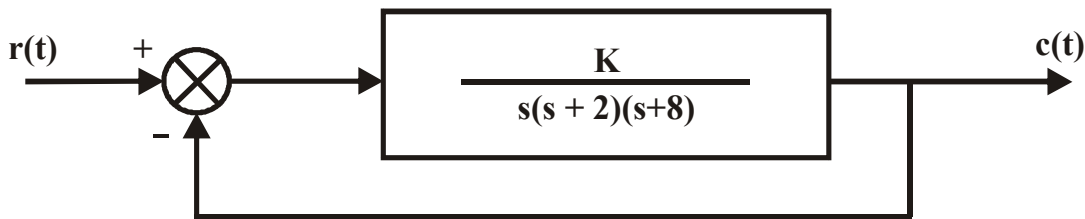




8. In a power system, each bus or node is associated with four quantities, namely
- (i) real power
  - (ii) reactive power
  - (iii) bus voltage magnitude
  - (iv) phase angle of the bus voltage

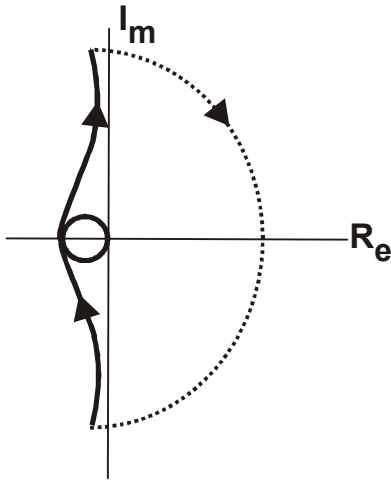
For load flow solution, among these four, the number of quantities to be specified is

- (a) any one
  - (b) any two
  - (c) any three
  - (d) all the four
9. A three phase 400V, 50Hz synchronous motor is working at 50 percent load. In case an increase in the field current of the motor causes a reduction in the armature current, it can be concluded that
- (a) the motor is delivering reactive power to the mains
  - (b) the motor is absorbing reactive power to the mains
  - (c) the motor is neither absorbing nor delivering reactive power
  - (d) none of these
10. By a suitable choice of the scalar parameter 'K' the system shown in figure given below can be made to oscillate continuously at a frequency of



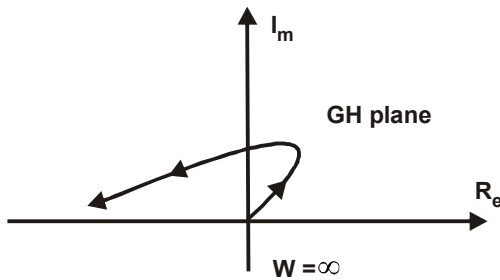
- (a) 1 rad/sec
  - (b) 2 rad/sec
  - (c) 4 rad/sec
  - (d) 8 rad/sec
11. The charging current in a transmission line increases due to corona effect because corona increases
- (a) line current
  - (b) effective line voltage
  - (c) power loss in lines
  - (d) the effective conductor diameter
12. In a synchronous motor armature reaction at rated voltage and zero power factor leading is
- (a) Magnetizing
  - (b) Cross magnetizing
  - (c) Demagnetizing
  - (d) None of these
13. In case of a second order system described by the differential equation  $J \frac{d^2\theta_0}{dt^2} + F \frac{d\theta_0}{dt} + K\theta_0 = K\theta_i$  (where,  $\theta_i$  and  $\theta_0$  are the input and output shaft angles), the natural frequency is given by
- (a)  $\sqrt{\frac{K}{J}}$
  - (b)  $\sqrt{\frac{J}{K}}$
  - (c)  $\sqrt{KJ}$
  - (d)  $\sqrt{K-J}$
14. When a single phase induction motor is excited with single phase ac voltage, the magnetic field set up is equivalent to
- (a) two fields, rotating in opposite directions with different speeds
  - (b) two fields, rotating at synchronous speed in opposite directions
  - (c) two fields, rotating at synchronous speed
  - (d) two fields rotating in the same direction but at different speed

