MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR RECRUITMENT TO THE POST OF

INSPECTOR OF LEGAL METROLOGY

UNDER FOOD, CIVIL SUPPLIES & CONSUMER AFFAIRS, GOVT. OF MIZORAM

NOVEMBER, 2023

ELECTRICAL ENGINEERING PAPER-II

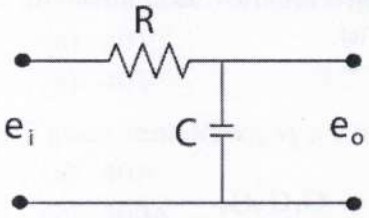
Time Allowed : 2 hours | Full Marks : 200

All questions carry equal marks of 2 each.
Attempt all questions.

1. For a stable system
(a) gain margin and phase margin both are negative
(b) gain margin is positive and phase margin is negative
(c) gain margin is negative and phase margin is positive
(d) gain margin and phase margin both are positive

2. The transfer function of a system is $\frac{10}{1+s}$. When operated as a unity feedback system, the steady-state error to a unit step input will be
(a) infinity
(b) 10
(c) zero
(d) $\frac{1}{11}$

3. The transfer function for the network given below is



(a) $\frac{1}{Rs+1}$
(b) $\frac{1}{RCs+1}$
(c) RCs+1
(d) $\frac{R}{C}+1$

4. The gain for constructing the Bode plot in relation to transfer function $G(s)H(s)=\frac{20}{s(s+2)}$ is
(a) 20
(b) 5
(c) 10
(d) 2

5. The initial slope of the Bode plot gives an indication of
(a) nature of the system time response
(b) type of the system
(c) system stability
(d) gain margin

6. The frequency at which the magnitude of the Bode plot crosses 0db axis is termed as
   (a) natural frequency
   (b) phase crossover frequency
   (c) corner frequency
   (d) gain crossover frequency

7. For a stable system
   (a) the phase crossover occurs earlier than gain crossover
   (b) the gain crossover occurs earlier than phase crossover
   (c) the gain crossover and phase crossover frequencies are very near to each other
   (d) the gain crossover and phase crossover frequencies are coincident

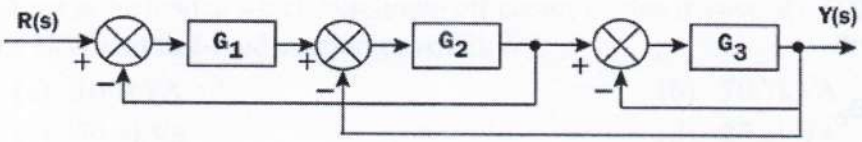
8. For the system $\frac{C(s)}{R(s)} = \frac{16}{s^2 + 8s + 16}$. The nature of the time response will be
   (a) critically damped
   (b) over damped
   (c) under damped
   (d) none of these

9. Smaller the damping ratio
   (a) keeps the time within limits
   (b) larger is the rise time
   (c) smaller is the rise time
   (d) none of the above

10. For the system $\frac{C(s)}{R(s)} = \frac{25}{s^2 + 6s + 25}$, the damping factor ζ and damping frequency of oscillation ω_d respectively will be
   (a) 0.6, 4
   (b) 0.4, 6
   (c) 0.5, 3
   (d) 0.3, 5

11. The natural frequency of oscillation of the output for the equation $\frac{d^2x}{dt^2} + 1.5\frac{dx}{dt} + 4s = 1$ is
   (a) 0 rad/sec
   (b) 1.5 rad/sec
   (c) 2 rad/sec
   (d) 4 rad/sec

12. Consider the given block diagram. The overall transfer function $\frac{Y(s)}{R(s)}$ is



   (a) $\frac{G_1G_2G_3}{1 + G_1G_2 + G_2G_3 + G_1G_2G_3 + G_3}$
   (b) $\frac{G_1G_2G_3}{1 + G_1G_2 + G_2G_3 + G_1G_3 + G_3}$
   (c) $\frac{G_1G_2G_3}{1 - G_1G_2 - G_2G_3 - G_1G_3 + G_3}$
   (d) $\frac{G_1G_2G_3}{1 - G_1G_2 - G_2G_3 + G_1G_2G_3 + G_3}$

