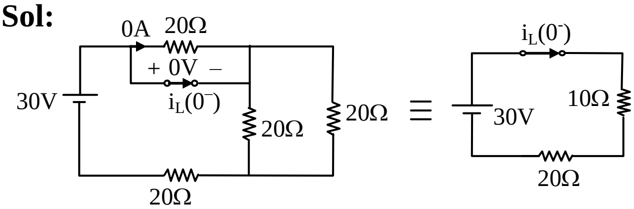
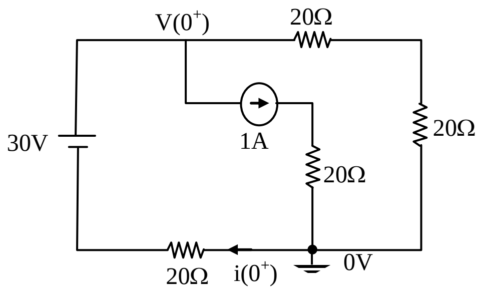
Branch: Instrumentation Engineering - SOLUTIONS

01. Ans: (C)

Sol:



So, $i_L(0^-) = \frac{30}{30} = 1A = i_L(0^+)$



Nodal: $\frac{V_L(0^+) - 30}{20} + 1 + \frac{V_L(0^+)}{40}$

$= 0 \Rightarrow V_L(0^+) = \frac{20}{3} V$

So, $i(0^+) = \frac{30 - V_L(0^+)}{20} = \frac{7}{6} A$

02. Ans: – 3.33 (Range –3 to –4)

Sol: $A_V \approx - g_m R_D$

$$g_m = \sqrt{2 I_D \mu_n C_{ox}\left(\frac{W}{L}\right)} = \frac{1}{300}$$

$A_V = -3.33$

03. Ans: 4

Sol: $G(s) = \frac{\left(1+\frac{s}{2}\right)2}{\left(1+\frac{s}{8}\right)8} = \left(\frac{1}{4}\right)\frac{\left(1+\frac{s}{2}\right)}{\left(1+\frac{s}{8}\right)}$

But $G(s) = \frac{1+s\tau}{1+\alpha s\tau}$

By comparing $\tau = \frac{1}{2}$

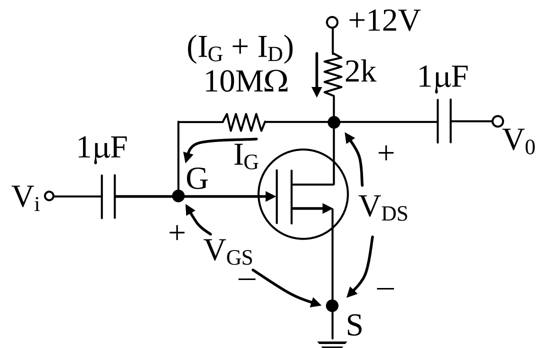
$\alpha\tau = \frac{1}{8} \Rightarrow \alpha = \frac{1}{4}$

$\omega_m = \frac{1}{\tau\sqrt{\alpha}} = \frac{1}{\frac{1}{2}\sqrt{\frac{1}{4}}}$

$= 4$ rad/sec

04. Ans: (a)

Sol:



Step (1): Consider $k = \frac{I_{D(ON)}}{[V_{GS(ON)} - V_{Th}]^2}$

$$= \frac{6\text{mA}}{(8V - 3V)^2} = 0.24\text{mA}/V^2 \;\_\_(1)$$

Step (2): $I_D = k\,(V_{GS} - V_{Th})^2$ ____(2)

$$= (0.24\text{mA}/V^2)[6.4V - 3V]^2 \;\_\_\_\_(3)$$

$$\therefore\; I_{D_Q} = 2.7744\text{mA} \;\_\_\_\_(4)$$

Step (3): KVL for output section

$$V_{DS} = 12V - (I_D + I_G)\,2k = 0 \;\_\_\_\_(5)$$

$$= 12V - I_D \times 2k \;\_\_\_\_(6)\; (\because I_G = 0)$$

$$\therefore\; V_{DS_Q} = 6.45\text{ V} \;\_\_\_\_(7)$$

05. Ans: (c)

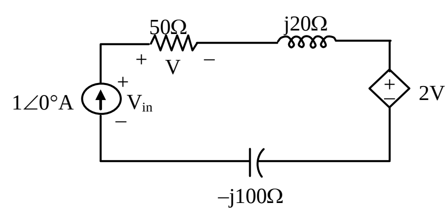
Sol: Electronic voltmeters offer very high input impedance than non-electronic voltmeters because of existence of solid state electronic device at i/p side.

06. Ans: 170 (range: 169 to 171)

Sol: $2\text{mH} \rightarrow j\omega L = j\,(10 \times 10^3)\,(2\times 10^{-3}) = j20$

$$1\mu F \rightarrow \frac{1}{j\omega C} = \frac{1}{j(10\times10^3)(1\times10^{-6})}$$

$$= -j100$$



$V = (1\angle 0^\circ)\,(50) = 50$

$V_{in} = (1\angle 0^\circ)\,(50 + j20 - j100) + (2)\,(50)$

$V_{in} = 50 - j80 + 100 = 150 - j80$

$$Z_{in} = \frac{V_{in}}{1\angle 0^\circ} = 150 - j80\Omega$$

$$= 170\Omega$$

07. Ans: (b)

Sol: The L.T of periodic signal x(t), with period 'T' is

$$X(s) = \frac{1}{1-e^{-sT}}\int_0^T x(t)e^{-st}dt$$

08. Ans: 2.585 (2.3 to 2.8)

Sol: Here monostable multivibrator is implemented with 555 timer,

pulse width = 1.1RC

$= 1.1 \times 4.7K \times 0.5\mu$

$= 2.585ms$

09. Ans: (c)

Sol: $G(s) = \frac{k(s+2)(s+3)}{(s+1)(s+4)}$

$$CLTF = \left.\frac{G(s)}{1+G(s)}\right|_{k=1} = \frac{(s+2)(s+3)}{(s+1)(s+4)+(s+2)(s+3)}$$

10. Ans: 2.12 (Range: 2 to 2.3)

Sol: $\frac{d\phi}{ds} = \hat{a}.\text{grad}\,\phi$

$\phi = 2y + z$

$\hat{a} = \hat{j} + \hat{k}$

$$\hat{a} = \frac{\bar{a}}{|\bar{a}|} = \frac{j+k}{\sqrt{1^2+2^2}} = \frac{j+k}{\sqrt{2}}$$

$$\text{grad}\,\phi = \nabla\phi = \left(i\frac{\partial}{\partial x} + j\frac{\partial}{\partial y} + k\frac{\partial}{\partial z}\right)(2y+z)$$

$$= j(2y) + k(z)$$

$$\frac{d\phi}{ds} = \frac{(j+k)}{\sqrt{2}}\left\{2y\,\hat{j} + \hat{k}\,z\right\} = 2\hat{j} + \hat{k}$$

$$= \frac{\hat{j}+\hat{k}}{\sqrt{2}}\left(2\hat{j}+\hat{k}\right) = \frac{3}{\sqrt{2}}$$

$= 2.12$

11. Ans: (b)

Sol: $f(A,B,C,D) = A + B\overline{C} + AB\overline{D} + ABCD$

$$= A\overline{B}\,\overline{C}\,\overline{D} + A\overline{B}\,\overline{C}D + A\overline{B}C\overline{D} + A\overline{B}CD$$
$$+ AB\overline{C}\,\overline{D} + AB\overline{C}D + ABC\overline{D} + ABCD$$
$$+ \overline{A}B\overline{C}\,\overline{D} + \overline{A}\,B\overline{C}D + AB\overline{C}\,\overline{D} + AB\overline{C}D$$
$$+ AB\overline{C}\,\overline{D} + ABC\overline{D} + ABCD$$

$$= \sum m(4,5,8,9,10,11,12,13,14,15)$$

$$= \prod M(0,1,2,3,6,7)$$

12. Ans: (b)

Sol: For $t \geq 0^+$; KVL gives

$$E = \frac{1}{C}\int_{0^-}^{t} i(t)\,dt + (E/2)$$

Laplace transforming, $\frac{1}{Cs}I(s) + \frac{E}{2}\frac{1}{s} = E\frac{1}{s}$;

from which $I(s) = \frac{CE}{2}$

Hence $i(t) = \frac{CE}{2}\delta(t)$ A.

