MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (COMBINED) UNDER VARIOUS DEPARTMENT,

GOVERNMENT OF MIZORAM, JULY-2024

ELECTRONICS & COMMUNICATION ENGINEERING
PAPER-II

Time Allowed : 3 hours   FM : 200

SECTION - A *(Multiple Choice questions) (100 Marks)*
All questions carry equal mark of 2 each. Attempt all questions.

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

1. The mode with lowest cut-off frequency for an electromagnetic wave propagating between two perfectly conducting parallel plates of infinite extent is-
   - (a) TE_{10}
   - (b) TM_{10}
   - (c) TM_{01}
   - (d) TEM

2. Which of the following equations result from the circuital form of Ampere's law?
   - (a) $\nabla \times E = -\dfrac{\partial B}{\partial t}$
   - (b) $\nabla \cdot B = 0$
   - (c) $\nabla \cdot D = \rho$
   - (d) $\nabla \times H = J + \dfrac{\partial D}{\partial t}$

3. A line characteristic impedance $50\,\Omega$ is terminated at one end by $+j50\,\Omega$. The VSWR on the line is-
   - (a) 1
   - (b) 0
   - (c) ∞
   - (d) j

4. What will be the equipotential surfaces for a pair of equal and opposite line charges?
   - (a) Spheres
   - (b) Concentric cylinders
   - (c) Non-concentric cylinder
   - (d) Elliptical

5. For plane wave propagating in free space or two conductor transmission line, what must be the relationship between the phase velocity, v_p, the group velocity, v_g, and speed of light, c ?
   - (a) $v_p > c > v_g$
   - (b) $v_p < c < v_g$
   - (c) $v_p = c = v_g$
   - (d) $v_p < v_g < c$

6. In a charge-free space, the Poisson's equation results in which of the following?
   - (a) Continuity equation
   - (b) Maxwell's equation
   - (c) Laplace equation
   - (d) Displacement equation

7. An air-filled parallel plate capacitor is made of square plates, each 10cm × 10cm and has a capacitance C. If the plates are reduced to 2.5cm × 2.5cm, what would be the new capacitance?
   - (a) C/4
   - (b) C/8
   - (c) C/16
   - (d) C/32

8. For an electromagnetic wave incident on a conducting medium, the depth of penetration-
   (a) is directly proportional to the attenuation constant.
   (b) is inversely proportional to the attenuation constant.
   (c) has a logarithmic relationship with the attenuation constant.
   (d) is independent of the attenuation constant.

9. Consider a 565 PLL with $R_T = 10\ k\Omega$ and $C_T = 0.01\ \mu F$. What is the output frequency of the VCO?
   (a) 10 kHz
   (b) 5 kHz
   (c) 2.5 kHz
   (d) 1.25 kHz

10. CE configuration is the most preferred transistor configuration when used as switch, because-
    (a) it requires only one power supply
    (b) it requires low voltage or current for operating the switch
    (c) it has small I_{CEO}
    (d) it gives large output

11. A power supply has a full-load voltage of 24 V. What is its no-load voltage for 5% regulation (rounded to the nearest integer)?
    (a) 6 V
    (b) 12 V
    (c) 23 V
    (d) 25 V

12. Operating point shift can occur in an amplifier due to which one of the following?
    (a) Input frequency variation
    (b) Noise at the input
    (c) Parasitic capacitances
    (d) Power supply fluctuation

13. In a class-B push-pull operation, the DC power drawn is 28 W. What is the power delivered by the amplifier at the ideal maximum efficiency of power conversion?
    (a) 8 W
    (b) 16 W
    (c) 22 W
    (d) 28 W

14. The pinch-off voltage, $V_p = + 6V$ for a *p-channel* FET. If $V_{GS} = + 2V$, what is the value of V_{DS} at which it will enter into saturation region?
    (a) – 6V
    (b) – 4V
    (c) + 8V
    (d) + 4V

15. A tuned amplifier has a voltage gain of 100 and a bandwidth of 10 kHz at 500 kHz. It is required to increase the bandwidth to 20 kHz. This can be achieved by which one of the following ways?
    (a) By doubling the gain
    (b) By doubling the resonant frequency
    (c) By halving the Q of the coil
    (d) By halving the power supply voltage

