Branch: Instrumentation Engineering - SOLUTIONS

01. Ans: 496 (No Range)

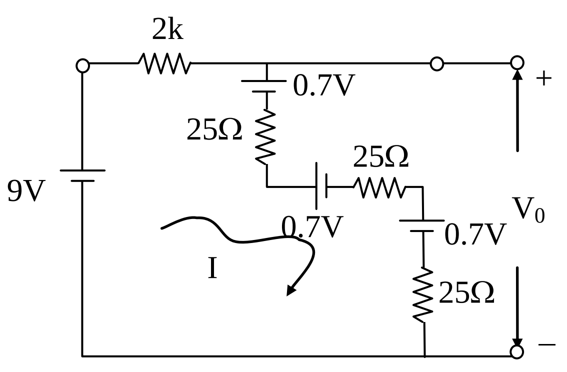
Sol: For n-bit comparator,
Number of combinations for which A > B is $\frac{2^{2n} - 2^n}{2}$

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

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

02. Ans: (a)

Sol: In the given circuit D_1, zener & $D_4 \rightarrow$ F.B
D_3 & D_2 – R.B → 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
$\xi < 1$

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

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

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

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

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

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

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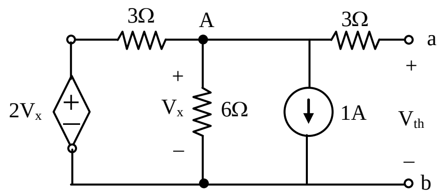
06. Ans: (d)

Sol:



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

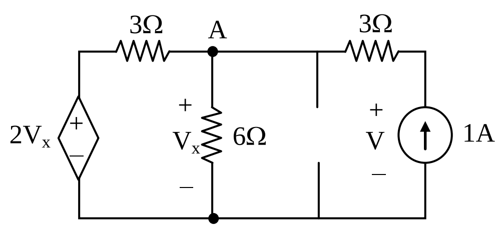
Apply KCL at node A, then

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

$-2V_x + V_x + 6 = 0$

$V_x = 6V$

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)

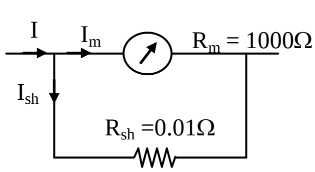
Sol: $\%\eta_{FM} = (1 - J_0^2(\beta)) \times 100$

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

$= 75\%$

08. Ans: 40 (no range)

Sol:



$V_m = V_{sh}$

$V_m = 400mV$

$$I_{sh} = \frac{V_m}{R_{sh}} = \frac{400 \times 10^{-3}}{0.01}$$

$I_{sh} = 40A$

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

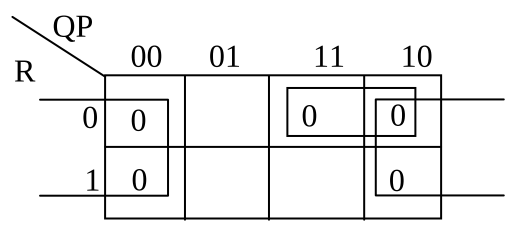
$y(t) = 6\,[e^{-t} - e^{-2t}]u(t)$

10. Ans: (d)

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

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

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



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

11. Ans: 7.07 (Range: 6.5to7.5)

Sol: Vertical sensitivity = 4 V/cm

Peak to peak amplitude = 5 cm

$\therefore V_{p-p}$ = (vertical sensitivity) × (distance between peak to peak)

$V_{pp} = 4 \times 5 = 20V$

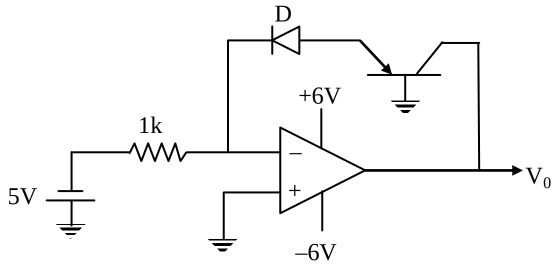
$$V_P = \frac{V_{PP}}{2} = \frac{20}{2} = 10V$$

$$V_{rms} = \frac{V_P}{\sqrt{2}} = \frac{10}{\sqrt{2}}$$

$\Rightarrow V_{rms} = 7.07$ V

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 $V_0 = +6$V

13. Ans: 0.36

Sol: $C = \frac{2x}{\Delta t}$

C = velocity of light = 3×10^8 (m/sec)

x = distance that can be measured by laser ranging

Δt = time distance resolved

$$x = \frac{C\times\Delta t}{2} = \frac{3\times10^8\times2.4\times10^{-9}}{2}$$

x = 0.36 m

14. Ans: 0 (No range)

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

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

= 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) + 3^2V(y)

