Branch: Instrumentation Engineering MOCK-A - SOLUTIONS

01. Ans: (a)

Sol: The given function is odd function since $f(-x) = -f(x)$.

For odd function $\int_{-1}^{1} f(x) = 0$

02. Ans: (a)

Sol: The frequency of the signal is lower than that of the sweep signal

03. Ans: (a)

Sol: $G(s) = \dfrac{300}{s(s+1)(s+15)(s+20)}$

$$= \frac{300}{s(1+s)15\left(1+\frac{s}{15}\right)20\left(1+\frac{s}{20}\right)}$$

$$= \frac{1}{s(s+1)\left(1+\frac{s}{15}\right)\left(1+\frac{s}{20}\right)}$$

Approximate transfer function (considering dominant pole only) of system is $G(s) = \dfrac{1}{s(1+s)}$

04 Ans: (c)

Sol: $\dfrac{dy}{dx} = 4x^3 e^{-y}$

Using variable separable method

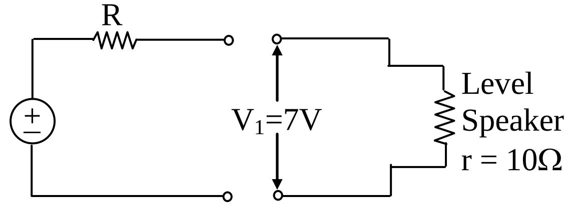
$e^y = x^4 + c$

at $x = 1$, $y = 0$, $\Rightarrow c = 0$

$\Rightarrow e^y = x^4$

05. Ans: 8.23 (Range: 8 to 8.5)

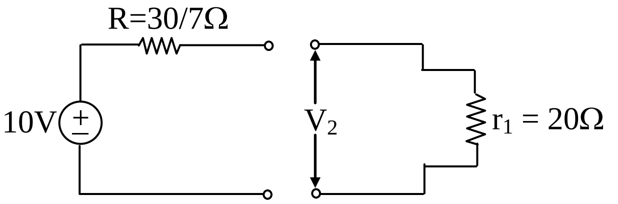
Sol:



$$7 = 10 \times \frac{10}{10+R}$$

$$R = \frac{30}{7}\Omega$$

Now 20 Ω loud speaker connected to the transducer then



$$V_2 = \frac{20}{20+\frac{30}{7}} \times 10$$

$V_2 = 8.235$ V

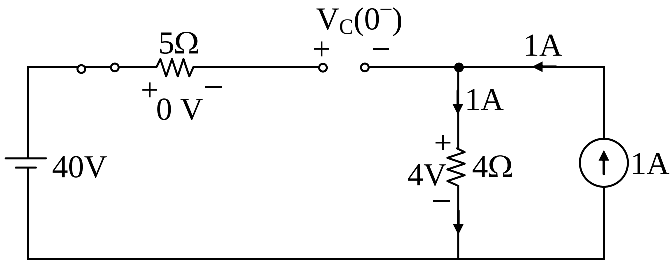
06. Ans: (c)

Sol: In case single or monomode optical fiber the core diameter is $2\mu m < d < 10\mu m$

Single or monomode is always step index as core is narrow.

07. Ans: 10 (No range)

Sol: Circuit at $t = 0^-$ is

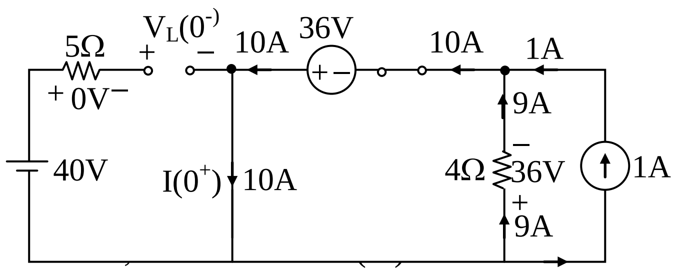


By KVL $\Rightarrow 40 - V_C(0^-) - 4 = 0$

$\Rightarrow V_C(0^-) = 36\text{ V} = V_C(0^-)$

$i_L(0^-) = 0\text{ A} = i_L(0^+)$

Circuit at $t = 0^+$ is

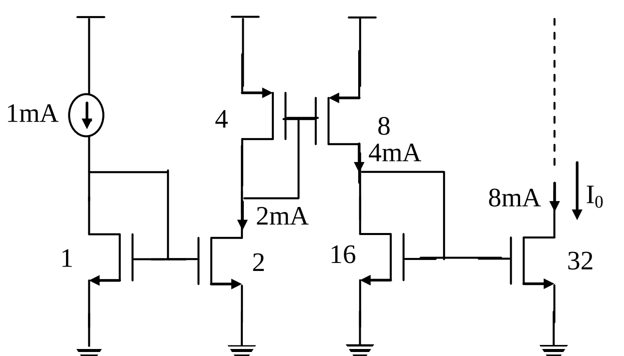


08. Ans: 8 (No range)

Sol: The drain current in saturation region is given by

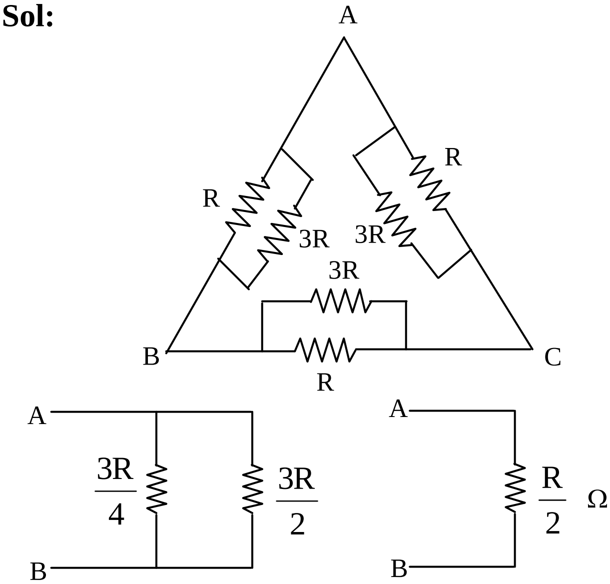
$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS} - V_T)^2$$

