TEST ID: 112

ACE Engineering Academy

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ESE- 2020 (Prelims) - Offline Test Series   Test- 24

ELECTRONICS & TELECOMMUNICATION ENGINEERING

FULL LENGTH MOCK TEST - 4 (PAPER - II)
SOLUTIONS

01. Ans: (c)

Sol: The flag register of 8086 microprocessor contains three control bits -

TF - Trap flag

IF - Interrupt flag

DF - Direction flag

The trap flag is set to put the 8086 in single step mode.

02. Ans: (b)

Sol: When active low is applied to $\overline{\text{RESET IN}}$, PC sets to 0000H and resets the interrupt enable and HLDA flip-flops and affects the contents of processor's internal register randomly.

03. Ans: (c)

Sol: $(444)_3 = (4\times3^2 + 4\times3 + 4)_{10}$

$= 4 \times 9 + 12 + 4$

$= (52)_{10}$

$(4000)_3 = (4\times 3^3)_{10}$

$= (27 \times 4)_{10}$

$= (108)_{10}$

$(4440)_3 = 4\times3^3 + 4\times3^2 + 4\times3 + 0$

$= 108 + 36 + 12$

$= (156)_{10}$

$(2000)_3 = [3^3 \times 2]$

$= 27 \times 2$

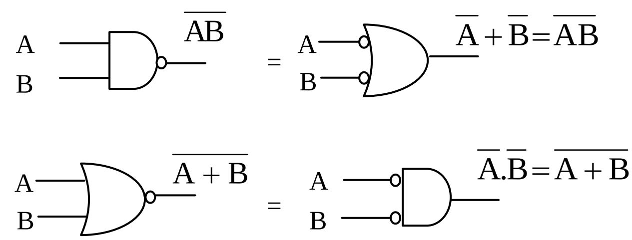
$= (54)_{10}$

$(0000)_3 = (00)_{10}$

$\therefore$ $(2000)_3$ comes immediately after 444.

04. Ans: (a)

Sol:



05. Ans: (b)

Sol: Characteristics equation for a J-K FF is

$Q(t+1) = J\overline{Q}(t) + \overline{K}Q(t) \quad -(1)$

From the diagram input of D FF can be written as

$D = \overline{Q(t)}X + Q(t)\overline{Y} \quad -(2)$

Comparing (1) & (2)

J = X, K = Y

$\therefore$ JK FF with J =X, K = Y

06. Ans: (c)

07. Ans: (d)

Sol:

Logic family	TTL	DTL	ECL	CMOS
Fanout	10	9	25	50

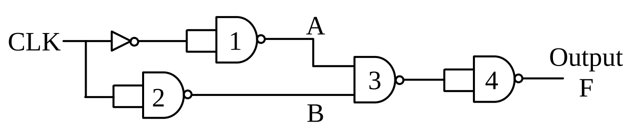
08. **Ans: (a)**

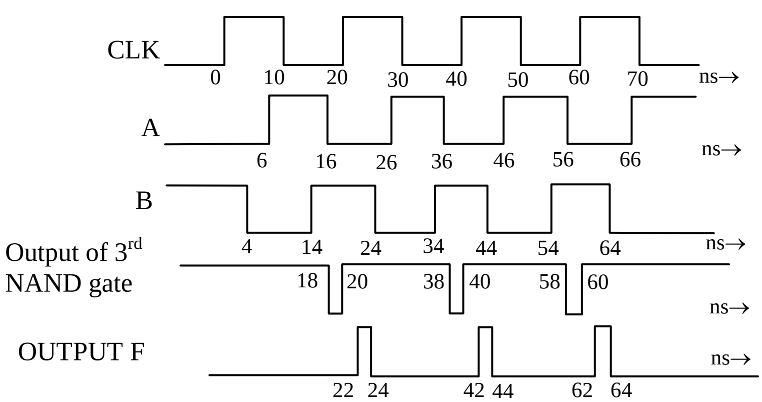
Sol :

- (HL) = 1234 H
- (H) $\rightarrow$ (A) = 12H
  (A) = 12H
- (A) = 12H = 0001 0010
  $\underline{(L)} = \underline{34H} = \underline{0011\ 0100}$
  $\underline{(A)} = \underline{46H} = \underline{0100\ 0110}$
- CY = 0, P = 0, AC = 0, Z = 0, S = 0
  (Flag reg) = 0 0 × 0 × 0 × 0
  = 0000 0000 = 00 H
- (TOS) $\leftarrow$ (PSW) = 4600H
  (HL) $\leftrightarrow$ (TOS)
  (HL) = 4600 H
  (TOS) = 1234 H

09. **Ans: (d)**

Sol: The waveform at input of 3rd NAND gate is

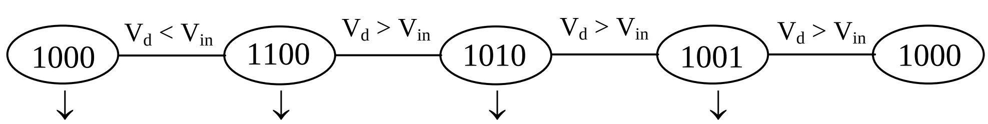




Duty cycle of waveform at $F = \frac{2}{20} \times 100\% = 10\%$

10. **Ans: (b)**

Sol:



$8 \times \frac{15}{16} = 7.5V$ $\quad 12 \times \frac{15}{16} = 11.25V$ $\quad 10 \times \frac{15}{16} = 9.375V$ $\quad 9 \times \frac{15}{16} = 8.4375V$

11. Ans: (a)

12. Ans: (d)

Sol: Digital output

$$= \frac{-1.5}{\left(\frac{4}{2^8}\right)} = \frac{-1.5}{\frac{4}{256}} = -1.5 \times 64 = -96_{10}$$

$= 1010\ 0000 = \text{A0H}$

13. Ans: (b)

Sol: The purpose of the state assignment in synchronous sequential circuit is to minimize the logic gates, reduce the number of states and to eliminate output glitches.

14. Ans: (c)

Sol: In an embedded system, the criterion for selection of the processor depends on speed, high code density and energy efficiency.

15. Ans: (c)

Sol: $A \leftarrow A + 02$ is done 32 times

i.e A value is 64_{10} = 40H

16. Ans: (b)

Sol: Bandwidth efficiency $= \frac{\text{Bitrate}}{\text{Bandwidth}} \times 100\,\%$

$$= \frac{R_b}{\frac{2\left[\frac{R_b}{2}(1+\alpha)\right]}{\log_2 M}} \times 100\,\%$$

$= \log_2 M \times 100\,\%$

$= \log_2 8 \times 100\,\%$

$= 3 \times 100\%$

$= 300\%$

17. Ans: (b)

Sol: R_b = 80kpbs B = 10kHz

$$C = 80\times10^3 = B\log_2\left(1+\frac{S}{N}\right)$$

$$\Rightarrow 80\times10^3 = 10\times10^3 \log_2\left(1+\frac{S}{N}\right)$$

$$\Rightarrow \log_2\left(1+\frac{S}{N}\right) = 8$$

$$\Rightarrow 1+\frac{S}{N} = 2^8 = 256$$

$$\Rightarrow \frac{S}{N} = 256 - 1 = 255$$

18. Ans: (b)

Sol: $K_a = 1$

$$\mu_1 = A_{m_1} = \frac{1}{2}$$

$$\mu_2 = A_{m_2} = \frac{1}{2}$$

$$\mu_f = \sqrt{\frac{1}{4}+\frac{1}{4}}$$

$$= \frac{1}{\sqrt{2}}$$

$= 0.707$

19. Ans: (d)

Sol: In A-law companding, the value of A used practically is 87.6

20. Ans: (c)

Sol: The Quantization error in Delta modulation varies from $-\Delta$ to $+\Delta$

21. Ans: (a)

Sol: f_c= 12MHz , Δf = 3.2kHz, f_{osc}= 10MHz.

