DETAILED SOLUTIONS

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ESE 2024 : Prelims Exam
CLASSROOM TEST SERIES

E & T ENGINEERING

Test 22

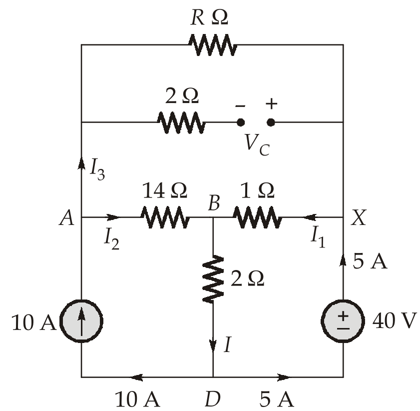
Full Syllabus Test 6 : Paper-II

1. (b)	26. (c)	51. (d)	76. (c)	101. (b)	126. (c)
2. (d)	27. (a)	52. (d)	77. (b)	102. (c)	127. (c)
3. (d)	28. (d)	53. (c)	78. (c)	103. (c)	128. (d)
4. (a)	29. (b)	54. (d)	79. (b)	104. (a)	129. (c)
5. (c)	30. (a)	55. (c)	80. (d)	105. (c)	130. (b)
6. (c)	31. (c)	56. (b)	81. (c)	106. (c)	131. (b)
7. (d)	32. (a)	57. (c)	82. (d)	107. (a)	132. (c)
8. (d)	33. (c)	58. (d)	83. (b)	108. (c)	133. (b)
9. (d)	34. (a)	59. (a)	84. (a)	109. (c)	134. (c)
10. (a)	35. (c)	60. (d)	85. (d)	110. (a)	135. (c)
11. (a)	36. (c)	61. (d)	86. (d)	111. (c)	136. (d)
12. (a)	37. (d)	62. (a)	87. (c)	112. (c)	137. (c)
13. (c)	38. (c)	63. (a)	88. (a)	113. (b)	138. (b)
14. (c)	39. (a)	64. (c)	89. (b)	114. (c)	139. (b)
15. (b)	40. (c)	65. (c)	90. (c)	115. (c)	140. (a)
16. (d)	41. (a)	66. (d)	91. (d)	116. (c)	141. (c)
17. (d)	42. (d)	67. (d)	92. (d)	117. (d)	142. (c)
18. (c)	43. (d)	68. (b)	93. (b)	118. (a)	143. (c)
19. (b)	44. (c)	69. (a)	94. (c)	119. (b)	144. (b)
20. (c)	45. (a)	70. (c)	95. (b)	120. (c)	145. (a)
21. (d)	46. (c)	71. (b)	96. (c)	121. (d)	146. (d)
22. (d)	47. (d)	72. (d)	97. (a)	122. (a)	147. (b)
23. (a)	48. (b)	73. (d)	98. (c)	123. (b)	148. (c)
24. (c)	49. (a)	74. (b)	99. (c)	124. (b)	149. (b)
25. (b)	50. (c)	75. (c)	100. (d)	125. (d)	150. (b)

DETAILED EXPLANATIONS

1. (b)

For DC supply, capacitor is open circuited. Hence, we can redraw circuit as



Apply KCL at node D, we get

$$I = 10 + 5$$
$$I = 15 \text{ A}$$

As we get $I = 15$ A $\Rightarrow$ $V_B = 15 \times 2 = 30$ V

We have,
$$V_C = -60 \text{ V}$$
$$V_X - V_A = -60 \text{ V} \qquad \because V_C = V_X - V_A$$
$$40 - V_A = -60$$
$$V_A = 100 \text{ V}$$

We get,
$$V_A = 100 \text{ V}; V_B = 30 \text{ V}; V_X = 40 \text{ V}$$
$$I_2 = \frac{V_A - V_B}{14} = \frac{100 - 30}{14} = 5\text{A}$$
$$I_1 = \frac{V_X - V_B}{1} = \frac{40 - 30}{1} = 10\text{ A}$$

Apply KCL at node A, we get

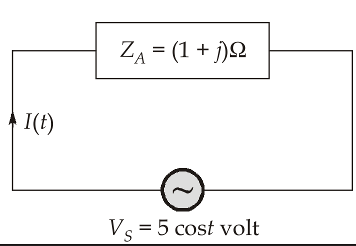
$$I_3 = 10 - I_2$$
$$I_3 = 10 - 5$$
$$I_3 = 5 \text{ A}$$

Now,

Power dissipated across resistor 'R' $= I_3 |V_C|$
$$P_{\text{dissipated}} = 5 \times 60 = 300 \text{ W}$$

2. (d)

Case-I: When $Z_A = (1 + j)\Omega = \sqrt{2}\angle 45° \ \Omega$



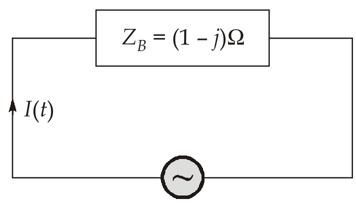
$$I_{max} = \frac{V_S}{Z_A} = \frac{5\angle 0°}{\sqrt{2}\angle 45°} = \frac{5\angle -45°}{\sqrt{2}} \text{A}$$

$$P_{complex} = P_A = V_{rms} I^*_{rms}$$

$$P_A = \left(\frac{5}{\sqrt{2}}\angle 0°\right)\left(\frac{5}{\sqrt{2}\sqrt{2}}\angle +45°\right)$$

$$P_A = \frac{25}{2\sqrt{2}}\angle 45° = \left(\frac{25}{4} + \frac{j25}{4}\right) \text{VA}$$

Case-II: When $Z_B = (1 - j)\Omega = \sqrt{2}\angle -45°\ \Omega$



$V_S = 5 \cos t$ volt

$$I_{max} = \frac{V_S}{Z_B} = \frac{5\angle 0°}{\sqrt{2}\angle -45°} = \frac{5\angle 45°}{\sqrt{2}} \text{A}$$

$$P_{complex} = P_B = V_{rms} I^*_{rms}$$

$$P_B = \left(\frac{5}{\sqrt{2}}\angle 0°\right)\left(\frac{5}{\sqrt{2}\sqrt{2}}\angle -45°\right)$$

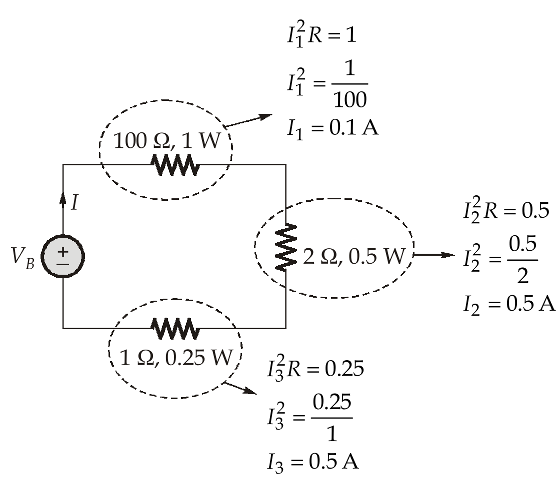
$$P_B = \frac{25}{2\sqrt{2}}\angle -45° = \frac{25}{4} - \frac{j25}{4}$$

$$P_A - P_B = \frac{25}{4} + \frac{j25}{4} - \frac{25}{4} + \frac{j25}{4}$$

$$P_A - P_B = \frac{j25}{2} = \frac{25}{2}\angle 90° \text{ VA}$$

Hence, option (d) is correct.

3. (d)



We get,
Maximum allowable current through resistances 100 Ω, 2 Ω and 1 Ω as 0.1 A, 0.5 A and 0.5 A respectively.
Hence, for safe operation, maximum 0.1 A current will circulate in the circuit.

$$I = \frac{V_B}{Z}$$

Here,
$$Z = R_1 + R_2 + R_3$$
$$Z = 100 + 2 + 1 = 103\ \Omega$$
$$0.1 = \frac{V_B}{103}$$
$$V_B = 10.3 \text{ Volt}$$

Now,
Maximum power dissipated by the source (V_B) is
$$V_B I = 10.3 \times 0.1 = 1.03 \text{ Watt}$$

Hence, option (d) is correct.

4. (a)

We have, Ammeter reading, $I = 5$ A (rms value)

Now, we know that,
$$5 = \sqrt{(3)^2 + (I_L - 4)^2}$$
$$25 = 9 + (I_L - 4)^2$$
$$(I_L - 4)^2 = 16$$
$$I_L - 4 = \pm 4$$
$$I_L - 4 = 4 \quad \text{or} \quad I_L - 4 = -4$$
$$I_L = 8 \text{ A} \quad \text{or} \quad I_L = 0 \text{ A}$$

As $|X_C| > |X_L| \Rightarrow |I_L| > |I_C|$
Therefore, discarding $I_L = 0$ A and hence, option (a) is correct.

5. (c)

Tellegen's Theorem is valid for any type of network (lumped network) as long as KVL and KCL equations are valid.

6. (c)

The Duality of charge is flux linkage.

7. (d)

Thevenin's theorem can't be applied:

- when dependent source value depends on load component i.e., circuit(1).
- when the sources have unequal value of frequency i.e., circuit(2).
- when the mutual inductance depends on load component i.e., circuit(3).

8. (d)

- Locus diagram are useful for analysis and designing of circuit showing the variation of impedance with frequency.
- We have, $Y = G + jB$, where B varies with frequency. Since, $G > 0$, hence for any combination of element– Locus diagram is only possible in I^{st} and IV^{th} quadrant.

9. (d)

- For a network to be stable, the network function cannot have poles in the right half of s-plane and cannot have multiple poles on the $j\omega$ axis. Also, the degree of the numerator of the function cannot exceed the degree of dominator by more than unity.
- Any network function $F(s)$ with poles in left half of the s-plane has inverse Laplace Transform, which is zero for $t < 0$. Therefore, such a network will be a causal network, and therefore, will always be a physically realisable network.

10. (a)

Soldering material should have low melting point and high electrical conductivity i.e., Tin(Sn) and Lead (Pb).

11. (a)

We have,

$$\text{Efficiency of kettle, } e = \frac{P_{out}}{P_{in}}$$

$$\frac{80}{100} = \frac{P_{out}}{1\text{ kW}}$$

$$P_{out} = \frac{80}{100} \times 1000$$

$$P_{out} = 800 \text{ Watt} = 0.8 \text{ kWatt}$$

$$P_{out} = \frac{\text{Output heat energy}}{\text{time}} \qquad \ldots(i)$$

$$\text{Output heat energy} = MS\Delta T$$

$$E = 1 \times 4.2 \times 10^3 \times (50 - 10)$$

$$E = 4200 \times 40$$

$$E = 168 \text{ kJ}$$

From equation (i),

$$\text{time, } t = \frac{\text{Output heat energy } (E)}{P_{out}}$$

$$t = \frac{168\,k}{0.8\,k}$$

$$t = 210 \text{ sec} = 3.5 \text{ min}$$

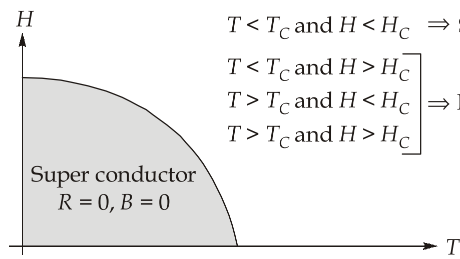
12. (a)

- Mercury is the only metal that is liquid at room temperature. Being a metal, it has free electrons and hence, it is a good conductor of electricity.

