4 Synchronous Machine

Multiple Choice Questions

1. A synchronous machine working in the motor mode, is fed from an infinite bus and is delivering half full-load. If an increase in field current causes an increase in the armature current, then the motor will
   (a) deliver reactive power and active power to the bus
   (b) absorb reactive power and active power from the bus
   (c) absorb reactive power from the bus and deliver active power to the bus
   (d) deliver reactive power to the bus and absorb active power from the bus

   [IAS-1994]

2. The voltage across the open-circuited field terminals of synchronous machine under slip test is
   (a) dc
   (b) ac of slip frequency
   (c) a modulated supply frequency ac voltage with slip frequency envelope
   (d) ac of supply frequency

   [IAS-1994]

3. **Assertion (A):** In the experimental determination of synchronous impedance of an ac generator, it is possible to take one set of data only from short-circuit test, and obtain therefrom the short-circuit characteristic of the machine as a straight line passing through the origin of the plot.

   Reason (R): During the short-circuit test, the magnetic circuit of an alternator; remains unsaturated even when the field excitation is high.
   (a) Both A and R are true and R is the correct explanation of A.
   (b) Both A and R are true but R is NOT the correct explanation of A.
   (c) A is true but R is false.
   (d) A is false but R is true.

   [IAS-1994]

4. A salient pole synchronous motor is running with normal excitation. If the excitation is reduced to zero
   (a) it becomes an induction motor
   (b) it becomes a synchronous reluctance motor
   (c) it remains a synchronous motor
   (d) the motor would stop

   [IAS-1995]

5. Consider the following reasons cited for providing damper bars on the pole faces of a synchronous motor:
   1. Starting the motor as a squirrel cage induction motor.
   2. To reduce the tendency of oscillation of the rotor with load changes.
   3. To provide additional induction motor torque besides the main synchronous motor torque.
   4. To reduce the effects of slot harmonics causing noise and vibrations.

   Of these reasons:
   (a) 1 alone is valid
   (b) 1 and 2 are valid
   (c) 1, 2 and 3 are valid
   (d) 2, 3 and 4 are valid

   [IAS-1995]

6. Open-circuit (oc) and short-circuit (sc) tests on an AC generator are conducted under which of the following conditions?

1. oc test at nominal flux and sc test at nominal current.
2. oc test at reduced flux and sc test at reduced current.
3. oc test at zero armature current and sc test at reduced flux.
4. oc test at zero current and sc test at nominal flux.

Select the correct answer using the codes given below:

Codes:

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

[IAS-1995]

7. **Assertion (A):** In a salient pole 3-phase alternator, direct axis synchronous reactance is more than the quadrature axis synchronous reactance.

Reason (R): The length of air-gap along the direct axis of the salient pole 3-phase alternator is less than that along quadrature axis.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true. **[IAS-1995]**

8. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I	List-II
A. Zero leading	1. Demagnetising
B. Unity	2. Magnetising
C. Zero lagging	3. Cross magnetising
D. Zero with armature terminals suddenly short-circuited	4. Initially constant, demagnetising

Codes:

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

[IAS-1996]

9. Consider the following statements about a three-phase synchronous generator synchronized to an infinite bus when its mechanical input is increased gradually with field current held constant:

1. The power factor of the current supplied becomes more lagging.
2. The power factor of the current supplied improves.
3. The power factor remains unity.
4. The load angle is increased.

Of these statements

(a) 1 alone is correct (b) 2 alone is correct
(c) 2 and 4 are correct (d) 3 and 4 are correct

[IAS-1996]

10. Which of the following will change in a three-phase synchronous motor, as a consequence of excitation variations?

1. Pull-out torque
2. Torque angle
3. Magnitude and power factor of stator current
4. Output power

Select the correct answer

(a) 1 and 3 (b) 2 and 4
(c) 2, 3 and 4 (d) 1, 2 and 3

[IAS-1996]

11. **Assertion (A):** An over-excited synchronous motor draws a leading current from the mains.