After down conversion $f_c - f_{osc}$

= 12MHz – 10MHz = 2MHz

Frequency deviation does not change.

22. Ans: (b)

Sol: For WBPM, Bandwidth = $2(\beta+1)f_m$

if f_m doubles, bandwidth also doubles.

23. Ans: (c)

Sol: $P_r = P_t$ – Losses = 20 – 30 = –10dB

$$P_r = 10^{-1} = \frac{1}{10} = 0.1\text{W}$$

24. Ans: (c)

Sol: BW = $2\Delta f + 2f_m \Rightarrow$ As Δf and f_m gets doubled, BW also gets doubled.

25. Ans: (c)

Sol: BW of the modulated signal depends on the message signal frequency only

26. Ans: (d)

Sol: MOSFETs are commonly used in IC technology, operated with a MOS current source and a PMOS active load, or an NMOS active load.

A common drain amplifier also known as a source follower with a sinking source offers unity gain, a very high input resistance and a low output resistance.

27. Ans: (b)

Sol: Here diodes are in parallel so, for positive cycle D_1 conducts. For negative cycle D_2 conducts. So, current always flows hence, it contains all harmonics of 'f '.

28. Ans: (b)

Sol: $\frac{dA_f}{dA} = 0.2\frac{A_f}{A} \Rightarrow \frac{dA_f}{dA} = \frac{1}{1+\beta A}\times\frac{A_f}{A}$

$(1+\beta A) = 5 \Rightarrow \beta A = 4$

$$A = \frac{4}{\beta} = \frac{4}{0.2}\times 100$$

$$= 2000$$

$$A_f = \frac{A}{1+\beta A} = \frac{2000}{5}$$

$$= 400$$

29. Ans: (b)

Sol: → Advantages of crystal oscillator:

i. It is one of the most stable oscillator

ii. High Q - factor of range of 10^4 to 10^6 compared to 10^2 for LC oscillator.

→ Phase shift oscillator is used in audio range frequency.

30. Ans: (a)

Sol: $\%\,\text{Duty cycle} = \frac{R_1 + R_2}{R_1 + 2R_2}\times 100$

$$60 = \frac{R_1 + 200\text{k}\Omega}{R_1 + (2\times 200\text{k}\Omega)}\times 100$$

$0.6(R_1 + 400\text{ k}\Omega) = (R_1 + 200\text{k}\Omega)$

$0.6R_1 + 240\text{ k}\Omega = R_1 + 200\text{k}\Omega$

$0.4\,R_1 = 40\text{ k}\Omega$

$R_1 = 100\text{ k}\Omega.$

31. Ans: (c)

Sol: For the given configuration,

Feedback	Input impedances	Output impedances
Series-shunt	$R_i(1+A\beta)$	$\frac{R_0}{(1+A\beta)}$
Shunt-Series	$\frac{R_i}{(1+A\beta)}$	$R_0(1+A\beta)$

So, input impedances of shunt-series impedance is low and output impedance is high compared to series-shunt feedback.

32. Ans: (b)

Sol: A = 250, β = 0.8

$$A_f = \frac{A}{1+A\beta} = \frac{250}{1+(250\times 0.8)} = 1.2438$$

Given, $\frac{\delta A}{A} = 20\%$

and $S_A^{A_f} = \frac{\delta A_f / A_f}{\delta A / A} = \frac{1}{1+\beta A}$

$$\frac{\delta A_f}{A_f} = \frac{1}{1+\beta A}.\frac{\delta A}{A} = \frac{1}{1+(250\times 0.8)}\times 20\%$$

$$\frac{\delta A_f}{A_f} = 0.1\%$$

33. Ans: (b)

Sol: In lowpass filter

$$\frac{V_o}{V_i}=\frac{\frac{1}{SC}}{R+\frac{1}{SC}}=\frac{1}{1+SCR}$$

For pure integrator capacitor should charge quickly and discharge slowly.

So, T is less than discharging time

Here T $\to$ Time period

T << RC

$$\frac{1}{\omega}<<RC$$

$$\omega\tau>>1$$

34. Ans: (b)

Sol: Gain = 30 dB

$$30dB=10\log_{10}\left(\frac{P_o}{P_i}\right)$$

$$3=\log_{10}\left(\frac{P_o}{P_i}\right)$$

$$\frac{P_o}{P_i}=10^3$$

$P_0 = 10^3 \times P_i$

$P_0 = 10^3 \times 1 \times 10^{-6}$

$P_0 = 10^{-3}$ W

P_0 = 1mW

$$P_0(\text{in dB})=10\log_{10}10^{-3}=-30dB$$

$$P_0(\text{in dBm})=-30+30=0dBm$$

35. Ans: (c)

Sol: By definition of I.D.F.T,

$$g(n)=\frac{1}{2\pi}\int_{-\pi}^{\pi}G(e^{j\Omega})e^{j\Omega n}.d\Omega$$

$\because$ $G(e^{j\Omega}) = -j2\Omega$

$$g(n)=\frac{1}{2\pi}\int_{-\pi}^{\pi}(-j2\Omega)e^{j\Omega n}d\Omega$$

$$=\frac{-j2}{2\pi}\int_{-\pi}^{\pi}\Omega.e^{j\Omega n}d\Omega$$

$$=\frac{-j}{\pi}\left[\Omega\left(\frac{e^{j\Omega n}}{jn}\right)-1\left(\frac{e^{j\Omega n}}{-n^2}\right)\right]_{\Omega=-\pi}^{\Omega=\pi}$$

$$g(n)=\frac{-j}{\pi}\left[\left\{\frac{\pi}{jn}e^{jn\pi}+\frac{e^{jn\pi}}{n^2}\right\}-\left\{\frac{-\pi}{jn}e^{-jn\pi}+\frac{e^{-jn\pi}}{n^2}\right\}\right]$$

$$g(n)=\frac{-j}{\pi}\left[\frac{\pi}{jn}(-1)^n+\frac{(-1)^n}{n^2}+\frac{\pi}{jn}(-1)^n-\frac{(-1)^n}{n^2}\right]$$

$$=\frac{-j}{\pi}\left(2\frac{\pi}{jn}(-1)^n\right)$$

$$g(n)=\frac{-2(-1)^n}{n}\quad ; n\neq 0$$

Now,

$$\sum_{n=1}^{5}g(n)=2\left[1-\frac{1}{2}+\frac{1}{3}-\frac{1}{4}+\frac{1}{5}\right]$$

$$=2\times\frac{47}{60}=\frac{47}{30}$$

36. Ans: (b)

Sol: $y(n)=\frac{1}{2}[x(n)+x(n-1)]$

$$Y(z)=\frac{1}{2}[X(z)+z^{-1}X(z)]$$

$$H(z)=\frac{Y(z)}{X(z)}=\frac{1}{2}(1+z^{-1})$$

$$H(z)=\frac{1}{2}(1+z^{-1})$$

$$H(e^{j\omega})=\frac{1}{2}(1+e^{-j\omega})=\frac{1}{2}[1+\cos\omega-j\sin\omega]$$

$$H(e^{j\omega})=\frac{1}{2}[(1+\cos\omega)-j\sin\omega]$$

$$|H(e^{j\omega})|=\frac{1}{2}\sqrt{(1+\cos\omega)^2+\sin^2\omega}$$

$$=\frac{1}{2}\sqrt{1+1+2\cos\omega}$$

$$= \frac{1}{2}\sqrt{2(1+\cos\omega)}$$

$$= \frac{1}{2}\sqrt{2\times 2\cos^2\left(\frac{\omega}{2}\right)}$$

Magnitude spectrum = $\left|H\left(e^{j\omega}\right)\right| = \left|\cos\left(\frac{\omega}{2}\right)\right|$