13. Ans: (c)

Sol: $\beta_1 = 2 \quad f_{m_1} = 1\,kHz$

$\beta_2 = 4 \quad f_{m_2} = 10\,kHz$

$\beta_3 = 5 \quad f_{m_3} = 20\,kHz$

$\Delta f = \beta_1 f_{m_1} + \beta_2 f_{m_2} + \beta_3 f_{m_3}$

$= 2\,kHz + 40\,kHz + 100\,kHz = 142\ kHz$

14. Ans: (b)

Sol: A thermocouple pair (A,B), the extension wires (C,D) should have identical temperature-emf relationship.

15. Ans: 1.22 (No range)

Sol: $\frac{dy}{dx} = y + x$

$x_0 = 0, y_0 = 1$

$x_1 = x_0 + h = 0.1$

$x_2 = x_0 + 2h = 0.2$

$y_1 = y_0 + h f(x_0, y_0) = 1 + (0.1)(1+0)$

$= 1.1$

$y_2 = y_1 + h f(x_1, y_1)$

$= 1.1 + 0.1 [0.1 + 1.1]$

$= 1.1 + 0.12$

$= 1.22$

16. Ans: (a)

Sol: $X(s) = \frac{2s e^{-2s}}{s^2 + 4s + 3}$

Assume $X_1(s) = \frac{2s}{s^2 + 4s + 3} = \frac{2s}{(s+1)(s+3)}$

$= \frac{-1}{s+1} + \frac{3}{s+3}$

Apply ILT

$x_1(t) = -e^{-t}u(t) + 3e^{-3t}u(t)$

$X(s) = e^{-2s}.X_1(s)$

Apply ILT

$x(t) = x_1(t-2)$

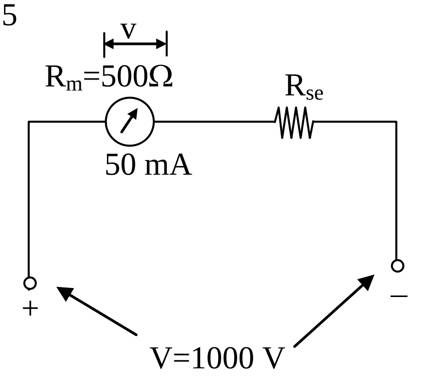
$x(t) = -e^{-(t-2)}u(t-2) + 3e^{-3(t-2)}u(t-2)$

17. Ans: (a)

Sol: Differential arrangement for a capacitance transducer is preferred, because it reduces non-linearity.

18. Ans: 19.5

Sol:



$R_{se} = R_m (m-1)$

$m = \frac{V}{v} = \frac{1000}{500 \times 50 \times 10^{-3}} = 40$

$R_{se} = 500 (40-1)$

$= 500 \times 39$

$= 19500\ \Omega$

$R_{se} = 19.5\ K\Omega$

19. Ans: (b)

Sol: Let X = Amount the player wins in rupees
The probability distribution for X is given below.

Number of heads	0	1	2
X	x	1	3
P(X)	$\frac{1}{4}$	$\frac{2}{4}$	$\frac{1}{4}$

For the game to be fair we have to find x, so that E(X) = 0

$\Rightarrow x.\left(\frac{1}{4}\right) + 1.\left(\frac{2}{4}\right) + 3.\left(\frac{1}{4}\right) = 0$

$\Rightarrow x = -5$

$\therefore$ Number of rupees, the player has to lose if no head occur = 5.

20. Ans: 6.2 (no range)

Sol: $V_{out} = 0.4V$ for input $(00010)_2 = (2)_{10}$

Step size $= \frac{0.4}{2} = 0.2$

V_{out} for input $(11111)_2 = 0.2 \times 31_{10} = 6.2V$

21. Ans: 4 No range

Sol: The constant term in the characteristic equation of a matrix is equal to the determinant of a matrix

$\therefore \det(A) = 4$

22. Ans: (d)

Sol: Frequency deviation $= \frac{f_{max} - f_{min}}{2}$

$f_{max} = 100\ 01$ MHz

$f_{min} = 99.97$ MHz

$= \left(\frac{100.01-99.97}{2}\right)$MHZ

$= 0.02\times10^6$

$= 20$ kHz

23. Ans: 2.83 (2.80 to 2.85)

Sol: $R_\chi = \frac{R_2R_3}{R_1} = \frac{800\times1200}{1500} = 640\Omega$

$L_\chi = R_2C_1R_3$

$= 800 \times 0.15 \times 10^{-6} \times 1200$

$L_\chi = 0.144$ H

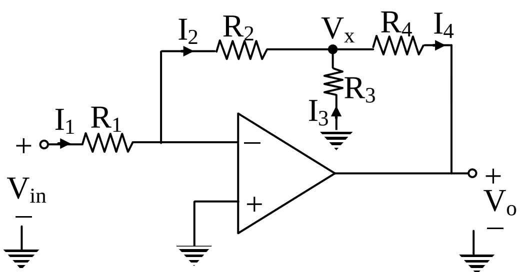
Q factor $= \frac{\omega L_\chi}{R_\chi}$

$= \frac{2\pi\times2\times10^3\times0.144}{640}$

$= 2.83$

24. Ans: (a)

Sol:



$V^- = V^+ = 0$ [∵ Virtual ground]

$I_1 = \frac{V_{in}}{R_1}$ ________(1)

$I_1 = I_2$ [∵ current entering into the inverting terminal is zero]

$I_2 + I_3 = I_4$ _______(2) and

$V_x = 0 - I_2R_2 = -\frac{R_2}{R_1}V_{in}$ _______(3)

$\frac{V_{in}}{R_1} + \frac{0-V_x}{R_3} = \frac{V_x - V_0}{R_4}$ ________(4)

Solving (3) and (4), we get

$\frac{V_0}{V_{in}} = -\frac{R_2}{R_1}\left[1+\frac{R_4}{R_2}+\frac{R_4}{R_3}\right]$

25. Ans: 24 No range

Sol: Given that F(x) = f(g(x))

$\Rightarrow F^1(x) = f^1(g(x)).\ g^1(x)$ (∵ by chain rule)

$\Rightarrow F^1(5) = f^1(g(5)).\ g^1(5)$

$\Rightarrow F^1(5) = f^1(-2)\ .6$

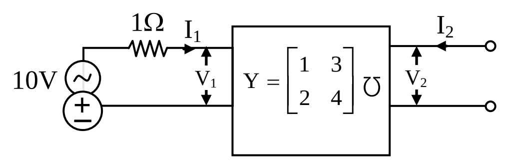
$\therefore F^1(5) = (4)\ (6) = 24$

26. Ans: 25 (range:25 to 25)

Sol: Maximum power transferred to load resistance R_L is

$= \frac{V_{Th}^2}{4R_{Th}}$

Calculation of V_{Th}: (open the load resistance)



