INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

Department of Electrical and Electronics Engineering

TUTORIAL QUESTION BANK

Course Name	**:**	**EHVAC TRANSMISSION**
Course Code	**:**	**A80235**
Class	**:**	**IV B.Tech II Sem**
Branch	**:**	**Electrical and Electronics Engineering**
Year	**:**	**2018 - 2019**
Course Coordinator	**:**	**Dr. P. Sridhar, Professor EEE**
Course Faculty	**:**	**Ms. B. Navothna, 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. This course covers all topics that are considered essential for understanding the operation and design of EHV ac overhead lines and underground cables. Theoretical analyses of all problems combined with practical application are dealt in this course.

UNIT – I			
INTRODUCTION			
PART – A (SHORT ANSWER QUESTIONS)			
S. No	**QUESTION**	**Blooms Taxonomy Level**	**Course Outcomes**
1	Explain in detail about necessity of EHV AC transmission	Understand	1
2	Mention advantages of EHV AC transmission and discuss problems related to EHV AC transmission.	Understand	1
3	Explain power loss in transmission line.	Remember	1

4	A power of 12,000 MW is required to be transmitted over a distance of 1000km. 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	1
5	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	1
6	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	1
7	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	1
8	Explain resistance of conductors and effect of resistance of conductances.	Understand	1
9	What is a bundled conductor? What are the advantages of bundled conductors?	Understand	2
10	Explain line inductances and capacitances	Understand	2
11	Examples of line configuration used in various parts of the world.	Remember	2
12	Explain the effect of resistance of conductor in EHV AC transmission system.	Understand	2
13	Discuss why EHV AC Lines are Necessary to transmit large blocks of power over long distances.	Understand	2
14	Write brief descriptions of a) Aeolian vibration, and b) Galloping c) Wake-induced oscillations. Describe the measures taken to minimize the damage due to them	Understand	2
PART – B (LONG ANSWER QUESTIONS)			
1	Explain necessity of EHV AC transmission and mechanical considerations for transmission	Understand	1
2	Explain the effect of resistance of conductor in EHV AC transmission system.	Understand	1
3	Discuss why EHV AC Lines are Necessary to transmit large blocks of power over long distances.	Understand	1
4	Explain sequence inductances and capacitances.	Remember	2
5	Explain Resistance and inductance of ground return.	Remember	2
6	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	2

7	Discuss the convenience offered by using modes of propagation and possible uses of this technique.	Understand	2
PART – C (ANALYTICAL QUESTIONS)			
1	A power of 12,000 MW is required to be transmitted over a distance of 1000km. 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	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	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	1
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	1
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. 1. diameter of each strand of Al and Fe in mils, inch, and meter units; Calculation of Line and Ground Parameters 2. 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. 3. Find increase in resistance due to skin effect.	Understand	2
UNIT – II			
VOLTAGE GRADIENTS OF CONDUCTORS			
PART – A (SHORT ANSWER QUESTIONS)			
1	What is electrostatics?	Understand	3
2	Explain field of a line charges and its properties	Understand	3
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, $\varepsilon r = 1$.	Understand	3
4	Explain Field of sphere gap and their properties.	Understand	3
5	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	3
6	Explain 2-conductor line in brief	Understand	3
7	Give charge potential relations for multi-conductor lines	Understand	3
8	Give maximum charge condition on a 3-phase line	Understand	3
9	Give numerical values of potential coefficients and charge of lines	Understand	3

10	Explain surface voltage gradient on single conductor	Understand	3
	PART – B (LONG ANSWER QUESTIONS)		
1	Explain in detail about field of sphere gap with their properties.	Understand	3
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	3
3	a) 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	3
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 Line.	Understand	3
5	Give in detail equations for potential relations for multi-conductors.	Understand	3
6	A charge of 10 μC is placed at a distance of 2 metres from the centre of a sphere of radius 0.5 meter (1-metre diameter sphere). Calculate the magnitude, polarity, and location of a point charge Q^2which will make the sphere at zero potential.	Understand	3
7	Explain in detail surface voltage gradient on conductors	Understand	3
8	What are gradient factors and their use?	Understand	3
9	A conductor 5 cm diameter is strung inside an outer cylinder of 2 meter 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 meter, and (e) The surge impedance.	Understand	3
10	A sphere gap with the spheres having radii R= 0.5 m has a gap of 0.5 m between their surfaces. 1. Calculate the required charges and their locations to make the potentials 100 and 0. 2. Then calculate the voltage gradient on the surface of the high-voltage sphere. 3. If the partial breakdown of air occurs at 30 kV/cm peak, calculate the disruptive voltage between the spheres	Understand	3
11	Derive the Expression for Inductance of a Multi conductor line used in EHV AC Transmission Line.	Understand	3
12	Explain the procedure of evaluation of voltage gradients for the phase single and double circuit lines.	Understand	3
13	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	3
14	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	3