&

$$\theta(\omega) = \tan^{-1}\left[\frac{-\frac{\sin\omega}{2}}{\left(\frac{1+\cos\omega}{2}\right)}\right]$$

$$= -\tan^{-1}\left(\frac{2\sin\frac{\omega}{2}.\cos\frac{\omega}{2}}{2\cos^2\frac{\omega}{2}}\right)$$

$$\theta(\omega) = -\tan^{-1}\left(\tan\frac{\omega}{2}\right)$$

Phase spectrum $\theta(\omega) = -\frac{\omega}{2}$

37. Ans: (b)

Sol: For a linear phase FIR filter

h(n) = ± h(M–1–n); n = 0, 1, 2, ------ (M–1)

→ For symmetric response

h(n) = h(M–1–n) ; n = 0, 1, 2, ------(M–1)

if M = odd then number of filter coefficients $= \frac{M+1}{2}$

if M = even then number of filter coefficients = M/2

→ For anti-symmetric response,

h(n) = –h(M–1–n)

if M = odd, number of filter coefficients = (M–1)/2

if M = even, number of filter coefficients $= \frac{M}{2}$

38. Ans: (b)

Sol: From differentiation in time domain property

$x(t) \leftrightarrow C_k$

$$\frac{dx(t)}{dt} \leftrightarrow [jk\omega_0]C_k$$

$$\frac{dx(t)}{dt} \leftrightarrow [jk\pi]\left[-k2^{-|k|}\right]$$

$$\leftrightarrow -jk^2\pi\, 2^{-|k|}$$

39. Ans: (c)

Sol: From standard fourier transform pair

$$\text{sgn}(t) \leftrightarrow \frac{2}{j\omega}$$

From duality property

$$\frac{2}{jt} \leftrightarrow 2\pi\,\text{sgn}(-\omega)$$

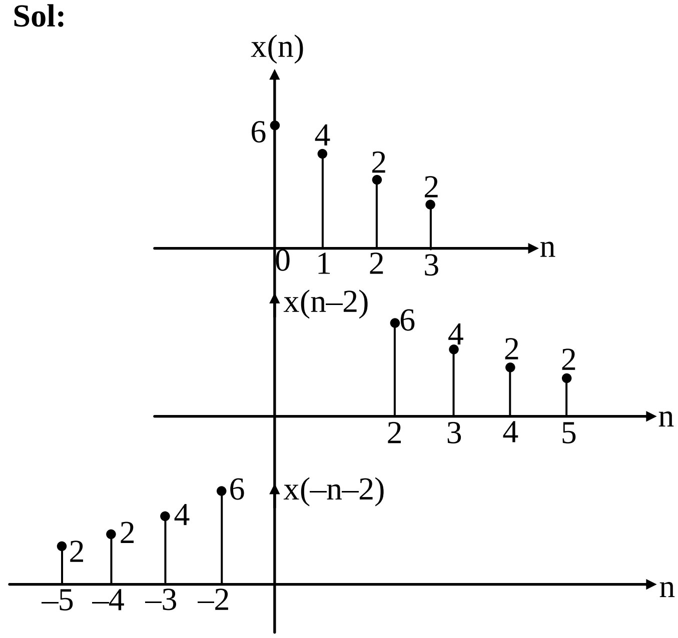
sgn(–ω) = –sgn(ω)

$$\frac{2}{jt} \leftrightarrow -2\pi\,\text{sgn}(\omega)$$

$$\frac{1}{\pi t} \leftrightarrow -j\,\text{sgn}(\omega)$$

40. Ans: (c)

Sol:



Assume y(n) = x(–n – 2)

$$E_{y(n)} = \sum_{n=-\infty}^{\infty} |y(n)|^2 = \sum_{n=-5}^{-2} |y(n)|^2$$

$$= 4 + 4 + 16 + 36$$

$$= 60$$

41. Ans: (b)

Sol: Given $s(t) = (1 - e^{-t})u(t)$

$$h(t) = \frac{ds(t)}{dt}$$

$$h(t) = \delta(t) - \{-e^{-t}u(t) + e^{-t}\delta(t)\}$$

$$e^{-t}\delta(t) = e^{-0}\delta(t) = \delta(t)$$

$$h(t) = e^{-t}u(t)$$

$$H(s) = \frac{1}{s+1}$$

Given $y(t) = (2 - 3e^{-t} + e^{-3t})u(t)$

Apply Laplace transform

$$Y(s) = \frac{2}{s} - \frac{3}{s+1} + \frac{1}{s+3}$$

$$= \frac{2s^2 + 8s + 6 - 3s^2 - 9s + s^2 + s}{s(s+1)(s+3)}$$

$$Y(s) = \frac{6}{s(s+1)(s+3)}$$

$$X(s) = \frac{Y(s)}{H(s)}$$

$$X(s) = \frac{6}{s(s+3)} = \frac{2}{s} - \frac{2}{s+3}$$

Apply inverse laplace transform

$x(t) = 2(1 - e^{-3t})u(t)$

42. Ans: (d)

Sol: Given $\frac{dy(t)}{dt} + y(t) = 4t\,u(t)$

Apply Laplace transform

$$sY(s) + Y(s) = \frac{4}{s^2}$$

$$Y(s) = \frac{4}{s^2(s+1)} = \frac{A}{s^2} + \frac{B}{s} + \frac{C}{s+1}$$

$$Y(s) = \frac{4}{s^2} - \frac{4}{s} + \frac{4}{s+1}$$

$y(t) = 4tu(t) – 4u(t) + 4e^{-t}u(t)$

43. Ans: (b)

Sol: If the input is eigen signal, the output is also same form as eigen signal.

From the given options, if the input is $e^{j\omega_0 n}$ to an LTI system the output is $H(e^{j\omega_0})e^{j\omega_0 n}$.

44. Ans: (d)

Sol: $f(t) = a_0 + \sum_{n=1}^{\infty} a_n \cos(n\omega_0 t) + \sum_{n=1}^{\infty} b_n \sin(n\omega_0 t)$

$= a_0 + A_n \cos(n\omega_0 t + \phi_n)$

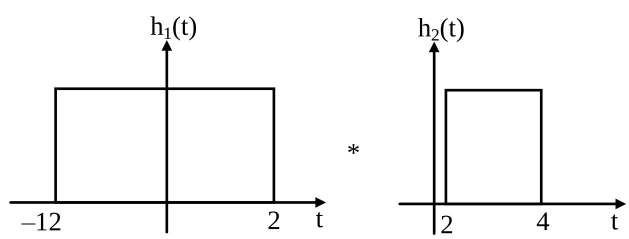
A_n and ϕ_n (Amplitude and phase spectra) occur at discrete frequencies.

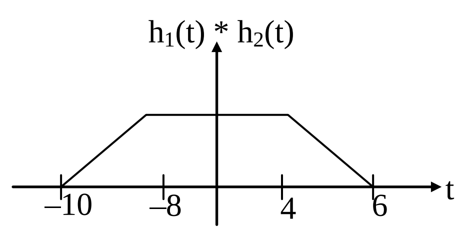
Waveform symmetries (Even, odd, Half-wave) simplify the evaluation of FS coefficients.

45. Ans: (d)

Sol:

1.





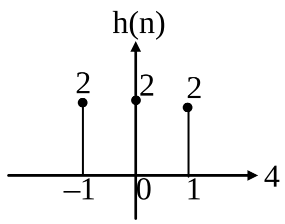
Which is non-causal. So, statement (1) is false.

2. The condition for causality is h(n) = 0 for n < 0

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

So, statement (2) is false.

3.



The above system is non-causal & stable.