16. In a PLL, lock occurs when the-
    (a) input frequency and VCO frequency are the same
    (b) phase error is 180°
    (c) VCO frequency is double the input frequency
    (d) phase error is 90°

17. Which one of the following power amplifiers has the maximum efficiency?
    (a) Class – A
    (b) Class – B
    (c) Class – C
    (d) Class – AB

18. The complement of the expression $Y = ABC + AB\overline{C} + \overline{A}\,\overline{B}C + \overline{A}BC$ is-

    (a) $(A+\overline{B})(A+\overline{C})$ (b) $(\overline{A}+B)(A+C)$

    (c) $(A+\overline{B})(\overline{A}+C)$ (d) $(\overline{A}+\overline{B})(A+\overline{C})$

19. The hexadecimal representation of 657_8 is-

    (a) 1AFH   (b) D78H

    (c) D71H   (d) 32FH

20. A 10-bit A/D converter is used to digitize an analog signal in the 0 to 5 V range. The maximum peak to peak ripple voltage that can be allowed in the DC supply voltage is nearly

    (a) 100 mV   (b) 50 mV

    (c) 25 mV   (d) 5 mV

21. What is the minimized logical expression corresponding to the given Karnaugh Map?

wx \\ yx	00	01	11	10
00			1	
01	1	1	1	
11		1	1	1
10		1		

    (a) xz   (b) $\overline{w}x\overline{y} + \overline{w}yz + w\overline{y}z + wxy$

    (c) $\overline{w}x\overline{y} + \overline{w}yz + w\overline{y}z + wx\overline{y}$ (d) $xz + \overline{w}xz + \overline{w}x\overline{y} + wxy + w\overline{y}z$

22. A master slave configuration consists of two identical flip-flops connected in such a way that the output of the master is input to the slave. Which one of the following is correct?

    (a) Master is level triggered and slave is edge triggered

    (b) Master is edge triggered and slave is level triggered

    (c) Master is positive edge triggered and slave is negative edge triggered

    (d) Master is negative edge triggered and slave is positive edge triggered

23. The characteristic equation of the T-flip-flop is given by-

    (a) $Q^+ = TQ + \overline{TQ}$ (b) $Q^+ = \overline{T}Q + T\overline{Q}$

    (c) $Q^+ = TQ$ (d) $Q^+ = T\overline{Q}$

24. The Boolean functions can be expressed in canonical SOP (sum of products) and POS (product of sums) form. For the function $Y = A + \overline{B} \cdot C$, which are such two forms?

    (a) $Y = \sum (1,2,6,7) \ and \ Y = \prod (0,2,4)$

    (b) $Y = \sum (1,4,5,6,7) \ and \ Y = \prod (0,2,3)$

    (c) $Y = \sum (1,2,5,6,7) \ and \ Y = \prod (0,1,3)$

    (d) $Y = \sum (1,2,4,5,6,7) \ and \ Y = \prod (0,2,3,4)$

25. If two counter, MOD_N counter and MOD_M counter are cascaded then the number of overall states of combined counter will be-

    (a) (M + N) states   (b) (M − N) states

    (c) (M × N) states   (d) (M / N) states

26. In the Bode plot of a unity feedback control system, the value of phase angle of $G(j\omega)$ is $-90°$ at the gain cross over frequency of the Bode plot, the phase margin of the system is-
    (a) $-180°$ (b) $-90°$
    (c) $+180°$ (d) $+90°$

27. In closed loop control system, what is the sensitivity of the gain of the overall system, M to the variation in G?

    (a) $\dfrac{1}{1+G(s)H(s)}$ (b) $\dfrac{1}{1+G(s)}$

    (c) $\dfrac{G(s)}{1+G(s)H(s)}$ (d) $\dfrac{G(s)}{1+G(s)}$

28. A controller transfer function is given by $C(s) = (2s+1)/(0.2s+1)$. What is its nature and parameter?
    (a) Lag controller, $\alpha = 10$ (b) Lag controller, $\alpha = 2$
    (c) Lead controller, $\beta = 0.1$ (d) Lead controller, $\beta = 0.2$