13. The phase crossover frequency of the system $G(s) = \frac{10}{s(s+20)(s+10)}$ is
   (a) 8.3 rad/sec
   (b) 14.14 rad/sec
   (c) 28.2 rad/sec
   (d) 20 rad/sec

14. The phase lead compensator $G_C(s) = \frac{10(1 + 0.3s)}{1 + 0.1s}$ would provide a maximum phase shift of
   (a) 45°
   (b) 30°
   (c) 60°
   (d) 20°

15. In a force-voltage analogy, the mass M, spring constant K and friction constant B are equivalent to which of the following corresponding electrical quantities (in order) as

(a) R, C, L
(b) R, 1/L, C
(c) L, 1/C, R
(d) C, L, R

16. The open-loop D.C gain of a unity negative feedback system with overall D.C gain 2/3 is

(a) 2
(b) 3/2
(c) 1/2
(d) 2/5

17. Using Routh's criterion, the number of roots in the right half S-plane for the characteristic equation $s^4 + 2s^3 + 2s^2 + 3s + 6 = 0$ is

(a) one
(b) three
(c) two
(d) four

18. Consider the following

1. Rise time
2. Settling time
3. Delay time
4. Peak time

What is the correct sequence of the time domain specification of a second order system in the ascending order of the values?

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

19. If the Nyquist plot cuts the negative real axis at a distance of 0.4, then the gain margin of the system is

(a) 0.4
(b) -0.4
(c) 4%
(d) 2.5

20. Given the transfer function $G(s) = \dfrac{121}{s^2 + 13.2s + 121}$ of a system. Which of the following characteristics does it have?

(a) overdamped and settling time 1.1s
(b) critically damped and settling time 0.8s
(c) under-damped and settling time 0.6s
(d) under-damped and settling time 0.707s

21. Considering the network function $H(s) = \dfrac{2(s+3)}{(s+2)(s+4)}$. What is the steady-state response due to a unit step input?

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

22. Given a unity feedback system with $G(s) = \dfrac{K}{s(s+4)}$, the value of K for damping ratio of 0.5 is

(a) 1
(b) 16
(c) 4
(d) 64

23. If the poles of a system lie on the imaginary axis, the system will be

(a) conditionally stable
(b) stable
(c) unstable
(d) marginally stable

24. The transfer function of a P-I controller is

(a) $K_p + \dfrac{K_i}{s}$
(b) $K_p + K_i s$
(c) $\dfrac{K_p}{s} + K_i s$
(d) $K_p s + \dfrac{K_i}{s}$

25. Root locus of $s(s+2)+K(s+4)=0$ is a circle. What are the co-ordinates of the centre of this circle?

(a) -2, 0 (b) -4, 0

(c) -5, 0 (d) -3, 0

26. A second order system has a natural frequency of oscillations of 3 rad/sec and damping ratio of 0.5. What are the values of resonant frequency and resonant peak of the system?