So, $I_D \propto \frac{W}{L}$



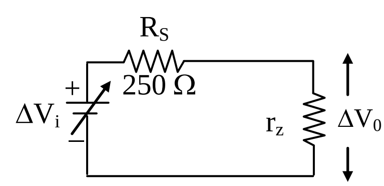
09. Ans: (c)

Sol:



10. Ans: 12.7 (Range: 10.5 to 14.5)

Sol:



(variable part of circuit)

$$\Delta V_0 = \frac{\Delta V_i r_z}{R_s + r_z}$$

$$0.29V = \frac{6 \times r_z}{250 + r_z}$$

$r_z = 12.697\ \Omega$

11. Ans: 12

Sol: Given CMRR = 80dB = 10^4 & $A_C = 1.5$

Step (1):

$$\text{CMRR} = \frac{A_d}{A_c} \Rightarrow A_d = 1.5 \times 10^4 \text{ \_\_\_\_(1)}$$

Step (2): $V_o = A_d V_{id} + A_C V_C$ ____(2)

$\because\ V_{id} = V_1 - V_2,\quad V_C = \frac{V_1 + V_2}{2}$

$$= 1.5 \times 10^4 (100.5 - 99.5)\text{mV}$$

$$+ 1.5\left(\frac{100.5 + 99.5}{2}\right)\text{mV} \text{ \_\_\_\_(3)}$$

$= 1.5\times10^4 \times 1\times10^{-3}\text{V} + 1.5\times100\times10^{-3}\text{V}$ ____(4)

$= 15.15\text{V}$ ___(5)

NOTE: The maximum possible output voltage in an op-amp circuit is $\le V_{sat}$

$\therefore V_o = +12\text{V}$ ____(6)

12. Ans: (d)

Sol: $I_0 = C$

$I_1 = D$

$I_2 = \overline{C}$

$I_3 = \overline{C}\,\overline{D}$

S_1	S_0	
A	**B**	**Y**
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

F(A, B, C, D)

$= \overline{A}\,\overline{B}C + \overline{A}BD + A\overline{B}\,\overline{C} + AB(\overline{C}\,\overline{D})$

$= \overline{A}\,\overline{B}C(D+\overline{D}) + \overline{A}B(C+\overline{C})D$
$\quad + A\overline{B}\,\overline{C}(D+\overline{D}) + AB\overline{C}\,\overline{D}$

$= \overline{A}\,\overline{B}CD + \overline{A}\,\overline{B}C\overline{D}$
$\quad + \overline{A}BCD + \overline{A}B\overline{C}D + A\overline{B}\,\overline{C}D$
$\quad + A\overline{B}\,\overline{C}\,\overline{D} + AB\overline{C}\,\overline{D}$.

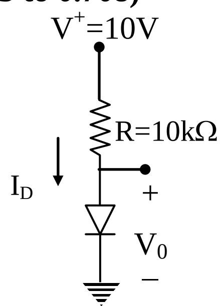
$F = \sum m(2,3,5,7,8,9,12)$

13. Ans: 0.7053 (Range: 0.703 to 0.708)

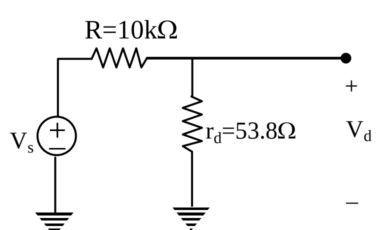
Sol: $I_D = \dfrac{10-0.7}{10\,k} = 0.93\,\text{mA}$

$r_d = \dfrac{\eta V_T}{I_D} = \dfrac{2\times25\,\text{mV}}{0.93\,\text{mA}}$

$= 53.8\ \Omega$



The signal voltage across the diode can be found from the small signal equivalent circuit shown below



Here V_S denotes the 50 Hz, 1 V peak sinusoidal component of V^+, the peak amplitude of

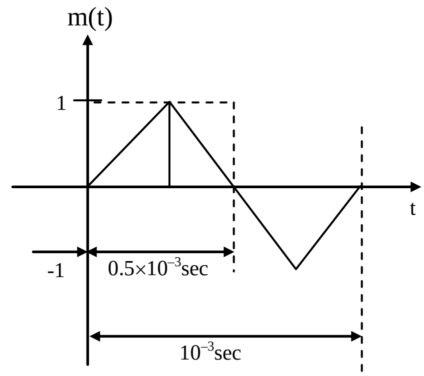
$V_{ac} = \hat{V}_s \cdot \dfrac{r_d}{R+r_d} = 1\text{V}\times\dfrac{53.8}{10k+53.8} = 0.0053\text{ V}$

$V_{dc} = 0.7\,\text{V}$

$V_d(\text{Peak}) = V_{ac} + V_{dc} = 0.0053 + 0.7 = 0.7053$

14. Ans: (d)

Sol: $f_i(t) = f_c + \dfrac{k_p}{2\pi}\dfrac{d}{dt}[m(t)]$



Slope = $\dfrac{1}{\frac{0.5}{2}\times10^{-3}} = 4\times10^3$

m(t) has slope 4×10^3

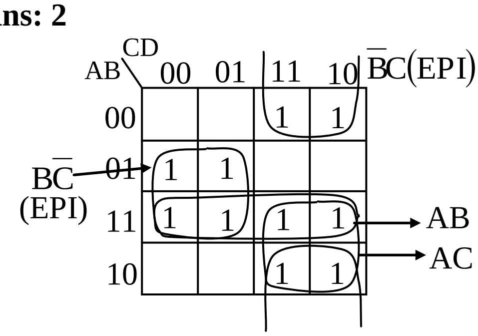
$\therefore$ $m^1(t)$ is a square wave with amplitude $\pm$ 4000.

