MIZORAM PUBLIC SERVICE COMMISSION

COMPETITIVE EXAMINATIONS FOR JUNIOR GRADE OF M.E.S. UNDER POWER & ELECTRICITY DEPARTMENT, AUGUST, 2018.

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. Which of the following material is not used as a piezoelectric transducer?
(a) Rochelle (b) Lithium sulphate
(c) Barium titanate (d) Tungsten oxide

2. If one of the diode in a full wave bridge rectifier opens, the output is
(a) 0 V
(b) One-fourth the amplitude of the input voltage
(c) A half wave rectifier voltage
(d) 120 V

3. If for a silicon n-p-n transistor, the base-to-emitter (V_{BE}) is 0.7V and collector-to-base(V_{CB}) is 0.2V, then the transistor is operating in the
(a) Normal active mode (b) Saturation mode
(c) Invererse active mode (d) Cut-off mode

4. Two P-N junction diodes are connected back to back to make a transistor. Which one of the following is correct?
(a) The current gain of such a transistor is high
(b) The current gain of such a transistor is moderate
(c) It cannot be used as a transistor due to large base width
(d) It can be used only for PNP transistor

5. Which of the following is a passive transducer?
(a) Piezoelectric (b) Thermocouple
(c) Photovoltaic cell (d) LVDT

6. . Electrolytic Capacitors are generally made of
(a) Aluminium (b) Copper
(c) Gold (d) Plastic

7. A photocell is illuminated by a small bright source placed 1m away. When the same source of light is placed 2 m away. The electrons emitted by the photocathode
(a) Each carry one quarter of their previous energy
(b) Each carry one quarter of their previous moments
(c) as half as numerous
(d) are one quarter as numerous.

8. With an increase in temperature, the Fermi level in an intrinsic semiconductor
(a) Moves closer to the conduction band edge
(b) Moves closer to the valance band edge
(c) Moves to the conduction band
(d) Remain at the centre of the forbidden gap.

9. The depletion layer in a p-n junction is made of which of the following
(a) Ionized acceptors in p-side and ionized donors in n-side
(b) Ionized donors in p-side and ionized acceptors in n-side
(c) Accumulated holes in p-side and accumulated electrons in n-side
(d) Accumulated electrons in p-side and accumulated holes in n-side

10. Which of the following has the highest input resistance?
(a) NPN transistor in CB configuration
(b) PNP transistor in CE configuration
(c) p-type channel MOSFET
(d) n- type channel MOSFET

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

12. How many SCR are to be connected in series with 800 V rating to be used for 3KV circuit using derating factor of 15%?
(a) 3
(b) 4
(c) 5
(d) 6

13. Ultraviolet radiation is used in IC fabrication process for
(a) Diffusion
(b) Masking
(c) Isolation
(d) Metallization

14. The electron hole concentrations in an intrinsic semiconductor are n_i per cm^3 at 300 k. If acceptor impurities are introduced with concentration of N_A per cm^3 (where $N_A >> n_i$) the electron concentration per cm^3 at 300 k will be
(a) n_i
(b) n_i^2 / N_A
(c) $N_A + n_i$
(d) $N_A - n_i$

15. Thin gate oxide in a CMOS process is preferablly grown using
(a) Wet oxidation
(b) Dry oxidation
(c) Epitaxial deposition
(d) Ion implementation

16. A silicon sample is uniformly doped with 10^{16} phosphorus atoms/cm^3 and $2x10^{16}$ boron atoms/cm^3. If all the dopants are fully ionized, the material is
(a) N-type with carrier concentration of $10^{16}/cm^3$
(b) P-type with carrier concentration of $10^{16}/cm^3$
(c) P-type with carrier concentration of $2x10^{16}/cm^3$
(d) N-type with carrier concentration of $2x10^{16}/cm^3$

17. The diffusion capacitance of a P-N junction
(a) Decreases with increasing current and increasing temperature
(b) Decreases with decreasing current and increasing temperature
(c) Increases with increasing current and increasing temperature
(d) Does not depend on current and temperature