(a) 1.5 rad/sec and 1.16 (b) 2.1 rad/sec and 1.16

(c) 1.16 rad/sec and 1.5 (d) 1.16 rad/sec and 2.1

27. The impulse response of a linear system is e^{-t}, $t>0$. The corresponding transfer function is

(a) $\frac{1}{s(s+1)}$ (b) $\frac{s}{s+1}$

(c) $\frac{1}{s+1}$ (d) $\frac{1}{s}$

28. The phase-lead compensation is used to

(a) increase rise time only (b) increase both rise time and overshoot

(c) decrease rise time and reduce overshoot (d) none of the above

29. What is the effect of lag compensator on the system bandwidth and the settling time?

(a) bandwidth is reduced and settling time is usually longer

(b) bandwidth increase and reduce settling time

(c) both bandwidth and settling time increases

(d) none of the above

30. The steady state error due to ramp input for a type-II system is equal to

(a) infinite (b) zero

(c) 1 (d) -1

31. In hydro electric plant, spill ways are used

(a) to store water in the upstream side

(b) to direct water in the reservoir

(c) to discharge supply water on the downstream side

(d) to reduce pressure swing in the conduit

32. For high head hydro-electric plants, the turbine used is

(a) Francis turbine (b) Pelton wheel

(c) Kaplan turbine (d) Reaction turbine

33. Diesel power plants are used as

(a) stand by plant (b) base load plant

(c) general purpose plant (d) none of the above

34. The value of demand factor of a power station is

(a) less than 1 (b) always zero

(c) greater than 1 (d) 1.5

35. The greater the diversity factor of a power station

(a) Indicates higher plant capacity (b) higher is the cost of generation of power

(c) lesser is the cost of generation of power (d) none of the above

36. A high load factor

(a) increase the overall cost per unit generated
(b) is not an indication of generated cost
(c) reduces the overall cost per unit generated
(d) indicates an increase in maximum demand

37. Transmission efficiency of a line

(a) decreases with the increase in load p.f
(b) increases with the decrease in load p.f
(c) decreases with the decrease in load p.f
(d) is not related to load p.f

38. The statutory limit of voltage variation is

(a) ± 0.6% of declared voltage at customers' terminals
(b) ± 10% of declared voltage at customers' terminals
(c) ± 6% of declared voltage at customers' terminals
(d) ± 1% of declared voltage at customers' terminals

39. In a transmission line, the generalised circuit constants of the transmission line AD-BC is equal to

(a) zero
(b) 1
(c) -1
(d) 0.5

40. Ferranti effect on long overhead lines is expressed when it is

(a) lightly loaded
(b) fully loaded at unity p.f
(c) fully loaded at 0.8 p.f lag
(d) none of the above

41. Corona loss increases with

(a) both increase in supply frequency and conductor size
(b) Increase supply frequency but reduction in conductor size
(c) both decrease in supply frequency and conductor size
(d) decrease in supply frequency but increase in conductor size

42. The value of A,B,C and D constants for a short transmission line are respectively

(a) 0, 1, 1 and 1
(b) Z, 0, 1 and 1
(c) 1, Z, 0 and 1
(d) 1, 1, Z and 0

43. A 100km long single phase transmission line is loaded at 110kV. If the loss of line is 15MW and the load is 150MVA, the resistance of the line is

(a) 0.806 ohm/phase
(b) 8.06 ohm/phase
(c) 80.6 ohm/phase
(d) 0.0806 ohm/phase

44. Consider the following quantities:

1. Real power
2. Reactive power
3. Power factor
4. Input current
5. Bus voltage magnitude
6. Bus voltage phase angle

For the purpose of the load flow studies of a power system, each bus or node is associated with which one of the combinations of the above four quantities?

(a) 1, 3, 4 and 5
(b) 1, 2, 3 and 4
(c) 1, 2, 5 and 6
(d) 2, 3, 5 and 6

45. The direct axis reactance X_d of a synchronous generator is given as 0.4 p.u. based on the generator's name plate rating of 10kV, 75MVA, the base for calculation is 11kV, 100MVA. What is the p.u. value of X_d on the new base?

(a) 0.279
(b) 0.44
(c) 0.578
(d) 0.412

46. Equivalent π model is quite suitable for analysing the performance of transmission line of

(a) 50 km length
(b) 150 km length
(c) 250 km length
(d) All of these

47. In a three phase, 5kV, 5MVA system, what is the base impedance?

(a) 5 ohm
(b) 50 ohm
(c) 500 ohm
(d) 0.5 ohm

48. In a three phase balanced delta connected system, each phase voltage contains a fundamental, a third harmonic and a fifth harmonic of RMS values 100V, 30V and 20V respectively, what is the RMS value of the line-to-line voltage?

