Branch: Electronics & Communication 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: B = bandwidth = 4000 Hz

$S = 0.1 \times 10^{-3}$ W

$N = \eta B = 2\times10^{-12}\times4000$

N = 8nW

$$\frac{S}{N} = \frac{0.1\times10^{-3}}{8\times10^{-9}} = 1.25\times10^{4}$$

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

$$= 4000\log_2\left(1+1.25\times10^{4}\right)$$

C = 54.44 kbps

03. Ans: (a)

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

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

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

Approximate transfer function (considering dominant pole only) of system is

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

04 Ans: (c)

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

Using variable separable method

$e^y = x^4 + c$

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

$\Rightarrow e^y = x^4$

05. Ans: 16.478 (Range: 16.4 to 16.5)

Sol: When port 2 is terminated with a matched load, the reflection coefficient seen at port 1 is $\Gamma = S_{11} = 0.15$.

So RL = $-20\log|\Gamma| = -20\log(0.15)$

= 16.478dB

06. Ans: 2.162 (Range: 1.8 to 2.4)

Sol: **Ge:**

$$I = I_0\left(e^{\frac{V}{\eta V_T}} - 1\right)$$

$$-0.9\, I_{G0} = I_{G0}\left(e^{-\frac{V_G}{\eta V_T}} - 1\right)$$

$$-0.9 + 1 = e^{-\frac{V_G}{\eta V_T}}$$

$$-\frac{V_G}{\eta V_T} = \ln(0.1)$$

$-V_G = \eta V_T \ln(0.1)$

$-V_G = (1)\ 26 \times 10^{-3} \ln(0.1)$

$V_G = 59.87$ mV

Si:

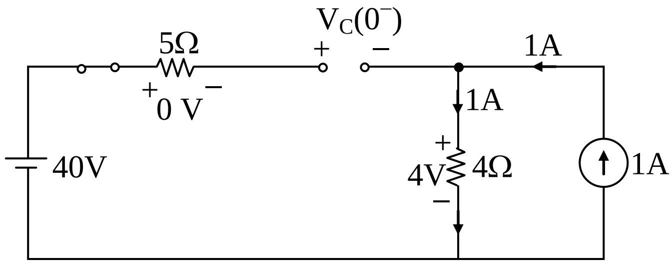
$$I = I_0\left(e^{\frac{V}{\eta V_T}} - 1\right)$$

