DETAILED SOLUTIONS

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ESE 2024 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 22

Full Syllabus Test 6 : Paper-II

1.	(b)	**26.**	(b)	**51.**	(a)	**76.**	(b)	**101.**	(d)	**126.**	(d)
2.	(d)	**27.**	(b)	**52.**	(b)	**77.**	(a)	**102.**	(d)	**127.**	(b)
3.	(b)	**28.**	(b)	**53.**	(a)	**78.**	(b)	**103.**	(c)	**128.**	(c)
4.	(b)	**29.**	(d)	**54.**	(b)	**79.**	(b)	**104.**	(b)	**129.**	(c)
5.	(a)	**30.**	(b)	**55.**	(a)	**80.**	(c)	**105.**	(a)	**130.**	(d)
6.	(b)	**31.**	(b)	**56.**	(a)	**81.**	(c)	**106.**	(b)	**131.**	(d)
7.	(a)	**32.**	(d)	**57.**	(d)	**82.**	(d)	**107.**	(c)	**132.**	(d)
8.	(a)	**33.**	(b)	**58.**	(b)	**83.**	(c)	**108.**	(a)	**133.**	(d)
9.	(a)	**34.**	(a)	**59.**	(b)	**84.**	(d)	**109.**	(c)	**134.**	(c)
10.	(a)	**35.**	(d)	**60.**	(c)	**85.**	(a)	**110.**	(d)	**135.**	(a)
11.	(b)	**36.**	(a)	**61.**	(b)	**86.**	(c)	**111.**	(b)	**136.**	(b)
12.	(b)	**37.**	(c)	**62.**	(b)	**87.**	(c)	**112.**	(d)	**137.**	(d)
13.	(d)	**38.**	(d)	**63.**	(c)	**88.**	(b)	**113.**	(c)	**138.**	(b)
14.	(c)	**39.**	(c)	**64.**	(c)	**89.**	(b)	**114.**	(a)	**139.**	(d)
15.	(c)	**40.**	(b)	**65.**	(a)	**90.**	(b)	**115.**	(c)	**140.**	(b)
16.	(b)	**41.**	(b)	**66.**	(a)	**91.**	(d)	**116.**	(d)	**141.**	(c)
17.	(d)	**42.**	(d)	**67.**	(c)	**92.**	(a)	**117.**	(a)	**142.**	(a)
18.	(a)	**43.**	(c)	**68.**	(c)	**93.**	(c)	**118.**	(a)	**143.**	(a)
19.	(b)	**44.**	(a)	**69.**	(c)	**94.**	(a)	**119.**	(b)	**144.**	(a)
20.	(b)	**45.**	(c)	**70.**	(c)	**95.**	(d)	**120.**	(a)	**145.**	(c)
21.	(a)	**46.**	(c)	**71.**	(a)	**96.**	(d)	**121.**	(b)	**146.**	(d)
22.	(b)	**47.**	(a)	**72.**	(a)	**97.**	(c)	**122.**	(d)	**147.**	(a)
23.	(b)	**48.**	(b)	**73.**	(b)	**98.**	(c)	**123.**	(c)	**148.**	(b)
24.	(d)	**49.**	(b)	**74.**	(b)	**99.**	(a)	**124.**	(d)	**149.**	(a)
25.	(c)	**50.**	(c)	**75.**	(a)	**100.**	(b)	**125.**	(d)	**150.**	(c)

DETAILED EXPLANATIONS

1. **(b)**

Hybrid parameters are defined as:

$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$
$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0} \Rightarrow \text{Reverse voltage gain}$$
$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0} \Rightarrow \text{Forward current gain}$$

2. **(d)**

For an ideal transformer z-parameter does not exist

$$V_1 = Z_{11}I_1 + Z_{12}I_2$$
$$V_2 = Z_{21}I_1 + Z_{22}I_2$$

Here, $$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{-I_2}{I_1}$$

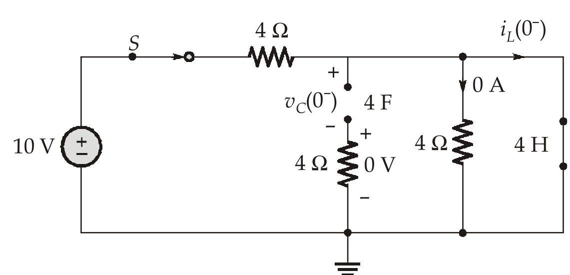
$\Rightarrow$ $$I_2 = -\frac{N_1}{N_2} I_1$$

$\Rightarrow$ $$I_2 = f(I_1).$$

So, Z-parameters does not exist.

