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ESE – 2019
(PRELIMS)
Questions with Detailed Solutions

ELECTRONICS & TELECOMMUNICATION ENGINEERING

SET – C

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ESE – 2019 Prelims Examination

Electronics & Telecommunication Engineering

Subject Wise Weightage

Subjects	**No. of Questions**	**Marks**
Basic Electrical Engineering	10	20
Materials Science	11	22
Electronic Measurements and Instrumentation	11	22
Network Theory	16	32
Control Systems	11	22
Computer Organization and Architecture	13	26
Digital Circuits & Microprocessors	18	36
Electro Magnetics	14	28
Signals & Systems	5	10
Advanced Electronics	4	8
Analog and Digital Communication Systems	13	26
Advanced Communication	10	20
Analog Circuits	11	22
Basic Electronics Engineering	3	6
Total	**150**	**300**

01. In a 440V, 50 Hz transformer, the total iron loss is 3700 W. When the applied voltage is 220 V at 25 Hz, the total iron loss is 750 W. The eddy current loss at the normal voltage and frequency will be

(a) 1000 W (b) 1200 W (c) 1400 W (d) 1850 W

01. Ans: None

Sol: 440V, 50Hz, 3700W

220V, 25Hz, 750W

$$B_{max} = \frac{V}{f} = \frac{440}{50} = \frac{220}{25} = \text{constant}$$

$$W_h \propto f \Rightarrow W_h = Af$$

$$W_e \propto f^2 \Rightarrow W_e = Bf^2$$

$$W_T = Af + Bf^2$$

$$\Rightarrow A(50) + B(50)^2 = 3700$$

$$A(25) + B(25)^2 = 750$$

$$B = 1.76$$

$\therefore$ Eddy current loss at 50Hz is

$$= Bf^2 = (1.76)\,(50)^2 = 1.76\,(2500) = 4400\text{W}$$

End of Solution

02. A transformer core is wound with a coil carrying an alternating current at a frequency of 50 Hz. The hysteresis loop has an area of 60000 units, when the axes are drawn in units of 10^{-4} Wb m^{-2} and 10^2 Am^{-1}. If the magnetization is uniform throughout the core volume of 0.01 m^3, then the hysteresis loss will be

(a) 200 W (b) 230 W (c) 270 W (d) 300 W

02. Ans: (d)

Sol: P_h = Volume of core × area of hysteresis loop × number of cycles

$$= 0.01 \times 60000\text{units} \times 50$$

$$= 0.01 \times 60000 \times 10^{-4} \times 10^2 \times 50$$

$$= 300 \text{ Watts}$$

End of Solution

03. The process of evaporating a metal in an inert atmosphere and allowing it to condense on the surface of a cold finger, which is kept at liquid nitrogen temperature of 77 K, is known as

(a) d.c. arc method (b) gas-phase condensation

(c) sonohydrolysis (d) flame pyrolysis

03. Ans: (b)

Sol: Inert gas evaporation - condensation technique:-

The process of evaporating a metal in an inert atmosphere and allowing it to condense on the surface of a cold finger, which is kept at liquid nitrogen temperature of 77 K, is known as gas-phase condensation.

This method is bottom-up approach method used to produce nano materials with a principle of "clustering".

End of Solution

04. Which one of the following materials is having the highest electrical conductivity at room temperature?

(a) Silver (b) Copper (c) Gold (d) Platinum

04. Ans: (a)

Sol: Silver has the highest electrical conductivity at room temperature .

Metal	**Conductivity $[(\Omega m)^{-1}]$**
Silver	6.8×10^7
Copper	6.0×10^7
Gold	4.3×10^7
Aluminium	3.8×10^7
Iron	1.0×10^7
Platinum	0.94×10^7
Stainless steel	0.2×10^7

End of Solution

05. Consider the following processes:

1. Sol-gel process
2. Electrodeposition
3. Plasma-enhanced vapour decomposition
4. Gas-phase condensation
5. Sputtering technique

The above processes are related to

(a) analysis of nano-powders (b) sintering of nano-powders

(c) synthesis of nano-powders (d) microwave sintering of nano-powders

05. Ans: (c)

Sol: The nanopowders are produced by (synthesis of nanopowders)

1. Sol-gel process
2. Electrodeposition
3. Plasma-enhanced vapour decomposition
4. Gas-phase condensation
5. Sputtering technique

End of Solution

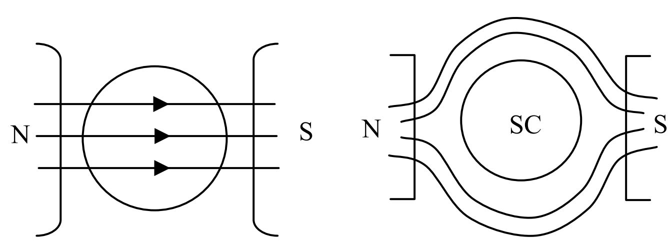
06. In the superconducting state, the flux lines of a magnetic field are ejected out of the superconductor as per

(a) Curie effect (b) Faraday's effect

(c) Maxwell's effect (d) Meissner effect

06. Ans: (d)

Sol: Meissner Effect: Expulsion of magnetic fluxlines by the super conductor is known as Meissner effect.



Normal Conductor Superconductor

End of Solution

07. A null type of instrument as compared to a deflection type of instrument

(a) has a higher accuracy (b) is less sensitive

(c) is more rugged (d) is faster in response

07. Ans: (a)

Sol: Null type instrument has negligible loading effect on quantity to be measured

End of Solution

08. A wheatstone bridge requires a change of 7 Ω in the unknown resistance arm of the bridge to produce a change in deflection of 3 mm of the galvanometer. The sensitivity and the deflection factor will be nearly

(a) 0.23 mm/Ω and 2.3 Ω/mm (b) 0.43 mm/Ω and 2.3 Ω/mm

(c) 0.23 mm/Ω and 1.3 Ω/mm (d) 0.43 mm/Ω and 1.3 Ω/mm

08. Ans: (b)

Sol: $$\text{Sensitivity} = \frac{\text{change output}}{\text{change input}} = \frac{3\text{mm}}{7} = 0.43\text{mm}/\Omega$$

$$D = \frac{\Delta I/P}{\Delta O/P} = \frac{7\Omega}{3\text{mm}} = 2.33\Omega/\text{mm}$$

End of Solution

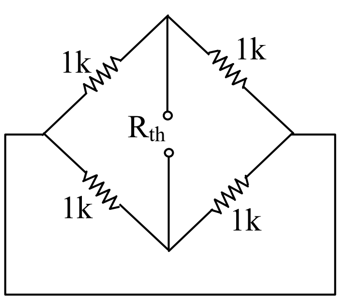
09. The galvanometer used in a wheatstone bridge as a detector can detect a current as low as 0.1 nA and its resistance is negligible compared to internal resistance of the bridge. Each arm of the bridge has a resistance of 1 kΩ. The input voltage applied to the bridge is 20 V. The smallest change in the resistance that can be detected is

(a) 10 μΩ (b) 20 μΩ (c) 30 μΩ (d) 40 μΩ

09. Ans: (b)

Sol: $$e_o = \left(\frac{\Delta R + R}{2R + \Delta R} - \frac{R}{2R}\right) \times e_i = \frac{\Delta R}{4R + 2\Delta R} \times 20$$

R_{th}:-



R_{th}=1kΩ

$$I = \frac{V_{th}}{R_{th} + R_g} = \frac{V_{th}}{R_{th} + 0} = \frac{V_{th}}{R_{th}}$$

$$0.1 \times 10^{-9} = \frac{\left(\frac{\Delta R}{4R + 2\Delta R} \times 20\right)}{1000}$$

$$\Delta R = 20\ \mu\Omega$$

End of Solution

10. The inductance of a 25 A electrodynamic ammeter changes uniformly at the rate of 0.0035 μH/degree. The spring constant is 10^{-6} N m/degree. The angle of deflection at full scale will be

(a) 135^o (b) 125^o (c) 115^o (d) 105^o

10. Ans: (b)

Sol: Electrodynamometor type Ammeter

$$\theta = \frac{I^2}{K_c}\frac{dM}{d\theta} \text{ in rad}$$

$$\frac{dM}{d\theta} = 0.0035\mu H/\pi/180 = 0.2 \times 10^{-6}\ Nm/rad$$

$$\theta = \frac{25^2}{10^{-6}\ Nm/\text{degree}} \times 0.2 \times 10^{-6}\ Nm/rad = 125^o$$

End of Solution

11. A resistance is determined by voltmeter ammeter method. The voltmeter reads 100 V with a probable error of ± 12 V and the ammeter reads 10 A with a probable error of ±2 A. The probable error in the computed value of the resistance will be nearly

(a) 0.6 Ω (b) 1.3 Ω (c) 2.3 Ω (d) 3.6 Ω

11. Ans: (c)

Sol: $V = 100 \pm 12V$

$I = 10 \pm 2A$

$$R = \frac{V}{I} \qquad \frac{\partial R}{\partial V} = \frac{1}{I} = \frac{1}{10}$$

$$\frac{\partial R}{\partial I} = \frac{-V}{I^2} = \frac{-100}{100} = -1$$

Probable Error in resistance $=\sqrt{\left(\frac{1}{10}\right)^2(12)^2+(-1)^2(2)^2}$

$=\sqrt{1.44+4}$

$= 2.33$

End of Solution

12. A temperature-sensing device can be modeled as a first-order system with a time constant of 6 s. It is suddenly subjected to a step input of 25 °C - 150 °C. The indicated temperature in 10 s after the process has started will be

(a) 118.2 °C (b) 126.4 °C

(c) 134.6 °C (d) 142.8 °C

12. Ans: (b)

Sol: For a first order system

$$T(t)=T_{Fi}+[T_{in}-T_{Fi}]e^{-\frac{t}{\tau}}$$

$$=150^\circ+[25^\circ-150^\circ]e^{-\frac{10}{6}}$$

$$= 126.4^\circ$$

End of Solution

13. In a parallel circuit having two branches, the current in one branch is I_1 = 100 ± 2 A and in the other is I_2 = 200 ± 5 A. Considering errors in both I_1 and I_2 as limiting errors, the total current will be

(a) 300 ± 5 A (b) 300 ± 6 A

(c) 300 ± 7 A (d) 300 ± 8 A

13. Ans: (c)

Sol: $I_1 = 100 \pm 2A$, $I_2 = 200 \pm 3A$

$I = I_1 + I_2 \Rightarrow I = 300A$

$\Delta I = \Delta I_1 + \Delta I_2 \Rightarrow \Delta I = 2 + 5 = 7$

$I = (300 \pm 7)$ A

End of Solution

14. A 0-150 V voltmeter has a guaranteed accuracy of 1% of full-scale reading. The voltage measured by this instrument is 75 V. The limiting error will be

(a) 5% (b) 4 % (c) 3% (d) 2%

14. Ans: (d)

Sol: (0 - 150V), % GAE = ± 1% fsd

% LE in 75V?

$$LE = \pm\frac{1}{100}\times 150V = \pm 1.5V$$

$$\%LE = \pm\frac{1.5V}{7.5V}\times 100 = \pm 2\%$$

End of Solution

15. A quartz piezoelectric crystal having a thickness of 2 mm and voltage sensitivity of 0.055 V m/N is subjected to a pressure of 1.5 MN/m^2. The voltage output will be

(a) 165 V (b) 174 V (c) 183 V (d) 192 V

15. Ans: (a)

Sol: t = 2mm

g = 0.055 Vm/N

$p = 1.5 \times 10^6$ N/m^2

E_0 = g.p.t

$= 0.055 \times 1.5 \times 10^6 \times 2 \times 10^{-3}$

E_0 = 165V

End of Solution

16. A resistance wire strain gauge with a gauge factor of 2 is bonded to a steel structural member subjected to a stress of 100 MN/m^2. The modulus of elasticity of steel is 200 GN/m^2. The change in the value of gauge resistance due to the applied stress will be

(a) 0.05% (b) 0.10% (c) 0.30% (d) 0.60%

16. Ans: (b)

Sol: $G_f = 2$

stress = 100×10^6N/m^2

$Y_{steel} = 200 \times 10^9$ N/m^2

$$\% \frac{\Delta R}{R} = ?$$

$$G_f = \frac{\frac{\Delta R}{R}}{\left(\frac{\Delta \ell}{\ell}\right)} = ?$$

$$\frac{\Delta R}{R} = G_f \frac{\Delta \ell}{\ell}$$

$$100 \times \frac{\Delta R}{R} = G_f \frac{1}{Y} \text{ stress} \times 100$$

$$= 2 \times \frac{1}{200 \times 10^9} \times 100 \times 10^6 \times 100$$

$$\frac{\Delta R}{R} = 0.1\%$$

End of Solution

17. The applications of photomultipliers are seen in

(a) night vision equipment, medical equipment

(b) mechanical counters, timers

(c) translational, optical instruments

(d) ultrasonic transducer, infrared imaging

17. Ans: (a)

Sol: Photo multipliers are transducer which content UV radiation to electrical output; they have applications in medical diagnostic, photography

End of Solution

18. A capacitance of 250 pF produces resonance with a coil at a frequency of $\left(\frac{2}{\pi}\right) \times 10^6$ Hz, while at the second harmonic of this frequency, resonance is produced by a capacitance of 50 pF. The self-capacitance of the coil will be nearly

(a) 16.7 pF (b) 20.5 pF (c) 24.3 pF (d) 28.1 pF

18. Ans: (a)

Sol: Given that $f_1 = \frac{2}{\pi} \times 10^6$ Hz

$C_1 = 250pF$

and $f_2 = 2f_1$

$C_2 = 50pF$

$$n = \frac{f_2}{f_1} = \frac{2f_1}{f_1} = 2 \qquad C_d = \frac{C_1 - n^2C_2}{n^2 - 1}$$

$$C_d = \frac{250pF - (2)^2 \times 50pF}{(2)^2 - 1} = \frac{250pF - 200pF}{3} = \frac{50pF}{3} = 16.7pF$$

