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-I

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. In ionic crystals, electrical conductivity
   - (a) depends on material
   - (b) depends on temperature
   - (c) is practically zero
   - (d) is very high

2. Which of the following pair is not correctly matched?
   - (a) Ferrite : Ferrimagnetic
   - (b) NaCl : Diamagnetic
   - (c) Cr_2O_3 : Ferromagnetic
   - (d) Godolinium : Paramagnetic

3. Piezoelectricity is the reverse effect of
   - (a) Hall effect
   - (b) Peltier effect
   - (c) Electrostriction
   - (d) Electroluminescence

4. When does $BaTiO_3$ loses its ferroelectric properties?
   - (a) Above its melting point
   - (b) Above room temperature
   - (c) Above $0°K$
   - (d) Above its Curie point

5. In a given material, the Fermi level is located between the centre of the forbidden band and the conduction band. Then, what is that material?
   - (a) An insulator
   - (b) An intrinsic semiconductor
   - (c) A n-type semiconductor
   - (d) A p-type semiconductor

6. As per the Hall effect, if any specimen carrying a current I is placed in a transverse magnetic field B, then an electric field E is induced in the specimen in the direction
   - (a) Parallel to I
   - (b) Parallel to I and B
   - (c) Perpendicular to both I and B
   - (d) Perpendicular to B and parallel to I

7. Assuming that the electron mobility in intrinsic silicon is 1500 cm^2/Vs at room temperature (T= 300K) and the corresponding volt equivalent of temperature V_T = 25.9 mV, what is the approximate value of the electron diffusion constant?
   - (a) 4 cm^2/s
   - (b) 40 cm^2/s
   - (c) 400 cm^2/s
   - (d) 4000 cm^2/s

8. The maximum power dissipation capacity of a transistor is 50 mW. If the collector-emitter voltage is 10 V, what is the safe collector current that can be allowed through the transistor?

    (a) 2.5 mA   (b) 10 mA

    (c) 5 mA   (d) 20 mA

9. A junction FET can be used as a voltage variable resistor

    (a) well below pinch-off condition   (b) at pinch-off condition

    (c) beyond pinch-off condition   (d) for any value of drain-to-source voltage

10. The doping concentration on the n-side of a p-n junction diode is enhanced. Which one of the following will get affected?

    (a) Width of the depletion region on the *p-side*   (b) Width of the depletion region on the *n-side*

    (c) No change in the width of depletion regions   (d) Width of the depletion region on both sides

11. Which one of the following is not a power MOSFET type?

    (a) Lateral construction (LMOSFET)

    (b) Lateral double diffusion construction (LDMOSFET)

    (c) T construction (TMOSFET)

    (d) Enhancement mode construction (EMOSFET)

12. The electron and hole concentrations, n and p, respectively, obey the relation $np=n_i^2$, where, n_i is the intrinsic carrier concentration. The expression is valid

    (a) for direct bandgap semiconductors only

    (b) for all semiconductors under any condition

    (c) for non-degenerate semiconductors under thermal equilibrium condition

    (d) for degenerate semiconductors having excess electrons and holes

13. The mathematical model of the given signal shown below is
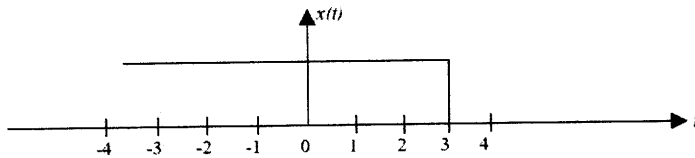
    (a) x(t) = u(3+t)   (b) x(t) = u(3-t)

    (c) x(t) = u(t-3)   (d) x(t) = u(t-1)

14. Z and Laplace transform are related by

    (a) $s = ln\, Z$ (b) $s = Z$

    (c) $s = \dfrac{ln Z}{T}$ (d) $s = \dfrac{T}{ln Z}$

15. What is the period of the sinusoidal signal x(n) = 5 cos[0.2 π n]?

    (a) 0   (b) 1

    (c) 5   (d) 10

16. The signal $x(t) = A\, cos(w_0 t + \Phi)$ is

    (a) an energy signal   (b) a power signal

    (c) an energy as well as a power signal   (d) neither an energy nor a power signal

17. A two-port network has ABCD parameter $\begin{bmatrix} 7 & 8 \\ 3 & 4 \end{bmatrix}$. Two such identical network are cascaded. The ABCD parameter of the overall cascaded network will be

(a) $\begin{bmatrix} 14 & 16 \\ 6 & 8 \end{bmatrix}$

(b) $\begin{bmatrix} 73 & 88 \\ 33 & 40 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 1 \\ 1 & 1 \end{bmatrix}$

(d) $\begin{bmatrix} 49 & 64 \\ 9 & 16 \end{bmatrix}$

18. It is required to find the current through a particular branch of linear bilateral network without mutual coupling when the branch impedance takes four different values. Which one of the following methods will be preferred?