(a) $\sqrt{3} \times \sqrt{100^2 + 30^2 + 20^2}$
(b) $\sqrt{100^2 + 20^2}$
(c) $\sqrt{100^2 + 30^2 + 20^2}$
(d) $\sqrt{3} \times \sqrt{100^2 + 20^2}$

49. The maximum demand of a consumer is 2kW and the corresponding daily energy consumption is 30 units. What is the corresponding load factor?

(a) 0.625
(b) 0.25
(c) 0.50
(d) 0.75

50. A system has 200 buses of which 20 buses are generator bus and the rest of them are load bus. The size of Jacobian matrix in Newton-Rapson method will be

(a) 376 × 376
(b) 380 × 380–
(c) 378 × 378
(d) 382 × 382–

51. The power generated by two plants are P_1=50MW and P_2=40MW. If the loss coefficients are B_{11}=0.001, B_{22}=0.0025 and B_{12}=-0.0005, then the calculated power loss will be

(a) 5.5MW
(b) 6.5 MW
(c) 7.5 MW
(d) 4.5 MW

52. A single phase transmission line of j0.8 Ω is supplying a load of 40A at 200V and unity power factor. The sending end power factor will be

(a) zero
(b) 0.85
(c) 0.987
(d) unity

53. A single phase AC voltage source has 200V rms and a system connected consumes an active power of 300W. What is the reactive power consumed by the system, if 2.5A rms current is drawn?

(a) 400 VAr
(b) 150 VAr
(c) 300 VAr
(d) 250 VAr

54. Which of the following statement is not true?

(a) selectivity is the quality of protective relay by which it is able to discriminate between a fault in the protected section and normal condition
(b) a protective relay should operate when the magnitude of the current exceeds the preset value
(c) a protective system should be fast enough to isolate the faulty element of the system
(d) adjacent protective zones must not overlap to each other

55. Which of the following structure is commonly used for obtaining the phase difference in the fluxes of an induction relay?

(a) shaded pole structure
(b) solenoid type structure
(c) balance beam type structure
(d) none of these

56. Which of the following relay structure produce torque more efficiently?
(a) induction cup structure
(b) watt-hour meter structure
(c) shaded pole structure
(d) none of these

57. A relay is connected to a 400/5 transformer and current setting is set at 150%, with a primary fault current of 2400A, and then the pickup current is
(a) 6.25A
(b) 5.25A
(c) 5A
(d) 7.5A

58. Re-striking voltage is the transient voltage that
(a) appear across the contacts at or near current zero during arcing period
(b) appear across the contacts at maximum current during arcing period
(c) appear across the contacts at or near current zero after arcing period
(d) none of these

59. Most serious fault on alternator which requires immediate attention is
(a) stator winding fault
(b) prime mover failure
(c) unbalance loading
(d) over voltage

60. In Merz-Price circulating current scheme of alternator protection, if the value of earth resistance is made to increase, then
(a) the unprotected region against earth fault will also increase
(b) the unprotected region against earth fault will reduce
(c) the unprotected region against earth fault will be only 20%
(d) none of these

61. It is a universal practice to use Buchholz relay on all such oil immersed transformer having rating in excess of
(a) 700 MVA
(b) 200 MVA
(c) 250 MVA
(d) 750 KVA

62. As compare to $\Delta - \Delta$ bank, the capacity of the V-V bank of transformers is
(a) 57.7%
(b) 66.7%
(c) 50%
(d) 86.6%

63. Of the following statements concerning parallel operation of transformers, the one which is not correct is
(a) transformers must have equal KVA ratings
(b) transformers must have equal voltage ratings
(c) transformers must have same ratio of transformation
(d) transformers must be operated at the same frequency

64. An autotransformer having a transformation ratio of 0.8 supplies a load of 3kW. The power transferred conductively from primary to secondary is
(a) 0.4 kW
(b) 1.5 kW
(c) 2.4 kW
(d) 0.27 kW

65. In performing the short circuit test of a transformer
(a) low voltage side is usually short circuited
(b) high voltage side is usually short circuited
(c) both sides are short circuited
(d) none of the above

66. The primary reason for making the coil span of a d.c armature winding equal to a pole pitch is to
(a) distribute the winding uniformly
(b) obtain a full pitch winding
(c) obtain a coil span of 180 degree
(d) ensure the addition of e.m.fs of consecutive turns.