End of Solution

19. Consider the following data for twigs and links:

N = Number of nodes

L = Total number of links

B = Total number of branches

The total number of links associated with a tree is

(a) B – N + 1 (b) B – N – 1 (c) B + N + 1 (d) 2B – N + 1

19. Ans: (a)

Sol: Total number of links = number of loops

= B – (N – 1)

= B – N + 1

End of Solution

20. In ABCD parameters, A and C are called

(a) reverse current ratio and transfer admittance

(b) reverse voltage ratio and transfer impedance

(c) reverse current ratio and transfer impedance

(d) reverse voltage ratio and transfer admittance

20. Ans: (d)

Sol: $V_1 = AV_2 - BI_2$

$I_1 = CV_2 - BI_2$

$$A = \left.\frac{V_1}{V_2}\right|_{I_2=0} \rightarrow \text{Open - Circuit reverse voltage gain}$$

$$C = \left.\frac{I_1}{V_2}\right|_{I_2=0} \rightarrow \text{Open - Circuit reverse transfer admittance}$$

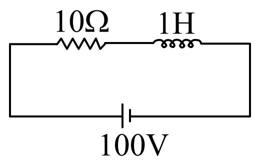
End of Solution

21. A coil having resistance of 10 Ω and inductance of 1 H is switched on to a direct voltage of 100 V. The steady-state value of the current will be

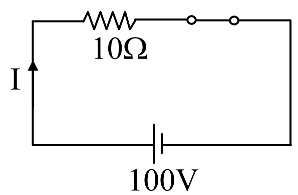
(a) 10 A (b) 15 A (c) 20 A (d) 25 A

21. Ans: (a)

Sol:



In steady state L $\Rightarrow$ short circuit



I=100/10=10A

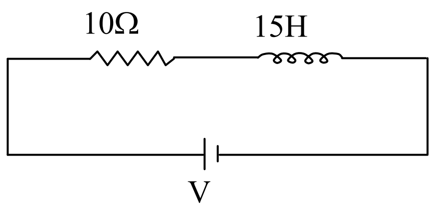
End of Solution

22. A coil has R = 10 Ω and L = 15 H. The voltage at the instant when the current is 10 A and increasing at the rate of 5 A/s will be

(a) 125 V (b) 150 V (c) 175 V (d) 200 V

22. Ans: (c)

Sol:



$$i(t)=\frac{V}{R}\left(1-e^{-t/\tau}\right)$$

$$i(t=t_1)=\frac{V}{R}\left(1-e^{-t_1/\tau}\right)=10 \text{----}(1)$$

$$\frac{di}{dt}=\frac{V}{R}\left[0-e^{-t/\tau}\times\frac{-1}{\tau}\right]$$

$$=\frac{V}{L}e^{-t/\tau}$$

$$\left.\frac{di}{dt}\right|_{t=t_1} = \frac{V}{L}e^{-t_1/\tau} = 5A/S \text{---(2)}$$

$$\text{From (1)} \Rightarrow 1 - e^{-t_1/\tau} = \frac{10R}{V}$$

$$1 - \frac{10R}{V} = e^{-t_1/\tau} \text{---(3)}$$

Substitute (3) in (2)

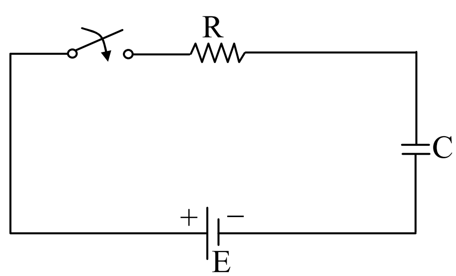
$$\Rightarrow \frac{V}{L}\left(1 - \frac{10R}{V}\right) = 5$$

$$\frac{V}{L} - \frac{10R}{L} = 5$$

$$V = 5L + 10R = 5\times15 + 10\times10 = 75 + 100 = 175V$$

End of Solution

23. Consider the following RC circuit. The capacitor has an initial charge q_0 such that it opposes the flow of charging current:

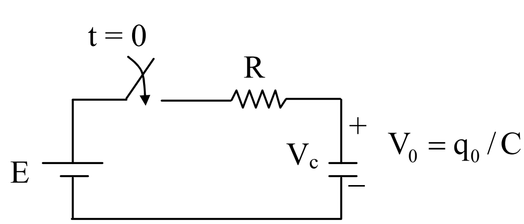


The response of the circuit i(t) will be

(a) $\left(\frac{E}{R} - \frac{q_0}{RC}\right)e^{-\frac{t}{RC}}$ (b) $-\frac{q_0}{RC}e^{-\frac{t}{RC}}$ (c) $\frac{E}{R}e^{-\frac{t}{RC}}$ (d) $\left(\frac{E}{R} + \frac{q_0}{RC}\right)e^{-\frac{t}{RC}}$

23. Ans: (a)

Sol:



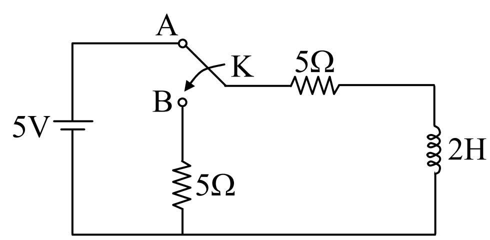
State-variable voltage only

$$\text{So, } V_c(t) = E + \left[\frac{q_o}{C} - E\right]e^{-t/RC}$$

$$i_c(t) = C\frac{dv_c(t)}{dt} = C\left[0 + \left(\frac{q_o}{C} - E\right)e^{-t/RC} \times \frac{-1}{RC}\right] = \left[\frac{E}{R} - \frac{q_o}{RC}\right]e^{-t/RC}$$

End of Solution

24. In the following circuit, switch K is thrown from position A to position B at time t = 0, the current having previously reached its steady state :

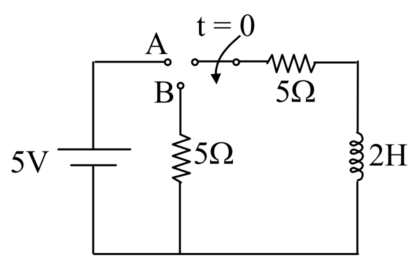


The current i(t) after switching will be

(a) $5e^{-5t}$ (b) $4e^{-5t}$ (c) $3e^{-5t}$ (d) e^{-5t}

24. Ans: (d)

Sol:



$i(0^-) = \frac{5}{5} = 1A \quad \because i(0^+) = i(0^-)$

$i(0^+) = 1A$

$i(\infty) = 0$

$\tau = \frac{L}{R} = \frac{2}{10} = 0.2$

$i(t) = 0 + (1 - 0)e^{-t/0.2} = 1e^{-5t} = e^{-5t}$

End of Solution

25. What is the condition for reciprocity and symmetry in Y-parameter representation?

(a) $Y_{21} = Y_{11}$ and $Y_{22} = Y_{21}$ (b) $Y_{21} = Y_{12}$ and $Y_{11} = Y_{22}$

(c) $Y_{21} = Y_{22}$ and $Y_{11} = Y_{22}$ (d) $Y_{11} = Y_{22}$ and $Y_{21} = Y_{22}$

25. Ans: (b)

Sol: Condition for reciprocity: $Y_{12} = Y_{21}$

Condition for symmetry : $Y_{11} = Y_{22}$

End of Solution

26. In hybrid parameters h_{11} and h_{21} are called as

(a) input impedance and forward current gain

(b) reverse voltage gain and output admittance

(c) input impedance and reverse voltage gain

(d) output impedance and forward current gain

26. Ans: (a)

Sol: $V_1 = h_{11} I_1 + h_{12} V_2$

$I_2 = h_{21} I_1 + h_{22} V_2$

$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0} \rightarrow \text{short circuit input impedance}$$

$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0} \rightarrow \text{short circuit forward current gain}$$

End of Solution

27. Consider the following equations :

$V_1 = 6V_2 - 4I_2$

$I_1 = 7V_2 - 2I_2$

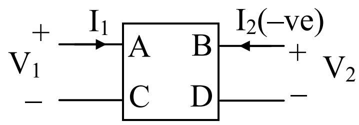
A, B, C and D parameters are

(a) 6, –4 Ω, 7 mho and –2 (b) 6, 4 Ω, 7 mho and 2

(c) –6, 4 Ω, –7 mho and 2 (d) 6, 4 Ω, –7 mho and –2

27. Ans: (b)

Sol:



Given

$V_1 = 6V_2 - 4I_2$

$I_1 = 7V_2 - 2I_2$

$V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

By comparing, we get

$A = 6$

$B = 4\Omega$

$C = 7\mho$

$D = 2$

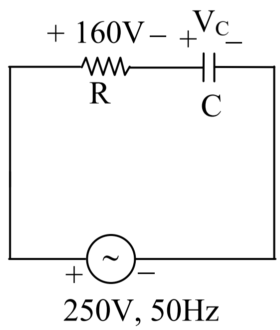
End of Solution

28. A supply of 250 V, 50 Hz is applied to a series RC circuit. If the power absorbed by the resistor be 400 W at 160 V, the value of the capacitor C will be nearly

(a) 30.5 μF (b) 41.5 μF (c) 64.0 μF (d) 76.8 μF

28. Ans: (b)

Sol:



$$P = \frac{V_R^2}{R}$$

$$400 = \frac{(160)^2}{R}$$

$R = 64\Omega$

$I^2R = 400$

$$I = \sqrt{\frac{400}{64}} = 2.5A$$

$$250 = \sqrt{160^2 + V_C^2}$$

$V_C = 192 = I.X_C \qquad \because X_C = \frac{1}{2\pi fC}$

$= 2.5 \times \frac{1}{2\pi \times 50 \times C}$

$C = \frac{2.5}{2\pi \times 50 \times 192} = 41.5\mu F$

End of Solution

29. A 50 Hz sinusoidal voltage V = 311sin ωt is applied to an RL series circuit. If the magnitude of resistance is 5 Ω and that of the inductance is 0.02 H, the r.m.s. value of the steady-state current and the relative phase angle are nearly

(a) 19.6 A and 51.5° (b) 27.4 A and –51.5°
(c) 19.6 A and –51.5° (d) 27.4 A and 51.5°

29. Ans: (b)

Sol: $I_{RMS} = \frac{V_{RMS}}{Z} = \frac{\frac{311}{\sqrt{2}}}{\sqrt{5^2 + (2\pi \times 50 \times 0.02)^2}} = 27.4A$

$\phi = -\tan^{-1}\left[\frac{2\pi 50(0.02)}{5}\right] = -51.5^o$

Note: In RL network the current is lagging. So, option (b) is correct.

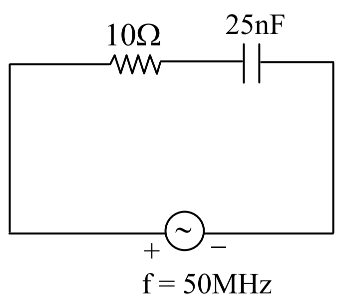
End of Solution

30. In a series RC circuit, the values of R = 10 Ω and C = 25 nF. A sinusoidal voltage of 50 MHz is applied and the maximum voltage across the capacitance is 2.5 V. The maximum voltage across the series combination will be nearly

(a) 172.7 V (b) 184.5 V (c) 196.3 V (d) 208.1 V

30. Ans: (c)

Sol:



$$X_C = \frac{-j}{2\pi \times 50 \times 10^6 \times 25 \times 10^{-9}} = -0.1273j$$

$$|i| = \frac{V}{|X_C|} = \frac{2.5}{|0.127j|} = 19.63\Omega$$

$|V_R| = 19.63 \times 10 = 196.3$

$$V_m = \sqrt{V_R^2 + V_C^2} = \sqrt{(196.3)^2 + (2.5)^2} = 196.3V$$

End of Solution

31. Consider the following open-loop transfer function :

$$G = \frac{K(s+2)}{(S+1)(S+4)}$$

The characteristic equation of the unity negative feedback will be

(a) (s+1)(s+4) + K (s+2) = 0

(b) (s+2)(s+1) + K (s+4) =0

(c) (s+1)(s–2) + K (s+4) = 0

(d) (s+2)(s+4) + K (s+1) = 0

31. Ans: (a)

Sol: $\underrightarrow{CE}\ 1 + G(s) = 0$

$$\underrightarrow{CE}\ 1 + \frac{K(S+2)}{(S+1)(S+4)} = 0$$

$$\underrightarrow{CE}\ (S+1)(S+4) + K(S+2) = 0$$

End of Solution

32. The magnitude and phase relationship between the sinusoidal input and the steady-state output of a system is called as

(a) magnitude response

(b) transient response

(c) steady-state response

(d) frequency response

32. Ans: (d)

Sol: Frequency response is called as steady state output of a system to the sinusoidal input .

End of Solution

33. A transfer function having all its poles and zeros only in the left-half of the s-plane is called

(a) a minimum-phase transfer function (b) a complex transfer function

(c) an all-pass transfer function (d) a maximum-phase transfer function

33. Ans: (a)

Sol: In minimum phase system, all poles & zeros will lie in the left half-s-plane.

End of Solution

34. The frequency where magnitude M has a peak value in frequency response is known as

(a) normalized frequency (b) resonant frequency

(c) peak frequency (d) tuned frequency

34. Ans: (b)

Sol: At resonant frequency, the magnitude is maximum.

End of Solution

35. For a lead compensator having transfer function

$$G_c(s) = \frac{(s+z_c)}{(s+p_c)} = \frac{\left(s+\frac{1}{\tau}\right)}{\left(s+\frac{1}{\alpha\tau}\right)}$$

1. $\alpha = \frac{z_c}{p_c} < 1$

2. $\alpha = \frac{z_c}{p_c} > 1$

3. $\tau > 0$

4. $\tau < 0$

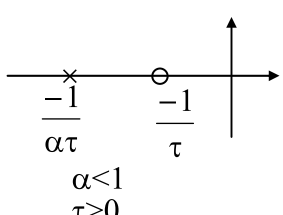
Which of the above are correct?

