Branch: Electronics & Communication Engineering - SOLUTIONS

01. Ans: 496 (No Range)

Sol: For n-bit comparator,

Number of combinations for which A > B is $\dfrac{2^{2n}-2^{n}}{2}$

Here n = 5. (It is a 4 bit magnitude comparator)

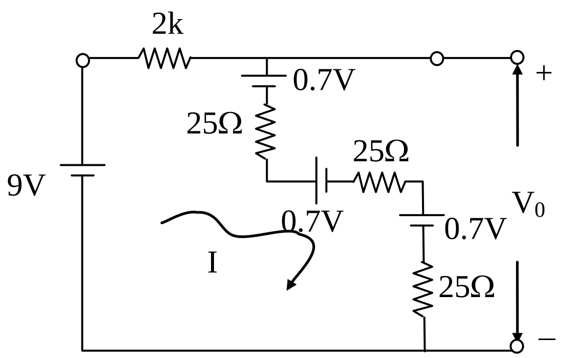
$= \dfrac{2^{2\times5}-2^{5}}{2} = 496$

02. Ans: (a)

Sol: In the given circuit D_1, zener & $D_4 \rightarrow$ F.B

D_3 & D_2 – R.B $\rightarrow$ O.C

When zener F.B it behaves like a pn diode



Then the equation for the circuit is

$$-9 + I(2k) + 0.7 + I(25) + 0.7 + I(25) + 0.7 + I(25) = 0$$

From the above circuit I is given by

I = 3.325 mA

$V_0 = (0.7+25I)3$

$= 2.1 + 75\times3.325\times10^{-3}$

$= 2.1+0.249$

$= 2.35V$

03. Ans: (a)

Sol: For series RLC transient current to be oscillatory

$\xi < 1$

$\dfrac{R}{2}\sqrt{\dfrac{C}{L}} < 1$

$R < 2\sqrt{\dfrac{L_{eq}}{C_{eq}}}$

$R < 2\sqrt{\dfrac{1}{9}}$

$R < \dfrac{2}{3}\ \Omega$

04. Ans: 1 (No range)

Sol: Let $A = \begin{bmatrix}1 & 2 & 0\\0 & 1 & 3\\0 & 0 & 1\end{bmatrix}$

A is the upper triangular matrix eigen value is 1 only

Consider $(A - I) = \begin{bmatrix}0 & 2 & 0\\0 & 0 & 3\\0 & 0 & 0\end{bmatrix}$

Clearly earth of (A – I) = 2

Geometric multiplicity of eigen value 1 = No. of linearly independent eigen vectors

= n – r

= 3 – 2 = 1

05. Ans: 10.5 (no range)

Sol: The average current

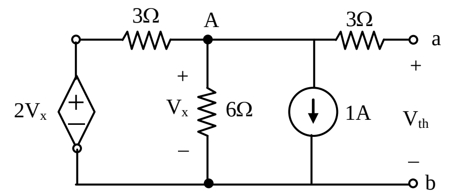
$$I_{CC} = \frac{I_{CCH} + I_{CCL}}{2} = \frac{2.4+1.8}{2} = 2.1\mu A$$

The average power dissipation

$P_D = V_{CC} \times I_{CC} = 5V \times 2.1\mu A = 10.5\ \mu W$

06. Ans: (d)

Sol:



Current flowing through 3Ω is zero so $V_{th} = V_x$

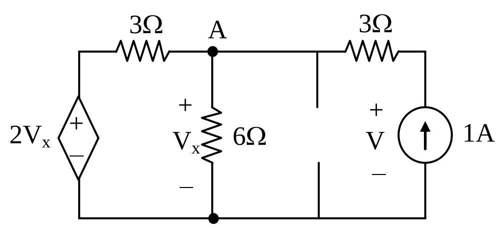
Apply KCL at node A, then

$$\frac{V_x - 2V_x}{3} + \frac{V_x}{6} + 1 = 0$$

$-2V_x + V_x + 6 = 0$

$V_x = 6V$

R_{th} can be find out by exciting the circuit with 1A, replace all independent sources by their internal resistances



By KCL at node A

$$\frac{V_x}{6} + \frac{(V_x - 2V_x)}{3} - 1 = 0$$

$V_x - 2V_x - 6 = 0$

$V_x = -6V$

$V = 3 + V_x = 3 - 6 = -3V$

$$R_{th} = \frac{V}{I} = \frac{-3}{1} = -3\Omega$$

07. Ans: (c)

Sol: $\%\eta_{FM} = (1 - J_0^2(\beta)) \times 100$

$= (1 - 0.5^2) \times 100$

$= 75\%$

08. Ans: (a)

Sol: We have

$$\rho_v = \nabla.\overline{D} = \frac{\partial D_z}{\partial z} = \frac{\partial}{\partial z}\left(z^3 \rho \cos^2\phi\right)$$

$$= 3z^2 \rho \cos^2 \phi$$

$$\text{Now, } Q = \int_v \rho_v dv$$

$$= \int_v 3z^2 \rho \cos^2\phi \times \rho d\phi d\rho dz$$

$$= 3 \int_{z=-2}^{2} z^2 dz \int_{\phi=0}^{2\pi} \cos^2\phi d\phi \int_{\rho=0}^{1} \rho^2 d\rho$$

$$= \frac{3}{3} \times 16 \times \pi \times \frac{1}{3} = \frac{16}{3}\pi \text{ C}$$