$(f_i(t))_{min} = 100\times10^3 - \dfrac{2\pi}{2\pi}\times4000 = 96$ kHz

$(f_i(t))_{max} = 100\times10^3 + \dfrac{2\pi}{2\pi}\times4000 = 104$ kHz

15. Ans: 2

Sol:



Total PI's are $\overline{B}C, B\overline{C}, AB, AC$

EPI's are $\overline{B}C, B\overline{C}$

16. Ans: (b)

Sol: The given differential equation

$4y''' + 4y'' + y' = 0$

$\Rightarrow 4D^3 + 4D^2 + D = 0$

$\Rightarrow D(2D + 1)^2 = 0$

$D = 0, \frac{-1}{2}, \frac{-1}{2}$

$\therefore y_c = C_1 + (C_2 + C_3 x)e^{-x/2}$

17. Ans: 2

Sol: Three non touching loops = 2

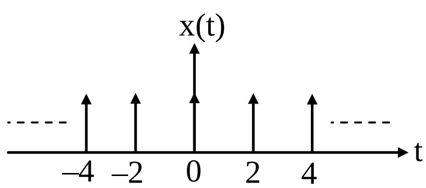
Three non touch loop gains

$= G_1 H_1 G_3 H_3 G_5 H_4$

$= G_1 H_1 G_3 H_3 G_6 H_5$

18. Ans: (d)

Sol: $x(t) = \sum_{n=-\infty}^{\infty} \delta(t - 2n)$



Fourier transform of periodic signal x(t) is

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

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

$$= \frac{1}{2}\int_0^2 \delta(t)e^{-jn\pi t}dt = \frac{1}{2}$$

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

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

19. Ans: 2

Sol: $y(t) = a\,x(t) + b\,x^2(t)$

$= a(m(t) + \cos(2\pi f_o t)) + b(m(t) + \cos(2\pi f_o t))^2$

Output of BPF $= a\left(1 + \frac{2b}{a}m(t)\right)\cos 2\pi f_o t$

Modulation Index $\mu = \frac{2b A_m}{a}$

$\Rightarrow b = \frac{\mu a}{2A_m} = \frac{0.8 \times 15}{2 \times 3} = 2$

20. Ans: (d)

Sol: $P(x = 1) = 0.5\,P(x = 2)$

$$\frac{\lambda e^{-\lambda}}{1!} = \frac{1}{2}\frac{\lambda^2 e^{-\lambda}}{2!}$$

$\Rightarrow \lambda = 4$

$$P(x = 4) = \frac{\lambda^4 e^{-\lambda}}{4!} = \frac{4^4 e^{-4}}{24} = \frac{32}{3}e^{-4}$$

21. Ans: (b)

Sol: Relationship between impulse response and step response is

$h(t) = \frac{d}{dt}s(t)$

Given, $s(t) = 2e^{-3t}\,u(t)$

$h(t) = 2\,[e^{-3t}\,\delta(t) - 3\,e^{-3t}\,u(t)]$

$= 2e^{-3t}\,\delta(t) - 6\,e^{-3t}\,u(t)$

But $e^{-3t}\,\delta(t) = 1\,\delta(t)$

$\therefore h(t) = 2\delta(t) - 6\,e^{-3t}\,u(t)$

22. Ans: 0.5

Sol: CE is $|SI - A| = 0$

$$\begin{vmatrix} s & -1 & 0 \\ 0 & s & -1 \\ 1 & k & s+2 \end{vmatrix} = 0$$

$s\,[s^2 + 2s + k] + [1] = 0$

$s^3 + 2s^2 + sk + 1 = 0$

RH criteria

s^3	1	k
s^2	2	1
s^1	$\frac{2k-1}{2}$	
s^0	1	

The value of k for which the system becomes just stable is

$2k - 1 = 0$

$2k = 1$

$\therefore k = 1/2$

23. Ans: 318.3 (Range: 317 to 320)

Sol: $\text{Tilt} = \dfrac{V - V'}{V} = \dfrac{50\text{mV} - 40\text{mV}}{50\text{mV}} = 0.2$

$$f_{L_0} = \frac{\text{Tilt}}{\pi} f = \left(\frac{0.2}{\pi}\right)(5\text{kHz}) = 318.31\text{Hz}$$

24. Ans: (d)

Sol: $z^2 + 9 = 0 \Rightarrow z = \pm 3i$

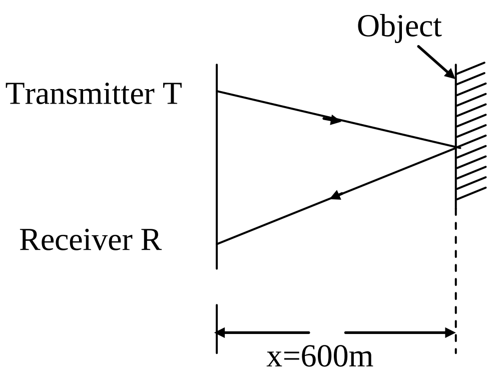
$z_0 = 3i$ lies inside the circle.

