	Remember	CO3	AEE504.12
4	Explain RI Excitation Function	Understand	CO3	AEE504.12
5	Draw the circuit diagram for measurement of radio influence voltage	Understand	CO3	AEE504.13
6	A test object for 400 kV is undergoing an RIV test. The coupling capacitor has 1000 pF and the voltage across the measuring system is to be 1 volt. Calculate the value of inductance required if V=243.5 kv	Understand	CO3	AEE504.13
7	Calculate and plot the field factors for the 3 modes of propagation for a line with H=15 m, S= 12 m as the distance from the line centre is varied from 0 to 3 H	Understand	CO3	AEE504.14
8	Describe the difference between a line spectrum and band spectrum for noise. What is the difference between a pure tone and broad-band spectrum?	Understand	CO3	AEE504.14
9	An overhead conductor of 1.6 cm radius is 10 m above ground. The normal voltage is 133 kV r.m.s. to ground (230 kV, line-to-line). The switching surge experienced is 3.5p.u. Taking K= 0.7, calculate the energy loss per km of line. Assume smooth conductor.	Understand	CO3	AEE504.15
10	Give equations for frequency spectrum of the RI field of line	Understand	CO3	AEE504.15
UNIT – IV				
ELECTRO STATIC FIELD				
PART – A (SHORT ANSWER QUESTIONS)				
1	Define electric shock current and threshold current	Understand	CO4	AEE504.16
2	Explain electric shock and types of electric shock	Understand	CO4	AEE504.16

3	Explain in-detail calculation of capacitance of long object	Remember	CO4	AEE504.16
4	The following details of a truck parked parallel to a line are given. Find its Capacitance. Length *a* = 8 m, height of body *v* = 3m, width *b* = 3m, *t* = 1.5 m. Height of line conductor *H* = 13m, dia. of conductor = 0.0406m, distance of parking *L* = 6m.	Understand	CO4	AEE504.16
5	Determine the equation for charge calculation of n-phase line configuration	Understand	CO4	AEE504.17
6	Discuss the effect of electrostatic field on Human beings	Understand	CO4	AEE504.17
7	Discuss the effect of electrostatic field on (a) Animals, (b) Plant life	Understand	CO4	AEE504.17
8	Discuss the effect of electrostatic field on (a) vehicles, (b) Fences	Remember	CO4	AEE504.17
9	Give the principle on which a meter for measuring the electrostatic field of EHV line is based	Understand	CO4	AEE504.18
10	What are the types of electrode configurations for measuring electrostatic field	Understand	CO4	AEE504.18
11	Explain Traveling wave expression and solution	Understand	CO4	AEE504.18
12	What are the reflection and refraction coefficients?	Understand	CO4	AEE504.18
13	Explain briefly lumped parameters of distributed lines	Understand	CO4	AEE504.19
14	What are the different sources of excitation?	Understand	CO4	AEE504.19
15	classify shock currents	Understand	CO4	AEE504.19
16	Differentiate primary shock current from secondary shock currents	Understand	CO4	AEE504.19
17	Write short notes on no load voltage conditions for travelling waves	Understand	CO4	AEE504.20
18	Give brief description about charging currents for travelling waves	Understand	CO4	AEE504.20
19	What is the effect of electric field on the design of tower	Understand	CO4	AEE504.20
20	Describe travelling wave concept with standing waves and natural frequencies	Understand	CO4	AEE504.20
	PART – B (LONG ANSWER QUESTIONS)			
1	a) Obtain electrostatic fields of single circuit 3-phase EHV line. b) Describe the difference between primary shock current and secondary shock current.	Understand	CO4	AEE504.16
2	a) Explain the effect of high electrostatic field on human, animals and plants. b) The following are the details of a truck parked parallel to a line. Find its capacitance. Length a = 8 m, height of body v =3m, width b=3 m, t=1.5 m. Height of line conductor H=13 m, dia of conductor = 0.04 m, distance of parking L=6m.	Understand	CO4	AEE504.16
3	Derive an equation for calculation of electrostatic field of single-circuit 3-phase AC line	Understand	CO4	AEE504.16
4	Derive an equation for calculation of electrostatic field of double-circuit 3-phase AC line	Understand	CO4	AEE504.16