- Sulphur and Diamond are non-metals with tightly bound electrons, making them poor conductors of electricity.
- Silicon is a semiconductor, and its conductivity lie between good conductors and good insulators.

13. (c)

Superconductor show superconductivity property because of formation of cooper pairs below critical temperature.



$T < T_C$ and $H < H_C$ ⇒ Superconducting state

$T < T_C$ and $H > H_C$
$T > T_C$ and $H < H_C$ ⇒ Normal state
$T > T_C$ and $H > H_C$

14. (c)

The evolution or absorption of heat when electric current passes through a circuit composed of a single material that has a temperature difference along its length is known as Thomson effect.

15. (b)

We have, $n = 1, \lambda = 2\ \text{Å} = 2 \times 10^{-10}\ \text{m}, \theta = 27°$

According to Bragg's law of X-ray diffraction, $2d \sin\theta = n\lambda$

$$\therefore \quad d = \frac{n\lambda}{2\sin\theta} = \frac{1\times 2\times 10^{-10}}{2\times \sin 27°}$$

$$d = \frac{10^{-10}}{0.45}$$

$$d = 2.22\ \text{Å}$$

16. (d)

For diamond cubic crystal-all odd h, k, l (or) if all even, then $(h + k + l)$ must be divisible by 4. i.e., (137), (224)

17. (d)

Crystal Structure	Number of atoms (N)	Atomic Packing Factor, APF	Co-ordination Number	Relation between radius of atom (r) and edge length of unit cell (a)
Simple cubic crystal	1	52%	6	$2r = a$
Body centered cubic	2	68%	8	$4r = \sqrt{3}a$
Face centered cubic	4	74%	12	$4r = \sqrt{2}a$
Diamond cubic crystal	8	34%	4	$8r = \sqrt{3}a$
Hexagonal close packed	6	74%	12	$2r = a$

18. (c)

$\frac{\epsilon_r - 1}{\epsilon_r + 2} = \frac{N\alpha}{3\epsilon_0}$ is called as Clausius Mossotti Equation.

Hence, option (c) is correct.

19. (b)

$$\phi_0(\max) = 0.115 \text{ radian}$$

$$\phi_0(\max) = \left(0.115 \times \frac{180°}{\pi}\right) = 6.6°$$

$$NA = \sin\phi_0(\max)$$

$$NA = \sin(6.6°) = 0.115$$

$$NA = n_1\sqrt{2\Delta}$$

Substituting value of NA = 0.115, we get

$$\Delta = 0.0045$$

$$n_1 = \frac{0.115}{\sqrt{2 \times 0.0045}} = 1.21$$

$$n_1 = \frac{\text{Velocity of light in free-space}}{\text{Velocity of light in the fiber-core}} = \frac{3 \times 10^8}{V_{core}}$$

$$V_{\text{core}} = \frac{3 \times 10^8}{1.21} = 2.48 \times 10^8 \text{ m/s}$$

20. (c)

The delay difference between the slowest and fastest modes at output of multimode step index fiber is given by

$$\Delta T = \frac{l\Delta n_1}{c} = \frac{6 \times 10^3 \times 1.6 \times 0.02}{3 \times 10^8} \text{sec}$$

$$= 640 \text{ ns}$$

The maximum bit rate assuming no intersymbol interference is given by

$$B = \frac{1}{2T_r} = \frac{1}{2\Delta T} = \frac{1 \times 10^9}{2 \times 640}$$

$$= \frac{1000}{2 \times 640} \times 10^6$$

$$= 0.78 \text{ Mbps}$$

21. (d)

The major axis of the elliptical orbit is a straight line between the apogee and perigee. Hence, the semi major axis length (a) is obtained from earth radius r_e, perigee height h_p and apogee height h_a as

$$2a = 2r_e + h_p + h_a$$

$$= 2 \times 6400 + 1000 + 4000$$

$$= 17800 \text{ km}$$

Thus the semimajor axis of the orbit has a length

$$a = \frac{17800}{2} = 8900 \text{ km}$$

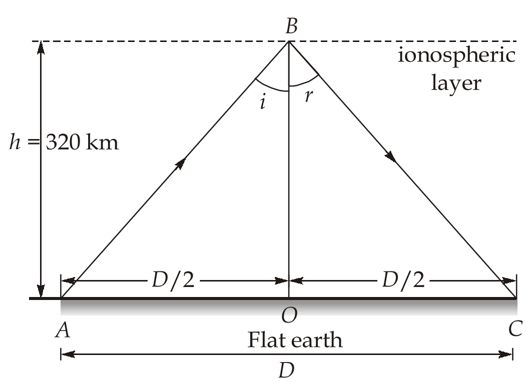
$$\text{Time period} = T^2 = \frac{4\pi^2 a^3}{\mu} = \frac{4\pi^2 (8900)^3}{3.98 \times 10^5}$$

$$T \cong 8.36 \times 10^3 \text{ sec}$$

22. (d)

- The loss suffered by signal to go to a geostationary satellite and for signal to come back is high. So, high power transmitters are required.
- Communication subsystems is the heart of communication satellite and consist of a set of transponders that receive the uplink signal and retransmit them to earth. The main function of communication subsystem is to provide a reliable communication between the satellite and ground station.
- VSAT is a technology, used to define two-way satellite communication. VSAT system use small dish antennas that vary from 75 cm to 1.5 m in diameters. VSAT terminal access satellites in orbit, to transfer data from one earth station to other or to access the internet (two way satellite internet). The VSAT network is managed by the hub.
- Three geosynchronous satellites give 100% global coverage.

23. (a)



Under flat earth assumptions we have,
From ΔAOB,

$$\cos\theta_i = \frac{OB}{AB} = \frac{h}{\sqrt{h^2 + \left(\frac{D}{2}\right)^2}} = \frac{2h}{\sqrt{4h^2 + D^2}}$$

$$\cos 45° = \frac{2 \times 320}{\sqrt{4 \times (320)^2 + D^2}}$$

$$4 \times (320)^2 + D^2 = (2\sqrt{2} \times 320)^2$$

$$D^2 = 320^2[8 - 4] = 320^2 \times 4$$

$$D = 320 \times 2 = 640 \text{ km}$$

Maximum permissible frequency under flat earth assumptions is,

$$f_{muf} = f_c\sqrt{1+\left(\frac{D}{2h}\right)^2}$$

$$f_c = 9\sqrt{N_{max}}$$

$$N_{max} = 4 \times 10^{10}/\text{m}^3$$

$$f_c = 9\sqrt{4\times10^{10}} = 9\times2\times10^5 = 18\times10^5\,\text{Hz}$$

$$f_{muf} = 18\times10^5\sqrt{1+\left(\frac{640}{640}\right)^2}$$

$$= \sqrt{2}\times18\times10^5\ \text{Hz}$$

$$= 1.414 \times 18 \times 10^5\ \text{Hz}$$

$$= 2.54\ \text{MHz}$$

24. (c)

- Skip distance is minimum distance from the transmitter to a point where sky wave of a given frequency is received.
- In case of space wave propagation, the signal strength at the receiver is given by

$$|E| = \frac{240\pi I h_r h_t}{\lambda d^2}$$

$$|E| \propto h_t;\ |E| \propto h_r;\ |E| \propto \frac{1}{d^2};\ |E| \propto \frac{1}{\lambda} \propto f$$

- In troposcatter links, diversity system is used to detect signal in presence of fading.

25. (b)

- Data link layer provides for the reliable transmission of data over the physical layer by framing (i.e., breaking the packets into frames), error detection, retransmission and flow-control. Therefore statement 2 is incorrect.
- The session layer controls the dialogues (connections) between applications. It provides mechanism for opening, closing and managing a session between end-user application processes.

26. (c)

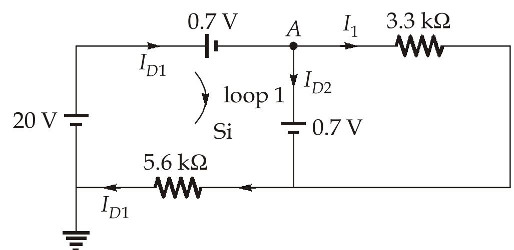
- SCTP (Stream control transmission protocol) is a new transport-layer protocol designed to combine same features of UDP and TCP in an effect to create a better protocol for multimedia communication. SCTP is a message oriented protocol.
- SCTP offers full duplex services, where data can flow in both directions at the same time. SCTP is a connection-oriented protocol. Flow control and error control in SCTP is similar to that in TCP. So, statement (3) is incorrect.

27. (a)

- The procedure for changing the assignment of a mobile unit from one BS to another as the mobile unit moves from one cell to another known as handoff.
- FDMA works on the principle of dividing one channel or bandwidth into multiple individual bands, each for use by a single user. Hence, the capacity is defined by the number of channels.
- The distribution of traffic and topographic is not uniform and this presents opportunities of capacity increase through cell splitting. Cells in areas of high usage can be split into smaller cells. Hence, statement 3 is incorrect.

28. (d)

The applied voltage is such as to turn both diodes ON. The equivalent circuit with both diodes "ON" can be drawn as below:



Applying KVL in loop-1, we get

$$20 - 0.7 - 0.7 - 5.6\, I_{D1} = 0$$

$\therefore$ $$I_{D1} = 3.32 \text{ mA}$$

$$I_1 = \frac{0.7}{3.3} = 0.212 \text{ mA}$$

Applying KCL at node A, we get

$$I_{D1} = I_{D2} + I_1$$

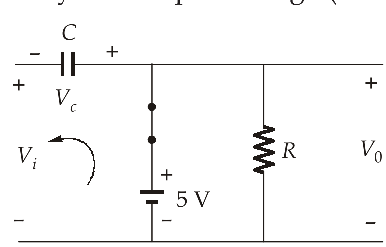
$$I_{D2} = 3.32 - 0.212$$

$\therefore$ $$I_{D2} = 3.108 \text{ mA}$$

$$I_{D2} \cong 3.11 \text{ mA}$$

29. (b)

Diode will conduct for the negative cycle of input voltage (for the period $t_1 \rightarrow t_2$)



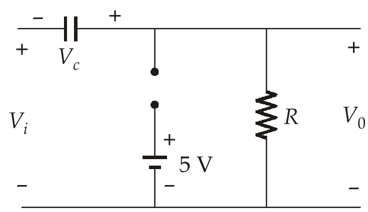
$$5 - V_c - V_i = 0$$

$$5 - V_i = V_c$$

$\therefore$ $$V_c = 5 - (-20) = 25 \text{ V}$$

The capacitor will therefore, charge upto 25 V.