$$\therefore I = 2\pi i \lim_{z \to 3i} \frac{(z-3i)}{(z+3i)(z-3i)}$$

$$= 2\pi i . \frac{1}{6i} = \frac{\pi}{3}$$

25. Ans: 4

Sol:



$C = \dfrac{L}{\Delta t}$ in this formula we take total distance traveled (L) as 2x

Hence $\Delta t = \dfrac{2x}{C}$

$= \dfrac{2 \times 600}{3 \times 10^8}$

$\Delta t = 4\ \mu\text{sec}$

26. Ans: (d)

Sol: The Characteristic equation is

$|A - \lambda I| = 0$

$$\Rightarrow \begin{vmatrix} 4-\lambda & 1 \\ -1 & 2-\lambda \end{vmatrix} = 0$$

$\Rightarrow \lambda^2 - 6\lambda + 9 = 0$

$\Rightarrow \lambda = 3, 3$

The eigen vectors for $\lambda = 3$ are given by the equation $[A - 3I]X = 0$ where $X = \begin{bmatrix} x \\ y \end{bmatrix}$

$\Rightarrow x + y = 0$

$\therefore (x, y) = (2, -2)$ is an eigen vector

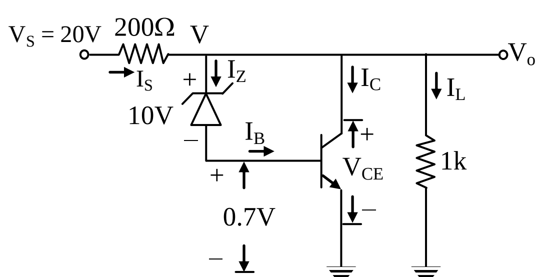
27. Ans: 379.26 (Range: 378 to 381)

Sol: **Step (1):**

From the circuit, $V_0 = 10V + 0.7V$

$= 10.7V$

$= V_{CE}$ ________(1)



Current through output load resistor

$\Rightarrow I_L = \dfrac{V_0}{1k} = 10.7\text{mA}$ ________(2)

Step (2): KVL for input loop

$$I_S = \frac{20V - 10.7V}{200\Omega} = 46.5\text{mA} \text{\_\_\_\_(3)}$$

Step (3): KCL at node V_0

$I_S = I_Z + I_C + I_L$

$= I_B + I_C + I_L$ ______(4) $[\because I_B = I_Z]$

$$\Rightarrow I_C\left[1+\frac{1}{\beta}\right]=46.5\text{mA}-10.7\text{mA}$$

$$=35.8\text{mA}\_\_\_\_\_(5)$$

$\Rightarrow I_C = 35.445\text{mA}$_______(6)

Step(4): $P_C = V_{CE}\ I_C = 379.26\text{mW}$_____(7)

28. Ans: (c)

Sol:

Case (i) Bright band

Path difference = $2n\left(\frac{\lambda}{2}\right)$

n is integer means to get bright band path difference must be even number multiple of $\lambda/2$.

Case (ii) Dark band

Path difference = $(2n+1)\left(\frac{\lambda}{2}\right)$

Means to get dark band path difference must be odd multiple of $\lambda/2$

Option (a)

$$\text{P.D} = 15\frac{\lambda}{3}=\frac{15}{3}\times 2\times\left(\frac{\lambda}{2}\right)=10\left(\frac{\lambda}{2}\right)$$

as 10 is even number so B.B

Option (b)

$$\text{P.D} = 21\frac{\lambda}{7}=\frac{21}{7}\times 2\times\left(\frac{\lambda}{2}\right)=6\left(\frac{\lambda}{2}\right)$$

as 6 is even number so B.B

Option (c)

$$\text{P.D} = 21\frac{\lambda}{6}=\frac{21}{6}\times 2\times\left(\frac{\lambda}{2}\right)=7\left(\frac{\lambda}{2}\right)$$

as 7 is odd number so D.B

option (d)

$$\text{P.D} = 21\frac{\lambda}{6}=\frac{35}{5}\times 2\times\left(\frac{\lambda}{2}\right)=14\left(\frac{\lambda}{2}\right)$$

as 7 is even number so B.B

29. Ans: (b)

Sol: $g(x)=\frac{f(x)}{x+1}$

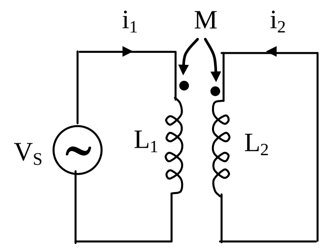
g(x) in continuous and differentiable in [0, 5].