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

35. Ans: (b)

Sol: $\Rightarrow z_c = 1/\tau$

$$p_c = \frac{1}{\alpha\tau}$$



$$TF = \frac{z_c(1+S/Z_c)}{p_c(1+S/P_c)}$$

End of Solution

36. The attenuation (magnitude) produced by a lead compensator at the frequency of maximum phase lead $\omega_m = \sqrt{ab}$ is

(a) $\sqrt{\frac{b}{a}}$ (b) $\sqrt{a+b}$ (c) $\sqrt{b-a}$ (d) $\sqrt{\frac{a}{b}}$

36. Ans: (d)

Sol: $$M = \sqrt{\frac{\omega^2 + a^2}{\omega^2 + b^2}}\Bigg|_{\omega=\sqrt{ab}} = \sqrt{\frac{ab + a^2}{a^2 + ab}} = \sqrt{\frac{a(b+a)}{b(a+b)}} = \sqrt{\frac{a}{b}}$$

End of Solution

37. Consider the following statement:

1. A computer will have a multiply instruction.
2. Multiply instruction will be implemented by a special multiply unit.

Which of the following is correct?

(a) Both 1 and 2 are not architectural design issues

(b) Both 1 and 2 are not organizational issues.

(c) 1 is an architectural design issue while 2 is an organizational issue.

(d) 1 is an organizational issue while 2 is an architectural design issue.

37. Ans: (c)

Sol: It is an architectural design issue whether a computer will have a multiply instruction where as organizational issue is whether the multiply instruction will be implemented by a special multiply unit or by a mechanism that makes repeated use of the add unit of the system.

End of Solution

38. Consider a disk with an average seek time of 4 ms, rotational delay of 2 ms, rotation speed of 15000 r.p.m. and 512-byte sectors with 500 sectors per track. A file occupies all of the sectors on 5 adjacent tracks. After reading the first track, if remaining tracks can be read with no seek time, then the time required in sequential organization to transfer the file will be nearly

(a) 0.01 second (b) 0.034 second (c) 0.34 second (d) 3.4 seconds

38. Ans: (b)

Sol: In one rotation 1 track can be transferred.

1 rotation time $= \frac{60\,\text{sec}}{15000} = \frac{60 * 1000\,\text{m sec}}{15000} = 4$ msec.

5 track transfer time = 4*5 = 20 msec

5 track rotational delay = 2*5 = 10 msec

seek time used once as given = 4 msec

Total time = 20 + 10 + 4 = 34 msec = 0.034 sec

End of Solution

39. Add 8 and 9 in BCD code.

(a) 00010111 (b) 00010001 (c) 01110111 (d) 10001001

39. Ans: (a)

Sol:

$$\begin{array}{lr} 8_{10} \rightarrow & 1000 \\ +9_{10} & +\underline{1001} \\ & 1\ \ 0000 \\ & +\underline{0110} \\ & \underline{10111} \end{array} = 00010111$$

End of Solution

40. Convert the binary number 11000110 to Gray code.

(a) 00100101 (b) 10100100 (c) 11100110 (d) 10100101

40. Ans: (d)

Sol:

Binary $\longrightarrow$ 1 1 0 0 0 1 1 0

Gray $\rightarrow$ 1 0 1 0 0 1 0 1

End of Solution

41. The decimal value of the signed binary number 10101010 expressed in 2's complement will be

(a) –42 (b) –86 (c) –116 (d) –170

41. Ans: (b)

Sol: Given:

2's Complement number is 10101010

2's complement of given 2's complement number is $\Rightarrow -\,01010110$

$$\Rightarrow -\,(2^6 + 2^4 + 2^2 + 2^1)$$

$$\Rightarrow -\,(64 + 16 + 4 + 2) = -\,86_{10}$$

Decimal equivalent of given 2's complement number is $= -\,86_{10}$

End of Solution

42. Which of the following statements is/are correct?

1. An address generated by the CPU is commonly referred to as a physical address.
2. An address seen by the memory unit is commonly referred to as a logical address.
3. The run-time mapping from virtual to physical address is done by the memory management unit (MMU).

Select the correct answer using the code given below.

(a) 1 only (b) 2 only

(c) 3 only (d) 1, 2 and 3

42. Ans: (c)

Sol: → CPU generally generates logical address

→ Memory is accessed using physical address

→ MMU translates logical or virtual address to physical address.

End of Solution

43. In a cache with 64-byte cache lines, how many bits are used to determine which byte within a cache line an address points to ?

(a) 16 (b) 8

(c) 6 (d) 3

43. Ans: (c)

Sol: Cache line or block size = 64B = 2^6 B

Number of bits for determining byte number = 6-bits

End of Solution

44. A system has 64-bit virtual addresses and 43-bit physical addresses. If the pages are 8kB in size, the number of bits required for VPN and PPN will be respectively

(a) 51 bits and 30 bits (b) 30 bits and 51 bits

(c) 51 bits and 13 bits (d) 30 bits and 13 bits

44. Ans: (a)

Sol: $$\text{VPN} = \frac{2^{64}}{2^3 . 2^{10}} = 2^{51} \Rightarrow 51 - \text{bits}$$

$$\text{PPN} = \frac{2^{43}}{2^3 . 2^{10}} = 2^{30} \Rightarrow 30 - \text{bits}\ .$$

End of Solution

45. A soft error is a

(a) regular-nondestructive event (b) random-nondestructive event

(c) random-destructive event (b) regular-destructive event

45. Ans: (b)

Sol: Soft error is random, nondestructive event that alters the contents of one or more memory cells.

End of Solution

46. A main memory can hold 3 page frames and initially all of them are vacant. Consider the following stream of page requests:

2, 3, 2, 4, 6, 2, 5, 6, 1, 4, 6

If the stream uses FIFO replacement policy, the hit ratio *h* will be

(a) $\frac{11}{3}$ (b) $\frac{1}{11}$ (c) $\frac{3}{11}$ (d) $\frac{2}{11}$

46. Ans: (d)

Sol:

2	3	2	4	6	2	5	6	1	4	6
2	2	2	2	6	6	6	6	1	1	1
	3	3	3	3	2	2	2	2	4	4
			4	4	4	5	5	5	5	6
		√					√			

Hit ratio $= \frac{2}{11}$

End of Solution

47. Which one of the following is an advantage of assembly language over high-level language?

(a) Assembly language program runs faster.

(b) Writing of assembly language programming is easy.

(c) Assembly language program is portable.

(d) Assembly language program contains less instruction.

47. Ans: (a)

Sol: Assembly language is a 'Low Level Language'. Compared to High Level Language assembly language contains more instructions and its programming is difficult. Assembly language is not portable.

End of Solution

48. Which of the following statements are correct?

1. A pseudoinstruction is a machine instruction.
2. A pseudoinstruction is an instruction to the assembler.
3. The ORG (origin) is an example of pseudoinstruction.
4. It is not possible to use ORG more than once in a program.

Select the correct answer using the code given below.

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

48. Ans: (b)

Sol: Pseudo instructions are special commands to the assembler about the positioning of the program. It can be used any number of times depending on the necessity.

Example: ORG $\rightarrow$ Origin is an example of pseudo instructions. It can be used to position the program code, Input data etc.

End of Solution

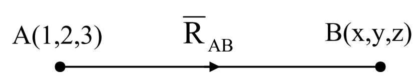
49. The vector R_{AB} extends from A(1, 2, 3) to B. If the length of R_{AB} is 10units and its direction is given by $a = 0.6a_x + 0.64a_y + 0.48a_z$ the coordinates of B will be

(a) $7a_x + 4.8a_y + 4.8a_z$ (b) $6a_x + 6.4a_y + 4.8a_z$

(c) $7a_x + 8.4a_y + 7.8a_z$ (d) $6a_x + 8.4a_y + 7.8a_z$

49. Ans: (c)

Sol:



$$\overline{R}_{AB} = (x-1)\hat{a}_x + (y-2)\hat{a}_y + (z-3)\hat{a}_z$$

$$|R_{AB}| = \sqrt{(x-1)^2 + (y-2)^2 + (z-3)^2}$$

Given $|R_{AB}| = 10$

$(x-1)^2 + (y-2)^2 + (z-3)^2 = 100$

$$\hat{a}_{AB} = \frac{\overline{R}_{AB}}{|R_{AB}|} = \frac{(x-1)\hat{a}_x + (y-2)\hat{a}_y + (z-3)\hat{a}_z}{10}$$

Given $\hat{a}_{AB} = 0.6\hat{a}_x + 0.64\hat{a}_y + 0.48\hat{a}_z$

By comparison

$$\frac{x-1}{10}=0.6 \quad \frac{y-2}{10}=0.64 \quad \frac{z-3}{10}=0.48$$

$$x=7 \quad y=8.4 \quad z=7.8$$

End of Solution

50. What is the value for the total charge enclosed in an incremental volume of $10^{-9}m^3$ located at the origin if $D = e^{-x}\sin y a_x - e^{-x}\cos y a_y + 2z a_z$ C/m^2 ?

(a) 8 nC (b) 4 nC (c) 2 nC (d) 1 nC

50. Ans: (c)

Sol: Given $\overline{D} = e^{-x}\sin y\hat{a}_x - e^{-x}\cos y\hat{a}_y + 2z\hat{a}_z \ C/m^2$

From Gauss's Law

$$\boxed{\Psi = Q_{enc} = \oint_S \overline{D}.\overline{ds}}$$

$$Q_{enc} = \oint_S \overline{D}\,.\overline{ds}$$

From Divergence theorem

$$Q_{enc} = \int_v (\nabla.\overline{D})dv$$

$$\nabla.\overline{D} = \frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$$

$$= -e^{-x}\,\text{siny} + e^{-x}\text{siny} + 2$$

$$\nabla.\overline{D} = 2$$

$$Q_{enc} = \int_v (\nabla.\overline{D})dv = \int_v 2dv$$

Q_{enc} = 2 (volume) = 2×10^{-9} = 2nC

End of Solution

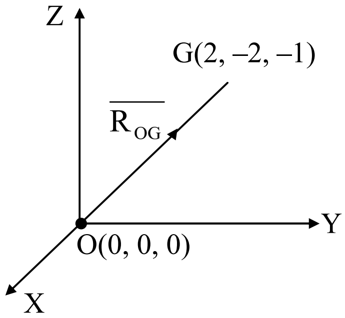
51. The unit vector extending from origin toward the point G(2, –2, –1) is

(a) $\frac{2}{3}a_x + \frac{2}{3}a_y + \frac{1}{3}a_z$ (b) $-\frac{2}{3}a_x + \frac{2}{3}a_y + \frac{1}{3}a_z$

(c) $\frac{2}{3}a_x - \frac{2}{3}a_y - \frac{1}{3}a_z$ (d) $-\frac{2}{3}a_x - \frac{2}{3}a_y - \frac{1}{3}a_z$

51. Ans: (c)

Sol:



$$\overline{R}_{OG} = 2\hat{a}_x - 2\hat{a}_y - 1\hat{a}_z$$

$$\hat{a}_{OG} = \frac{\overline{R}_{OG}}{|R_{OG}|} = \frac{2\hat{a}_x - \hat{a}_y - 1\hat{a}_z}{\sqrt{2^2 + 2^2 + 1}}$$

$$\hat{a}_{OG} = \frac{2}{3}\hat{a}_x - \frac{2}{3}\hat{a}_y - \frac{1}{3}\hat{a}_z$$

End of Solution

52. Ground waves progress along the surface of the earth and must be polarized

(a) horizontally (b) circularly (c) elliptically (d) vertically

52. Ans: (d)

Sol: Vertical polarization has considerably less attenuation than horizontally polarization. So, Ground waves progress along the surface of the earth and must be vertically polarized.

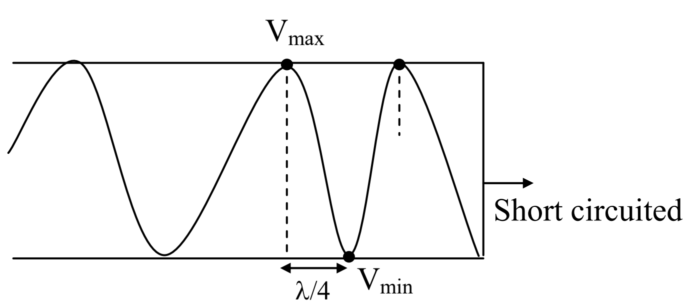
End of Solution

53. For a lossless line terminated in a short circuit, the stationary voltage minima and maxima are separated by

(a) $\frac{\lambda}{8}$ (b) $\frac{\lambda}{2}$ (c) $\frac{\lambda}{3}$ (d) $\frac{\lambda}{4}$

53. Ans: (d)

Sol:



When the load is terminated by a short circuit wave get reflected, and moves towards the source. So, inside the transmission line there exists two oppositely directed waves, the combination of two oppositely directed waves result a standing wave.

This standing wave reaches to maximum and minimum, continuously.