$$I = I_{S0}\left(e^{\frac{59.87\times10^{-3}}{(2)26\times10^{-3}}} - 1\right)$$

$I = 2.162\ I_{S0}$

07. Ans: 10 (No Range)

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

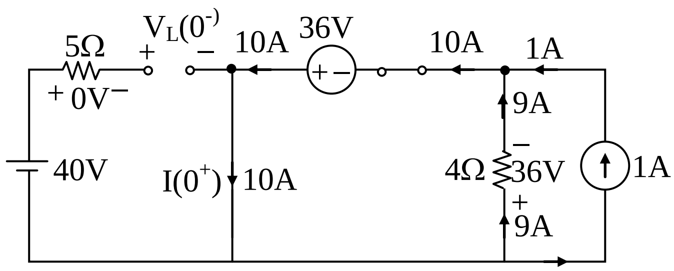


By KVL $\Rightarrow 40 - V_C(0^-) - 4 = 0$

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

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

Circuit at $t = 0^+$ is

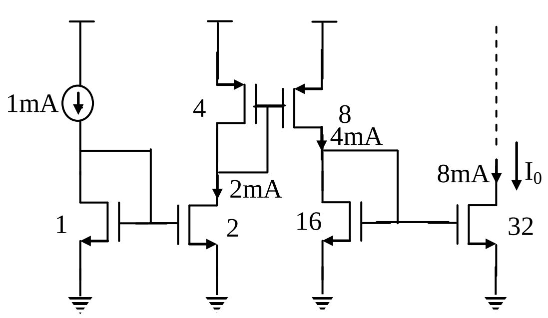


08. Ans: 8 (No range)

Sol: The drain current in saturation region is given by

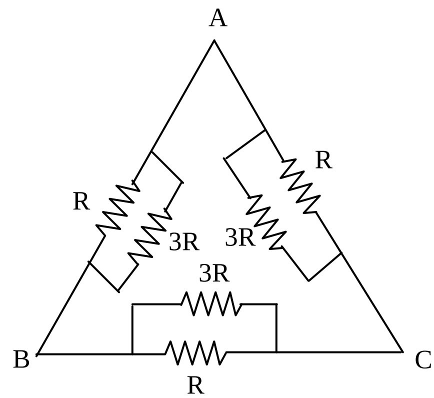
$$I_D = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)(V_{GS} - V_T)^2$$

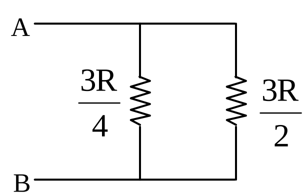
So, $I_D \propto \frac{W}{L}$

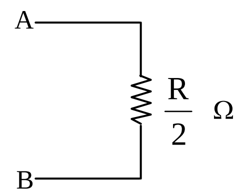


09. Ans: (c)

Sol:

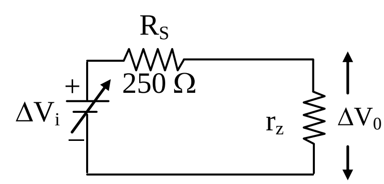






10. Ans: 12.7 (Range: 10.5 to 14.5)

Sol:



(variable part of circuit)

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

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

$r_z = 12.697\ \Omega$

11. Ans: 12

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

Step (1):

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

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

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

$$= 1.5\times10^{4}(100.5-99.5)\text{mV}$$
$$+1.5\left(\frac{100.5+99.5}{2}\right)\text{mV} \_\_\_\_(3)$$
$$=1.5\times10^{4}\times1\times10^{-3}\text{V}+1.5\times100\times10^{-3}\text{V}\_\_\_\_(4)$$
$$=15.15\text{V}\_\_\_(5)$$

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

$\therefore V_o = +12V \_\_\_\_(6)$

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)

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

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

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

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

$+ \overline{A}BCD + \overline{A}B\overline{C}D + A\overline{B}\,\overline{C}D$

$+ A\overline{B}\,\overline{C}\,\overline{D} + AB\overline{C}\,\overline{D}$.

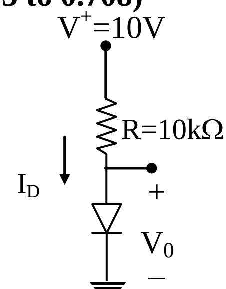
$F = \sum m(2,3,5,7,8,9,12)$

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

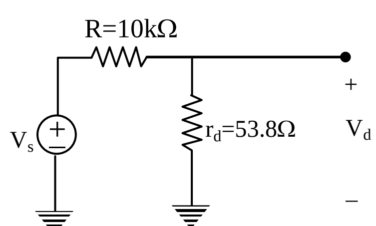
Sol: $I_D = \dfrac{10-0.7}{10\,k} = 0.93\,mA$

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

$= 53.8\ \Omega$



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

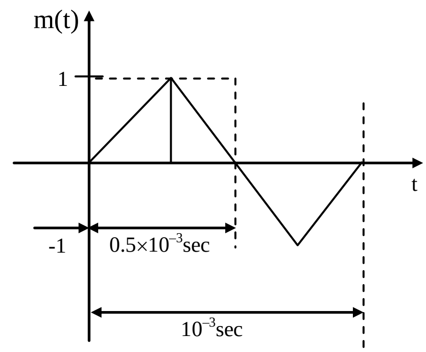


Here V_S denotes the 50 Hz, 1 V peak sinusoidal component of V^+, the peak amplitude of

$$V_{ac} = \hat{V}_s \cdot \frac{r_d}{R+r_d} = 1V\times\frac{53.8}{10k+53.8}$$
$$= 0.0053\ V$$
$$V_{dc} = 0.7\,V$$
$$V_d(\text{Peak}) = V_{ac}+V_{dc} = 0.0053+0.7 = 0.7053$$