By Lagrange's theorem, there exists a value $c \in (0, 5)$, such that

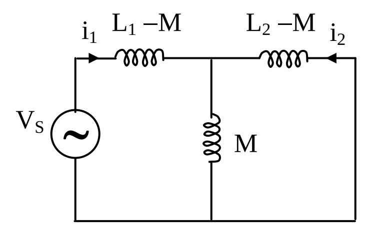
$$g^1(c)=\frac{g(5)-g(0)}{5-0}=\frac{\left(-\frac{1}{6}\right)-4}{5}=\frac{-5}{6}$$

30. Ans: (a)

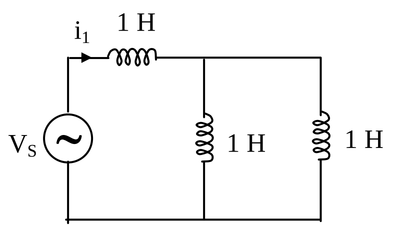
Sol:

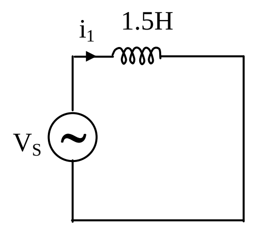


$\Rightarrow$



The equivalent circuit is





$$\therefore \text{ Energy stored} = \frac{1}{2}LI^2$$

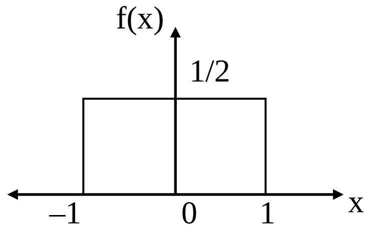
$$=\frac{1}{2}\times 1.5\times 2^2$$

$$E = 3J$$

31. Ans: 48.16 (Range: 47.5 to 49)

Sol: $\text{SQNR} = \frac{P_S}{P_N} = \frac{\text{Signal power}}{\text{Noise power}}$

$$P_N = \frac{\Delta^2}{12} = \frac{x_{max}^2}{3(2^{2n})}$$



$$P_S = \int_{-\infty}^{\infty} x^2 f_x(x)dx = \int_{-1}^{1} x^2\left(\frac{1}{2}\right)dx$$

$$= \left(\frac{x^3}{3}\right)_{-1}^{1} \times \frac{1}{2}$$

$$P_S = \frac{1}{3}W$$

$$\text{SQNR} = \frac{P_S}{P_N} = \frac{1/3}{\frac{x_{max}^2}{3(2^{2n})}} = \frac{2^{2n}}{(x_{max}^2)}$$

$$\text{SQNR} = \frac{2^{2n}}{(1)^2} = 4^n$$

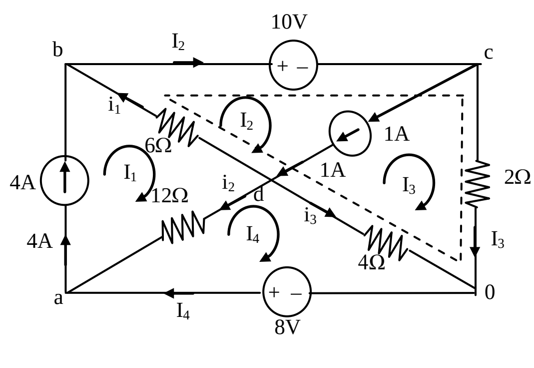
$$n = \log_2 256 = 8$$

SQNR = 4^8 = 65536

SQNR (dB) = 48.16 dB

32. Ans: 1 (Range: 0.9 to 1.1)

Sol:



It is evident that $I_1 = 4$ ………. (1)

For mesh 4,

$12(I_4 – I_1) + 4(I_4 – I_3) – 8 = 0$ ….….(2)

For the super mesh

$6(I_2 – I_1) + 10 + 2I_3 + 4(I_3 – I_4) = 0$

or

$–3I_1 + 3I_2 + 3I_3 – 2I_4 = –5$ …….. (3)

At node c, $I_2 = I_3 + 1$ ……… (4)

Solving (1), (2), (3) and (4) yields

$I_1 = 4$ A, $I_2 = 3$ A, $I_3 = 2$ A, and $I_4 = 4$ A

At node b, $i_1 = I_2 – I_1 = –1$ A

At node a, $i_2 = 4 – I_4 = 0$ A

At node 0, $i_3 = I_4 – I_3 = 2$ A

$i_1 + i_2 + i_3 = –1 + 0 + 2 = 1$A

33. Ans: 0.75

Sol: $\text{TF} = L[IR] = \frac{2}{(s+2)^2 + 2^2} = \frac{2}{s^2 + 4s + 8}$

$$= \frac{C(s)}{R(s)}$$

Steady state error $(e_{ss}) = \underset{t\to\infty}{Lt}\, e(t)$

$$= \underset{s\to 0}{Lt}\, sE(s)$$

$$= \underset{s\to 0}{Lt}\, s[R(s) - C(s)H(s)]$$

$e_{ss} = \underset{s\to 0}{Lt}\, s[R(s) - C(s)]$ [∵ H(s) =1]

$$= \underset{s\to 0}{Lt}\, s\left[\frac{1}{s} - \frac{2}{s^2+4s+8} \times \frac{1}{s}\right]$$

$$= 1 - \frac{1}{4} = \frac{3}{4} = 0.75$$

34. Ans: (c)

Sol: $S = 1\frac{\text{mV}}{\text{mm}}$

Min = 0.1mm

= 0.01cm ……..

0	.0	1

Max = 10cm………..

1	0	.0

Note: If 2 digits are there, then maximum can be only .99cm. But cannot be 10.0cm. As such 3 digits are required.

35. Ans: (d)

Sol: [A/B] =

$$\begin{bmatrix} 1 & 2 & 3 & 14 \\ 1 & 4 & 7 & 30 \\ 1 & 1 & 1 & \lambda \end{bmatrix} \sim \begin{bmatrix} 1 & 2 & 3 & 14 \\ 0 & 2 & 4 & 16 \\ 0 & 0 & 0 & 2\lambda - 12 \end{bmatrix}$$

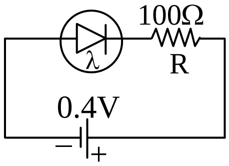
To be consistent Rank of augmented matrix (ρ(A/B)) and Rank of A matrix should be equal.