The distance between two successive maximas $-\frac{\lambda}{2}$

The distance between two successive minimas $-\frac{\lambda}{2}$

The distance between maxima and minima is $-\frac{\lambda}{4}$

End of Solution

54. The characteristic impedance of an 80 cm long lossless transmission line having L = 0.25 μH/m and C = 100 pF/m will be

(a) 25 Ω (b) 40 Ω

(c) 50 Ω (d) 80 Ω

54. Ans: (c)

Sol: Given

$L = 0.25 \times 10^{-6}$ H/m

$C = 100 \times 10^{-12}$ F/m

Characteristic impedance

$$Z_0 = \sqrt{\frac{R + j\omega L}{G + j\omega C}}$$

Given, loss less line

So, R = G = 0

$$Z_0 = \sqrt{\frac{L}{C}} = \sqrt{\frac{0.25 \times 10^{-6}}{100 \times 10^{-12}}}$$

$Z_0 = 50\Omega$

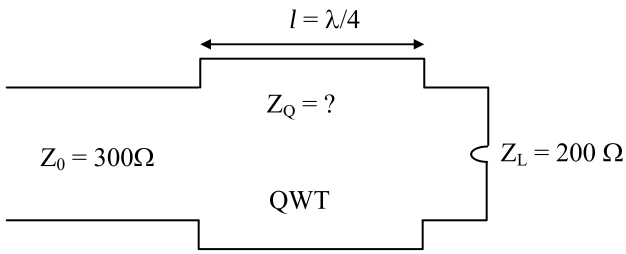
End of Solution

55. It is required to match a 200Ω load to a 300Ω transmission line to reduce the SWR along the line to 1. If it is connected directly to the load, the characteristic impedance of the quarter wave transformer used for this purpose will be

(a) 275 Ω (b) 260 Ω (c) 245 Ω (d) 230 Ω

55. Ans: (c)

Sol:



$$Z_Q = \sqrt{Z_O Q_L}$$

$$= \sqrt{(300)(200)}$$

$$Z_Q = \sqrt{6} \times 100\ \Omega \approx 245\ \Omega$$

End of Solution

56. For a standard rectangular waveguide having an aspect ratio of 2:1, the cutoff wavelength for $TM_{1,1}$ mode will be nearly

(a) 0.9 a (b) 0.7 a (c) 0.5 a (d) 0.3 a

56. Ans: (a)

Sol: $\frac{a}{b} = \frac{2}{1}$

$$\boxed{b = \frac{a}{2}}$$

Cutoff wavelength

$$\lambda_C / TM_{11} = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$$

$$\lambda_C = \frac{2}{\sqrt{\frac{1}{a^2} + \frac{1}{\left(\frac{a}{2}\right)^2}}} = \frac{2}{\sqrt{\frac{1}{a^2} + \frac{4}{a^2}}} = \frac{2a}{\sqrt{5}} = 0.9a$$

End of Solution

57. The irises in the rectangular metallic waveguide may be

1. inductive
2. resistive
3. capacitive

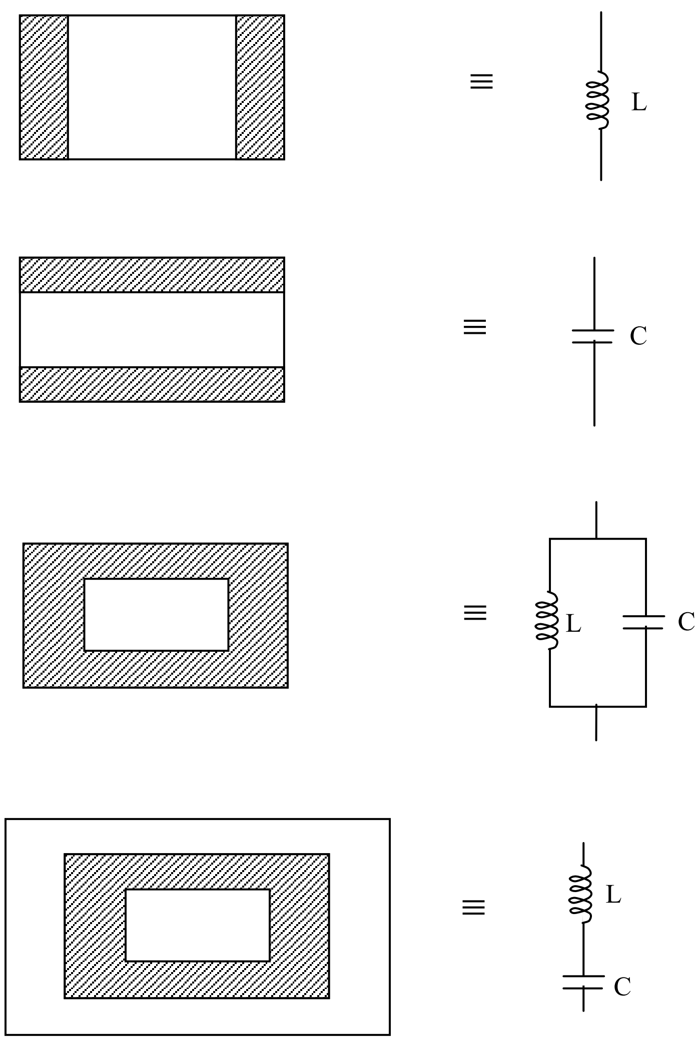
Select the correct answer using the code given below

(a) 1, 2 and 3 (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

57. Ans: (c)

Sol: An iris is a thin metal plate across the wave guide with one or more holes in it. It is used to couple together two lengths of wave guides and is a means of introducing a discontinuity.



Iris in the rectangular wave guides are inductor and capacitors only.

End of Solution

58. A 10 GHz signal is propagated in a waveguide whose wall separation is 6 cm. The greatest number of half-waves of electric intensity will be possible to establish between the two walls. The guide wavelength for this mode of propagation will be

(a) 6.48 cm (b) 4.54 cm (c) 2.48 cm (d) 1.54 cm

58. Ans: (b)

Sol: Given f = 10 GHz

$$\lambda = \frac{3\times10^8}{10\times10^9} = 3\,\text{cm}$$

a = 6 cm

$$\lambda_C = \frac{2}{\sqrt{\left(\frac{m}{a}\right)^2 + \left(\frac{n}{b}\right)^2}}$$

$$\lambda_C\Big|_{TE_{m0}} = \frac{2a}{m}$$

$$\lambda_C\Big|_{TE_{10}} = \frac{12}{1} = 12\text{cm}$$

$$\lambda_C\Big|_{TE_{20}} = \frac{12}{2} = 6\text{cm}$$

$$\lambda_C\Big|_{TE_{30}} = \frac{12}{3} = 4\text{cm}$$

$$\lambda_C\Big|_{TE_{40}} = \frac{12}{4} = 3\text{cm}$$

For the propagation of the wave

$$f > f_C$$

$$\lambda < \lambda_C$$

So, the maximum mode of propagation is

<u>TE_{30}</u>

$$\lambda_c\,|_{TE_{30}} = 4\text{cm}$$

$$\lambda_g = \frac{\lambda}{\sqrt{1-\left(\frac{f_C}{f}\right)^2}} = \frac{\lambda}{\sqrt{1-\left(\frac{\lambda}{\lambda_C}\right)^2}} = \frac{3}{\sqrt{1-\left(\frac{3}{4}\right)^2}} = 4.54\text{ cm}$$

End of Solution

59. In $TE_{m,n}$ mode, m and n are integers denoting the number of

(a) $\frac{1}{2}$ the wavelengths of intensity between each pair of walls

(b) $\frac{1}{3}$ the wavelengths of intensity between each pair of walls

(c) $\frac{1}{4}$ the wavelengths of intensity between each pair of walls

(d) $\frac{1}{8}$ the wavelengths of intensity between each pair of walls

59. Ans: (a)

Sol: $\underline{TE_{mn}}$

m - number of half field (half wave lengths) variations along the larger dimension

n - number of half field (half wave lengths) variations along the smaller dimension

End of Solution

60. Consider the following statements with reference to dipole arrays:

1. In broadside array, all the dipoles are fed in the same phase from the same source.
2. In end-fire array, the magnitude of the current in each element is same and there is no phase difference between these currents.

Which of the above statements is/are

(a) 1 only (b) 2 only (c) Both 1 and 2 (d) Neither 1 nor 2

60. Ans: (a)

Sol: Array factor (AF) $= \dfrac{\sin\frac{n\psi}{2}}{\sin\frac{\Psi}{2}}$

For 2 – element array

$$AF = 2\cos\left(\frac{\Psi}{2}\right)$$

For maximum radiation $\psi = 0$.

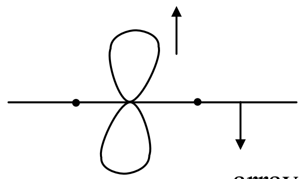
$\delta + \beta d \cos\phi_{max} = 0$

If $\delta = 0$

i.e phase difference between two antennas is zero

$\cos \phi_{max} = 0$

$\phi_{max} = \pm\frac{\pi}{2}$



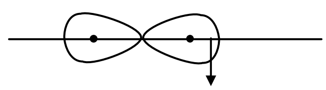
Here, maximum radiation is normal to the array axis, so the array is called as broad side array.

If $\delta = \pm \beta d$

$\pm \beta d + \beta d \cos \phi_{max} = 0$

$\cos \phi_{max} = \pm 1$

$\phi_{max} = 0, \pi$



Here, maximum radiation is tangential to the array axis, so the array is called as end fire array.

So, for the broad side array all the dipoles are fed in the same phase ($\delta = 0$)

For the end fire array, the phase difference between the dipoles is, $\delta = \pm \beta d$

End of Solution

61. Which of the following are the advantages of Silicon over Insulator (SOI)?

1. Lower diffusion capacitance
2. Smaller parasitic delay and lower dynamic power consumption
3. Lower threshold voltages

Select the correct answer using the code given below.

(a) 1, 2 and 3 (b) 1 and 2 only (c) 1 and 3 only (d) 2 and 3 only

61. Ans: (a)

Sol: Lower parasitic capacitance due to isolation from bulk silicon which improves power consumption.

Higher performance at equivalent V_{DD} can work at low V_{DD}.

Lower leakage current due to isolation, thus higher power efficient.

Lower sub threshold slope of SOI is a result of a reasonable capacitance arrangement.

End of Solution

62. The finite state machine in which

1. the output is a function of the current state and inputs
2. the output is a function of only the current state

Which of the following machines are respectively correct for these styles?

(a) Mealy machine and Moore machine

(b) Moore machine and Mealy machine

(c) State machine and Mealy machine

(d) State machine and State machine

62. Ans: (a)

Sol: In Mealy state machine the output depends on present state and the inputs

i.e. outputs = F(P.S, Inputs)

In Moore state machine, the output depends only on present state and doesn't depend on inputs

i.e. outputs = F(P.S)

End of Solution

63. In EPROMs, applying a high voltage to the upper gate causes electrons to jump through the thin oxide onto the floating gate through the process known as

(a) mask programming

(b) one-time programming

(c) avalanche injection or Fowler Nordheim tunneling

(d) erasing

63. Ans: (c)

Sol: Applying a 'high voltage' to the control gate causes 'Avalanche Injection' in the EPROMS. Due to this electrons overcome the resistance offered by SiO_2 layer and gets trapped on the floating gate.

End of Solution

64. What is the range of values of a and b for which the linear time-invariant system with impulse response

$$h(n) = \begin{cases} a^n, n \geq 0 \\ b^n, n < 0 \end{cases}$$

is stable?

(a) Both |a| < 1 and |b| > 1 are satisfied
(b) Both |a| > 1 and |b| < 1 are satisfied
(c) Both |a| > 1 and |b| > 1 are satisfied
(d) Both |a| < 1 and |b| > 1 are satisfied

64. Ans: (a)

Sol: $$h(n) = \begin{cases} a^n; & n \geq 0 \\ b^n; & n < 0 \end{cases}$$

LTI system stability condition is $\sum_{n=-\infty}^{\infty} |h(n)| < \infty$

$$\sum_{n=-\infty}^{\infty} |h(n)| = \sum_{n=-\infty}^{-1} b^n + \sum_{n=0}^{\infty} a^n$$

$\sum_{n=0}^{\infty} a^n$ is converges when |a| < 1

$\sum_{n=-\infty}^{-1} b^n$ is converges when |b| > 1

End of Solution

65. The special case of a finite-duration sequence is given as

$$x(n) = \{2, \underset{\uparrow}{4}, 0, 3\}$$

The sequence x(n) into a sum of weighted impulse sequences will be

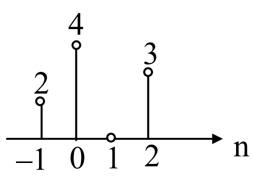
(a) 2δ(n+1) + 4δ(n) + 3δ(n–2)
(b) 2δ(n) + 4δ(n–1) + 3δ(n–3)
(c) 2δ(n) + 4δ(n–1) + 3δ(n–2)
(d) 2δ(n+1) + 4δ(n) + 3δ(n–1)

65. Ans: (a)

Sol:

$$x(n) = \{2, \underset{\uparrow}{4}, 0, 3\}$$

$$x(n) = 2\delta(n+1) + 4\delta(n) + 3\delta(n-2)$$



End of Solution

66. The two advantages of FIR filters over IIR filters are

(a) they are guaranteed to be stable and non-linear

(b) they are marginally stable and linear

(c) they are guaranteed to be stable and may be constrained to have linear phase

(d) they are marginally stable and non-linear

66. Ans: (c)

Sol: FIR filters are guaranteed to be stable since all poles lie at $z = 0$ and they are defined for finite number of samples.

They can have linear phase response if impulse response is symmetric (or) anti-symmetric

End of Solution

67. The frequency response and the main lobe width for rectangular window are

(a) $\dfrac{\sin\frac{\omega N}{2}}{\sin\frac{\omega}{2}}$ and $\dfrac{4\pi}{N}$

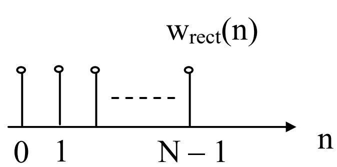
(b) $\dfrac{\sin\frac{\omega N}{2}}{\frac{\omega}{2}}$ and $\dfrac{\pi}{N}$

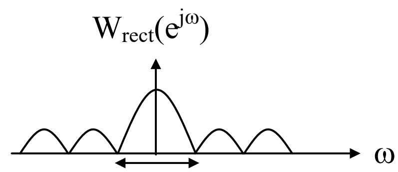
(c) $\dfrac{\sin\frac{\omega}{2}}{\sin\frac{\omega N}{2}}$ and $\dfrac{2\pi}{N}$

(d) $\dfrac{\sin\frac{\omega N}{4}}{\sin\frac{\omega}{2}}$ and $\dfrac{8\pi}{N}$

67. Ans: (a)

Sol:





Main lobe width $= \dfrac{4\pi}{N}$

$$W_{rect}(e^{j\omega}) = \sum_{n=0}^{N-1} (1)e^{-j\omega n} = \frac{\sin\left(\frac{\omega N}{2}\right)}{\sin\left(\frac{\omega}{2}\right)} e^{-j\omega\left(\frac{N-1}{2}\right)}$$

End of Solution

68. A controller that takes control of the buses and transfers data directly between source and destination bypassing the microprocessor is known as

(a) DMA controller (b) read-write controller

(c) high-speed controller (d) master-slave controller

68. Ans: (a)

Sol: The Input Devices can access the memory directly without the help of microprocessor is called DMA Transfer. This process is achieved by using DMA controller, which is tailor made for DMA operations.