Reason (R): A synchronous machine irrespective of its operation as generator or motor has demagnetising armature reaction when over excited.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true. **[IAS-1996]**

12. Short-circuit ratio of a synchronous machine is the ratio of the

(a) open-circuit voltage to the short-circuit current at a given excitation
(b) short-circuit current to the open-circuit voltage at a given excitation
(c) excitation current required for the rated voltage on open circuit to the excitation current required for the rated armature current under short-circuit
(d) excitation current required for the rated armature current under short-circuit to the excitation current required for rated voltage on open-circuit

[IAS-1997]

13. A synchronous machine connected to infinite bus bars is initially delivering active power to and absorbing lagging reactive power from the bus bars. An increase in the power input to the synchronous machine will cause

(a) an increase in both armature current and power factor
(b) an increase in armature current and a decrease in power factor
(c) a decrease in both armature current and power factor
(d) a decrease in armature current and an increase in power factor

[IAS-1997]

14. For proper synchronisation of a large synchronous machine to a bus, the frequency of the incoming machine

(a) should be exactly the same as that of the bus
(b) should be slightly higher than that of the bus
(c) should be slightly lower than that of the bus
(d) can be of any value

[IAS-1997]

15. A 3-phase alternator delivers power to a balanced 3-phase load of power factor 0.707 lagging. It is observed that the open-circuit emf phasor leads the corresponding terminal voltage phasor by 15°. Neglecting the effect of harmonics, the angle between the axis of the main field mmf and the axis of the armature mmf will be

(a) 30° electrical (b) 60° electrical
(c) 90° electrical (d) 150° electrical

[IAS-1997]

16. A 3-phase, 400 V, delta connected alternator has a synchronous impedance of $(0 + j20)$ ohms per phase. If it delivers a balanced load of 12 kVA at zero power factor leading, then the percentage voltage regulation of the alternator is equal to

(a) – 50 (b) + 50
(c) – 150 (d) + 150

[IAS-1997]

17. Suppose a synchronous generator connected to an infinite bus is supplying electrical power at unity PF to the bus. If its field current is now increased

(a) both the active and reactive power output of the generator will remain unchanged.
(b) the active power supplied will remain unchanged but the machine will also supply lagging reactive power.
(c) the active power supplied will increase and he machine will draw leading reactive power.
(d) the active power supplied will decrease and the machine will supply leading reactive power.

[IAS-1998]

18. In the phasor-diagram of a round-rotor synchronous generator, the voltage equation is $\bar{E}_f = \bar{V}_t + \bar{I}_a\ (r_a + jX_s)$, where $\bar{E}_f$ = excitation voltage, V_t = terminal voltage, I_a = armature current at lagging pf, r_a = armature resistance; X_s = synchronous reactance. While remaining synchronised to the bus-bars (infinite bus), if the power input from the prime mover is gradually decreased and finally stopped, it will result in

(a) reversal of I_a, and E_f lagging V_t
(b) reversal of I_a, and E_f leading V_t
(c) the sign pf I_a remaining unchanged, but E_f leading V_t
(d) the sign of I_a remaining unchanged, but I_a lagging V_t

[IAS-1998]

19. **Assertion (A):** For a 3-phase alternator operating on leading p.f. at full load, the terminal voltage may be more than the no-load induced e.m.f.

Reason (R): At leading power factor, the effect of armature reaction is demagnetising.

(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

[ESE-2008]

20. In a 3-phase ac machine, the phase emf and output power for a phase spread of 60° are respectively E_1 and P_1; the phase emf and output power for a phase spread of 120° are respectively E_2 and P_2. In this context which one of the following sets of relations is correct?

