1 Performance of Transmission Lines, Line Parameters and Corona

1.1 The inductance of a power transmission line increases with
(a) Decrease in line length
(b) Increase in diameter of conductor
(c) Increase in spacing between the phase conductors
(d) Increase in load current carried by the conductors

[1992 : 1 Mark]

1.2 A three phase overhead transmission line has its conductors horizontally spaced with spacing between adjacent conductors equal to 'd'. If now the conductors of the line are rearranged to from an equilateral triangle of sides equal to 'd' then
(a) Average capacitance and inductance will increase
(b) Average capacitance will increase and inductance will increase
(c) Average capacitance will increase and inductance will decrease
(d) Surge impedance loading of the line increases

[1993 : 1 Mark]

1.3 The increase in resistance due to non-uniform distribution of current in a conductor is known as ______effect.

[1994 : 1 Mark]

1.4 The charging current of a 400 kV transmission line is more than that of a 220 kV line of the same length. [True/False]

[1994 : 2 Marks]

1.5 The surge impedance of a 400 km long overhead transmission line is 400 Ω. For a 200 km length of the same line, the surge impedance will be
(a) 200 Ω (b) 800 Ω
(c) 400 Ω (d) 100 Ω

[1995 : 1 Mark]

1.6 For a 500 Hz frequency excitation, a 50 km short power line will be modeled as
(a) Short line (b) Medium line
(c) Long line (d) Data insufficient

[1996 : 1 Mark]

1.7 For equilateral spacing of conductors of an untransposed 3-phase line, we have
(a) Balanced receiving end voltage and no communication interference.
(b) Unbalanced receiving end voltage and no communication interference.
(c) Balance receiving end voltage and communication interference.
(d) Unbalanced receiving end voltage and communication interference.

[1996 : 2 Marks]

1.8 Corona losses are minimized when
(a) Conductor size is reduced
(b) Smoothness of conductor is reduced
(c) Sharp points are provided in the line hardware
(d) Current density in conductors is reduced

[1999 : 1 Mark]

1.9 A 220 kV, 20 km long, 3-phase transmission line has the following A, B, C, D constants. $A = D = 0.96\angle 3°$, $B = 55\angle 65°$ Ω/phase, $C = 0.5 \times 10^{-4}\angle 90°$ S/phase. Its correct charging current/phase is
(a) $\frac{11}{\sqrt{3}}$ A (b) $11\sqrt{3}$ A
(c) 11 A (d) $\frac{220}{\sqrt{3}}$ A

[1999 : 2 Marks]

1.10 For a single-phase overhead line having solid copper conductors of diameter 1 cm, spaced 60 cm between centres, the inductance in mH/km is
(a) 0.05 + 0.2 ln 60
(b) 0.2 ln 60
(c) 0.05 + 0.2 ln (60/0.5)
(d) 0.2 ln (60/0.5)

[1999 : 2 Marks]

1.11 The corona loss on a particular system at 50 Hz is 1 kW/km per phase. The corona loss at 60 Hz would be
(a) 1 kW/km per phase
(b) 0.83 kW/km per phase
(c) 1.2 kW/km per phase
(d) 1.13 kW/km per phase

[2000 : 2 Marks]

1.12 The conductors of a 10 km long, single-phase, two wire line are separated by a distance of 1.5 m. The diameter of each conductor is 1 cm. If the conductors are of copper, the inductance of the circuit is
(a) 50.0 mH (b) 45.3 mH
(c) 23.8 mH (d) 19.6 mH
[2001: 2 Marks]

1.13 Consider a long, two-wire line composed of solid round conductors. The radius of both conductors is 0.25 cm and the distance between their centres is l meters. If this distance is doubled, then the inductance per unit length.
(a) Doubles
(b) Halves
(c) Increase but does not double
(d) Decrease but does not halve
[2002 : 1 Mark]

1.14 A long wire composed of a smooth round conductor runs above parallel to the ground (Assumed to be a large conductive plane). A high voltage exists between the conductor and the ground. The maximum electric stress occurs at
(a) The upper surface of the conductor
(b) The lower surface of the conductor
(c) The ground surface
(d) Midway between the conductor and the ground
[2002 : 1 Mark]

1.15 Bundled conductors are mainly used in high voltage overhead transmission lines to
(a) reduce transmission line losses
(b) increase mechanical strength of the line
(c) reduce corona
(d) reduce sag
[2003 : 1 Mark]

1.16 The ABCD parameters of a 3-phase overhead transmission line are $A = D = 0.9 \angle 0$ $B = 200 \angle 90° \, \Omega$ and $C = 0.95 \times 10^{-3} \angle 90°$ S. At no-load condition a shunt inductive, reactor is connected at the receiving end of the line to limit the receiving-end voltage to be equal to the sending-end voltage. The ohmic value of the reactor is
(a) $\infty \, \Omega$ (b) $2000 \, \Omega$
(c) $105.26 \, \Omega$ (d) $1052.6 \, \Omega$
[2003 : 2 Marks]

1.17 A surge of 20 kV magnitude travels along a lossless cable towards its junction with two identical lossless overhead transmission lines. The inductance and the capacitance of the cable are 0.4 mH and 0.5 μF per km. The inductance and capacitance of the overhead transmission lines are 1.5 mH and 0.015 μF per km. The magnitude of the voltage at the junction due to surge is
(a) 36.72 kV (b) 18.36 kV
(c) 6.07 kV (d) 33.93 kV
[2003 : 2 Marks]

1.18 The generalized circuit constants of a 3-phase, 220 kV rated voltage, medium length transmission line are

$$A = D = 0.936 + j\,0.016 = 0.936 \angle 0.98°$$
$$B = 33.5 + j\,138 = 142.0 \angle 76.4° \, \Omega$$
$$C = (-5.18 + j\,914) \times 10^{-6} \, \mho$$

If the load at the receiving end is 50 MW at 220 kV with a power factor of 0.9 lagging, then magnitude of line to line sending end voltage should be
(a) 133.23 kV (b) 220.00 kV
(c) 230.78 kV (d) 246.30 kV
[2004 : 2 Marks]

1.19 The parameters of transposed overhead transmission line are given as:
Self reactance X_s = 0.4 Ω/km and Mutual reactance X_m = 0.1 Ω/km
The positive sequence reactance x_1 and zero sequence reactance x_0, respectively, in Ω/km are
(a) 0.3, 0.2 (b) 0.5, 0.2
(c) 0.5, 0.6 (d) 0.3, 0.6
[2005 : 2 Marks]

1.20 The concept of an electrically short, medium and long line is primarily based on the
(a) nominal voltage of the line
(b) physical length of the line
(c) wavelength of the line
(d) power transmitted over the line
[2006 : 1 Mark]

1.21 The A, B, C, D constants of a 220 kV line are: $A = D = 0.94 \angle 10$, $B = 130 \angle 730$, $C = 0.001 \angle 900$. If the sending end voltage of the line for a given load delivered at nominal voltage is 240 kV, the % voltage regulation of the line is

(a) 5 (b) 9
(c) 16 (d) 21

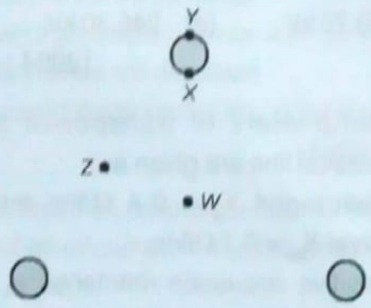
[2006 : 2 Marks]

1.22 A single phase transmission line and a telephone line are both symmetrically strung one below the other, in horizontal configurations, on a common tower. The shortest and longest distances between the phase and telephone conductors are 2.5 m and 3 m respectively. The voltage (volt/km) induced in the telephone circuit, due to 50 Hz current of 100 amps in the power circuit is

(a) 4.81 (b) 3.56
(c) 2.29 (d) 1.27

[2006 : 2 Marks]

1.23 Consider a bundled conductor of an overhead line consisting of three identical sub-conductors placed at the corners of an equilateral triangle as shown in the figure. If we neglect the charges on the other phase conductors and ground, and assume that spacing between sub-conductors is much larger than their radius, the maximum electric field intensity is experienced at



(a) Point X (b) Point Y
(c) Point Z (d) Point W

[2007 : 1 Mark]

1.24 The total reactance and total susceptance of a lossless overhead EHV line, operating at 50 Hz, are given by 0.045 pu and 1.2 pu respectively. If the velocity of wave propagation is 3×10^5 km/s, then the approximate length of the line is

(a) 122 km (b) 172 km
(c) 222 km (d) 272 km

[2007 : 2 Marks]

1.25 An extra high voltage transmission line of length 300 km can be approximate by a lossless line having propagation constant $\beta = 0.00127$ radians per km. Then the percentage ratio of line length to wavelength will be given by

(a) 24.24 % (b) 12.12 %
(c) 19.05 % (d) 6.06 %

[2008 : 1 Mark]

1.26 A lossless transmission line having Surge Impedance Loading (SIL) of 2280 MW is provided with a uniformly distributed series capacitive compensation of 30%. Then, SIL of the compensated transmission line will be

(a) 1835 MW (b) 2280 MW
(c) 2725 MW (d) 3257 MW

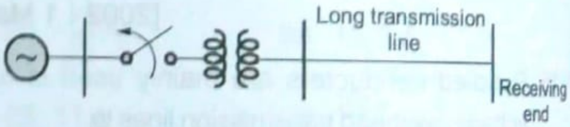
[2008 : 2 Marks]

1.27 For a fixed value of complex power flow in a transmission line having a sending end voltage V, the real power loss will be proportional to

(a) V (b) V^2
(c) $\frac{1}{V^2}$ (d) $\frac{1}{V}$

[2009 : 1 Mark]

1.28 A 50 Hz synchronous generator is initially connected to a long lossless transmission line which is open circuited at the receiving end. With the field voltage held constant, the generator is disconnected from the transmission line. Which of the following may be said about the steady state terminal voltage and field current of the generator?



(a) The magnitude of terminal voltage decreases, and the field current does not change.
(b) The magnitude of terminal voltage increases, and the field current does not change.
(c) The magnitude of terminal voltage increases, and the field current increases.
(d) The magnitude of terminal voltage does not change and the field current decreases.

[2010 : 2 Marks]

1.29 The horizontally placed conductors of a single-phase line operating at 50 Hz are having outside diameter of 1.6 cm, and the spacing between centers of the conductors is 6 m. The permittivity of free space is 8.854×10^{-12} F/m. The capacitance to ground per kilometer of each line is

(a) 4.2×10^{-9} F (b) 8.4×10^{-9} F
(c) 4.2×10^{-12} F (d) 8.4×10^{-12} F

[2014 : 2 Marks, Set-2]

1.30 In a long transmission line with r, *l*, g and c are the resistance, inductance, shunt conductance and capacitance per unit length, respectively, the condition for distortionless transmission is

(a) $rc = lg$ (b) $r = \sqrt{l/c}$
(c) $rg = lc$ (d) $g = \sqrt{c/l}$

[2014 : 1 Mark, Set-3]

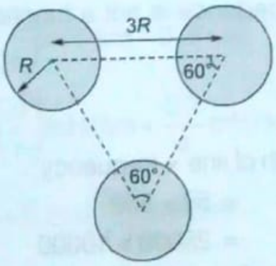
1.31 For a fully transposed transmission line
(a) positive, negative and zero sequence impedances are equal
(b) positive and negative sequence impedances are equal
(c) zero and positive sequence impedances are equal
(d) negative and zero sequence impedances are equal

[2014 : 1 Mark, Set-3]

1.32 For a 400 km long transmission line, the series impedance is (0.0 + j0.5) Ω/km and the shunt admittance is (0.0 + j5.0) μmho/km. The magnitude of the series impedance (in Ω) of the equivalent π circuit of the transmission line is _______ .