So, statement-3 is false.

4. $\sum_{n=-\infty}^{\infty}|h(n)| = \sum_{n=-\infty}^{10}(3)^n = \sum_{n=-10}^{\infty}\left(\frac{1}{3}\right)^n < \infty$

So, system is stable system.

46. Ans: (b)

Sol: $W = \sqrt{\frac{2 \in V_j}{q}\left(\frac{1}{N_A} + \frac{1}{N_D}\right)}$

$W \ \alpha \ \sqrt{V_j}$

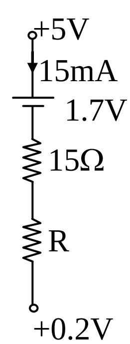
$\Rightarrow \frac{W_1}{W_2} = \sqrt{\frac{V_0 + V_{R1}}{V_0 + V_{R2}}}$

$\frac{4\mu m}{W_2} = \sqrt{\frac{0.7+1.3}{0.7+7.3}} = \sqrt{\frac{2}{8}} = \frac{1}{2}$

$\Rightarrow W_2 = 8\mu m$

47. Ans: (c)

Sol:



$5 = 1.7 + (15 + R) \times 15 \times 10^{-3} + 0.2$

$3.1 = 15\times10^{-3}\ (15+R)$

$R = 191.67\Omega$

$\approx 192\Omega$

48. Ans: (b)

Sol: $\eta = \frac{\text{Number of EHP generated}}{\text{Number of incident photons}}$

$= \frac{5.4\times10^6}{6\times10^6} = 0.9$

$= 90\%$

49. Ans: (c)

Sol: Bulk resistance of the diode can be written as

$r_B = \frac{V - V_K}{I_f}$, where V_K = knee voltage

$r_B = \frac{1.3-0.7}{120mA} = \frac{0.6}{120mA} = 5\Omega$

The ac resistance is given by

$R_{ac} = r_B + r_j$ [where r_j is junction resistance]

$r_j = \frac{25mV}{2.5mA} = 10\Omega$

$r_{ac} = 5+10 = 15\,\Omega$

50. Ans: (c)

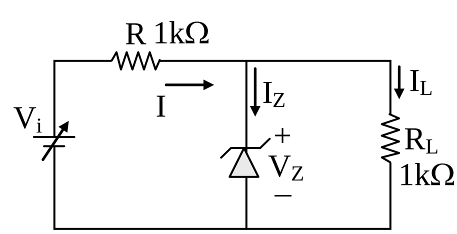
Sol: $V_Z = 10V$, $P_{Zmax} = 0.15W$

$\Rightarrow I_{Z\max} = \frac{0.15}{10} = 15mA$

$I_{Zmin} = 0A$

$V_i = IR + V_Z$

$I = I_Z + I_L$



$I_L = \frac{10}{1k} = 10mA$

$I_{min} = I_{Zmin} + I_L = 10mA$

$I_{max} = I_{Zmax} + I_L = 25mA$

$(V_i)_{min} = I_{min}R + V_Z = (10m)(1K) + 10 = 20V$

$(V_i)_{max} = I_{max}R + V_Z = (25m)(1K) + 10 = 35V$

51. Ans: (d)

Sol: The Fermi dirac function for hole i.e., probability that at state E is filled (occupied) by hole.

$$= 1 - F(E)$$

$$= 1 - \frac{1}{1+e^{(E-E_F)/KT}}$$

$$= \frac{e^{(E-E_F)/KT}}{1+e^{(E-E_F)/KT}}$$

52. Ans: (b)

Sol: Given data:

$\tau = 20\mu sec$

$T = 300K$

$I = 26mA$

Diffusion capacitance

$$C_D = \frac{I\tau}{\eta V_T} \quad (\because C_D = \tau g)$$

$$= \frac{26\times10^{-3}\times20\times10^{-6}}{1\times26\times10^{-3}}$$

$$= 20\mu F$$

53. Ans: (c)

Sol: 1. p-n junction diode is a passive component

2. $W \propto V_j^{1/n}$ (n = 2 for non-linear junction

n = 3 for linear junction)

and $V_j = V_0 - V_B \rightarrow$ For forward biasing

3. $I_{02} = I_{01}\times 2^{\frac{T_2-T_1}{10}}$

So statement (2) and (3) are correct and (1) is false.

54. Ans: (d)

Sol: The drain current in

Saturation region:

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS}-V_T)^2(1+\lambda V_{DS})$$

Linear region:

$$I_D = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}\left(2(V_{GS}-V_T)^2 V_{DS} - V_{DS}{}^2\right)$$

From the above equations $I_D \,\alpha\, \frac{1}{L}$

$$\frac{I_{D2}}{I_{D1}} = \frac{L_1}{L_2}$$

$$I_{D2} = I_{D1}\ \frac{L_1}{2L_1}$$

$$\Rightarrow I_{D2} = \frac{I_{D1}}{2}$$

55. Ans: (b)

Sol: $E_{Fi} = \frac{E_C+E_V}{2} - \frac{kT}{2}\ln\left(\frac{N_C}{N_V}\right)$

Given,

electron effective mass < hole effective mass

(m_n) (m_p)

$\therefore N_C < N_V$	$\because N_C = 4.82\times10^{15}\left(\frac{m_n}{m}\right)^{3/2} T^{3/2}/cm^3$
	$N_V = 4.82\times10^{15}\left(\frac{m_p}{m}\right)^{3/2} T^{3/2}/cm^3$

$$\therefore E_{Fi} > \frac{E_C+E_V}{2}$$

However the sample is not doped,

$\therefore$ E_F is not in conduction band or valance band at room temperature.

$\therefore$ E_{Fi} is between E_C and $\frac{E_C+E_V}{2}$.