From Y-parameters

$I_1 = V_1 + 3V_2$ ………..(1)

$I_2 = 2V_1 + 4V_2$ ………..(2)

But $I_2 = 0$, so $-2V_1 = 4V_2$

$V_1 = -2V_2$ ……...(3)

And $I_1 = 10 - V_1$

From(1), $10 - V_1 = V_1 + 3V_2$

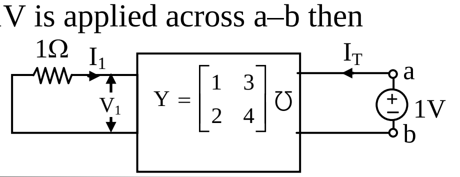
$10 - 2V_1 = 3V_2$

From(3), $10 - 2(-2V_2) = 3V_2$

$V_2 = -10V$

Calculation of R_{Th}: (deactivate all independent sources)

if 1V is applied across a–b then



$I_2 = I_T$

$V_2 = 1V$

From (1) & (2)

$I_1 = V_1 + 3(1)$ ……...(4)

$I_T = 2V_1 + 4(1)$ ………(5)

But $V_1 = -I_1$, $I_1 = -V_1$

$-V_1 = V_1 + 3$

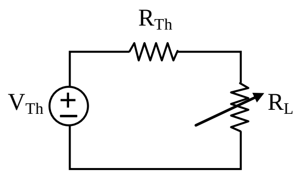
$V_1 = \frac{-3}{2}$

From (5) $I_T = 2\left(\frac{-3}{2}\right) + 4$

$I_T = 1$

$R_{Th} = \frac{1}{I_T} = 1\Omega$

∴



$$P_{max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{100}{4\times1} = 25\,W$$

27. Ans: 175 (172 to 179)

Sol: at $10^oC \rightarrow$

$$R_{T1} = R_o e^{\beta\left(\frac{1}{T}-\frac{1}{T_o}\right)}$$

$$= 10k\Omega\, e^{3500\left(\frac{1}{10+273}-\frac{1}{25+273}\right)}$$

$R_{T1} = 18.64\ k\Omega$

At 20^oC

$$R_{T2} = R_o\, e^{\beta\left(\frac{1}{T_2}-\frac{1}{T_o}\right)}$$

$$10k\Omega \times e^{3500\left(\frac{1}{20+273}-\frac{1}{25+273}\right)}$$

$R_{T2} = 12.22\ k\Omega$

$$V_{T1} = \frac{18.64k}{18.64k+10k}\times5 = 3.25V$$

$$V_{T2} = \frac{12.22k}{12.22k+10k}\times5 = 2.75V$$

$$\frac{\Delta V}{\Delta T} = \frac{V_{T2}-V_{T1}}{T_2-T_1} = \frac{2.75-3.25}{20-10}$$

$$= -50\left(\frac{mV}{^oC}\right)$$

$$V_{out} = -50\left(\frac{mV}{^oC}\right)\times\left(1+\frac{25k}{10k}\right)$$

$$V_{out} = -175\left(\frac{mV}{^oC}\right)$$

28. Ans: (a)

Sol: $$\frac{E(s)}{R(s)} = \frac{1\left\{1-\left\{\frac{2}{3}-\frac{3}{2}\right\}+\left\{\frac{2}{3}\times\frac{-3}{2}\right\}\right\}}{1-\left\{\frac{2}{3}-\frac{3}{2}-3\right\}+\left\{\frac{2}{3}\times\frac{-3}{2}\right\}}$$

$$= \frac{1\left\{1-\frac{2}{3}+\frac{3}{2}-2\times3\times\frac{1}{2}\times\frac{1}{3}\right\}}{1-\frac{2}{3}+\frac{3}{2}+3-2\times3\times\frac{1}{2}\times\frac{1}{3}}$$

$$= \frac{1+\frac{5}{6}-1}{1+\frac{5}{6}+3-1}$$

$$\frac{E(s)}{R(s)} = \frac{5}{23}$$

29. Ans: (b)

Sol: line equation of AB is,

Here A = (1, 1) B = (3, 2)

$$y-1 = \frac{1}{2}(x-1) \Rightarrow y = \frac{x+1}{2}$$

$$dy = \frac{dx}{2}$$

$$\therefore \int_C \text{Re } z\ dz = \int_1^3 x(dx + i dy)$$

$$= \int_1^3 x\left(dx + i\frac{dx}{2}\right) = \left(1+\frac{i}{2}\right)\left[\frac{x^2}{2}\right]_1^3$$

$= 4 + 2i$

30. Ans: (C)

Sol: $s\,\omega(s) = -\omega(s) + i_a(s)$

$\Rightarrow \omega(s)\,[s+1] = i_a(s) \Rightarrow \omega(s) = \frac{i_a(s)}{s+1}$ …. (1)

$s\,i_a(s) = -\omega(s) - 10\,i_a(s) + 10\,U(s)$

$i_a(s)\,[s+10] + \omega(s) = 10\,U(s)$

$i_a(s)\left[s+10+\frac{1}{s+1}\right] = 10\,U(s)$ [∵ eq (1)]

$$\Rightarrow \frac{i_a(s)}{U(s)} = \frac{10(s+1)}{s^2+11s+11}$$

31. Ans: (c)

Sol: $\frac{I}{P} = \frac{\eta e\lambda}{hc}$

η= quantum efficiency =0.65

λ= wavelength =900nm

P= power =0.5μW

I= unknown current in A

e= 1.6×10^{-19}C

c=3×10^{8}(m/sec)

h= 6.624×10^{-34} (Js)

$$I = \frac{0.5\times10^{-6}\times0.65\times1.6\times10^{-19}\times900\times10^{-9}}{6.624\times10^{-34}\times3\times10^{8}}$$

I= 0.2355 (μA)

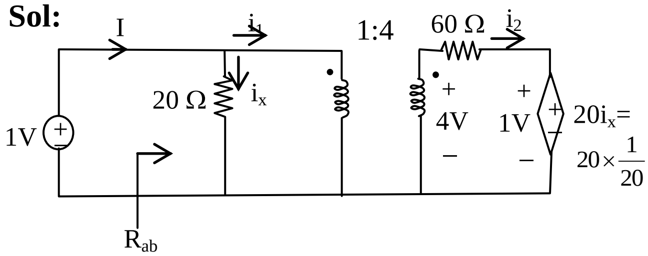
Multiplication factor

$$m = \frac{10\times10^{-6}}{I} = \frac{10\times10^{-6}}{0.236\times10^{-6}}$$

$m = 42.373 \cong 43$

32.Ans: (C)

Sol:



i_x=1/20

$$i_2 = \frac{4-1}{60} = \frac{3}{60} = \frac{1}{20}$$

$$\frac{i_1}{i_2} = 4 \Rightarrow i_1 = \frac{4}{20}$$

$$I = \frac{1}{20} + \frac{4}{20} = \frac{1}{4}$$

R_{ab}= 4 Ω

33. Ans: (d)

Sol: $h(n) = 2^n u(n) - \left(\frac{1}{2}\right)^n u(-n-1)$

ROC1 is $|z| > 2$ ROC2 is $|z| < \frac{1}{2}$

R.O.C. of H(z) = R = $R_1 \cap R_2$ = { } = ϕ

∵ There is no R.O.C. of H(z)

∴ H(z) does not exist.