3. **(b)**

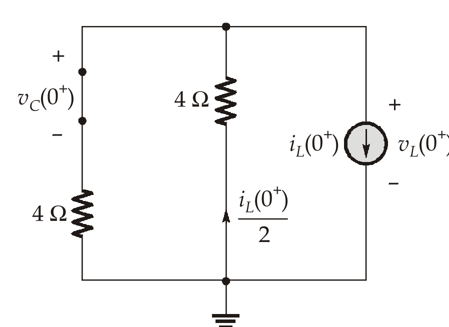
At $t = 0^-$:



$$i_L(0^-) = \frac{10\text{ V}}{4\ \Omega} = 2.5\text{ A}$$
$$v_C(0^-) = 0\text{ V}$$

At $t = 0^+$:

$$v_C(0^+) = v_C(0^-) = 0\text{ V}$$
$$i_L(0^+) = i_L(0^-) = 2.5\text{ A}$$
$$v_L(0^+) = -(4\ \Omega)\frac{i_L(0^+)}{2}$$
$$= -4\times\frac{2.5}{2} = -5\text{ V}$$



4. (b)

Average power absorbed by a load depends only on fundamental components.

$$v(t) = 100\cos(\omega t) = 100\sin(\omega t + 90°)\text{ V}$$

So, $$P_{avg(load)} = \frac{V_1 I_1}{2}\cos\phi = \frac{100 \times 5}{2}\cos(90° - 30°)\text{ mW}$$

$$= 250\cos(60°) = 125\text{ mW} = 0.125\text{ W}$$

5. (a)

Initially, $C_1 = 5\ \mu\text{F}$ and $Q_1 = 17\ \mu\text{C}$

$C_2 = C\ \mu\text{F}$ and $Q_2 = 0$

$\therefore$ $$Q_T = Q_1 + Q_2 = 17\ \mu\text{C} \quad ...(i)$$

When C_1 is connected to C_2 parallely, the charge is transferred from C_1 to C_2. However the total charge remains equal to 17 μC. Due to the law of conservation of charge, for the capacitors connected in parallel.

$\therefore$ $$V_1 = V_2$$

$$\frac{Q_1}{C_1} = \frac{Q_2}{C_2}$$

$$\frac{10}{5} = \frac{7}{C}$$

$$C = \frac{7}{2} = 3.5\ \mu\text{F}$$

6. (b)

The degree of each node in a fully connected graph is equal to $(n - 1)$.

7. (a)

For the given circuit $L_{eq} = L_1 + L_2 \pm 2\text{ M}$

where $M \propto \sqrt{L_1 L_2}$

and $L \propto N^2$

when number of turns get halved,

$$L_1' = \frac{1}{4}L_1$$

and $$L_2' = \frac{1}{4}L_2$$

$$L_{eq}' = \frac{1}{4}L_1 + \frac{1}{4}L_2 \pm \frac{1}{4} \times 2\text{ M}$$

$$L_{eq}' = \frac{1}{4}(L_{eq})$$

$$\therefore \quad f_0' = \frac{1}{2\pi\sqrt{L_{eq}'C}} = \frac{1}{2\pi\sqrt{\frac{1}{4}L_{eq}C}}$$

$$= \frac{2}{2\pi\sqrt{L_{eq}C}} = 2f_0$$

8. (a)

From the given characteristics, it is clear that,

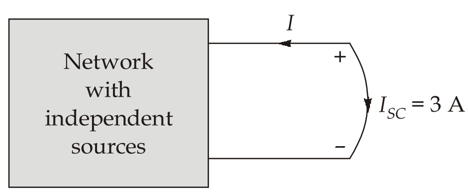
when $V = 0$ V (short circuit)

$I = -3$ A

and when $V = 15$ V

$I = 0$ A (open circuit)

$\therefore$ Network becomes,



$$V_{OC} = 15 \text{ V}$$

$$I_{SC} = -I = 3 \text{ A}$$

$$\therefore \quad R_{Th} = \frac{15}{3} = 5\ \Omega$$

and maximum power transferred is

$$P_{max} = \frac{V_{OC}^2}{4R_{Th}} = \frac{(15)^2}{4\times 5} = \frac{15\times 15}{20}$$

$$= \frac{45}{4} = 11.25 \text{ W}$$

9. (a)

Here $X_L = j\omega L = j \times 1000 \times 10^{-3} = j$

and $X_C = \dfrac{1}{j\omega C} = \dfrac{-j}{1000\times 10^{-3}} = -j$

$\therefore$ $Z_{eq} = 1 + (X_L \,||\, X_C)$

$$= 1 + \frac{(j)(-j)}{-j+j} = 1 + \frac{1}{0} = \infty$$

$\therefore$ $I = 0$

10. (a)