(a) $E_1 = E_2$ and $P_1 = P_2$
(b) $E_1 = 1.15\ E_2$ and $P_1 = 1.15\ P_2$
(c) $E_1 = 1.15\ E_2$ and $P_1 = P_2$
(d) $E_1 = E_2$ and $P_1 = 1.15\ P_2$

[IAS-1999]

21. The field winding of a 3-phase synchronous motor is short-circuited directly. If a 3-phase balanced voltage is impressed across the stator terminals, then the rotor will

(a) rotate at synchronous speed
(b) rotate at a speed slightly less than synchronous speed
(c) rotate at a speed very near to half the synchronous speed
(d) not rotate at all

[IAS-1999]

22. In a synchronous machine, the electric circuits are armature circuit, field circuit and damper circuit and X_d is *d*-axis synchronous reactance; X'_d is *d*-axis transient synchronous reactance and X''_d is *d*-axis sub-transient synchronous reactance. If there is no damper winding, then

(a) $X'_d = X''_d$
(b) $X''_d = X_d$
(c) $X'_d = X_d$
(d) $X_d = X'_d = X''_d$ **[IAS-1999]**

23. A 3-phase synchronous motor with negligible losses is connected to the supply at rated frequency and constant terminal voltage '*V*'. The induced emf of the motor is designated as *E*. If the motor is now gradually loaded to its rated power, adjusting its excitation to obtain, say 0.8 leading power factor operation, then E-phasor would

(a) be less than *V*-phasor and also lead *V*-phasor
(b) be greater than *V*-phasor and also lead *V*-phasor
(c) be less than *V*-phasor and also lag *V*-phasor
(d) be greater than *V*-phasor and also lag *V*-phasor

[IAS-2000]

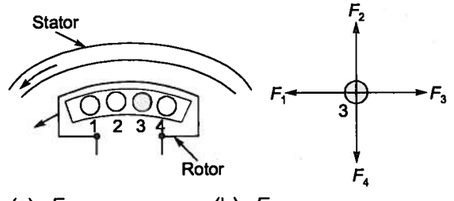
24. Consider the following statements:
Ancient alternators are designed for large air-gap to have

1. large inherent regulation.
2. very stable parallel operation.
3. higher stability limit.
4. sinusoidal mmf distribution.

(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1, 3 and 4 (d) 1, 2 and 4

[IAS-2000]

25. A synchronous motor having a synchronous speed of 1500 rpm slows down to 1490 rpm due to sudden increase in load on the motor shaft. Assuming a south pole on the stator near the damper bars labelled 1, 2, 3 and 4 as shown in the below figure. Determine the direction of force on conductor 3.



(a) F_1 (b) F_2
(c) F_3 (d) F_4 **[IAS-2000]**

26. **Assertion (A):** In the slip test for determining of the d-axis and q-axis synchronous reactance 'X_d' and 'X_q' respectively of a salient pole machine, the stator has to be fed with suitable reduced voltage at the rated frequency and the rotor (with the field circuit open) has to be rotated at a speed slightly different from the synchronous speed, and the fluctuating terminating voltage and armature current are to be recorded for computing 'X_d' and 'X_q'
Reason (R): During the slip test, a slip frequency voltage is induced across the open field circuit terminals that could be measured by connecting a voltmeter across these terminals.

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is NOT the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true **[IAS-2000]**

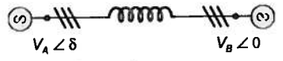
27. Consider the following statements regarding an electrical machine having cylindrical stator and salient-pole rotor:

1. Reluctance torque is produced when rotor winding is excited.
2. Reluctance torque is produced when stator winding is excited.
3. When both stator and rotor windings are excited, electromagnetic torque is produced.
4. When both stator and rotor windings are excited, electromagnetic as well as reluctance torques are produced.

Which of these statements are correct?