Due to high value of R, the capacitor does not discharge much and the diode remains in the OFF state.



$$V_0 - V_c - V_i = 0$$

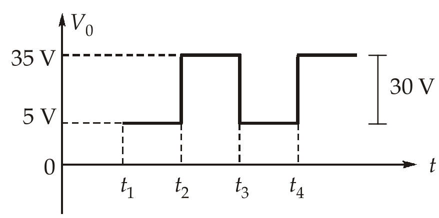
$$V_0 = V_c + V_i$$

∴ For V_i = 10 V, we get

$$V_{0\ max} = 25 + 10 = 35\text{ V}$$

For V_i = –20 V, we get

$$V_{0\ min} = 25 - 20 = 5\text{ V}$$



Difference of V_{0max} and V_{0min} = 35 – 5 = 30 V

30. (a)

Voltage gain without feedback,

$$A_v = \frac{2}{5\times10^{-3}} = 400$$

$$V_f = V_0\left(\frac{1}{1+19}\right) = \frac{V_0}{20}$$

$$\text{feedbac ratio, } \frac{V_f}{V_0} = \beta = \frac{1}{20}$$

Now,

$$(V_s + V_f)A_v = V_0$$

⇒

$$(V_s - \beta V_0)A_v = V_0$$

$$V_sA_v - \beta V_0 A_v = V_0$$

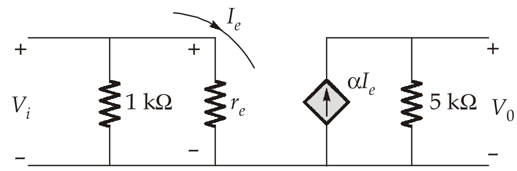
$$V_sA_v = V_0(1 + A\beta)$$

Voltage gain with feedback

$$A_{vf} = \frac{V_0}{V_s} = \frac{A_v}{1+A\beta} = \frac{400}{1+\frac{400}{20}} = 19.047$$

31. (c)

At mid-band frequency, the coupling capacitors acts as short circuit. The equivalent T model for given common base configuration by short circuiting the capacitors is shown below:



from the figure,

$$V_0 = 5(\alpha\, I_e)$$

$$I_e = \frac{V_i}{r_e}$$

$\therefore$
$$A_V = \frac{V_0}{V_i} = \frac{5\alpha}{r_e}$$

given
$$\alpha = 0.98$$

$$r_e = \frac{V_T}{I_E} = \frac{26\text{ mV}}{1.3\text{ mA}} = 20\ \Omega$$

$\because$
$$I_E = \frac{2 - V_{BE}}{1\text{ k}\Omega} = \frac{2-0.7}{1} = 1.3\text{ mA}$$

$\therefore$
$$A_V = \frac{5 \times 0.98 \times 10^3}{20} = 245$$

32. (a)

For the emitter-follower configuration

$$V_{01} = \frac{Z_{i2}}{Z_{i2} + Z_{01}} A_{VNL} V_{i1}$$

$\therefore$
$$A_{V1} = \frac{V_{01}}{V_{i1}} = \frac{20\ \Omega \times 1}{20\ \Omega + 10\ \Omega} = \frac{20}{30} = \frac{2}{3}$$

For the common-base configuration

$$V_{02} = \frac{R_L}{R_L + Z_{02}} A_{VNL} \cdot V_{i2}$$

$$A_{V2} = \frac{V_{02}}{V_{i2}} = \frac{R_L}{R_L + Z_{02}} A_{VNL} = \frac{8}{8+5} \times 260 = \frac{8}{13} \times 260$$

$$A_{V2} = 8 \times 20 = 160$$

$\therefore$ total voltage gain of the system

$$A_V = A_{V1} * A_{V2}$$

$$A_V = \frac{2}{3} \times 160 = 106.67$$

33. (c)

$$g_m = g_{m0}\left(1 - \frac{V_{GS}}{V_P}\right)$$

for $$V_{GS} = \frac{V_P}{2}$$

$$g_m = g_{m0}\left(1 - \frac{1}{2}\frac{V_P}{V_P}\right)$$

$$g_m = \frac{g_{m0}}{2}$$ where, g_{m0} is the maximum value of g_m.

* JFET can actually be used as a voltage controlled resistor because of a unique sensitivity of the drain to source impedance to the gate to source voltage.

34. (a)

$$BW = \frac{0.35}{t_r}$$

where, Rise time t_r = 18 – 2 = 16 μsec

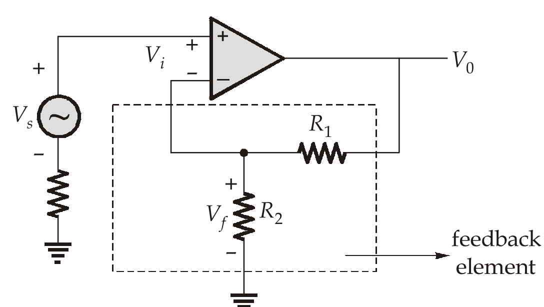
[Rise time the time required for a signal to move from 10% to 90% of the final value]

$$BW = \frac{0.35}{16} \times 10^6 \cong 22 \text{ kHz}$$

35. (c)

- An astable circuit has no stable state and thus, produce a square wave pulse (clock).
- Monostable circuit generates a single output pulse of a specified duration in response to a triggering input signal. Hence, it acts as a one-shot circuit.
- A PLL is a feedback system that includes a VCO, phase detector, and low pass filter within its loop.

36. (c)



Feedback element is directly connected to the output, therefore voltage sampling.
Feedback element is not directly connected to the input, therefore series mixing.
The feedback present in above configuration is voltage series.

37. (d)

Given $\vec{A}$ in cylindrical coordinate system,

∴ $$\text{div } \vec{A} = \frac{1}{\rho}\frac{\partial}{\partial\rho}\rho A_\rho + \frac{1}{\rho}\frac{\partial}{\partial\phi}A_\phi + \frac{\partial A_z}{\partial z}$$

$$A_\rho = \rho z \sin\phi,\ A_\phi = 3\rho z^2 \cos\phi,\ A_z = 0$$

$$\text{div}\vec{A} = \frac{1}{\rho}\frac{\partial}{\partial\rho}\rho^2 z\sin\phi + \frac{1}{\rho}\cdot\frac{\partial}{\partial\phi}3\rho z^2\cos\phi$$

$$\text{div}\vec{A} = 2z\sin\phi - 3z^2\sin\phi$$

At point P, $\rho = 5$, $\phi = \frac{\pi}{2}$, $z = 1$

$$\therefore \quad \text{div}\vec{A} = 2\sin\frac{\pi}{2} - 3\sin\frac{\pi}{2}$$

$$\text{div}\vec{A} = 2 - 3 = -1 \text{ at point } P$$

38. (c)

The condition for both the current densities to have equal magnitude is

$$\frac{|\vec{J}_c|}{|\vec{J}_d|} = \frac{\sigma}{\omega\varepsilon} = 1$$

$$\therefore \quad \omega = \frac{\sigma}{\varepsilon}$$

$$\omega = \frac{2\times10^{-8}}{\frac{10^{-8}}{36\pi}} = 72\pi \text{ rad/sec}$$

But $\omega = 2\pi f$

$$\therefore \quad f = \frac{\omega}{2\pi} = \frac{72\pi}{2\pi} = 36 \text{ Hz}$$

39. (a)

For a non-magnetic material, $\mu_r = 1$

For good conductor, the phase constant is given by

$$\beta = \sqrt{\pi f\mu\sigma}$$

where, $$\beta = \frac{2\pi}{\lambda} = \frac{2\pi}{2}\times10^3 = \pi\times10^3 \text{ rad/m}$$

and, $$c = f\lambda$$

$$\frac{3\times10^8}{2\times10^{-3}} = f$$

$$f = 1.5\times10^{11} \text{ Hz}$$

$$\beta = \sqrt{\pi f\mu\sigma}$$

$$\frac{(\pi\times10^3)^2}{\pi f\mu} = \sigma$$

$$\therefore \quad \sigma = \frac{\pi^2\times10^6}{\pi\times4\pi\times10^{-7}\times1.5\times10^{11}} = \frac{10^6}{4\times1.5\times10^4}$$

$$\sigma = 16.67 \text{ S/m}$$

40. (c)

In free space, velocity $v = c = 3 \times 10^8$ m/s. The power is radiated in free space at frequency $f = 100$ MHz.

Hence, wavelength λ is given by

$$\lambda = \frac{c}{f} = \frac{3\times 10^8}{100\times 10^6} = 3 \text{ m}$$

The power radiated in terms of r.m.s. current is given by

$$P_{\text{rad}} = 80\pi^2\left(\frac{dL}{\lambda}\right)^2 I_{\text{rms}}^2$$

$$100 = 80\pi^2\left[\frac{0.01}{3}\right]^2 I_{\text{rms}}^2$$

$$\frac{100\times 9}{80\pi^2\times(0.01)^2} = I_{\text{rms}}^2$$

$$I_{\text{rms}} = 106.76 \text{ Ampere}$$

41. (a)

$$I = \int_s \overline{J}\cdot\overline{dS}$$

$\overrightarrow{dS}$ in $\hat{a}_r$ direction is $r^2\sin\theta d\theta d\phi\,\hat{a}_r$

$$I = \oint_s\left[\frac{2}{r^2}\cos\theta\right]\left[r^2\sin\theta d\theta d\phi\right]$$

$$I = \oint_s 2\cos\theta\sin\theta\, d\theta d\phi$$

$$I = \int_0^{2\pi}\int_0^{45^\circ}(\sin 2\theta)\, d\theta\, d\phi$$

$$I = -\left[\frac{\cos 2\theta}{2}\right]_0^{45^\circ}[2\pi]$$

$$I = \frac{-1}{2}[\cos 90^\circ - \cos 0^\circ][2\pi]$$

$$I = \frac{1}{2}\times 2\pi = \pi = 3.14 \text{ Ampere}$$

42. (d)

Characteristic impedance of the lossy transmission line,

$$z_0 = \sqrt{\frac{R+j\omega L}{G+j\omega C}}$$

where ω is the frequency, G represents the conductance per unit length of the dielectric separating the conductors and R represents the resistance per unit length of the conductors which is a measure of conductivity of conductors.

$\therefore$ It does not depends upon the length of the line.

43. (d)

The reflection coefficient at any given point on the transmission line corresponds directly to the impedance at that point.

$$Z_L = \frac{Z_L}{Z_0} = R_L + jX_L$$

where R_L and X_L are normalized load resistance and reactance. Smith chart consists of constant resistance and constant reactance circles representing normalized impedance.