    (a) Mesh Analysis

    (b) Thevenin's equivalent circuit

    (c) Nodal Analysis

    (d) Superposition theorem

19. For a series R-L-C circuit, the characteristic equation is given as $s^2 + \dfrac{R}{L}s + \dfrac{1}{LC} = 0$. If $\dfrac{R}{2L}$ is denoted by α and $\dfrac{1}{\sqrt{LC}}$ is denoted by β, then under the condition $\beta^2 > \alpha^2$, the system will be

    (a) Critically damped

    (b) Underdamped

    (c) Undamped

    (d) Overdamped

20. For determining the network functions of a two-port, it is required to consider that

    (a) all initial conditions remain same.

    (b) all initial conditions are zero.

    (c) part of initial conditions is equal to zero.

    (d) initial conditions vary depending on nature of network.

21. In a network containing active components, the output voltage

    (a) will always be greater than the input voltage.

    (b) will always be equal to the input voltage.

    (c) can be less than or greater than the input voltage.

    (d) will be less than, equal to or greater than the input voltage.

22. If a unit-step current is passed through a capacitor, what will be the voltage across the capacitor?

    (a) Zero

    (b) A step function

    (c) A ramp function

    (d) An impulse function

23. A two-port network has $Z_{11}=11/35$, $Z_{12}=Z_{21}=2/35$, $Z_{22}=3/35$. Its Y_{11} and Y_{12} parameters will, respectively be

    (a) 3, -2

    (b) 3, 2

    (c) 13, -2

    (d) 13, 2

24. Two-port networks are connected in parallel. The combination is to be represented as a single two-port network. The parameters of this network are obtained by addition of the individual

    (a) z-parameters

    (b) h-parameters

    (c) y-parameters

    (d) ABCD parameters

25. What is the value of R in the circuit?
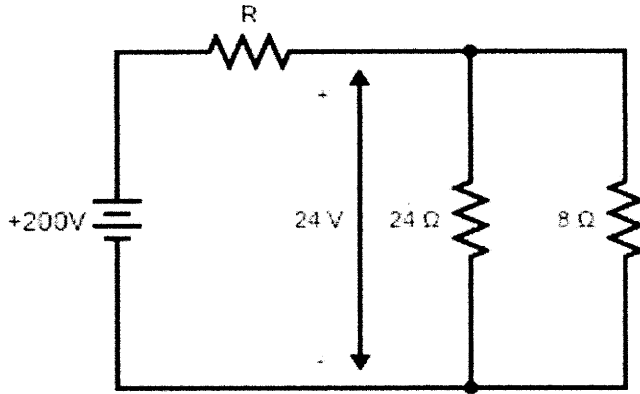
(a) $4\,\Omega$ (b) $40\,\Omega$

(c) $44\,\Omega$ (d) $440\,\Omega$

26. Thevenin equivalent voltage V_{AB} and resistance R_{Th} across the terminals AB in the below circuit are.
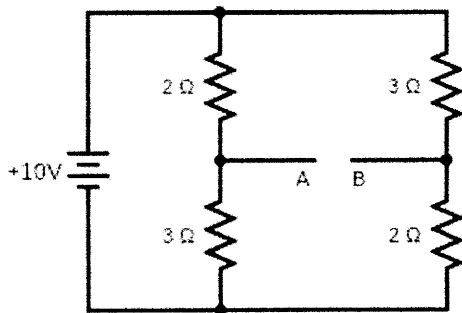
(a) $6V, 5\,\Omega$ (b) $4V, 5\,\Omega$

(c) $2V, 2.4\,\Omega$ (d) $2V, 2.5\,\Omega$

27. The dual of a parallel R-C circuit is a

(a) Series R-C circuit   (b) Series R-L circuit

(c) Parallel R-C circuit   (d) Parallel R-L circuit

28. As the Fermi energy of silver is 8.8×10^{-19} Joule, the velocity of the fastest electron in silver at $0°K$ (Given: Rest mass of electron $= 9.1 \times 10^{-31}$ kg) is

(a) 1.39×10^{6} m/s   (b) 7.22×10^{9} m/s

(c) 9.21×10^{7} m/s   (d) 3.33×10^{6} m/s

29. At $0°K$, semiconductor materials have same structure as _____ except the difference in the size of band gap.

(a) Metals   (b) Conductors

(c) Insulators   (d) None of these

30. A 'hole' in a semiconductor has

1. Positive charge equal to the electron charge
2. Positive mass equal to the mass of the electron
3. An 'effective mass' greater than the 'effective mass' of electron
4. Negative mass and positive charge equal to the charge in nucleus

Which of these statements are correct?