5	Obtain electrostatic induction on unenergised circuit of double circuit EHVAC line	Understand	CO4	AEE504.17
6	Explain in-detail about meters and measurements of electrostatic field	Understand	CO4	AEE504.17
7	Discuss the effect of electrostatic field on (a) Human beings, (b) Animals, (c) Plant life, (d) vehicles, (e) Fences	Understand	CO4	AEE504.17
8	Compute the RMS values of ground level E.S field of a 400 KV line at its maximum operating voltage of 420 KV (L-L) given the following details: Single circuit horizontal configuration H=13 m, S=12 m, conductor 2×3.18 cm diameter, B = 45.7 cm. Vary the horizontal distance along ground from the line centre from 0 to 3H.	Understand	CO4	AEE504.17
9	a) Obtain the reflection and refraction of travelling waves. b) A transmission line is 300 Km long and open at the far end. The attenuation of surge is 0.9 over one length of travel at light velocity. It is energized by: i) A step of 1000KV and ii) A sine wave of 325 kV peak when the wave is passing through its peak. Calculate and plot the open end voltage up to 20 msec.	Understand	CO4	AEE504.18
10	Derive the general equations for voltage and current at any distance on the line in the operation form and illustrate with different conditions.	Understand	CO4	AEE504.18
11	Explain the travelling wave concept with standing waves and natural frequencies	Understand	CO4	AEE504.18
12	A 420 kV line is 750 km long. Its inductance and capacitance per km are L=1.5 mH/km and C=10.5 nF/km. The voltages at the two ends are to be held 420 kV at no load. Neglect resistance. Calculate: i) MVAR of shunt reactors to be provided at the two ends and at	Understand	CO4	AEE504.18
13	a) A single-circuit 3-phase, 50 Hz, 400 kV line has a series reactance per phase of 0.327 ohm/km. Neglect line resistance. The line is 400 km long and the receiving-end load is 600 MW at 0.9 p.f. lag. The positive-sequence line capacitance is 7.27nF/km. In the absence of any	Understand	CO4	AEE504.19
14	a) What is the reason for the existence of SSSR in the steady state and transient conditions in series capacitor compensated lines? b) Explain the voltage control using synchronous condensers.	Remember	CO4	AEE504.19
15	Explain in detail sub synchronous resonance problem and counter measures.	Understand	CO4	AEE504.19
16	Explain the classification of shock currents?	Understand	CO4	AEE504.19
17	a) Describe the difference between primary shock current and second a hock current. b) Obtain the electrostatic fields of double circuit 3-phase EHV AC line.	Understand	CO4	AEE504.20
18	a)How does the electric field at ground level influence tower design? b)Explain the effect of electric field intensity nearer to conductor urface and nearer to ground surface with respect to E.H.V. lines.	Understand	CO4	AEE504.20
19	Explain the travelling wave concept with standing waves and natural frequencies	Understand	CO4	AEE504.20
20	Explain if the Transmission line is Open-Ended and is excited when Double- exponential wave response?	Understand	CO4	AEE504.20

PART – C (ANALYTICAL QUESTIONS)				
1	Explain electric shock and types of electric shock	Understand	CO4	AEE504.16
2	Explain in-detail calculation of capacitance of long object	Remember	CO4	AEE504.16
3	The following details of a truck parked parallel to a line are given. Find its Capacitance. Length *a* = 8 m, height of body *v* = 3m, width *b* = 3m, *t* = 1.5 m. Height of line conductor *H* = 13m, dia. of conductor = 0.0406m, distance of parking *L* = 6m.	Understand	CO4	AEE504.17
4	Compute the RMS values of ground level E.S field of a 400 KV line at its maximum operating voltage of 420 KV (L-L) given the following details: Single circuit horizontal configuration H=13 m, S=12 m, conductor 2×3.18 cm diameter, B = 45.7 cm. Vary the horizontal distance along ground from the line centre from 0 to 3H.	Understand	CO4	AEE504.17
5	a) Obtain the reflection and refraction of travelling waves. b) A transmission line is 300 Km long and open at the far end. The attenuation of surge is 0.9 over one length of travel at light velocity. It is energized by: i) A step of 1000KV and ii) A sine wave of 325 kV peak when the wave is passing through its peak. Calculate and plot the open end voltage up to 20 msec.	Understand	CO4	AEE504.18
6	Derive the general equations for voltage and current at any distance on the line in the operation form and illustrate with different conditions.	Understand	CO4	AEE504.18
7	Explain the travelling wave concept with standing waves and natural frequencies	Understand	CO4	AEE504.19
8	Discuss the line energization with tapped charge voltage of travelling waves in EHV AC lines. Explain the traveling wave concept for step response of transmission line: i)Losses neglected, ii) Losses and attenuation included.	Understand	CO4	AEE504.19
9	Obtain the reflection and refraction of travelling waves.	Understand	CO4	AEE504.20
10	150 KV, Δ line has conductors at heights 26m and 44 m with 24m pacing conductor on circle of 1.2m diameter. At 1200 KV, calculate the lectrostatic field at ground level atdistances from the line centre d =0, 13, 6 m.	Understand	CO4	AEE504.20