[2014 : 2 Marks, Set-3]

1.33 A composite conductor consists of three conductors of radius *R* each. The conductors are arranged as shown below. The geometric mean radius (GMR) (in cm) of the composite conductor is *kR*. The value of *k* is _______.



[2015 : 2 Marks, Set-2]

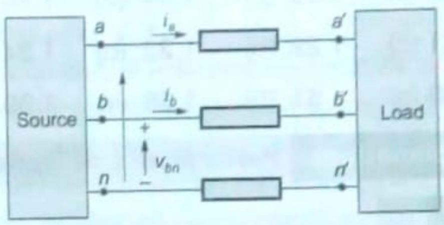
1.34 A single-phase transmission line has two conductors each of 10 mm radius. These are fixed at a center-to-center distance of 1 m in a horizontal plane. This is now converted to a three-phase transmission line by introducing a third conductor of the same radius. This conductor is fixed at an equal distance *D* from the two single-phase conductors. The three-phase line is fully transposed. The positive sequence inductance per phase of the three-phase system is to be 5% more than that of the inductance per conductor of the single-phase system. The distance *D*, in meters, is _____.

[2016 : 2 Marks, Set-2]

1.35 At no load condition, a 3-phase, 50 Hz, lossless power transmission line has sending-end and receiving-end voltages of 400 kV and 420 kV respectively. Assuming the velocity of traveling wave to be the velocity of light, the length of the line, in km, is _______.

[2016 : 2 Marks, Set-2]

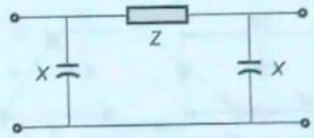
1.36 A source is supplying a load through a 2-phase, 3-wire transmission system as shown in figure below. The instantaneous voltage and current in phase-a are $v_{an} = 220 \sin(100\pi t)$ V and $i_a = 10 \sin(100\pi t)$ A, respectively. Similarly for phase-*b*, the instantaneous voltage and current are $v_{bn} = 220 \cos(100\pi t)$ V and $i_b = 10 \cos(100\pi t)$ A, respectively.



The total instantaneous power flowing from the source to the load is
(a) 2200 W
(b) $2200 \sin^2(100\pi t)$ W
(c) 4400 W
(d) $2200 \sin(100\pi t) \cos(100\pi t)$ W

[2017 : 1 Mark, Set-1]

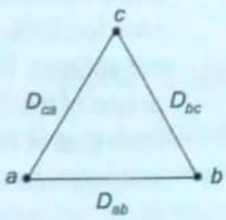
1.37 The nominal-π circuit of a transmission line is shown in the figure.



Impedance, $Z = 100\angle 80°$ Ω and reactance $X = 3300$ Ω. The magnitude of the characteristic impedance of the transmission line, in Ω, is _____.
(Give the answer up to one decimal place.)

[2017 : 1 Mark, Set-2]

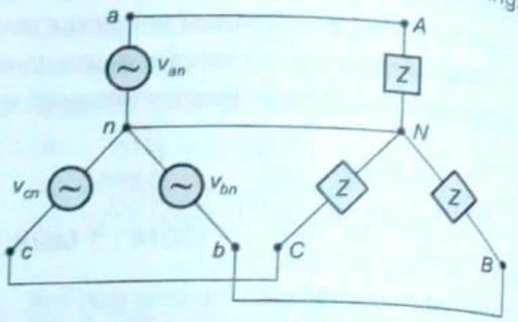
1.38 Consider an overhead transmission line with 3-phase. 50 Hz balanced system with conductors located at the vertices of an equilateral triangle of length $D_{ab} = D_{bc} = D_{ca} = 1$ m as shown in figure.



The resistances of the conductors are neglected. The geometric mean radius (GMR) of each conductor is 0.01 m. Neglecting the effect of ground, the magnitude of positive sequence reactance in Ω/km (rounded off to three decimal places) is ______ .

[2017 : 2 Marks, Set-2]

1.39 For the balanced Y-Y connected 3-phase circuit shown in the figure below, the line-line voltage is 208 V rms and the total power absorbed by the load is 432 Ω at a power factor of 0.6 leading.



The approximate value of the impedance Z is

(a) $33\angle{-53.1°}\,\Omega$
(b) $60\angle{53.1°}\,\Omega$
(c) $60\angle{-53.1°}\,\Omega$
(d) $180\angle{-53.1°}\,\Omega$

[2017 : 2 Marks, Set-2]

Answers Performance of Transmission Lines, Line Parameters and Corona

1.1 (c)	1.2 (c)	1.5 (c)	1.6 (c)	1.7 (d)	1.8 (d)	1.9 (a)	1.10 (c)	1.11 (d)
1.12 (c)	1.13 (c)	1.14 (b)	1.15 (c)	1.16 (b)	1.17 (d)	1.18 (c)	1.19 (d)	1.20 (b)
1.21 (c)	1.22 (c)	1.23 (b)	1.24 (c)	1.25 (d)	1.26 (c)	1.27 (c)	1.28 (b)	1.29 (b)
1.30 (a)	1.31 (b)	1.36 (a)	1.39 (c)					

2 Compensation Techniques and Voltage Profile Control

2.1 In a 400 kV network, 360 kV is recorded at a 400 kV bus. The reactive power absorbed by a shunt rated for 50 MVAR, 400 kV connected at the bus is
(a) 61.73 MVAR (b) 55.56 MVAR
(c) 45 MVAR (d) 40.5 MVAR
[1994 : 1 Mark]

2.2 A load draws 100 kW at 0.7 p.f. lagging from a 3-phase, 11 kV supply. It is desired to raise the p.f. to 0.95 lagging using series capacitors. Calculate the rating of the capacitor required.
[1997 : 2 Marks]

2.3 Series capacitive compensation in EHV transmission lines is used to
(a) Reduce the line loading
(b) Improve the stability of the system
(c) Reduce the voltage profile
(d) Improve the protection of the line
[1998 : 1 Mark]

2.4 A shunt reactor of 100 MVAR is operated at 98% of its rated voltage and at 96% of its rated frequency. The reactive power absorbed by the reactor is
(a) 98 MVAR (b) 104.02 MVAR
(c) 96.04 MVAR (d) 100.04 MVAR
[1998 : 2 Marks]

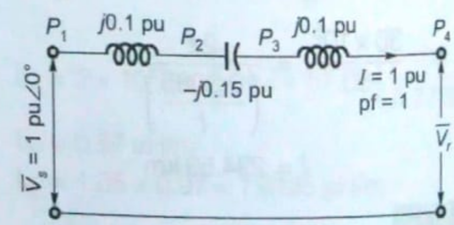
2.5 The voltage phasor of a circuit is $10\angle 15°$ V and the current phasor is $2\angle -45°$ A. The active and the reactive powers in the circuit are
(a) 10 W and 17.32 VAR
(b) 5 W and 8.66 VAR
(c) 20 W and 60 VAR
(d) $20\sqrt{2}$ W and $10\sqrt{2}$ VAR
[1999 : 1 Mark]

2.6 A 3-phase, 11 kV, 50 Hz, 200 kW load has a power factor of 0.8 lag. A delta connected 3-phase capacitor is used to improve the power factor to unity. The capacitance per-phase of the capacitor in micro-farad is
(a) 3.948 (b) 1.316
(c) 0.439 (d) 11.844
[1999 : 2 Marks]

2.7 A transmission line has equal voltages at the two ends, maintained constant by two sources. A third source is to be provided to maintain constant voltage (equal to end voltages) at either the midpoint of the line or at 75% of the distances from the sending end. Then the maximum power transfer capabilities of the line in the original case and the other two cases respectively will be in the following ratios.
(a) 1 : 1 : 1 (b) 1 : 2 : 1 / 0.75
(c) 1 : 2 : 4 (d) 1 : 4 : 6
[2000 : 2 Marks]

2.8 A lossless radial transmission line with surge impedance loading
(a) Taking negative VAR at sending end and zero VAR at receiving end.
(b) Takes positive VAR at sending end and zero VAR at receiving end.
(c) Has flat voltage profile and unity power factor at all points along it.
(d) Has sending end voltage higher than receiving end voltage and unity power factor at sending end.
[2001 : 1 Mark]

2.9 Consider the model shown in figure of a transmission line with a series capacitor at its mid-point. The maximum voltage on the line is at the location



(a) P_1 (b) P_2
(c) P_3 (d) P_4
[2001 : 2 Marks]

2.10 A 3-phase 11-kV generator feeds power to a constant power unity power factor load of 100 MW through a 3-phase transmission line. The line-to-line voltage at the terminals of the machine is maintained constant at 11 kV. The per unit positive sequence impedance of the line based on 100 MVA and 11 kV is j 0.2. The line to line voltage at the load terminals is measured to be less than 11 kV. The total reactive power to be injected at the terminals of the load to increase the line-to-line voltage at the load terminals to 11 kV is

(a) 100 MVAR (b) 10.1 MVAR
(c) −100 MVAR (d) −10.1 MVAR

[2003 : 2 Marks]

2.11 A balanced delta connected load of (8 + j6) Ω per phase is connected to a 400 V, 50 Hz, 3-phase supply lines. If the input power factor is to be improved to 0.9 by connecting a bank of star connected capacitors the required kVAR of the bank is

(a) 42.7 (b) 10.2
(c) 28.8 (d) 38.4

[2003 : 2 Marks]

2.12 At an industrial sub-station with a 4 MW load, a capacitor of 2 MVAR is installed to maintain the load power factor at 0.97 lagging. If the capacitor goes out of service, the load power factor becomes

(a) 0.85 (b) 1.00
(c) 0.80 lag (d) 0.90 lag

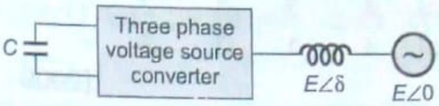
[2005 : 2 Marks]

2.13 A 400 V, 50 Hz, three phase balanced source supplies power to a star connected load whose rating is $12\sqrt{3}$ KVA, 0.8 pf (lag). The rating (in KVAR) of the delta connected (capacitive) reactive power bank necessary to bring the pf to unity is

(a) 28.78 (b) 21.60
(c) 16.60 (d) 12.47

[2006 : 2 Marks]

2.14 The figure below shows a three phase self-commutated voltage source converter connected to a power system. The converter's dc bus capacitor is marked as C in the figure. The circuit in initially operating in steady state with $\delta = 0$ and the capacitor dc voltage is equal to V_{dc0}. You may neglect all losses and harmonics. What action should be taken to increase the capacitor dc voltage slowly to a new steady state value?



(a) Make δ positive and maintain it at a positive value
(b) Make δ positive and return it to its original value
(c) Make δ negative and maintain it at a negative value
(d) Make δ negative and return it to its original value

[2007 : 2 Marks]

2.15 A 230 V (Phase), 50 Hz, three-phase,4-wire, system has a sequence ABC. A unity power-factor load of 4 kW is connected between phase A and neutral N. It is desired to achieve zero neutral current through the use of a pure inductor and pure capacitor in the other two phases. The Value of inductor and capacitor is

(a) 72.95 mH in phase C and 139.02 μF in phase B
(b) 72.95 mH in Phase B and 139.02 μF in phase C
(c) 42.12 mH in Phase C and 240.79 μF in phase B
(d) 42.12 mH in Phase b and 240.79 μF in phase C

[2007 : 2 Marks]

2.16 Match the items in List-I (To) with the items in List-II (Use) and select the correct answer using the codes given below the lists.