(a) 1 and 4 only   (b) 1 and 3 only

(c) 2 and 4 only   (d) 3 and 4 only

31. Electron mobility and life time in a semiconductor at room temperature are respectively $0.36 \, m^2/(Vs)$ and $340 \, \mu s$. The diffusion length is

(a) 9,11 mm   (b) 1.77 mm

(c) 5.77 mm   (d) 2.87 mm

32. In which region are both the collector-base and base-emitter junctions forward-biased?

(a) Active   (b) Cutoff

(c) Saturation   (d) Non-saturation

33. Which among the following is an example for a voltage bidirectional two quadrant switch?

(a) SCR   (b) BJT

(c) Diode   (d) MOSFET

34. FET has offset voltage of about

(a) 0.2 V   (b) 0.9 V

(c) 0.7 V   (d) 0 V

35. The concentration of minority carriers in an extrinsic semiconductor under equilibrium is

(a) directly proportional to the doping concentration.

(b) inversely proportional to the doping concentration.

(c) directly proportional to the intrinsic concentration.

(d) inversely proportional to the intrinsic concentration.

36. In an n–type silicon crystal at room temperature, which of the following can have a concentration of $4 \times 10^{19}/cm^3$?

(a) Silicon atoms   (b) Holes

(c) Dopant atoms   (d) Valence electrons

37. For a base current of $10 \, \mu A$, what is the value of collector current in a common emitter transistor if $\beta_{dc} = 100$?

(a) $10 \, \mu A$ (b) $100 \, \mu A$

(c) 1 mA   (d) 10 mA

38. A small leakage current in SCR forward conduction type mode flows in _____ direction.

(a) anode to cathode   (b) anode to ground

(c) cathode to anode   (d) cathode to ground

39. The final value of a system whose transfer function is represented by $F(s) = \dfrac{s+1}{s^2 + 2s + 5}$ is,

(a) infinity   (b) 0

(c) 0.7   (d) unity

40. A network has 10 nodes and 17 branches. The number of different node pair voltage would be

(a) 25   (b) 35

(c) 45   (d) 55

41. Unit step response of the system described by difference equation $y(n) + y(n-1) = x(n)$ is

(a) $\dfrac{z^2}{(z+1)(z-1)}$ (b) $\dfrac{2z}{(z+1)(z-1)}$

(c) $\dfrac{2(z+1)}{(z-1)}$ (d) $\dfrac{z(z-1)}{2(z+1)}$

42. If $X(z)$ is $\dfrac{1}{1-z^{-1}}$ with $|z| > 1$, then what is the corresponding $x(n)$?

    (a) e^{-n} (b) e^{n}

    (c) $u(n)$ (d) $u(n)e^{-n}$

43. A piezoelectric crystal has Young's modulus of 130 GPa. The uniaxial stress that must be applied to increase its polarization from 550 to 555 C m^{-2} is

    (a) 3.732 GPa   (b) 0.312 GPa

    (c) 1.961 GPa   (d) 1.182 GPa

44. If an impedance Z_L is connected across a voltage source V with source impedance Z_S, then for maximum power transfer, the load impedance must be equal to

    (a) source impedance Z_S (b) complex conjugate of Z_S

    (c) real part of Z_S (d) imaginary part of Z_S

45. A DC voltage source is connected across a series R-L-C circuit. Under steady state conditions, the applied DC voltage drops entirely across the

    (a) R only   (b) L only

    (c) C only   (d) R and L combination

46. When determining Thevenin's resistance of a circuit

    (a) all sources must be open circuited

    (b) all sources must be short circuited

    (c) all voltage sources must be open circuited and all current sources must be short circuited

    (d) all sources must be replaced by their internal resistances

47. The Fourier transform of a signal $h(t)$ is $H(j\omega) = (2\cos\omega)(\sin 2\omega)/\omega$. The value of $h(0)$ is

    (a) 3.9   (b) 2.5

    (c) 1   (d) 0

48. Two of the angular frequencies at which its Fourier transform becomes zero are

    (a) $\pi, 2\pi$ (b) $2\pi, 4\pi$

    (c) $4\pi, 8\pi$ (d) $8\pi, 16\pi$

49. If a signal $f(t)$ has energy E, the energy of the signal $f(2t)$ is equal to

    (a) E^2 (b) $E/2$

    (c) $2E^2$ (d) $9E$

50. A time invariant system is a system whose output

    (a) increases with a delay in input   (b) decreases with a delay in input

    (c) remains same with a delay in input   (d) vanishes with a delay in input

**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. Define Region of Convergence (ROC) for Laplace Transform. Write down its properties.

2. Explain with a circuit diagram how a zener diode works as a voltage regulator.

3. What are the main differences between BJT and FET? What are the factors that affect the bias stability of a transistor?