Here $v_0(t)$ is negative means current direction is opposite in the coils

$$\therefore \quad v_0(t) = \frac{M\,di_1(t)}{dt}$$

$$M = \frac{|v_0(t)|}{\left|\frac{di_1(t)}{dt}\right|} = \frac{40}{16} = 2.5\text{ H}$$

11. (b)

The time constant for RC circuit is

$$\tau = R_{eq}\,C_{eq}$$

here, $\quad R_{eq} = 2\ \Omega$

and $\quad C_{eq} = \dfrac{(4\text{ F}+4\text{ F})(8\text{ F})}{(4\text{ F}+4\text{ F})+8\text{F}} = \dfrac{8\text{ F}\times 8\text{ F}}{16\text{ F}} = 4\text{ F}$

$\therefore \quad \tau = 2 \times 4 = 8$ sec

12. (b)

For a symmetrical two port network,

$$z_{11} = z_{22}$$

$$y_{11} = y_{22}$$

$$\Delta h = 1$$

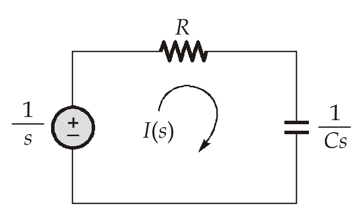
and $\quad A = D$

13. (d)

$$i(t) = \frac{1}{8}e^{-t/2}\text{A} \quad \text{(given)}$$

$$\therefore \quad I(s) = \frac{1}{8\left(s+\frac{1}{2}\right)} = \frac{2}{8(2s+1)} = \frac{1}{4(2s+1)} \quad \text{...(i)}$$

as per the question,



The KVL equation in the loop

$$\frac{1}{s} = \left(R+\frac{1}{Cs}\right)I(s)$$

$$\frac{1}{s} = \left(\frac{1+RCs}{Cs}\right)I(s)$$

$$I(s) = \frac{C}{(1+RCs)} \quad \text{...(ii)}$$

Comparing with equation (i), we get

$$C = \frac{1}{4} = 0.25\text{ F}$$

and $$RC = 2$$

$$R \times \frac{1}{4} = 2$$

$$R = 8\ \Omega$$

14. (c)

The fault is assumed to occur on the R-phase. Taking R-phase as the reference,

Phase e.m.f. of R-phase,

$$\vec{E}_R = \frac{11\times10^3}{\sqrt{3}} = 6350\text{ V}$$

$$\vec{Z}_{1\text{eq}} = j1.2 + j1.0 = j2.2\ \Omega$$

$$\vec{Z}_{2\text{eq}} = j0.9 + j1.0 = j1.9\ \Omega$$

$$\vec{Z}_{0\text{eq}} = j0.4 + j3.0 = j3.4\ \Omega$$

For a line to ground fault, we have

$$\vec{I}_1 = \vec{I}_2 = \vec{I}_0 = \frac{\vec{E}_R}{\vec{Z}_1 + \vec{Z}_2 + \vec{Z}_0}$$

$$= \frac{6350}{j2.2 + j1.9 + j3.4} = -j846\text{ A}$$

$$V_R = E_R - I_1 Z_{g1} - I_2 Z_{g2} - I_0 Z_{g0}$$

$$= 6350 + j846\ (j2.5)$$

$$= 4235\text{ V}$$

15. (c)

$$S_L = 1000\text{ kVA at 0.8 pf lag} + 750\text{ kVA at 0.5 pf lead}$$

$$= (1000 \times 0.8 + j1000 \times 0.6) + (750 \times 0.6 - j750 \times 0.8)$$

$$S_L = 1250\text{ kW}$$

So, pf of main is UPF.

16. (b)

$$J = 9000 \text{ kg-m}^2$$
$$P = 2$$
$$S = \frac{60}{0.85} = 70.588 \text{ MVA}$$
$$f = 50 \text{ Hz}$$
$$\omega_m = \frac{\omega}{\frac{P}{2}} = \frac{2\pi f}{P/2} = \frac{4\pi f}{P}$$
$$\text{Kinetic energy} = \frac{1}{2}J\omega^2 = \frac{1}{2}J\left(\frac{4\pi f}{P}\right)^2$$
$$= \frac{1}{2}\times\frac{9000\times 16\pi^2\times 50\times 50}{2^2}\text{mJ} = 444.132 \text{ MJ}$$
$$\therefore \quad \text{Inertia constant, } H = \frac{K.E.}{s} = \frac{444.132}{70.588} = 6.29$$

17. (d)

For lagging pf; $E < V$

For leading pf; $E > V$

Since $\phi \propto \frac{E}{f}$

So, ϕ reduces at lagging pf and ϕ increases at leading power factor.

18. (a)

STATCOM has ability to maintain full capacitive output current at low system voltage. It is more effective than SVC in improving transient stability.