Voltage maximum, current minimum $\Rightarrow$ Impedance maximum

Voltage minimum, current maximum $\Rightarrow$ Impedance minimum

44. (c)

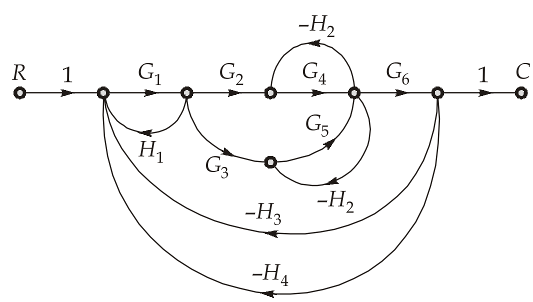
45. (a)

Cutoff wavelength in a circular guide for dominant mode (TE_{11}),

$$\lambda_c = \frac{2\pi a}{1.84} = \frac{2\pi \times 6}{1.84} = 20.488$$

46. (c)

Given signal flow graph is



$$
\begin{aligned}
\text{Number of forward paths} &= G_1G_2G_4G_6 \\
&\quad G_1G_3G_5G_6 \\
\text{Number of individual loops} &= G_1H_1 \\
&\quad -G_4H_2 \\
&\quad -G_5H_2 \\
&\quad -G_1G_2G_4G_6H_3 \\
&\quad -G_1G_3G_5G_6H_3 \\
&\quad -G_1G_2G_4G_6H_4 \\
&\quad -G_1G_3G_5G_6H_4 \\
\text{Number of non touching loops} &= G_1H_1 \text{ and } -G_5H_2 \\
&\quad G_1H_1 \text{ and } -G_4H_2
\end{aligned}
$$

47. (d)

When switch is opened,

$$G(s)H(s) = \frac{k}{s(s+a)}$$

$$\omega_n = \sqrt{k}$$

$$\xi = \frac{a}{2\sqrt{k}}$$

$$K_v = \frac{k}{a}$$

When switch is closed,

$$G(s)H(s) = \frac{k}{s(s+a+kk_1)} \equiv \frac{\omega_n^2}{s(s+2\xi\omega_n)}$$

$$\omega_n = \sqrt{k}$$

$$\xi = \frac{a+kk_1}{2\sqrt{k}} \uparrow$$

As ξ increases, $\downarrow M_p = e^{\frac{-\xi\pi}{\sqrt{1-\xi^2}}}$

$$\left. t_s \downarrow = \frac{4}{\xi\omega_n} \right\} \text{stability} \uparrow$$

Velocity error coefficient,

$$K_v = \lim_{s\to 0} sG(s)H(s) = \frac{k}{a+kk_1} \downarrow$$

For unit ramp input, $e_{ss} = \dfrac{1}{K_v} \uparrow$

48. (b)

$$G(s)H(s) = \frac{1}{s^2(s-a)(s-b)(s-c)}$$

put $s = j\omega$, $G(j\omega)H(j\omega) = \dfrac{1}{(j\omega)^2(j\omega-a)(j\omega-b)(j\omega-c)}$

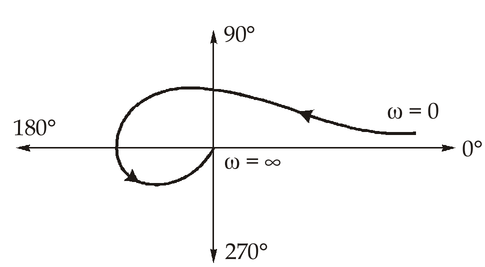
$$|G(j\omega)H(j\omega)| = \frac{1}{\omega^2\sqrt{\omega^2+a^2}\sqrt{\omega^2+b^2}\sqrt{\omega^2+c^2}}$$

When $\omega = 0$, magnitude $= \infty$; phase $= 0°$

When $\omega = \infty$, $M = 0$; $\phi = 270°$

$$\phi = |G(j\omega)H(j\omega)| = -180° - 180° + \tan^{-1}\frac{\omega}{a} - 180° + \tan^{-1}\frac{\omega}{b} - 180° + \tan^{-1}\frac{\omega}{c}$$

$$= -720° + \tan^{-1}\frac{\omega}{a} + \tan^{-1}\frac{\omega}{b} + \tan^{-1}\frac{\omega}{c}$$



Note: Since a, b and c are positive values, for $\omega = 1$, phase of $G(j\omega)\,H(j\omega)$ will be a positive quantity. So, the polar plot will start into the first quadrant.

49. (a)

The closed loop transfer function,

$$T = \frac{G}{1+GH}$$

$$S_G^T = \frac{\partial T}{\partial G}\cdot\frac{G}{T} = \left[\frac{1}{1+GH} - \frac{GH}{(1+GH)^2}\right](1+GH)$$

$$= \frac{1}{1+GH} = \frac{1}{1+200\times 0.2} = \frac{1}{41}$$

$$S_G^T = \frac{\partial T/T}{\partial G/G} = \frac{\%\text{ change in } T}{\%\text{ change in } G} = \frac{1}{41}$$

$$\%\text{ change in } T = \frac{12}{41} = 0.293 \cong 0.3\%$$

50. (c)

The closed loop transfer function is

$$\frac{C(s)}{R(s)} = \frac{12}{s^2+6s+12}$$

The standard form of second order transfer function is $\dfrac{C(s)}{R(s)} = \dfrac{\omega_n^2}{s^2+2\xi\omega_n S+\omega_n^2}$

$$\omega_n^2 = 12$$

$$\omega_n = \sqrt{12} = 3.46 \text{ rad/sec}$$

$$2\xi\omega_n = 6$$

$$\xi = \frac{3}{3.46} = 0.86$$

Since damping ratio $\xi < 1$, the system is underdamped and response will be damped oscillatory.

51. (d)

If there is no pole-zero cancellation, the system can always be represented by discrete dynamic equations as a completely controllable and observable system. If the transfer function has pole-zero cancellation, the system will be either uncontrollable or unobservable or both, depending on how the state variables are defined.

52. (d)

We can rewrite the transfer function as,

$$\frac{Y(s)}{U(s)} = \frac{s+5}{(s+1)(s+4)} = \frac{A}{s+1} + \frac{B}{s+4}$$

$$A = \frac{4}{3}, B = -\frac{1}{3}$$

Hence,
$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -4 \end{bmatrix}\begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} \frac{4}{3} & -\frac{1}{3} \end{bmatrix}\begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix}$$

53. (c)

Number of poles of Open Loop control system (OLCS) in RHS of s-plane = 1

Hence, OLCS is unstable.

N = Number of encirclements of point (–1, 0) by the Nyquist plot

$$N = -2$$

$$N = P - Z$$

$\because$ P = 1 (open loop poles on RHS of $j\omega$ axis). Hence,

$$-2 = 1 - Z$$

$$Z = 1 + 2 = 3$$

i.e., there are three roots of characteristics equation on RHS of $j\omega$ axis i.e., three closed loop poles on RHS of $j\omega$ axis.

Hence, open loop and closed loop systems, both are unstable.

54. (d)

For given bode plot

$$G(s)H(s) = \frac{k}{(j\omega)^3} \qquad [\because -18 \text{ dB/octave} \equiv -60 \text{ dB/dec}]$$

$$H(s) = 1$$

$$\angle G(j\omega)H(j\omega) = -270°$$

$$\text{P.M(maximum)} = -270° + 180° = -90°$$

55. (c)

Priority order of 8085 interrupts:

TRAP > RST 7.5 > RST 6.5 > RST 5.5 > INTR

Given that device A has highest priority and device C has the lowest priority, hence A uses TRAP, B uses RST 6.5 and C uses RST 5.5 interrupt.

56. (b)

At a time, 8085 can drive only a digit. In a second, each digit is refreshed 500 times. During this time period, 5 digits are referred in multiplexed form. Thus, time given to each digit $= \frac{1}{5 \times 500} = 0.4\, m\text{sec}$

57. (c)

For an RST-n interrupt in 8085 microprocessor, vector addresses in decimal format are calculated using the formula 8 * n. We have,

$$(0038)_H = (56)_{10}$$
$$n \times 8 = 56$$
$$n = 7$$

58. (d)

For 4K RAM, there will be 12 address lines: $A_{11} - A_0$. The chip is selected when $A_{15}A_{14}A_{13} = 011$.

	A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
Starting address :	0	1	1	X	0	0	0	0	0	0	0	0	0	0	0	0
End address :	0	1	1	X	1	1	1	1	1	1	1	1	1	1	1	1

For $A_{12} = 0$,
memory range → 6000 H – 6FFF H
For $A_{12} = 1$,
Memory range → 7000 H – 7FFF H

59. (a)

In this program, we are using BC register pair as a pointer to memory address and register C is also used as counter which is not possible. That's why this program will not work.

60. (d)

DMA enables data transfer without the involvement of CPU. The DMA controller notifies the processor that it is ready for a transfer. Thus, the processor relinquishes control of its external memory bus and grants the control of the bus to the DMA controller. The DMA controller then transfers the specified amount of data and signals the processor upon completion of the transfer.

61. (d)

8251 : USART – Universal synchronous asynchronous receiver/transmitter.

8255: General purpose programmable I/O device used for parallel data transfer. It can be programmed to transfer data under various conditions, from simple I/O to Interrupt I/O.

8259 : Programmable Interrupt Controller. It is also known as a priority interrupt controller and used to increase the interrupt handling ability of the microprocessor. It can handle up to eight vectored priority interrupts for the CPU.

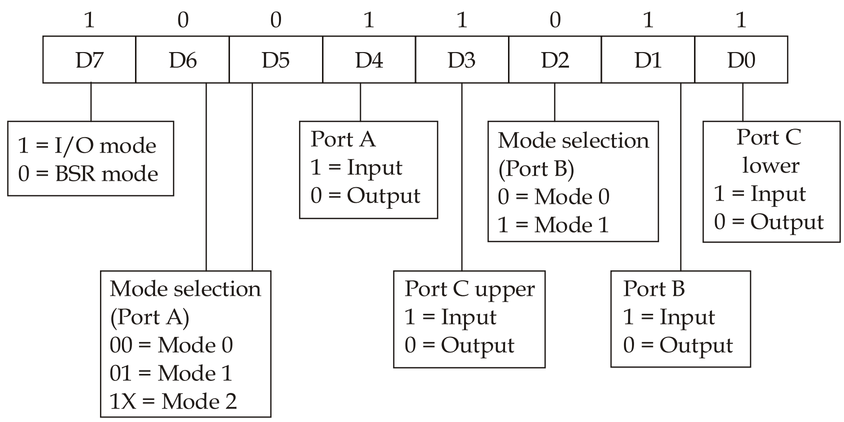
8089 : I/O Processor. It is a specialized processor which loads and stores data in memory along with the execution of I/O instructions.

62. (a)

The peripheral sends a 'strobe' or 'ready' signal to the microprocessor. The processor then sends the status signal if it is ready for the data transfer. Thereafter, the data transfer takes place and when the data transfer is complete, an acknowledgement signal is sent.

63. (a)

The format of 8255 control word is as follows:



To configure 8255 to operate in Mode 0 with all ports as input ports, the control world would be 1001 1011 = 9B H.