34. Ans: 25.06 (Range 24.5 to 25.5)

Sol: W = 4.5 kHz

NR = 2W = 9kHz

SR = 2 (N. R) = 2×9 kHz

= 18 k samples / sec

L = number of quantization levels = 128

Number of bits n = $\log_2 L = \log_2 128 = 7$

SNR (dB) = 10 $\log_{10}$ SNR

SNR ⇒ $10^{15/10}$

SNR = 31.62

R_b = bit rate = nf_s

= n×(SR)

$= 7 \times 18000$

$= 126000$ bps

$R_b = 126$ kbps

Shannon Hartley law

$C = B \log_2 (1 + S/N)$

B = transmission bandwidth of channel

For error free transmission of messages

$C \geq R_b$

$B\log_2 (1+S/N) \geq 126$ kbps

$$B \geq \frac{126\text{kbps}}{\log_2(1+S/N)} \Rightarrow B \geq 25.06 \text{ kHz}$$

$B_{min} = 25.06$ kHz

35. Ans: (a)

Sol: $J_1 = X$, $K_1 = \overline{X}$

from the truth table of JK flip-flop

J	K	Q_{n+1}
0	0	Q_n
0	1	0
1	0	1
1	1	$\overline{Q}_n$

When X = 0 $J_1 = 0$, $K_1 = 1$ $Q_{n+1} = 0 = X$

When X = 1 $J_1 = 1$, $K_1 = 0$ $Q_{n+1} = 1 = X$

X	Q_1	Q_2	Q_3	Z
0	0	0	0	0
1	1	1	1	1

Finally Z = X, the given circuit is a shift register.

36. Ans: 71.56 (70 to 73)

Sol:

$$\frac{30\angle 0 + \overline{V}_{NS}}{-j30} + \frac{30\angle -120^0 + \overline{V}_{NS}}{30} + \frac{30\angle 120^0 + \overline{V}_{NS}}{30} = 0$$

$$\overline{V}_{NS}\left[\frac{1}{15} + j\frac{1}{30}\right] = -30\left[1\angle -120^0 + 1\angle 120^0 + j1\right]$$

$$= -30\left[-1\angle 0 + j1\right] = 1 - j1$$

$$\overline{V}_{NS} = \frac{30(1-j1)}{\frac{1}{15} + j\frac{1}{30}} \quad \angle\overline{V}_{NS} = -45^0 - \tan^{-1}\frac{1}{2} = 71.56^0$$

37. Ans: 70 (No range)

Sol: $X(e^{j\omega}) = e^{6j\omega} - 3e^{-j2\omega} + 5e^{j\omega} + 5 - 2e^{-j6\omega} - 3e^{-j4\omega}$

Apply IDTFT

$$x(n) = \{1, 0, 0, 0, 0, 5, \underset{\uparrow}{5}, 0, -3, 0, -3, 0, -2\}$$

$x(4) = -3$;

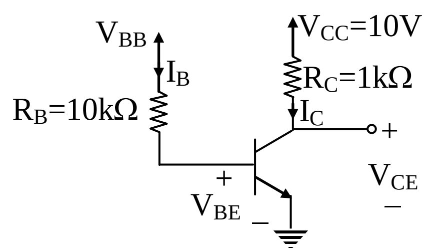
$$\sum_{n=-\infty}^{\infty} |x(n)|^2 = 1 + 25 + 25 + 9 + 9 + 4$$

$$= 50 + 18 + 5 = 73$$

$$x(4) + \sum_{n=-\infty}^{\infty} |x(n)|^2 = -3 + 73 = 70$$

38. Ans: (d)

Sol:



i) Operating at the edge of saturation is obtained with $V_{CE} = 0.3$V. Thus

$$I_C = \frac{10 - 0.3}{1k\Omega} = 9.7\text{mA}$$

Since, at the edge of saturation, I_C and I_B are still related by β,

$$I_B = \frac{9.7\text{mA}}{50} = 0.194\text{mA}$$

$V_{BB} = (0.194 \times 10) + 0.7 = 2.64$V

ii) To operate deep in saturation,

$V_{CE} = V_{CEsat} \approx 0.2$V

$$I_C = \frac{10 - 0.2}{1k\Omega} = 9.8\text{mA}$$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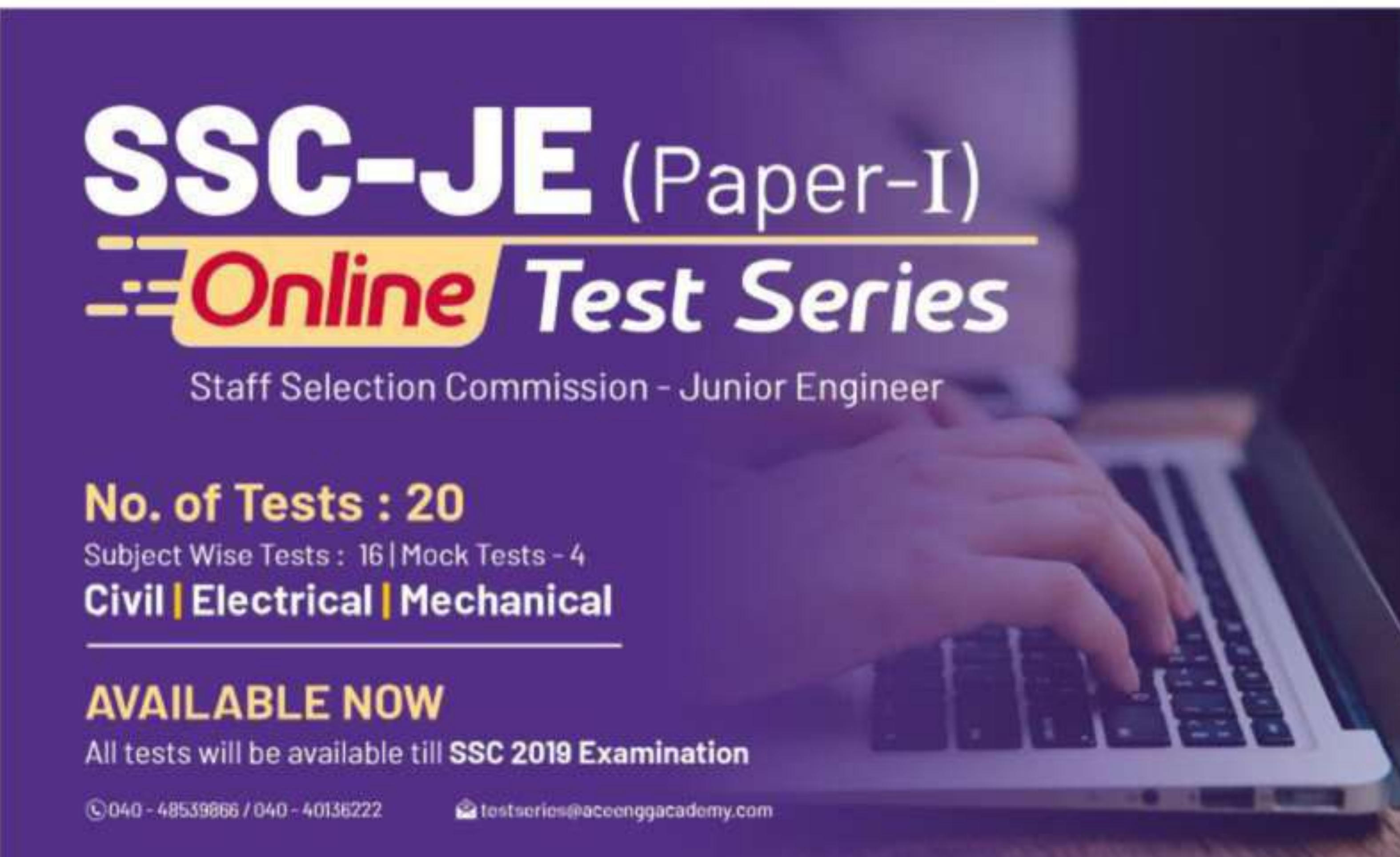
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$$I_B = \frac{I_C}{\beta_{forced}} = \frac{9.8}{10} = 0.98mA$$