4. Derive the expression of Fourier series in exponential form.

5. By means of the convolution theorem, show that,

$$LT^{-1}\left[\frac{s}{(s^2+a^2)^2}\right]=\frac{t}{2a}\,sinat\,.$$

6. Determine the Z-parameters for the resistive network shown in Figure.
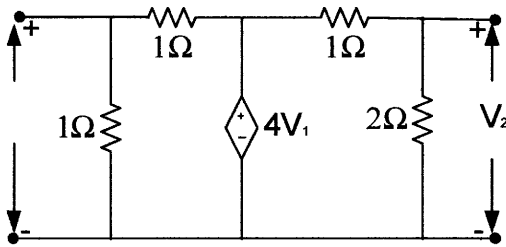
7. Expain the working and construction of Complementary Metal Oxide Semiconductor (CMOS).

8. The relative dielectric constant of Al_2O_3 is 8. The dielectric constant of free space is 8.854×10^{-12} F/m. What is the capacitance of a layer of Al_2O_3 which is 0.5×10^{-6} m thick and has 1000 mm^2 of surface area?

9. Show and explain the dipole characteristics of ferromagnetic and ferrimagnetic materials.

10. Assuming an operating temperature T = 300K and corresponding V_T = 25 mV, what is the change in semiconductor silicon diode forward voltage V_D to produce a 10:1 change in diode current I_D, while operating in the forward bias region (< 25 mA)?

11. A bipolar junction transistor is in the saturation region. Given V_{CC}=10V, R_C=1kΩ, h_{FE}=100 and $V_{CE,sat}$=0.3V. What is the collector current in saturation?

12. Explain Hall Effect with proper diagram.

13. For a continuous-time systems, state variable representation $\frac{d}{dt}q(t)=Aq(t)+bx(t)$. What is the corresponding representation of discrete-time system?

14. For a random variable x having the probability density function (PDF) as shown in below figure, what are the values of the mean and the variance, respectively.
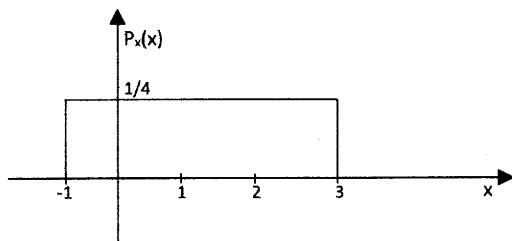
15. A casual discrete time LTI system is described by $y(n) - \frac{3}{4}y(n-1) + \frac{1}{8}y(n-2) = x(n)$, where $x(n)$ and $y(n)$ are the input and output of the system respectively. Determine the system function $H(z)$.

16. The complex exponential Fourier series representation of a signal $f(t)$ over the interval $(0, T)$ is

$$f(t) = \sum_{n=-\infty}^{+\infty} \frac{3}{4 + (n\pi)^2} e^{jn\pi t}$$. Determine the numerical value of T.

17. What load resistance connecting X and Y will draw maximum power? What is the value of the power?
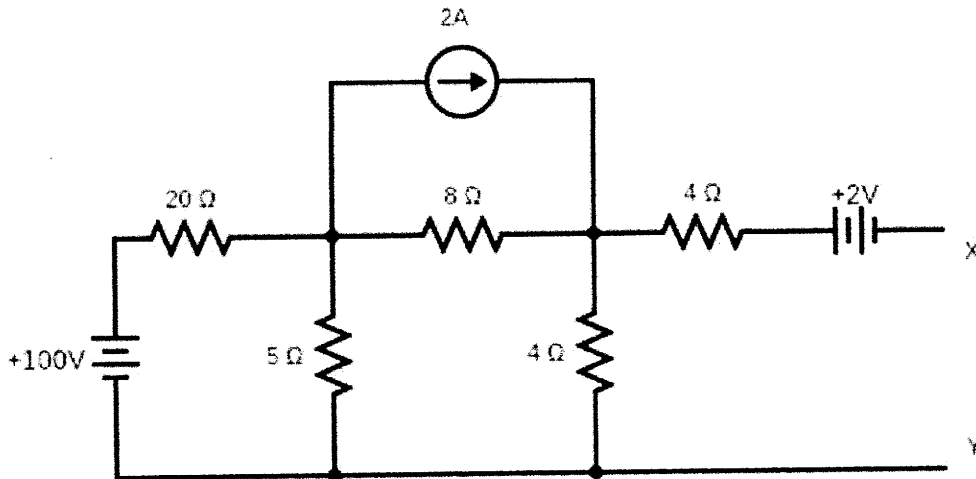
18. Explain briefly the small signal model for MOSFET.

19. Draw the block diagram of the system represented by the following constant co-efficient difference equation: $y(n) = b_0 x(n) + b_1 x(n-1) + ay(n-1)$; where, $x(n)$ is the input sequence and $y(n)$ is the output sequence.

20. State the condition for Norton's theorem, and explain it with an example.

* * * * * * *