19. (b)

$$\text{Plug setting multiplier} = \text{PSM} = \frac{\text{Fault current}}{\text{Relay current setting} \times \text{CT ratio}}$$
$$\text{PSM} = \frac{3000}{0.5\times 5\times \frac{400}{5}} = 15$$

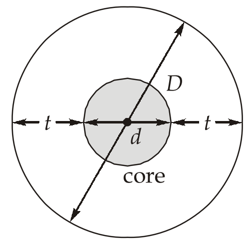
The operating time corresponding to PSM of 15 is 2.4 s

The time of operation of relay,

$$= 2.4 \times 0.75 = 1.8 \text{ sec}$$

20. (b)

We know that,



$$\frac{g_{max}}{g_{min}} = \frac{D}{d}$$

$$\frac{40}{10} = \frac{D}{d}$$

$$D = 8 \text{ cm}$$

and $$D = d + 2t$$

$\therefore$ Insulation thickness, $t = \dfrac{D-d}{2} = \dfrac{8-2}{2} = 3$ cm

21. (a)

Reflection coefficient, $\Gamma = \dfrac{Z_L - Z_0}{Z_L + Z_0}$; for $-1 < \Gamma < 1$

for $\Gamma = 0$; $Z_L = Z_0$

for $\Gamma = 1$; $Z_L = \infty$

for $\Gamma = -1$; $Z_L = 0$

22. (b)

FACTS (Flexible AC transmission systems) controllers can enable a line to carry power closer to its thermal rating.

23. (b)

In the End condenser method,

$$A = 1 + ZY$$

$$D = 1$$

24. (d)

To have a shunt element i.e. $y_{10}, y_{20}, y_{30},$ or y_{40}

$$Y_{11} = y_{10} + y_{12} + y_{13} + y_{14}$$

$$y_{10} = Y_{11} - y_{12} - y_{13} - y_{14}$$

$$y_{10} = -5 + 2.5 + 2 + 0 = -0.5 \neq 0$$

$$y_{10} = -0.5$$

$\therefore$ shunt element is present

$$y_{20} = Y_{22} - y_{12} - y_{23} - y_{24}$$

$$= -9 + 2.5 + 1 + 5 = -0.5$$

$$y_{20} = -0.5$$

$$y_{30} = Y_{33} - y_{13} - y_{23} - y_{43}$$

$$= -9 + 2 + 1 + 4 = -2$$

$$y_{30} = -2$$

$$y_{40} = Y_{44} - y_{14} - y_{24} - y_{34}$$
$$= -9 + 0 + 5 + 4$$
$$y_{40} = 0$$

∴ Only bus 4 is not having shunt element.

25. (c)

$$\frac{dF_1}{dP_1} = 20 + 0.1\,P_1,$$

$$\frac{dF_2}{dP_2} = 16 + 0.2\,P_2$$

For economic operation

$$20 + 0.1\,P_1 = 16 + 0.2\,P_2$$
$$4 = -0.1\,P_1 + 0.2\,P_2 \quad \text{...(i)}$$
$$P_1 + P_2 = 200 \text{ MW} \quad \text{...(ii)}$$

From equation (i) and (ii), we get

$$P_2 = 80 \text{ MW}$$

and $P_1 = 120$ MW

But the limits of generator 2 is $20 \le P_2 \le 60$ MW

$$P_1 = 140 \text{ MW}, P_2 = 60 \text{ MW}$$

26. (b)

Reactive power, Q = Active power × tan ϕ

$$= 100 \times 10^3 \times \tan(\cos^{-1} 0.8))$$
$$Q = 75 \text{ kVAR}$$

The capacitor bank should supply

$$Q = 75 \text{ kVAR}$$

$$Q_{ph} = \frac{75000}{3} = 25 \text{ kVAR}$$

$$Q_{ph} = V_{ph}^2 \omega C_{ph}$$

$$C_{ph} = \frac{Q_{ph}}{V_{ph}^2 \times 2\pi f}$$

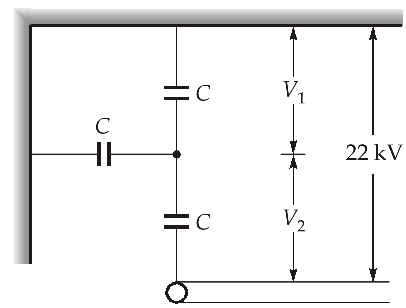
$$C_{ph} = \frac{25000}{\left[\frac{10 \times 10^3}{\sqrt{3}}\right]^2 \times 2\pi \times 50} = 2.38 \times 10^{-6} \text{ F}$$