15. Nyquist plot shown in the given figure is for a type



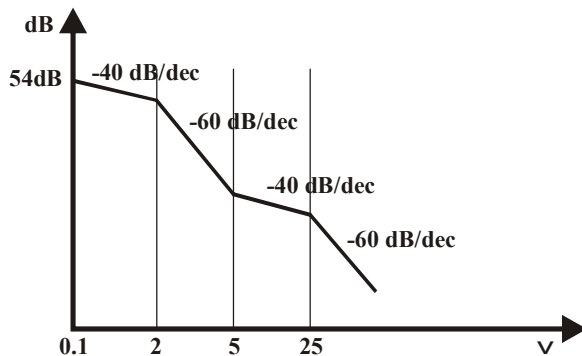
- (a) Zero System
  - (b) one system
  - (c) Two System
  - (d) Three system
16. In a short transmission line, voltage regulation is zero when the power factor angle of the load at the receiving end side is equal to
- (a)  $\tan^{-1}(X/R)$
  - (b)  $\tan^{-1}(R/X)$
  - (c)  $\tan^{-1}(R/Z)$
  - (d)  $\tan^{-1}(X/Z)$
17. An induction motor when started on load does not accelerate up to full speed but runs at  $1/7^{\text{th}}$  of the rated speed. The motor is said to be
- (a) locking
  - (b) plugging
  - (c) crawling
  - (d) cogging
18. The open loop transfer function of a system is  $G(s)H(s) = \frac{K}{(1+s)(1+2s)(1+3s)}$ . The phase crossover frequency  $\omega_c$  is
- (a)  $\sqrt{2}$
  - (b) 1
  - (c) zero
  - (d)  $\sqrt{3}$
19. The per-unit impedance of an alternator corresponding to base values 13.2kV and 30MVA is 0.2 p.u. The p.u. value of the impedance for base values 13.8kV and 50 MVA in pu will be
- (a) 0.131
  - (b) 0.226
  - (c) 0.305
  - (d) 0.364
20. If an eternal resistance is to be added in the rotor circuit of a slip ring motor then
- (a) its maximum torque increases but occurs at the same slip
  - (b) its maximum torque decreases but occurs at the same slip
  - (c) its maximum torque does not change but occurs at a lower slip
  - (d) its maximum torque does not change but occurs at a higher slip
21. The polar plot of a transfer function passes through the critical point (-1,0). Gain margin is
- (a) zero
  - (b) -1dB
  - (c) 1 dB
  - (d) infinity
22. For a practical synchronous motor the pull-out torque will occur when the torque angle is nearly equal to
- (a)  $0^\circ$
  - (b)  $30^\circ$
  - (c)  $45^\circ$
  - (d)  $75^\circ$

23. The  $Y_{\text{BUS}}$  matrix of a 100-bus interconnected system is 90% sparse. Hence the number of transmission lines in the system must be
- (a) 450 (b) 500  
(c) 900 (d) 1000
24. The system matrix of a discrete system is given by  $A = \begin{bmatrix} 0 & 1 \\ -3 & -5 \end{bmatrix}$ . The characteristics equation is given by
- (a)  $z^2+5z+3=0$  (b)  $z^2-5z-3=0$   
(c)  $z^2+3z+5=0$  (d)  $z^2+z+2=0$
25. Which one of the following statements is not correct in respect of synchronous machine?
- (a) In a salient pole machines, the direct-axis synchronous reactance is greater than the quadrature axis synchronous reactance  
(b) The damping 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.
26. Which is the main relay for protecting up to 90% of the transmission line-length in the forward direction?
- (a) Directional over-current relay (b) Mho relay  
(c) Carrier-current protective relay (d) Impedance relay
27. The Niquist plot of a control system is shown below. For this system  $G(s)H(s)$  is equal to



- (a)  $\frac{K}{s(1+sT_1)}$  (b)  $\frac{K}{s^2(1+sT_1)}$   
(c)  $\frac{K}{s^3(1+sT_1)}$  (d)  $\frac{K}{s^2(1+sT_1)s(1+sT_1)}$
28. 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  $X_s$
29. When a 'pumped storage' power plant is operated in conjunction with a steam power plant
- (a) The operating cost of the steam plant becomes optimum.  
(b) Load factor of the steam plant is increased.  
(c) Chances of the tripping of the system decrease because of the use of two heterogeneous types of plants.  
(d) Operation of the storage plant in the pumping-mode during the low-load period improves the steam-plant stability.