09. Ans: (a)

Sol: Given $x(t) = 3e^{-t}u(t)$, $h(t) = 2e^{-2t}u(t)$

Apply L.T

$$X(s) = \frac{3}{s+1}, H(s) = \frac{2}{s+2}$$

$$Y(s) = X(s).H(s) = \frac{6}{(s+1)(s+2)}$$

$$Y(s) = \frac{6}{s+1} - \frac{6}{s+2}$$

Apply ILT

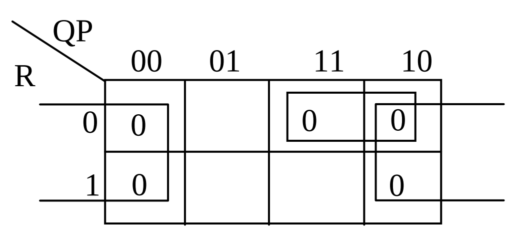
$y(t) = 6\,[e^{-t} - e^{-2t}]u(t)$

10. Ans: (d)

Sol: $F = \overline{\Sigma m(0,2,3,4,6)}$

$= \Sigma m(1,5,7)$

$= \Pi M(0,2,3,4,6)$



$$F = P\left[R + \overline{Q}\right]$$

11. Ans: 7 (No range)

Sol: $d_{min} = 2t + 1$

$t = 3$

$d_{min} = 7$

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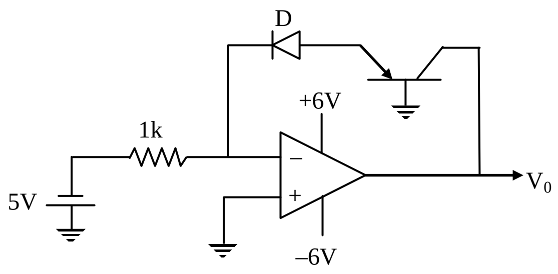
12. Ans: 6 (No range)

Sol:



In this circuit diode tries to conduct but the transistor which is in cut-off region does not allow
any current and hence negative feedback does not exist.
Therefore op-amp acts as comparator. So output voltage V_0 = +6V

13. Ans: (a)

Sol: We have for lossy medium

$$|\eta| = \frac{\sqrt{\frac{\mu}{\varepsilon}}}{\left[1+\left(\frac{\sigma}{\omega\varepsilon}\right)^2\right]^{1/4}} \quad \text{and} \quad \tan 2\theta_n = \frac{\sigma}{\omega\varepsilon}$$

For good conductor

$$\frac{\sigma}{\omega\varepsilon} >> 1$$

$$\text{So, } |\eta| = \frac{\sqrt{\frac{\mu}{\varepsilon}}}{\left(\left(\frac{\sigma}{\omega\varepsilon}\right)^2\right)^{1/4}} = \frac{\sqrt{\frac{\mu}{\varepsilon}}}{\sqrt{\frac{\sigma}{\omega\varepsilon}}}$$

$$= \sqrt{\frac{\mu}{\varepsilon}} \times \sqrt{\frac{\omega\varepsilon}{\sigma}} = \sqrt{\frac{\omega\mu}{\sigma}}$$

$$\theta_n = \frac{1}{2}\tan^{-1}\left(\frac{\sigma}{\omega\varepsilon}\right) = \frac{1}{2}\times 90^0 = 45^0 \quad \left(\because \frac{\sigma}{\omega\varepsilon} >> 1\right)$$

For good conductor skin depth

$$\delta = \frac{1}{\alpha} = \frac{1}{\beta} = \frac{1}{\sqrt{\frac{\omega\mu\sigma}{2}}}$$

So, intrinsic impedance

$$\eta = |\eta| e^{j\theta_n}$$

$$= \sqrt{\frac{\omega\mu}{\sigma}}\, e^{j\pi/4}$$

$$= \sqrt{\frac{\omega\mu\sigma}{2}} \times \frac{1}{\sigma} \times \sqrt{2} e^{j\pi/4}$$

$$= \frac{1}{\delta} \times \frac{1}{\sigma} \times \sqrt{2} \times e^{j\pi/4}$$

$$= \frac{1}{\sigma\delta} \times \sqrt{2}\left(\cos\frac{\pi}{4} + j\sin\frac{\pi}{4}\right)$$

$$= \frac{1}{\sigma\delta} \times \sqrt{2}\left(\frac{1}{\sqrt{2}} + j\frac{1}{\sqrt{2}}\right)$$

$$= \frac{1}{\sigma\delta}(1+j)$$

14. Ans: 0 (No range)

Sol: $\text{Grad}(l\text{nr}) = \frac{1}{r}\frac{1}{r}\vec{r} = \frac{\vec{r}}{r^2}$

$$\text{Curl } (r^2 \text{ grad } l\text{nr}) = \text{curl}\left(r^2 \frac{\vec{r}}{r^2}\right)$$

$$= \text{curl } (\vec{r}) = 0$$

15. Ans: 0.4 (No range)

Sol: $$\frac{4s+10}{s} = 4 + \frac{10}{s} = 4\left[1+\frac{10}{4s}\right]$$

$$= 4\left[1+\frac{1}{\frac{4}{10}s}\right]$$

$$= 4\left[1+\frac{1}{0.4s}\right]$$

$$= 4\left[1+\frac{1}{T_I s}\right]$$

$\therefore T_I$ = reset time = 0.4 sec

16. Ans: 53 (No range)

Sol: $V(2x + 3y) = 2^2 V(x) + 3^2 V(y)$

$= (4 \times 2) + (9 \times 5)$

$= 53$

17. Ans: 5 (No range)

Sol: $Z_{11} = 6\Omega$, $Z_{12} = Z_{21} = 4\Omega$

For symmetrical network, $Z_{11} = Z_{22} = 6\Omega$

ABCD parameters

$V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

$$B = \left.\frac{-V_1}{I_2}\right|_{V_2=0}$$

Now from Z – parameters

$V_1 = Z_{11} I_1 + Z_{12}I_2 = 6I_1 + 4I_2$ …….. (1)

$V_2 = Z_{21} I_1 + Z_{22}I_2 = 4I_1 + 6I_2$ …….. (2)

By putting $V_2 = 0$ in equation (2)

$4I_1 = -6I_2$

Put value of I_1 in equation (1) than

$$V_1 = 6\left(-\frac{6}{4}\right)I_2 + 4I_2$$

$$= I_2\left[\frac{-36}{4} + 4\right] = -5I_2$$

So $\frac{V_1}{I_2} = -5$

$B = -(-5) = 5\Omega$

18. Ans: (b)

Sol: Given $f_i = 100$ kHz

Frequency at $A = f_A = \frac{100\text{kHz}}{10} = 10\text{kHz}$

Frequency at $B = f_B = \frac{10\text{kHz}}{20} = 500\text{Hz}$

Frequency at $C = f_C = \frac{500\text{Hz}}{16} = 31.25\text{Hz}$

Frequency at $D = f_D = \frac{31.25\text{Hz}}{8} = 3.9\text{Hz}$

19. Ans: (d)

Sol:

Bag -1	**Bag- 2**
5 Red	4 Red
7 Green	8 Green

By total probability $= \frac{1}{2}\times\frac{7}{12} + \frac{1}{2}\times\frac{8}{12}$

$= \frac{15}{24}$

20. Ans: 36 (No range)

Sol: To get the peak current both NMOS and PMOS are operated in saturation at switching threshold $V_m = \frac{V_{DD}}{2}$ and the peak current is given by

$$I_{peak} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_n\left(\frac{V_{DD}}{2} - V_{tn}\right)^2$$

$$= \frac{1}{2}\times 300\times 10^{-6}\times 1.5\times(0.9-0.5)^2$$

$= 36\mu A$

21. Ans: (d)

Sol: $G = kD$

$= k\times\frac{4\pi}{\lambda^2}\times A_e$ (k is the efficiency factor)

$= 1\times\frac{4\pi}{\lambda^2}\times\frac{\pi}{4}3^2$ (for loss less antenna k=1)

$$= \frac{9\pi^2}{\lambda^2}$$

$$= \frac{9\pi^2}{(1)^2} \quad \left(\because \lambda = \frac{3\times 10^8}{300\times 10^6} = 1\text{m}\right)$$

22. Ans: (c)

Sol: $S_{AM}(t) = 10\cos(198\pi t) + 40\cos(200\pi t) + 10\cos(202\pi t)$

Carrier term is $= 40\cos(200\pi t)$

$A_C = 40$, $f_C = 100$

LSB term: $10\cos(198\pi t)$

$\frac{A_C\mu}{2} = 10$ $\quad f_C - f_m = 99$

$\mu = \frac{2\times 10}{40} = 0.5$, $f_m = 1$

message signal: $A_m\cos(2\pi f_m t)$

$\frac{A_m}{A_C} = \mu \Rightarrow A_m = \mu.A_C = 0.5\times 40 = 20$

$m(t) = 20\cos(2\pi t)$

23. Ans: (c)

Sol: By observing the N-MOS circuit, C is in parallel to the series combination of A and B. Thus, $\overline{Y} = AB + C$

24. Ans: (c)

Sol: Given $f_c = 1000Hz$ and $f_s = 1500Hz$

$\Omega_c = 2\pi f_c$ $\Omega_s = 2\pi f_s$

$\Omega_c = 2000\pi$ $\Omega_s = 3000\pi$

For attenuation of –20dB

$-20 \log_{10}(x) = 20$

$\Rightarrow x = 10^{-1} = 0.1$

Here, $x = \delta_s = 0.1$

Now,

$$N = \frac{\log_{10}\left[\frac{1}{\delta_s^2} - 1\right]}{2\log_{10}(\Omega_s/\Omega_c)}$$

$$N = \frac{\log_{10}(100-1)}{2\log_{10}(1.5)} = 5.67$$

N = 6

25. Ans: –1 (No range)

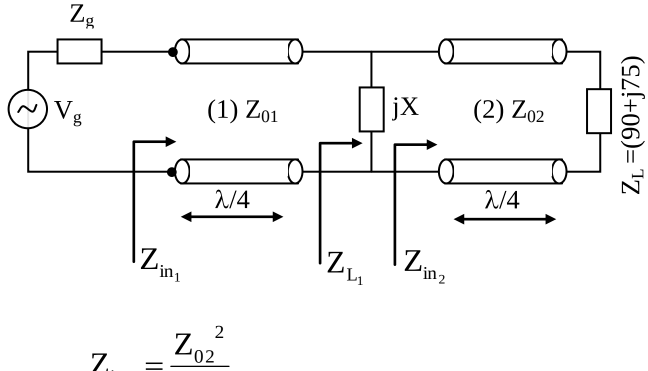
Sol: $$\underset{x\to 0}{\text{Lt}} \frac{\sin x}{x(x-1)} = \underset{x\to 0}{\text{Lt}} \frac{1}{x-1} . \underset{x\to 0}{\text{Lt}} \frac{\sin x}{x}$$

$= -1 \times 1$

$= -1$

26. Ans: (a)

Sol: For maximum power to be delivered to the load, the power delivered to the input terminals of line (1) must be maximum, so, the equivalent input impedance of the transmission line must be equal to its source impedance.



$$Z_{in_2} = \frac{Z_{02}^2}{Z_L}$$

$$Z_{L_1} = (jX // Z_{in_2})$$

$$\frac{1}{Z_{L_1}} = \frac{1}{jX} + \frac{1}{Z_{in_2}}$$

$$\frac{1}{Z_{L_1}} = \frac{1}{jX} + \frac{Z_L}{Z_{02}^2} \rightarrow (1)$$

$$Z_{in_1} = \frac{Z_{01}^2}{Z_{L_1}}$$

$$= \frac{Z_{in_1}}{Z_{01}^2} = \frac{1}{Z_{L_1}} \rightarrow (2)$$

From equation (1) and (2)

$$\frac{Z_{in_1}}{Z_{01}^2} = \frac{1}{jX} + \frac{Z_L}{Z_{02}^2}$$

$Z_{in_1} = Z_g^*$ (from maximum power transfer theorem)

$Z_{in_1} = 40 - j50$

$$\frac{40-j50}{50^2} = \frac{-j}{X} + \frac{90+j75}{Z_{02}^2}$$

Equating real parts,

$$\frac{40}{50^2} = \frac{90}{Z_{02}^2}$$

$Z_{02} = 75\Omega$

Equating Imaginary parts,

$$\frac{-50}{50^2} = \frac{-1}{X} + \frac{75}{Z_{02}^2}$$

$X = 30\Omega$

27. Ans: (b)

Sol: Given f(D) y = Q(x) ....(1)

where $f(D) = D^2 + 3D + 2$

and Q(x) = cos(x)