$\rho(A/B) = \rho(A) = 2\lambda - 12 = 0 \Rightarrow \lambda = 6$

36. Ans: 122.2 (Range: 121 to 123)

Sol: Photo-diode current

$I_d = 1.8$ mA $= 1.8 \times 10^{-3}$A



Voltage applied, $V_s = 0.4$ V

Series resistor, R = 100 Ω

If R_P is the resistance offered by the photodiode in ohms then

$$I_d = \frac{V_s}{R_P + R}$$

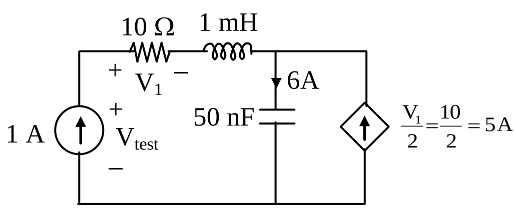
$$R_P = \frac{V_S}{I_d} - R$$

$$= \frac{0.4}{1.8 \times 10^{-3}} - 100$$

= 122.22 Ω

37. Ans: (b)

Sol:



$$V_{test} = 10 + j\omega L + \frac{1}{j\omega C} \times 6$$

$$Z_{in} = \frac{V_{test}}{1} = 10 + j\left(\omega L - \frac{6}{\omega C}\right)$$

At resonance, imaginary part of Z_{in} is zero

$$\omega_0 L - \frac{6}{\omega_0 C} = 0$$

$$\omega_0^2 LC = 6$$

$$\omega_0^2 = \frac{6}{LC}$$

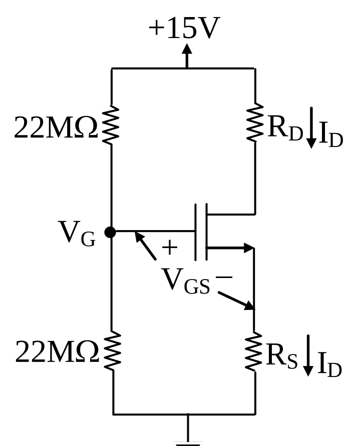
$$\omega_0 = \sqrt{\frac{6}{LC}}$$

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{6}{LC}} = \frac{1}{2\pi}\sqrt{\frac{6}{1m \times 50n}}$$

$f_0 = 55$ kHz

38. Ans: (c)

Sol: Step (1): $V_G = \frac{22M\Omega}{44M\Omega}(15V) = 7.5V$



Step (2):

KVL for G-S loop

$\because I_D R_S$ = one third of supply voltage

$V_{GS} = V_G - I_D R_S = 7.5V - \frac{1}{3}(15V) = 2.5V$

Consider $I_D = \frac{1}{2} k_n' \frac{W}{L}(V_{GS} - V_{th})^2$

$$= \frac{1}{2} \times 80\mu A / V^2 \left(\frac{240}{6}\right)[2.5V - 1.2]^2$$

= 2.7mA

Step (3): $I_D R_D = \frac{1}{3}(15V) = 5V$

$\therefore\ R_D = \frac{5V}{2.7mA} = 1.85k\Omega$

Step (4): $I_D R_S = \frac{1}{3}(15V) = 5V$

$\therefore\ R_S = \frac{5V}{2.7mA} = 1.85k\Omega$

39. Ans: (c)

Sol: Number of ways we can distribute 5 red balls into 3 numbered boxes

= C(3 – 1 + 5, 5)

= 21

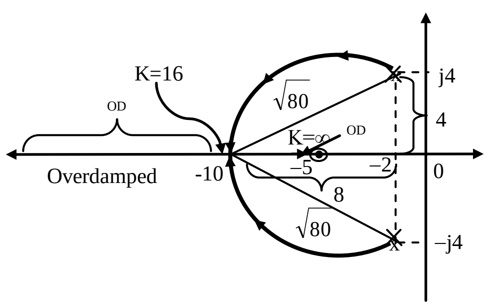
Similarly we can distribute 5 white balls in 21 ways and 5 blue balls in 21 ways.

By product rule, required number of ways

= (21) (21) (21) = 9261

40. Ans: (b)

Sol:



$$K\Big|_{s=s_1} = \frac{\text{Product of distance vectors from various poles of } G(s)H(s) \text{ to } s = s_1}{\text{Product of distance vectors from various zeroes of } G(s)H(s) \text{ to } s = s_1}$$

$$K = \frac{\sqrt{80} \times \sqrt{80}}{5} = 16$$

K > 16 the system is over damped.

41. Ans: –1 (No Range)

Sol: $X(z) = \frac{2+3z}{1-z+3z^2} = 2 + 5z - z^2 + - - - - -$

So, x(–2) = –1

42. Ans: (a)

Sol: $\text{Step size} = \frac{5 \times 10^{-3}}{2^8 - 1} = 19.6\mu A$

Analog output = 130×19.6 = 2.548 mA

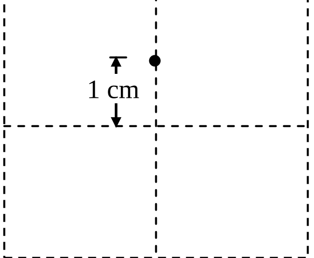
$$\text{error} = \pm \frac{0.25 \times 5 \times 10^{-3}}{100} = \pm 12.5\mu A$$

Range of analog output = 2.548 ± 12.5μA

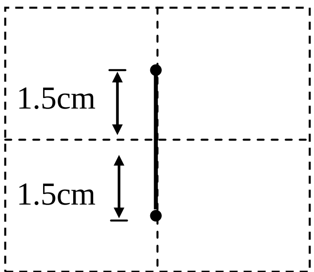
= 2.5355 to 2.5605 mA

43. Ans: (b)

Sol: When 20 V dc supply to the vertical deflecting plates, the bright spots moves 1 cm away from the centre. (spot will move vertically when a voltage is applied to vertical deflecting plate and no voltage applied to the horizontal deflecting plates).



