MIZORAM PUBLIC SERVICE COMMISSION

TECHNICAL COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF MIZORAM ENGINEERING SERVICE (M.E.S.) UNDER PUBLIC HEALTH DEPARTMENT, GOVERNMENT OF MIZORAM, MARCH, 2019.

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. A relay has a resistance of 300 V. It is switched on to a 110 V DC supply. If the current reaches 63.2 % of its final steady value in 0.002 second then the inductance of the circuit will be

(a) 0.001 H (b) 0.002 H

(c) 0.06 H (d) 0.6 H

2. The derivative of a step function is

(a) 0 (b) an impulse function

(c) a ramp function (d) a constant

3. An RC circuit initially at rest has a step signal u(t) giving a response $V_c(t)$ across the capacitor where $V_c(t) = 1 - e^{-2t}$. It there is an initial voltage $V_o = 1.0$ on the capacitor and the signal is 2 u(t) the response $V_c(t)$ is

(a) $2 - 2e^{-2t}$ (b) $2 - e^{-2t}$

(c) $3 - e^{-2t}$ (d) 1

4. Which one of the given sets functions of 'i' will form the solution of the differential equation $\frac{d^2i}{dt^2} + 3\frac{di}{dt} + 2i = 0$?

(a) Ke^{-2t}, Ke^{t} (b) Ke^{2t}, Ke^{-t}

(c) Ke^{2t}, Ke^{t} (d) Ke^{-2t}, Ke^{-t}

5. The Laplace transform of the response of a circuit to some excitation is $I(s) = \frac{s+3}{(s+1)^2}$. The time domain current i(t) is given by,

(a) $e^{-t} + 2te^{-t}$ (b) $2e^{-t} + te^{-t}$

(c) $e^{-t} + te^{-t}$ (d) $e^{-t} + 3te^{-t}$

6. The transformed current in a certain branch of a circuit is $\frac{(2s+5)}{(s+1)(s+3)}$. The value of the current for t=0 is

(a) 0 (b) 2

(c) 3 (d) 5

7. Which of the following relation among two port parameters is not correct?

(a) $y_{12} = -\frac{h_{12}}{h_{11}}$ (b) $z_{12} = \frac{h_{12}}{h_{22}}$

(c) $B = -\frac{h_{12}}{h_{22}}$ (d) None of these

8. For a two port network transmission parameters are A = 6, B = 45 W, C = 1.5 S, D = 3. What are the values of input impedances when the output terminals are short circuited and open circuited?

(a) 7.5 W (open-circuited), 2 W (short-circuited)

(b) 4 W (open-circuited), 15 W (short-circuited)

(c) 2 W (open-circuited), 7.5 W (short-circuited)

(d) 15 W (open-circuited), 4 W (short-circuited)

9. Which among the following is also regarded as "Dual of Thevenin's Theorem"?

(a) Norton's Theorem (b) Superposition Theorem

(c) Millman's Theorem (d) Maximum Power Transform Theorem

10. If a network comprises purely resistive elements, what will it provide from the following?

(a) Phase Shift (b) Attenuation

(c) Both (a) & (b) (d) None of these

11. What is an ideal value of network function at poles?

(a) Zero (b) Unity

(c) Infinity (d) Finite and non-zero

12. Which elements act as an independent variables in Y-parameters?

(a) Current (b) Voltage

(c) Both (a) & (b) (d) None of these

13. Why does the Superposition Theorem not applicable to power?

(a) Because it is proportional to square of current and current is a non-linear function

(b) Because it is proportional to square of voltage and voltage is a non-linear function

(c) Both (a) & (b)

(d) None of these

14. Two ports containing no sources in their branches are called?

(a) active ports (b) passive ports

(c) one port (d) three port

15. n-type silicon in obtained by doping silicon with

(a) Germanium (b) Aluminium

(c) Boron (d) Phosphorus

16. Electron mobility and life time in a semiconductor at room temperature are respectively 0.36 m^2/(V-s) and 340 ms. The diffusion length is

(a) 3.13 mm (b) 1.77 mm

(c) 3.55 mm (d) 3.13 cm

17. The ratio of the minority to majority diffusion coefficient, $\left(\frac{D_p}{D_n}\right)$ for germanium is

(a) 2 (b) 0.5

(c) 3 (d) 0.33

18. A semiconductor specimen of breadth (d), width (w) and carrying current (I) is placed in a magnetic field (B) to develop Hall voltage (V_H) in a direction perpendicular to I and B. V_H is not proportional to

(a) B (b) I

(c) 1/w (d) 1/d

19. Long wavelength threshold for silicon at room temperature is

(a) 1.13 mm (b) 1.73 mm

(c) 1 mm (d) 1.21 mm

20. The intrinsic carrier concentration of silicon sample at 300 K is $1.5\times10^{16}/m^3$. If after doping, the number of majority carriers is $5\times10^{20}/m^3$, the minority carrier density is