End of Solution

69. A 2-byte instruction which accepts the data from the input port specified in the second byte and loads into the accumulator is

(a) OUT <8-bit port address> (b) IN <8-bit port address>

(c) OUT R <8-bit port address> (d) IN R <8-bit port address>

69. Ans: (b)

Sol: The Instruction used to read a byte from an input device is IN 8 Bit address

End of Solution

70. Consider the following instruction:

EI

MVI A, 08H

SIM

It means

(a) disable all interrupts (b) enable all interrupts

(c) disable RST 7.5 and 6.5 (d) enable RST 7.5 and 6.5

70. Ans: (b)

Sol: EI $\rightarrow$ Enable all Interrupts

$A = 08_H = 0\,0\,0\,0\ \ 1\,0\,0\,0$

SIM

Masking is enabled

RST 7.5, 6.5, 5.5 are inmasked i.e. all interrupts are enabled

End of Solution

71. The instruction BC 0x15 means

(a) jump 15 bytes relative to the program counter

(b) copy and load 15 words in reverse direction to the program counter

(c) move to a location by 15 bits to the program counter

(d) redirect (jump) to a location by 15 words relative to the program counter

71. Ans: (a)

Sol: All conditional jumps are short jumps.

End of Solution

72. Which of the following constraints are to be considered by the designer while designing an embedded system?

1. Selecting the microcontroller as a controlling device
2. Selecting the language to write the software
3. Partitioning the tasks between hardware and software to optimize the cost

Select the correct answer suing the code given below.

(a) 1, 2 and 3 (b) 1 and 2 only (c) 1 and 3 only (d) 2 and 3 only

72. Ans: (c)

Sol: In an Embedded system design, the task of a designer are mix of selecting the appropriate hardware (micro controller) and task partitioning.

End of Solution

73. Which one of the following is the correct combination for a layer providing a service by means of primitives in an open systems interconnection?

(a) Request, Indication, Response and Confirm

(b) Request, Inform Response and Service

(c) Request, command, Response and Action

(d) Request, Confirm, Indication and Action

73. Ans: (a)

Sol: Request primitive induces an indication primitive.

If an indication primitive requires a reply, a response primitive may be issued.

This response primitive will induce a confirmation primitive.

End of Solution

74. A network uses a fully interconnected mesh topology to connect 10 nodes together. The number of links required will be

(a) 35 (b) 40 (c) 45 (d) 50

74. Ans: (c)

Sol: Number of links $= \frac{n(n-1)}{2} = \frac{10*9}{2} = 45$

End of Solution

75. Which of the following are the advantages of packet switching?

1. Greater link efficiency than circuit switching
2. Connections are not blocked when traffic congestion occurs
3. Direct channel established between transmitter and receiver
4. No time is taken to establish connection

Select the correct answer using the code given below.

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

75. Ans: (b)

Sol: Packet switching leads better channel utilization.

In packet switching no need to establish the connection.

End of Solution

76. A message consisting of 2400 bits is to be passed over an internet. The message is passed to transport layer which appends a 150-bit header, followed by the network layer which uses a 120-bit header. Network layer packets are transmitted via two networks, each of which uses a 26-bit header. The destination network only accepts up to 900 bits long. The number of bits, including headers delivered to the destination network, is

(a) 2706 bits (b) 2634 bits (c) 2554 bits (d) 2476 bits

76. Ans: (a)

Sol: **Step 1:** Data + Transport header = 2400 + 150 = 2550 bits

Step 2: The data field of each internet packet is 900 – 26 = 874bits

So transport layer data is encapsulated into three internet packets.

Packet 1: 874 bits

Packet 2: 874 bits

Packet 3: 802 bits

Packet 1 and 2 are each of 900 bits, Packet 3 is 802 + 26 bits, or 828 bits long

The number of bits delivered to destination network is

$= (900\times2) + 828 + (3\times26)$

$= 2706$ bits

End of Solution

77. In a communication network, 4 T1 streams are multiplexed to form 1 T2 stream and 7 T1 streams are multiplexed to form 1 T3 stream. Further 6 T3 streams are multiplexed to form 1 T4 stream. If each T1 stream is of 1.544 Mbps, the data rate of 1 T4 stream should be

(a) 211.8 Mbps (b) 232.6Mbps (c) 243.4 Mbps (d) 274.2 Mbps

77. Ans: (d)

Sol: The bit rate of T-1 system = 1.544 Mbps

$R_b = 1.544\times4\times7\times6 = 260$ Mbps

But synchronization requires additional bits so the bit rate = 274.2 Mbps

Note: There is a printing mistake. $7T_2$ streams are multiplexed to form $1T_3$ stream, but given $7T_1$.

End of Solution

78. Which of the following statements are correct regarding CDMA?

1. It is similar to GSM.
2. It allows each station to transmit over the entire frequency spectrum all the time.
3. It assumes that multiple signals add linearly.

Select correct answer using the code given below.

(a) 1 and 2 only (b) 1 and 3 only (c) 2 and 3 only (d) 1, 2 and 3

78. Ans: (c)

Sol:
1. CDMA and GSM both are different because, CDMA uses Code division for multiple access whereas GSM uses TDM and FDM.
2. CDMA allows each station to transmit over entire frequency spectrum all the time because it doesn't use FDM technique.
3. CDMA consists of RAKE receiver due to which CDMA assumes that multiple signals (Multipath fading signals) add linearly.

Option (c) is correct if the 3^{rd} statement is "multipath signals" instead of "multiple signals".

End of Solution

79. Which of the following regarding cellular systems with small cells are correct?

1. Higher capacity and robustness
2. Needless transmission power and have to deal with local interference only
3. Frequency planning and infrastructure needed
4. These require both circuit switching and packet switching

Select the correct answer using the code given below.

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

79. Ans: (c)

Sol: Small cell size provides higher capacity. Generally we go for smaller cell size in metro cities to provide service to more number of mobile phones provided frequency planning is properly managed.

End of Solution

80. A satellite is orbiting in the equatorial plane with a period from perigee to perigee of 12 h. If the eccentricity = 0.002, i = 0°, K_1 = 66063.17km^2, $\mu = 3.99\times10^{14}$ m^3/s^2 and the earth's equatorial radius = 6378.14 km, the semi-major axis will be

(a) 34232 km (b) 30424 km
(c) 26612 km (d) 22804 km

80. Ans: (c)

Sol: $$n = \sqrt{\frac{\mu}{a^3}}.\left(\frac{1+k_1[1-1.5\sin^2 i]}{a^2(1-e^2)^{1.5}}\right)$$

$i = 0,$

$$n = \frac{2\pi}{P}$$

P = anormalistic period. P = 12hr = 12×hr = 12×60×60sec

$$\frac{2\pi}{12\times60\times60} = \sqrt{\frac{3.99\times10^{14}}{a^3}}\left[\frac{1+66063.17[1-0]}{a^2(1-(0.002)^2)^{1.5}}\right]$$

$\Rightarrow a = 26612\text{km}.$

End of Solution

81. A single-mode optical fiber has a beat length of 8 cm at 1300 nm. The value of birefringence B_f will be nearly

(a) 1.6×10^{-5} (b) 2.7×10^{-5} (c) 3.2×10^{-5} (d) 4.9×10^{-5}

81. Ans: (a)

Sol: The birefringence (B) of the fiber is a measure of the difference in the effective indices of two orthogonal modes.

The minimum length of the fiber over which the state of polarization comes back to the original state is called beat length 'L'.

$$L = \frac{\lambda}{B}$$

$$B = \frac{\lambda}{L}$$

$\lambda = 1300$ nm

$L = 8$ cm

$$B = \frac{\lambda}{L} = \frac{1300\times10^{-9}}{8\times10^{-2}} = 1.6\times10^{-5}$$

End of Solution

82. Which one of the following instruments is useful while measuring the optical power as a function of wavelength?

(a) Optical power attenuator (b) Optical power meter

(c) Optical spectrum analyzer (d) Optical return loss tester

82. Ans: (c)

Sol: Optical spectrum analyzer is used to measure the spectral characteristics of light. The OSA displays the optical power as a function wavelength.

End of Solution

83. The optical performance monitoring involves

(a) transport layer monitoring, optical signal monitoring and protocol performance monitoring

(b) physical layer, network layer and application layer monitoring

(c) data-link layer, presentation layer and session layer monitoring

(d) transport layer, session layer and application layer monitoring

83. Ans: (a)

Sol: Three layers of OPM: transport monitoring, signal quality monitoring and protocol monitoring.

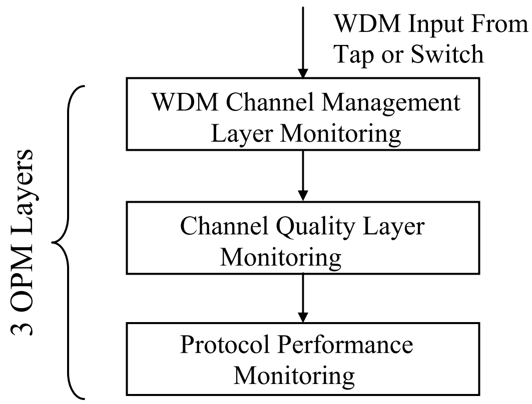


Fig. 1. Three layers of OPM: transport monitoring, signal quality monitoring, and protocol monitoring.

End of Solution

84. An earth station at sea level communicates at an elevation angle of 35° with GEO satellite. The vertical height of the stratiform rain is 3km. The physical path length L through the rain will be nearly

(a) 6.3km (b) 5.2 km

(c) 4.1 km (d) 3.0 km

84. Ans: (b)

Sol: $\text{Sin EL} = \frac{h}{L}$

$$\Rightarrow L = \frac{h}{\text{SinEL}}$$

$$= \frac{3\text{km}}{\text{Sin}35^{\circ}}$$

$$= 5.2\text{km}$$

End of Solution

Directions:

The following **six (6)** items consist of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answers to these items using the code given below:

Code:

(a) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(b) Both Statement (I) and Statement (II) are individually true but Statement (II) is **not** the correct explanation of Statement (I)

(c) Statement (I) is true but Statement (II) is false

(d) Statement (I) is false but Statement (II) is true

85. **Statement (I):**

Sign-magnitude representation is rarely used in implementing the integer portion of the ALU.

Statement (II):

There are two representations of zero in sign-magnitude representation.

85. Ans: (a)

Sol: In sign magnitude form and 1's complement form, the disadvantage is '0' has two representations.

Only 2's complement form has unique representation of 0. Hence 2's complement form is preferred.

End of Solution

86. **Statement (I):**

Dynamic loading gives better memory space utilization.

Statement (II):

In dynamic loading, an unused routine is never loaded.

86. Ans: (a)

Sol: In dynamic loading a library is loaded only when it is executed so less memory will be required. Unused library are never loaded.

End of Solution

87. **Statement (I):**

SRAM is used for cache memory and DRAM is used for main memory.

Statement (II):

SRAM is somewhat faster than DRAM.

87. Ans: (a)

Sol: SRAM is used for External cache memory as it is faster than DRAM.

DRAM is used for primary memory of the computer.

End of Solution

88. **Statement (I):**

In a multiuser system, each user is assigned a section of usable memory area and is not allowed to go out of the assigned memory area.

Statement (II):

In multiuser system there is a software mechanism to prevent unauthorized access of memory by different users.

88. Ans: (d)

Sol: Multiple users programs can be reside any where in memory to provide efficient memory utilization. OS provide protection by preventing unauthorized access.

End of Solution

89. **Statement (I):**

The external surface of a crystal is an imperfection in itself as the atomic bonds do not extend beyond the surface.

Statement (II):

The external surfaces have surface energies that are related to the number of bonds broken at the surface.

89. Ans: (a)

Sol: The external surface of a crystal is an imperfection in itself as the atomic bonds do not extend beyond the surface. External surfaces have surface energies that are related to the number of bonds broken of the surface.

Example: Consider a close packed plane as the surface of a close packed crystal. An atom on the surface of this crystal has six nearest bonding neighbours on the surface plane, three below it, and none above.

End of Solution

90. **Statement (I):**

By organizing various 'optical functions' into an 'array structure' via nano-pattern replication, 'spatial integration' is established.

Statement (II):

By adding a nano-optic layer or layers to functional optical materials, the 'hybrid integration' is possible to be achieved.

90. Ans: (b)

Sol: Nano-optic elements consists of numerous nano scale structure created by replicating nano pattern masters, with spatial integration method is established.

In hybrid integration method, discreate nono-optic devices are produced by adding a nano-optic layer or layers.

Statement (I) and Statement (II) are correct and Statement (II) is not correct explanation of Statement (I).