When 30 V (peak) ac is applied to the vertical deflecting plates with no voltage applied to the horizontal deflecting plates we will get a straight line (spot moves up and down with ac supply frequency).



Distance travelled by the spot for one cycle = 4 × 1.5 = 6 cm

44. Ans: (d)

Sol: It is a 3 bit shift Register, for each clk pulse $Q_3 \rightarrow Q_1$, $Q_3 \odot Q_1 \rightarrow Q_2$, $Q_2 \rightarrow Q_3$

Clk	Q_1	Q_2	Q_3
0	0	0	0
1	0	1	0

45. Ans: (c)

Sol: ω_0 = GCD (4, 12) = 4

$x(t) = 3\sin(\omega_0 t + 20^o) - 4\cos(3\omega_0 t - 40^o)$

$x(t) = 3\sin(\omega_0 t + 20^o) + 4\cos(3\omega_0 t + 140^o)$

The phase of III harmonic is 140°

46. Ans: 2.203 (2.0 to 2.3)

Sol: $Z_{in} = j\omega L \parallel \left(R + \frac{1}{j\omega C}\right)$

$$Z_{in} = \frac{j\omega L\left(R + \frac{1}{j\omega C}\right)}{R + j\omega L + \frac{1}{j\omega C}} = \frac{\frac{L}{C} + j\omega LR}{R + j\left(\omega L - \frac{1}{\omega C}\right)}$$

$$Z_{in} = \frac{\left(\frac{L}{C} + j\omega LR\right)\left(R - j\left(\omega L - \frac{1}{\omega C}\right)\right)}{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

To have a resistive impedance, $\text{Im}(Z_{in}) = 0$.

Hence,

$$\omega LR^2 - \left(\frac{L}{C}\right)\left(\omega L - \frac{1}{\omega C}\right) = 0$$

$\omega R^2 C = \omega L - 1/\omega C$

$\omega^2 R^2 C^2 = \omega^2 LC - 1$

$$L = \frac{\omega^2 R^2 C^2 + 1}{\omega^2 C}$$

Now we can solve for L.

$L = R^2 C + 1/(\omega^2 C)$

$= (200^2)(50 \times 10^{-9})$

$+ 1/((2\pi \times 50{,}000)^2 (50 \times 10^{-9}))$

$= 2 \times 10^{-3} + 0.2026 \times 10^{-3}$

= 2.203mH

47. Ans: 42.33 (Range: 41.50 to 43.50)

Sol: We know

$$V = C\sqrt{\frac{2\Delta P}{\rho}}$$

C = 1, $\Delta P = \rho gh$ here ρ_m = manometric fluid = 1000 kg/m^3 (for water)

$$V = \sqrt{\frac{2 \times 1000 \times 9.81 \times 100 \times 10^{-3}}{1.1}}$$

= 42.23 (m/sec)

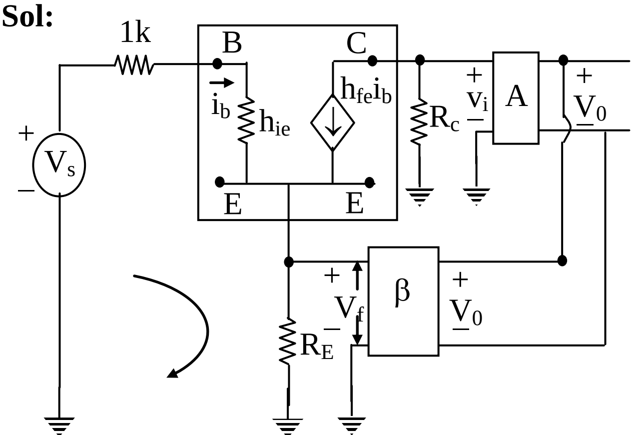
48. Ans: (c)

Sol:

LXI B, 0010H	:	(BC) ← 0010H
LOOP: DCX B	:	(BC) ← (BC)–1
MOV A, B	:	(A) ←(B)
ORA C	:	(A) ←(A)V(C)
	:	This logical operation sets 'Z' Flag
	:	when (BC) becomes 0000H
JNZ LOOP	:	Branch to "LOOP" if Z = 0
	:	LOOP will be continued for 16 times

49. Ans: 99.8 (Range: 99 to 100)

Sol:



Small signal model of the given amplifier

Step (1):
From the small signal model shown in fig(a)

$V_i = -h_{fe}i_bR_C$

$= -100\times1k\Omega\ i_b$

$V_o = AV_i$

$= (-1000)(-100)(1k\ \Omega)i_b$

$V_f = \beta V_o = \beta AV_i$

$= \frac{1}{100}\times(-1000)\times(-100)\times1k\Omega\ i_b$

$= 1000\times1k\Omega\ i_b$

Step (2): KVL for input loop

$V_s = i_b\,[R_s + h_{ie}] + V_f$

$= i_b[R_s + h_{ie} + 1000\times1k\Omega]$

$= i_b[2k\Omega + 1000k\Omega]$

Step(3): $\frac{V_0}{V_s} = \frac{1000\times100\times1k\Omega\, i_b}{1002\,k\Omega\ i_b} = 99.8$