56. Ans: (d)

Sol: All the given characteristics are belonging to RISC processor.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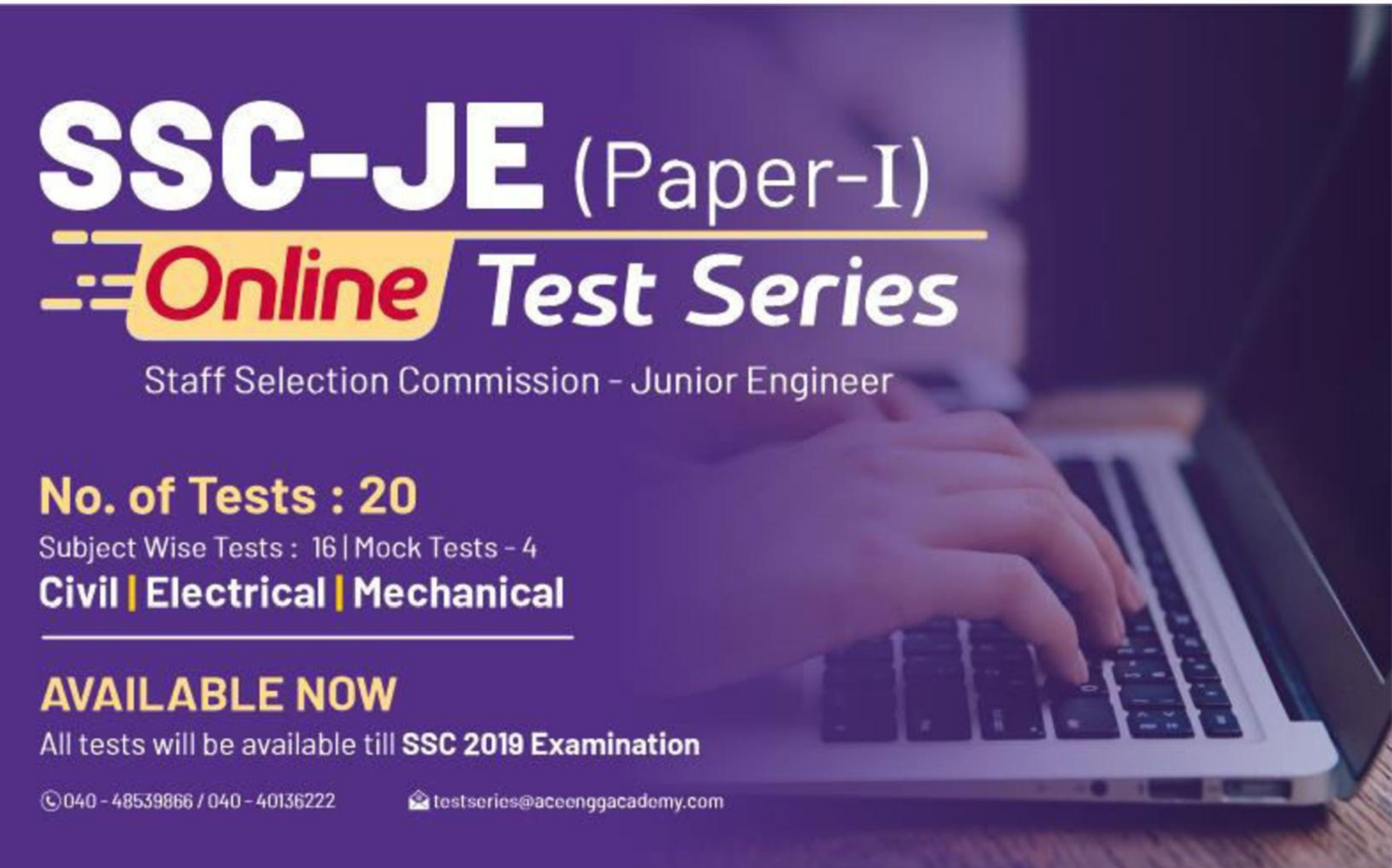
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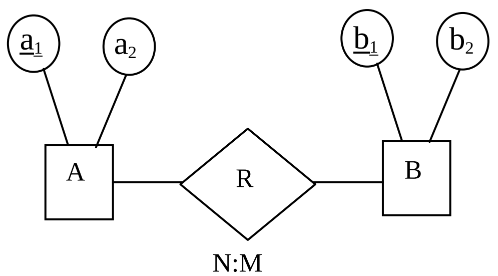
57. Ans: (c)

Sol: In set associative mapping, Tag field size = $\log_2 \frac{M}{S}$, where M = number of blocks in main memory and S = number of sets in cache memory. Here $S = \frac{Q}{4}$

Hence tag field size $\log_2 \frac{P}{Q/4} = \log_2 \frac{4P}{Q}$

58. Ans: (c)

Sol:



The above ER model is represented as the following relations

A(a1, a2)

B (b1, b2)

R($a_1 b_1$), where a_1, b_1 are foreign keys of A and B.

59. Ans: (c)

Sol: The precedence graph contains edges from T1→T2, T3→T1 and T3→T2

60. Ans: (c)

Sol: It is necessary to assign name of inner structure at the time of declaration otherwise we cannot access the member of inner structure. So correct declaration is:

```
struct outer {
  int a;
  struct inner {
          char c;
  } name;
};
```

61. Ans: (d)

Sol: Parameters are evaluated from right to left so in abc(++a, a++); first a++ evaluated, later ++a evaluated

∴ abc(22,20); i.e. passing values 22,20 to abc(int x, int y).

62. Ans: (d)

Sol: Ideal speed up = number of stages = 5

For 'A', Pipeline time = (5 + 99) × 20 ns
= 2080 ns

and non pipeline time = 10000 ns

∴ speed up = 4.8

then $\eta = \frac{4.8}{5} = 96$

For 'B', Pipeline time = 1004 × 20
= 20080ns

non pipeline time = 1000 × 5 × 20 = 100000

Speed up = 4.98

then $\eta = \frac{4.98}{5} = 99.6$

63. Ans: (b)

Sol: In virtual memory system CPU generates virtual address, so for translation first of all TLB should be accessed. As given in case of TLB miss, memory system should be accessed. In memory system the first access should be of cache before main memory.

64. Ans: (b)

Sol: Ferromagnetic material susceptibility is positive and large.

Paramagnetic material susceptibility is positive and small.

Diamagnetic material susceptibility is negative and small.

Superconductors are perfect diamagnetic materials having susceptibility as −1.

65. Ans: (c)

Sol: In Rectangular waveguide TM_{00}, TM_{0n}, TM_{m0}, TE_{00} modes doesn't exist.

So option (c) is correct.

66. Ans: (b)

Sol: Given:

$f_c|TE_{10} = 3\times10^9$ Hz

$$\Rightarrow \frac{c}{2a} = 3\times 10^9$$

$$\Rightarrow \frac{3\times 10^{10}}{2a} = 3\times 10^9$$

$$\Rightarrow a = \frac{3\times 10^{10}}{2\times 3\times 10^9} = 5\text{cm}$$

$$f_c|TE_{01} = 6\times 10^9\ \text{Hz}$$

$$\Rightarrow \frac{c}{2b} = 6\times 10^9$$

$$\Rightarrow \frac{3\times 10^{10}}{2b} = 6\times 10^9$$

$$\Rightarrow b = \frac{3\times 10^{10}}{2\times 6\times 10^9} = 2.5\text{cm}$$

67. Ans: (a)

Sol: $$f_c|_{TM_{11}} = \frac{c}{2}\sqrt{\left(\frac{1}{a}\right)^2 + \left(\frac{1}{b}\right)^2}$$

$$= \frac{c}{2}\sqrt{\left(\frac{1}{2b}\right)^2 + \left(\frac{1}{b}\right)^2}$$

$$= \frac{c}{2}\sqrt{\frac{1}{4b^2} + \frac{1}{b^2}}$$

$$= \frac{c}{2}\sqrt{\frac{1+4}{4b^2}} = \frac{c}{2}\times\sqrt{\frac{5}{4b^2}}$$

$$= \frac{\sqrt{5}}{2}\times\frac{c}{2b} = \frac{\sqrt{5}}{2}\times f_C|_{TE_{01}}$$

68. Ans: (d)

Sol: Given:

Z_R = X ohm

$Z_{in} = Z_0$ = Y ohm

The required characteristic impedance of quarter wave transmission line is given by

$$Z_0' = \sqrt{Z_{in} Z_R}$$

$$= \sqrt{Z_0 Z_R}$$

$$\therefore Z_0' = \sqrt{XY}\ \text{ohm}$$

69. Ans: (c)

Sol: Impedance looking into the input end is called input impedance

Given: Transmission line is lossless $\gamma = j\beta$

length of line $\ell = \frac{\lambda}{8}$

$$\beta\ell = \frac{2\pi}{\lambda}\times\frac{\lambda}{8} = \frac{\pi}{4}$$

$$\tan\beta\ell \equiv \tan\frac{\pi}{4} = 1$$

$$Z_{in} = Z_0\left(\frac{Z_R + jZ_0\tan\beta\ell}{Z_0 + jZ_R\tan\beta\ell}\right)$$

$$Z_{in} = Z_0\left(\frac{Z_R + jZ_0}{Z_0 + jZ_R}\right)$$

$$= 50\left(\frac{50 + j25 + j50}{50 + j50 - 25}\right)$$

$$= 50\left(\frac{50 + j75}{25 + j50}\right)$$

$$= 50\times\frac{25(2+j3)}{25(1+j2)}$$

$$= 50\frac{(2+j3)(1-j2)}{(1+j2)(1-j2)}$$

$$Z_{in} = 50\frac{(2 - j4 + j3 + 6)}{5}$$

= 10 (8 – j)