18. Pinch-off voltage for a FET is the drain voltage at which

(a) Significance drain current starts flowing (b) Drain current becomes zero

(c) All free charges get removed from the channel (d) Avalanche breakdown takes place

19. The effective channel length of a MOSFET in saturation decreases with increase in

(a) Gate voltage (b) Drain voltage

(c) Source voltage (d) Body voltage

20. The period of the function

(a) $\frac{1}{8}$ sec (b) 8 Sec

(c) 4 sec (d) $\frac{1}{4}$ sec

21. A composed signal is given by $x(t)=Cos(\omega t)+Sin(\omega t)+Sin^2(\omega t)+Cos(\omega t)Sin^2(\omega t)$. The odd component is

(a) $Cos(\omega t)$ (b) $Sin(\omega t)$

(c) $Sin^2(\omega t)$ (d) $Cos(\omega t)Sin^2(\omega t)$

22. The power in the signal $x(t)=8Cos\left(20\pi t-\frac{\pi}{2}\right)+4Sin(15\pi t)$

(a) 40 (b) 41

(c) 42 (d) 82

23. Which of the following is a causal system?

(a) $y(t)=x(t^2)$ (b) $y(t)=x^2(t)$

(c) $y(t)=x(-t)$ (d) $y(t)=x(2t)$

24. If F_s is sampling frequency then the relation between analog frequency F and digital frequency f is

(a) $f=\frac{F}{2F_s}$ (b) $f=\frac{F_s}{F}$

(c) $f=\frac{F}{F_s}$ (d) $f=\frac{2F}{2F_s}$

25. For even function, the necessary condition is

(a) $f(t)=-f(-t)$ (b) $f(t)=+f(-t)$

(c) $f(t)=\frac{1}{f(-t)}$ (d) $f(t)=-f\left(t-\frac{T}{2}\right)$

26. In a signal x(n), if 'n' is replaced by $\frac{n}{3}$, then it is called,

(a) Upsampling (b) Folded version

(c) Downsampling (d) Shifted version

27. A system is defined by its impulse response $h(n)=5^n u(n-5)$. The system is

(a) Unstable & non-causal (b) Stable & causal

(c) Unstable & causal (d) Stable & non-causal

28. Two systems with impulse responses $h_1(n)$ and $h_2(n)$ are connected in parallel. Then the overall impulse response of the system is given by

(a) Product of $h_1(n)$ and $h_2(n)$ (b) Sum of $h_1(n)$ and $h_2(n)$

(c) Convolution of $h_1(n)$ and $h_2(n)$ (d) Subtraction of $h_1(n)$ from $h_2(n)$

29. The output of a system whose impulse response is $h(t)=e^{-\alpha t}$ for a delta input is

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

(c) $(1-\alpha)e^{-\alpha t}$ (d) $\alpha e^{-\alpha t}$

30. For distortionless transmission the amplitde & phase response are respectively

(a) Zero & constant (b) Constant & linear

(c) Infinite & zero (d) Linear & non-linear

31. The frequency spectrum of an aperiodic signal is

(a) Continuous (b) Discrete

(c) Both Continuous & Discrete (d) None

32. Parseval's identity states that $\sum_{n=-\infty}^{\infty}\left|x(n)\right|^2$ is

(a) $\frac{1}{2\pi j}\int_{-\pi}^{\pi}\left|X\left(e^{j\omega}\right)\right|^2 d\omega$ (b) $\int_{-\pi}^{\pi}\left|X\left(e^{j\omega}\right)\right|^2 d\omega$

(c) $2\pi\int_{-\pi}^{\pi}\left|X\left(e^{j\omega}\right)\right|^2 d\omega$ (d) $\int_{-\pi}^{\pi}[\frac{1}{2\pi}\left|X\left(e^{j\omega}\right)\right|]^2 d\omega$

33. The Fourier transform of $ACos\,\Omega_0 t$ is given by

(a) $A\pi[\delta(\Omega-\Omega_0)+\delta(\Omega+\Omega_0)]$ (b) $A\pi\,\delta(\Omega-\Omega_0)$

(c) $A\pi\,\delta(\Omega+\Omega_0)$ (d) $A\pi[\delta(\Omega-\Omega_0)-\delta(\Omega+\Omega_0)]$