UNIT – V				
VOLTAGE CONTROL				
PART – A (SHORT ANSWER QUESTIONS)				
1	Define power circle diagram and how is it useful	Understand	CO5	AEE504.21
2	Write the equation for radius of circle in-terms of receiving and sending voltages	Remember	CO5	AEE504.21
3	Briefly explain about voltage control in synchronous conductors	Understand	CO5	AEE504.21
4	Write short notes on series compensation	Understand	CO5	AEE504.21
5	For the 750-kV line of previous examples, L = 500 km, l = 6000 km at 50 H_z and Z_{00} = 260 ohms. Assuming E_s = E_r = 750 kV, calculate the reactance and 3-phase MVAR required at load end in the shunt-compensating reactor. Neglect line resistance.	Understand	CO5	AEE504.21
6	What is sub-synchronous resonance	Understand	CO5	AEE504.21
7	Give equations for natural frequency and shot circuit current	Understand	CO5	AEE504.21
8	Explain the problems associated with sub-synchronous resonance	Understand	CO5	AEE504.22
9	Explain briefly about induction generator effect	Understand	CO5	AEE504.22
10	Explain armature current relay protection	Understand	CO5	AEE504.22
11	Explain briefly about torsional interaction and give the solution to the problem	Understand	CO5	AEE504.22
12	Mention the remedies for transient torque problem	Understand	CO5	AEE504.22
13	What is synchronous condensor	Understand	CO5	AEE504.22
14	Discuss the voltage control using synchronous condensers.	Understand	CO5	AEE504.22
15	What is voltage compensation	Understand	CO5	AEE504.23
16	What is cascaded compensation	Understand	CO5	AEE504.23
17	What is static VAR compensation	Understand	CO5	AEE504.23
18	What are compensated lines?	Understand	CO5	AEE504.23
19	Discuss briefly about the sub synchronous resonance in series capacitor	Understand	CO5	AEE504.23
20	What is the necessity of phase modifier	Understand	CO5	AEE504.23
PART – B (LONG ANSWER QUESTIONS)				
1	Derive generalized constants(A, B, C, D)	Understand	CO5	AEE504.21
2	Explain in-detail about power circle diagram and its use	Remember	CO5	AEE504.21

3	Explain in-detail about voltage control using synchronous condensers	Understand	CO5	AEE504.21
4	a) Determine maximum power (p_m) b) The following details are given for a 750-kV 3-phase line: Resistance *r* =0.014 ohm/km, inductance *l* = 0.866 mH/km, reactance *x* = 0.272 ohm/km at 50 Hz, *c* = 12.82nF/km giving a susceptance of y =4.0275 × 10^{-6} mho/km, velocity v_0 = 3 × 10^8 m/s = 3 × 10^5 km/sec, line length = 500 km. Calculate items (*a*) and (*b*) below, and work parts (*c*) and (*d*). Give proper units for all quantities. (*a*) Z=L(r+jωl), Y=jωcL, (*b*) The generalized constants *A*, *B*, *C*, and *D*, in both polar and rectangular forms.	Understand	CO5	AEE504.21
5	A 420 kV line is 750 km long. Its inductance and capacitance per km are L=1.5 mH/km and C=10.5 nF/km. The voltages at the two ends are to be held 420 kV at no load. Neglect resistance. Calculate: i) MVAR of shunt reactors to be provided at the two ends and at intermediate station midway with all four reactors having equal resistance. ii) The A, B, C, D constants for the entire line with shunt reactors connected.	Understand	CO5	AEE504.21
6	a) A single-circuit 3-phase, 50 Hz, 400 kV line has a series reactance per phase of 0.327 ohm/km. Neglect line resistance. The line is 400 km long and the receiving-end load is 600 MW at 0.9 p.f. lag. The positive-sequence line capacitance is 7.27nF/km. In the absence of any compensating equipment connected to ends of line, calculate the sending-end voltage. Work with and without considering line capacitance. The base quantities for calculation are 400 kV, 1000 MVA.	Understand	CO5	AEE504.21
7	a) What is the reason for the existence of SSSR in the steady state and transient conditions in series capacitor compensated lines? b) Explain the voltage control using synchronous condensers.	Understand	CO5	AEE504.21
8	Explain briefly about torosional interaction, transient torque problem and discuss their counter measures	Understand	CO5	AEE504.22
9	Explain in detail sub synchronous resonance problems and counter measures.	Understand	CO5	AEE504.22
10	a) A single-circuit 3-phase, 50 Hz, 400 kV line has a series reactance per phase of 0.327 ohm/km. Neglect line resistance. The line is 400 km long and the receiving-end load is 600 MW at 0.9 p.f. lag. The positive-sequence line capacitance is 7.27nF/km. In the absence of any compensating equipment connected to ends of line, calculate the sending-end voltage. Work with and without considering line capacitance. The base quantities for calculation are 400 kV, 1000 MVA.	Understand	CO5	AEE504.22
11	a) What is the reason for the existence of SSSR in the steady state and transient conditions in series capacitor compensated lines? b) Explain the voltage control using synchronous condensers.	Understand	CO5	AEE504.22