$\therefore Z_{in}$ = 80 –10j (or) 80 – j10Ω

70. Ans: (b)

Sol: $$Z_{in} = Z_0\left(\frac{Z_R + Z_0\tanh\gamma\ell}{Z_0 + Z_R\tanh\gamma\ell}\right)$$

$Z_R \approx \infty$

$$Z_{in} = Z_0\frac{Z_R\left(1 + \frac{Z_0\tanh\gamma\ell}{Z_R}\right)}{Z_R\left(\frac{Z_0}{Z_R} + \tanh\gamma\ell\right)}$$

$Z_{in} = Z_0 \cot h\gamma l$

For lossless line $\alpha = 0$, $\gamma = j\beta$

$Z_{in} = Z_0 \cot h(j\beta l)$
$\therefore\ Z_{in} = -jZ_0 \cot\beta l$

71. Ans: (a)

Sol: Given: $\vec{E} = E_0 \cos(2\pi\times10^7 t - 2\pi z)\hat{a}_x + E_0 \cos(2\pi\times10^7 t - 3\pi z)\hat{a}_y$

Direction of propagation: +z

$$\vec{E}_{at(-2,1,1)} = E_0 \cos(2\pi\times10^7 t - 2\pi)\hat{a}_x + E_0\cos(2\pi\times10^7 t - 3\pi)\hat{a}_y$$

Let $2\pi\times10^7 = \omega$

$$\vec{E} = E_0 \cos(\omega t - 2\pi)\hat{a}_x + E_0 \cos(\omega t - 3\pi)\hat{a}_y$$

Amplitude are equal and phase difference is 180^o.

Therefore the wave is said to be linearly polarized.

72. Ans: (a)

Sol: Given :

$\vec{J} = kx\ \hat{a}_x - 5y\ \hat{a}_y$

Then for a steady current i.e, charge entering and leaving a cross-section of the conductor to be equal at any time,

$\nabla.\vec{J} = 0$

{Continuity equation, $\nabla.\vec{J} = -\dfrac{\partial\rho_v}{\partial t}$

but ρ_v = constant}

$$\Rightarrow\left(\frac{\partial}{\partial x}\hat{a}_x + \frac{\partial}{\partial y}\hat{a}_y + \frac{\partial}{\partial z}\hat{a}_y\right).(kx\ \hat{a}_x - 5y\ \hat{a}_y) = 0$$

$k - 5 = 0 \Rightarrow k = 5$

73. Ans: (d)

Sol: $A_e = k\ A_p$

$$A_P = \frac{A_e}{k} = \frac{4}{0.8}$$

$A_p = 5\ m^2$

74. Ans: (b)

Sol: Beam area, $\Omega_A = \dfrac{4\pi}{D}$

Where D is directivity

$$\Omega_A = \frac{4\pi}{8\pi} = 0.5\ Sr$$

75. Ans: (c)

Sol: Babbit metal (or) bearing metal is any of several alloys used to provide the bearing surface in a plain bearing. Some common compositions are (90% Sn, 10% Cu), (89% Sn, 7% Sb, 4% Cu), (80% Pb, 15% Sb, 5% Sn)

76. Ans: (b)

Sol: The total number of atoms per unit cell is given by

$$N = N_{interior} + \frac{N_{face}}{2} + \frac{N_{corner}}{8}$$

For simple cubic, BCC and FCC the number of atoms per unit cell are 1, 2 & 4.

77. Ans: (a)

Sol: Ferrite (α-iron) experiences an allotropic transformation to FCC austenite (or) γ-iron at 912°C. This austenite persists upto 1394°C.

78. Ans: (b)

Sol: In superconducting state entropy and thermal conductivity decreases.

79. Ans: (c)

Sol: $H_c(T) = H_c(0)\left[1 - \left(\dfrac{T}{T_c}\right)^2\right]$

$$= 32\times10^3\left[1 - \left(\frac{6}{7.26}\right)^2\right]$$

$= 10.14\times 10^3$ A/m

80. Ans: (c)

Sol: If the radius ratio x = 0.414, a more stable configuration is possible with six anions bonding with a cation. This configuration called the octahedral configuration is stable for $0.414 < x < 0.732$. Here the cation occupies the void created by six anions forming an octahedral structure.

81. Ans: (d)

Sol: Volume of unit cell = a^3

number of atoms per unit cell = 4

radius of Atoms = $\frac{a\sqrt{2}}{4}$

packing fraction = $\frac{4\times\frac{4}{3}\pi r^3}{a^3}$

$$= 4\times\frac{4}{3}\pi\left(\frac{\sqrt{2}}{4}\right)^3$$

$$= \frac{\pi\sqrt{8}}{12} \Rightarrow \frac{\pi\times 2\sqrt{2}}{12}$$

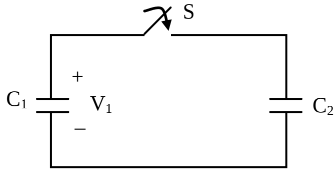
$$= \frac{\pi\sqrt{2}}{6}$$

82. Ans: (b)

Sol: In top down technique generally a bulk material is taken and machined it to modify into the desired shape and product. Examples of this type of technique are the manufacturing of integrated circuits using a sequence of steps such as crystal growth, lithography, etching, ion implantation, etc. For nanomaterial synthesis ball-milling is an important top down approach, where microcrystalline structure are broken down to nanocrystalline structures, but original integrity of the material is retained.

83. Ans: (b)

Sol: Consider below circuit,



Initial charge = C_1V_1

Final charge = $C_1V + C_2V$

By charge conservation principle

$\Rightarrow C_1V_1 = C_1V + C_2V$

$\Rightarrow V = \frac{C_1V_1}{C_1+C_2}$

84. Ans: (c)

Sol: $|e| = L\frac{di}{dt} = L\left[\frac{i_2 - i_1}{\Delta t}\right]$

$$= (0.1)\left[\frac{5-(-5)}{10\times10^{-3}}\right]$$

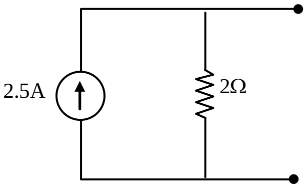
$$= \frac{1000}{10} = 100\,\text{Volts}$$

85. Ans: (d)

Sol: $V_{oc} = V_{th} = 5\text{Volts}$

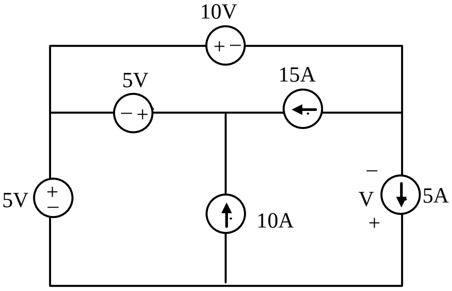
$I_{sc} = \frac{5}{2}\text{A} = 2.5\text{ A}$

So, $R_{th} = \frac{V_{oc}}{I_{sc}} = \frac{5}{5/2} = 2\Omega$



86. Ans: (a)

Sol:



Apply KVL in outer loop

$5 - 10 + V = 0$

$\Rightarrow V = 5$

$\therefore$ Power delivered by 5A source is P_{del}

$= 5\times 5$

= 25 Watts

87. Ans: (a)

Sol: $M = \frac{N_2\phi_{12}}{i_1} = \frac{K\phi_1 N_2}{i_1}$

$\Rightarrow M = \frac{(0.6)(0.1)\times 10^{-3}\times 2000}{1}$

$\Rightarrow M = 0.12H$

88. Ans: (a)

89. Ans: (a)

Sol: Average Power = $P_{avg} = \frac{V_{rms}^2}{R} = \frac{\left(\frac{2}{\sqrt{2}}\right)^2 + \left(\frac{4}{\sqrt{2}}\right)^2}{4}$

$= \frac{2+8}{4} = \frac{10}{4} = 2.5$ Watts

90. Ans: (b)

Sol: Bandwidth $= \frac{1}{\tau} = \frac{1}{RC}$

So, $R = \frac{1}{BW \times C} = \frac{1}{10\times10^3 \times 100\times10^{-12}}$

$= \frac{10^6}{1} = 10^6\ \Omega$

$\Rightarrow R = 1M\Omega$

91. Ans: (b)

Sol: Given, $V = 100\angle30°$

$I = 5\angle{-30°}$

We know, $S = VI^*$

$= (100\angle30°)(5\angle30°)$

$= 500\angle60°$

Here $\phi = 60°$

$\therefore$ Power factor $= \cos\phi$

$= \cos 60°$

$= 0.5$ (lag)

92. Ans: (b)

Sol: $S_{AC} = 0.9 \times 1\ k\Omega/V$

$= 0.9\ k\Omega/V$

$= 900\ \Omega/V$

93. Ans: (a)

94. Ans: (b)

95. Ans: (a)

Sol: **Error:** Error is defined as the difference between the measured value and true value.