34. The trigonometric Fourier series of an even function does not have the

(a) dc term (b) cosine terms

(c) sine terms (d) odd harmonic terms

35. The ROC for a finite duration non-causal signal is

(a) Entire Z-plane (b) Entire Z-plane except Z = 0 and Z = ∞

(c) Entire Z-plane except Z = 0 (d) Entire Z-plane except Z = ∞

36. If $X(z)=\frac{1}{1-z^2}$ then initial & final values of x(n) are respectively

(a) 1, 0 (b) 0, 1

(c) $\frac{1}{2}$, 1 (d) 1, $\frac{1}{2}$

37. Consider the Z-transform $X(z)=5Z^2+4Z^{-1}+3; 0<|Z|\infty$. The inverse Z-transform x(n) is

(a) $5\delta(n+2)+3\delta(n)+4\delta(n-1)$ (b) $5\delta(n-2)+3\delta(n)+4\delta(n+1)$

(c) $5\delta(n+2)+3u(n)+4u(n-1)$ (d) $5u(n-2)+3u(n)+4u(n+1)$

38. *H(s)* is the transfer function $H(s)=\frac{s}{s^2-s-2}(\sigma<-1)$. Then function is

(a) Causal & stable (b) Causal & unstable

(c) Non-causal & stable (d) Non-causal & unstable

39. A linear time invarient, causal, continuous time system has a natural transfer function with sample poles at s = -2 and s = -4, and one sample zero at s = -1. A unit step u(t) is applied at the input of the system. A steady state output has constant value 1. Theimpulse response of this system is

(a) $-4e^{-2t}\,u(t)$ (b) $-12e^{-4t}\,u(t)$

(c) $(-4e^{-2t}+12e^{-4t})\,u(t)$ (d) $-4e^{-4t}\,u(t)$

40. The internal resistance of a baterry which has an open circuit voltage of 12V deliver a current of 100A to a load resistance of 0.1 Ω is

(a) 2 Ω (b) 200 mΩ

(c) 20 mΩ (d) 2 mΩ

41. Two 2H inductance coil are connecetd in series and are also magnetically coupled to each other with coefficient of coupling being 0.1. The total inductance of the combination can be

(a) 0.4 H (b) 3.2 H

(c) 4 H (d) 4.4 H

42. The nodal method of circuit analysys is based on

(a) Kirchhoff's Voltage law and Ohm law

(b) Kirchhoff's Current law and Ohm law

(c) Kirchhoff's Current law and Kirchhoff's Voltage law

(d) Kirchhoff's Voltage law, Kirchhoff's Voltage law and Ohm law

43. The average power deliverd to an impedance (4-j3) Ω by a current 5Cos(100 πt + 100)A is

(a) 44.2 W (b) 50 W

(c) 62.5 W (d) 125W

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. Superposition theorem is not applicable to networks containing

(a) Non-linear elements (b) Dependent voltage source

(c) Dependent current source (d) Transformer

46. A source of angular frequency 1rad/sec has a source impedance consisting of 1 Ω resistance in series with 1H inductance. The load that will obtain the maximum power transfer is

(a) 1 Ω resistance

(b) 1 Ω resistance in parallel with 1H inductance

(c) 1 Ω resistance in series with 1F capacitance

(d) 1 Ω resistance in parallel with 1F capacitance

47. The current i(t), through a 20 Ω resistor in series with inductance, is given by $i(t) = 3+4 \text{ Sin}(100t+45^0) + 4 \text{ Sin}(300t + 60^0)$ A. The rms value of the current and the power dessipated in the circuit are

(a) $\sqrt{41}A$, 410W respectively (b) $\sqrt{35}A$, 350W respectively

(c) 5A, 250W respectively (d) 11A, 1210W respectively

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

(a) z- parameters (b) y- parameters

(c) h- parameters (d) ABCD- parameters

49. The condition AD-BC = 1 for a two-port network implies that the network is a

(a) Reciprocal network (b) Lumped element network

(c) Lossless network (d) Unilateral element network

50. A two port network is represented by ABCD parameters given by $\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_1 \\ -I_2 \end{bmatrix}$. If port 2 is terminated by R_L, the input impedance seen at port 1 is given by

(a) $\frac{A+BR_L}{C+DR_L}$ (b) $\frac{AR_L+C}{BR_L+D}$

(c) $\frac{DR_L+A}{BR_L+C}$ (d) $\frac{B+AR_L}{D+CR_L}$

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. State whether the following system is linear, time-invarience, stable and causal $y(n)=a^{\{x(n)\}}$.