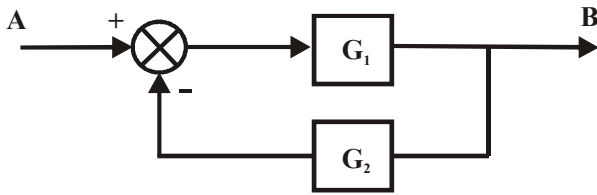
30. While designing controller, the advantage of pole-zero cancellation is
- (a) the system order is increased (b) The system order is reduced  
 (c) The cost of controller becomes low (d) system's error reduced to optimum levels
31. Damping windings in a synchronous machine are
- (a) embedded on the rotor in interpolar regions to prevent the rotor from running at sub-synchronous speed.  
 (b) embedded in the pole shoes to prevent the rotor from running at super-synchronous speed.  
 (c) embedded in the pole shoes to reduce the rotor oscillation about the operating point.  
 (d) embedded on the rotor in interpolar regions to reduce the rotor oscillation about the operating point.
32. In case of phase-lag compensation used is system, gain crossover frequency, band width and undamped frequency are respectively
- (a) Decreased, decreased, decreased (b) Increased, Increased, Increased  
 (c) Increased, Increased, decreased (d) Increased, decreased, decreased
33. If  $I_d$  and  $I_q$  are the direct and quadrature current component in a salient pole synchronous machine and  $E_a$  is the internal induced emf, then which of the following is true?
- (a)  $I_d$  and  $I_q$  are both in phase with induced emf  $E_a$   
 (b)  $I_q$  is in phase with  $E_a$  and  $I_d$  is at  $90^\circ$  to  $E_a$   
 (c)  $I_q$  is at  $90^\circ$  to  $E_a$  and  $I_d$  is in phase with  $E_a$   
 (d)  $I_d$  and  $I_q$  are at  $90^\circ$  to  $E_a$
34. The asymptotic approximation of the log-magnitude versus frequency plot of a certain system is shown. Its transfer function is



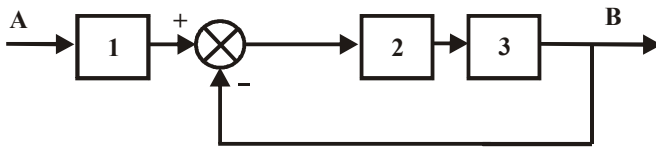
- (a)  $\frac{50(s+5)}{s^2(s+2)(s+25)}$  (b)  $\frac{20(s+5)}{s^2(s+2)(s+25)}$   
 (c)  $\frac{10s^2(s+5)}{(s+2)(s+25)}$  (d)  $\frac{20(s+5)}{s(s+2)(s+25)}$
35. In a cylindrical rotor synchronous machine, the phasor addition of stator and rotor mmfs is possible because
- (a) two mmfs are rotating in opposite direction  
 (b) two mmfs are rotating in same direction at different speed  
 (c) two mmfs are stationary with respect to each other  
 (d) one mmfs is stationary and the other mmf is rotating
36. An open loop system has a transfer function  $\frac{1}{s^3 + 1.5s^2 + s - 1}$ . It is converted into a closed loop system by providing a negative feedback having transfer function  $20(s+1)$ . Which one of the following is correct? The open loop and closed loop systems are respectively
- (a) stable and stable (b) stable and unstable  
 (c) unstable and stable (d) unstable and unstable