PART – C (ANALYTICAL QUESTIONS)			
1	a) 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	3
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	3
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	3
4	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	3
5	A conductor 5 cm diameter is strung inside an outer cylinder of 2 meter 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 meter, and (e) The surge impedance.	Understand	3
UNIT – III			
CORONA EFFECTS			
PART – A (SHORT ANSWER QUESTIONS)			
1	What is corona?	Understand	5
2	Explain power loss in detail.	Remember	5
3	Explain audible noise (AN) in detail.	Understand	5
4	Give corona loss formulae based on voltages	Understand	5
5	Give corona loss formulae based on voltage gradients.	Remember	5
6	What is corona current	Understand	5
7	Give peek's formula	Remember	5

8	What is the effect of Increase in Effective Radius of Conductor and Coupling Factors	Understand	5
9	Explain what are measurements of AN	Understand	5
10	What is radio interference(RI)	Remember	5
11	Explain generation of corona pulses.	Understand	5
12	What is electro noise filter and why is it used	Remember	5
13	Describe the mechanism of formation of a positive corona pulse train.	Remember	5
1	Explain about audio noise and radio interference due to Corona in EHV lines.	Understand	6
2	Give corona loss formulae based on voltages and voltage gradients.	Remember	6
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	6
4	Explain Charge-Voltage Diagram with Corona.	Understand	6
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	6
6	Explain generation and characteristics of audible noise	Understand	6
7	Give limits for audible noise.	Understand	6
8	Draw the block diagram of AN Measuring Circuit.	Remember	6
9	Explain Octave band AN meter circuit.	Understand	6
10	Give relation between single-phase and 3-phase AN levels	Remember	6
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	6
12	Explain generation of corona pulses and give their properties	Understand	6
13	Give some properties of corona losses.	Remember	6
14	Give equations for frequency spectrum of the RI field of line	Remember	6
15	Explain RI Excitation Function	Understand	6
16	Draw the circuit diagram for measurement of radio influence voltage	Understand	6

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	6
18	Explain cage setups for measuring excitation function	Understand	6
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	6
20	Why does line-generated corona noise not interfere with TV reception or FM radio reception? What causes interference at these frequencies?	Understand	6
PART – B (LONG ANSWER QUESTIONS)			
1	Explain about audio noise and radio interference due to Corona in EHV lines.	Understand	6
2	Give corona loss formulae based on voltages and voltage gradients.	Remember	6
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	6
4	Explain Charge-Voltage Diagram with Corona.	Remember	6
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	6
6	Explain generation and characteristics of audible noise	Understand	6
7	Give limits for audible noise.	Understand	6
8	Draw the block diagram of AN Measuring Circuit.	Remember	6
9	Explain Octave band AN meter circuit.	Understand	6
10	Give relation between single-phase and 3-phase AN levels	Remember	6
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	6
12	Explain generation of corona pulses and give their properties	Understand	6
13	Give some properties of corona losses.	Understand	6
14	Give equations for frequency spectrum of the RI field of line	Remember	6
15	Explain RI Excitation Function	Understand	6
16	Draw the circuit diagram for measurement of radio influence voltage	Understand	6
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	Understand	6