2. Determine the periodicity of the continuous time signal given as $x(t) = 2\cos\left(\frac{2\pi t}{3}\right) + 3\cos\left(\frac{2\pi t}{3}\right)$

3. Determine the Laplace transform of $x(t) = \cosh \Omega_0 tu(t)$.

4. Determine the impulse response of the system given as $\frac{d^2y(t)}{dt^2} + 4\frac{dy(t)}{dt} + 3y(t) = \frac{dx(t)}{dt} + 2x(t)$. Assume zero initial conditions.

5. Write down the conditions for exixtance of Fourier Series and Fourier Transform.

6. Perform convolution of the causal signals given as $x_1(t) = \text{Cost } u(t)$, $x_2(t) = t\, u(t)$

7. Determine the unit sample response of the system charectarized by the difference equation $y(n) = 2.5y(n - 1) - y(n - 2) + x(n) - 5x(n - 1) + 6x(n - 2)$.

8. Calculate the coefficient to Trigonometric Fourier series.

9. Consider an n-type semiconductor on which light is incident on one end and is absorbed entirely at the surface to create an excess hole density of $5\times10^{15}/cm^3$ in steady-state at x = 0. Given μ_p=500cm^2/V-s, μ_n = 1200 cm^2/V-s, $n_0 = 10^{18}/cm^3$ and $\tau_p = 2\mu s$. Determine the drift current density for holes and electrons.

10. What is fermi level? Explain how does the Fermi level of a semiconductor changes with doping?

11. A cylindrically shaped section of n-type silicon has a 1mm length and 0.1mm^2 cross-sectional area. Calculate its conductivity and resistance

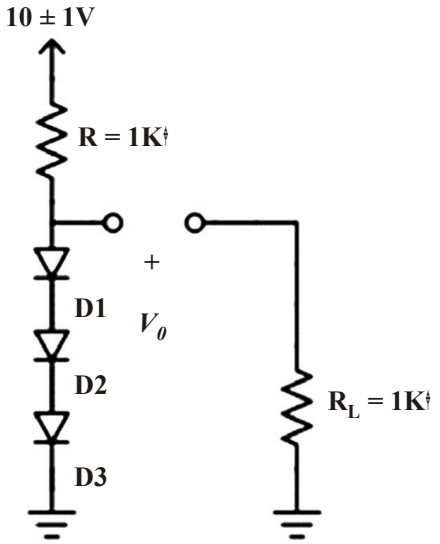
(a) when it is purely intrinsic material

(b) when it has a free electron density of $n= 8\times10^{13}/cm^3$.

12. Consider the circuit shown below a string of three diodes is used to provide a constant voltage of 2.1V. Calculate the percentage change in this regulated voltage caused by

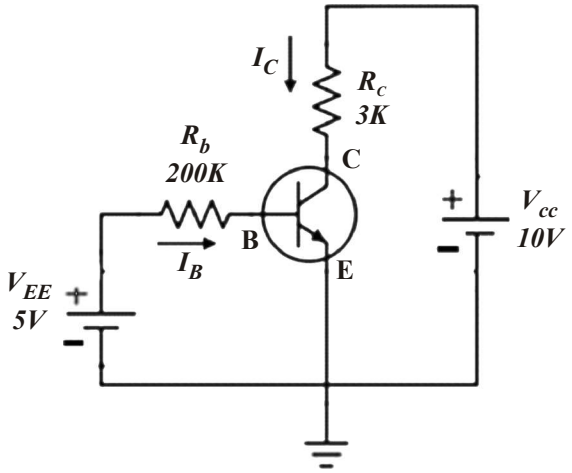
(a) a ± 10% change in the power supply voltage

(b) connection of a 1 KΩ load resistance. Assume n = 2.