C.F: Consider A.E, f(m) = 0

$\Rightarrow m^2 + 3m + 2 = 0$

$\Rightarrow m = -1, -2$

$\therefore y_c = c_1e^{-x} + c_2e^{-2x}$

P.I: Here, Q(x) = cos(x) = cos(ax+b)

and $f(D) = \phi(D^2) = \phi(-a^2) = \phi(-1)$

$= (-1) + 3D + 2 = 1 + 3D \neq 0$

Now,

$$y_p = \frac{1}{1+3D} \times \frac{1-3D}{1-3D}\cos(x) = \frac{1-3D}{1-9D^2}\cos(x)$$

$$\Rightarrow y_p = (1-3D)\left[\frac{1}{1-9(-1)}\cos x)\right]$$

$$= (1-3D)\left(\frac{1}{10}\cos(x)\right)$$

$$\therefore\ y_p = \frac{\text{cox}(x)}{10} + \frac{3}{10}\sin x$$

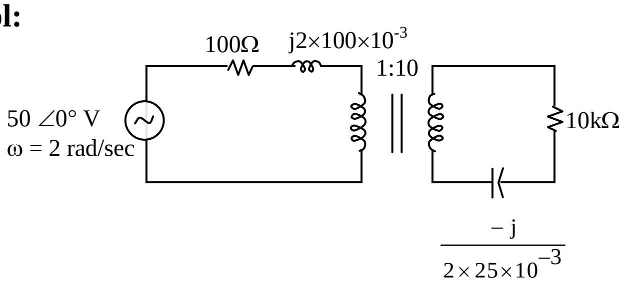
Hence, the general solution of (1) is

$y = y_c + y_p$

$$\text{i.e., } y = c_1 e^{-x} + c_2 e^{-2x} + \frac{\cos(x)}{10} + \frac{3}{10}\sin x$$

28. Ans: (c)

Sol:



By transferring secondary impedance to primary then

$$z_2' = \frac{z_2}{k^2} \qquad k = \frac{10}{1} = 10$$

$$z_2' = \frac{10\,k\Omega - \dfrac{j}{2\times 25\times 10^{-3}}}{100}$$

$$= 100 - \frac{j}{5} = 100 - j0.2$$

$$I_1 = \frac{50}{100 + j0.2 + 100 - j0.2}$$

$$= \frac{50}{200} = \frac{1}{4} = 250\,\text{mA}$$

$$I_2 = \frac{I_1}{k} = \frac{I_1}{10} = 25\,\text{mA}$$

So power dissipated in the 10kΩ resistor is

$P = (25 \times 10^{-3})^2\ 10k\Omega$

$= 6.25$ W

29. Ans: (a)

Sol: $\angle G(s) = -3\ \omega_{pc} - 90° = -180°$

$$\Rightarrow \omega_{pc} = 30° = \frac{\pi}{6}$$

$$\text{Magnitude (a)} = \frac{k}{\omega_{pc}} = \frac{6k}{\pi}$$

For stability a < 1

$$\Rightarrow k < \frac{\pi}{6}$$

$$\text{Therefore Range is } 0 < k < \frac{\pi}{6}$$

30. Ans: (a)

Sol: Given $x(n) = \dfrac{3^n}{n!}$

$$X(z) = \sum_{n=-\infty}^{\infty} x(n).z^{-n}$$

Let $g(n) = \dfrac{1}{n!}$

$$\therefore\ G(z) = Z\{g(n)\} = Z\left\{\frac{1}{n!}\right\}$$

$$G(z) = Z\left\{\frac{1}{n!}\right\} = \sum_{n=0}^{\infty}\frac{1}{n!}z^{-n}$$

$$G(z) = 1 + \frac{(1/z)}{1!} + \frac{(1/z)^2}{2!} + \frac{(1/z)^3}{3!} + ...$$

$$G(z) = Z\left\{\frac{1}{n!}\right\} = e^{1/z}\ ....(1)$$

By property,

$$a^n g(n) \leftrightarrow G\left(\frac{z}{a}\right)$$

$$3^n\frac{1}{n!} \leftrightarrow e^{3/z}$$

$$\therefore\ X(z) = Z\left\{\frac{3^n}{n!}\right\} = e^{3/z}$$

31. Ans: (a)

Sol: Given f(D)y = Q(x) …………(1)

where $f(D) = D^2 + 4D + 4$

& $Q(x) = x^4\,e^{-2x} = e^{-2x}.x^4 = e^x\,.\,V(x)$

Now, $y_P = \frac{1}{f(D)}\left[e^{-2x}\,x^4\right]$

$\Rightarrow y_P = e^{-2x}\left[\frac{1}{f(D-2)}x^4\right]$

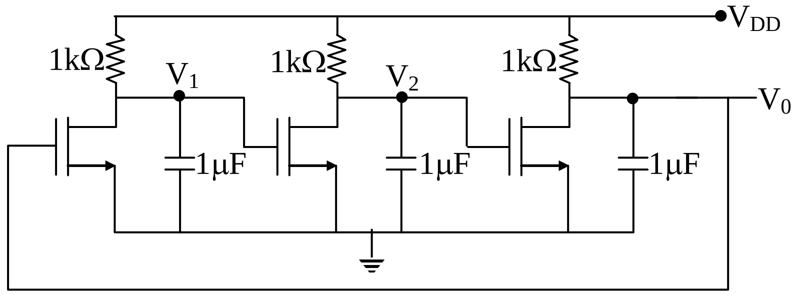
$\Rightarrow y_P = e^{-2x}\left[\frac{1}{(D-2)^2+4(D-2)+4}x^4\right]$

$\Rightarrow y_P = e^{-2x}\left[\frac{1(x^4)}{D^2}\right]$

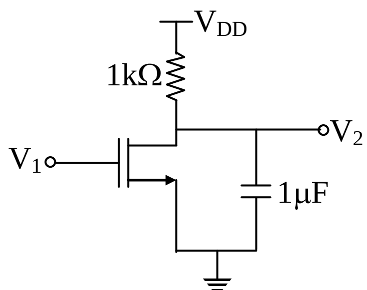
$\therefore y_p = e^{-2x}\cdot\frac{x^6}{30}$

32. Ans: 0.275 {Range: 0.25 to 0.29}

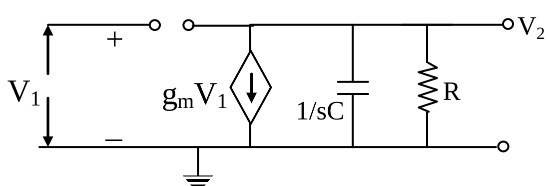
Sol:



Consider a single-stage:



small-signal equivalent:



$V_2 = -g_m V_1(R\,//(1/sC))$

$\frac{V_2}{V_1} = -g_m[R\,//(1/sC)]$

So, similarly $\frac{V_1}{V_0} = \frac{V_0}{V_2} = \frac{V_2}{V_1} = -g_m\{R\,//(1/sC)\}$

For oscillators, loop gain = 1

$$\frac{V_1}{V_0}\times\frac{V_2}{V_1}\times\frac{V_0}{V_2}=1$$

i.e., $\{-g_m[R//(1/sC)]\}^3 = 1$

$$\Rightarrow -\left[\frac{g_m R}{1+RsC}\right]^3 = 1$$

Put s = jω

$$\Rightarrow -\left[\frac{g_m R}{1+j\omega RC}\right]^3 = 1$$

$$\Rightarrow -\left[\frac{(g_m R)^3}{(1+j\omega RC)^3}\right] = 1$$

Equating angle condition i.e., angle = 360^0 for sustained oscillations

i.e., $180^0 - 3\tan^{-1}(\omega RC) = 0^0$

$\text{Tan}^{-1}(\omega RC) = 60^0$

$$\omega = \frac{\sqrt{3}}{RC}$$

$$f = \frac{\sqrt{3}}{2\pi RC} = 0.2756 \text{ kHz}$$

33. Ans: (b)

Sol: $\int_{-\infty}^{\infty} x e^{-x^2} dx$

Let $f(x) = xe^{-x^2}$

$f(-x) = -xe^{-x^2} = -f(x)$

∴ f(x) is odd function

∴ The value of given integral is zero.

34. Ans: (c)

Sol: From parseval's theorem

$$2\pi\int_{-\infty}^{\infty}|x(t)|^2 dt = \int_{-\infty}^{\infty}|X(\omega)|^2 d\omega$$

$$x(t) = \begin{cases} t+1 & ; -1<t<0 \\ -t+1 & ; 0<t<2 \\ t-3 & ; 2<t<3 \end{cases}$$

$$\int_{-\infty}^{+\infty} |X(\omega)|^2 d\omega = 2\pi\left[\int_{-1}^{0}(t^2+2t+1)dt + \int_{0}^{2}(t^2-2t+1)\,dt + \int_{2}^{3}(t^2-6t+9)dt\right]$$

$$= 2\pi\left[\left(\frac{t^3}{3}+t^2+t\right)_{-1}^{0} + \left(\frac{t^3}{3}-t^2+t\right)_{0}^{2} + \left(\frac{t^3}{3}-3t^2+9t\right)_{2}^{3}\right]$$

$$= 2\pi\left[\frac{1}{3}-1+1+\frac{8}{3}-4+2+9-27+27-\frac{8}{3}+12-18\right] = 8\pi/3$$

35. Ans: 25 (No range)

Sol: Method: I

Closed loop gain $A_f(s) = \dfrac{A_0(s)}{1+\beta A_0(s)}$

$$= \frac{\dfrac{250}{1+\dfrac{s}{(2\pi\times 100)}}}{1+\dfrac{(0.8)(250)}{1+\dfrac{s}{(2\pi\times 100)}}}$$

Low frequency gain/DC gain

$$= \frac{250}{1+(0.8)(250)}$$

Band width = 100(1+(0.8)(250))

Gain × Bandwidth = 250×100 = 25×10^3 Hz

Method: 2

If $A(s) = \dfrac{A_0}{1+j\left(\dfrac{f}{f_H}\right)}$

Then Gain (DC gain) = A_0

BW = f_H

Gain×BW = $A_0 f_H$

Gain BW is constant {i.e., same for open loop as well as feedback closed loop amplifier}

$$A_0(s) = \frac{250}{1+\dfrac{j\omega}{2\pi\times 100}} = \frac{250}{1+j\left(\dfrac{f}{100}\right)}$$

Gain = 250

BW = 100

So, Gain×BW = 250×100 = 25×10^3 Hz

36. Ans: (d)

Sol: The power decays as $Pe^{-2\alpha z}$

at z = d power is attenuated to 10^{-12}P

$\therefore$ P $e^{-2\alpha d}$ = 10^{-12} P

$-2\alpha d = \ell n\,(10^{-12})$

$\alpha d = 13.8155$

$d = \dfrac{13.8155}{\alpha}$ ----(1)

Since $f < f_{cmn}$, γ_{mn} must be real

$$\therefore \gamma_{mn} = \alpha = \beta\sqrt{\left(\frac{f_{cmn}}{f}\right)^2 - 1}$$

$\lambda f = 3\times10^8$ m/sec

$$\lambda = \frac{3\times10^8}{10^9} = 0.3\text{m}$$

$$\beta = \frac{2\pi}{\lambda} = \frac{2\pi}{0.3} = 20.94\text{rad/m}$$

$$\therefore \gamma_{mn} = \alpha = 20.94\sqrt{(1.5)^2-1}$$

= 23.41 Np/m

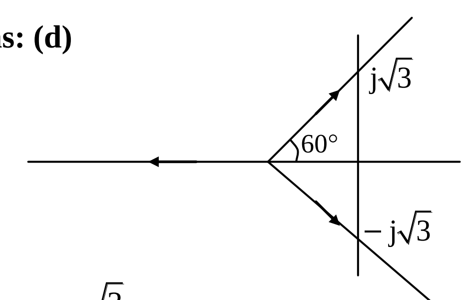
substitute α value in equation (1)

$$d = \frac{13.8155}{23.411} = 0.590\text{m}$$

d = 0.590m

37. Ans: (d)

Sol:



$\tan 60° = \dfrac{\sqrt{3}}{x} \Rightarrow \quad x = 1$

Pole is at s = −1

Open loop TF $G(s) = \dfrac{K}{(s+1)^3}$

Closed loop TF = $\dfrac{G(s)}{1+G(s)H(s)}$

H(s) = 1, K = 2

$$\text{CLTF} = \frac{\frac{2}{(s+1)^3}}{1+\frac{2}{(s+1)^3}} = \frac{2}{s^3+3s^2+3s+3}$$