27. (b)

$$\text{String efficiency} = \frac{\text{Voltage across the string}}{n \times \text{Voltage across the lower most unit}}$$

$$\eta = \frac{V_1 + V_2}{n \times V_2} \times 100$$

$$V_2 = V_1 + KV_1$$



$$\because \quad K = \frac{C_s}{C_m} = 1$$

$$V_2 = 2\ V_1$$

$$\eta = \frac{V_1 + 2V_1}{2 \times 2V_1} \times 100$$

$$= \frac{3V_1}{4V_1} \times 100$$

$$= 0.75 \times 100 = 75\%$$

28. (b)

By putting $R(s) = 0$

$P_1 = -H_2G_1$, $\Delta = 1$, $L_1 = -G_1H_2H_1$

$$\frac{C(s)}{N(s)} = \frac{-G_1H_2}{1-(-G_1H_1H_2)} = \frac{-G_1H_2}{1+G_1H_1H_2}$$

If $|G_1(s)H_1(s)H_2(s)| >>> 1$

$$\frac{C(s)}{N(s)} = \frac{-G_1H_2}{G_1H_1H_2} = \frac{-1}{H_1}$$

29. (d)

From the above figure

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

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

Comparing with

$$\frac{C(s)}{R(s)} = \frac{s+2}{s+1}$$

$$G = 1$$

30. (b)

Characteristic equation: $1 + G(s)H(s) = 0$

$s^2 + 2s + 1 + Ks^2 - 2Ks + 2K = 0$

$s^2(1 + K) + s(2 - 2K) + 1 + 2K = 0$

Routh table is:

s^2	$(1+K)$	$(1+2K)$
s^1	$(2-2K)$	0
s^0	$(1+2K)$	

For stable system:

$$2 - 2K > 0 \Rightarrow K < 1$$

and $$1 + 2K > 0 \Rightarrow K > \frac{-1}{2}$$

for stable system: $\frac{-1}{2} < K < 1$

31. (b)

Standard 2nd order transfer function

$$T(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} = \frac{40000}{s^2 + 500s + 40000}$$

$$\frac{C(s)}{R(s)} = \frac{40000}{(s+100)(s+400)}$$

For unit step input $R(s) = \frac{1}{s}$

$$C(s) = \frac{40000}{s(s+100)(s+400)}$$

$$C(s) = \frac{1}{s} - \frac{4}{3(s+100)} + \frac{1}{3(s+400)}$$

Taking inverse Laplace transform

$$C(t) = 1 - \frac{4}{3}e^{-100t} + \frac{1}{3}e^{-400t}u(t)$$

32. (d)

Given, $$R(s) = \frac{3}{s^4}$$

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

$$e_{ss} = \lim_{s\to 0} sF(s)$$

$$e_{ss} = \lim_{s\to 0} \frac{s\times\frac{3}{s^4}}{1+\frac{1000(s^2+4s+20)(s^2+20s+15)}{s^3(s+2)(s+10)}}$$

$$= \lim_{s\to 0} \frac{3}{s^3\left[\frac{s^3(s+2)(s+10)+1000(s^2+4s+20)(s^2+20s+15)}{s^3(s+2)(s+10)}\right]}$$

$$= \frac{3}{\frac{1000(20)(15)}{2\times 10}} = \frac{1}{5000} = 2\times 10^{-4}$$

33. (b)

- At $\angle G(j\omega)$ = 180° gain is –2 dB. Hence gain margin is 2 dB.
- At 0 dB gain phase is –140. Hence phase margin is

$$\phi_m = 180° + \phi = 180° - 140° = 40°$$

34. (a)

From the frequency vs magnitude plot

DC gain of transfer function:

$$T(s) = \frac{K\cdot\omega_n^2}{s^2+2\xi\omega_n s+\omega_n^2} \rightarrow \frac{K\cdot\omega_n^2}{(\omega_n^2-\omega^2)+j2\xi\omega\cdot\omega_n}$$

DC gain $\rightarrow S = 0$

$$1 = \frac{K\cdot\omega_n^2}{\omega_n^2} \quad\Rightarrow\quad K = 1$$

Resonant peak $\rightarrow M_r = \frac{1}{2\xi\sqrt{1-\xi^2}} = 2.5$

$$\xi\sqrt{1-\xi^2} = \frac{0.4}{2}$$

$$\xi = 0.2$$

35. (d)

In derivative error compensation, damping ratio increases and settling time decreases.

36. (a)

State transition matrix:

$$\phi(t) = L^{-1}[(sI - A)]^{-1} \qquad (sI - A) = \begin{bmatrix} s & -2 \\ 2 & s \end{bmatrix}$$

$$(sI - A)^{-1} = \frac{1}{s^2+4}\begin{bmatrix} s & 2 \\ -2 & s \end{bmatrix} = \begin{bmatrix} \frac{s}{s^2+4} & \frac{2}{s^2+4} \\ \frac{-2}{s^2+4} & \frac{s}{s^2+4} \end{bmatrix}$$

$$\phi(t) = \begin{bmatrix} \cos 2t & \sin 2t \\ -\sin 2t & \cos 2t \end{bmatrix}$$

37. (c)

Controllability matrix, $[Q_c] = [B \quad AB]$

$$B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$AB = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix}\begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$[Q_c] = \begin{bmatrix} 0 & 1 \\ 1 & -1 \end{bmatrix} = -1 \quad |Q_c| \neq 0$$

System is controllable.