64. (c)

$$\text{Cycle time} = 10 \text{ ns}$$
$$\text{ALU} = 4 \text{ cycles}$$
$$\text{Branches} = 4 \text{ cycles}$$
$$\text{Memory operations} = 5 \text{ cycles}$$

Average execution time (Non-pipeline)

$$= [0.3 \times 4 + 0.2 \times 4 + 0.5 \times 5]10$$
$$= 12 + 8 + 25 = 45$$
$$= 45 \text{ ns}$$
$$\text{Pipeline execution time} = [0.3 \times 1 + 0.2 \times 1 + 0.5 \times 1]11$$
$$= (0.3 + 0.2 + 0.5) \times 11$$
$$= 11 \text{ ns}$$
$$\text{speedup} = \frac{45}{11} = 4.09 \cong 4.1$$

65. (c)

A few bits of the microinstruction are used to control the generation of the address for the next micro instruction. Thus, a microinstruction contains bits for initiating micro-operations and bits that determine the next address for the control memory itself. Hence, statement 3 is incorrect.

66. (d)

With a write-through caching policy, the system's processor writes data to the cache first and then immediately copies that new cache data to the corresponding memory or disk. Hence,

$$\text{Average access time} = 0.7[0.9 \times 80 + 0.1 \times (80 + 450)] + 0.3 \times 450$$
$$= 0.7[72 + 53] + 135$$
$$= 0.7 \times 125 + 135$$
$$= 87.5 + 135 = 222.5 \text{ nsec}$$

67. (d)

The decimal number is 0.425×2^{13}.

We have to find hexadecimal representation without normalization.

$$\text{Biased exponent} = 13 + 64 = 77$$

Representing 77 in binary

$$(77)_{10} = (1001101)_2$$

Representing mantissa in binary

$$(0.425)_{10} = 0.011011001100$$

Floating point representation is as follows:

0	1001101	01101100

$$\underbrace{0100}_{4}\ \underbrace{1101}_{D}\ \underbrace{0110}_{6}\ \underbrace{1100}_{C}$$

4 D 6 C

68. (b)

$$\text{Page size} = 8\text{ K}$$
$$= 2^{13}\text{ Bytes}$$
$$\text{Virtual address space} = 2^{47}\text{ bytes [1 tera byte} = 2^{40}\text{ byte]}$$

$\therefore$ Number of pages in virtual memory $= \dfrac{2^{47} B}{2^{13} B} = 2^{34}$

$\Rightarrow$ $2^4 \cdot 2^{30}$ pages = 16 giga pages

69. (a)

Page sequence:

0, 7, 0, 2, 9, 2, 9, 8, 9, 8, 2, 1, 9, 1, 8, 9, 1, 3, 9, 3

Given 3 page frames are available and using optimal replacement policy,

~~0~~ 9
~~7~~ ~~8~~ 3
~~2~~ 1

Page faults : 0, 7, 2, 9, 8, 1, 3

Page hit : 0, 2, 9, 9, 8, 2, 1, 9, 1, 8, 9, 1, 9, 3

Number of page faults = 7

70. (c)

Process	Arrival time	Brust time	CT	TAT	WT
P_1	0	6	12	12	6
P_2	1	4	7	6	2
P_3	3	8	20	17	9
P_4	2	2	4	2	0

Gantt Chart:

P_1	P_2	P_4	P_4	P_2	P_2	P_2	P_1	P_3

0 1 2 3 4 5 6 7 12 20

TAT = CT – AT and WT = TAT – BT

$$\text{Average WT} = \frac{6+2+9+0}{4} = \frac{17}{4} = 4.25 \text{ ms}$$

71. (b)

Accessing a random sector requires adjustement for every sector. We have,
9600 revolution in 60 sec

1 revolution in $\frac{60}{9600} = 6.25\, m\text{sec}$

1 revolution — 1 track (1024 sectors)

$$1 \text{ sector} — \frac{6.25 \times 1}{1024} \text{ms} = 6.1\ \mu\text{sec}$$

Avg. rotational latency (No best or worst case)

$$= \frac{1}{2} \times 6.25 = 3.125 \text{ ms}$$

$$T_{avg} = (9.2 + 3.125 + 6.1 \times 10^{-3}) \times 200 = 2.46 \text{ sec}$$

72. (d)

- CISC (Complex instruction set computers) as the name says uses complex addressing modes to enhance the performance with limited resources. Hence, in the CISC, arithmetic or logical instructions may be memory based. Also, the instructions may take multiple cycles for execution.
- CISC control units are typically micro-programmed, so that any changes made are easily acceptable.

73. (d)

74. (b)

When $A = 0$, the upper transmission gate acts as a closed switch and transmits B and when $A = 1$, the lower transmission gate acts as a closed switch and transmits $\overline{B}$. Hence, the given circuit implements XOR function:

i.e.,
$$F = \overline{A}B + A\overline{B} = A \oplus B$$

75. (c)

In pre-deposition diffusion

$$N(x, t) = N_0 erfc\left(\frac{x}{2\sqrt{Dt}}\right)$$

i.e., the doping profile is complementary error function.
In drive-in diffusion

$$N(x, t) = \frac{Q}{\sqrt{\pi Dt}} e^{-x^2/Dt}$$

i.e., doping profile is gaussian. In VLSI processing, a two-step diffusion sequence is commonly used, in which a predeposition diffusion layer is formed under a constant-surface-concentration condition and is followed by a drive-in diffusion under a constant-total-dopant condition. Hence, in drive-in diffusion, the existing dopants are diffused inside the substrate.

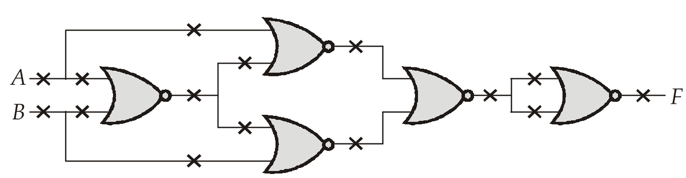
76. (c)

- Oxidation occurs at Si-SiO_2 interface and not on the top of the substrate.
- As oxidation progress, oxidation rate (oxide growth rate) goes on decreasing because existing oxide prevent further oxidation.
- For the growth of an oxide of thickness 'd', a layer of silicon equal to a thickness of $0.44d$ is consumed.

77. (b)

For a positive photoresist, exposed part becomes soluble in developing solution and unexposed part remains non-soluble in developing solution.

78. (c)



Possible positions where fault can occur,

$$n = 15$$

and, $k = 2$ → $s - a - 0$, $s - a - 1$

i.e. either $s - a - 0$ or $s - a - 1$ fault can occur at any of the position.

Total possible single stuck at faults $= k \times n$

$$= 2 \times 15$$

$$= 30$$

79. (b)

Defect: Defect is the unintended differences between the implemented hardware and its intended design.

Fault: Fault is the representation of a defect at the abstracted functional level.

Error: A wrong O/P signal produced by a defective system. The error is caused by a fault (or) a design error.

80. (d)

The three basic types of programmable elements for an FPGA are static RAM, anti-fuses, and flash EPROM.

81. (c)

Parallel simulation speeds up a simulation's execution by concurrently distributing its workload over multiple processors whereas the concurrent simulation exploits the inherent parallelism within the circuit itself to speed up the simulation.

82. (d)

$$X_{FM}(t) = 10\cos[2\pi \times 10^6 t + 0.1 \sin 10^3 \pi t]$$

$$X_{FM}(t) = A\cos\left[\omega_c t + k_f \int_0^t m(\lambda)d\lambda\right]$$

Assuming $m(t) = A_m \cos(10^3 \pi t)$

We get,

$$10\pi \int_{-\infty}^{t} m(\lambda)d\lambda = 10\pi A_m \int_0^t \cos(10^3 \pi\lambda)\, d\lambda$$

$$= \frac{A_m}{100} \sin 10^3 \pi t = 0.1 \sin(10^3 \pi t)$$

$$A_m = 10$$

$$m(t) = 10\cos(10^3 \pi t) \text{ V}$$

83. (b)

From the envelope of modulated AM waveform,

$$A_{max} = 120; \quad A_{min} = 20$$

$$\mu = \frac{A_{max} - A_{min}}{A_{max} + A_{min}}$$

$$= \frac{120 - 20}{120 + 20} = \frac{100}{140} = \frac{5}{7}$$

$$P_{PEP} = A_{max}^2 \times \frac{1}{R} = 120^2 \times \frac{1}{60}$$

$$= 240 \text{ W}$$

$$A_C = \frac{A_{max} + A_{min}}{2} = \frac{120 + 20}{2} = 70 \text{ V}$$

For a single tone AM signal, $X_{AM}(t) = A_C(1 + \mu \cos \omega_m t) \cos \omega_c t$

$$= 70\left[1 + \frac{5}{7}\cos\omega_m t\right]\cos\omega_c t$$

After adding the additional carrier,

$$X_{AM}(t) = 70\left[1 + \frac{5}{7}\cos\omega_m t\right]\cos\omega_c t + A\cos\omega_c t$$

$$= (70 + A)\left[1 + \frac{50}{(70 + A)}\cos\omega_m t\right]\cos\omega_c t$$

$$\text{Modulation Index} = \frac{50}{70 + A} = 0.8 \text{ (Given)}$$

$$A = -7.5 = 7.5\angle 180^\circ$$

84. (a)

Spectral bandwidth of M-ary PSK.

$$\text{BW} \geq \frac{R_b}{\log_2 M}$$

$$3.2 \times 10^3 \geq \frac{4.8\times10^3}{\log_2 M}$$

$$\log_2 M \geq \frac{3}{2}$$

$$M \geq 2^{1.5}$$

$$M \geq 2.82$$

$$M = 4, 8, 16$$

85. (d)

$$(\text{SNR}) = (1.76 + 6.02n)$$

$$= 1.76 + 6.02 \times 8 = 49.92 \text{ dB}$$

86. (d)

- PAM, PPM and PWM are pulse-analog modulation scheme.
- PCM is pulse-digital modulation scheme.
- In PCM, the effect of channel noise can be reduced by placing the repeaters at short distance and by using adequate signal to noise ratio by increasing the transmitter power.
- PCM has better noise immunity than PAM, PPM and PWM.
- Quantization noise in delta modulation systems falls into two categories, granular noise and slope overload noise.

87. (c)

The FM signal can be expressed as

$$S(t) = A_c \sum_{n=-\infty}^{\infty} J_n(\beta)\cos\left[2\pi\left(f_c + nf_m\right)t\right]$$

- The FM signal consists of infinite sidebands, whose amplitude varies as $A_c J_n(\beta)$. Hence, the amplitude of any sideband depends on the modulation index, β.
- The amplitude of carrier frequency, f_c is obtained by substituting $n = 0$ as $A_c J_0(\beta)$. Hence, the carrier frequency can disappear when $J_0(\beta) = 0$.