12	What is the purpose of synchronous condenser and how voltage profile increases using synchronous condenser also the design of the rating of the synchronous phase modifier (or condenser for short)?	Understand	CO5	AEE504.22
13	Explain the voltage control using synchronous condensers.	Understand	CO5	AEE504.22
14	Explain Shunt Reactor Compensation of Very Long Line with Intermediate Switching Station and give the Voltage and current expression at Intermediate station	Understand	CO5	AEE504.22
15	Find the generalized constants for transmission line with series-Capacitor Compensation at middle of line.	Understand	CO5	AEE504.23
16	What is the reason for the existence of SSSR in the steady state and transient?	Understand	CO5	AEE504.23
17	Explain the Conditions in series capacitor compensated lines?	Understand	CO5	AEE504.23
18	Explain the voltage control using sub synchronous condensers.	Understand	CO5	AEE504.23
19	Define compensation and explain Cascade connection of components of shunt series compensation with generalized equations and chain rule?	Understand	CO5	AEE504.23
20	Expalin about static VAR Compensation	Understand	CO5	AEE504.23
PART – C (ANALYTICAL QUESTIONS)				
1	What is the purpose and significance of power circle diagram and its uses and also explain in detail the receiving end circle diagram for calculating reactive compensation for voltage control buses.	Understand	CO5	AEE504.21
2	Explain Shunt Reactor Compensation of Very Long Line with Intermediate Switching Station and give the Voltage and current expression at Intermediate station.	Understand	CO5	AEE504.21
3	Briefly explain about voltage control in synchronous conductors	Understand	CO5	AEE504.21
4	Write short notes on series compensation	Understand	CO5	AEE504.22

5	For the 750-kV line of previous examples, L = 500 km, l = 6000 km at 50 H_z and Z_{00} = 260 ohms. Assuming E_s = E_r = 750 kV, calculate the reactance and 3-phase MVAR required at load end in the shunt-compensating reactor. Neglect line resistance.	Understand	CO5	AEE504.22
6	A 420 kV line is 750 km long. Its inductance and capacitance per km are L=1.5 mH/km and C=10.5 nF/km. The voltages at the two ends are to be held 420 kV at no load. Neglect resistance. Calculate: i) MVAR of shunt reactors to be provided at the two ends and at	Understand	CO5	AEE504.22
7	a) A single-circuit 3-phase, 50 Hz, 400 kV line has a series reactance per phase of 0.327 ohm/km. Neglect line resistance. The line is 400 km long and the receiving-end load is 600 MW at 0.9 p.f. lag. The positive-sequence line capacitance is 7.27nF/km. In the absence of any compensating equipment connected to ends of line, calculate the sending-end voltage. Work with and without considering line capacitance. The base quantities for calculation are 400 kV, 1000	Remember	CO5	AEE504.23
8	a) A single-circuit 3-phase, 50 Hz, 400 kV line has a series reactance per phase of 0.327 ohm/km. Neglect line resistance. The line is 400 km long and the receiving-end load is 600 MW at 0.9 p.f. lag. The positive-sequence line capacitance is 7.27nF/km. In the absence of any compensating equipment connected to ends of line, calculate the sending-end voltage. Work with and without considering line capacitance. The base quantities for calculation are 400 kV, 1000 MVA.	Remember	CO5	AEE504.23
9	a) What is the reason for the existence of SSSR in the steady state and transient conditions in series capacitor compensated lines? b) Explain the voltage control using synchronous condensers.	Apply	CO5	AEE504.23
10	Write short notes on series compensation	Understand	CO5	AEE504.23

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