$V_{BB} = (0.98 \times 10) + 0.7 = 10.5V$

39. Ans: (a)

Sol:

ABC	D = 0	D = 1	
000	(0)	(1)	$= 1 = I_0$
001	(2)	(3)	$= 1 = I_1$
010	(4)	5	$= \overline{D} = I_2$
011	6	7	$= 0 = I_3$
100	8	9	$= 0 = I_4$
101	(10)	(11)	$= 1 = I_5$
110	12	13	$= 0 = I_6$
111	(14)	(15)	$= 1 = I_7$

40. Ans: 0.75 (No range)

Sol: From the given circuit

$\rightarrow V_C = 2V$

$$I_C = \frac{10 - V_C}{R_{C1}}$$

$$R_{C1} = \frac{10-2}{I_C} = \frac{8}{I_C}$$

$\rightarrow V_C = 4V$

$$I_C = \frac{10 - V_C}{R_{C2}}$$

$$R_{C2} = \frac{10-4}{I_C} = \frac{6}{I_C}$$

$$\frac{R_{C2}}{R_{C1}} = \frac{\frac{6}{I_C}}{\frac{8}{I_C}} = \frac{6}{8} = \frac{3}{4} = 0.75$$

41. Ans: (d)

Sol: $\rightarrow$ (A) = XXH ⊕ XXH = 00H

$\rightarrow$ (HL) = 4000H

$\rightarrow$ (SP) = 3000H

$\rightarrow$ (A) = 35 H

$\rightarrow$ (M) = (4000H) = 36H

$\rightarrow$ (A) = 35H = 0011 0101

(M) = 36H = 0011 0110

(A) = 6BH = 0110 1011

CY = 0, P = 0, AC = 0, Z = 0, S = 0

$\rightarrow$ Decimal Adjust Accumulator

06H is added to lower digit since it is > 9

(A) = 6BH = 0110 1011

= 06H = 0000 0110

(A) = 71H = 0111 0001

CY = 0, P = 1, AC = 1, Z = 0, S = 0

(PSW) = 0111 0001 0001 0100

= 7114H

42. Ans: (a)

Sol: Output voltage of electromagnetic transducer

$= BlV$

$= 1.1\times100\times10^{-3}\times50\times10^{-3} = 5.5(mV)$

op – amp output voltage

$$V_0 = \frac{e_0 \times 10^6 \times 100}{10^6 + (0.1\times10^6)} = \frac{e_0 100}{1+0.1} = \frac{e_0 \times 100}{1.1}$$

$$= 5.5\times10^{-3} \times \frac{100}{1.1} \Rightarrow V_0 = 0.5V$$

43. Ans: (c)

Sol: To obtain the loop gain, we break the positive feedback at the positive input terminal of the op-amp where the input impedance is infinite, apply an input voltage V_i, and find its output voltage, V_0

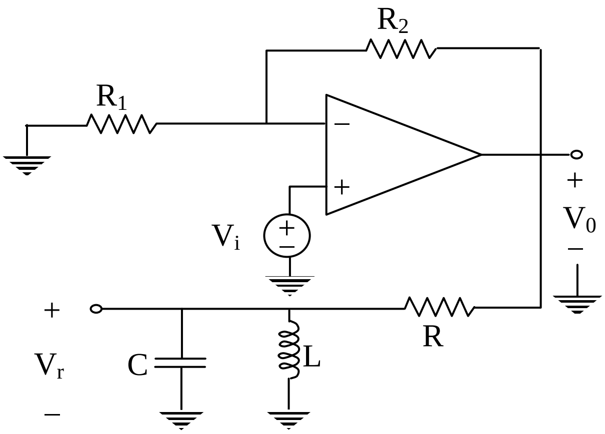


Fig. Breaking the feedback loop at the input of the op-amp

$$A(s) = \frac{V_0}{V_i} = 1 + \frac{R_2}{R_1}$$

$$\beta(s) = \frac{V_r}{V_0} = \frac{s\frac{1}{CR}}{s^2 + s\frac{1}{CR} + \frac{1}{LC}}$$

$$A(s)\beta(s) = \frac{s\frac{1}{CR}\left(1+\frac{R_2}{R_1}\right)}{s^2 + s\frac{1}{CR} + \frac{1}{LC}}$$

$$A(j\omega)\beta(j\omega) = \frac{j\frac{\omega}{CR}\left(1+\frac{R_2}{R_1}\right)}{\left(-\omega^2 + \frac{1}{LC}\right) + j\frac{\omega}{CR}}$$

From this expression, we see that the phase angle of $A(j\omega)\ \beta(j\omega)$ will be zero at the value of ω that makes the real part of denominator zero,

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

At this frequency, the magnitude of the loop gain is given by

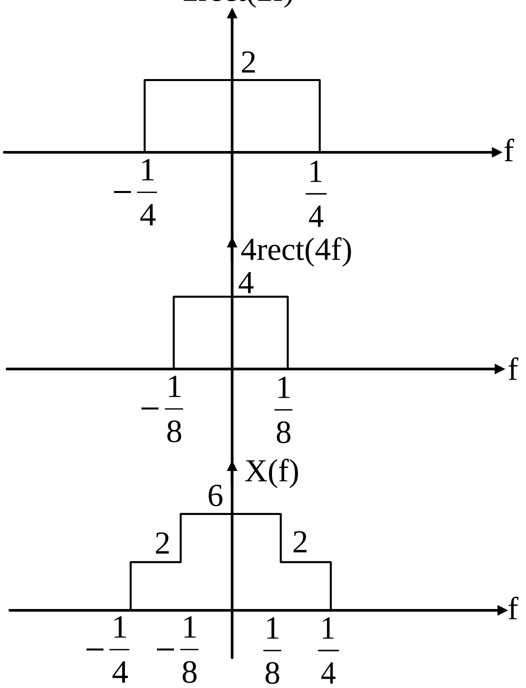
$$|A(j\omega_0)\beta(j\omega_0)| = 1 + \frac{R_2}{R_1} = 1 + \frac{10k}{1k} = 11$$

44. Ans: 1

Sol: $\text{Sinc}(t) \leftrightarrow \text{rect}(f)$

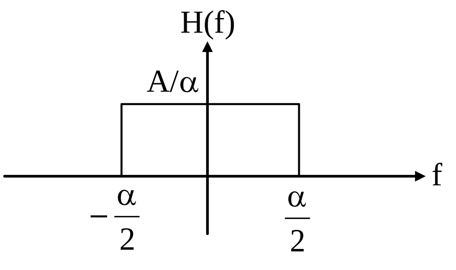
$\text{Sinc}(t/2) \leftrightarrow 2\ \text{rect}(2f)$