67. Lap winding is suitable for
(a) high current, low voltage d.c generators
(b) high current, high voltage d.c generators
(c) low current, low voltage d.c generators
(d) low current, high voltage d.c generators

68. The primary reason for providing compensating winding in a d.c generator is to
(a) neutralize armature mmf
(b) compensate for decrease in main flux
(c) neutralize cross-magnetising effect of armature reaction
(d) maintain uniform flux distribution

69. The slight curvature at the lower end of the O.C.C of a self-excited d.c generator is due to
(a) magnetic inertia
(b) high field circuit resistance
(c) high armature speed
(d) residual pole flux

70. If field resistance of a d.c shunt generator is increased beyond its critical value, the generator
(a) will not build up
(b) output voltage will exceed its name plate rating
(c) may burn out if loaded to its name plate rating
(d) power output may exceed its name plate rating

71. The counter e.m.f (back e.m.f) of a d.c motor
(a) often exceed the supply voltage
(b) aids the applied voltage
(c) regulates its armature voltage
(d) helps in energy conversion

72. The speed of a d.c motor can be controlled by varying
(a) its flux per pole
(b) resistance of the armature circuit
(c) applied voltage
(d) all of the above

73. Regenerative braking in d.c shunt motor is used when
(a) load has overhauling characteristics
(b) quick motor reversal is required
(c) controlling elevators, rolling mills and printing presses etc.
(d) other methods cannot be used

74. The most economical method of finding no-load losses of a large d.c shunt motor is
(a) Swinburne's test
(b) Hopkinson's test
(c) retardation
(d) Field's

75. The principle of operation of a 3-phase induction motor is most similar to that of
(a) synchronous motor
(b) repulsion-start induction motor
(c) transformer with a shorted secondary
(d) capacitor-start, induction run motor

76. One of the characteristics of a single phase motor is that it
(a) is self starting
(b) is not self starting
(c) requires only one winding
(d) can rotate in one direction only

77. The starting winding of a single-phase motor is placed in the
(a) rotor
(b) stator
(c) field
(d) none of the above

78. The main disadvantage of using short-pitch winding in alternators is that it
(a) reduces harmonics in the generated voltage
(b) reduces the total voltage around the armature coils
(c) produces asymmetry in the three phase winding
(d) increase copper of end connections

79. While running, a synchronous motor is compelled to run at synchronous speed because of
(a) damper winding in its pole faces
(b) magnetic locking between stator and rotor poles
(c) induce e.m.f. in rotor field winding by stator flux
(d) compulsion due to Lenz's law

80. In a single phase transformer, the magnitude of leakage reactance is twice that of resistance of both primary and secondary. With secondary short-circuited, the input power factor is
(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{1}{\sqrt{5}}$
(c) $\frac{2}{\sqrt{5}}$ (d) $\frac{1}{3}$

81. For a P-pole machine, the relation between electrical and mechanical degree is given by
(a) $\theta_{elect} = \frac{P}{2}\theta_{mech}$ (b) $\theta_{elect} = \frac{4}{P}\theta_{mech}$
(c) $\theta_{elect} = 2\theta_{mech}$ (d) none of the above

82. A 4-pole d.c generator is running at 1500 r.p.m. The frequency of current in the armature winding will be
(a) 25 Hz (b) 50 Hz
(c) 100 Hz (d) 200 Hz

83. Neglecting losses, the power transformed inductively is equal to that conductively in case of an auto-transformer. Then the secondary to primary ratio of transformer is
(a) 0.5 (b) 1
(c) 1.5 (d) 2

84. A 440V d.c shunt motor has an armature resistance of 0.5 ohm and shunt field resistance of 650 ohms. If the no load current is 3A, then current in the armature will be
(a) 2.32 A (b) 3 A
(c) 0.68 A (d) 0.880 A