Observability matrix

$$Q_0 = \begin{bmatrix} C^T & A^T & C^T \end{bmatrix}$$

$$C^T = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$A^T C^T = \begin{bmatrix} 1 & -2 \\ 1 & -1 \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

$$Q_0 = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$$

$$Q_0 \neq 0 = \text{observable}$$

The system is controllable and observable.

38. (d)

Given $$H(s) = \frac{4}{s^2 + 2s + 4}$$

On comparing with standard 2nd order T.F.

$$\omega_n = 2 \text{ rad/sec}$$

$$2\xi\omega_n = 2$$

$$\xi = 0.5$$

First peak undershoot time

$$t_p = \frac{2\pi}{\omega_d} = \frac{2\pi}{\omega_n\sqrt{1-\xi^2}}$$

$$= \frac{2\pi}{2\sqrt{1-0.5^2}} = 3.62\,\text{sec}$$

settling time:

$$t_s = \frac{4}{\xi\omega_n} = \frac{4}{0.5\times 2} = 4\,\text{sec}$$

39. (c)

Silver oxidation is slower than that of copper. It has a high resistance to oxidation.

40. (b)

Manganese ferrite is a 1 : 1 mixture of manganese oxide and iron oxide.

41. (b)

Here, $\chi_m = 3.7 \times 10^{-3}$

and $H = 10^4$ A/m

So $M = \chi_m H = 3.7 \times 10^{-3} \times 10^4$

$= 37$ A/m

42. (d)

NaCl has rock salt crystal structure.

43. (c)

All of the above are applications of a superconducting material.

44. (a)

Unit of polarizability is F-m^2 or C-m^2/V.

45. (c)

$$\text{Power loss, } W(t) = \frac{\omega}{2}\epsilon_0\epsilon_r'' E^2\ \text{W/m}^3$$

So, power loss is directly proportional to ω.

47. (a)

Oriental polarization is given by,

$$p = \frac{\mu_p^2}{3kT}E$$

Where $\frac{\mu_p^2}{3kT} = \alpha_0$ called orientation polarizability.

48. (b)

For 4-bit flash type ADC → Number of comparators $2^4 - 1 = 15$

49. (b)

A computer program that consists only of basic elemental commands.

50. (c)

Size of instruction is 24 bits.

Starting address of the program is 300. The size of instruction is 3 Byte long. So, the address is always the multiple of 3 Byte next address is 600. If it also the next instruction of the program.

51. (a)

$$(35)_6 = (23)_{10}$$
$$(63)_8 = (51)_{10}$$
$$(87)_{10} = (87)_{10}$$
$$(235)_9 = (194)_{10}$$

Thus, $23 + 51 + 87 + x = 194$

$$x = 194 - 161 = 33$$
$$(x)_{10} = 33 = (113)_5$$

52. (b)

Extern storage classes have global visibility in C.

53. (a)

Loader is part of operating system. So it always resides in main memory.

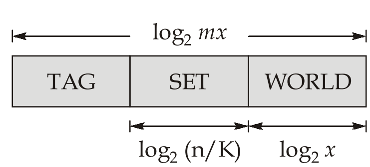
54. (b)

8255 is known as PPI (Programmable Peripheral Interface) and it is used for data transmission between 8085 microprocessor and an 8-bit ADC.

55. (a)

$$\text{Number of sets} = \frac{n}{K}$$

Let there are x words per block in main memory



$$\text{Number of TAG bits} = \log_2(mx) - \left(\log_2 \frac{n}{K} + \log_2 x\right)$$
$$= \log_2\left(\frac{mK}{n}\right)$$

56. (a)

For proportional load sharing:

Pu impedances of both transformer should be same on their own bases,

So, leakage pu impedance of 250 kVA transformer

$$= 0.05 \text{ p.u.}$$

57. (d)