38. Ans: (b)

Sol: $P(T_1/R_1) = \dfrac{P(R_1/T_1)\times P(T_1)}{P(R_1)}$

$P(R_1) = P(T_1)\,P(R_1/T_1) + P(T_0)P\,(R_1/T_0)$
$= 0.4\,(0.92) + 0.6(0.1) = 0.428$

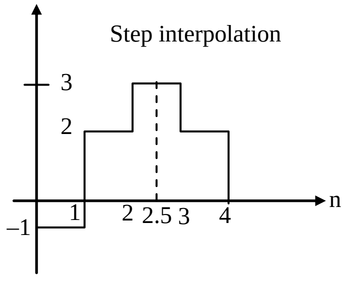
$\therefore\ P(T_1/R_1) = \dfrac{0.92\times 0.4}{0.428} = 0.8598 \approx 0.86$

39. Ans: (d)

Sol: →(HL) = 4000H
→ (SP) = 2500H
→ (A) = AAH
→ (A) = AAH ⊕ AAH = 00H
⇒ (A) = 00H
→ PSW contents pushed on to top of stack
→ HL pair contents i.e., 4000H is exchanged with contents of top of stack
Top of stack contains 4000H.
→ Contents of top of stack i.e., 4000H popped back into PSW
⇒ (PSW) = 4000H
Then flag register contents are 00H.

40. Ans: (b)

Sol:



x(2.5) = 3

41. Ans: 1.93 (Range: 1.8 to 2.05)

Sol: $P_e = Q\left(\sqrt{\dfrac{A_c^2 T_b}{N_0}\cos^2\phi}\right)$

$\therefore P_{e(BPSK)} = Q\left(\sqrt{\dfrac{10^{-4}\times 3}{10^4\times 2\times 10^{-9}\times 4}}\right)$

$= Q(1.93)$

42. Ans: (a)

Sol: $\dfrac{P_R}{P_T} = G_T G_R\left(\dfrac{\lambda}{4\pi R}\right)^2$

$\lambda = \dfrac{c}{f} = \dfrac{3\times 10^8}{75\times 10^6} = 4\text{m}$

$\lambda = 4\text{m},\ \dfrac{\ell}{\lambda} = \dfrac{1}{2}$

$\ell = \dfrac{\lambda}{2}$

Half wave dipole

So, D = 1.64

$\therefore \dfrac{P_R}{P_T} = \dfrac{1.64\times 1.64\times 4^2}{16\pi^2\times 10^6}$

$\dfrac{P_R}{P_T} = 27.25\times 10^{-8}$

43. Ans: 0.25 (No range)

Sol: $BW = \dfrac{R_b}{2}[1+\alpha]$

$4.5\times 10^3 = \dfrac{7200}{2}[1+\alpha]$

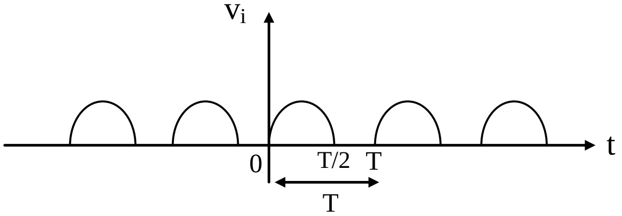
α = 0.25

44. Ans: 1 (No range)

Sol: Given

V_i = Halfwave rectified output of 5sinωt.

Representing V_i in graph



From the given transfer characteristics, we can conclude that

If $V_i > +3 \Rightarrow V_0$ changes from –10 to +10

$V_i < -3 \Rightarrow V_0$ changes from +10 to –10

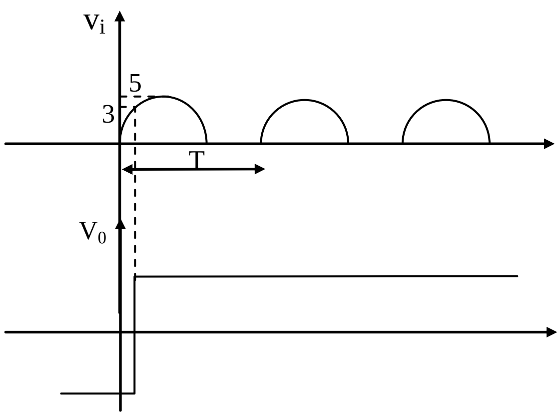
Given at $t = 0^- \Rightarrow V_0 = -10V$

Now starting from $t = 0^-$

$\Rightarrow V_0 = -10V, \quad V_i = 0V$

Now as $V_i > +3$

$\Rightarrow V_0$ changes from –10 to +10



and Now if V_0 becomes +10V, it will never come back to –10V since for that to happen V_i should be less than –3 but given V_i is always positive, so number of transitions is 1.

45. Ans: (b)

Sol: Given $y''(t) - y'(t) - 6y(t) = e^t u(t)$

Apply L.T

$$s^2.Y(s) - sy(0) - y'(0) - sY(s) + y(0) - 6Y(s) = \frac{1}{s-1}$$

Given y(0) = 1, $y'(0) = 0$

$$s^2Y(s) - s - sY(s) + 1 - 6Y(s) = \frac{1}{s-1}$$

$$Y(s)[s^2 - s - 6] = s - 1 + \frac{1}{s-1}$$

$$Y(s)[s^2 - s - 6] = \frac{s^2 - 2s + 2}{s-1}$$

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

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

$$Y(s) = -\frac{1}{6}\frac{1}{s-1} + \frac{1}{2}\frac{1}{s-3} + \frac{2}{3}\frac{1}{s+2}$$

Apply ILT

$$y(t) = -\frac{1}{6}e^t + \frac{1}{2}e^{3t} + \frac{2}{3}e^{-2t} \quad t > 0$$

46. Ans: 258.85 (Range 255 to 265)

Sol: Since, $N_{AB} = n_p\,[x = x_B] = n_{p_0} \exp\left(\frac{V_{BC}}{V_T}\right)$