37. The armature reaction mmf in a dc machine has a form of  
 (a) sinusoidal (b) rectangular  
 (c) trapezoidal (d) triangular

38. Original block diagram



Equivalent block diagram



Blocks 1, 2 and 3 are respectively

- (a)  $G_1, G_2, G_1$  (b)  $1/G_1, 1/G_2, 1/G_1$   
 (c)  $1/G_2, G_2, G_1$  (d)  $1/G_2, G_1, G_2$

39. Which of the following are true in respect of interpoles in dc machines?

- I. Reduce armature reaction effects in interpolar region.  
 II. Windings are connected in series with armature.  
 III. Have the same dimensions as main poles.

Select the correct answer using the code given below:

- (a) I and II (b) II and III  
 (c) I and III (d) I, II and III
40. A separately excited dc generator operates at a voltage  $V$  and armature current  $I_a$ . The armature resistance is  $R_a$  and the generator has a constant loss of  $P_c$  (W). For the maximum efficiency of the generator

- (a)  $I_a = \sqrt{\frac{P_c}{R_a}}$  (b)  $I_a = \sqrt{\frac{P_c}{4R_a}}$   
 (c)  $I_a = \sqrt{\frac{2P_c}{R_a}}$  (d)  $I_a = \sqrt{\frac{P_c}{2R_a}}$

41. The damping ratio and natural frequency of a second order system are 0.6 and 2 rad/s respectively. Which one of the following combination gives the correct values of peak and settling time, respectively for the unit step response of the system?

- (a) 3.33s and 1.95s (b) 1.95s and 3.33s  
 (c) 1.95s and 1.5s (d) 1.5s and 1.95s

42. Wave winding is employed in a d.c. machine of

- (a) high current and low voltage rating (b) low current and high voltage rating  
 (c) high current and high voltage rating (d) low current and low voltage rating

43. For two phase ac servomotor, if the rotor's resistance and reactance are respectively  $R$  and  $X$ , its length and diameter are respectively  $L$  and  $D$  then

- (a)  $X/R$  and  $L/D$  are both small (b)  $X/R$  is large and  $L/D$  is small  
 (c)  $X/R$  is small and  $L/D$  is large (d)  $X/R$  and  $L/D$  is both large

44. A self-excited shunt generator fails to excite because the residual magnetism has destroyed. In order to revive the machine one should
- (a) connect the armature to a ac source
  - (b) connect the field to a ac source
  - (c) excite the field for a few minutes with a battery
  - (d) excite the armature for a few minutes with a battery
45. Backlash in a stable control system may cause
- (a) underdamping
  - (b) overdamping
  - (c) high level oscillation
  - (d) low level oscillation
46. The incremental cost characteristics of two generators delivering a total load of 200 MW are as follows:
- $$\frac{dF_1}{dP_1} = 2.0 + 0.01P_1 \qquad \frac{dF_2}{dP_2} = 1.6 + 0.02P_2$$
- What should be the values of  $P_1$  and  $P_2$ , for economic operation?
- (a)  $P_1 = P_2 = 100\text{MW}$
  - (b)  $P_1 = 80\text{ MW}, P_2 = 120\text{ MW}$
  - (c)  $P_1 = 200\text{ MW}, P_2 = 0$
  - (d)  $P_1 = 120\text{ MW}, P_2 = 80\text{MW}$
47. A dc shunt motor has external resistance  $R_1$  in the field circuit and  $R_2$  in the armature circuit. The starting armature current for the motor will be minimum when
- (a)  $R_1$  is minimum and  $R_2$  is maximum
  - (b)  $R_1$  is maximum and  $R_2$  is minimum
  - (c)  $R_1$  and  $R_2$  both are minimum
  - (d)  $R_1$  and  $R_2$  both are maximum
48. The driving power from the prime mover driving the alternator is lost but the alternator remains connected to the supply network and the field supply also remains on. The alternator will
- (a) get burnt
  - (b) behave as an induction motor but will rotate in the opposite direction
  - (c) behave as a synchronous motor and will rotate in the same direction
  - (d) behave as a synchronous motor but will rotate in a reverse direction to that corresponding to generator action.
49. What is the surge impedance loading of a loss less 400 kV, 3-phase, 50Hz overhead line of average of surge impedance of 400 ohms?
- (a) 400 MW
  - (b)  $400\sqrt{3}$  MW
  - (c)  $400/\sqrt{3}$  MW
  - (d) 400 kW
50. A two-winding transformer is converted into an auto-transformer. If we apply additive polarity and subtractive polarity for the connections, then the secondary voltage is 2640 V and 2160 V, respectively. What is the ratio of primary to secondary voltage of the original transformer?
- (a) 66:54
  - (b) 54:66
  - (c) 10:1
  - (d) 1:10