= (4 × 2) + (9 × 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) = 5Ω

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18. Ans: (b)

Sol: Given f_i = 100 kHz

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

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

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

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

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

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

$$= \frac{1}{2}\times 300\times10^{-6}\times1.5\times(0.9-0.5)^2$$

$= 36\mu A$

21. Ans: (d)

Sol: 0 m corresponds to 0V

2m corresponds $\rightarrow$

$P = \rho gh = 1.3\times10^3\times9.81\times2$

$= 25.506$ (kPa)

Sensor output will be

$$V = 25\left(\frac{mV}{kPa}\right)\times25.506(kPa) = 0.638\text{ V}$$

Sensitivity of level measurement $= \frac{0.638(V)}{2(m)}$

$$= 0.319\left(\frac{V}{m}\right) = 3.19\left(\frac{mV}{cm}\right)$$

22. Ans: (c)

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

Carrier term is = 40 cos(200πt)

$A_C = 40$, $f_C = 100$

LSB term: 10 cos(198πt)

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

$\mu = \frac{2\times10}{40} = 0.5$, $f_m = 1$

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

$\frac{A_m}{A_C} = \mu \Rightarrow A_m = \mu.A_C = 0.5\times40 = 20$

m(t) = 20 cos(2πt)

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

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

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

For attenuation of –20dB

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

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

Here, $x = \delta_s = 0.1$

Now,

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

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

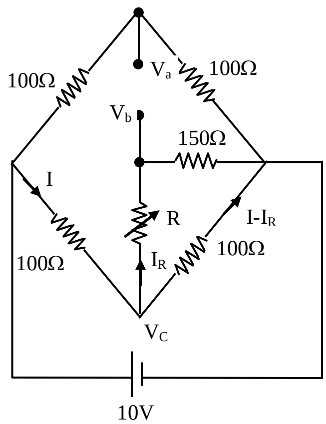
N = 6

25. Ans: –1 (No range)

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

26. Ans:50.1Ω [49 to 51]

Sol: When bridge is balanced $V_a = V_b$



$$V_a = \frac{10\times 100}{200} = 5V$$

$V_a = V_b = 5V$

$$I_R = \frac{V_b}{150} = \frac{1}{30}A$$

$$10 - 100I - 100\left(I - \frac{1}{30}\right) = 0$$

$$I = \frac{1}{15}A$$

$$V_c = \left[\frac{1}{15} - \frac{1}{30}\right]\times 100 = 3.33V$$

$$|R| = \frac{V_b - V_c}{I_R} = \frac{5-3.33}{\left[\frac{1}{30}\right]} = 50.1\Omega$$

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,

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

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

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

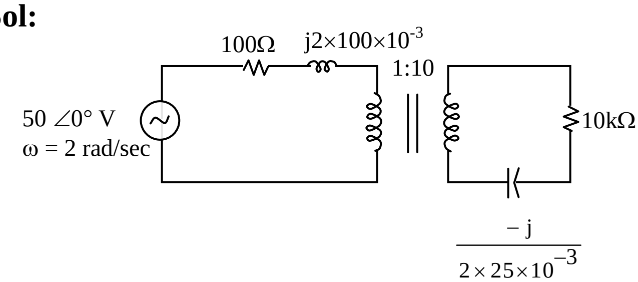
$$\therefore y_p = \frac{\text{cox}(x)}{10} + \frac{3}{10}\sin x$$

Hence, the general solution of (1) is
$y = y_c + y_p$

$$\text{i.e., } y = c_1e^{-x} + c_2e^{-2x} + \frac{\cos(x)}{10} + \frac{3}{10}\sin x$$

28. Ans: (c)

Sol:



By transferring secondary impedance to primary then

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

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

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

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

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

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

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

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

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

30. Ans: (a)

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

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

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

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

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

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

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

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

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

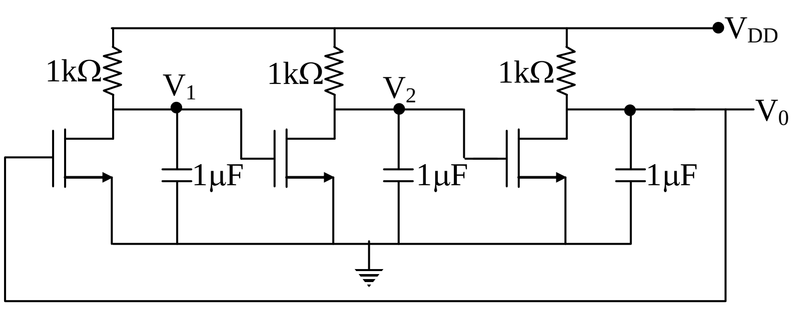
$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{(D-2)^2 + 4(D-2) + 4}x^4\right]$$

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

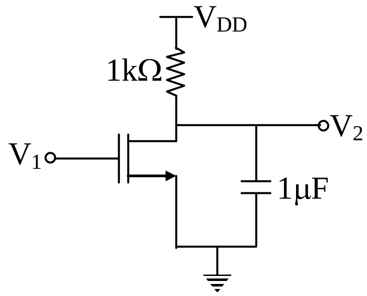
$$\therefore y_p = e^{-2x}.\frac{x^6}{30}$$

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

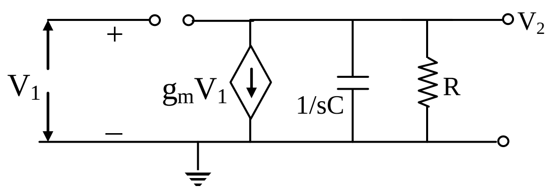
Sol:



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

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

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

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

33. Ans: (b)

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

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

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

$\therefore$ f(x) is odd function

$\therefore$ 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_0f_H

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

$$A_0(s) = \frac{250}{1+\dfrac{j\omega}{2\pi\times100}} = \frac{250}{1+j\left(\dfrac{f}{100}\right)}$$

Gain = 250

BW = 100

So, Gain×BW = 250×100 = 25×10^3 Hz

36. Ans: 40.32 (range 40 to 41)

Sol: Efficiency, $\eta = \dfrac{I_p/q}{P_{opt}/hf} = \dfrac{I_p}{P_{opt}}\left(\dfrac{hf}{q}\right)$

$$\eta = R\left(\frac{h\times c}{q}\right)\frac{1}{\lambda}$$

$$R = \eta.\frac{\lambda(\mu m)}{1.24}$$

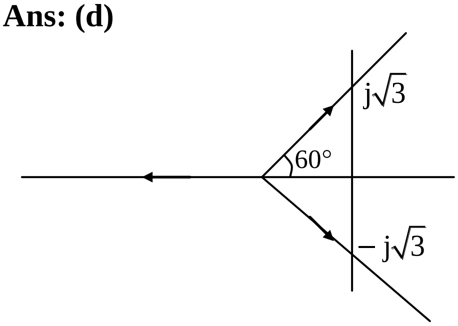
$$R = 1.\left(\frac{50}{1.24}\right)$$

$(\because \eta = 100\%)$

$$R = \frac{50}{1.24} = 40.32$$

37. Ans: (d)

Sol:



$\tan60° = \dfrac{\sqrt{3}}{x} \Rightarrow \quad x = 1$

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

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

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

$\therefore\ P(T_1/R_1) = \dfrac{0.92\times0.4}{0.428} = 0.8598 \approx 0.86$

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.

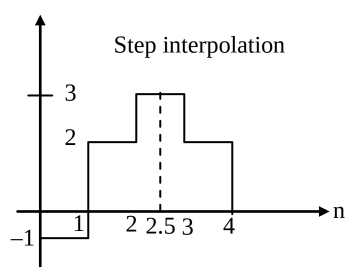
→ Contents of top of stack i.e., 4000H popped back into PSW

⇒ (PSW) = 4000H

Then flag register contents are 00H.