End of Solution

91. The peak-to-peak ripple voltage for a half-wave rectifier and filter circuit operating at 60Hz, which has a 680 μF reservoir capacitor, an average output of 28V and 200 Ω load resistance, will be nearly

(a) 2.5V (b) 3.4V

(c) 4.3V (d) 5.2V

91. Ans: (b)

Sol: Given frequency, f = 60Hz

$C = 680\mu F \ = 28V$

$V_{output\ average} = 28V$

$R_L = 200\Omega$

peak to peak ripple voltage with HWR + Capacitor filter,

$$V_{r_{p.p}} = \frac{V_{dc}}{f_C R_L}$$

$$= \frac{28}{60 \times 680\mu \times 200}$$

$\therefore\ Vr_{p.p} = 3.4V$

End of Solution

92. The components of full-wave voltage doubler circuit are

(a) 2 diodes and 1 capacitor

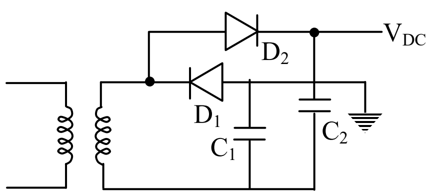
(b) 4 diodes and 1 capacitor

(c) 2 diodes and 2 capacitors

(d) 4 diodes and 2 capacitors

92. Ans: (c)

Sol: The components of full-wave voltage doubler must be → 2 diode's, 2 capacitor's



End of Solution

93. An amplifier has a signal input voltage V_i of 0.25 V and draws 1 mA from the source. If the amplifier delivers 8V to a load of 10 mA, the power gain is

(a) 340 (b) 320

(c) 250 (d) 150

93. Ans: (b)

Sol: An amplifier input voltage signal, $V_i = 0.25V$

$I_i = 1mA$

$V_0 = 8V$

$I_L = 10mA$

Amplifier power gain = $A_V A_i$

$$= \left(\frac{V_0}{V_{in}}\right)\left(\frac{I_0}{I_{in}}\right)$$

$$= \frac{V_0}{V_{in}} \times \frac{I_0}{I_{in}}$$

$$= \frac{80mV}{0.25mW}$$

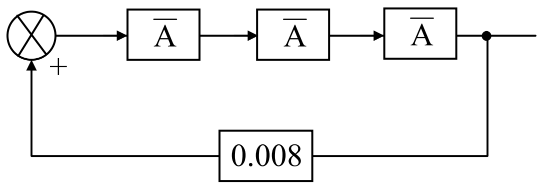
$$= 320W$$

End of Solution

94. Three amplifiers of gain

$$\bar{A} = \left(\frac{A_0}{2}\right)\angle -60^\circ$$

are connected in tandem. The feedback loop is closed through a positive gain of 0.008.

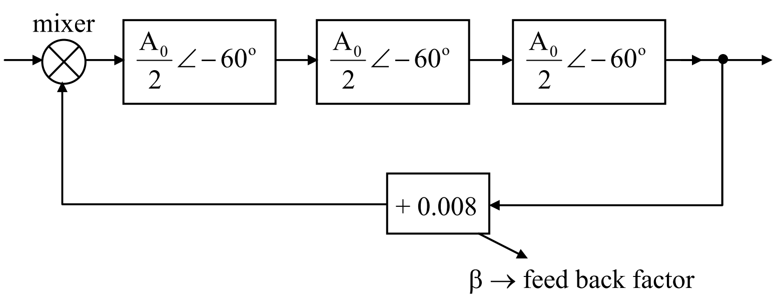


The magnitude of A_0 for the system to be oscillatory will be

(a) 0.2 (b) 0.1 (c) 5.0 (d) 10.0

94. Ans: (d)

Sol: Given, gain, $\bar{A} = \left|\frac{A_0}{2}\right|\angle -60^\circ$



for sustained oscillation's, loop gain = 1

$\beta A_T = 1$, where

$$A_T = \bar{A}\times\bar{A}\times\bar{A} = \frac{A_0}{2}\frac{A_0}{2}\frac{A_0}{2} = \left(\frac{A_0}{2}\right)^3$$

$$\therefore \beta\left[\frac{V_0}{2}\right]^3 = 1 \Rightarrow \left(\frac{A_0}{2}\right)^3 = \frac{1}{\beta}$$

$$\Rightarrow \left(\frac{A_0}{2}\right)^3 = 125$$

$$\Rightarrow \frac{A_0}{2} = 5 \Rightarrow A_0 = 10$$

End of Solution

95. The output voltage from a 5-bit ladder type DAC that has a digital input of 11010, and by assuming 0 = 0V and 1 = + 10V, is nearly

(a) 26.0V (b) 16.3V (c) 10.3V (d) 8.1V

95. Ans: (d)

Sol: $11010_2 = 26_{10}$

The output of 5-Bit DAC for 11010 input is

$$= 26 \times \frac{10}{2^5} = \frac{260}{32} = 8.1\text{V}$$

End of Solution

96. An 8-bit D/A converter has step size of 20mV. The full-scale output and the resolution will be nearly

(a) 5.1 V and 0.3% (b) 4.6V and 0.4% (c) 5.1 V and 0.4% (d) 4.6 V and 0.3%

96. Ans: (c)

Sol: (i) Full scale output = $(2^N - 1) \times$ stepsize

$= (2^8 - 1) \times 20$ mV

$= 255 \times 20$ mV = 5.1V

(ii) Resolution $= \frac{1}{2^N - 1} \times 100$

$$= \frac{1}{2^8 - 1} \times 100 = \frac{100}{255} = 0.3921\%$$

$= 0.4\%$

End of Solution

97. For 555 astable multivibrator, if C = 0.01 μF, R_A = 10kΩ, R_B = 50 kΩ, the frequency and the duty cycle will be nearly

(a) 1.6kHz and 54.5% (b) 1.3Hz and 54.5%

(c) 1.6kHz and 46.5% (d) 1.3kHz and 46.5%

97. Ans: (b)

Sol: Given 555 Astable multivibrator,

C = 0.01μF

R_A = 10kΩ

$R_B = 50k\Omega$,

The frequency of oscillation

$$f = \frac{1.4}{(R_A + 2R_B)C} = \frac{1.4}{0.0011}$$

$\therefore\ f = 1.27kHz \approx 1.3kHz$

$$\%\text{ Duty cycle, } D = \frac{R_A + R_B}{R_A + 2R_B} = \frac{60k}{110k} = 54.5\%$$

$\therefore\ D = 54.5\%$

End of Solution

98. Consider the following expression:

$$A.B.C.D + A.B.\overline{C}.\overline{D} + A.B.C.\overline{D} + A.B.\overline{C}.D + A.B.C.D.E + A.B.\overline{C}.\overline{D}.\overline{E} + A.B.\overline{C}.D.E$$

The simplification of this by using theorems of Boolean algebra will be

(a) A + B (b) A ⊕ B

(c) (A + B) (A.B) (d) A.B

98. Ans: (d)

Sol: $\Rightarrow ABCD + AB\overline{C}\overline{D} + ABC\overline{D} + AB\overline{C}D + ABCDE + AB\overline{C}\overline{D}\overline{E} + AB\overline{C}DE$

$\Rightarrow ABCD + AB\overline{C}\overline{D}(1+\overline{E}) + AB\overline{C}D + ABC\overline{D} + (AB\overline{C}DE)$

$\Rightarrow ABCD + AB\overline{D} + AB\overline{C}DE + AB\overline{C}D$

$\Rightarrow \underline{\underline{ABCD}} + AB\overline{D} + A\underline{\underline{B\overline{C}D}}$

$\Rightarrow ABD + AB\overline{D}$

$\Rightarrow A.B$

End of Solution

99. An electric power generating station supplies power to three loads A, B and C. Only a single generator is required when any one load is switched on. when more than one load is on, an auxiliary generator must be started. The Boolean equation for the control of switching of the auxiliary generator will be

(a) AA + BB + CC (b) ABC + BCA + CAB

(c) AB + AC (d) AB + AC + BC

99. Ans: (d)

Sol:

A	B	C	Auxiliary generator ON condition (F)
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

$F = \sum m\,(3, 5, 6, 7)$

A \ BC	00	01	11	10
0			1	
1		1	1	1

$F = A.B + B.C + C.A$

End of Solution

100. Which one of the following types of instructions will be used to copy from the source to the destination location?

(a) Arithmetic instructions

(b) Data transfer instructions

(c) Logical instructions

(d) Machine control instructions

100. Ans: (b)

Sol: In a microcomputer, the copy of data from one location to another is achieved by data transfer instructions.

101. A cascaded arrangement of flip-flops, where the output of one flip-flop drives the clock input of the following flip-flop, is known as

(a) synchronous counter (b) ripple counter

(c) ring counter (d) up counter

101. Ans: (b)

Sol: It is an Asynchronous counter which is also called as "Ripple counter".

End of Solution

102. The number of flip-flops required to construct an 8-bit shift register will be

(a) 32 (b) 16 (c) 8 (d) 4

102. Ans: (c)

Sol: A 8-bit shift register is built using 8 D-FlipFlops.

End of Solution

103. Which one of the following specifications does **not** fit for a single-mode fiber?

(a) The bandwidth is 1 GHz/km.

(b) The digital communication rate is excess of 2000 Mbytes/s.

(c) More than 100000 voice channels are available.

(d) The mode field diameter (MFD; spot size) is larger than the core diameter.

103. Ans (a)

Sol: Bandwidth does not depends on the length of the cable.

End of Solution

104. For a binary FSK signal with a mark frequency of 49 kHz, a space frequency of 51 kHz and an input bit rate of 2 kbps, the peak frequency deviation will be

(a) 0.5kHz (b) 1.0kHz (c) 2.0kHz (d) 4.0 kHz

104. Ans: (b)

Sol: Assume unmodulated carrier frequency f_c

mark frequency $f_m = f_c + \Delta f$

space frequency $f_s = f_c - \Delta f$

where Δf = frequency deviation

$f_m - f_s = 2\Delta f$

$$\Delta f = \frac{f_m - f_s}{2} = \frac{51k - 49k}{2} = 1\text{kHz}$$

End of Solution

105. A random process X(t) is defined as $X(t) = 2\cos(2\pi t + Y)$

where Y is a discrete random variable with $P(Y=0)=\frac{1}{2}$ and $P\left(Y=\frac{\pi}{2}\right)=\frac{1}{2}$.

The mean $\mu_x(1)$ is

(a) $\frac{1}{4}$ (b) $\frac{1}{3}$ (c) $\frac{1}{2}$ (d) 1

105. Ans: (d)

Sol: $X(t) = 2\cos[2\pi t + Y]$

$= 2\cos 2\pi t \cos Y + 2\sin 2\pi t.\sin Y$

$X(1) = 2\cos 2\pi.\cos Y + 2\sin 2\pi \,.\, \sin Y$

$= 2\cos Y + 2\times 0\times \sin Y$

$= 2\cos Y$

$E[X(1)] = 2E[\cos Y]$

$$= 2\left(\cos 0\times\frac{1}{2}\right)+2\left(\cos\frac{\pi}{2}\times\frac{1}{2}\right)$$

$$= \left(2\times 1\times\frac{1}{2}\right)+\left(2\times 0\times\frac{1}{2}\right)$$

$= 1$

End of Solution

106. A source produces three symbols A, B and C with probabilities $P(A)=\frac{1}{2}, P(B)=\frac{1}{4}$ and $P(C)=\frac{1}{4}$. The source entropy is

(a) $\frac{1}{2}$ bit/symbol (b) 1 bit/symbol (c) $1\frac{1}{4}$ bit/symbol (d) $1\frac{1}{2}$ bit/symbol

106. Ans: (d)

Sol: $P(A)=\frac{1}{2}$ $P(B)=\frac{1}{4}$ $P(C)=\frac{1}{4}$

$$\text{Entropy } H = \frac{1}{2}\log_2 2+\frac{1}{4}\log_2 4+\frac{1}{4}\log_2 4 = \frac{1}{2}+\frac{2}{4}+\frac{2}{4} = 1\frac{1}{2}\text{ bits/symbol}$$

End of Solution

107. An AM wave with modulation index 0.8 has total sideband power of 4.85kW. The carrier power and the total power radiated will be nearly

(a) 12.2kW and 20kW (b) 15.2kW and 20kW

(c) 12.2kW and 25kW (d) 15.2kW and 25kW

107. Ans: (b)

Sol: $\mu = 0.8$

$$P_{SB} = 4.85\text{kW} = \frac{P_c \mu^2}{2}$$

$$P_c = \frac{4.85 \times 10^3 \times 2}{0.64}$$

Carrier power = P_c = 15.2 kW

Total power = $P_c + P_{SB}$

= 15.2 + 4.85

P_t = 20 KW

End of Solution

108. A 360 W carrier is simultaneously modulated by two audio waves with modulation percentages of 55 and 65 respectively. The effective modulation index and the total power radiated are

(a) 0.85 and 490.5W (b) 0.65 and 490.5W

(c) 0.85 and 450.5W (d) 0.65 and 450.5W

108. Ans: (a)

Sol: P_c = 360 W

$\mu_1 = 0.55$ $\mu_2 = 0.65$

$$\mu_t^2 = 0.55^2 + 0.65^2 = 0.3025 + 0.4225 = 0.725$$

$$\mu_t = \sqrt{0.725} = 0.85$$

$$P_t = P_c + \frac{P_c \mu_t^2}{2} = 360 + 130.5 = 490.5 \text{ W}$$

End of Solution

109. An amplitude modulated amplifier has a radio frequency output of 50W at 100% modulation. The internal loss in the modulator is 10W. The unmodulated carrier power is

(a) 40W (b) 50W (c) 60W (d) 80W

109. Ans: (a)

Sol: $P_t = 50W + 10W = 60W$

$\mu = 1$

$$P_t = P_c\left[1+\frac{\mu^2}{2}\right]$$

$$60 = P_c\left[1+\frac{1}{2}\right]$$

$$60 = P_c \times \frac{3}{2}$$

$$P_c = \frac{60\times 2}{3} = \frac{120}{3} = 40W$$

End of Solution

110. For an FM receiver with an input signal-to-noise ratio of 29dB, a noise figure of 4 dB and an FM improvement factor of 16dB, the pre-detection and post-detection signal-to-noise ratios are

(a) 25 dB and 41 dB (b) 30 dB and 49 dB

(c) 25 dB and 49 dB (d) 30 dB and 41 dB

110. Ans: (a)

Sol: $$\left(\frac{S}{N}\right)_o = \frac{1}{NF}\left(\frac{S}{N}\right)_i$$

$$\left(\frac{S}{N}\right)_o = -4dB + 29dB$$

$= 25dB$ = pre-detector signal to noise ratio

Improvement factor = 16dB

So, post detector signal to noise ratio = 25 + 16

= 41dB

End of Solution

111. For Gaussian and white channel noise, the capacity of a low-pass channel with a usable bandwidth of 3000 Hz and $\frac{S}{N} = 10^3$ at the channel output will be

(a) 15000 bits/s (b) 20000 bits/s (c) 25000 bits/s (d) 30000 bits/s

111. Ans (d)

Sol: B = 3 kHz, $\frac{S}{N} = 10^3$

$$C = B\log_2\left[1+\frac{S}{N}\right]$$

$$C = 3\times10^3 \log_2\left[1+10^3\right]$$

$$C \approx 3\times10^3 \times \log_2 2^{10} = 30 \text{ kbps}$$

C = 30,000 bps

End of Solution

112. For a PM modulator with a deviation sensitivity K = 2.5rad/V and a modulating signal $v_m(t) = 2\cos(2\pi\, 2000t)$, the peak phase deviation m will be

(a) 1.25 rad (b) 2.5 rad

(c) 5.0 rad (d) 7.5 rad

112. Ans: (c)

Sol: K = 2.5 rad/volt

$V_m(t) = 2\cos(2\pi\, 2000t)$

Phase deviation = $\Delta\phi = K A_m$

$= 2.5 \times 2$

$= 5$ rad

End of Solution

113. In a PCM system, non-uniform quantization leads to

(a) increased quantizer noise

(b) simplification of the quantization process

(c) higher average SNR

(d) increased bandwidth

113. Ans: (c)

Sol: If uniform quantization is used, low amplitude signals of voice are quantized to the same value. This problem is eliminated using non-uniform quantization. If non-uniform quantization is used the average SNR will increase.