(a) 2 and 4 (b) 1 and 4
(c) 1 and 3 (d) 2 and 3 **[IAS-2001]**

28. The identical synchronous machines *A* and *B*, running at the same speed, are linked through inductors as shown in the given figure:

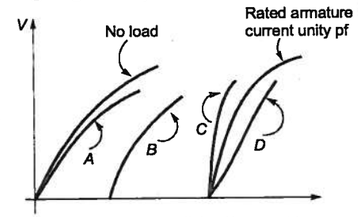


Machine *A* will supply active and reactive power to machine *B* when δ is

(a) positive and V_A is less than V_B
(b) positive and V_A is greater than V_B
(c) negative and V_A is less than V_B
(d) negative and V_A is greater than V_B

[IAS-2001]

29. Figure shows the magnetization curves of an alternator at rated armature current, unity power factor and also at no-load. The magnetization curve for rated armature current, 0.8 power factor leading is given by



(a) Curve *A* (b) Curve *B*
(c) Curve *C* (d) Curve *D*

[GATE-2001]

30. Two 3-phase, *Y*-connected alternators are to be paralleled to a set of common busbars. The armature has a per phase synchronous reactance of 1.7 Ω and negligible armature resistance. The line voltage of the first machine is adjusted to 3300 V and that of the second machine is adjusted to 3200 V. The machine voltages are in phase at the instant they are paralleled. Under this condition, the synchronizing current per phase will be

(a) 16.98 A (b) 29.41 A
(c) 33.96 A (d) 58.82 A

[GATE-2004]

31. A 400 V, 50 kVA, 0.8 pf leading Δ-connected, 50 Hz synchronous machine has a synchronous reactance of 2 Ω and negligible armature resistance. The friction and windage losses are 2 kW and the core loss is 0.8 kW. The shaft is supplying 9 kW load at a power factor of 0.8 leading. The line current drawn is

(a) 12.29 A (b) 16.24 A
(c) 21.29 A (d) 36.88 A

[GATE-2004]

32. When the rotor speed, in a synchronous machine, becomes more than the synchronous speed during hunting, the damper bars develop

(a) induction motor torque
(b) induction generator torque
(c) synchronous motor torque
(d) dc motor torque

[ESE-2014]

33. An alternator is operation on infinite bus. It will develop maximum synchronizing power when it is operating at
(a) no load
(b) its steady state stability limit
(c) full load
(d) any load **[IAS-2002]**

34. A 3-phase 20-pole, synchronous generator has 180 stator slots with single-layer full pitch coils. There are 6 conductors per slot and all coils per phase are connected in series. The rotor is driven at 300 rpm and the flux per pole (sinusoidally distributed) is 25 mWb. The voltage induced per phase is nearest to
(a) 500 V (b) 1000 V
(c) 1500 V (d) 2000 V **[IAS-2002]**

35. Which one of the following is the correct statement?
(a) The armature current upon symmetrical 3-phase short circuit of a synchronous machine (armature resistance is negligible) constitutes q-axis current only
(b) The armature current upon symmetrical 3-phase short circuit of a synchronous machine (armature resistance is negligible) constitutes *d*-axis current only
(c) The armature current upon symmetrical 3-phase short circuit of a synchronous machine (armature resistance is negligible) has both *d*-axis and *q*-axis components
(d) Short circuit current can not be divided into d and q-axis components
[ESE-2007]

36. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I
A. Slip test
B. Open circuit and zero power factor test
C. Sumpner's test
D. Swinburnee's test

List-II
1. Determination of constant losses of a d.c. shunt machine
2. Determination of efficiency and regulation of transformer
3. Determination of synchronous Potiere reactance of synchrnous machine
4. Determination of direct andquadrature-axis synchronousreactances of salient pole synchronous machine

Codes:

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

[IAS-2003]

37. The power angle characteristic of machine-infinite bus system is

$$P_e = 2 \sin \delta \; pu$$

It is operating at $\delta = 30°$. Which one of the following is the synchronising power coefficient at the operating point?
(a) 1.0 (b) $\sqrt{3}$
(c) 2.0 (d) $1/\sqrt{3}$
[IAS-2004]