88. (a)

$$\text{Channel capacity } C_s = \max I[X; Y]$$

$$I[X; Y] = H(X) + H(Y) - H(X, Y)$$

$$= H(Y) - H(Y/X)$$

Given channel matrix is

$$P\left(\frac{Y}{X}\right) = \begin{bmatrix} \frac{1}{2} & \frac{1}{2} & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

$$P(X, Y) = [P(X)]_d\,[P(Y/X)] = \begin{bmatrix} \frac{1}{4} & \frac{1}{4} & 0 \\ 0 & 0 & \frac{1}{2} \end{bmatrix}$$

$$P[Y] = \left[\frac{1}{4}, \frac{1}{4}, \frac{1}{2}\right]$$

$$H[Y] = 2\times\frac{1}{4}\log_2 4 + \frac{1}{2}\log_2 2 = \frac{3}{2}\text{ bits/symbol}$$

$$H\left(\frac{Y}{X}\right) = -\sum_{j=1}^{\infty}\sum_{k=1}^{\infty} P(x_j, y_k)\log_2 P\left(\frac{Y_k}{X_j}\right)$$

$$= \frac{1}{4}\log_2 1 + \frac{1}{4}\log_2 2 + \frac{1}{2}\log_2 1$$

$$= \frac{1}{4} + \frac{1}{4} + 0 = \frac{1}{2}\text{ bits/symbol}$$

$$I(X; Y) = \frac{3}{2} - \frac{1}{2} = 1\text{ bits}$$

89. (b)

$$\text{Symbol rate } R_s = \frac{R_b}{\log_2 M},$$

where $\log_2 M$ is the number of bits to be represented by each symbol

$$2400 = \frac{19.2\times 1000}{\log_2 M}$$

$$\log_2 M = \frac{19.2}{2.4} = 8$$

$$M = 2^8 = 256$$

As B.W. efficiency = 1 bps/Hz, initial B.W = 2400 Hz = transmission rate

After increasing the data rate,

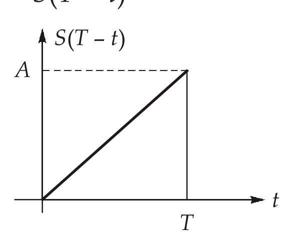
$$\text{B.W efficiency } \eta = \frac{R_b}{B.W} = \frac{19.2\text{ kbps}}{2400\text{ bps}}$$

$$= \frac{19200}{2400} = 8\text{ bps/Hz}$$

90. (c)

The impulse response of matched filter is given as

$$h(t) = S(T - t)$$



The output signal-to-noise ratio of a matched filter depends only on the ratio of the signal energy to the power spectral density of the white noise at the filter input. Hence,

$$S/N = \frac{2E}{\eta} = \frac{2A^2T}{3\eta}, \text{ where } E = \text{signal energy} = A^2T/3$$

91. (d)

$$x[n] = a^n u[n] + a^{-n} u[n] = x_1[n] + x_2[n]$$

$$X_1(z) = \frac{1}{1 - az^{-1}}; |z| > |a|$$

$$X_2(z) = \frac{1}{1 - (az)^{-1}}; |z| > \left|\frac{1}{a}\right|$$

$\therefore$ ROC of $X(z)$ will be $|z| > \max\left(|a|, \frac{1}{|a|}\right)$

92. (d)

For a causal system, the impulse response of the system must use only the present and past values of the input to determine the output. The output of an LTI system with input $x(n)$ and impulse response $h(n)$ is given by

$$y(t) = \int_{-\infty}^{\infty} h(\tau)x(t-\tau)d\tau$$

The output will depend only on the present and past values of input only if $h(\tau) = 0$ for $\tau < 0$.

93. (b)

$$y[n] = \sum_{k=-\infty}^{\infty} u(k+3)\, u[n-k-3]$$

$$u(k+3) = 1, \quad \text{for } k + 3 \geq 0 \text{ or } k \geq -3$$

$$u[n-k-3] = 1, \quad \text{for } n - k - 3 \geq 0 \text{ or } k \leq n - 3$$

So, $$y[n] = \sum_{k=-3}^{n-3} 1 = n + 1 \quad \text{for } n > 0$$

$\therefore$ $$y[n] = (n+1)\, u(n)$$

Given, $$y[n] = (n+k)\, u[n+k-1]$$

By comparing, we get $k = 1$.

94. (c)

Given, $$X(z) = \ln\left(\frac{\alpha}{\alpha - z^{-1}}\right);\ \text{ROC}; |z| > \frac{1}{\alpha}$$

$$= -\ln\left(1 - (\alpha z)^{-1}\right)$$

now, by expanding using Taylor series,

$$X(z) = \left[(\alpha z)^{-1} + \frac{(\alpha z)^{-2}}{2} + \frac{(\alpha z)^{-3}}{3} + ...\right]$$

$$= \sum_{k=1}^{\infty} \frac{[(\alpha z)^{-1}]^k}{k}$$

$$X(z) = \sum_{k=1}^{\infty} \frac{\alpha^{-k}}{k} \cdot z^{-k}$$

Taking the inverse z-transform,

$$x[n] = \sum_{k=1}^{\infty} \frac{\alpha^{-k}}{k} \delta(n-k) \qquad \left[\because \delta(n-k) \leftrightarrow z^{-k}\right]$$

$$\therefore \qquad x[n] = \left(\frac{\alpha^{-n}}{n}\right) u(n-1)$$

95. (b)

Only complex exponentials are periodic. $e^{j\omega_0 t}$ is periodic with period $2\pi/\omega_0$

$$x_2(t) = e^{t(j+1)} = e^{jt}\left(e^{t}\right)$$

(because of this term, x_2(t) is non-periodic)

96. (c)

Given, $H(\omega) = -2j\omega$

From the definition of inverse fourier transform,

$$x(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} X(\omega) e^{j\omega t} d\omega$$

Differentiating both sides,

$$\frac{dx(t)}{dt} = \frac{1}{2\pi}\int_{-\infty}^{\infty} j\omega X(\omega)\, e^{j\omega t} d\omega$$

$$-2\frac{dx(t)}{dt} = \frac{1}{2\pi}\int_{-\infty}^{\infty} \underbrace{-2j\omega}_{H(\omega)} X(\omega) e^{j\omega t} d\omega$$

$\therefore$ Passing $x(t)$ through $H(\omega)$ is equivalent to performing $-2\dfrac{dx(t)}{dt}$

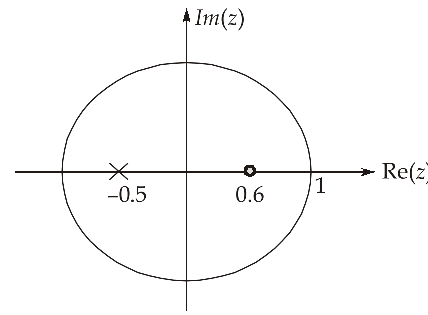
$$\therefore \qquad y(t) = -2\frac{dx(t)}{dt}$$

given, $x(t) = e^{jt}$

$$\therefore \qquad y(t) = -2\frac{d}{dt}[e^{jt}]$$

$$y(t) = -2je^{jt0}$$

97. (a)



Given,

$$H(z) = b_0\frac{1+bz^{-1}}{1+az^{-1}}$$

$$= b_0\frac{1-0.6z^{-1}}{1+0.5z^{-1}}$$

$$H(z) = b_0\frac{z-0.6}{z+0.5}, \text{ ROC : } |z| > 0.5$$

[As the filter is causal, the ROC of the impulse repsonse must be right sided]

Since ROC includes the unit circle, hence the system is stable.

98. (c)

From the definition of inverse DTFT, impulse response,

$$h[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} H(\omega)e^{j\omega n}d\omega$$

$$= \frac{1}{2\pi}\left[\int_{-\frac{3\pi}{8}}^{\frac{-\pi}{8}} e^{j\omega n}d\omega + \int_{\frac{\pi}{8}}^{\frac{3\pi}{8}} e^{j\omega n}d\omega\right]$$

$$= \frac{1}{2\pi}\left[\frac{e^{j\omega n}}{jn}\Bigg|_{-\frac{3\pi}{8}}^{\frac{-\pi}{8}} + \frac{e^{j\omega n}}{jn}\Bigg|_{\frac{\pi}{8}}^{\frac{3\pi}{8}}\right]$$

$$= \frac{1}{2j\pi n}\left[e^{-j\frac{\pi}{8}n} - e^{-j\frac{3\pi}{8}n} + e^{j\frac{3\pi}{8}n} - e^{j\frac{\pi}{8}n}\right]$$

$$= \frac{1}{\pi n}\left[\sin\frac{3\pi}{8}n - \sin\frac{\pi}{8}n\right]$$

$$h[n] = \frac{2}{\pi n}\sin\frac{\pi}{8}n\cos\frac{\pi}{4}n$$

99. (c)

$$t^{100}e^{-t}u(t) \xleftrightarrow{L.T.} \frac{100!}{(s+1)^{101}}$$

Using differentiation property,

$$\frac{d^{100}}{dt^{100}}t^{100}e^{-t}u(t) \xleftrightarrow{L.T.} \frac{s^{100}\,100!}{(s+1)^{101}}$$

Using frequency shifting property,

$$e^t\left(\frac{d^{100}}{dt^{100}}t^{100}e^{-t}u(t)\right)\xleftrightarrow{L.T.}\frac{(s-1)^{100}}{s^{101}}\times 100!$$

100. (d)

- From 0 to A, because of thermal energy, electrons from valence band gets excited to acceptor level and free electrons from donor level gets excited to conduction band, hence conductivity increases because of impurity ionization.
- From A to B, as temperature increases, mobility decreases due to collision with lattice atoms and therefore, conductivity decreases. Also, the minority carrier concentration increases.
- At $T = T_c$, minority carrier concentration will become equal to majority carrier concentration and the extrinsic semiconductor will become intrinsic semiconductor. Hence, from B onwards, the conductivity increases with temperature due to thermal generation of carriers.

All the given statements are correct.

101. (b)

The small signal dynamic resistance of the *pn*-junction diode can be given as,

$$r_d = \frac{\eta V_T}{I_D}$$

For small increase in forward bias voltage across the diode, there is tremendous increase in forward current I_D. Hence AC resistance (r_d) decreases, when forward bias voltage increases.

102. (c)

Quantum efficiency,
$$\eta = \frac{I_L/q}{P_{in}/h\nu} = \frac{\text{Number of EHPs generated and collected}}{\text{Number of incident photons}}$$

Here, I_L is in amperes
q is in Coulomb
P_{in} is in Watts
$h\nu$ is in Joules

$$h\nu = 2\text{ eV} = 2 \times 1.6 \times 10^{-19}\text{ J} = 2q\text{ J}$$

$$\therefore \quad \eta = \frac{I_L}{P_{in}/2} \qquad \Rightarrow 0.8 = \frac{I_L}{\frac{10\times 10^{-3}}{2}}$$

$\therefore$ Generated photo current,

$$I_L = 4\text{ mA}$$

103. (c)

Phosphorus is a pentavalent impurity resulting in n-type semiconductor. For n-type semiconductor,

$$E_C - E_F = kT\ln(N_C/N_D)$$

We have, $N_C \propto T^{3/2}$, hence as temperature is increased, $E_C - E_F$ increases i.e. the position of fermi level moves towards the middle of energy gap.