End of Solution

114. The bandwidth required in DPCM is less than that of PCM because

(a) the number of bits per code is reduced resulting in a reduced bit rate

(b) the difference signal is larger in amplitude than actual signal

(c) more quantization levels are needed

(d) the successive samples of signal often differ in amplitude

114. Ans: (a)

Sol: The dynamic range in DPCM is less when compared with PCM. It requires less number of quantization levels. So number of bits/code is reduced resulting in reducing in bit rate. As the bit rate reduces, bandwidth decreases.

End of Solution

115. For the given transfer function

$$G(s)=\frac{Y(s)}{R(s)}=\frac{1}{s^2+3s+2}$$

the response y(t) for a step input r(t) = 5u(t) will be

(a) $\left[\frac{5}{2}-5e^{-t}+\frac{5}{2}e^{-2t}\right]u(t)$

(b) $\left[\frac{5}{2}-5e^{-t}\right]u(t)$

(c) $\left[\frac{5}{2}+\frac{5}{2}e^{-2t}\right]u(t)$

(d) $\left[-5e^{-t}+\frac{5}{2}e^{-2t}\right]u(t)$

where u(t) is a unit step input.

115. Ans: (a)

Sol: $$\frac{Y(s)}{R(s)}=\frac{1}{s^2+3s+2}=\frac{1}{(s+1)(s+2)}$$

$$Y(s)=\frac{5}{s(s+1)(s+2)}=\frac{5}{2s}-\frac{5}{s+1}+\frac{5}{2(s+2)}$$

Apply, ILT

$$y(t)=\left(\frac{5}{2}-5e^{-t}+\frac{5}{2}e^{-2t}\right)u(t)$$

End of Solution

116. The price for improvement in sensitivity by the use of feedback is paid in terms of

(a) loss of system gain

(b) rise of system gain

(c) improvement in transient response, delayed response

(d) poor transient response

116. Ans: (a)

Sol: With feedback, sensitivity improved by factor of $\left(\frac{1}{1+GH}\right)$. Hence gain reduces by factor $\frac{1}{(1+GH)}$

End of Solution

117. Consider a feedback system with the characteristics equation

$$1+K\frac{1}{s(s+1)(s+2)}=0$$

The asymptotes of the three branches of root locus plot of this system will form the following angles with the real axis

(a) 60°, 120° and 300° (b) 60°, 120° and 180°

(c) 60°, 180° and 300° (d) 40°, 120° and 200°

117. Ans: (c)

Sol: $G(s)H(s)=\frac{K}{S(S+1)(S+2)}$

Number of asymptotes = 3

Angle of asymptotes, $\theta=\frac{(2q+1)180°}{(p-z)}$ $q = 0, 1, 2$

$= 60^o, 180^o, 300^o$

End of Solution

118. If the characteristic equation of a feedback control system is given by

$s^4 + 20s^3 + 15s^2 + 2s + K = 0$

then the range of values of K for the system to be stable will be

(a) $1 < K < 2.49$ (b) $0 < K < 1.49$ (c) $1 < K < 4.49$ (d) $0 < K < 3.49$

118. Ans: (b)

Sol: $\underrightarrow{CE}$ $s^4+20s^3+15s^2+2s+K=0$

$$\begin{array}{c|ccc} s^4 & 1 & 15 & K \\ s^3 & 20 & 2 & \\ s^2 & 14.9 & & \\ s^1 & \left(\dfrac{14.9-10K}{14.9}\right)>0 \ (s) & \Rightarrow & K<1.49 \\ s^0 & K>0 \ (s) & & 0<K<1.49 \end{array}$$

End of Solution

119. For a Type-2 system, the steady-state errors for unit step and unit ramp input are

(a) 0 and ∞ (b) ∞ and 0 (c) 0 and 0 (d) ∞ and ∞

119. Ans: (c)

Sol: For type - 2 system K_p & K_v are ∞ hence steady state errors are 0 & 0.

End of Solution

120. Consider the following statements regarding a parabolic function:

1. A parabolic function is one degree faster than the ramp function.

2. A unit parabolic function is defined as

$$f(t)=\begin{cases}\dfrac{t^2}{2}, & \text{for } t>0\\ 0\ , & \text{otherwise}\end{cases}$$

3. Laplace transform of unit parabolic function is $\dfrac{1}{s^3}$.

Which of the above statements are correct?

(a) 1 and 2 only (b) 1 and 3 only (c) 2 and 3 only (d) 1, 2 and 3

120. Ans: (d)

Sol: $\Rightarrow$ Ramp = tu(t)

Parabolic = $\dfrac{t^2}{2}u(t)$

Parabolic is one degree faster than ramp

$$= L\left[t^2/2\right]=\frac{1}{s^3}$$

End of Solution

121. Consider a common-emitter current gain of β = 150 and a base current of i_B = 15μA. If the transistor is biased in the forward active mode, the collector and emitter current will be

(a) 2.25 mA and 2.27 mA (b) 3.25 mA and 2.27 mA

(c) 2.25 mA and 1.37 mA (d) 3.25 mA and 1.37 mA

121. Ans: (a)

Sol: Given β_{dc} = 150 and i_B = 15μA

Biased in forward active

$\therefore I_C = \beta_{dc} I_B = 150 \times 15\mu = 2.25\text{mA}$

$I_E = (1+\beta_{dc})\, I_B = 151 \times 15\mu = 2.27\text{mA}$

End of Solution

122. The input to a bridge rectifier is 230 V (r.m.s.), 50 Hz. The d.c. output voltage and the ripple factor with R_L of 100 Ω and capacitor filter of 1000 μF are

(a) 207 V and 0.028 (b) 325 V and 0.028

(c) 207 V and 0.020 (d) 325 V and 0.020

122. Ans: (b)

Sol: Given bridge rectifier, $V_i = 230V_{rms}$,

$f = 50\text{Hz}$

$R_L = 100\Omega$

Capacitor filter, C = 1000μf

Ripple factor, for FWR $r = \dfrac{1}{4\sqrt{3}f_C R_L} = \dfrac{1}{4\sqrt{3}\times 50\times 1000\times 10^{-6}\times 100} = 0.028$

$V_{DC} = V_m = \sqrt{2}V_{rms} = 230\sqrt{2} = 325\text{V}$

End of Solution

123. The effect of reduction in effective base width due to increase in reverse voltage of BJT is

(a) Hall effect (b) Early effect (c) Zener effect (d) Miller effect

123. Ans: (b)

Sol: The Early effect or base width modulation is the variation in the width of the base in a bipolar transistor due to a variation in the applied base to collector reverse bias voltage.

End of Solution

124. What is the drain current for a D-MOSFET having the characteristics values I_{DSS} of 10 mA, $V_{GS(off)}$ of –4 V and V_{GS} of + 2 V?

(a) 22.5 mA (b) 17.5 mA (c) 12.5 mA (d) 2.5 mA

124. Ans: (a)

Sol: Given data

D-MOSFET

I_{DSS} = 10 mA

$V_{GS(off)} = V_P = -4$ volts

V_{GS} = 2 volts

As we know, $I_D = I_{DSS}\left(1-\frac{V_{GS}}{V_p}\right)^2 \Rightarrow I_D = 10\times10^{-3}\left(1-\frac{2}{(-4)}\right)^2$

$$\Rightarrow I_D = 10\times10^{-3}\left(1+\frac{1}{2}\right)^2 = 10\times10^{-3}\left(\frac{3}{2}\right)^2 = \frac{9}{4}\times10\times10^{-3}$$

$\Rightarrow I_D = 22.5$ mA

End of Solution

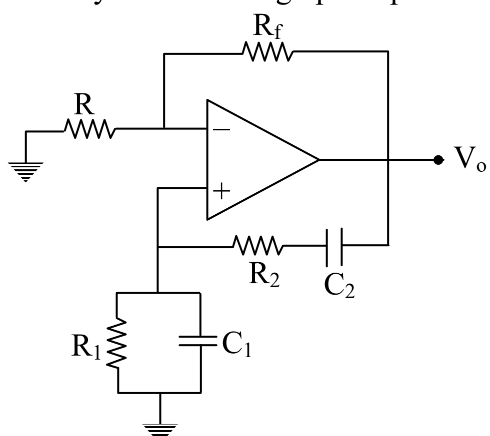
125. In the Wien bridge oscillator, the 0° phase-shift is met by using lead-lag network and by using

(a) inverting op-amp (b) non-inverting op-amp

(c) feedback op-amp (d) high-gain op-amp

125. Ans: (b)

Sol: Since, for Wien bridge oscillator, the lead lag network (ie.. positive feedback circuit → act as improved output response at $f = \frac{1}{2\pi RC}$) give phase shift of 0°, and the remaining 0° phase shift must be maintained by non-inverting op-Amp circuit.



End of Solution

126. What is the frequency of oscillator for an RC phase-shift oscillator with R of 10 kΩ and C of 0.001 μF in each of its three RC sections?

(a) 5.0 kHz (b) 5.5 kHz (c) 6.0 kHz (d) 6.5 kHz

126. Ans: (d)

Sol: Given RC phase shift oscillator of three RC sections,

$$f = \frac{1}{2\pi RC\sqrt{6}} = \frac{1}{2\times\pi\times10\times10^{3}\times0.001\times10^{-6}\times\sqrt{6}} = 6.5\text{kHz}$$

End of Solution

127. When there is no clock signal applied to CMOS logic circuits, they are referred to as

(a) complex CMOS logic circuits (b) static CMOS logic circuits

(c) NMOS transmission gates (d) random PMOS logic circuits

127. Ans: (b)

Sol: Static logic circuits allow versatile implementation of logic functions based on static or steady-state behaviour of simple CMOS structures.

A typical static logic gate generates its output levels as long as the power supply is provided.

Unclocked CMOS logic is a static CMOS logic circuit.

End of Solution

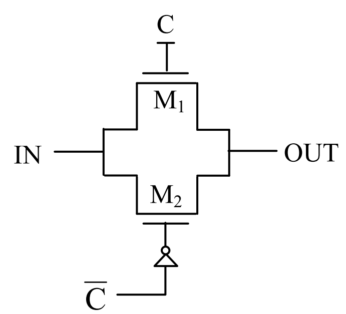
128. One form of NMOS circuit logic that minimizes power dissipation and maximizes device density is called

(a) pass transistor logic (b) sequential logic circuit

(c) NMOS SRAM cell (d) NMOS transmission gate

128. Ans: (d)

Sol:



The above figure shows a transmission gate, if M_1 is on then M_2 is off and vice-versa. Thus the power dissipation is less in transmission gate.

End of Solution

129. The ideal op-amp has

(a) infinite voltage gain and zero input impedance

(b) infinite voltage gain and infinite bandwidth

(c) zero voltage gain and infinite CMRR

(d) zero output impedance and zero CMRR

129. Ans: (b)

Sol: An ideal op-amp properties

Infinite open loop voltage gain

Infinite input impedance

Zero output impedance

Zero noise contribution (infinite CMRR)

Zero DC output offset

Infinite bandwidth

End of Solution

130. A d.c. voltage supply provides 60 V when the output is unloaded. When connected to a load, the output drops to 56 V. The value of the voltage regulation is

(a) 3.7% (b) 5.7% (c) 7.1% (d) 9.1%

130. Ans: (c)

Sol: $V_{DC} = 60V$, without load $\Rightarrow V_{NL} = 60V$

$V_{DC} = 56V$ with load $\Rightarrow V_{FL} = 56V$

$$\therefore \text{ \% resolution } = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100 = 7.1\%$$

End of Solution

131. In optical communication, the maximum angle in which external light rays may strike the air/glass interface and still propagate down the fiber is called as

(a) critical angle (b) numerical aperture

(c) angle of refraction (d) acceptance angle

131. Ans: (d)

Sol: Acceptable angle is defined as the maximum angle in which the light ray enters the air-core interface, and propagate through the core.