Resolution: The smallest change in measured value to which the instrument will respond is called resolution.

Sensitivity: Sensitivity of an instrument is defined as the ratio of magnitude of the output signal or response to the magnitude of input signal or response of the quantity being measured.

96. Ans: (a)

Sol: Meter constant to given data

$K = \frac{40\times60\times60}{5\times60} = 480$ rev/kWh

But it is given that meter constant is 500.

Therefore % error in meter constant

$= \frac{480-500}{500}\times100$

$= -4\%$

97. Ans: (d)

Sol: Thermocouple voltmeter measures true rms voltage

$V_{rms\,(true)} = \sqrt{1^2 + \left(\frac{2}{\sqrt{2}}\right)^2}\ V$

$= \sqrt{3}\ V$

98. Ans: (c)

Sol: Schering Bridge is used for measurement of capacitance, Dielectric loss, D-factor.

99. Ans: (a)

Sol: $\frac{2dT_i}{dt} + T_i = T_a$

Apply Laplace transform on both sides

$\frac{T_i(s)}{T_a(s)} = \frac{1}{2S+1}$

$$\frac{T_i(s)}{T_a(s)} = \frac{0.5}{S+0.5}$$

$\omega_c = 0.5$

$$f_c = \frac{1}{4\pi}\text{Hz}$$

100. Ans: (a)

Sol. $f_{new} = \dfrac{f_{old}}{2}$ $\quad\quad\because \text{Cable length} \propto \dfrac{1}{f}$

101. Ans: (b)

Sol: $T_{sweep} = 2 \times T_{signal}$ (since 2 cycles displayed)

$$= 2 \times \frac{1}{100\,\text{Hz}} = 2 \times 10 \text{ ms}$$

$$= 20 \text{ ms}$$

102. Ans: (b)

Sol: If P is the power, I current and R resistance, then $I = \sqrt{\dfrac{P}{R}} = \sqrt{\dfrac{4}{10000}} = 0.02\text{A}$

So, voltage across R is $10000 \times 0.02 = 200$V

Sensitivity = 200/50 = 4.0V/mm.

103. Ans: (a)

Sol: For all positive values of 'K' roots are left side of s-plane.

104. Ans: (c)

Sol: $GM = \dfrac{1}{0.4} = 2.5$

PM = 180° – 30° = 150°.

105. Ans: (b)

Sol: For option (a) Break point is – 6 and $\sigma = -6$

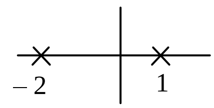
For option (b) Break point is – 4 and $\sigma = -4$

[BP = $\sigma = -4$]

For option (c) & (d) Break point & Centroid are not same.

106. Ans: (c)

Sol: $G(s) = \dfrac{10}{(s-1)(s+2)}$



So, G(s) is unstable

$$\frac{C(s)}{R(s)} = \frac{G(s)}{1+G(s)} = \frac{10}{(s-1)(s+2)+10}$$

$$= \frac{10}{s^2-2+2s-s+10}$$

$$= \frac{10}{s^2+s+8}$$

C.E = $s^2 + s + 8 = 0$

s^2	1	8
s^1	1	0
s^0	8	

There is no sign changes in the first column of RH criteria table. Therefore the closed loop $\dfrac{C(s)}{R(s)}$ is stable

107. Ans: (d)

Sol: Let us assume, $G(s) = \dfrac{K}{s(s+a)}$

s = 0 and s = –a are open loop poles

Characteristics Equation is $s^2 + as + K = 0$

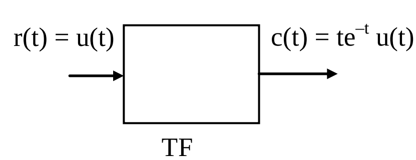
Roots of characteristics equation are

$$s_1, s_2 = \frac{-a}{2} \pm \sqrt{\left[\left(\frac{a}{2}\right)^2 - K\right]}$$

When K = 0, the roots are $s_1 = 0$ and $s_2 = -a$ .i.e., they coincides with the open loop poles of system.

108. Ans: (c)

Sol:



$$TF = \frac{L.T[\text{output}]}{L.T[\text{input}]}$$

$$= \frac{L.T[te^{-t}]}{L.T[u(t)]}$$

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

$$TF = \frac{s}{(s+1)^2}$$

109. Ans: (c)

Sol: $\text{Transfer Function} = \left.\frac{5}{s^2+s+5}\right|_{s=j\omega}$

$$= \frac{5}{-\omega^2+j\omega+5} = \frac{-5}{\omega^2-j\omega-5}$$

110. Ans: (d)

Sol: $|20\log 2\zeta| = \left|\left(20\log 2\frac{1}{8}\right)\right| = 12\text{ dB}$

111. Ans: (b)

Sol: Shifting the take off point before the block.

112. Ans: (c)

Sol: PI compensator is equivalent to adding the pole at origin.

113. Ans: (b)

Sol: By applying Mason's gain formula

$$\frac{C(s)}{R(s)} = \frac{K}{s^2(s+25)+KK_ts+K(1+0.02s)}$$

$R(s) = \frac{1}{s}$ (step input)

$$C(s) = \frac{K}{s\left(s^2(s+25)+KK_ts+K(1+0.02s)\right)}$$

$$C(\infty) = \lim_{s\to 0} sC(s)$$

$$= \lim_{s\to 0} s\frac{K}{s\left(s^2(s+25)+KK_ts+K(1+0.02s)\right)}$$

$$= 1$$

114. Ans: (c)

Sol: $k = 0.8$

Power transferred inductively from primary to secondary

= (1 – k) times of total load

= (1 – 0.8) ×10 kW = 2 kW

115. Ans: (c)

Sol: Core losses = 150 W (Constant)

Copper loss at full load = 220 W

∴ Copper loss at halt full load

$$= \left(\frac{1}{2}\right)^2 220\text{W} = 55\text{ W}$$

∴ Total losses at half full load

= 150 + 55

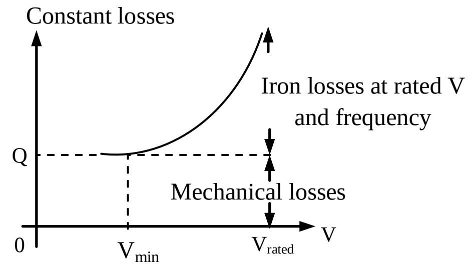
= 205 W

Efficiency at half full load

$$= \frac{\frac{1}{2}\times 10^3\times 1}{\frac{1}{2}\times 10\times 10^3+205}\times 100 = 96.06\%$$

116. Ans: (b)

Sol:



The intersection 'Q' of the extrapolated curve on the Y-axis will give mechanical losses (friction and windage loss)

117. Ans: (b)

Sol: Induction motor is a constant flux machine. As statement 3 is false, option (b) is correct answer.