List-I

A. improve power factor
B. reduce the current ripples
C. increase the power flow in line
D. reduce the Ferranti effect

List-II

1. shunt reactor
2. shunt capacitor
3. series capacitor
4. series reactor

	A	B	C	D
(a)	2	3	4	1
(b)	2	4	3	1
(c)	4	3	1	2
(d)	4	1	3	2

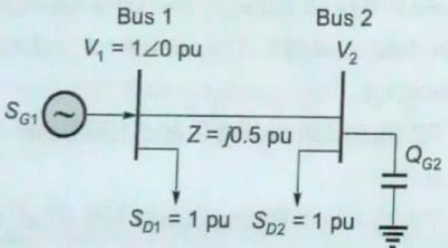
[2009 : 2 Marks]

2.17 For enhancing the power transmission in a long EHV transmission line, the most preferred method is to connect a

(a) series inductive compensator in the line
(b) shunt inductive compensator at the receiving end
(c) series capacitive compensator in the line
(d) shunt capacitive compensator at the sending end

[2011 : 1 Mark]

2.18 For the system shown below, S_{D1} and S_{D2} are complex power demands at bus 1 and bus 2 respectively. If $|V_2| = 1$ pu, the VAR rating of the capacitor (Q_{G2}) connected at bus 2 is



(a) 0.2 pu (b) 0.268 pu
(c) 0.312 pu (d) 0.4 pu

[2012 : 2 Marks]

2.19 Shunt reactors are sometimes used in high voltage transmission systems to

(a) limit the short circuit current through the line.
(b) compensate for the series reactance of the line under heavily loaded condition.
(c) limit over voltages at the load side under lightly loaded condition.
(d) compensate for the voltage drop in the line under heavily loaded condition.

[2014 : 1 Mark, Set-2]

2.20 The complex power consumed by a constant voltage load is given by $(P_1 + jQ_1)$, where $1 \text{ kW} \le P_1 \le 1.5$ kW and $0.5 \text{ kVAR} \le Q_1 \le 1$ kVAR. A compensating shunt capacitor is chosen such that $|Q| \le 0.25$ kVAR, where Q is the net reactive power consumed by the capacitor load combination. The reactive power (in kVAR) supplied by the capacitor is ______.

[2014 : 2 Marks, Set-3]

2.21 The inductance and capacitance of a 400 kV, 3-ϕ, 50 Hz lossless transmission line are 1.6 mH/km/phase and 10 nF/km/phase respectively. The sending end voltage is maintained at 400 kV. To maintain a voltage of 400 kV at the receiving end, when the line is delivering 300 MW load, the shunt compensation required is

(a) capacitive (b) inductive
(c) resistive (d) zero

[2016 : 1 Mark, Set-2]

2.22 A load is supplied by a 230 V, 50 Hz source. The active power P and the reactive power Q consumed by the load are such that $1 \text{ kW} \le P \le 2$ kW and $1 \text{ kVAR} \le Q \le 2$ kVAR. A capacitor connected across the load for power factor correction generates 1 kVAR reactive power. The worst case power factor after power factor correction is

(a) 0.447 lag (b) 0.707 lag
(c) 0.894 lag (d) 1

[2017 : 2 Marks, Set-1]

■■■■

Answers Compensation Techniques and Voltage Profile Control

2.1 (d)	2.3 (b)	2.4 (d)	2.5 (a)	2.6 (b)	2.7 (b)	2.8 (c)	2.9 (c)	2.10 (b)
2.11 (b)	2.12 (c)	2.13 (d)	2.14 (d)	2.15 (b)	2.16 (b)	2.17 (c)	2.18 (b)	2.19 (c)
2.21 (b)	2.22 (b)							

3 Distribution Systems, Cables and Insulators

3.1 The selection of size of conductors for a distributor in a distribution system is governed by
(a) Corona loss
(b) Temperature rise
(c) Radio interference
(d) Voltage drop

[1992 : 1 Mark]

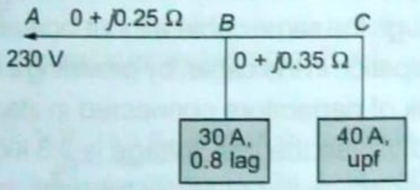
3.2 The insulation resistance of a cable of length 10 km is 1 MΩ. For a length of 100 km of the same cable, the insulation resistance will be
(a) 1 MΩ (b) 10 MΩ
(c) 0.1 MΩ (d) 0.01 MΩ

[1995 : 1 Mark]

3.3 A cable has the following characteristics. L = 0.201 μH/m and C = 196.2 pF/m. The velocity of wave propagation through the cable is
(a) 32 m/s (b) 159.24 m/ms
(c) 0.0312 m/s (d) 159.24 m/(μ-s)

[1998 : 2 Marks]

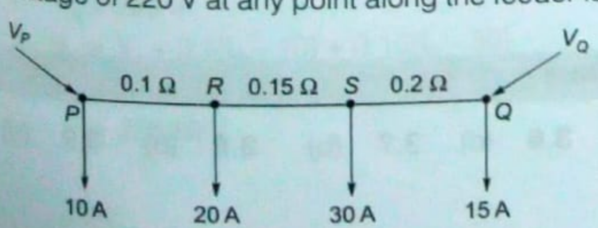
3.4 A single phase AC distributor supplies two single phase loads as shown in figure. The voltage drop from A to C is



(a) 4.5 V (b) 31.5 V
(c) 30.34 V (d) 20 V

[1999 : 2 Marks]

3.5 A dc distribution system is shown in figure with load currents as marked. The two ends of the feeder are fed by voltage sources such that $V_P - V_Q = 3$ V. The value of the voltage V_P for a minimum voltage of 220 V at any point along the feeder is



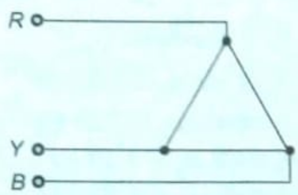
(a) 225.89 V (b) 222.89 V
(c) 220.0 V (d) 228.58 V

[2003 : 2 Marks]

3.6 The rated voltage of a 3-phase power system is given as
(a) rms phase voltage
(b) peak phase voltage
(c) rms line to line voltage
(d) peak line to line voltage

[2004 : 1 Mark]

3.7 The phase sequence of the 3-phase system shown in figure is



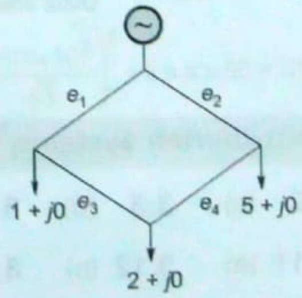
(a) RYB (b) RBY
(c) BRY (d) YBR

[2004 : 1 Mark]

3.8 A 110 kV, three core coaxial, XLPE insulated power cable delivering power at 50 Hz, has a capacitance of 125 nF/km. If the dielectric loss tangent of XLPE is 2×10^{-4}, then dielectric power loss in this cable in W/km is
(a) 5.0 (b) 31.7
(c) 37.8 (d) 189.0

[2004 : 2 Marks]

3.9 Single line diagram of a 4-bus single source distribution system is shown below. Branches e_1, e_2, e_3 and e_4 have equal impedances. The load current values indicated in the figure are in per unit.

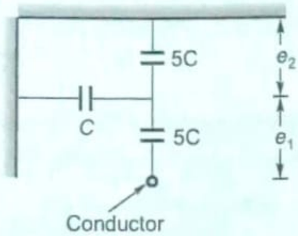


Distribution company's policy requires radial system operation with minimum loss. This can be achieved by opening of the branch

(a) e_1 (b) e_2
(c) e_3 (d) e_4

[2008 : 2 Marks]

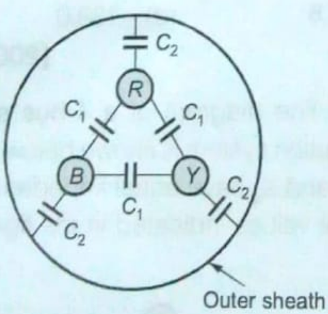
3.10 Consider a three-phase, 50 Hz, 11 kV distribution system. Each of the conductors is suspended by an insulator string having two identical porcelain insulators. The self capacitance of the insulator is 5 times the shunt capacitance between the link and the ground, as shown in the figures. The voltage across the two insulators are



(a) $e_1 = 3.74$ kV, $e_2 = 2.61$ kV
(b) $e_1 = 3.46$ kV, $e_2 = 2.89$ kV
(c) $e_1 = 6.0$ kV, $e_2 = 4.23$ kV
(d) $e_1 = 5.5$ kV, $e_2 = 5.5$ kV

[2010 : 2 Marks]

3.11 Consider a three-core, three-phase, 50 Hz, 11 kV cable whose conductors are denoted as R, Y and B in the figure. The inter-phase capacitance (C_1) between each pair of conductors is 0.2 μF and the capacitance between each line conductor and the sheath is 0.4 μF. The per-phase charging current is



(a) 2.0 A (b) 2.4 A
(c) 2.7 A (d) 3.5 A

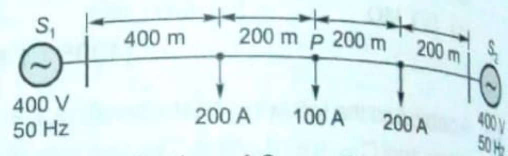
[2010 : 2 Marks]

3.12 The undesirable property of an electrical insulating material is

(a) high dielectric strength
(b) high relative permittivity
(c) high thermal conductivity
(d) high insulation resistivity

[2014 : 1 Mark, Set-1]

3.13 A distribution feeder of 1 km length having resistance, but negligible reactance, is fed from both the ends by 400 V, 50 Hz balanced sources. Both voltage sources S_1 and S_2 are in phase. The feeder supplies concentrated loads of unity power factor as shown in figure.



The contribution of S_1 and S_2 in 100 A current supplied at location P respectively, are

(a) 75 A and 25 A (b) 50 A and 50 A
(c) 25 A and 75 A (d) 0 A and 100 A

[2014 : 2 Marks, Set-1]

3.14 A three-phase cable is supplying 800 kW and 600 kVAr to an inductive load. It is intended to supply an additional resistive load of 100 kW through the same cable without increasing the heat dissipation in the cable, by providing a three-phase bank of capacitors connected in star across the load. Given the line voltage is 3.3 kV, 50 Hz, the capacitance per phase of the bank, expressed in microfarads, is ________.

[2016 : 2 Marks, Set-1]

Answers **Distribution Systems, Cables and Insulators**

3.1 (d) 3.2 (c) 3.3 (d) 3.4 (c) 3.5 (a) 3.6 (c) 3.7 (b) 3.8 (b) 3.9 (d)
3.10 (b) 3.11 (a) 3.12 (c) 3.13 (d)

4 Economic Power Generation and Load Dispatch

4.1 The incremental cost characteristic of two generators delivering 200 MW are as follows:

$$\frac{dF_1}{dP_1} = 20 + 0.1P_1$$

$$\frac{dF_2}{dP_2} = 16 + 0.2\,P_2$$

For economic operation, the generation P_1 and P_2 should be

(a) $P_1 = P_2 = 100$ MW
(b) $P_1 = 80$ MW, $P_2 = 120$ MW
(c) $P_1 = 200$ MW, $P_2 = 0$ MW
(d) $P_1 = 120$ MW, $P_2 = 80$ MW

[2000 : 2 Marks]

4.2 In a power system, the fuel inputs per hour of plants 1 and 2 are given as

$$F_1 = 0.20\,P_1^2 + 30\,P_1 + 100 \text{ Rs. per hour}$$

$$F_2 = 0.25\,P_2^2 + 40\,P_2 + 80 \text{ Rs. per hour.}$$

The limits of generators are

$20 \le P_1 \le 80$ MW

$40 \le P_2 \le 200$ MW

Find the economic operating schedule of generation, if the load demand is 130 MW, neglecting transmission losses.