29. The given characteristic polynomial $s^4 + s^3 + 2s^2 + 2s + 3 = 0$ has-
    (a) zero root in RHS of s-plane   (b) one root in RHS of s-plane
    (c) two roots in RHS of s-plane   (d) three roots in RHS of s-plane

30. Which one of the following compensations is adopted for improving transient response of a negative unity feedback system?
    (a) Phase lead compensation
    (b) Phase lag compensation
    (c) Gain compensation
    (d) Both phase lag compensation and gain compensation

31. What is the value of K for a unity feedback system with $G(s) = \dfrac{K}{s(1+s)}$ to have a peak overshoot of 50%?
    (a) 0.53   (b) 5.39
    (c) 0.6   (d) 0.047

32. The Nyquist plot of $G(z) \cdot H(z) = \dfrac{10}{s^2(1+0.5s)(1+s)}$

    (a) will start ($\omega = \infty$) in the first quadrant and will terminate ($\omega = 0$) in the second quadrant

    (b) will start ($\omega = \infty$) in the fourth quadrant and will terminate ($\omega = 0$) in the second quadrant

    (c) will start ($\omega = \infty$) in the second quadrant and will terminate ($\omega = 0$) in the third quadrant

    (d) will start ($\omega = \infty$) in the first quadrant and will terminate ($\omega = 0$) in the fourth quadrant

33. The characteristic polynomial of a system is $q(s) = 2s^5 + s^4 + 4s^3 + 2s^2 + 2s + 1$. The system is-
    (a) stable   (b) marginally stable
    (c) unstable   (d) oscillatory

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34. An open loop transfer function is given by $G(s)H(s) = \dfrac{k(s+1)}{s(s+2)(s^2+2s+2)}$. It has-

    (a) one zero at infinity   (b) two zeroes at infinity

    (c) three zeroes at infinity   (d) four zeroes at infinity

35. A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by any one of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles.

    (a) an AND gate   (b) an OR gate

    (c) an XOR gate   (d) a NAND gate

36. Convert the following number system:

$(743)_8 = (?)_{10}$

    (a) 483   (b) 871

    (c) 796   (d) 377

37. Memory of computer which is used to speed up the computer processing is-

    (a) BIOS   (b) Cache Memory

    (c) RAM   (d) ROM

38. An R-S latch is a-

    (a) combinational circuit   (b) synchronous sequential circuit

    (c) one clock delay element   (d) one bit memory element

39. How many flip flops are required to build a binary counter circuit to count from 0 to 1023?

    (a) 7   (b) 10

    (c) 16   (d) 25

40. The number of comparators in a 4-bit flash ADC is-

    (a) 67   (b) 77

    (c) 15   (d) 11

41. A common source amplifier has a voltage gain of-

    (a) $g_m r_s / (1-g_m r_s)$ (b) $g_m r_d / (1-g_m r_d)$

    (c) $g_m r_s$ (d) $g_m r_d$

42. An amplifier has an open loop gain of 1000 ± 10. Negative feedback is provided such that the gain variation remains within 0.1 %. What is the amount of feedback β_F ?

    (a) 9/10   (b) 9/100

    (c) 9/1000   (d) 9/10000

43. A half wave rectifier is used to supply 50 V DC to a resistive load of 800 Ω. The diode has resistance of 25 Ω. What is the required AC voltage?

    (a) $20.2\,\pi$ (b) $30.0\,\pi$

    (c) $51.5\,\pi$ (d) $63.3\,\pi$

44. An ideal Opamp is an ideal-

    (a) voltage controlled current source   (b) current controlled current source

    (c) voltage controlled voltage source   (d) current controlled voltage source

45. A common gate amplifier has-
    (a) high input resistance and high output resistance
    (b) low input resistance and high output resistance
    (c) low input resistance and low output resistance
    (d) high input resistance and low output resistance

46. If the line frequency is 50 Hz, the output frequency of the bridge rectifier is-
    (a) 1 Hz   (b) 10 Hz
    (c) 100 Hz   (d) 1000 Hz

47. A plane wave travelling in a medium of $\varepsilon_r = 1$, $\mu_r = 1$ (free space) has an electric field intensity of $100(\pi)^{1/2} V/m$. Determine the total energy density of this magnetic field.
    (a) 23.9 nJ/m³   (b) 27.8 nJ/m³
    (c) 139 nJ/m³   (d) 239 nJ/m³