38. The field current of a synchronous motor is increased while its load is constant. How will its power angle and power factor change?
(a) Power angle decreases and power factor improves
(b) Power angle remains same throughout but power factor improves
(c) Power angle increases while its power factor gradually decreases
(d) Power angle and power factor both increase
[IAS-2005]

39. Two alternators (M_1 and M_2) have been properly synchronized and connected in parallel to a common busbar. If there is no load on the busbar, and the field excitation of the second alternator (M_2) is increased gradually by a small amount, from its 'normal' excitation for which the induced e.m.f.'s E_1 and E_2 of the two machines are equal, the armature reaction due to the circulating armature current would be
(a) magnetising for M_1, but demagnetising for M_2
(b) demagnetising for M_1, but magnetising for M_2
(c) magnetising for both M_1 and M_2
(d) demagnetising for both M_1 and M_2
[IAS-2005]

40. How can the reactive power delivered by a synchronous generator be controlled?
(a) By changing the prime mover input
(b) By changing the excitation
(c) By changing the direction of rotation
(d) By changing the prime mover speed
[ESE-2007]

41. A 3-phase synchronous motor connected to a.c. mains is running at full load and unity power factor. If its shaft load is reduced by half, with field current held constant, its new power factor will be
(a) unity
(b) leading
(c) lagging
(d) dependent on machine parameters
[GATE-2007]

42. A 100 kVA, 415 V (line), star-connected synchronous machine generates rated open circuit voltage of 415 V at a field current of 15 A. The short circuit armature current at a field current of 10 A is equal to the rated armature current. The per unit saturated synchronous reactance is
(a) 1.731 (b) 1.5
(c) 0.666 (d) 0.577
[GATE-2007]

43. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I	List-II
A. Three phase induction motor	1. Adjustable speed
B. Synchronous motor	2. High starting torque
C. D.C. series motor	3. Not self-starting
D. D.C. shunt motor	4. Self-starting

Codes:

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

[ESE-2004]

44. Four important parameters of alternator have comparatively larger or smaller values, depending upon the type of the alternator. In comparison to a steam turbine driven alternator, a hydraulically driven machine will have which one of the following combinations?

	Number of armature conductors	Axial length of armature conductors	Number of poles	Operating speed
(a)	Smaller	larger	smaller	higher
(b)	Larger	smaller	larger	lower
(c)	Larger	larger	smaller	lower
(d)	Smaller	smaller	larger	higher

[ESE-2004]

45. Which one of the following is the primary reason for placing field on rotor in an alternator?
(a) Smaller power in field circuit
(b) Insulation of high voltages is made easy on stator than on rotor
(c) Large power in stator
(d) Large current in the stator
[ESE-2004]

46. Consider the following:
1. Supply voltage
2. Excitation current
3. Maximum value of load angle

The maximum power developed by a synchronous motor is a function of which of the above?
(a) 1 and 2 (b) 1 and 3
(c) 2 and 3 (d) 1, 2 and 3
[ESE-2004]

47. When a 3-phase alternator is suddenly short-circuited at its terminals, the initial value of the short-circuit current is limited by which one of the following?
(a) Subtransient reactance x''_d
(b) Transient reactance x'_d
(c) Synchronous reactance x_s
(d) Sum of x''_d, x'_d and x_s **[ESE-2004]**

48. Which one of the following methods gives more accurate result for determination of voltage regulation of an alternator?

(a) m.m.f. method
(b) Synchronous impedance method
(c) Potier triangle method
(d) American Institution Standard method

[ESE-2004]

49. Which one of the following statements is correct?
In a salient pole synchronous machine the air-gap is
(a) uniform under the whole pole shoe
(b) least under the middle of the pole shoe and increases outwards
(c) largest under the middle of the pole shoe and decreases outwards
(d) least at one end of the pole shoe and increases to the maximum value at the other end

[ESE-2004]

50. **Assertion (A):** A synchronous motor operating from constant voltage and constant frequency source has substantially constant resultant air-gap flux.
Reason (R): If the d.c. field current in this motor can set up the required resultant air-gap flux, the lagging reactive volt-amperes drawn from a.c. source is zero.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true. [ESE-2004]