[2000 : 2 Marks]

4.3 A power system has two generators with the following cost curves.

Generator 1: $C_1(P_{G1}) = 0.006\,P^2_{G1} + 8\,P_{G1} + 350$ (Thousand Rupees/Hour)

Generator 2: $C_2(P_{G2}) = 0.006\,P^2_{G2} + 7\,P_{G2} + 400$ (Thousand Rupees/Hour)

The generator limits are

100 MW $\le P_{G1} \le$ 650 MW

50 MW $\le P_{G2} \le$ 500 MW

A load demand of 600 MW is supplied by the generators in an optimal manner. Neglecting losses in the transmission network, determine the optimal generation of each generator.

[2001 : 2 Marks]

4.4 Consider a power system with three identical generators. The transmission losses are negligible. One generator (G1) has a speed governor which maintains its speed constant at the rated value, while the other generators (G2 and G3) have governors with a droop of 5%. If the load of the system is increased, then in steady state.

(a) Generation of G2 and G3 is increased equally while generation of G1 is unchanged.
(b) Generation of G1 alone is increased while generation of G2 and G3 is unchanged.
(c) Generation of G1, G2 and G3 is increased equally.
(d) Generation of G1, G2 and G3 is increased in the ratio 0.5 : 25 : 0.25.

[2002 : 1 Mark]

4.5 Incremental fuel costs (in some appropriate unit) for a power plant consisting of three generating units are

$IC_1 = 20 + 0.3\,P_1$, $IC_2 = 30 + 0.4\,P_2$, $IC_3 = 30$

where P_i is the power in MW generated by unit i, for i = 1, 2 and 3.

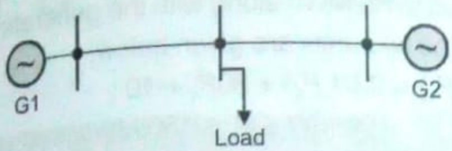
Assume that all the three units are operating all the time. Minimum and maximum loads on each unit are 50 MW and 300 MW respectively. If the plant is operating on economic load dispatch to supply the total power demand of 700 MW, the power generated by each unit is

(a) P_1 = 242.86 MW ; P_2 = 157.14 MW ; and P_3 = 300 MW
(b) P_1 = 157.14 MW ; P_2 = 242.86 MW ; and P_3 = 300 MW
(c) P_1 = 300.0 MW ; P_2 = 300.0 MW ; and P_3 = 100 MW
(d) P_1 = 233.3 MW ; P_2 = 233.3 MW ; and P_3 = 233.4 MW

[2003 : 2 Marks]

4.6 A load centre is at an equidistant from the two thermal generating stations G_1 and G_2 as shown in the figure. The fuel cost characteristics of the generating stations are given by

$F_1 = a + bP_1 + cP_1^2$ Rs/hour
$F_2 = a + bP_2 + 2cP_2^2$ Rs/hour

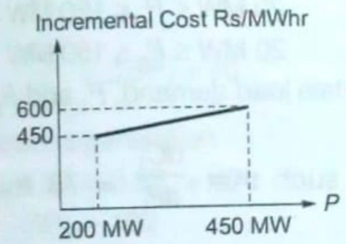


where P_1 and P_2 are the generation in MW of G_1 and G_2, respectively. For most economic generation to meet 300 MW of load, P_1 and P_2, respectively, are

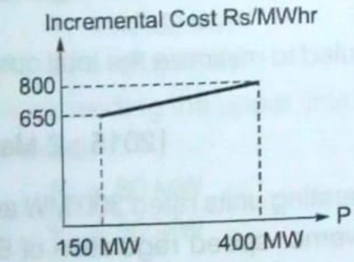
(a) 150, 150 (b) 100, 200
(c) 200, 100 (d) 175, 125

[2005 : 2 Marks]

4.7 The incremental cost curves in Rs/ MWhr for two generators supplying a common load of 700 MW are shown in the figures. The maximum and minimum generation limits are also indicated. The optimum generation schedule is:



GENERATOR A



GENERATOR B

(a) Generator A : 400 MW, Generator B : 300 MW
(b) Generator A : 350 MW, Generator B : 350 MW
(c) Generator A : 450 MW, Generator B : 250 MW
(d) Generator A : 425 MW, Generator B: 275 MW

[2007 : 1 Mark]

4.8 A lossless power system has to serve a load of 250 MW. There are two generators (G1 and G2) in the system with cost curves C_1 and C_2 respectively defined as follows:

$$C_1(P_{G1}) = P_{G1} + 0.055 \times P_{G1}^2$$

$$C_2(P_{G2}) = 3\,P_{G2} + 0.03 \times P_{G2}^2$$

Where P_{G1} and P_{G2} are the MW injections from generator G1 and G2 respectively. Thus, the minimum cost dispatch will be

(a) P_{G1} = 250 MW; P_{G2} = 0 MW
(b) P_{G1} = 150 MW; P_{G2} = 100 MW
(c) P_{G1} = 100 MW; P_{G2} = 150 MW
(d) P_{G1} = 0 MW; P_{G2} = 250 MW

[2008 : 2 Marks]

4.9 Three generators are feeding a load of 100MW. The details of the generators are

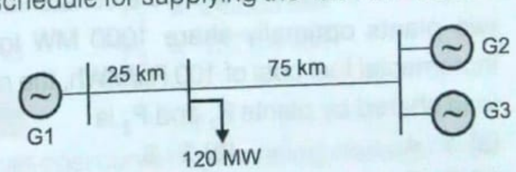
	Rating (MW)	Efficiency (%)	Regulation (pu) on 100 MVA base
Generator-1	100	20	0.02
Generator-2	100	30	0.04
Generator-3	100	40	0.03

In the event of increased load power demand, which of the following will happen?

(a) All the generators will share equal power
(b) Generator-3 will share more power compared to Generator-1
(c) Generator-1 will share more power compared to Generator-2
(d) Generator-2 will share more power compared to Generator-3

[2009 : 2 Marks]

4.10 A load center of 102 MW derives power from two power stations connected by 220 kV transmission lines of 25 km and 75 km as shown in the figure below. The three generators G1, G2 and G3 are of 100 MW capacity each and have identical fuel cost characteristics. The minimum loss generation schedule for supplying the 120 MW load is



(a) P1 = 80 MW + losses
P2 = 20 MW
P3 = 20 MW

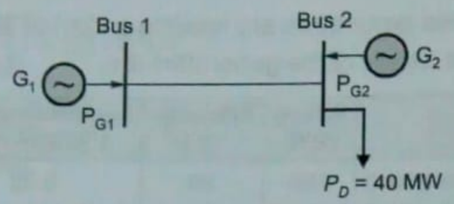
(b) P1 = 60 MW
P2 = 30 MW + losses
P3 = 30 MW

(c) P1 = 40 MW
P2 = 40 MW
P3 = 40 MW + losses

(d) P1 = 30 MW + losses
P2 = 45 MW
P3 = 45 MW

[2011 : 2 Marks]

4.11 The figure shows a two-generator system supplying a load of P_D = 40 MW, connected at bus 2.



The fuel cost of generators G_1 and G_2 are:
$C_1(P_{G1})$ = 10,000 Rs/MWh and
$C_2(P_{G2})$ = 12,500 Rs/MWh

and the loss in the line is $P_{loss(pu)} = 0.5P^2_{G1(pu)}$, where the loss coefficient is specified in pu on a 100 MVA base. The most economic power generation schedule in MW is

(a) $P_{G1} = 20, P_{G2} = 22$
(b) $P_{G1} = 22, P_{G2} = 20$
(c) $P_{G1} = 20, P_{G2} = 20$
(d) $P_{G1} = 0, P_{G2} = 40$

[2012 : 1 Mark]

4.12 The fuel cost functions of two power plants are:

Plant P_1 : $C_1 = 0.05Pg_1^2 + A\,Pg_1 + B$

Plant P_2 : $C_2 = 0.10Pg_2^2 + 3A\,Pg_2 + 2B$

where, Pg_1 and Pg_2 are the generated powers of two plants, and A and B are the constants. If the two plants optimally share 1000 MW load at incremental fuel cost of 100 Rs/MWh, the ratio of load shared by plants P_1 and P_2 is

(a) 1 : 4
(b) 2 : 3
(c) 3 : 2
(d) 4 : 1

[2014 : 2 Marks, Set-1]

4.13 Consider the economic dispatch problem for a power plant having two generating units. The fuel costs in Rs/MWh along with the generation limits for the two units are given below:

$C_1(P_1) = 0.01\,P_1^2 + 30P_1 + 10$;
$100 \text{ MW} \le P_1 \le 150 \text{ MW}$
$C_2(P_2) = 0.05\,P_2^2 + 10P_2 + 10$;
$100 \text{ MW} \le P_2 \le 180 \text{ MW}$

The incremental cost (in Rs/MWh) of the power plant when it supplies 200 MW is ______.

[2015 : 2 Marks, Set-1]

4.14 The incremental costs (in Rs/MWh) of operating two generating units are function of their respective powers P_1 and P_2 in MW, and are given by

$$\frac{dC_1}{dP_1} = 0.2P_1 + 50$$

$$\frac{dC_2}{dP_2} = 0.24P_2 + 40$$

where,

$20 \text{ MW} \le P_1 \le 150 \text{ MW}$
$20 \text{ MW} \le P_2 \le 150 \text{ MW}$

For a certain load demand, P_1 and P_2 have been chosen such that $\frac{dC_1}{dP_1}$ = 76 Rs/MWh and $\frac{dC_2}{dP_2}$ = 68.8 Rs/MWh. If the generations are rescheduled to minimize the total cost, then P_2 is ______.

[2015 : 2 Marks, Set-2]

4.15 Two generating units rated 300 MW and 400 MW have governor speed regulation of 6% and 4% respectively from no load to full load. Both the generating units are operating in parallel to share a load of 600 MW. Assuming free governor action, the load shared by the larger units is ______ MW.

[2017 : 2 Marks, Set-2]

■■■■

Answers Economic Power Generation and Load Dispatch

4.1 (d) 4.4 (b) 4.5 (a) 4.6 (c) 4.7 (c) 4.8 (c) 4.9 (c) 4.10 (a) 4.11 (a)

4.12 (d)

Fault Analysis

5.1 In a power-system, the 3-phase fault MVA is always higher than the single-line-ground fault MVA at a bus. (True/False).

[1994 : 1 Mark]

5.2 For an unbalanced fault, with paths for zero sequence currents, at the point of fault

(a) The negative and zero sequence voltages are minimum.
(b) The negative and zero sequence voltages are maximum.
(c) The negative sequence voltage is minimum and zero sequence voltage is maximum.
(d) The negative sequence voltage is maximum and zero sequence voltage is minimum.