48. A TEM wave impinges obliquely on a dielectric-dielectric boundary $(\varepsilon_{r1} = 2, \varepsilon_{r2} = 1)$. The angle of incidence for total reflection is-
    (a) 30°   (b) 45°
    (c) 60°   (d) 90°

49. A dynamic RAM consists of-
    (a) 3 transistors   (b) 1 transistor and 1 capacitor
    (c) 2 transistors and 3 capacitors   (d) 2 transistors

50. A system has fourteen poles and two zeros. The slope of its highest frequency asymptote in its magnitude plot is-
    (a) -340 dB/decade   (b) -240 dB/decade
    (c) -140 dB/decade   (d) -440 dB/decade

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. For a good conductor, derive the expressions of attenuation constant, phase constant and the depth of penetration as functions of relevant parameters of the conductor.

2. Describe the working of non-inverting amplifier and inverting amplifier realized using Op-Amp.

3. Define Standing Wave Ratio (SWR) for a transmission line terminated by a resistive load.

4. Define gauge factor for a strain gauge and derive an expression for it.

5. Draw and explain the circuit diagram of a Colpitt's oscillator using transistor.

6. Explain the race around condition in a JK flip-flop.

7. Design a logic circuit for detecting equality of two 2-bit binary numbers.

8. State and explain the terms gain margin and phase margin.

9. Design a Schmitt trigger using an Op-Amp.

10. Draw the circuit diagram for implementation of 2-input EX-OR using CMOS transistors.

11. A phase lead compensator has a transfer function: $G(s) = \dfrac{1+2s}{2(1+s)}$. Determine the maximum values of the phase lead and the frequency at which it occurs.

12. What is Priority Encoder? Design a Priority Encoder using NAND gate only.

13. Draw the circuit diagram of a Dual Slope A/D converter and explain the operation of the conversion process. Prove that in Dual Slope A/D converter the output of the counter is proportional to the analog voltage V_a.

14. With a neat circuit diagram, explain the working principle of RC coupled multi stage transistor amplifier.

15. A two stage RC coupled transistor amplifier is having the following parameters:

    $R_3 = R_7 = 12\ K\Omega$, $R_4 = R_8 = 3.9\ K\Omega$, $R_1 = R_5 = 120\ K\Omega$, $R_2 = R_6 = 39\ K\Omega$, $C_1 = C_3 = 6.8\ \mu F$, $C_2 = C_4 = 150\ \mu F$, $C_5 = 0.12\ \mu F$, $V_{cc} = 24\ V$, $R_L = 120\ K\Omega$, $\beta = 100$, $h_{ie} = 2\ K\Omega$.

    Determine Z_{in}, Z_{out}, and the overall voltage gain.

16. With a neat circuit diagram and wave form, explain the operation of a square wave generator.

17. The signal flow graph for a feedback control system is shown below. Determine the closed loop transfer function C(s)/R(s).
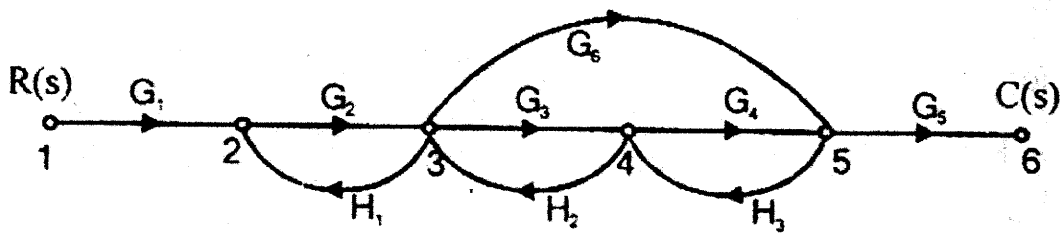
18. Explain the fundamental differences between frequency response and time response analysis in the context of control systems. Define Static error constant.

19. Define open-loop and closed loop control systems with an example. What is the purpose of a transfer function in control system analysis?

20. Write down four Maxwell's equation in free space (linear homogeneous isotropic medium).

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