(a) $4.5\times10^{11}/m^3$ (b) $3.33\times10^{4}/m^3$

(c) $5\times10^{20}/m^3$ (d) $3\times10^{-5}/m^3$

21. The depletion region in a semiconductor p-n junction diode has

(a) Electrons and holes (b) Positive and negative ions on either side

(c) Neither electrons nor ions (d) No holes

22. The shot noise in photoconductive photodiodes is expressed by (the terms have their usual meaning)

(a) $I_n = \sqrt{2qI_d\Delta f}$ (b) $I_n = 2qI_d\Delta f$

(c) $I_n = \sqrt{2KRT\Delta f}$ (d) None of these

23. The photoconductive cells most popularly used for visible light spectrum uses

(a) Ge (b) Si

(c) GaAs (d) CdS

24. The type of bypass capacitor that work best at high frequency is

(a) Electrolytic (b) Mica

(c) Ceramic (d) Plexiglass

25. At 25 °C, the collector-emitter voltage drop of a silicon transistor at saturation is approximately

(a) 0.2 V (b) 0.3 V

(c) 0.5 V (d) 0.7 V

26. A CE-amplifier has an upper 3 db frequency of 20 kHz. If two such stages are cascaded together, the new upper 3 db frequency would be

(a) 13 kHz (b) 31.25 kHz

(c) 8.28 kHz (d) 9.9 kHz

27. If $\alpha = 0.995$, $I_E = 10$ mA and $I_{co} = 0.5$ mA, then I_{CEO} will be,

(a) 100 mA (b) 200 mA

(c) 300 mA (d) 400 mA

28. Early effect in BJT refers to

(a) Avalanche breakdown (b) Thermal runway

(c) Base narrowing (d) Zener breakdown

29. The unit of thermal resistance of a semiconductor device is

(a) Ohms (b) Ohms/°C

(c) °C/Ohm (d) °C/Watt

30. FET has offset voltage of about

(a) 0.2 V (b) 1.1 V

(c) 0.6 V (d) 0 V

31. In CMOS logic circuit the n-MOS transistor acts as:

(a) Load (b) Pull up network

(c) Pull down network (d) Not used in CMOS circuits

32. When both nMOS and pMOS transistors of CMOS logic design are in OFF condition, the output is:

(a) 1 or V_{DD} or HIGH state (b) 0 or ground or LOW state

(c) High impedance or floating (Z) (d) None of these

33. In clocked CMOS logic, output in evaluated in

(a) ON period (b) OFF period

(c) both ON and OFF periods (d) half of ON period

34. An SCR is a solid state equivalent of

(a) Triode (b) Pentode

(c) Gas-filled triode (d) Tetrode

35. In normal operation of an SCR, gate is _____ with respect to cathode

(a) Positive (b) Negative

(c) At zero potential (d) None of these

36. Hall effect device can be used to

(a) Multiply two signals

(b) Divide one signal by another on an instantaneous basis

(c) Add two signals

(d) Subtract one signal from another

37. The device possessing the highest photosensitivity is a

(a) Photoconductive cell (b) Photovoltaic cell

(c) Photodiode (d) Phototransistor

38. The electrical conductivity of metals is typically of the order of (in $Ohm^{-1}m^{-1}$)

(a) 10^7 (b) 10^5

(c) 10^{-4} (d) 10^{-6}

39. Fourier transform of f(t) = d(t) is

(a) $\frac{1}{\omega}$ (b) $\frac{\omega}{2}$

(c) 1 (d) $1-\frac{\omega}{2}$

40. The Laplace transform of $e^{\alpha t}$ is

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

(c) $\frac{1}{s^2}e^{\alpha t}$ (d) None of these

41. The inverse Laplace transform of $\frac{1}{(s-\alpha)^3}$ is

(a) $e^{\alpha t}$ (b) $\frac{1}{2}t^2$

(c) $\frac{1}{3}t^2e^{-\alpha t}$ (d) None of these

42. The initial value of $F(s)=\frac{1}{s(s^2+3s+2)}$ is given by

(a) 0.5 (b) 1

(c) 0.8 (d) 0.2

43. The system y(t) = 3x(t) + 4 is

(a) Linear system (b) Non-linear system

(c) Partly (a) and partly (b) (d) None of these

44. A continuous time system with impulse response $h(t) = e^{at}\,u(t)$ is stable and casual when

(a) Stable for a < 0 (b) Casual for all a

(c) Stable for all a and casual for a = 0 (d) Stable for a = 5 and casual for a < 0