118. Ans: (d)

Sol: Speed $\propto N_s = \frac{120f}{P}$ as f ↓, speed ↓

Motor output = Torque × speed
But torque = constant
So motor output decreases as speed decreases

$$T_{max} \propto \frac{1}{X}\left(X \downarrow \text{as } f \downarrow\right)$$

So $T_{max} \uparrow$

119. Ans: (c)

Sol: For cylindrical motor synchronous machine

$$P = \frac{EV}{X}\sin\delta$$

$$\frac{P_1}{P_2} = \frac{\sin\delta_1}{\sin\delta_2}$$

$$\frac{P}{2P} = \frac{\sin 30°}{\sin\delta_2}$$

$$\sin\delta_2 = 1 \Rightarrow \delta_2 = 90°$$

120. Ans: (b)

Sol: $E = \frac{\phi ZN}{60}\left(\frac{P}{A}\right) = \frac{1.5\times10^{-3}\times55\times19\times1500}{60}\left(\frac{4}{2}\right)$

= 78.375 V

121. Ans: (d)

Sol: **Given data,** V = 250 V, N_1 = 900 rpm, I_a = 30 A, R_a = 0.4 Ω, I_{a2} = 20 A and N_2 = 600 rpm

$$\frac{E_{b1}}{E_{b2}} = \frac{N_1}{N_2}$$

$$\Rightarrow \frac{V - I_{a1}R_a}{V - I_{a2}(R_a + R_{se})} = \frac{900}{600}$$

$$\Rightarrow \frac{250-(30\times0.4)}{250-20(0.4+R_{se})} = \frac{900}{600}$$

$\Rightarrow 20(0.4 + R_{se}) = 250 - 158.6$

$\Rightarrow R_{se} = 4.17\ \Omega$

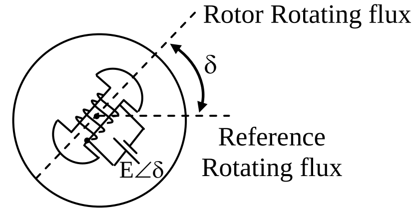
122. Ans: (b)

Sol: **Load angle/torque angle:**

It is the angle between the internal induced emf and the terminal voltage.

Or,

It is the angle between rotor rotating flux and reference rotating flux.



123. Ans: (a)

Sol: If first octet number of is between

1	-	126	-	Class A
128	-	191	-	Class B
192	-	223	-	Class C
224	-	239	-	Class D
240	-	255	-	Class E

124. Ans: (c)

Sol: In RSA, decryption is performed under modulo n (RSA modulus). If x's value is taken more than n then correctness of decryption will not be maintained.

125. Ans: (d)

126. Ans: (c)

Sol: In Selective Repeat protocol

Senders window size
= Receivers window size

SWS + RWS = 2^n

Then maximum window size

$$= 2^n/2 = 2^4/2 = 2^3$$

127. Ans: (b)

Sol: HLEN = 8 words = (8 × 4) Bytes
TL = 308 Bytes
Payload size = (308 – 8 × 4) Bytes
= 276 Bytes
Payload size is not multiple of 8, definitely it is last fragment (M = 0).
276 Bytes and M = 0

128. Ans: (d)

Sol: HDL: Hardware Description Language
EDA: Electronic Design Automation
SPLD: Simple Programmable Logic Device
RTL: Register Transfer Level

129. Ans: (b)

Sol: → Oxides used for masking are usually grown by wet oxidation.
→ A typical growth cycle consists of a sequence of dry-wet-dry oxidations. Most of the growth in such a sequence occurs in the wet phase, since growth rate is much higher.

130. Ans: (d)

Sol: → To generate a stuck-at-fault at a node, the node must be both 0 & 1 controllable
→ To propagate a stuck-at-fault at a node, that node must be observable.
→ Sequential circuits have poor controllability and observability, as it requires a sequence of input vectors to control and observe a signal value at majority of the nodes.

131. Ans: (c)

Sol: For unipolar return-to-zero transmissions, the maximum data transmission rate in bits per second (bps) is expressed as

$$f_{b(bps)} = \frac{1}{\Delta t \times L} = \frac{1}{5ns/km \times 10km} = 20Mbps$$

132. Ans: (c)

133. Ans: (a)

Sol: Because there is no limitation on the bandwidth, CDMA is sometimes referred to as spread spectrum multiple access.

134. Ans: (b)

135. Ans: (a)

Sol: MMU is a hardware device which maps virtual address to physical address. Mapping is done by adding the value in the base register to every address generated by a user process, it is treated as offset at the time it is sent to memory.

136. Ans: (c)

Sol: Armature core is laminated to reduce eddy current loss to lower value.

137. Ans: (b)

Sol: $E = 4.44\ K_p . K_d\ \phi_{/pole}.f.T_{/phase}$

$\Rightarrow$ airgap flux $(\phi) \propto \frac{E}{f} \propto \frac{V}{f}$

As V, f are constants

$\Rightarrow \phi_{airgap}$ is constant.

138. Ans: (a)

Sol: Nyquist stability criteria states that (–1, j0) critical point should be encircled in the counter clock wise direction as many number of times as the number of right half of s-plane poles of loop transfer function.
Nyquist contour encircles the right half of s-plane and drawn in the clockwise direction.
Both statements are correct. Statement (II) is correct explanation for statement (I).

139. Ans: (a)

140. Ans: (d)

141. Ans: (a)

Sol: Diode is a nonlinear and unilateral device. Hence, Thevenin's theorem cannot be applied. Both Statement I and Statement II are true and Statement II is the correct explanation of Statement I.

142. Ans: (a)

Sol: The Curie temperature is the critical point where a material's intrinsic magnetic moments change direction. Magnetic moments are permanent dipole moments within the atom which originate from electrons angular momentum and spin. Materials have different structures of intrinsic magnetic moments that depend on temperature. At a material's Curie Temperature those intrinsic magnetic moments change direction.

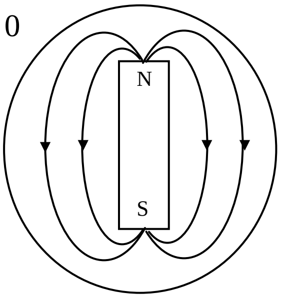
143. Ans: (d)

Sol: Resistance inversely proportional to the area of cross section of the wires, so the thicker wire has low resistance. Since heat produced is directly related to resistance ($H = i^2R_t$), it should be less in the thicker wire.

144. Ans: (d)

Sol: **Statement I** is incorrect as

$\int_S \bar{B} \,.\, ds \neq 0$



Maxwell equation: $\oint B.ds = 0$

i.e., net flux leaving closed surface is zero.

When surface is open

$\int B.ds = \psi_m \rightarrow$ weber

Statement II is correct as

Tubes of magnetic flux have no source (or) sink i.e. monopoles do not exist in case of magnetic field.

145. Ans: (c)

Sol: Aliasing occurs when the sampling frequency is less than twice the maximum frequency in the signal. So, Statement-I is true.

Aliasing is a irreversible process. So, Statement-II is false.

146. Ans: (a)

147. Ans: (d)

Sol: Quantization error depends on the step size only.

148. Ans: (b)

149. Ans: (d)

150. Ans: (b)

Sol: Both are correct, but statement II is not the reason for statement I.

- In both PAL & PLAs outputs of OR gates are directly connected to output pins of the chip.

  This kind of configuration will limit us to use PAL (or) PLA for only combinational circuit design, as there are no flipflops. To design a sequential circuit, we must add the flipflops externally to the chip.