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}

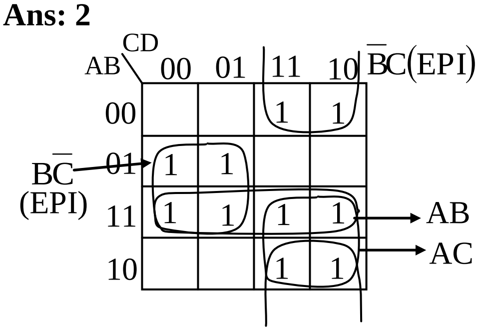
$\therefore m^{1}(t)$ is a square wave with amplitude ± 4000.

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

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

15. Ans: 2

Sol:



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

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

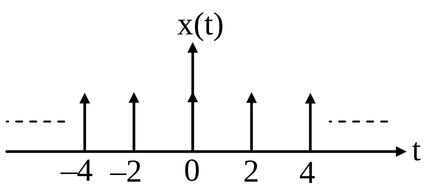
Three non touch loop gains

$= G_1 H_1 G_3 H_3 G_5 H_4$

$= G_1 H_1 G_3 H_3 G_6 H_5$

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

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

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

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

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: 3.56 (Range: 3.4 to 3.7)

Sol: At 300 MHz, $\lambda = 1m$

$\therefore R_{rad} = 80\pi^2 \left(\frac{d\ell}{\lambda}\right)^2$

$= 80\pi^2 \left(\frac{1\times10^{-2}}{1}\right)^2 = 78.9m\Omega$

Thus, for 1 W radiated power

$I_{rms}^2 = \frac{P_{rad}}{R_{rad}} = \frac{1}{78.9\times10^{-3}}$

$\therefore I_{rms} = 3.56$ A

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

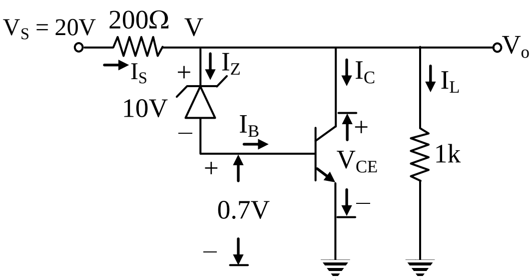
27. Ans: 379.26 (Range: 378 to 381)

Sol: Step (1):

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

$= 10.7V$

$= V_{CE}$ ________(1)



Current through output load resistor

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

Step (2): KVL for input loop

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

Step (3): KCL at node V_0

$I_S = I_Z + I_C + I_L$

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

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

$= 35.8mA$ _____(5)

$\Rightarrow I_C = 35.445mA$_______(6)