50. Ans: (b)

Sol: $G(j\omega) = \frac{3(2-j\omega)}{(j\omega+1)(j\omega+5)}$

$\Rightarrow M = \frac{3\sqrt{4+\omega^2}}{\sqrt{\omega^2+1}\sqrt{\omega^2+25}}$

$\omega = 0$ magnitude M =1.2

$\Rightarrow \phi = -\tan^{-1}\left(\frac{\omega}{2}\right) - \tan^{-1}(\omega) - \tan^{-1}\left(\frac{\omega}{5}\right)$

$\omega = 0$ ------- $\phi = 0°$

$\omega = \infty$ ------ $\phi = -270°$

The polar starts at $1.2\angle0°$ and ends at $0\angle-270°$

51. Ans: (b)

Sol: $E = \frac{hc}{\lambda} = \frac{6.624\times10^{-34}\times3\times10^8}{633\times10^{-9}}$

$E = 3.14\times10^{-19}$ J

This is the energy emitted by the single photon.

Now photons emitted in one sec

$= \frac{3\times10^{-3}}{3.14\times10^{-19}}\left(\frac{\text{photon}}{\text{sec}}\right)$

$= 9.55\times10^{15}\left(\frac{\text{photon}}{\text{sec}}\right)$

Now the photons emitted per minute

$= 9.55\times10^{15}\times60$

$= 5.73\times10^{17}$ (photons/minute)

52. Ans: (b)

Sol: $(a)^n u(n) \leftrightarrow \frac{1}{1-ae^{-j\omega}}$

$$X(e^{j\omega}) = \frac{1}{1-ae^{-j\omega}} = \frac{1}{1-a(\cos\omega - j\sin\omega)}$$

$$ESD = |X(e^{j\omega})|^2$$

$$= \left(\frac{1}{\sqrt{(1-a\cos\omega)^2 + (a\sin\omega)^2}}\right)^2$$

$$\therefore ESD = \frac{1}{1+a^2-2a\cos\omega}$$

At $\omega = 0$ ESD value is $\frac{1}{1+a^2-2a}$

53. Ans: (b)

Sol: Total marbles = 10 + 30 + 20 + 15 = 75

P[both are white]

= P[first is white and second is white]

$$= \frac{30}{75} \times \frac{30}{75} = \frac{4}{25}$$

54. Ans: (c)

Sol: 75°F is the midpoint temperature that will be used as T_0 $R(T_0) = 110.2(\Omega)$

Slope α is $\frac{1}{R_{T0}}\left(\frac{R_{final} - R_{initial}}{T_{final} - T_{initial}}\right)$

$$\text{Slope} = \frac{1}{110.2} \times \frac{(112.2 - 106.0)}{(90-60)}$$

= 0.001875 ($1/^oF$)

Then the linear approximation for resistance

$R_T = R_0\ (1+\alpha\Delta T)$

$R_T = 110.2[1 + 0.001875(T - 75)]\ (\Omega)$

55. Ans: (c)

Sol: $x(t) = C_{12}$ (A cos t) $0 < t < 2\pi$

$$C_{12} = \frac{\int_{t_1}^{t_2} x(t)\ A\cos t}{\int_{t_1}^{t_2} (A\cos t)^2\ dt}$$

$$= \frac{\int_0^{\pi/2} A^2\cos t + \int_{\pi/2}^{3\pi/2} -A^2\cos t + \int_{3\pi/2}^{2\pi} A^2\cos t}{\int_0^{2\pi} A^2\cos^2 t\ dt}$$

$$C_{12} = \frac{4}{\pi}$$

So, $x(t) = \frac{4A}{\pi}\cos t \quad 0 < t < 2\pi$

56. Ans: (a)

Sol: Vulgarity (n.) means offensive speech or conduct.

57. Ans: (a)

58. Ans: (b)

59. Ans: (a)

Sol: Cylinder volume = $\pi r^2 h$

$$= \frac{22}{7} \times 10 \times 10 \times 14$$

$= 4400\ m^3$

60. Ans: (d)

Sol: Speed = 10 kmph = $10 \times \frac{5}{18}$ m/sec

$$= \frac{50}{18}\ \text{m/sec}$$

Man walks 50 m in 18 sec.

61. Ans: (d)

Sol: Rate downstream = (24/2) kmph = 12 kmph.

Rate upstream = (24/4) kmph = 6 kmph.

Therefore, speed in still water

= 1/2* (12 + 6) = 9 kmph.

62. Ans: (b)

Sol: Let principle be 4. Then amount = $4 \times \frac{7}{4} = 7$

Interest = 7 – 4 = 3

Rate of interest $= \frac{3 \times 100}{4 \times 4} = 18\frac{3}{4}\%$

63. Ans: (c)

Sol: Net part filled in 1 hour

$$= \frac{1}{10} + \frac{1}{12} - \frac{1}{20} = \frac{6+5-3}{60}$$

$$= \frac{11-3}{60} = \frac{8}{60} = \frac{2}{15}$$

The tank will be full in $\frac{15}{2}$ hrs

= 7 hrs.30 min.

64. Ans: (a)

Sol: Share of wealth that C gets (in Rs lakhs)

= 20

Tax = 40%

$\Rightarrow$ Wealth tax (in Rs lakhs) that C has to pay

$= \frac{40}{100} \times 20 = 8$

65. Ans: (a)

Sol: Note that an assumption is like a premise in that if it is wrong the argument is invalid, and if it is right it supports the conclusion. If the statement in (A) is correct, it supports the idea that point and shoot is not art, but if it is wrong, and choosing what to point the camera at involves art, then the argument is invalid. Hence, (A) is an assumption.