40. Ans: (b)

Sol:



x(2.5) = 3

41. Ans: (d)

Sol: Range ability $R = \frac{Q_{max}}{Q_{min}}$

$$= \frac{50(cm^3/sec)}{2(cm^3/sec)}$$

R = 25

The flow at 1cm opening is

$$Q = Q_{min} R^{(s/s_{max})}$$

$$Q = 2\left(\frac{cm^3}{sec}\right) \times (25)^{(1cm/3cm)}$$

Q = 5.85 (cm^3/sec)

42. Ans: (b)

Sol:

Current (I)	4mA	20mA
Motor speed rpm (R)	140 rpm	600 rpm

Now by using this table we make equation of straight line.

$$\frac{I - 4mA}{20mA - 4mA} = \frac{R - 140}{600 - 140}$$

$$I = \left(\frac{R - 140}{460}\right) \times 16mA + 4mA$$

I = 9.913 (mA)

The current 9.913mA expressed as percentage of controller output is

$$= \frac{I - I_{min}}{I_{max} - I_{min}} \times 100 = \frac{I - 4mA}{20A - 4mA} \times 100$$

$$= \frac{9.913mA - 4mA}{20mA - 4mA} \times 100 = 36.9\%$$

43. Ans: 0.25 (No range)

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

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

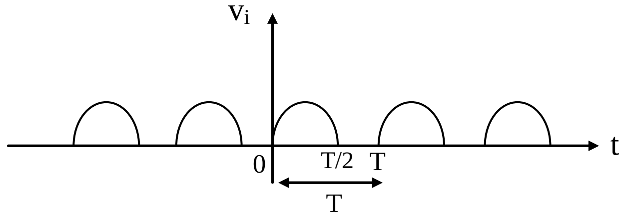
α = 0.25

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

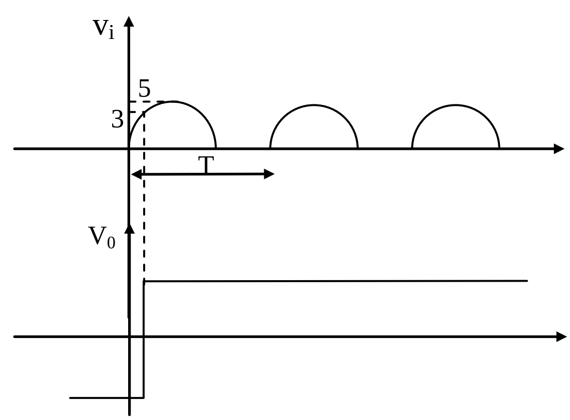
Given at $t = 0^- \Rightarrow V_0 = -10V$

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: 200

Sol: Given data:

Δx = movement of movable mirror = 50μm

λ = wavelength of light used = 500nm

We know the relation in Michelson interferometer

$n\lambda = 2\Delta x$

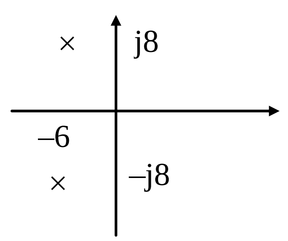
n = number of fringes

$$n = \frac{2\Delta x}{\lambda} = \frac{2\times 50\times 10^{-6}}{500\times 10^{-9}}$$

n = 200

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: (a)

Sol: from given data we can write

High flow rate Q_A, Q_B, Q_C

Low flow rate $\overline{Q}_A\ \overline{Q}_B\ \overline{Q}_C$

High pressure P

Low pressure $\overline{P}$

High level L

Low level $\overline{L}$

Condition-Either input flow rate is high

$Q_A\overline{Q}_B + \overline{Q}_A Q_B$

Low output flow $\overline{Q}_C$

Low pressure $\overline{P}$

High level L

$$\text{Overfill alarm condition} = (Q_A\overline{Q}_B + \overline{Q}_A Q_B)\overline{Q}_C\overline{P}L$$