**SECTION - B (Short answer type question) (100 Marks)**

All questions carry equal marks of 5 each.

This Section should be answered only on the **Answer Sheet** provided.

1. What do you mean by hunting of a synchronous motor? How does damper winding of a synchronous motor reduce hunting?
2. Sketch the root locus of the system whose open loop transfer function is  $G(s) = \frac{K}{s(s+2)(s+4)}$ . Find the value of 'K' so that the damping ratio of the closed loop system is 0.5.
3. The power input to a three phase induction motor is 50kW and the corresponding stator losses are 2kW. Calculate (a) the total mechanical power developed and the rotor I<sup>2</sup>R-loss when the slip is 3% (b) the output horse power of the motor if the friction and windage losses are 1.0 kW, and (c) Efficiency of the motor.
4. Explain the factors which determine the formation of corona on overhead lines. What are the advantages and limitations of corona and how can it be minimized?
5. Derive the expression and draw the response of the first order system for unit ramp input.
6. Discuss the production of starting torque, through the concept of interaction of flux and mmf waves in a 3-phase slip ring induction motor.
7. Derive the expression to determine fault current for L-L-G fault. Draw the sequence network.
8. A 50KVA single –phase transformers of 2300V/230V rating has the primary and secondary winding resistance of 2W and 0.02W respectively. The iron losses equal to 412 Watts. Calculate the efficiency: i) at half full load ii) at full load, when the power factor of the load is 0.8.
9. The forward path transfer function of a unity feedback control system is given by
$$G(s) = \frac{5(s^2 + 2s + 100)}{s^2(s + 5)(s^2 + 3s + 10)}$$
Determine K<sub>p</sub>, K<sub>v</sub>, and K<sub>a</sub>. Also determine the type of the system.
10. What are the causes of harmonics in the emf waveforms of synchronous generators and what means are adopted to minimize them?
11. Find state transition matrix of following system,  $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$
12. What do you understand by positive, negative and zero sequence impedances? Discuss them with the reference to synchronous generators, transformers and transmission lines.
13. A shunt generator has a F.L. current of 196 A at 220V. The stray losses are 720W and the shunt field coil resistance is 55 ohm. If it has a F.L. efficiency of 88%, find the armature resistance. Also, find the load current corresponding to maximum efficiency.
14. Explain briefly the equal area criterion and how it may be used to study the stability of a two machine system. List the factors determining the stability limit and indicate how it may be improved.
15. A unity feedback control system has an open loop transfer function  $G(s) = \frac{s}{s(s+1)}$ . Find the rise time, percentage overshoot, peak time and settling time for a step input of 10 units. Also determine the peak overshoot.
16. Explain the process of commutation for a d.c. generator. What are the causes of bad commutation? Explain methods of improve the commutation.
17. What are the problems associated with AC interconnection? How HVDC interconnections are technically superior to HVAC interconnection?
18. What is meant by armature reaction? Show that the effect of armature mmf on the field is entirely cross magnetizing. Explain briefly the four bad effects of armature reaction.
19. What is the significance of load flow analysis in a power system? Give the classification of various types of buses in a power system for load flow studies. Justify the classification.
20. State the need for parallel operation of alternators. What are the conditions for parallel operation of three phase alternators?