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

28. Ans: 25.09 (Range: 24.00 to 26.00)

Sol: Given: Air-filled rectangular waveguide

$a = 6cm$

$b = 3cm$

$P_{avg} = 1h.P = 746W$

Dominant mode, TE_{10}

$f = 20GHz$

$$f_c(TE_{10}) = \frac{c}{2a} = \frac{3\times10^{10}}{2\times6}$$

$f_c = 2.5$ GHz

$$\eta_{TE} = \frac{\eta_0}{\sqrt{1-\left(\frac{f_c}{f}\right)^2}}$$

$$= \frac{377}{\sqrt{1-\left(\frac{2.5}{20}\right)^2}}$$

$\therefore \eta_{TE} = 380\Omega$

Average power carrying by the dominant mode is given by

$$P_{avg} = \frac{E_0{}^2}{\eta_{TE}}\left(\frac{ab}{4}\right)$$

$$E_0 = \sqrt{\frac{746\times380\times4}{6\times3\times10^{-4}}}$$

$\therefore E_0 = 25.09$kV/m

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

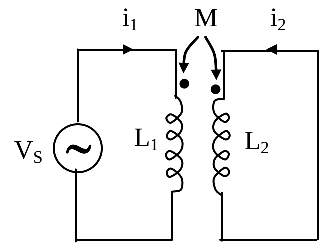
$c \in (0, 5)$, such that

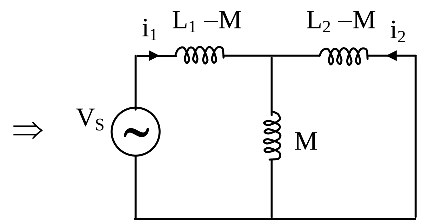
$$g^1(c) = \frac{g(5)-g(0)}{5-0}$$

$$= \frac{\left(-\frac{1}{6}\right)-4}{5} = \frac{-5}{6}$$

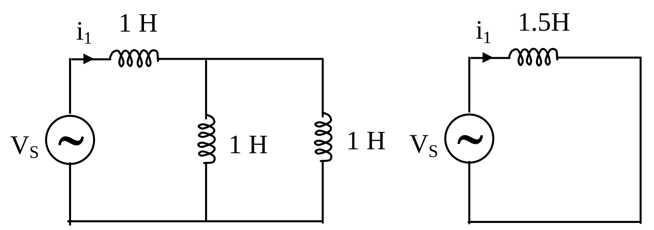
30. Ans: (a)

Sol:





The equivalent circuit is



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

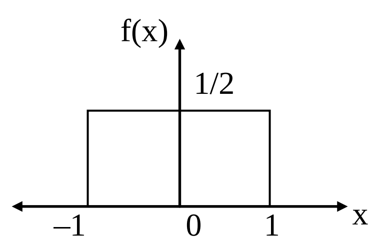
$$= \frac{1}{2}\times1.5\times2^2$$

$E = 3J$

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

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

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



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

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

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

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

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

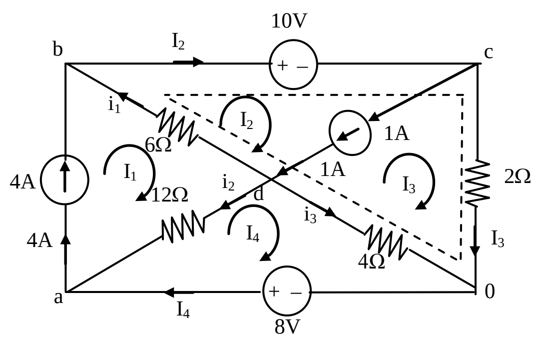
$$n = \log_2 256 = 8$$

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

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

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: 4.9486 (Range: 4.81 to 5.15)

Sol: $N_A = 10^{16}/cm^3$

$E_g = 1.1$ eV

Electron affinity of silicon $q\chi = 4.05$ eV

$n_i = 1.5\times 10^{10}/cm^3$

$V_T = 26$ mV

Work function $\phi_s = q\chi + \phi_{FP} + \dfrac{E_g}{2}$

$$= 4.05\,eV + KT\ln\left(\frac{N_A}{n_i}\right) + \frac{1.1eV}{2}$$

$$= 4.05\,eV + 26\times 10^{-3}\ln\left(\frac{10^{16}}{1.5\times 10^{10}}\right) + 0.55\ eV$$

= 4.9486 eV

35. Ans: (d)

Sol: [A/B] =

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

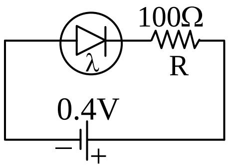
To be consistent Rank of augmented matrix (ρ(A/B)) and Rank of A matrix should be equal.