Where,

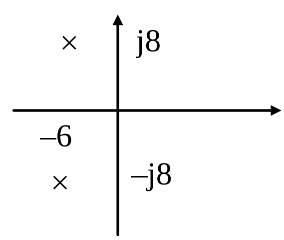
$$n_{p_0} = \frac{n_i^2}{N_{AB}} = \frac{(1.5\times10^{10})^2}{10^{16}} = 2.25\times10^4\,/\text{cm}^3$$

$$n_p[x = x_B] = 2.25\times10^4 \times \exp\left[\frac{0.6}{0.0259}\right]$$

$$= 258.85\times10^{12}\,/\text{cm}^3$$

47. Ans: 10(No range)

Sol: $c(t) = 12.5e^{-6t}\sin 8t$



ω_n is radial distance from origin

$\omega_n = \sqrt{6^2 + 8^2}$

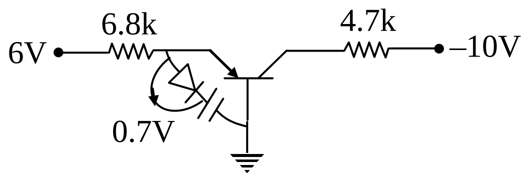
ω_n = 10 rad/sec

48. Ans: 0.03 (Range: 0.028 to 0.032)

Sol: Since, Dynamic conductance, $g = \frac{I_C}{V_T}$,

$$\therefore I_E = \frac{6 - 0.7}{6.8}\text{mA} = 0.779\text{mA}$$

$$\therefore \beta_{dc} = \frac{\alpha_{dc}}{1-\alpha_{dc}} = \frac{0.998}{1-0.998} = 499$$



$\therefore I_B = \frac{I_E}{1+\beta_{dc}} = 1.55\mu A$

$\therefore$ Transconductance,

$g = \frac{I_C}{V_T} \approx \frac{I_E}{26mV} = \frac{0.779}{26} = 0.03\,℧$

49. Ans: 9 (No range)

Sol: Forward paths: $M_1 = G_1\, G_2\, G_3\, G_4\, G_5\, G_6$

$M_2 = G_1\, G_2\, G_7\, G_6$

$M_3 = G_1\, G_2\, G_3\, G_4\, G_8$

Loops: $L_1 = G_4\, H_2$

$L_2 = G_5\, G_6\, H_3$

$L_3 = G_1\, G_2\, G_3\, G_4\, G_5\, G_6\, H_1$

$L_4 = G_1\, G_2\, G_7\, G_6\, H_1$

$L_5 = G_1\, G_2\, G_3\, G_4\, G_8\, H_1$

$L_6 = G_8\, H_3$

50. Ans: (d)

Sol: Given that 8 KB ROM & 8 KB RAM interfaced to 8085.

ROM is selected when A_{15} is 0

RAM is selected when A_{15} is 1

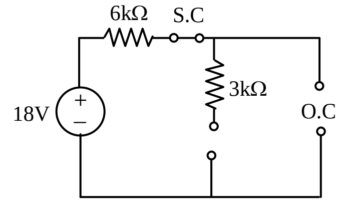
A_{13} & A_{14} are unused.

MVI	A, 00H	; (A) = 00H
STA	8080H	; (8080H) ← (A) = 00H
DCR	A	; (A) = FFH
STA	C080H	; (C080H) ←(A) = FFH
		; (8080H) ←(A) = 00H
RET		; (PC) ← (T0S)

Contents of memory location 8080H is 00H.

51. Ans: – 60 (No Range)

Sol: At time $t = 0^-$ switch is in open condition



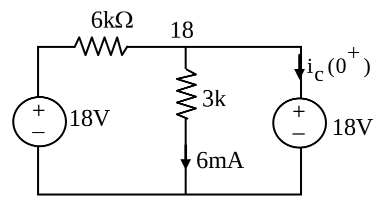
So, L is short circuit, C is open circuit

$i_L(0^-) = 0$

$V_C(0^+) = V_C(0^-) = 18V$

At $t = 0^+$ switch is closed

$I_C(0^+) = C\frac{dv(0^+)}{dt}$



$\frac{dv(0^+)}{dt} = \frac{i_C(0^+)}{C}$

$i_C(0^+) = -6\times10^{-3}A$

$\frac{dv(0^+)}{dt} = \frac{-6\times10^{-3}}{100\times10^{-6}}$

$\frac{dv(0^+)}{dt} = -60V/sec$

52. Ans: (c)

Sol: Given

$f(x) = \frac{\pi^2}{3} - 4\left(\frac{\cos x}{1^2} - \frac{\cos 2x}{2^2} + ...\right)$

clearly f(x) is continuous at x = 0

($\because \underset{x\to0}{Lt}$ f(x) = 0) the four series converges to f(0)

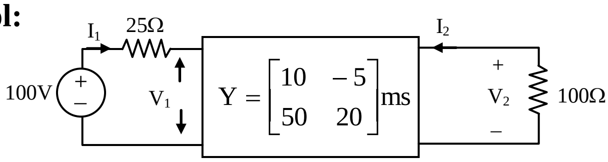
$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$

$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$

$\frac{1}{1^2} + \frac{1}{2^2} - \frac{1}{3^2} + ... = \frac{\pi^2}{12}$

53. Ans: 68.57 (Range: (67.5 to 69.5V)

Sol:



By applying at KVL input side

$V_1 = 100 - 25I_1$ …….. (1)

$V_2 = -100\, I_2$ ……… (2)

From Y-parameters

$I_1 = (10\times10^{-3})\, V_1 - (5\times10^{-3})\, V_2$ …….. (3)

$I_2 = (50\times10^{-3})\, V_1 + (20\times10^{-3})\, V_2$ …….. (4)

By putting value of V_2 in equation (4)

$I_2 = (50\times10^{-3})\, V_1 + (20\times10^{-3})\,(-100.I_2)$

$= (50\times10^{-3})\, V_1 - 2I_2$

$3I_2 = (50\times10^{-3})\, V_1$

And from equation (3)