$\text{Sinc}(t/4) \leftrightarrow 4\ \text{rect}(4f)$



Given $h(t) = A\ \text{Sinc}(\alpha t)$

$$H(f) = \frac{A}{\alpha}\text{rect}\left(\frac{f}{\alpha}\right)$$



$Y(f) = X(f)\ .\ H(f) = X(f)$ only when

$$\frac{-\alpha}{2} = \frac{-1}{4} \Rightarrow \alpha = \frac{1}{2}$$

$$\frac{A}{\alpha} = 1 \Rightarrow A = \alpha = \frac{1}{2}$$

$A + \alpha = 1$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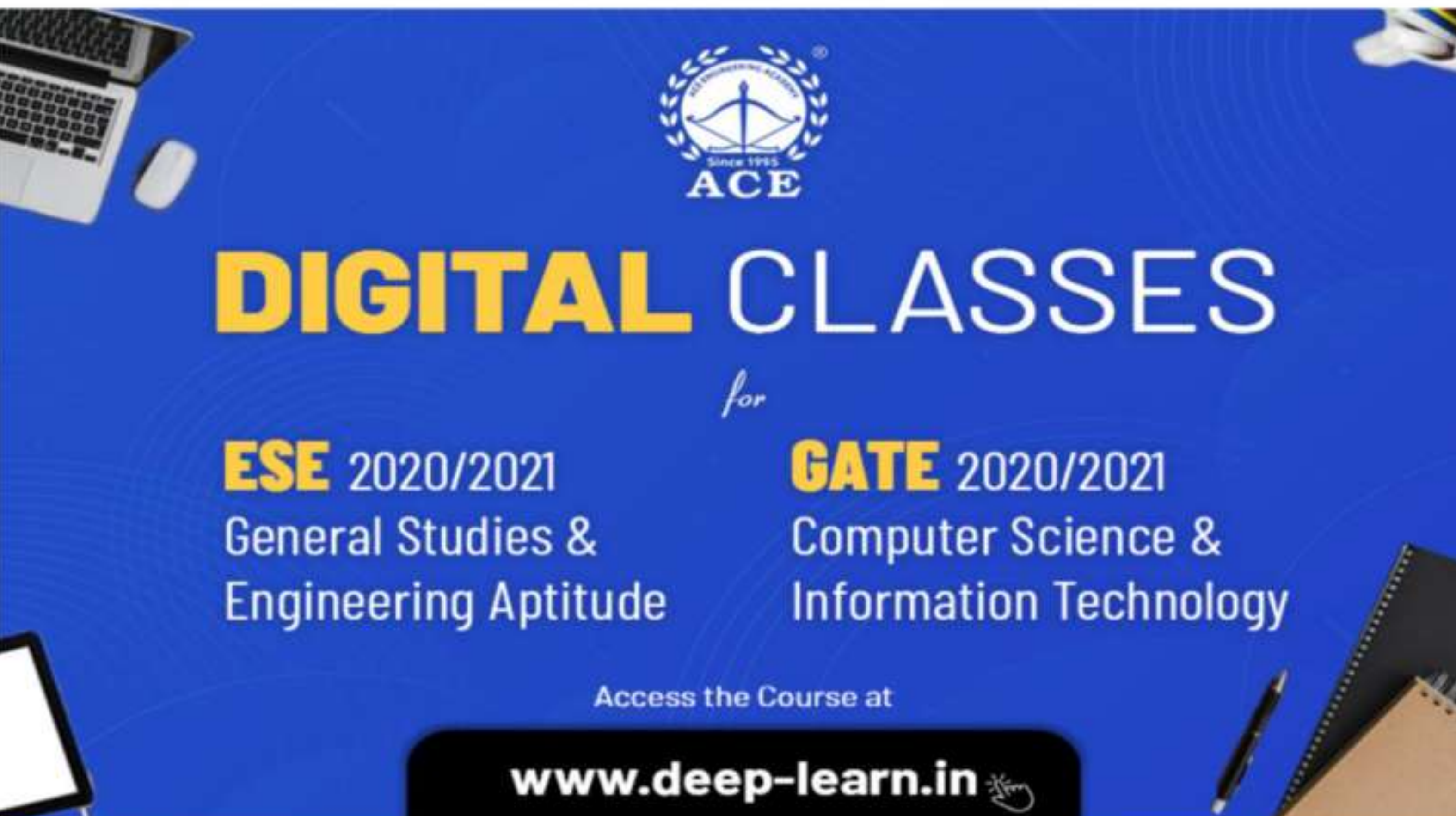
AIR 8 HEMANT KUMAR ME
AIR 8 YOGESH KUMAR CE
AIR 9 DEEPITA ROY EE
AIR 9 E&T
AIR 9 ME
AIR 9 ANKIT KUMAR CE
AIR 10 ANKITA SHARMA EE
AIR 10 E&T
AIR 10 SUMIT ME
and many more...
TOTAL SELECTIONS in Top 10: 33
(EE: 9, E&T: 8, ME: 9, CE: 7) and many more...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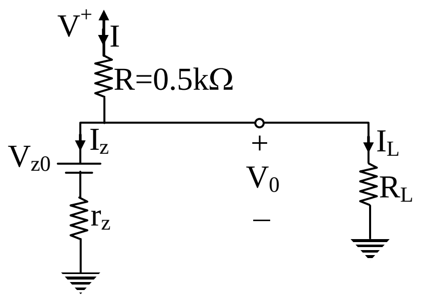
45. Ans: 6.83 (6.75 to 6.9)

Sol:



$V_z = V_{z0} + r_z I_z$

$6.8 = V_{z0} + (20\Omega \times 5mA)$

$\Rightarrow V_{z0} = 6.7V$ ______(1)

With no load connected, the current through the zener is given by

$$I_z = I = \frac{V^+ - V_{z0}}{R + r_z} = \frac{10 - 6.7}{0.5k + 0.02k}$$

$I_z = 6.35mA$ ______(2)

$\rightarrow V_0 = V_{z0} + I_z r_z = 6.7 + (6.35 \times 0.02)$

$= 6.83V$

46. Ans: 3750

Sol: Give data:

$\lambda = 9000A°$

$\Delta = 2\%$

$\mu_{core} = 1.6 = n_1$

$\pi = 3$

$V = 8$

$$V = \frac{2\pi r}{\lambda} n_1 \sqrt{2\Delta}$$

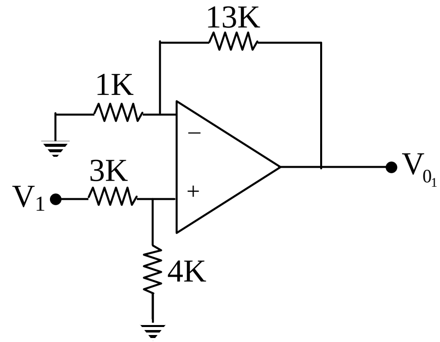
$$8 = \frac{2 \times 3 \times r}{9000 \times 10^{-10}} \times 1.6 \sqrt{2 \times \frac{2}{100}}$$

$r = 3750nm$

47. Ans:–28

Sol: Using superposition principle,

Case (1): consider only V_1 and make V_2 = 0



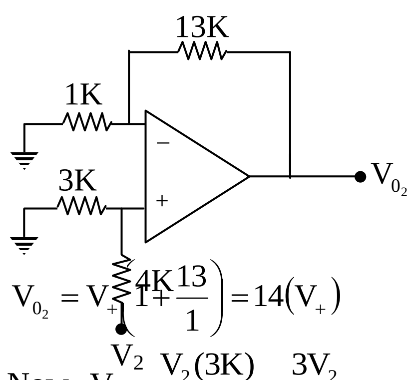
$$\text{So, } V_{0_1} = V_+\left(1 + \frac{13}{1}\right) = 14(V_+)$$

$$\text{Now, } V_+ = V_1\left(\frac{4K}{7K}\right) = \frac{4V_1}{7}$$

$$\text{So, } V_{0_1} = 14\left(\frac{4V_1}{7}\right) = 8V_1$$

Case (2):