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

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

Sol: Photo-diode current

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



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

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

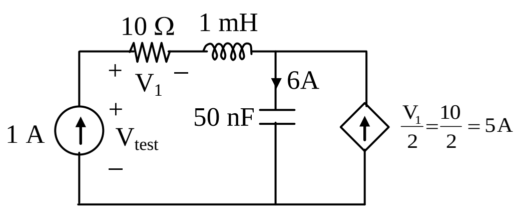
$$R_P = \frac{V_S}{I_d} - R$$

$$= \frac{0.4}{1.8\times10^{-3}} - 100$$

$= 122.22\ \Omega$

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

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

$$\omega_0^2 LC = 6$$

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

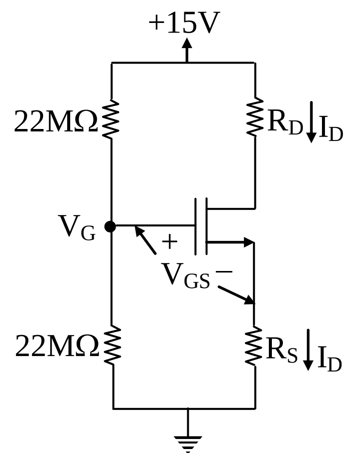
$$\omega_0 = \sqrt{\frac{6}{LC}}$$

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

$f_0 = 55$ kHz

38. Ans: (c)

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



Step (2):

KVL for G-S loop

∵ I_DR_S = one third of supply voltage

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

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

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

= 2.7mA

Step (3): $I_DR_D = \frac{1}{3}(15\text{V}) = 5\text{V}$

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

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

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

39. Ans: (c)

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

= C(3 – 1 + 5, 5)

= 21

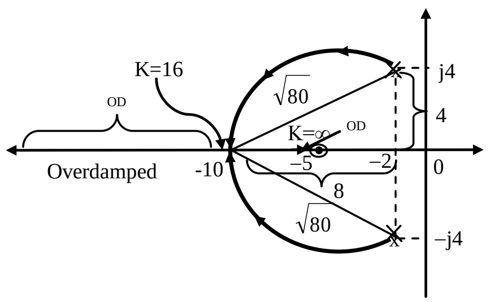
Similarly we can distribute 5 white balls in 21 ways and 5 blue balls in 21 ways.

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: $\text{Step size} = \frac{5\times10^{-3}}{2^8 - 1} = 19.6\mu A$

Analog output = 130×19.6 = 2.548 mA

$\text{error} = \pm\frac{0.25\times5\times10^{-3}}{100} = \pm12.5\mu A$

Range of analog output = 2.548 ± 12.5μA

= 2.5355 to 2.5605 mA

43. Ans: (b)

Sol: For a dispersive medium, both V_p & β are function of frequency

We know, $V_p = \frac{\omega}{\beta}$

$V_g = \frac{1}{\frac{d\beta}{d\omega}}$

Then, differentiating V_p with respect to β is given by,

$$\frac{dV_p}{d\beta} = \frac{\beta.\frac{d\omega}{d\beta} - \omega(1)}{\beta^2}$$

$$\Rightarrow \beta\frac{dV_p}{d\beta} = \frac{d\omega}{d\beta} - \frac{\omega}{\beta}$$

$$\Rightarrow \frac{d\omega}{d\beta} = V_p + \beta\frac{dV_p}{d\beta} \quad ....(1)$$

We know, $\beta = \frac{2\pi}{\lambda}$

$$\Rightarrow \frac{d\beta}{d\lambda} = -\frac{2\pi}{\lambda^2}$$

$$\Rightarrow d\beta = -\frac{2\pi}{\lambda^2}.d\lambda$$

So we can write equation (1) as

$$\Rightarrow \frac{d\omega}{d\beta} = V_p + \frac{2\pi}{\lambda}\frac{dV_p}{(-2\pi)d\lambda}.\lambda^2$$

$$\Rightarrow V_g = V_p - \lambda\frac{dV_p}{d\lambda}$$

Given, $V_p = K\sqrt{\lambda}$

$$\frac{dV_p}{d\lambda} = \frac{K}{2\sqrt{\lambda}}$$

$$V_g = K\sqrt{\lambda} - \lambda\frac{K}{2\sqrt{\lambda}} = K\sqrt{\lambda} - \frac{K\sqrt{\lambda}}{2}$$

$$= V_p(1 - 1/2) = \frac{V_p}{2}$$

$$= \frac{300\times 10^6\ m/s}{2}$$

$$= 150\times 10^6\ m/s$$

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 (Range: 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, $Im(Z_{in}) = 0$. 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.