51. **Assertion (A):** If the load requirement of a synchronous motor exceeds the pull-out torque, the synchronous motor, action is lost.
Reason (R): Rotor and stator fields are no longer stationary with respect to each other.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

[ESE-2004]

52. In the measurement of X_d, X_q (in ohms), following data are obtained by the slip test on a salient pole machine:
I_d max = 10 A I_d min = 6.5 A
V_d max = 30 V V_d min = 25 V
Which one of the following is correct?
(a) $X_d = 3, X_q = 3.86$
(b) $X_d = 4.615, X_q = 2.5$
(c) $X_d = 3, X_q = 2.5$
(d) $X_d = 4.61, X_q = 3.86$ [ESE-2005]

53. What are the conditions to be satisfied for alternator to be synchronised with an incoming supply?
1. Equal voltage
2. Equal frequency
3. Same power rating
4. Same phase sequency
Select the correct answer using the code given below:
(a) 2, 3 and 4 (b) 3 and 4
(c) 1, 2 and 3 (d) 1, 2 and 4

[ESE-2005]

54. The resultant flux density in the air-gap of a synchronous generator is the lowest during
(a) Open circuit (b) Solid short circuit
(c) Full load (d) Half load

[ESE-2006]

55. Which one of the following statements is ***not*** correct in respect of synchronous machines?
(a) In salient pole machines, the direct-axis synchronous reactance is greater than the quadrature axis synchronous reactance.
(b) The damper bars help the motor to self-start.
(c) Short circuit ratio is the ratio of field current required to produce the rated voltage on open circuit to the rated armature current.
(d) The V-curve of a synchronous motor represents the variation in the armature current with field excitation at a given output power.

[ESE-2006]

56. A loss-less cylindrical rotor synchronous generator is floating on the system bus-bar after being properly synchronised and is running at no-load. Now, if the prime mover is acting as a mechanical load on the machine, then
(a) the torque developed by the machine will act in the same direction as the prime-mover torque
(b) the torque developed by the machine will act in the opposite direction to that of the prime-mover torque
(c) the machine rotor would fall-back and the induced emf would lag behind the terminal voltage
(d) the machine rotor would overspeed and the induced emf would lead the terminal voltage

[ESE-2006]

57. **Assertion (A):** Large synchronous machines are constructed with armature winding on stator.
Reason (R): Stationary armature winding would have reduced armature reactance.
(a) Both A and R are true and R is the correct explanation of A.
(b) Both A and R are true but R is NOT the correct explanation of A.
(c) A is true but R is false.
(d) A is false but R is true.

[ESE-2007]

58. What is the angle between the induced voltage and supply voltage of a synchronous motor under running condition?
(a) Zero
(b) Greater than zero but $\leq 90°$
(c) Between 90° and 180°
(d) $> 180°$

[ESE-2007]

59. What does the SCR (short circuit ratio) of a synchronous machine yield?
(a) $\frac{1}{X_s(\text{unsaturated})\,pu}$
(b) $\frac{1}{X_s(\text{unsaturated})\,\text{in Ohm}}$
(c) $\frac{1}{X_s(\text{adjusted})\,pu}$
(d) $\frac{1}{X_s(\text{adjusted})\,\text{in Ohm}}$ [ESE-2007]

60. A three-phase, salient pole synchronous motor is connected to an infinite bus. It is operated at no load at normal excitation. The field excitation of the motor is first reduced to zero and then increased in the reverse direction gradually. Then the armature current
(a) increases continuously
(b) first increases and then decreases steeply
(c) first decreases and then increases steeply
(d) remains constant

[GATE-2011]