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

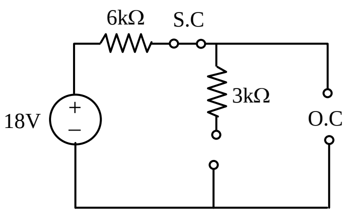
A_{13} & A_{14} are unused.

```
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



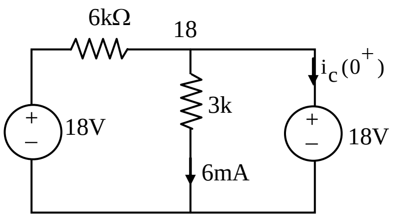
So, L is short circuit, C is open circuit

$i_L(0^-) = 0$

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

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)

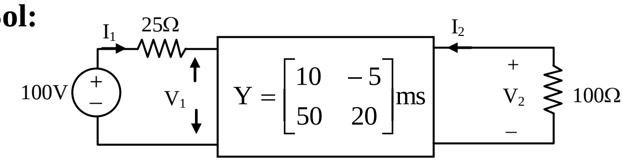
$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

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

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

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: (d)

Sol: $t_{measured}$ = 1650 ^oC = 1923 k

$\varepsilon_1 = 0.85,\ \varepsilon_2 = 0.75$

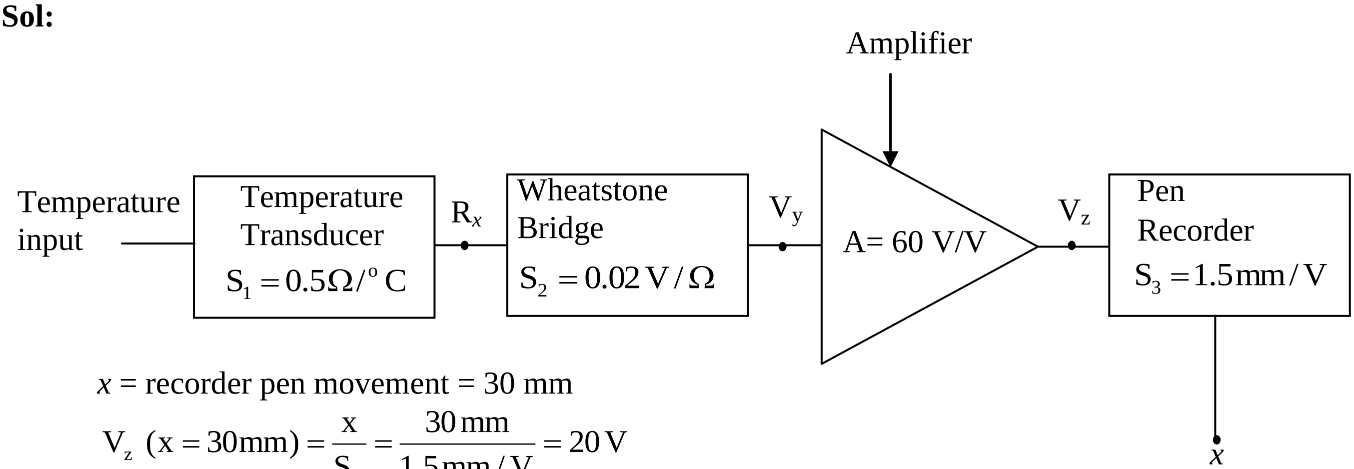
$$T_{actual} = T_{measured} \times \left(\frac{\varepsilon_1}{\varepsilon_2}\right)^{0.25}$$

$$= 1923 \times \left(\frac{0.85}{0.75}\right)^{0.25} = 1984.12 \text{ k}$$

T_{actual} = 1984.12 – 273 = 1711.12^oC

55. Ans: 33.33 (33.0 to 33.8)

Sol:



x = recorder pen movement = 30 mm

$$V_z\ (x = 30\text{mm}) = \frac{x}{S_3} = \frac{30\,\text{mm}}{1.5\,\text{mm/V}} = 20\,\text{V}$$

$$V_y = \frac{V_z}{60} = \frac{20}{60} = \frac{1}{3}\text{V}$$

$$R_x = \frac{V_y}{S_2} = \frac{V_3\ \text{V}}{0.02\,\text{V}/\Omega} = \frac{50}{3}\Omega$$

Temperature input for n = 30 mm displacement

$$= \frac{R_x}{S_1} = \frac{50/3\,\Omega}{0.5\,\Omega/^o\text{C}} = \frac{50/3\,\Omega}{0.5\,\Omega/^o\text{C}} = \frac{100}{3}\,^o\text{C} = 33.33\,^o\text{C}$$

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 × 1 = 3

∴ Simple interest = 3 – 1 = 2

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

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

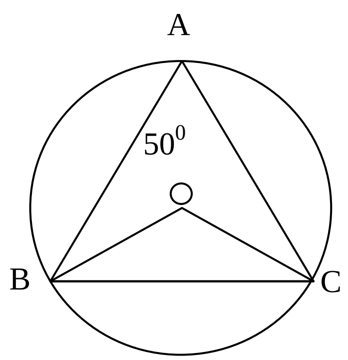
Required number
= L.C.M. of (20, 25, 35 and 40) – 6.
= $(2 \times 2 \times 2 \times 5 \times 5 \times 7) - 6$
= 1400 – 6 = 1394

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 = $\frac{17400}{4}$ = 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)