W_1 = Core losses of both transformer at rated voltage = 5 kW

W_2 = Copper losses of both transformer at rated current = 7.5 kW

Total losses (copper + core) of each transformer

$$= \frac{5+7.5}{2} = 6.25 \text{ kW}$$

Efficiency of each transformer at unit pf

$$= \frac{\text{output}}{\text{output + losses}}$$

$$= \frac{250}{250 + 6.25} = 97.56\%$$

58. (b)

demagnetization ampere turn per pole:

$$\left(\frac{AT_d}{P}\right) = \frac{2\theta°}{180°}\left(\frac{Z_a}{A} \cdot \frac{Z}{2P}\right)$$

$$\theta_e^\circ = \frac{P}{2}\theta_m^\circ = \frac{4}{2} \times 3 = 6°$$

for wave winding → $A = 2$

$$\left(\frac{AT_d}{P}\right) = \frac{2 \times 6}{180°}\left(\frac{120}{2} \times \frac{880}{2 \times 4}\right)$$

$$= 440 \text{ Ampere-turn}$$

For neutralizing the demagnetization:

$$I_f \text{ (field winding turns/pole)} = \frac{AT_d}{P}$$

$$I_f \times 1100 = 440$$

$$I_f = 0.4 \text{ A}$$

59. (b)

$$\text{Stator input} = 60 \text{ kW}$$

$$\text{Stator output} = 60 - 1 = 59 \text{ kW} = \text{rotor input}$$

$$\text{Total rotor copper loss} = S \times \text{rotor power input}$$

$$= 0.03 \times 59 = 1.77 \text{ kW}$$

Rotor copper loss per phase $= 1.77 \times \frac{1}{3} = 0.59$ kW

60. (c)

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{6} = 1000 \text{ rpm}$$

speed at maximum torque ,

$$N_m = 960 \text{ rpm}$$

slip at maximum torque, $s_m = \frac{N_s - N_m}{N_s} = \frac{1000 - 960}{1000} = 0.04$

We know, $$\frac{\tau_s}{\tau_{max}} = \frac{2s.s_m}{s^2 + s_m^2}$$

$$\tau_s = \frac{2 \times 0.04 \times 0.05}{(0.05)^2 + (0.04)^2} \times 30$$

$$\tau_s = 29.27 \text{ N-m}$$

61. (b)

A double cage rotor has low starting current and high starting torque, therefore it is more suitable for direct-on-line starting.

62. (b)

The direction of rotating field in shaded pole motor is from the unshaded to the shaded portion of the pole.

63. (c)

Given, $$\frac{N_{\Delta(P)}}{N_{Y(P)}} = 4 = \frac{V_{\Delta(P)}}{V_{Y(P)}}$$

Also, $$V_{Y(P)} = \frac{500}{\sqrt{3}} \text{V}$$

$\therefore$ $$V_{\Delta(P)} = \frac{4 \times 500}{\sqrt{3}} = \frac{2000}{\sqrt{3}} = 1154.70 \text{ V}$$

For delta connection,

Secondary line voltage, $V_{\Delta(L)} = V_{\Delta(P)} = 1154.70$ V

64. (c)

Synchronous speed, $N_S = \frac{120 \times 50}{8} = 750$ rpm

Slip, $s = \frac{N_s - N_r}{N_s} = \frac{750 - 710}{750} = 0.053$

Electrical power input = 35 kW

Stator copper loss = 1.0 kW

Power across air gap = P_{input} – Stator copper loss

= 35 – 1 = 34 kW

Mechanical power developed,

$$P_m = (1 - s)P_g$$
$$= (1 - 0.053) \times 34$$
$$= 32.186 \text{ kW}$$

65. (a)

Given,

$$\mu_r = 50$$
$$\mu_0 = 4\pi \times 10^{-7}$$

We know that, $\mu = \mu_0\mu_r$

Cross-section area, $A = 5 \text{ cm}^2 = 5 \times 10^{-4} \text{ m}^2$

Core length, $l = 25 \text{ cm} = 25 \times 10^{-2} \text{ m}$

Now, $$\text{Reluctance} = \frac{l}{\mu_0\mu_r A} = \frac{25\times10^{-2}}{4\pi\times10^{-7}\times50\times5\times10^{-4}}$$

Also, $$\text{Flux} = \frac{\text{mmf}}{\text{Reluctance}}$$
$$= \frac{500\times4\pi\times10^{-7}\times50\times5\times10^{-4}}{25\times10^{-2}}$$
$$= 0.628 \times 10^{-4} \text{ Wb} = 0.0628 \text{ mWb} \approx 0.06 \text{ mWb}$$

66. (a)

Series excited and should have polarity opposite to that of the next main pole in the direction of rotation of armature.

67. (c)

- The curves obtained by plotting power factor versus field current are called as inverted *V* curves.
- If the field current is made less than the normal excitation, the motor is under excited.