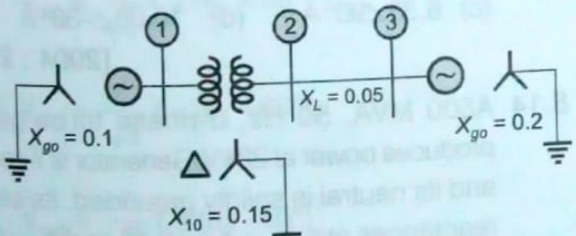
[1996 : 1 Mark]

5.3 For a fault at the terminals of a synchronous generator, the fault current is maximum for a

(a) 3-phase fault
(b) 3-phase to ground fault
(c) line-to ground fault
(d) line-to-line fault

[1997 : 1 Mark]

5.4 For the network shown in figure the zero sequence reactances in p.u. are indicated. The zero sequence driving point reactance of the node 3 is



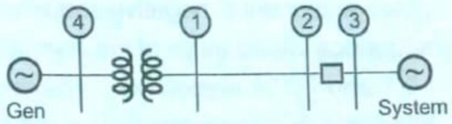
(a) 0.12 p.u.
(b) 0.30 p.u.
(c) 0.10 p.u.
(d) 0.20 p.u.

[1998 : 2 Marks]

5.5 Determine the magnitudes of the symmetrical components (I_{R1}, I_{R2} and I_{R0}) of the currents in a 3-phase (RYB) three wire system, when a short circuit occurs between R and Y phase wires, the fault current being 100 A.

[1999 : 2 Marks]

5.6 For the configuration shown in figure the breaker connecting a large system to bus 2 is initially open. The system 3-phase fault level at bus 3 under this condition is not known. After closing the system breaker, the 3-phase fault level at bus 1 was found to be 5.0 p.u. What will be the new 3-phase fault level at system bus 3 after the interconnection? All per unit values are on common base. Prefault load currents are neglected and prefault voltages are assumed to be 1.0 p.u. at all buses.



E_g = 1.0 p.u., X_T = 0.2 p.u., X_{Line} = 0.3 p.u., X_d = 0.2 p.u.

[2000 : 2 Marks]

5.7 The severity of line-to-ground and 3-phase faults at the terminals of an unloaded synchronous generator is to be same. If the terminal voltage is 1.0 p.u. and $X_1 = X_2 = j0.1$ p.u, $X_0 = j0.05$ p.u., for the alternator, then the required inductive reactance for neutral grounding is

(a) 0.0166 p.u.
(b) 0.05 p.u.
(c) 0.1 p.u.
(d) 0.15 p.u.

[2000 : 2 Marks]

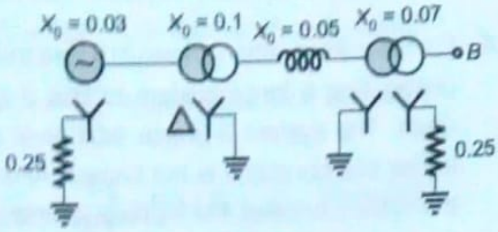
5.8 A 50 Hz alternator is rated 500 MVA, 20 kV, with $X_d = 1.0$ per unit and $X''_d = 0.2$ per unit. It supplies a purely resistive load of 400 MW at 20 kV. The load is connected directly across the generator terminals when a symmetrical fault occurs at the load terminals. The initial rms current in the generator in per unit is

(a) 7.22
(b) 5.05
(c) 3.22
(d) 2.25

[2001 : 2 Marks]

5.9 A generator is connected to a transformer which feeds another transformer through a short feeder.

The zero sequence impedance values are expressed in p.u. on a common base and are indicated in figure. The Thevenin equivalent zero sequence impedance at point B (in p.u.) is



(a) 0.8 + j0.6 (b) 0.75 + j0.22
(c) 0.75 + j0.25 (d) 1.5 + j0.25

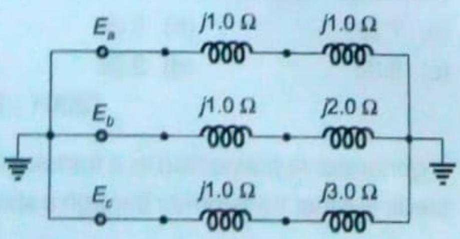
[2002 : 2 Marks]

5.10 A 20-MVA, 6.6-kV, 3-phase alternator is connected to a 3-phase transmission line. The per unit positive-sequence, negative-sequence and zero-sequence impedances of the alternator are j 0.1, j 0.1 and j 0.04 respectively. The neutral of the alternator is connected to ground through an inductive reactor of j 0.05 p.u. The per unit positive-, negative- and zero-sequence impedances of the transmission line are j 0.1, j 0.1 and j 0.3, respectively. All per unit values are based on the machine ratings. A solid ground fault occurs at one phase of the far end of the transmission line. The voltage of the alternator neutral with respect to ground during the fault is

(a) 513.8 V (b) 889.9 V
(c) 1112.0 V (d) 642.2 V

[2003 : 2 Marks]

5.11 A three-phase alternator generating unbalanced voltages is connected to an unbalanced load through a 3-phase transmission line as shown in figure. The neutral of the alternator and the star point of the load are solidly grounded. The phase voltages of the alternator are $E_a = 10\ \angle 0°$V, $E_b = 10\ \angle -90°$V, $E_c = 10\ \angle 120°$V. The positive-sequence component of the load current is



(a) $1.310\ \angle -107°$ A
(b) $0.332\ \angle -120°$ A
(c) $0.996\ \angle -120°$ A
(d) $3.510\ \angle -81°$ A

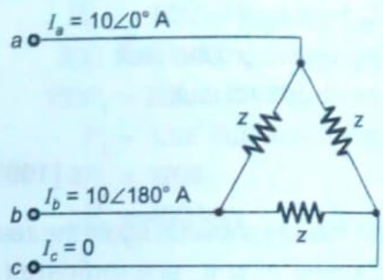
[2003 : 2 Marks]

5.12 A 3-phase generator rated at 110 MVA, 11 kV is connected through circuit breakers to a transformer. The generator is having direct axis sub-transient reactance X''_d = 19%, transient reactance X'_d = 26% and synchronous reactance = 130%. The generator is operating at no load and rated voltage when a three phase short circuit fault occurs between the breakers and the transformer. The magnitude of initial symmetrical rms current in the breakers will be

(a) 4.44 kA (b) 22.20 kA
(c) 30.39 kA (d) 38.45 kA

[2004 : 2 Marks]

5.13 A 3-phase transmission line supplies Δ-connected load Z. The conductor 'c' of the line develops an open circuit fault as shown in figure. The currents in the lines are as shown on the diagram. The +ve sequence current component in line 'a' will be



(a) $5.78\angle -30°$ A (b) $5.78\angle 90°$ A
(c) $6.33\angle 90°$ A (d) $10.00\angle -30°$ A

[2004 : 2 Marks]

5.14 A500 MVA, 50 Hz, 3-phase turbo-generator produces power at 22 kV. Generator is Y-connected and its neutral is solidly grounded. Its sequence reactances are $X_1 = X_2 = 0.15$ and $X_0 = 0.05$ pu. It is operating at rated voltage and disconnected from the rest of the system (no load). The magnitude of the sub-transient line current for single line to ground fault at the generator terminal in pu will be

(a) 2.851 (b) 3.333
(c) 6.667 (d) 8.553

[2004 : 2 Marks]

Data for Questions (5.15 and 5.16):

At a 220 kV substation of a power system, it is given that the three-phase fault level is 4000 MVA and single-line to ground fault level is 5000 MVA. Neglecting the resistance and the shunt susceptances of the system.

5.15 The positive sequence driving point reactance at the bus is

(a) 2.5 Ω (b) 4.033 Ω
(c) 5.5 Ω (d) 12.1 Ω

[2005 : 2 Marks]

5.16 The zero sequence driving point reactance at the bus is

(a) 2.2 Ω (b) 4.84 Ω
(c) 18.18 Ω (d) 22.72 Ω

[2005 : 2 Marks]

5.17 Three identical star connected resistors of 1.0 p.u. are connected to an unbalanced 3 phase supply. The load neutral is isolated. The symmetrical components of the line voltages in p.u. are:

$$V_{ab1} = X\angle\theta_1,\ V_{ab2} = Y\angle\theta_2$$

If all the p.u. calculations are with the respective base values, the phase to neutral sequence voltages are

(a) $V_{an1} = X\angle(\theta_1 + 30°)$, $V_{an2} = Y\angle(\theta_2 - 30°)$

(b) $V_{an1} = X\angle(\theta_1 - 30°)$, $V_{an2} = Y\angle(\theta_2 + 30°)$

(c) $V_{an1} = \dfrac{1}{\sqrt{3}}X\angle(\theta_1 - 30°)$, $V_{an2} = \dfrac{1}{\sqrt{3}}Y\angle(\theta_2 + 30°)$

(d) $V_{an1} = \dfrac{1}{\sqrt{3}}X\angle(\theta_1 - 60°)$, $V_{an2} = \dfrac{1}{\sqrt{3}}Y\angle(\theta_2 - 60°)$

[2006 : 2 Marks]

5.18 A three phase balanced star connected voltage source with frequency ω rad/s is connected to a star connected balanced load which is purely inductive. The instantaneous line currents and phase to neutral voltages are denoted by (i_a, i_b, i_c) and (V_{an}, V_{bn}, V_{cn}) respectively, and their rms values are denoted by V and I.

If $R = [V_{an}\ V_{bn}\ V_{cn}]\begin{bmatrix} 0 & \frac{1}{\sqrt{3}} & -\frac{1}{\sqrt{3}} \\ -\frac{1}{\sqrt{3}} & 0 & \frac{1}{\sqrt{3}} \\ \frac{1}{\sqrt{3}} & -\frac{1}{\sqrt{3}} & 0 \end{bmatrix}\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix}$, then the magnitude of R is

(a) 3 VI (b) VI
(c) 0.7 VI (d) 0

[2007 : 2 Marks]

5.19 Suppose we define a sequence transformation between "a-b-c" and "p-n-o" variables as follows:

$$\begin{bmatrix} f_a \\ f_b \\ f_c \end{bmatrix} = K\begin{bmatrix} 1 & 1 & 1 \\ \alpha^2 & \alpha & 1 \\ \alpha & \alpha^2 & 1 \end{bmatrix}\begin{bmatrix} f_p \\ f_n \\ f_o \end{bmatrix}$$

where $\alpha = e^{j\frac{2\pi}{3}}$ and k is a constant Now, if it is given that:

$$\begin{bmatrix} V_p \\ V_n \\ V_0 \end{bmatrix} = \begin{bmatrix} 0.5 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 2.0 \end{bmatrix}\begin{bmatrix} i_p \\ i_n \\ i_0 \end{bmatrix}$$

and $\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = z\begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix}$ then,

(a) $z = \begin{bmatrix} 1.0 & 0.5 & 0.75 \\ 0.75 & 1.0 & 0.5 \\ 0.5 & 0.75 & 1.0 \end{bmatrix}$

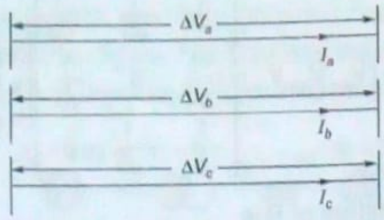
(b) $z = \begin{bmatrix} 1.0 & 0.5 & 0.5 \\ 0.5 & 1.0 & 0.5 \\ 0.5 & 0.5 & 1.0 \end{bmatrix}$

(c) $z = 3k^2\begin{bmatrix} 1.0 & 0.75 & 0.5 \\ 0.5 & 1.0 & 0.75 \\ 0.75 & 0.5 & 1.0 \end{bmatrix}$

(d) $z = \dfrac{K^2}{3}\begin{bmatrix} 1.0 & -0.5 & -0.5 \\ -0.5 & 1.0 & -0.5 \\ -0.5 & -0.5 & 1.0 \end{bmatrix}$

[2007 : 2 Marks]

5.20 A 3-phase transmission line is shown in figure:



Voltage drop across the transmission line is given by the following equation:

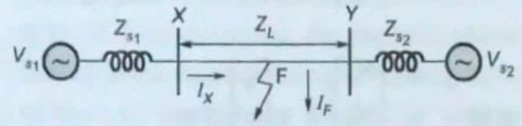
$$\begin{bmatrix} \Delta V_a \\ \Delta V_b \\ \Delta V_c \end{bmatrix} = \begin{bmatrix} Z_s & Z_m & Z_m \\ Z_m & Z_s & Z_m \\ Z_m & Z_m & Z_s \end{bmatrix} \begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix}$$

Shunt capacitance of the line can be neglect. If the line has positive sequence impedance of 15 Ω and zero sequence impedance of 48 Ω, then the values of Z_s and Z_m will be

(a) $Z_s = 31.5\ \Omega$; $Z_m = 16.5\ \Omega$
(b) $Z_s = 26\ \Omega$; $Z_m = 11\ \Omega$
(c) $Z_s = 16.5\ \Omega$; $Z_m = 31.5\ \Omega$
(d) $Z_s = 11\ \Omega$; $Z_m = 26\ \Omega$

[2008 : 1 Mark]

Data for Questions (5.21 to 5.23):



Given that: $V_{s1} = V_{s2} = 1 + j\,0$ p.u, +ive sequence impedance are $Z_{s1} = Z_{s2} = 0.001 + j\,0.01$ p.u and $Z_L = 0.006 + j\,0.06$ p.u, 3 ϕ. Base MVA = 100, voltage base = 400 kV(L – L).