61. A 20 pole alternator is having 180 identical stator slots with 6 conductors in each slot. All the coils of a phase are in series. If the coils are connected to realize single-phase winding, the generated voltage is V_1. If the coils are reconnected to realize three-phase star connected winding, the generated phase voltage is V_2. Assuming full pitch, single-layer winding, the ratio V_1/V_2 is
(a) $\frac{1}{\sqrt{3}}$ (b) $\frac{1}{2}$
(c) $\sqrt{3}$ (d) 2 [GATE-2014]

62. Match **List-I** (Machine characteristic) with **List-II** (Quantity) and select the correct answer using the code given below the lists:

List-I	List-II
A. Open-circuit characteristic	1. *p.f.* vs. I_f
B. *V*-curve	2. E_a vs. I_a
C. Internal characteristic	3. E_g vs. I_f
D. Inverted *V*-curve	4. I_a vs. I_f

Codes:

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

[ESE-2008]

63. A 440 V, 3-phase, 10 pole and 50 Hz synchronous motor delivering a torque of $50/\pi$ Nm, delivers a power of
(a) 50 W (b) 500 W
(c) 1000 W (d) 2000 W

[ESE-2011]

64. Consider a system consisting of a synchronous generator working at a lagging power factor, a synchronous motor working at an overexcited condition and a directly grid-connected induction generator. Consider capacitive *VAr* to be a source and inductive *VAr* to be a sink of reactive power. Which one of the following statements is TRUE?

(a) Synchronous motor and synchronous generator are sources and induction generator is a sink of reactive power.
(b) Synchronous motor and induction generator are sources and synchronous generator is a sink of reactive power.
(c) Synchronous motor is a source and induction generator and synchronous generator are sinks of reactive power.
(d) All are sources of reactive power.

[GATE-2016]

Numerical Data Type Questions

65. A non-salient pole synchronous generator having synchronous reactance of 0.8 pu is supplying 1 pu power to a unity power factor load at a terminal voltage of 1.1 pu. Neglecting the armature resistance, the angle of the voltage behind the synchronous reactance with respect to the angle of the terminal voltage in degrees is _____ .

[GATE-2014]

66. A single phase, 2000 V alternator has armature resistance and reactance of 0.8 Ω and 4.94 Ω respectively. The voltage regulation of the alternator at 100 A load at 0.8 leading power factor is $-x$% then x is _____.

67. A 3-ϕ, 3300 V, *Y* connected synchronous motor has an effective resistance and synchronous reactance of 2 Ω and 18 Ω per phase respectively. If the open circuit generated emf is 2195 V per phase, the maximum power developed by motor is _____ kW.

68. The power consumption of an industry is 500 kVA, at 0.8 p.f. lagging. A synchronous motor is added to raise the power factor of the industry to unity. If the power intake of the motor is 100 kW, the p.f. of the motor is _____.

Try Yourself

T1. A 1500 kVA, 6600 V, 3-ϕ, *Y* connected alternator with a resistance of 0.4 Ω and reactance 6 Ω/ph, delivers full-load current at power factor 0.8 lagging and normal rated voltage. Estimate terminal voltage for the same excitation and load current at 0.8 power factor leading.

(a) 7880.85 V (b) 8216.85 V
(c) 8440.85 V (d) 8660.85 V

[Ans. : (b)]

T2. A turbo generator, connected to an infinite bus is operating at 0.8 power factor lag. If its excitation is increased, with steam input kept constant then it would

1. Feed more leading KVAR to the bus.
2. Feed more lagging KVAR to the bus.
3. Feed more real power to the bus.
4. Start operating at power factor < 0.8.

From these, the correct answer is

(a) 2 and 4 (b) 1, 3 and 4
(c) 1 and 4 (d) 2, 3 and 4

[Ans. : (c)]

T3. A 3-ϕ, salient pole alternator has direct axis reactance as 0.6 pu and quadrature axis reactance as 0.3 pu, when its terminal voltage is 1.0 pu, excitation voltage is 1.1 pu. To deliver maximum power, the rotor angle should be _____ degree.

[Ans. : 61.12°]