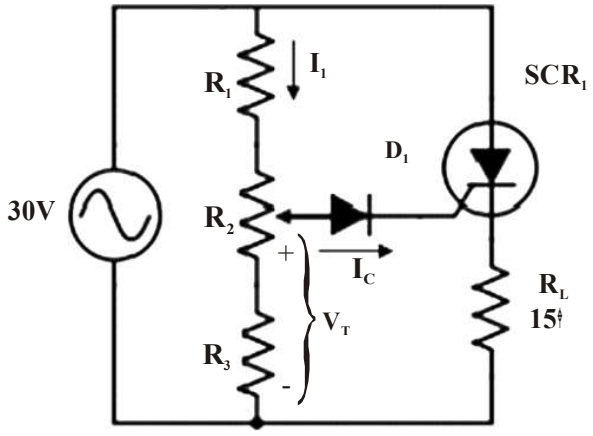


13. Explain how to identify the doping type & doping concentration of a semiconductor with the help of Hall effect?

14. A silicon transistor operating in active region with $V_{BE} = 0.7V$, $\beta = 100$ and I_{co}=20nA is shown below. Find I_B, I_C, V_{CB}.

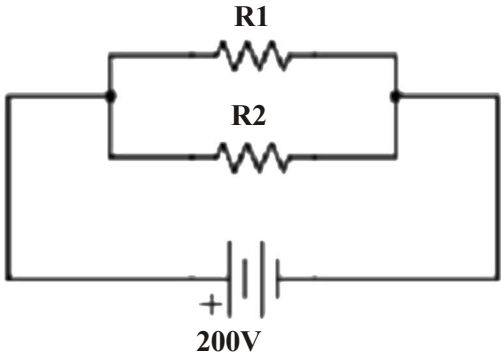


15. The SCR shown below is to be triggered on between 5^0 and 90^0 during the positive half-cycle of the 30V supply. The gate triggering current and voltage are 200μA and 0.8V. Determine the values of R_1, R_2, R_3.



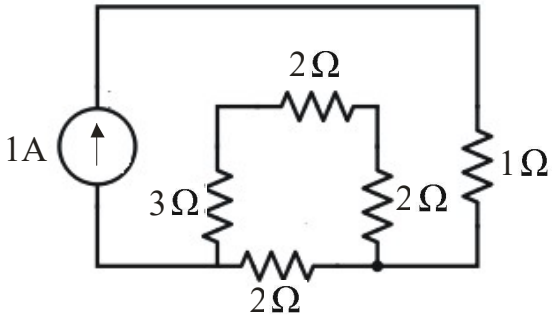
16. Determine the cut-off wavelength for silicon and germanium photodiodes with bandgap energies 1.1eV and 0.72eV respectively at 25^0 C. How the cut-off wavelength change when operating temparature changes from 25^0 C to 200^0C.

17. Two resistors are connected in parallel and a voltage of 200V is applied to the terminals. The total current taken is 25 A and the power dissipated in one of the resistors is 1500 W. What is the resistance of each element?

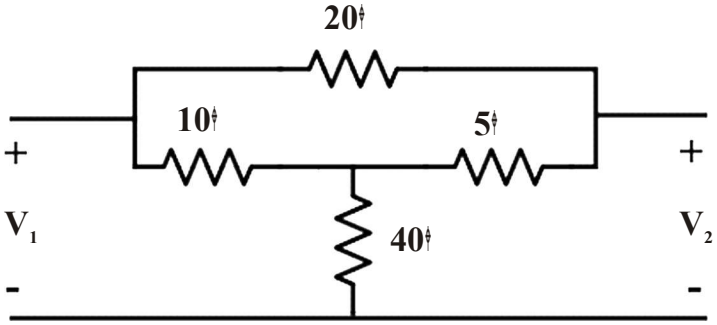


18. State the maximum power transfer theorem. Derive conditions for maximum power transfer for a resistive network and resistive load.

19. Find the current through the 1 Ω resistor in the circuit shown below using Tellegen's theorem.



20. Find the Y parameters for the circuit shown below



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