Nominal system frequency = 50 Hz. The reference voltage for phase 'a' is defined as $V(t) = V_m \cos(\omega t)$. A symmetrical 3ϕ fault occurs at centre of the line, i.e. at point 'F' at time 'to' the +ve sequence impedance from source S_1 to point 'F' equals (0.004 +j 0.04) p.u. The wave form corresponding to phase 'a' fault current from bus X reveals that decaying d.c. offset current is –ve and in magnitude at its maximum initial value. Assume that the negative sequence are equal to +ve sequence impedances and the zero sequence (Z) are 3 times +ve sequence (Z).

5.21 The instant (t_0) of the fault will be

(a) 4.682 ms (b) 9.667 ms
(c) 14.667 ms (d) 19.667 ms

[2008 : 2 Marks]

5.22 The rms value of the ac component of fault current (I_x) will be

(a) 3.59 kA (b) 5.07 kA
(c) 7.18 kA (d) 10.15 kA

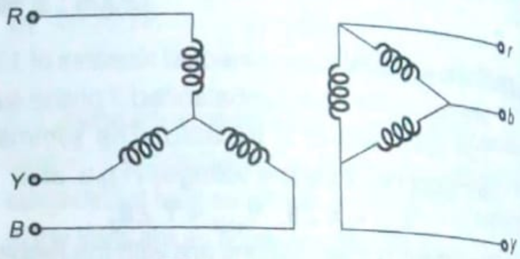
[2008 : 2 Marks]

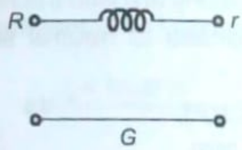
5.23 Instead of the three phase fault, if a single line to ground fault occurs on phase 'a' at point 'F' with zero fault impedance, then the rms of the ac component of fault current (I_x) for phase 'a' will be

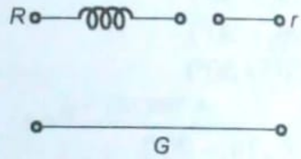
(a) 4.97 pu (b) 7.0 pu
(c) 14.93 pu (d) 29.85 pu

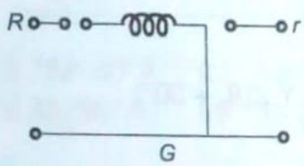
[2008 : 2 Marks]

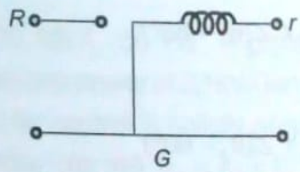
5.24 The zero-sequence circuit of the three phase transformer shown in the figure is



(a)


(b)


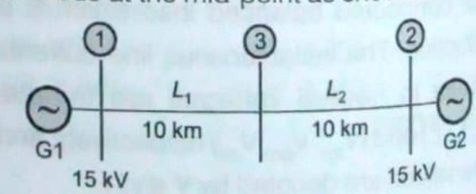
(c)


(d)


[2010 : 2 Marks]

Statement for Linked Answer Questions (5.25 and 5.26):

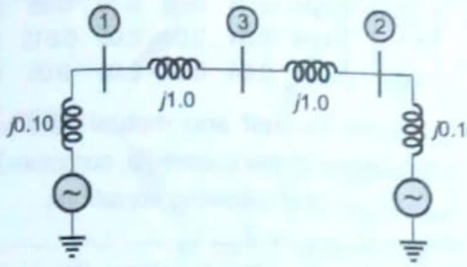
Two generator units G1 and G2 are connected by 15 kV line with a bus at the mid-point as shown below,



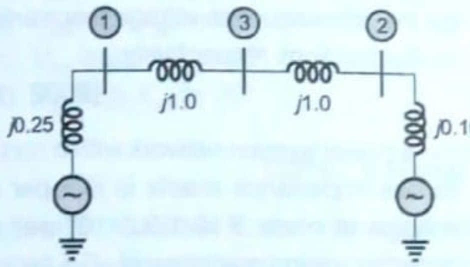
G1 = 250 MVA, 15 kV, positive sequence reactance X = 25% on its own base.
G2 = 100 MVA, 15 kV, positive sequence reactance X = 10% on its own base.
L_1 and L_2 = 10 km, positive sequence reactance X = 0.225 Ω/km.

5.25 For the above system, the positive sequence diagram with the p.u. values on the 100 MVA common base is

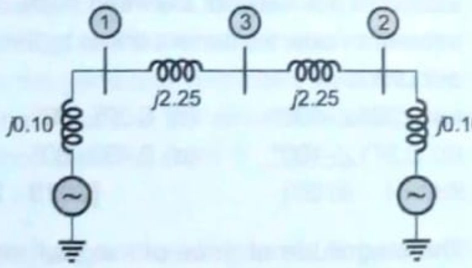
(a)



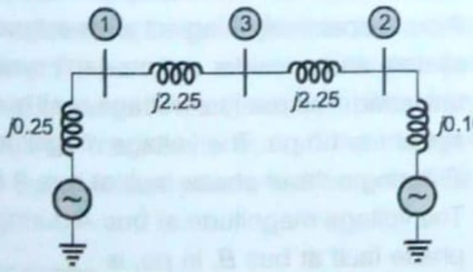
(b)



(c)



(d)



[2011 : 2 Marks]

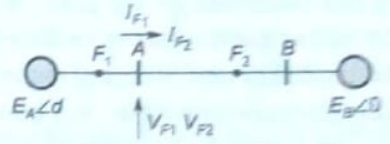
5.26 In the above system, the three-phase fault MVA at the bus 3 is
(a) 82.55 MVA (b) 85.11 MVA
(c) 170.91 MVA (d) 181.82 MVA

[2011 : 2 Marks]

5.27 The sequence components of the fault current are as follows: $I_{positive}$ = j1.5 pu, $I_{negative}$ = −j0.5 pu, I_{zero} = −j1 pu. The type of fault in the system is
(a) LG (b) LL
(c) LLG (d) LLLG

[2012 : 1 Mark]

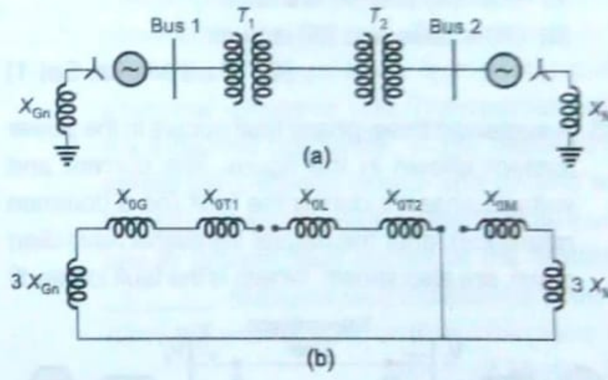
5.28 Three-phase to ground fault takes place at locations F_1 and F_2 in the system shown in the figure.



If the fault takes place at location F_1, then the voltage and the current at bus A are V_{F1} and I_{F1} respectively. If the fault takes place at location F_2, then the voltage and the current at bus A are V_{F2} and I_{F2} respectively. The correct statement about voltages and currents during faults at F_1 and F_2 is
(a) V_{F1} leads I_{F1} and V_{F2} leads I_{F2}
(b) V_{F1} leads I_{F1} and V_{F2} lags I_{F2}
(c) V_{F1} lags I_{F1} and V_{F2} leads I_{F2}
(d) V_{F1} lags I_{F1} and V_{F2} lags I_{F2}

[2014 : 1 Mark, Set-1]

5.29 A 2-bus system and corresponding zero sequence network are shown in the figure.



The transformer T_1 and T_2 are connected as
(a) ⅄ ⅄ and ⅄ Δ
(b) ⏚⅄ ⅄ and ⏚⅄ Δ
(c) ⏚⅄ Δ and Δ ⏚⅄
(d) Δ ⏚⅄ and ⅄ ⏚⅄

[2014 : 1 Mark, Set-1]

5.30 In an unbalanced three-phase system, phase current $I_a = 1\angle(-90°)$ pu, negative sequence current $I_{b2} = 4\angle(-150°)$ pu, zero sequence current $I_{c0} = 3\angle 90°$ pu. The magnitude of phase current I_b in pu is

(a) 1.00 (b) 7.81
(c) 11.53 (d) 13.00

[2014 : 2 Marks, Set-1]

5.31 A three-phase, 100 MVA, 25 kV generator has solidly grounded neutral. The positive, negative and the zero sequence reactances of the generator are 0.2 pu, 0.2 pu and 0.05 pu, respectively, at the machine base quantities. If a bolted single phase to ground fault occurs at the terminal of the unloaded, generator, the fault current in amperes immediately after the fault is _______.

[2014 : 2 Marks, Set-2]

5.32 Determine the correctness or otherwise of the following Assertion [A] and the Reason [R].

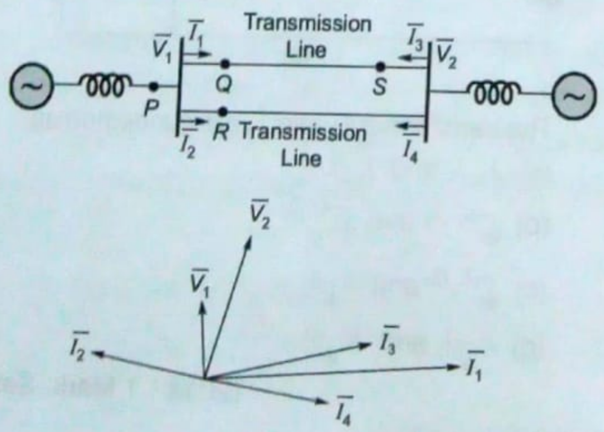
Assertion (A): Fast decoupled load flow method gives approximate load flow solution because it uses several assumptions.

Reason (R): Accuracy depends on the power mismatch vector tolerance.

(a) Both (A) and (R) are true and (R) is the correct reason for (A).
(b) Both (A) and (R) are true but (R) is not the correct reason for [a].
(c) Both (A) and (R) are false.
(d) (A) is false and (R) is true.

[2015 : 2 Marks, Set-1]

5.33 A sustained three-phase fault occurs in the power system shown in the figure. The current and voltage phasors during the fault (on a common reference), after the natural transients have died down, are also shown. Where is the fault located?