18	Explain cage setups for measuring excitation function	Remember	6
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	6
20	Why does line-generated corona noise not interfere with TV reception or FM radio reception? What causes interference at these frequencies?	Understand	6
PART – C (ANALYTICAL QUESTIONS)			
1	What is the effect of Increase in Effective Radius of Conductor and Coupling Factors	Understand	5
2	Explain what are measurements of AN	Understand	5
3	Give equations for frequency spectrum of the RI field of line	Remember	6
4	Explain RI Excitation Function	Understand	6
5	Draw the circuit diagram for measurement of radio influence voltage	Understand	6
UNIT – IV			
ELECTRO STATIC FIELD			
PART – A (SHORT ANSWER QUESTIONS)			
1	Define electric shock current and threshold current.	Understand	7
2	Explain electric shock and types of electric shock.	Understand	7
3	Explain in-detail calculation of capacitance of long object.	Remember	4
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	4
5	Determine the equation for charge calculation of n-phase line configuration	Understand	4
6	Discuss the effect of electrostatic field on Human beings	Understand	4
7	Discuss the effect of electrostatic field on (a) Animals, (b) Plant life	Understand	4
8	Discuss the effect of electrostatic field on (a) vehicles, (b) Fences	Remember	4
9	Give the principle on which a meter for measuring the electrostatic field of EHV line is based	Understand	4
10	What are the types of electrode configurations for measuring electrostatic field.	Understand	4
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	4

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	4
3	Derive an equation for calculation of electrostatic field of single-circuit 3-phase AC line.	Understand	4
4	Derive an equation for calculation of electrostatic field of double-circuit 3-phase AC line.	Understand	4
5	Obtain electrostatic induction on unenergised circuit of double circuit EHVAC line	Understand	4
6	Explain in-detail about meters and measurements of electrostatic field	Understand	4
7	Discuss the effect of electrostatic field on (a) Human beings, (b) Animals, (c) Plant life, (d) vehicles, (e) Fences	Understand	4
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.	Remember	4
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	4
10	Derive the general equations for voltage and current at any distance on the line in the operation form and illustrate with different conditions.	Remember	4
11	Explain the travelling wave concept with standing waves and natural frequencies	Understand	4
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 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	4
13	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	4
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	4
15	Explain in detail sub synchronous resonance problem and counter measures.	Understand	4

PART – C (ANALYTICAL QUESTIONS)			
1	Explain electric shock and types of electric shock	Understand	7
2	Explain in-detail calculation of capacitance of long object	Remember	4
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	4
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	4
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	4
6	Derive the general equations for voltage and current at any distance on the line in the operation form and illustrate with different conditions.	Remember	4
7	Explain the travelling wave concept with standing waves and natural frequencies	Understand	4
UNIT – V			
VOLTAGE CONTROL			
PART – A (SHORT ANSWER QUESTIONS)			
1	Define power circle diagram and how is it useful	Understand	5
2	Write the equation for radius of circle in-terms of receiving and sending voltages	Remember	5
3	Briefly explain about voltage control in synchronous conductors	Understand	5
4	Write short notes on series compensation	Understand	5
5	For the 750-kV line of previous examples, L = 500 km, l = 6000 km at 50H_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	5
6	What is sub-synchronous resonance	Understand	5
7	Give equations for natural frequency and shot circuit current	Remember	5
8	Explain the problems associated with sub-synchronous resonance	Understand	5
9	Explain briefly about induction generator effect	Remember	5
10	Explain armature current relay protection	Understand	5
11	Explain briefly about torsional interaction and give the solution to the problem	Understand	5

12	Mention the remedies for transient torque problem	Remember	5
PART – B (LONG ANSWER QUESTIONS)			
1	Derive generalized constants(A, B, C, D)	Understand	5
2	Explain in-detail about power circle diagram and its use	Understand	5
3	Explain in-detail about voltage control using synchronous condensers	Understand	5
4	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	5
5	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	5
6	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	5
7	Explain briefly about torsional interaction, transient torque problem and discuss their counter measures	Understand	5
8	Explain in detail sub synchronous resonance problems and counter measures.	Remember	5
9	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	5
10	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	5
PART – C (ANALYTICAL QUESTIONS)			
1	Briefly explain about voltage control in synchronous conductors	Understand	5
2	Write short notes on series compensation	Understand	5
3	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	5
4	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: 1. MVAR of shunt reactors to be provided at the two ends and at intermediate station midway with all four reactors having equal resistance. 2. The A, B, C, D constants for the entire line with shunt reactors connected.	Understand	5

5	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	5
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.	Remember	5
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.	Apply	5
8	Write short notes on series compensation	Understand	5

Prepared by:
Ms. B. Navothna, Assistant Professor

HOD, EEE