85. A 220V d.c machine has an armature resistance of 1 Ω. If the full load current is 20A, the difference in the induced voltages when the machine is running as a motor, and as a generator is
(a) 20V (b) Zero
(c) 40V (d) 50V

86. The current drawn by a 220V d.c motor of armature resistance 0.5 Ω and back e.m.f 200V is
(a) 40A (b) 44A
(c) 400A (d) 440A

87. A 6-pole, 3-phase alternator running at 1000 rpm supplies to an 8-pole, 3-phase induction motor which has a rotor current of frequency 2Hz. The speed at which the motor operates is
(a) 1000 rpm (b) 960 rpm
(c) 750 rpm (d) 720 rpm

88. The current drawn by a 120V d.c motor with back e.m.f of 110V and armature resistance of 0.4 ohm is
(a) 4A (b) 25A
(c) 274A (d) 300A

89. An induction motor having 8 poles runs at 727.5 rpm. If the supply frequency is 50Hz, the e.m.f in the rotor will have a frequency of
(a) 1.5Hz (b) 48.5Hz
(c) 51.5Hz (d) 75Hz

90. In a d.c machine, for the same value of ϕ, Z and N. Which one of the following statements is correct?

(a) Armature e.m.f is more with wave winding than lap winding

(b) Armature e.m.f is less with wave winding than with lap winding

(c) Armature e.m.f depends on whether the machine is running as a motor or a generator

(d) Armature e.m.f is the same as long as the flux density in the air gap remains the same

91. Three single phase 11000/220V transformers are connected to form 3-phase transformer bank. High voltage side is connected in star, and low voltage side is in delta. What are the voltage ratings and turn ratio of 3-phase transformer?

(a) 19052/220V, 50 (b) 19052/220V, $50\sqrt{3}$

(c) 11000/381V, $50\sqrt{3}$ (d) 11000/220V, 50

92. The armature resistance of a 6-pole lap wound d.c machine is $0.05\,\Omega$. if the armature is rewound as a wave winding, what is the armature resistance?

(a) $0.45\,\Omega$ (b) $0.30\,\Omega$

(c) $0.15\,\Omega$ (d) $0.10\,\Omega$

93. If P_1 and P_2 be the iron and copper losses of a transformer at full load, and the maximum efficiency of the transformer is at 75% of the full load, then what is the ratio of P_1 and P_2?

(a) 9/16 (b) 10/16

(c) 3/4 (d) 3/16

94. A 10 pole, 25 Hz alternator is directly coupled to and is driven by 60 Hz synchronous motor. What is the number of poles for the synchronous motor?

(a) 48 (b) 12

(c) 24 (d) 16

95. What is the frequency of rotor current of a 50Hz induction motor operating at 2% slip?

(a) 1Hz (b) 100Hz

(c) 2Hz (d) 50Hz

96. Torque developed by the armature of a d.c motor is proportional to which one of the following?

(a) (back e.m.f)×(armature current) (b) (magnetic flux per pole)×(armature current)

(c) (back e.m.f)×(magnetic flux per pole) (d) (back e.m.f)/(magnetic flux per pole)

97. What is the load at which maximum efficiency occurs in case of a 100kVA transformer with iron loss of 1kW and full-load copper loss of 2kW?

(a) 100kVA (b) 70.7kVA

(c) 50.5kVA (d) 25.2kVA

98. A three phase 6 pole 50Hz induction motor is running at 5% slip. What is the speed of the motor?

(a) 850 rpm (b) 900 rpm

(c) 950 rpm (d) 1000 rpm

99. A squirrel cage induction motor having a rated slip of 2% on full load has a starting torque of 50% of full load torque. The starting current is

(a) two times the full load current (b) four times the full load current

(c) five times the full load current (d) equal to the full load current

100. An 8 pole d.c generator has a simple wave wound armature containing 32 coils of 6 turns each. Its flux per pole is 0.06 Wb. The machine is running at 250 rpm. The induced armature voltage is

(a) 96V (b) 192V

(c) 384V (d) 768V

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