104. (a)

Zener breakdown voltage is less because in higher doping region, depletion layer width is small and a small reverse voltage is able to break the covalent bond and gives sudden increase in current. The avalanche breakdown occurs when a high reverse voltage is applied across the diode. As we increase the applied reverse voltage, the electric field across the junction increases. This electric field exerts a force on the electrons at the junction and frees them from covalent bonds, causing a sudden increase in current.

Hence, zener breakdown voltage V_1 corresponds to point A and avalanche breakdown voltage V_2 corresponds to point B.

105. (c)

We know that,

Collector current, $I_C = \beta I_B + (1 + \beta)I_{CO}$

$$I_C = \beta I_B + \beta I_{CO} + I_{CO}$$

$$\therefore \quad \beta = \frac{I_C - I_{CO}}{I_B + I_{CO}}$$

but,

$$\alpha = \frac{\beta}{1+\beta} = \frac{\frac{I_C - I_{CO}}{I_B + I_{CO}}}{1 + \frac{I_C - I_{CO}}{I_B + I_{CO}}} = \frac{I_C - I_{CO}}{I_B + I_{CO} + I_C - I_{CO}}$$

$$\therefore \quad \alpha = \frac{I_C - I_{CO}}{I_C + I_B}$$

106. (c)

Given, resistivity, $\rho = 1.5\ \Omega\text{-cm}$

Hall coefficient, $R_H = -1250\ \text{cm}^3/\text{C}$

Since, R_H is negative, the charge carriers are electrons.

Mobility, $\mu_e \approx \sigma |R_H|$

$$= \frac{1}{\rho}|R_H| = \frac{1}{1.5} \times 1250$$

$$\therefore \quad = 833\ \text{cm}^2/\text{V-sec}$$

107. (a)

The conductors have the positive temperature coefficient of resistance. As temperature rises, the thermal agitation increases speeding up the process of collisions, thereby increasing the resistance. The conductors have almost linear increase in resistivity given by $\rho_t = \rho_0\ [1 + \alpha(T - T_0)]$.

108. (c)

As base doping decrease, the recombination current decreases leading to an increase in emitter injection efficiency and base transport factor. As effective base width will decrease due to less doping at the base region, so early voltage will decrease.

109. (c)

For the maximum output of 10 V achieved with input voltage, the reference voltage is integrated till the output of integrator reaches zero. Hence, the maximum time the reference voltage can be integrated can be calculated as

$$V_{0\,max} = \frac{1}{RC}\int_0^{t_{max}} V_{ref}\,dt$$

$$10 = \frac{1}{0.1\times10^{-6}\times100\times10^{3}}\int_0^{t_{max}} 2\,dt$$

$$10 = \frac{1}{10^{-2}}\times 2\,t_{max}$$

$$t_{max} = 50 \text{ ms}$$

110. (a)

As the shaft rotates, the teeth pass in front of the pickup and produce a change in the reluctance of the magnetic circuit. The field expands or collapses and a voltage is induced in the coil. The frequency of the pulses depends on the number of teeth on the wheel and it's speed of rotation. We have,

$$\text{speed} = \frac{\text{Number of pulses per second}}{\text{Number of teeth}}\times 60 \text{ rpm}$$

$$= \frac{2400}{120}\times 60 = 1200 \text{ rpm}$$

111. (c)

$$\because \quad \phi = \sin^{-1}\left[\frac{y_1}{y_2}\right] = \sin^{-1}\left[\frac{2}{4}\right] = \sin^{-1}\left(\frac{1}{2}\right) = 30^\circ$$

112. (c)

Error as % of reading when meter reads 100 mV = $100 \text{ mV} \times \frac{0.5}{100} = 0.5 \text{ mV}$

A $3\frac{1}{2}$ digit meter can read from 0 to 1999 i.e., 2000 counts.

$$\text{Error due to 5 counts} = \frac{200 \text{ mV}}{2000}\times 5 = 0.5 \text{ mV}$$

Hence, total error = 0.5 + 0.5 = ±1.0 mV

∴ meter will read between (100 – 1) mV and (100 + 1) mV.

i.e., between 99.0 mV and 101.0 mV

113. (b)

For a PMMC meter, Deflecting torque,

$$T_d = BINA$$

Controlling torque, $T_c = K\theta$

At balance, $T_c = T_d$

$K\theta = BINA$

Deflection, $\theta \propto BI$

Given, magnetic flux density is doubled i.e. 2 B

Current in the coil also becomes twice i.e. $2I$

New deflection, $\theta' \propto (2B)\ (2I)$

$\theta' \propto 4\ BI$

Hence, the new deflection becomes 4 times i.e.

$$4 \times 15° = 60°$$

114. (c)

Voltage across ammeter remains same as they are connected in parallel combination. The current is distributed between the milliammeters depending on their internal resistances.

Hence,

$$\text{Internal resistance of ammeter-1} = \frac{V}{I_{fsd1}} = \frac{V}{1\,\text{mA}}$$

$$\text{Internal resistance of ammeter-2} = \frac{V}{I_{fsd2}} = \frac{V}{10\,\text{mA}}$$

$$\text{Internal resistance of ammeter-3} = \frac{V}{I_{fsd3}} = \frac{V}{100\,\text{mA}}$$

Ratio of internal resistances = 100 : 10 : 1

115. (c)

Given,

Limiting error in current measurement = ±2%

Limiting error in power measurement = ±4%

$$P = I^2R$$

$$\ln P = 2\ln I + \ln R$$

$$\ln R = \ln P - 2\ln I$$

Differentiating both sides, we get

$$\frac{\delta R}{R} = \frac{\delta P}{P} - 2\frac{\delta I}{I}$$

We have, $\frac{\delta I}{I} = \pm 2\% = \pm 0.02$

$$\frac{\delta P}{P} = \pm 4\% = \pm 0.04$$

Limiting error, $\frac{\delta R}{R} = \pm\frac{\delta P}{P} \pm \frac{2\delta I}{I}$

$$= \pm 0.04 \pm 0.04 = \pm 0.08 = \pm 8\%$$

116. (c)

- The Gauge Factor is given as:

$$GF = 1 + 2v + \partial\rho/\rho$$

Semiconductor strain gauges depend for their action upon the piezo resistive effect, i.e. change in value of the resistance due to change in resistivity, unlike metallic gauges where change in resistance is mainly due to the change in dimension when strained. For metals, the value of the gauge factor is 2. For semiconductors, the value of the gauge factor is high generally 100-200.

Semiconductor strain gauges are used where a very high gauge factor and a small envelope is required.

117. (d)

The bridge sensitivity is defined as the amount of deflection of the galvanometer per unit fractional change in the unknown resistance. A higher sensitivity implies a larger deflection for a small change, hence making the measurement more precise.

118. (a)

$$T_r/\text{Phase} \propto \frac{1}{\omega_s} \times E_2 I_2 \cos\theta_2 \qquad \left[\omega_s = \frac{2\pi N_s}{60}\right]$$

Hence, the torque developed by 3-phase induction motor depends on rotor emf (E_2), rotor current (I_2) and rotor p.f ($\cos\theta_2$).

119. (b)

$$P = \frac{V \times E_f}{X_s} \sin\delta$$

$$0.5 = \frac{1 \times 1.5}{0.6} \sin\delta$$

$$\sin\delta = \frac{0.3}{1.5} = 0.2$$

$$\delta = 11.53°$$

120. (c)

$$E_f = 4.44\ K_W f \phi T_{ph}$$

$$\%\ \text{Regulation} = \frac{E_f - V}{V} \times 100$$

$$E_f = V + I_a Z_s$$

$$E_f - V = I_a Z_s$$

$$\%\ \text{Regulation} = \frac{I_a Z_s}{V} \times 100$$

$$E \propto f$$

$$Z_s \cong X_a \propto f$$

121. (d)

The synchronous speed

$$N_s = \frac{120f}{P} = \frac{120 \times 60}{6} = 1200 \text{ rpm}$$

The full load slip,

$$s = \frac{N_s - N_r}{N_s} = \frac{1200 - 1000}{1200} = \frac{200}{1200} = \frac{1}{6}$$

At low values of slip, the increase in slip is proportional to the increase in load.
So, for half load,

$$s_2 = \frac{s_1}{2} = \frac{1}{12}$$

So, speed $N_2 = N_s(1 - s_2) = 1200\left(1 - \frac{1}{12}\right)$

$$= \frac{1200 \times 11}{12}$$

$$= 1100 \text{ rpm}$$

122. (a)

The armature torque for dc motor,

$$T_a = 0.159\phi I_a \frac{ZP}{A} \text{Nm} = 400 \text{ Nm}$$

$$T_a = 9.55\frac{E_b I_a}{N} = 400 \text{ Nm} \quad \text{...(i)}$$

where, $E_b = V - I_a R_a = 500 - 0.75\, I_a$ ...(ii)

From equations (i) and (ii),

$$500 - 0.75 I_a = \frac{NT_a}{9.55 I_a} = \frac{2\pi \times 1500}{60} \times \frac{400}{I_a}$$

$$500 - 0.75 I_a = \frac{20000\pi}{I_a}$$

$$500 I_a - 0.75 I_a^2 = 20000\pi$$

$$0.75 I_a^2 - 500 I_a + 20000\pi = 0$$

$$I_a = \frac{500 \pm \sqrt{25 \times 10^4 - 4 \times 0.75 \times 2 \times 10^4 \times 3.14}}{2 \times 0.75}$$

$$I_a = \frac{500 \pm \sqrt{6.16 \times 10^4}}{2 \times 0.75} = \frac{500 \pm 248.2}{2 \times 0.75}$$

$$= \frac{748.2}{2 \times 0.75}, \frac{251.8}{2 \times 0.75} = 498.8 \text{A}, 167.87 \text{A}$$

Consider, $I_a = 167.87$ A

$$0.159\frac{\phi ZP}{A} = \frac{400}{I_a} = \frac{400}{167.87} = 2.38 \text{ Nm/A}$$

If the shunt field flux is reduced by 20%,

$$I_a' = \frac{T}{\left(0.159\phi\frac{ZP}{A}\right)} = \frac{400}{2.38 \times 0.8} = 210.1 \text{ A}$$

Considering, I_a = 498.8A, we get $I_a' \approx 625\text{A}$

123. (b)

- The interpole neutralizes the reactance voltage and gives spark-free commutation. It also neutralizes the cross-magnetizing effect of armature reaction so that the brushes are not required to be shifted from its original position for any load.
- Interpoles are small poles compared to main poles and placed in Interpolar region between the main poles.
- The inter-pole winding is connected in series with the armature winding because the inter-pole must produce flux that is directly proportional to the armature current.