(a) Location P (b) Location Q
(c) Location R (d) Location S

[2015 : 2 Marks, Set-1]

5.34 Two transposed 3-phase lines run parallel to each other. The equation describing the voltage drop in both lines given below.

$$\begin{bmatrix} \Delta V_{a1} \\ \Delta V_{b1} \\ \Delta V_{c1} \\ \Delta V_{a2} \\ \Delta V_{b2} \\ \Delta V_{c2} \end{bmatrix} = \begin{bmatrix} 0.15 & 0.05 & 0.05 & 0.04 & 0.04 & 0.04 \\ 0.05 & 0.15 & 0.05 & 0.04 & 0.04 & 0.04 \\ 0.05 & 0.05 & 0.15 & 0.04 & 0.04 & 0.04 \\ 0.04 & 0.04 & 0.04 & 0.15 & 0.05 & 0.05 \\ 0.04 & 0.04 & 0.04 & 0.05 & 0.015 & 0.05 \\ 0.04 & 0.04 & 0.04 & 0.05 & 0.05 & 0.15 \end{bmatrix} \begin{bmatrix} I_{a1} \\ I_{b1} \\ I_{c1} \\ I_{a2} \\ I_{b2} \\ I_{c2} \end{bmatrix}$$

Compute the self and mutual zero sequence impedances of this system i.e. complete Z_{011}, Z_{012}, Z_{021}, Z_{022} in the following equations.

$\Delta V_{01} = Z_{011} I_{01} + Z_{012} I_{02}$

$\Delta V_{02} = Z_{021} I_{01} + Z_{022} I_{02}$ where ΔV_{01}, ΔV_{02}, I_{01}, I_{02} are the zero sequence voltage drops and currents for the two lines respectively.

[2002 : 2 Marks]

5.35 For a power system network with n nodes, Z_{33} of its bus impedance matrix is j0.5 per unit. The voltage at node 3 is $1.3\angle-10°$ per unit. If a capacitor having reactance of $-j3.5$ per unit is now added to the network between node 3 and the reference node, the current drawn by the capacitor per unit is

(a) $0.325\angle-100°$ (b) $0.325\angle 80°$
(c) $0.371\angle-100°$ (d) $0.433\angle 80°$

[2013 : 2 Marks]

5.36 The magnitude of three-phase fault currents at buses A and B of a power system are 10 pu and 8 pu, respectively. Neglect all resistances in the system and consider the pre-fault system to be unloaded. The pre-fault voltage at all buses in the system is 1.0 pu. The voltage magnitude at bus B during a three-phase fault at bus A is 0.8 pu. The voltage magnitude at bus A during a three-phase fault at bus B, in pu, is _______?

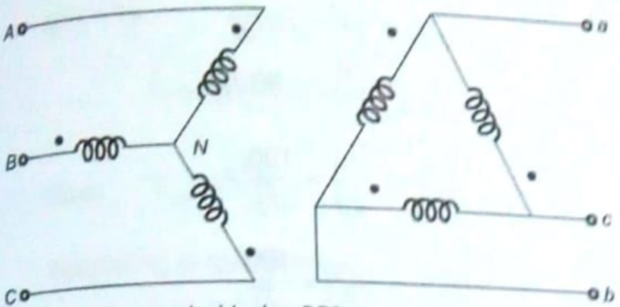
[2016 : 1 Mark, Set-1]

5.37 A 30 MVA, 3-phase, 50 Hz, 13.8 kV, star-connected synchronous generator has positive, negative and zero sequence reactances, 15%, 15% and 5% respectively. A reactance (X_n) is connected between the neutral of the generator and ground

A double line to ground fault takes place involving phases 'b' and 'c', with a fault impedance of j0.1 p.u. The value of X_n (in p.u.) that will limit the positive sequence generator current to 4270 A is ______.

[2016 : 2 Marks, Set-1]

5.38 If the star side of the star-delta transformer shown in the figure is excited by a negative sequence voltage, then



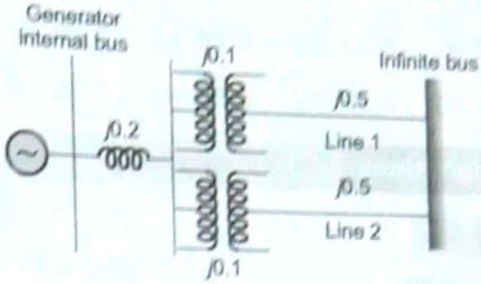
(a) V_{AB} leads V_{ab} by 60°
(b) V_{AB} lags V_{ab} by 60°
(c) V_{AB} leads V_{ab} by 30°
(d) V_{AB} lags V_{ab} by 30°

[2016 : 2 Marks, Set-1]

5.39 A 50 MVA, 10 kV, 50 Hz, star-connected, unloaded three-phase alternator has a synchronous reactance of 1 p.u. and a sub-transient reactance of 0.2 p.u. If a 3-phase short circuit occurs close to the generator terminals, the ratio of initial and final values of the sinusoidal component of the short circuit current is ______.

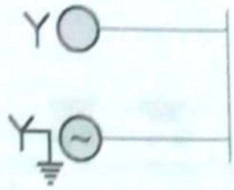
[2016 : 1 Mark, Set-2]

5.40 The single line diagram of a balanced power system is shown in the figure. The voltage magnitude at the generator internal bus is constant and 1.0 p.u. The p.u. reactances of different components in the system are also shown in the figure. The infinite bus voltage magnitude is 1.0 p.u. A three phase fault occurs at the middle of line 2. The ratio of the maximum real power that can be transferred during the pre-fault condition to the maximum real power that can be transferred under the faulted condition is ______.



[2016 : 2 Marks, Set-2]

5.41 Two identical unloaded generators are connected in parallel as shown in the figure.



Both the generators are having positive, negative and zero sequence impedance of j0.4 p.u, j0.3, p.u. and j0.15 p.u., respectively. If the pre-fault voltage is 1 p.u., for a line-to-ground (L-G) fault at the terminals of the generators, the fault current, in p.u., is ______.

[2016 : 2 Marks, Set-2]

5.42 The positive, negative and zero sequence reactances of a wye-connected synchronous generator are 0.2 pu, 0.2 pu and 0.1 pu respectively. The generator is on open circuit with a terminal voltage of 1 pu. The minimum value of the inductive reactance, in pu, required to be connected between neutral and ground so that the fault current does not exceed 3.75 pu if a single line to ground fault occurs at the terminals is ______. (Assume fault impedance to be zero). (Give the answer up to one decimal place.)

[2017 : 2 Marks, Set-1]

■■■■

Answers Fault Analysis

5.2 (b)	5.3 (c)	5.4 (c)	5.7 (a)	5.8 (b)	5.9 (b)	5.10 (d)	5.11 (d)	5.12 (c)
5.13 (a)	5.14 (d)	5.15 (d)	5.16 (b)	5.17 (b)	5.18 (a)	5.19 (b)	5.20 (b)	5.21 (a)
5.22 (a)	5.23 (c)	5.24 (c)	5.25 (a)	5.26 (d)	5.27 (c)	5.28 (c)	5.29 (b)	5.30 (c)
5.32 (b)	5.33 (b)	5.35 (d)	5.38 (d)					

6 Power System Stability

6.1 The transient stability of the power system can be effectively improved by
(a) improving generator excitation
(b) phase shifting transformer
(c) single pole switching of circuit breakers
(d) increasing the turbine valve opening
[1993 : 1 Mark]

6.2 In a system, there are two generators operating in parallel. One generator, of rating 250 MVA, has an inertia constant of 6 MJ/MVA while the other generator of 150 MVA has an inertia constant of 4 MJ/MVA. The inertia constant for the combined system on 100 MVA common base is MJ/MVA.
[1994 : 2 Marks]

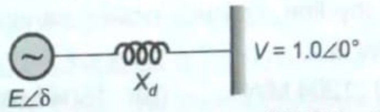
6.3 During a disturbance on a synchronous machine, the rotor swings from A to B, before finally settling down to a steady state at point C on the power angle curve. The speed of the machine during oscillation is synchronous at point(s).
(a) A and B (b) A and C
(c) B and C (d) Only at C
[1996 : 1 Mark]

6.4 A 100 MVA, 11 kV, 3-phase, 50 Hz, 8 pole synchronous generator has an inertia constant H equal to 4 MJ/MVA. The stored energy in the rotor of the generator at synchronous speed will be
(a) 100 MJ (b) 400 MJ
(c) 800 MJ (d) 12.5 MJ
[1997 : 1 Mark]

6.5 The use high speed circuit breakers
(a) reduces the short circuit current
(b) improves system stability
(c) decreases system stability
(d) increase the short-circuit current
[1997 : 1 Mark]

6.6 A power station consists of two synchronous generators A and B of ratings 250 MVA and 500 MVA with inertia 1.6 p.u. and 1.0 p.u., respectively on their own base MVA ratings. The equivalent p.u. inertia constant for the parallel system on 100 MVA common base is
(a) 2.6 (b) 0.615
(c) 1.625 (d) 9.0
[1998 : 2 Marks]

6.7 An alternator is connected to an infinite bus as shown in figure. It delivers 1.0 p.u. current at 0.8 p.f. lagging at V = 1.0 p.u. The reactance X_d of the alternator is 1.2 p.u. Determine the active power output and the steady state power limit. Keeping the active power fixed, if the excitation is reduced, find the critical excitation corresponding to operation at stability limit.



[1998 : 2 Marks]

6.8 The load carrying capability of a long AC transmission line is
(a) Always limited by the conductor size
(b) Limited by stability considerations
(c) Reduced at low ambient temperature
(d) Decreased by the use of bundled conductors of single conductors
[1999 : 1 Mark]

6.9 Steady state stability of a power system is the ability of the power system to
(a) maintain voltage at the rated voltage level
(b) maintain frequency exactly at 50 Hz
(c) maintain a spinning reserve margin at all times
(d) maintain synchronism
[1999 : 1 Mark]

6.10 A transmission line has a total series reactance of 0.2 p.u. Reactive power compensation is applied at the mid-point of the line and it is controlled such that the mid-point voltage of the transmission line is always maintained at 0.98 p.u. If voltage at both ends of the linear maintained at 1.0 p.u., then the steady state power transfer limit of the transmission line is

(a) 9.8 p.u. (b) 4.9 p.u.
(c) 19.6 p.u. (d) 5 p.u.