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

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

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

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

$= 2.203$mH

47. Ans: (c)

Sol: The constellation of figure (A) has four points at a distance of 2A from the origin & 4 points at a distance of $2\sqrt{2}$ A.

Thus Average power of A

$$P_A = \frac{1}{8}\left[4\times(2A)^2 + 4\times(2\sqrt{2}A)^2\right]$$

$= 6A^2$

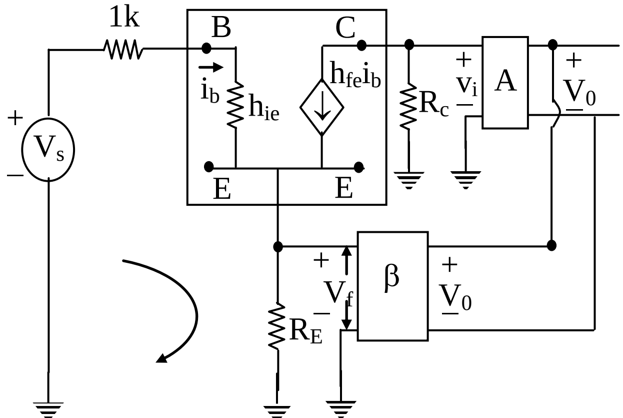
48. Ans: (c)

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

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

ω = 0 magnitude M =1.2

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

ω = 0 ------- ϕ = 0°

ω = ∞ ------ ϕ = –270°

The polar starts at 1.2∠0° and ends at 0∠–270°

51. Ans: (b)

Sol: For all

$\ell = (2m+1)\frac{\lambda}{4}$

$Z_{in} = \frac{Z_0^2}{Z_L}$

Normalized input impedance

$\left(\frac{Z_{in}}{Z_0}\right) = \frac{1}{\left(\frac{Z_L}{Z_0}\right)}$

$\frac{Z_L}{Z_0}$ is the normalized load impedance

$\overline{Z}_{in} = \frac{1}{\overline{Z}_L} = \overline{Y}_L$ Where $\left\{\begin{array}{l}\overline{Z}_{in} = \frac{Z_{in}}{Z_0}\\ \overline{Z}_L = \frac{Z_L}{Z_0}\end{array}\right\}$

$$\therefore \ell_{min} = \frac{\lambda}{4} \left\{ \lambda = \frac{c}{f} = \frac{3\times10^8}{200\times10^6} = 1.5\text{ m} \right\}$$

$$\therefore \ell_{min} = \frac{1.5}{4} = 0.375\text{m}$$

52. Ans: (b)

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

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

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

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

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

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

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: (b)

Sol: $P_e = Q\left[\sqrt{\dfrac{2A^2T}{\eta}}\right] \le 10^{-4}$

$Q(x) = 10^{-4}$ for x = 3.71

$$\therefore \sqrt{\frac{2A^2T}{\eta}} = \sqrt{\frac{2(1)^2T}{2\times10^{-5}}} = 3.71$$

$T = 1\times10^{-5}\times3.71^2$

$T = 1.376\times10^{-4}$

$R = \dfrac{1}{T} = 7.265\text{kbps}$

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

56. Ans: (a)

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

57. Ans: (a)

58. Ans: (b)

59. Ans: (a)

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

$$= \frac{22}{7}\times10\times10\times14$$

$$= 4400\text{ m}^3$$

60. Ans: (d)

Sol: Speed = 10 kmph = $10\times\dfrac{5}{18}$ 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.