124. (b)

RMS value of the induced emf in the transformer is given by

$$E = 4.44\, fN\, \phi_{\max 1}$$

$$1.6E = 4.44 \times (0.6) fN\, \phi_{\max 2}$$

$$\frac{1.6E}{E} = 0.6\frac{\phi_{\max 2}}{\phi_{\max 1}}$$

$$\frac{\phi_{\max 2}}{\phi_{\max 1}} = \frac{1.6}{0.6} = \frac{8}{3}$$

125. (d)

$$\text{Core loss component} = \frac{10 \times 1000}{240}$$

$$= \frac{125}{3} = 41.67\text{A}$$

126. (c)

$$\text{Power transferred inductively, } S_{\text{trans}} = S_{in}\left(1 - \frac{V_L}{V_H}\right) \times 100\%$$

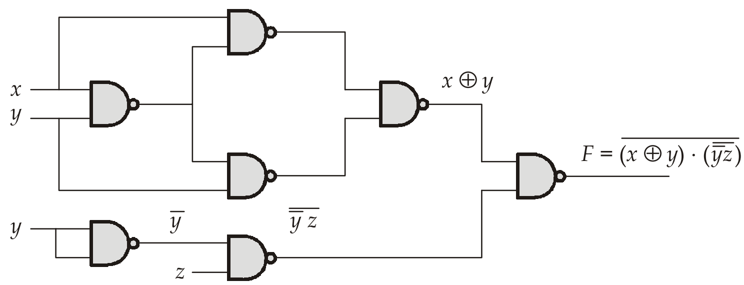
$$= S_{in}\left(1 - \frac{180}{250}\right) \times 100$$

$$= S_{in}\left(\frac{70}{250}\right) \times 100$$

$$= 28\%\ S_{\text{in}}$$

127. (c)

$$F = \bar{x}\bar{y} + xy + \bar{y}z = x \odot y + \bar{y}z$$
$$\bar{\bar{F}} = \overline{x \odot y + \bar{y}z} = \overline{\overline{x \odot y} \cdot \overline{\bar{y}z}} = \overline{(x \oplus y) \cdot (\overline{\bar{y}z})}$$



128. (d)

TTL gates is the fastest saturating logic family. TTL gates are available in the form of high speed, high speed Schottky, low power, low power Schottky, etc.

ECL gates: Since transistors operate in active region, it has highest speed among all logic families.

CMOS devices dissipate less power than NMOS devices because the CMOS dissipates power only when switching, whereas N channel MOSFET dissipates power whenever the transistor is ON because there is a current path from V_{dd} to V_{ss}.

CMOS gates have extremely large fan-out capability (> 50).

129. (c)

	$\bar{y}\bar{z}$	$\bar{y}z$	yz	$y\bar{z}$	
$\bar{w}\bar{x}$	0	1	3	2	→ I_3
$\bar{w}x$	1 (4)	1 (5)	1 (7)	6	→ I_2
wx	1 (12)	13	1 (15)	14	→ I_0
$w\bar{x}$	1 (8)	9	11	1 (10)	→ I_1

$$I_3 = 0$$
$$I_2 = \overline{y\bar{z}}$$
$$I_0 = \bar{y}\bar{z} + yz = y \odot z$$
$$I_1 = \bar{y}\bar{z} + y\bar{z} = \bar{z}[\bar{y} + y] = \bar{z}$$

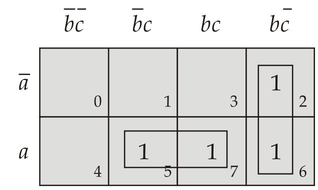
130. (b)

For F_1:

	$\bar{b}\bar{c}$	$\bar{b}c$	bc	$b\bar{c}$
$\bar{a}$	0	1	1 (3)	1 (2)
a	4	1 (5)	1 (7)	6

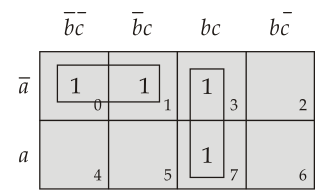
$$F_1 = ac + \bar{a}b$$

For F_2:



$$F_2 = ac + b\bar{c}$$

For F_3:



$$F_3 = \bar{a}\bar{b} + bc$$

Thus, $P_1 = \bar{a}b,\ \ P_2 = ac,\ \ P_3 = b\bar{c},\ \ P_4 = bc,\ \ P_5 = \bar{a}\bar{b}$

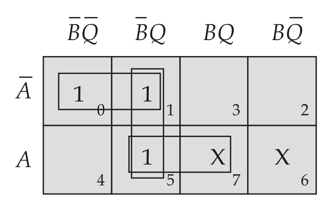
(P_4 and P_5 can be interchanged).

131. (b)

From the circuit diagram, $S = A \odot B$ and $R = B$

The state table is shown below:

A	B	Q	S	R	Q^+
0	0	0	1	0	1
0	0	1	1	0	1
0	1	0	0	1	0
0	1	1	0	1	0
1	0	0	0	0	0
1	0	1	0	0	1
1	1	0	1	1	X
1	1	1	1	1	X



$\therefore$ $$Q^+ = \bar{A}\bar{B} + \bar{B}Q$$

$$Q^+ = \bar{B}(\bar{A} + Q)$$

or $$Q^+ = \overline{A}\overline{B} + AQ$$

132. (c)

$$\text{Step size} = 0.5\text{ V}$$

For calculating step size, we consider the input as

$$\text{DCBA} = 0001$$

$\therefore$ $$\frac{5}{8\text{ k}\Omega} \times R_F = 0.5$$

$$R_F = 800\ \Omega$$

133. (b)

134. (c)

FOM of a logic Family is defined as the product of the propagation delay (t_{pd}) and the power dissipation (P_D). Hence,

$$FOM = P_D \; t_{pd}$$

$$t_{pd} = \frac{t_{PLH} + t_{PHL}}{2}$$

For Gate-A: $t_{pd} = \frac{1+1.2}{2} = 1.1 \text{ ns}$

For Gate-B: $t_{pd} = \frac{5+4}{2} = 4.5 \text{ ns}$

For Gate-C: $t_{pd} = \frac{10+10}{2} = 10 \text{ ns}$

For Gate-A: FOM = 15 × 1.1 = 16.5 pJ

For Gate-B: FOM = 8 × 4.5 = 36 pJ

For Gate-C: FOM = 0.5 × 10 = 5 pJ

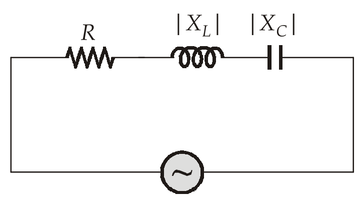
Lower value of FOM gives better performance i.e. fast speed and lower power dissipation. Here,

$$(FOM)_C < (FOM)_A < (FOM)_B$$

So, Gate-C gives the better performance based on the speed-power product.

135. (c)

136. (d)



$$Z = R + j\,|X_L - X_C|$$

At resonance frequency,

$$|X_L| = |X_C|$$
$$Z = R$$

Thus, Statement (I) is incorrect.

Bandwidth of parallel R-L-C circuit = $\frac{1}{RC}$

Time constant, $\tau = 2RC$

$$\text{Bandwidth} = \frac{2}{\tau}$$

Therefore, statement-II is correct.

137. (c)

Soft magnetic materials can be easily magnetised and demagnetised. Therefore, they can't be used for making permanent magnets.

138. (b)

In RSA algorithm,

- Sender chooses a large No. X and calculates $R_1 = G^X \bmod N$ and sends it to receiver.
- Receiver chooses a large No. Y and calculates $R_2 = G^Y \bmod N$ and sends it to sender.
- The key is obtained as $K = (R_2)X \bmod N$ at sender and $K = (R_1)Y \bmod N$ at receiver.

139. (b)

The ripple factor of rectified signal is represented by r.

For a half wave rectifier, $I_{\text{rms}} = \dfrac{I_m}{2}$ and $I_{dc} = \dfrac{I_m}{\pi}$

$$r = \sqrt{\left(\frac{I_{\text{rms}}}{I_{dc}}\right)^2 - 1} = \sqrt{\left(\frac{\pi}{2}\right)^2 - 1}$$

$$r = 1.21$$

For a full wave rectifier, $I_{\text{rms}} = \dfrac{I_m}{\sqrt{2}}$ and $I_{dc} = \dfrac{2I_m}{\pi}$

$$r = \sqrt{\left(\frac{I_{\text{rms}}}{I_{dc}}\right)^2 - 1} = \sqrt{\left(\frac{\pi}{2\sqrt{2}}\right)^2 - 1}$$

$$r = 0.48$$

$$VR = \frac{V_{NL} - V_{FL}}{V_{FL}}$$

If the value of full-load voltage is the same as the no load voltage, the voltage regulation calculated is 0%, which is best expected.

This mean that the supply is a perfect voltage source for which the output voltage is independent of the current drawn from the supply. The smaller the voltage regulation, the better is the operation of the voltage supply circuit.

140. (a)

As ωt varies from 0 to T, the field rotates anticlockwise in the x-y plane. Since, the wave is travelling in $\hat{a}_z$ direction, hence the wave is right elliptically polarized.

141. (c)

142. (c)

D → Direction flag is used to set direction for accessing address locations in string manipulation instructions.

D → 0 : Auto increment mode i.e. the string is accessed from lower memory address to higher memory address.

D → 1 : Auto decrement mode i.e. the string is accessed from higher memory address to lower memory address.

143. (c)

UNDO operation is used to update the DB file with old values of a LOG file when the transaction is terminated before commit statement.

144. (b)

- Most computers use Dynamic RAM as the computer's main memory because it supports greater densities at a lower cost per MB.
- The electric charge on the capacitors gradually leaks away. To prevent this, DRAM requires an external periodic refreshing to rewrite the data in the capacitors, restoring them to their original charge.

145. (a)

146. (d)

The spectrum of a periodic signal has the following properties:

- Discreteness: Spectral lines exist only at integral multiples of fundamental frequency, and amplitude changes are nonperioidic.
- Harmonics: Spectral lines are uniformly spaced on the frequency axis with an interval of fundamental frequency.
- Convergence: The general changing trend of each harmonic amplitude is gradually damped with an increase in the harmonic mumber.

The continuous time periodic signal $x(t) = \sin\omega_0 t$ contains only one spectral component at ω_0, hence not all continuous time periodic signal contains infinite number of sidebands. Therefore, Statement (I) is incorrect.

147. (b)

Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

As temperature increases, covalent bonds will break and free electron-hole pairs are generated. Due to this, concentration of electrons and holes increases.

148. (c)

Compared to thermistors, platinum RTDs are less sensitive to small temperature changes and have a slower response time. Hence, Statement (II) is incorrect.

149. (b)

- The energy released during nuclear fission heat up the water surrounding the reactor core.
- Cadmium or boron easily absorbs slow moving neutrons, so they are used in nuclear reactor to control the fission rate.

150. (b)

- Each output of the flip-flop in a Johnson counter represents a different phase of the clock signal, hence it can be used to generate multiphase clock signals.
- As compared to 'n' states in the ring counter, Johnson counter has '$2n$' states, where n is the number of flip-flops.

■■■■