Consider only V_2 and make $V_1 = 0$



$$V_{0_2} = V_+\left(1 + \frac{13}{1}\right) = 14(V_+)$$

$$\text{Now, } V_+ = \frac{V_2(3K)}{7K} = \frac{3V_2}{7}$$

$$\text{So } V_{0_2} = 14\left(\frac{3V_2}{7}\right) = 6V_2$$

So, overall output voltage $V_0 = V_{0_1} + V_{0_2}$

So, $V_0 = 8V_1 + 6V_2$

On comparing A = 8, B = 6

So, (B + A) (B – A) = (6 + 8) (6 – 8)
= –28

48. Ans: 4 (No range)

Sol: $X(k)=\sum_{n=0}^{N-1} x(n)e^{\frac{-j2\pi kn}{N}}$

$$=\sum_{n=0}^{\frac{N}{2}-1} x(2n)e^{\frac{-j2\pi k(2n)}{N}}+\sum_{n=0}^{\frac{N}{2}-1} x(2n+1)e^{\frac{-j2\pi k(2n+1)}{N}}$$

$$=\sum_{n=0}^{\frac{N}{2}-1} x(2n)W_{N/2}^{kn}+W_N^k\sum_{n=0}^{\frac{N}{2}-1} x(2n+1)W_{N/2}^{kn}$$

$$X(0)=\sum_{n=0}^{\frac{N}{2}-1} x(2n)W_{N/2}^{0}+W_N^0\sum_{n=0}^{\frac{N}{2}-1} x(2n+1)W_{N/2}^{0}$$

$$X(0)=\sum_{n=0}^{\frac{N}{2}-1} x(2n)+\sum_{n=0}^{\frac{N}{2}-1} x(2n+1)$$

$$X(N/2)=\sum_{n=0}^{\frac{N}{2}-1} x(2n)W_{N/2}^{\frac{Nn}{2}}+W_N^{\frac{N}{2}}\sum_{n=0}^{\frac{N}{2}-1} x(2n+1)W_{N/2}^{\frac{Nn}{2}}$$

$$=\sum_{n=0}^{\frac{N}{2}-1} x(2n)-\sum_{n=0}^{\frac{N}{2}-1} x(2n+1)$$

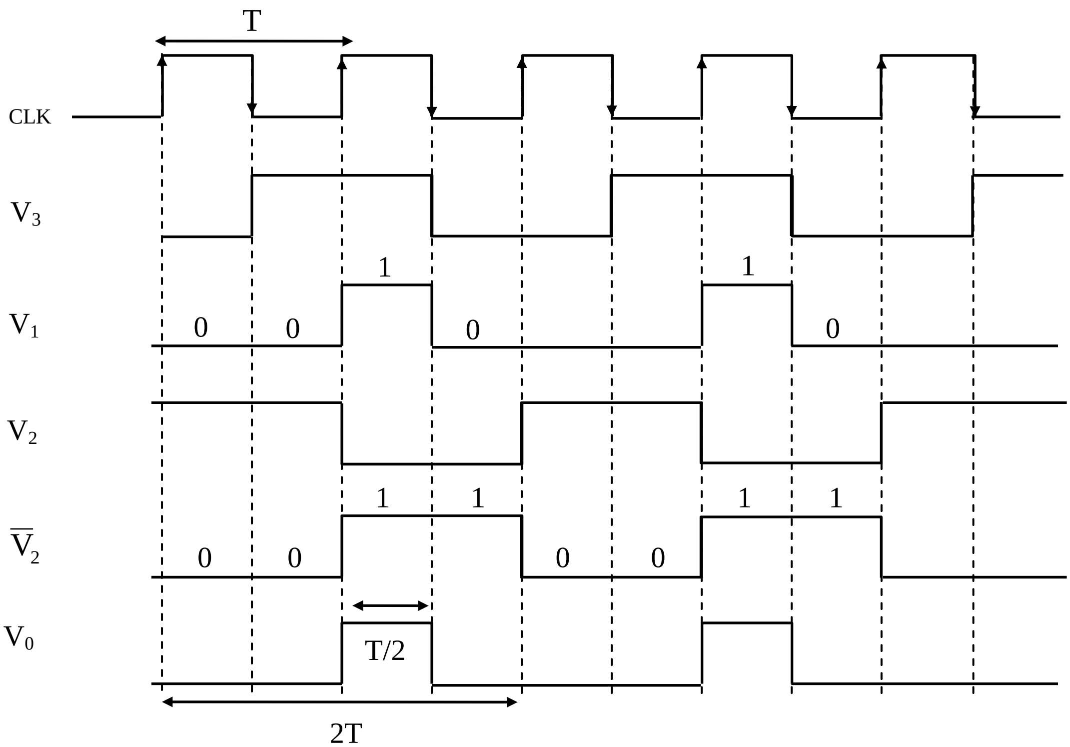
$$X(0)+X(N/2)=2\sum_{n=0}^{\frac{N}{2}-1} x(2n)$$

$$\Rightarrow \sum_{n=0}^{3} x(2n)=\frac{1}{2}[X(0)+X(N/2)]=\frac{1}{2}[X(0)+X(4)]$$

$$=\frac{1}{2}[(0+8)]=4$$

49. Ans: 25 (No range)

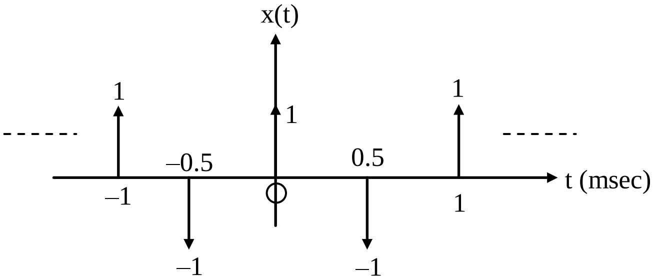
Sol:



Duty cycle $=\frac{\frac{T}{2}}{2T}\times 100=25\%$

50. Ans: (c)

Sol:



$$C_n = \frac{1}{T_0}\int_0^{T_0} x(t)e^{-jn\omega_0 t}dt$$

$$C_n = \frac{1}{1\times10^{-3}}\left[\int_0^1 x(t)e^{-jn\omega_0 t}dt\right]$$

$$C_n = 10^3[1-e^{-jn\omega_0(0.5\times10^{-3})}]$$

$$C_n = 10^3\left[1-e^{-jn\left(\frac{2\pi}{1\times10^{-3}}\right)(0.5\times10^{-3})}\right]$$

$$C_n = 10^3[1-e^{-jn\pi}] = 1000[1-(-1)^n]$$

Fourier transform of periodic signal is

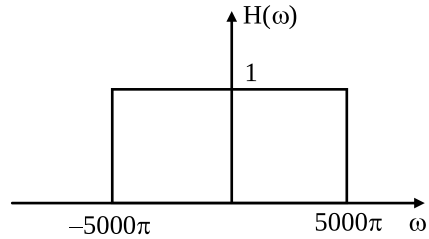
$$X(\omega) = 2\pi\sum_{n=-\infty}^{\infty} C_n\delta(\omega - n\omega_0)$$

$$X(\omega) = 2000\pi \sum_{n=-\infty}^{\infty}\left[1-(-1)^n\right]\delta(\omega - 2000n\pi)$$

$X(\omega) = 2000\pi[\ldots..2\delta(\omega + 2000\pi)$
$+ 2\delta(\omega - 2000\pi) + \ldots\ldots..]$