[2002 : 2 Marks]

6.11 A generator delivers power of 1.0 p.u. to an infinite bus through a purely reactive network. The maximum power that could be delivered by the generator is 2.0 p.u. A three-phase fault occurs at the terminals of the generator which reduces the generator output to zero. The fault is cleared after t_c second. The original network is then restored. The maximum swing of the rotor angle is found to be δ_{max} = 110 electrical degree. Then the rotor angle in electrical degrees at $t = t_c$ is

(a) 55 (b) 70
(c) 69.14 (d) 72.4

[2003 : 2 Marks]

6.12 A 800 kV transmission line is having per phase line inductance of 1.1 mH/km and per phase line capacitance of 11.68 nF/km. Ignoring the length of the line, its ideal power transfer capability in MW is

(a) 1204 MW (b) 1504 MW
(c) 2085 MW (d) 2606 MW

[2004 : 2 Marks]

6.13 A new generator having $E_g = 1.4\angle 30^\circ$ pu [equivalent to (1.212 + j0.70) pu] and synchronous reactance 'X_s' of 1.0 pu on the system base, is to be connected to a bus having voltage V_t in the existing power system. This existing power system can be represented by Thevenin's voltage $E_{th} = 0.9\angle 0^\circ$ pu in series with Thevenin's impedance $Z_{th} = 0.25\angle 90^\circ$ pu. The magnitude of the bus voltage V_t of the system in pu will be

(a) 0.990 (b) 0.973
(c) 0.963 (d) 0.900

[2004 : 2 Marks]

6.14 A 50 Hz, 4-pole, 500 MVA, 22 kV turbo-generator is delivering rated MVA at 0.8 power factor. Suddenly a fault occurs reducing is electric power output by 40%. Neglect losses and assume constant power input to the shaft. The accelerating torque in the generator in MNm at the time of the fault will be

(a) 1.528 (b) 1.018
(c) 0.848 (d) 0.509

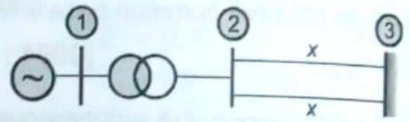
[2004 : 2 Marks]

6.15 An 800 kV transmission line has a maximum power transfer capacity of P. If it is operated at 400 kV with the series reactance unchanged, then new maximum power transfer capacity is approximately

(a) P (b) 2P
(c) P/2 (d) P/4

[2005 : 1 Mark]

6.16 A generator with constant 1.0 p.u. terminal voltage supplies power through a step-up transformer of 0.12 p.u. reactance and a double-circuit line to an infinite bus bar as shown in the figure. The infinite bus voltage is maintained at 1.0 p.u. Neglecting the resistances and susceptances of the system, the steady state stability power limit of the system is 6.25 p.u. If one of the double-circuit is tripped, then resulting steady state stability power limit in p.u. will be



(a) 12.5 p.u. (b) 3.125 p.u.
(c) 10.0 p.u. (d) 5.0 p.u.

[2005 : 2 Marks]

Statement for Common Data Questions (6.17 and 6.18):

A generator feeds power to an infinite bus through a double circuit transmission line. A 3-phase fault occurs at the middle point of one of the lines. The infinite bus voltage is 1 pu, the transient internal voltage of the generator is 1.1 pu and the equivalent transfer admittance during fault is 0.8 pu. The 100 MVA generator has an inertia constant of 5 MJ/MVA and it was delivering 1.0 pu power prior of the fault with rotor power angle of 30°. The system frequency is 50 Hz.

6.17 The initial accelerating power (in pu) will be

(a) 1.0 (b) 0.6
(c) 0.56 (d) 0.4

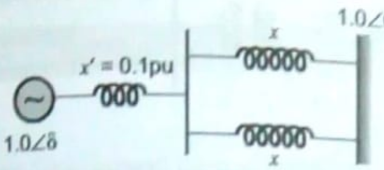
[2006 : 2 Marks]

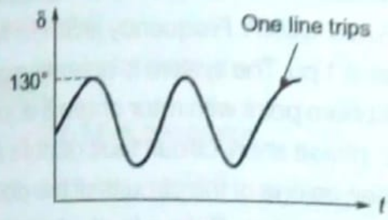
6.18 If the initial accelerating power is X pu, the initial acceleration in elect deg/sec, and the inertia constant in MJ-sec/elect deg respectively will be

(a) 31.4 X, 18 (b) 1800 X, 0.056
(c) X/1800, 0.056 (d) X/31.4, 18

[2006 : 2 Marks]

6.19 Consider a synchronous generator connected to an infinite bus by two identical parallel transmission lines. The transient reactance X′ of the generator is 0.1 pu and the mechanical power input to it is constant at 1.0 pu. Due to some previous disturbance, the rotor angle (δ) is undergoing an undamped oscillation, with the maximum value of δ(t) equal to 130°. One of the parallel lines trip due to relay maloperation at an instant when δ(t) = 130° as shown in the figure. The maximum value of the per unit line reactance, X such that the system does not lose synchronism subsequent to this tripping is





(a) 0.87 (b) 0.74
(c) 0.67 (d) 0.54

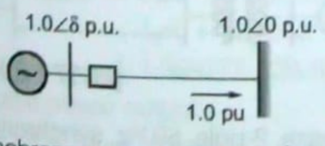
[2007 : 2 Marks]

6.20 An isolated 50 Hz synchronous generator is rated at 15 MW which is also the maximum continuous power limit of its prime mover. It is equipped with a speed governor with 5% droop. Initially, the generator is feeding three loads of 4 MW each at 50 Hz. All of these loads is programmed to trip permanently if the frequency falls below 48 Hz. If an additional load of 3.5 MW is connected then the frequency will settle down to

(a) 49.417 Hz (b) 49.917 Hz
(c) 50.083 Hz (d) 50.583 Hz

[2007 : 2 Marks]

6.21 A lossless single machine infinite bus power system is shown below:



The synchronous generator transfers 1.0 per unit of power to the infinite bus. The critical clearing time of circuit breaker is 0.28 s. If another identical synchronous generator is connected in parallel to the existing generator and each generator is scheduled to supply 0.5 per unit of power, then the critical clearing time of the circuit breaker will

(a) reduce to 0.14 s
(b) reduce but will be more than 0.14 s
(c) remain constant at 0.28 s
(d) increase beyond 0.28 s

[2008 : 2 Marks]

6.22 A 500 MW, 21 kV, 50 Hz, 3-phase, 2-pole synchronous generator having a rated p.f. = 0.9, has a moment of inertia of 27.5×10^3 kg-m². The inertia constant (H) will be

(a) 2.44 MJ/MVA (b) 2.71 MJ/MVA
(c) 4.88 MJ/MVA (d) 5.42 MJ/MVA

[2009 : 2 Marks]

6.23 A cylindrical rotor generator delivers 0.5 pu power in the steady-state to an infinite bus through a transmission line of reactance 0.5 pu. The generator no-load voltage is 1.5 pu and the infinite bus voltage is 1 pu. The inertia constant of the generator is 5 MW-s/MVA and the generator reactance is 1 p.u. the critical clearing angle, in degrees, for a three-phase dead short circuit fault at the generator terminal is

(a) 53.5 (b) 60.2
(c) 70.8 (d) 79.6 [2012 : 2 Marks]

6.24 A synchronous generator is connected to an infinite bus with excitation voltage E_f = 1.3 pu. The generator has a synchronous reactance of 1.1 pu and is delivering real power (P) of 0.6 pu to the bus. Assume the infinite bus voltage to be 1.0 pu. Neglect stator resistance. The reactive power (Q) in pu supplied by the generator to the bus under this condition is ________.

[2014 : 2 Marks, Set-2]

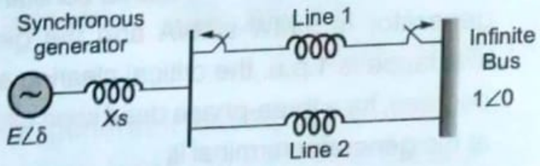
6.25 There are two generators in a power system. No load frequencies of the generators are 51.5 Hz and 51 Hz, respectively, and both are having droop constant of 1 Hz/MW. Total load in the system is 2.5 MW. Assuming that the generators are operating under their respective droop characteristics, the frequency of the power system in Hz in the steady state is ______ .

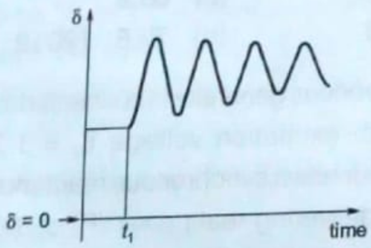
[2014 : 2 Marks, Set-2]

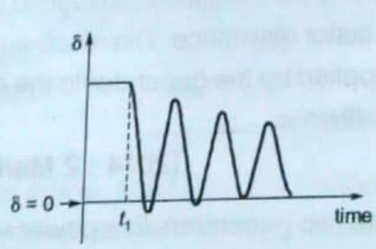
6.26 A 50 Hz generating unit has H-constant of 2 MJ/MVA. The machine is initially operating in steady state at synchronous speed, and producing 1 pu of real power. The initial value of the rotor angle δ is 5°, when a bolted three phase to ground short circuit fault occurs at the terminal of the generator. Assuming the input mechanical power to remain at 1 pu, the value of δ in degrees, 0.02 second after the fault is ______.

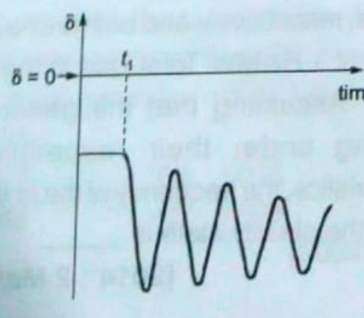
[2015 : 2 Marks, Set-1]

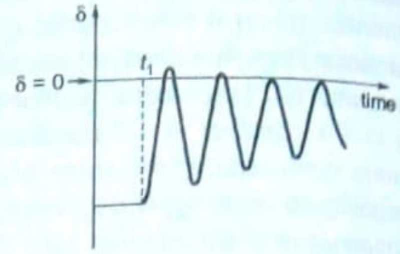
6.27 The synchronous generator shown in the figure is supplying active power to an infinite bus via two short, lossless transmission lines, and is initially in steady state. The mechanical power input to the generator and the voltage magnitude E are constant. If one line is tripped at time t_1 by opening the circuit breakers at the two ends (although there is no fault), then it is seen that the generator undergoes a stable transient. Which one of the following waveforms of the rotor angle d shows the transient correctly?



(a)


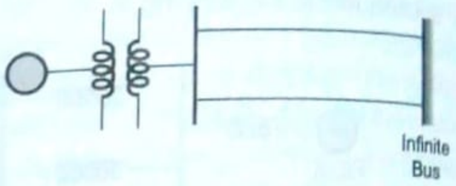
(b)


(c)


(d)


[2015 : 1 Mark, Set-2]

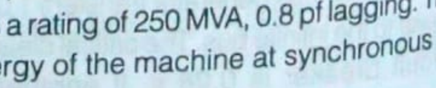
6.28 The figure shows the single line diagram of a single machine infinite bus system.



The inertia constant of the synchronous generator H = 5 MW-s/MVA. Frequency is 50 Hz. Mechanical power is 1 pu. The system is operating at the stable equilibrium point with rotor angle δ equal to 30°. A three-phase short-circuit fault occurs at a certain location on one of the circuits of the double circuit transmission line. During fault, electrical power in pu is $P_{max} \sin \delta$. If the values of δ and $d\delta/dt$ at the instant of fault clearing are 45° and 3.762 radian/s respectively, then P_{max} (in pu) is ______.

[2014 : 2 Marks, Set-3]

6.29 The figure shows the single line diagram of a power system with a double circuit transmission line. The expression for electrical power is 1.5 sinδ, where δ is the rotor angle. The system is operating at the stable equilibrium point with mechanical power equal to 1 pu. If one of the transmission line circuits is removed the maximum value of δ, as the rotor swings is 1.221 radian. If the expression for electrical power with one transmission line circuit removed is $P_{max} \sin \delta$, the value of P_{max}, in pu is ______.
(Give the answer up to three decimal places.)



[2017 : 2 Marks, Set-1]

6.30 A 3-phase, 2-pole, 50 Hz, synchronous generator has a rating of 250 MVA, 0.8 pf lagging. The kinetic energy of the machine at synchronous speed is 1000 MJ.

Answers Power System Stability

6.1 (c)	6.3 (a)	6.4 (b)	6.5 (b)	6.6 (d)	6.8 (b)	6.9 (d)	6.10 (a)	6.11 (c)
6.12 (c)	6.13 (b)	6.14 (b)	6.15 (d)	6.16 (d)	6.17 (c)	6.18 (b)	6.19 (c)	6.20 (a)
6.21 (d)	6.22 (a)	6.23 (d)	6.27 (a)					