45. Memory in a discrete time system is analog of

(a) Energy storage in a continuous time system

(b) Memory in a continuous time system

(c) Sampled memory of a continuous time LTI system

(d) All of these

46. For a linear system $y = f(x)$ find the valid points

(a) $f[x(t+T)]=f[x(t)]+f[x(T)]$ (b) $f(kx)=kf(x)$

(c) $f(x_1+x_2)=f(x_1)+f(x_2)$ (d) All are correct

47. The trigonometric Fourier series of an even function of time does not contain

(a) Sine term (b) Odd harmonic term

(c) Cosine term (d) DC term

48. If F(w) be the Fourier transform of f(t), then Fourier transform of f(t-a) is

(a) $F(w)e^{-jwa}$ (b) $F(w)e^{jwa}$

(c) $aF(w)e^{jwa}$ (d) $\frac{1}{a}F(\omega)e^{-j\omega a}$

49. Z-transform $X(z)$ of the sequence $x(n)$ is given by

(a) $X(z)=\sum_{0}^{\infty}x(n)\left(\frac{1}{z}\right)^n$ (b) $X(z)=\sum_{-\infty}^{0}x(n)\left(\frac{1}{z}\right)^n$

(c) $X(z)=\sum_{-\infty}^{\infty}|x(n)|\left(\frac{1}{z}\right)^n$ (d) $X(z)=\sum_{-\infty}^{\infty}x(n)\left(\frac{1}{z}\right)^n$

50. Z-transform of [ax(n) + by(n)] is

(a) ax(n) – by(n) (b) ax(n) – y(n)

(c) ax(n) + by(n) (d) x(n) – by(n)

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. A certain homogenous slab of lossless dielectric material is characterized by an electric suspectibility of 0.12 and carries a uniform flux density with in it of 1.6 nC/m^2. Find the electric field intensity, the polarization if there are 2×10^{19} dipoles per cubic meter and the voltage between two equipotential 2.54 cm apart.

2. Explain the phenomenon of superconductivity. Briefly explain its salient features, mechanism and applications.

3. Draw sketches illustrating a (100) plane, a (110) plane, and a (111) plane in a cubic unit cell. How many equivalent (100) planes are there in a cubic crystal?

4. Distinguish between the following:
   (a) Conductivity and Mobility
   (b) Piezoelectric and Ceramic

5. Certain metal works as superconductor below the critical temperature $T_C = 7.2^\circ$K. The critical magnetic field for the metal at 0°K is 7.8×10^5Amp/m. What is the critical magnetic field for the metal to be usable as superconductor at 5°K?

6. Show that a semiconductor has minimum conductivity at a given temperature when:

$n = n_i\sqrt{\mu_h / \mu_e}$ and $p = n_i\sqrt{\mu_e / \mu_h}$. n, p, n_i, μ_e and μ_h are usual meaning.

7. What parameters determine the threshold voltage, V_T of a MOS device? How can V_T be controlled?

8. A Silicon NMOS device has gate width W=100μm (10^{-4}m), gate length L=2μm (2×10^{-6}m), oxide thickness, T_{ox}=0.2 μm (2×10^{-7}m), relative dielectric constant of oxide ϵ_{ox}=3.9 and electron mobility μ_n=0.08m^2/V-sec. Finds the trans conductance of the device in the linear region of operation for drain voltage V_D=1V.

9. What is photodiode? Draw typical I-V characteristic curves at two illumination levels and explain how it works as a photoresistor.

10. Explain Hall Effect. An n-type germanium sample is 2 mm wide and 0.2 mm thick. A current of 10 mA is passed through the sample (x-direction) and a field of 0.1 Weber/m^2 is directed perpendicular to the current flow (z-direction). The developed Hall voltage is – 1.0 mV. Calculate the Hall constant.

11. With mathematical expressions, define the properties 'stability' and 'causality' of a system.

12. With the sketches of waveforms, explain the four classes of signals (periodic continuous time signals, aperiodic continuous time signal, periodic discrete time signal, aperiodic discrete time signal), mention the Fourier representation applicable to these four classes of signals.

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

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

14. Solve the following difference equation using z-transform:

$y[n+2] - 5y[n+1] + 6y[n] = 3x[n+1] + 5x[n]$.

It is given that y[-1]=11/6, y[-2]=37/36 and input $x[n]=[2]^{-n}u[n]$.

15. Evaluate the cross-correlation between the following signals:

$x(t)=u(t)-2u(t-1)+u(t-2)$

$y(t)=u(t+1)-u(t)$

16. State clearly the Thevenin's Theorems and explain their usefulness in linear network.

17. State Tellegen's Theorem. Enumerate the implication of this theorem.

18. Obtain the transform impedances and admittances of

(a) a resistor with initial current

(b) an inductor with initial current

19. Design a delay line using T-sections with characteristic impedance R_0=600 Ω. Total delay=1.5 msec and rise time of 0.4 msec.

20. A certain 2-terminal linear network, including a generator, has an open-circuit voltage of 125 V, and on short circuit produces a current of 5.59 A. When a 10 Ω resistive load is connected, the load current is 4.41 A. Find Thevenin's equivalent of this network. How could the sign of reactance be determined?

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