$I_1 = (10\times10^{-3})\, V_1 - (5\times10^{-3})\,(-100.I_2)$

$$= (10\times10^{-3})V_1 + (5\times10^{-3}\times100\left(\frac{50\times10^{-3}}{3}\right)V_1$$

$$=(10\times10^{-3})V_1 + \frac{25}{3}\times10^{-3}V_1$$

$$=\frac{55}{3}\times10^{-3}V_1$$

$$\therefore V_1 = 100 - [25\times I_1]$$

$$V_1 = 100 - \left[25\times\frac{55}{3}\times10^{-3}V_1\right]$$

$$V_1\left[1+25\times\frac{55}{3}\times10^{-3}\right] = 100$$

$$V_1 = \frac{100}{1.458} = 68.57V$$

54. Ans: 19.23 (Range 19 to 20)

Sol: Since, $N_{AB} << N_{DC} \Rightarrow \frac{1}{N_{AB}} + \frac{1}{N_{DC}} = \frac{1}{N_{AB}}$

As at early effect, $[V_j]_{B\text{-}C} = V_{punch}$ and $[W_{dep}]_{B\text{-}C} = W_B$ (base width).

$$\therefore [W_{dep}]_{B-C} = W = W_B = \sqrt{\frac{2\varepsilon}{q}\left(\frac{1}{N_A}+\frac{1}{N_D}\right)[V_{punch}]}$$

$$= \sqrt{\frac{2\varepsilon}{q}\frac{1}{N_A}V_{punch}}$$

$$\therefore V_{punch} = \frac{qN_AW_B^2}{2\varepsilon},$$

where $\varepsilon = \varepsilon_0\, \varepsilon_r$ and $[\varepsilon_r]_{Si} = 11.7$

Now given,

$\rho_B = 0.5\Omega cm = \frac{1}{\sigma_B} \approx \frac{1}{N_A q\mu_P}$ and it is given that, $[[\mu_p]_{Si}]_{300^o k} = 500 cm^2/V sec$

$\therefore N_{DB} = N_{DA} = 2.5\times10^{16}/cm^3$

$$\therefore V_{punch} = \frac{1.6\times10^{-19}\times2.5\times10^{16}\times(10^{-4})^2}{2\times1.04\times10^{-12}}$$

$$=19.23V$$

55. Ans: (d)

Sol: In hamming code, K parity bits are added to an n-bit data word, forming a new word of n + K bits.

The bit positions are numbered in sequence from 1 to n + K. Those positions numbered as a power of 2 are reserved for the parity bits.

Step-1: Finding the value of K:

$2^K - 1 - K \geq n$

For K = 3, n ≤ 4

For K = 4, n ≤ 11

Thus, K = 4

Step-2: The 4 parity bits, P_1, P_2, P_4 and P_8 are in positions 1,2,4 and 8 respectively.

P_1 = XOR of bits (3, 5, 7, 9, 11) = 0

P_2 = XOR of bits (3, 6, 7, 10, 11) = 0

P_4 = XOR of bits (5, 6, 7, 12) = 1

P_8 – XOR of bits (9, 10, 11, 12) = 1

Therefore, the 12-bit word is

$P_1\ P_2\ D_0\ P_4\ D_1\ D_2\ D_3\ P_8\ D_4\ D_5\ D_6\ D_7$

= 0 0 1 1 1 0 0 1 0 1 0 0

56. Ans: (d)

Sol: 'Cut out for' means designed to be so. 'Cut up' means 'to be emotionally upset'. 'Cut down' means 'to kill somebody' or 'to make something fall down by cutting it at the base'. 'Cut off' means 'separated from the rest of the world'.

57. Ans: (c) **58. Ans: (a)**

59. Ans: (d)

Sol: Let principle be 1.

then amount after 10 years = $3 \times 1 = 3$

$\therefore$ Simple interest = $3 - 1 = 2$

$\therefore$ Rate of interest $= \dfrac{2\times100}{1\times10} = 20\%$

60. Ans: (c)

Sol: Note that $20 - 14 = 6$; $25 - 19 = 6$; $35 - 29 = 6$; $40 - 34 = 6$.

20=2*2*5
25=5*5
35=1*5*7
40=2*2*2*5

Required number

= L.C.M. of (20, 25, 35 and 40) – 6.

= $(2 \times 2 \times 2 \times 5 \times 5 \times 7) - 6$

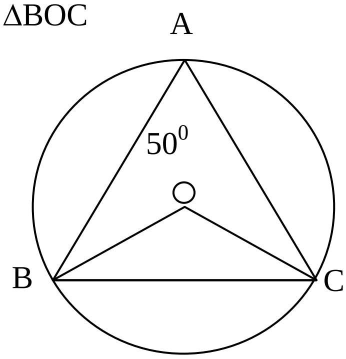
= $1400 - 6 = 1394$

61. Ans: (c)

Sol: The angle subtended by an arc at the centre of the circle is twice the angle subtended by the arc at any point on the remaining part of the circle.

$\therefore \angle BOC = 2\angle BAC = 2 \times 50^0 = 100^0$

Now in ΔBOC



OB = OC [radii of circumcentre]

$\therefore \angle OBC = \angle OCB = x$ (let)

$\therefore x + x + 100^0 = 180^0$

$\Rightarrow 2x = 80^0$

$\Rightarrow x = 40^0$

62. Ans: (a)

Sol: At 4:10 the hour hand is a head of minute hand

Given that n = 4 and x = 10

Then according to the formula required angle

$$= \left\{30\left(n - \frac{x}{5}\right) + \frac{x}{2}\right\}^0$$

$$= \left\{30\left(4 - \frac{10}{5}\right) + \frac{10}{2}\right\}^0$$

$$= \{(30 \times 2) + 5\}^0 = (60 + 5)^0$$

$$= 65^0$$

63. Ans: (b)

Sol: Total cost (in Rs) of journey to Town A

= 4300 + 3100 + 4000 + 6000 = 17400

Average cost = $\dfrac{17400}{4}$ = Rs. 4350

64. Ans: (a)

Sol: Maximum cost (in Rs) of journey from Delhi to town A = By Train 4 = Rs. 6000

Similarly, for town B = Rs. 6300

Town C = Rs. 5600 and

Town D = Rs. 5700

$\Rightarrow$ Maximum cost = 6000 + 6300 + 5600

= Rs. 23600

65. Ans: (d)