$x(t) = 4000\pi[\delta(\omega + 2000\pi)$
$+ \delta(\omega - 2000\pi) + \ldots\ldots]$

$X(\omega) = 4000[\cos(2000\pi t)$
$+ \cos(6000\pi t) + \ldots\ldots.]$



The output of low pass filter is
$y(t) = 4000\cos(2000\pi t)$

51. Ans: 1200

Sol: $m(t) = \sin(250\pi t) + \cos(250\pi t)$

$= \sqrt{2}\cos[250\pi t - 45^o]$

$$f_m = \frac{250\pi}{2\pi} = 125\text{Hz}$$

SR = 1.2 (NR)
$= 1.2\times2\times125$
= 300 samples /sec

Step size $\Delta = 0.4$

$$\frac{\Delta}{2} = Q_e = \frac{(V_{max} - V_{min})}{2^n};$$

$$0.40 = \frac{\sqrt{2}-(-\sqrt{2})}{2^n}$$

$$2^n = \frac{2\sqrt{2}}{0.4}$$

$n = 3.82 \Rightarrow n = 4$

$\therefore R_b = nf_s = 4\times300$ bps = 1200 bps

$R_b = 1200$ bps

52. Ans:(a)

Sol: The energy of each photon will be

$$hv = h\frac{c}{\lambda_0} = \frac{(6.6\times10^{-34})\times(3\times10^8)}{0.5\times10^{-6}} = 4\times10^{-19}\text{J}$$

So, the number of photons emitted per second = $\frac{1W}{4\times10^{-19}J} = 2.5\times10^{18}$

53. Ans: (b)

Sol: For eigen vector, AX = λX

$$\begin{bmatrix}1 & 1 & 3\\1 & 5 & 1\\3 & 1 & 1\end{bmatrix}\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix} = (-2)\begin{bmatrix}x_1\\x_2\\x_3\end{bmatrix}$$

$\Rightarrow x_1 + x_2 + 3x_3 = -2x_1 \rightarrow (1)$
$\Rightarrow x_1 + 5x_2 + x_3 = -2x_2 \rightarrow (2)$
$\Rightarrow 3x_1 + x_2 + x_3 = -2x_3 \rightarrow (3)$

$(1) \Rightarrow 3(x_1 + x_3) = -x_2 \rightarrow (4)$
$(2) \Rightarrow x_1 + x_3 = -7x_2 \rightarrow (5)$
$(3) \Rightarrow 3(x_1 + x_3) = -x_2 \rightarrow (6)$

From (4)&(5) $\rightarrow x_1 + x_3 - 7(3(x_1 + x_3)) = 0$
$\Rightarrow x_1 + x_3 = 0$

Suppose $x_1 = k \Rightarrow x_3 = -k$
$\therefore x_2 = -3(x_1 + x_3) = 0$

$\therefore$ Eigen vector $\begin{bmatrix}k\\0\\-k\end{bmatrix}$

For k = 1 ⇒ eigen vector = $\begin{bmatrix}1\\0\\-1\end{bmatrix}$

54.Ans: 45°

Sol: $\left|\frac{(50)\sqrt{50}}{(j\omega_{gc}+5)^3}\right| = 1$

$\left(\sqrt{\omega_{gc}^2 + 5^2}\right)^3 = 50\sqrt{50}$

$\omega_{gc} = 5$ rad/sec

$PM = 180^\circ + \angle G(j\omega_{gc})H(j\omega_{gc})$

$= 180^\circ - 3\tan^{-1}\frac{\omega_{gc}}{5} = 180 - 135 = 45^\circ$

55. Ans: 0.2 No range

Sol: Given that $\frac{dy}{dx} = x^3 - 2y$ $\quad (\because \frac{dy}{dx} = f(x,y))$

with y(0) = 0.25 $\quad (\because y(x_0) = y_0)$

Let $x_0 = 0$, $y_0 = 0.25$ & h = 0.1

Then $x_1 = x_0 + h = 0.1$

The formula for Euler's forward method is

$y(x_1) \simeq y_1 = y_0 + h\, f(x_0, y_0)$

$\Rightarrow y(0.1) \simeq y_1 = 0.25 + (0.1)\ (x_0^3 - 2y_0)$

$\Rightarrow y(0.1) \simeq y_1 = 0.25 + (0.1)\ [0 - 2(0.25)]$

$\therefore y(0.1) \simeq y_1 = 0.25 - (0.1)(0.5)$
$= 0.25 - 0.05 = 0.2$

56. Ans: (a)

Sol: The right choice is 'on'. 'Tell on' means 'to affect'. 'Tell against' means 'to go against'. 'Tell of' means 'to tell about something'.

57. Ans: (c)

Sol: 'is' tired verb must agree with the first subject when 'as well as' is used.

58. Ans: (a)

59. Ans: (d)

Sol: $L = \frac{5}{2}B$

Area = L × B = 1000

$L \times \frac{2L}{5} = 1000$

$L^2 = 2500 \Leftrightarrow L = 50$ m

60. Ans: (b)

Sol: Supplement of $80^0 = 180^0 - 80^0 = 100^0$.

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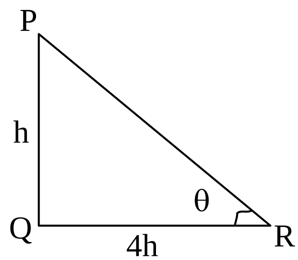
61. Ans: (d)

Sol: Let the height of tower be 'PQ', 'QR' be the length of shadow to tower in ΔPQR.

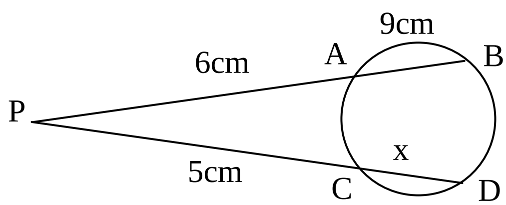
$$\tan\theta = \frac{PQ}{QR} = \frac{h}{4h}$$

$$\therefore\ \theta = \tan^{-1}\left(\frac{1}{4}\right)$$



62. Ans: (a)

Sol: If two chords of a circle, intersect inside a circle (outside a circle) at any point. Then,



PA × PB = PC × PD

⇒ 6 × 15 = 5 × (x + 5)

⇒ x + 5 = 18 ⇒ x = 13 cm

63. Ans: (a)

Sol: Total time between 10 pm to 6 am = 8 hours

% time spent in Light sleep or in Extreme sleep = 30 + 25 = 55%

⇒ Time spent in Light sleep or in Extreme sleep = $\frac{55}{100}\times 8$

⇒ $\frac{22}{5} = 4.4\,\text{hours}$

64. Ans: (b)

Sol: Total cost of mobiles = 99 × 15000
= Rs. 14,85,000

Total cost of cameras = 53 × 13000
= Rs. 6,89,000

Total cost of TVs = 29 × 59000
= Rs. 17,11,000

Total cost of Refrigerator = 21 × 56000
= Rs. 11,76,000

Total cost of AC = 97 × 25000
= Rs. 24,25,000

Total cost = 14,85,000 + 6,89,000
+ 17,11,000 + 11,76,000
+ 24,25,000 = Rs. 74,86,000

Total cost in lakhs = Rs. 74.86 lakhs

65. Ans: (a)

Sol: An assumption is an unstated premise. So, we are looking for something that is implied in the argument, and if wrong, will undermine the argument. All that the speaker implies is that Josh is efficient because he has twenty years of practice, and so answer (A) is correct.