End of Solution

132. The light intensity 3 m from a lamp that emits 25 W of light energy will be

(a) 243 mW/m^2 (b) 232 mW/m^2

(c) 221 mW/m^2 (d) 210 mW/m^2

132. Ans: (c)

Sol: Illumination

Intensity of light depends on its distance from source and its power rating.

$$\text{Intensity} = \frac{W}{4\pi r^2} = \frac{25}{4\times\pi\times(3)^2} = 0.221 = 221 mW/m^2$$

End of Solution

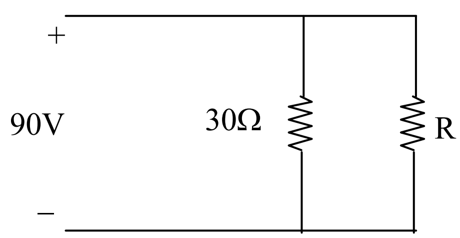
133. Two resistances, one of 30 Ω and another of unknown value, are connected in parallel. The total power dissipated in the circuit is 450 W when the applied voltage is 90 V. The unknown resistance is

(a) 45 Ω (b) 35 Ω

(c) 30 Ω (d) 20 Ω

133. Ans: (a)

Sol:



$$P = \frac{V^2}{R_T}$$

$$450 = \frac{(90)^2}{\left(\frac{30R}{30+R}\right)}$$

$R = 45\Omega$

End of Solution

134. An electric kettle contains 1.5 kg of water at 15°C. It takes 15 minutes to raise the temperature of water to 95°C. If the heat loss due to radiations and heating the kettle is 15 kcalories and the supply voltage is 100 V, the current taken will be

(a) 8.0 A (b) 7.1 A

(c) 6.3 A (d) 5.4 A

134. Ans: (c)

Sol: $Q = mC(T - T_0)$ Here C = 1 (for water)

$Q = 1.5\times10^3\times1\times(95 - 15)$

$Q = 120$ kcal

Total heat supplied = 120 + 15 = 135 kcal = $135\text{kcal}\times 4.184\left(\dfrac{\text{J}}{\text{cal}}\right)$ = 564.84 (kJ)

$Q = (IV)\,t$

$$560.84\times10^3 = \text{I}\times100\times15\,\text{minutes}\times60\left(\frac{\text{sec}}{\text{min}}\right)$$

I = 6.23 A

End of Solution

135. A heater element is made of nichrome wire having resistivity equal to 100×10^{-8} Ωm and diameter of 0.4 mm. The length of the wire required to get a resistance of 40 Ω will be nearly

(a) 9 m (b) 7 m

(c) 5 m (d) 3 m

135. Ans: (c)

Sol: $R = \dfrac{\rho l}{a}$

$$\Rightarrow 40 = \frac{100\times10^{-8}(l)}{\pi(0.2)^2\times10^{-6}}$$

$$\frac{l}{\pi\times0.04} = 40$$

$l = \pi\times1.6$

$l = 5.02$m

End of Solution

136. A car is travelling at 72 km/h. If the length of an axle is 2 m and the vertical component of the earth's magnetic field is 40 μWb/m^2, the e.m.f generated in the axle of the car is

(a) 2.6 mV (b) 2.2 mV (c) 1.6 mV (d) 1.2 mV

136. Ans: (c)

Sol: v = 72 km/hr

$$v = 72 \times \frac{5}{18} = 20\ m/s$$

$l = 2$ m

$B = 40 \times 10^{-6}$ Wb/m^2

emf generated in the axle of the car is

$V_{emf} = Blv$

$= 40\times10^{-6}\times2\times20$

$V_{emf} = 16 \times 10^{-4} = 1.6$ mV

End of Solution

137. In a telephone receiver, the size of each of the two poles is 1.2cm×0.2cm and the flux between each pole and the diaphragm is 3×10^{-6} Wb. The force attracted to the poles will be nearly

(a) 0.15 N (b) 0.20 N (c) 0.30 N (d) 0.40 N

137. Ans: (a)

Sol: The force between two poles of the magnet.

$$F = \frac{B^2 A}{2\mu_0}$$

$$F = \frac{\Phi^2}{2A\mu_0} = \frac{9\times10^{-12}}{2\times1.2\times10^{-2}\times0.2\times10^{-2}\times4\pi\times10^{-7}}$$

$$F = \frac{9\times10^{-12}}{2\times12\times2\times10^{-13}\times4\pi}$$

$$F = \frac{9\times10^{-12+13}}{48\times4\pi}$$

$$F = \frac{9\times10^{1}}{48\times4\pi} = \frac{90}{603}$$

$F = 0.149$ N ≈ 0.15N

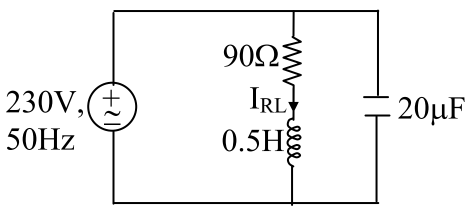
End of Solution

138. An inductor of 0.5 H inductance and 90Ω resistance is connected in parallel with a 20 μF capacitor. A voltage of 230 V at 50 Hz is maintained across the circuit. The total power taken from the source is nearly

(a) 588 W (b) 145 W (c) 135 W (d) 125 W

138. Ans: (b)

Sol:



$$X_L = 2\pi(50)\left(\frac{1}{2}\right) = 157$$

$$X_L = \frac{1}{2\pi(50)(20\times10^{-6})} = 159$$

$$I_{RL} = \frac{|V|}{|Z|} = \frac{230}{\sqrt{(90)^2 + (157)^2}} = 1.27$$

$$P_W = |I_{RL}|^2 (R) = (1.27)^2 (90) = 145W$$

End of Solution

139. A 240 V shunt motor with the armature resistance of 0.1 Ω runs at 850 r.p.m. for an armature current of 70 A. If its speed is to be reduced to 650 r.p.m., the resistance to be placed in series for an armature current of 50 A is nearly

(a) 0.82 Ω (b) 1.14 Ω (c) 1.24 Ω (d) 1.34 Ω

139. Ans: (b)

Sol: $$\frac{N_1}{N_2} = \frac{V_1 - I_{a1}R_a}{V_2 - I_{a2}(R_a + R_{ext})}$$

$$\frac{850}{650} = \frac{240 - 70(0.1)}{240 - 50(0.1 + R_{ext})}$$

$R_{ext} = 1.136\ \Omega$

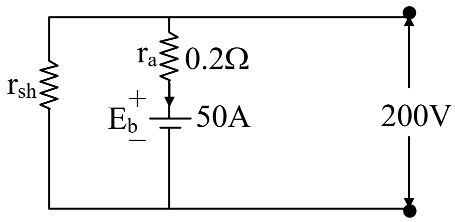
End of Solution

140. A 200 V d.c. shunt motor with armature resistance of 0.2 Ω and carrying a current of 50 A is running at 960 r.p.m. If the flux is reduced by 10% at constant torque and with negligible iron and friction losses, the speed will be nearly

(a) 1280 r.p.m (b) 1170 r.p.m (c) 1100 r.p.m (d) 1060 r.p.m

140. Ans: (d)

Sol:



Torque = constant

$T \propto \phi I_a$

$$\frac{T_1}{T_2} = \frac{\phi_1}{\phi_2} \times \frac{I_{a1}}{I_{a2}}$$

$$I_{a_2} = \frac{\phi_1}{0.9\phi_1} \times 50 = 55.55 \text{ Amps}$$

$E_b \propto \phi\,(N)$

$$\frac{E_{b_1}}{E_{b_2}} = \frac{\phi_1}{\phi_2} \times \frac{N_1}{N_2}$$

$$\frac{200 - 50 \times 0.2}{200 - 55.55 \times 0.2} = \frac{\phi_1}{0.9\phi_1} \times \frac{960}{N_2}$$

$\Rightarrow N_2 = 1060.5$ rpm

End of Solution

141. Which of the following statements are correct for d.c. shunt motor?

1. Speed of a shunt motor is sufficiently constant.
2. For the same current input, its starting torque is not as high as that of a series motor.
3. The motor can be directly coupled to a load such as a fan whose torque increases with speed.

Select the correct answer using the code given below.

(a) 2 and 3 only (b) 1 and 3 only (c) 1 and 2 only (d) 1, 2 and 3

141. Ans: (c)

Sol: 1. Speed of shunt motor droops slightly from no load to full load. So statement 1 is correct.

2. For the same input starting torque of series motor is high because $T_L \alpha I_a^2$, so statement 2 is also correct.

3. Statement 3 is wrong as shut motor drives variable load with slight change in speed.

End of Solution

142. Consider the following materials:

1. Lead peroxide
2. Sponge lead
3. Dilute sulphuric acid

Which of the above are active materials of a lead-acid battery?

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

142. Ans: (d)

Sol: The main active materials required to construct a lead acid battery are

1. Lead peroxide (PbO_2)
2. Sponge Lead (Pb)
3. Dilute sulphuric acid (H_2SO_4)

End of Solution

143. Which of the following statements are correct for a fully charged lead-acid cell?

1. Gassing occurs at both electrodes.
2. The terminal voltage is 2.6 V
3. The specific gravity of the electrolyte is 1.21.

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

143. Ans: (d)

Sol: In a fully charged lead acid cell gassing occurs at both electrodes, the terminal voltage is around 2.1V and the specific gravity of the electrolyte is 1.21.

End of Solution

144. Which of the following statements are correct for synchronous motors?

1. Synchronous motors are well-suited for direct connection to reciprocating compressors.
2. Over-excited synchronous motors are most commonly used for power factor improvement.
3. Synchronous motors are generally used for current regulation of long transmission lines.

Select the correct answer using the code given below.

(a) 1, 2 and 3 (b) 1 and 3 only

(c) 1 and 2 only (d) 2 and 3 only

144. Ans: (a)

Sol:
1. Synchronous motors are well suited for loads where constant speed is required, so it is well suited for reciprocating compressors.
2. Over excited synchronous motors, p.f. tends to approach unity with increase in load so it is used for power factor correction.
3. By using synchronous motor we can control the reactive power of the line by which current in the line can be changed.

End of Solution

145. Which crystal system requires six lattice parameters to fully specify its unit cell?

(a) Triclinic (b) Monoclinic

(c) Cubic (d) Hexagonal

145. Ans: (a)

Sol: For Triclinic Lattice system,

$a \neq b \neq c$

$\alpha \neq \beta \neq \gamma \neq 90^o$

All six lattice parameters required to define a triclinic unit cell.

End of Solution

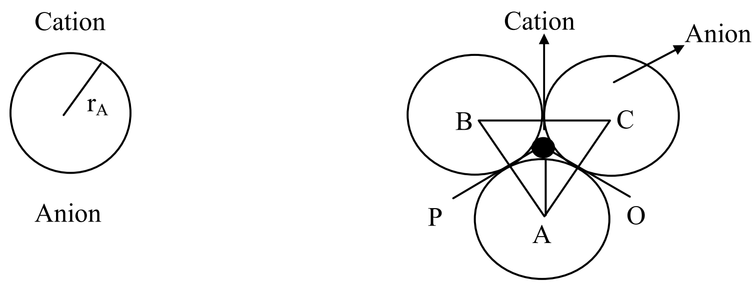
146. The minimum cation-to-anion radius ratio for the coordination number 3 is

(a) 0.175 (b) 0.155

(c) 0.135 (d) 0.115

146. Ans: (b)

Sol: For this coordination, the small cation is surrounded by three anions to form an equilateral triangle as shown below - triangle ABC, the center of all four ions are coplanar.



Triangle APO

$$\frac{r_A}{r_A + r_C} = \cos 30^\circ$$

$$1 + \frac{r_C}{r_A} = \frac{1}{\cos 30^\circ}$$

$$\frac{r_C}{r_A} = \frac{1}{\cos 30^\circ} - 1 = 0.155$$

End of Solution

147. Which of the following materials are categories of ceramic materials?

1. Oxides-Alumina, Zirconia
2. Non-oxides-carbides, Borides, Nitrides and Silicides
3. Composites-Particulate reinforced combinations of oxides and non-oxides

Select the correct answer using the code given below.

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

147. Ans: (d)

Sol: Ceramics: ceramics are compounds of both metal and non-metal formed predominantly by ionic bonds.

(1) Oxide ceramics: Alumina, Zirconia

(2) Non-oxide ceramics: Carbides, Borides, nitrides and silicides.

(3) composites: Particulate reinforced combinations of oxides and non oxides.

End of Solution

148. Consider the following data for copper:

Energy for vacancy formation is 0.9 eV/atom

Atomic weight is 63.5 g/mol

Density is 8.4 g/cm^3 at 1000 °C

The equilibrium number of vacancies per cubic meter at 1000 °C will be

(a) 3.2×10^{20} (b) 3.2×10^{25}

(c) 2.2×10^{20} (d) 2.2×10^{25}

148. Ans: (d)

Sol: Given: Energy for vacancy formation (Q_v) = 0.9 eV/atom

Atomic weight (A_{cu}) = 63.5 g/mol

Density (ρ) = 8.4g /cm^3

$$\frac{N_V}{N} = e^{-\frac{Q_v}{kT}} = 2.7\times10^{-4}$$

For 1m^3, $N = \rho\times\frac{N_A}{A_{cu}}\times1 = 8\times10^{28}$ sites

$N_V = (2.7\times10^{-4})(8\times10^{28})$ sites $= 2.2\times10^{25}$ vacancies

End of Solution

149. Which of the following are electrical insulating materials?

1. Lucite 2. Mica 3. Bakelite

Select the correct answer using the code given below

(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

149. Ans: (d)

Sol: Lucite, Mica, Bakelite are insulators.

Lucite is a trade name of polymethyl metha crylate, a synthetic organic compound of high molecular weight.

Properties:

(1) More dimensional stability

(2) Good resistance to weathering and shock

(3) Colourless & transparent

(4) Insulator

End of Solution

150. The magnitude of the energy gap for an insulator is

(a) less than 1 eV (b) between 2 eV to 3 eV

(c) more than 3 eV (d) between 1 eV to 2 eV

150. Ans: (c)

Sol: If the energy gap >3ev, then it is called an insulator.

End of Solution