68. (c)

For an over compounded dc generator,
Percentage of compounding = voltage regulation

$$\%\text{V.R.} = \left(\frac{E_a - V}{V}\right)\times100 = \left(\frac{I_a R_a}{V}\right)\times100$$

$$\%\text{V.R.} = \left(\frac{800\times0.02}{500}\times100\right) = \frac{16}{5} = 3.2\%$$

69. (c)

As $$\frac{T_{st}}{T_{max}} = \frac{2s_m}{s_m^2+1} = \frac{1}{2}$$

$$s_m^2 - 4s_m + 1 = 0$$

$$s_m = \frac{4 \pm \sqrt{16-4}}{2} = 3.762, 0.268$$

Neglecting the higher value

$$s_m = 0.268$$

70. (c)

Gate circuit impedance of MOSFET is higher than that of BJT with lower switching losses.

71. (a)

The turn-on and turn-off time of SCR is dependent on junction capacitance value of transistor.

72. (a)

Given, $I_0 = 10$ A; $f = 5$ kHz

$D = 0.5$;

$C = 10$ μF, $L = 5$ mH

Peak to peak ripple voltage,

$$\Delta V_c = \frac{I_0 D}{fC} = \frac{10 \times 0.5}{5 \times 10^3 \times 10 \times 10^{-6}} = 100 \text{ V}$$

73. (b)

We know,

$$Q_{RR} = \frac{1}{2} \cdot \frac{di}{dt} \cdot t_{rr}^2$$

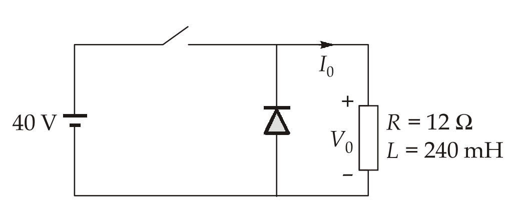
$$= \frac{1}{2} \times \frac{40}{10^{-6}} \times (2 \times 10^{-6})^2 = 80 \text{ μC}$$

74. (b)

Circuit turn off time for 3-ϕ full wave rectifier for firing angle α < 60°.

$$t_c = \frac{\frac{4\pi}{3} - \alpha}{\omega} = \frac{\frac{4\pi}{3} - \frac{\pi}{4}}{100\pi} = \frac{13\pi}{12 \times 100\pi} = 10.833 \text{ msec}$$

75. (a)



For step down chopper,

$$\text{Ripple current, } \Delta I = \frac{\alpha(1-\alpha)V_s}{fL}$$

Maximum ripple in load current is observed at duty ratio = 0.50

Maximum ripple is given by $(\Delta I_0)_{max} = \dfrac{V_s}{4 \times f \times L_a}$

$$= \frac{40}{4 \times 40 \times 10^3 \times 240 \times 10^{-3}} = \frac{40}{160 \times 240} = 1.042 \times 10^{-3} \text{ A}$$

76. (b)

If commutation fails, then some excess charge carriers are still present in the vicinity of gate junction i.e. device did not regain its normal state. Then, for the next operation when anode is made positive with respect to cathode, SCR will get turned on immediately before applying gate pulse. Thus SCR behaves like diode losing its forward blocking capability.

77. (a)

For step down chopper without filter,

Output voltage is given by,

$$V_0 = DV_s + \sum_{n=1}^{\infty} \frac{2V_s}{n\pi} \sin \pi n D \sin(n\omega t + \phi_n)$$

Where, D = duty ratio

To eliminate n^{th} harmonic, condition is

$$\sin \pi\, nD = 0$$

$$\therefore \quad nD = 1$$

$$D = \frac{1}{n}$$

And to eliminate 5^{th} harmonic

$$\text{Duty ratio } (D) = \frac{1}{5} = 0.2$$

78. (b)

For single phase PWM inverter, distortion factor (g) is given by,

$$g = \frac{2\sqrt{2} \sin d}{\sqrt{2d\pi}}$$

Given, pulse width ($2d$)

$$2d = 120° = \frac{2\pi}{3}$$

$$g = \frac{2\sqrt{2}\sin 60°}{\sqrt{\frac{2\pi}{3}\cdot\pi}} = 0.95493$$

Total harmonic distortion factor is given by

$$\text{THD} = \sqrt{\frac{1}{g^2} - 1} = 0.3108$$

$$\%\text{THD} = 31.08\%$$

79. (b)

- For 180° mode square wave inverter, line output voltage waveform is quasi wave form,

$$\therefore \quad V_{or} = \sqrt{\frac{2}{3}}V_s$$

- And for star load,

$$V_{phase} = \frac{V_{line}}{\sqrt{3}} = \sqrt{\frac{2}{3}} \times \frac{1}{\sqrt{3}}V_s$$

$$V_{phase} = \frac{\sqrt{2}}{3}V_s$$

- For 120° mode square wave inverter, line voltage waveform is six step waveform

$$\therefore \quad V_{or} = \frac{V_s}{\sqrt{2}}$$

80. (c)

We know,

Forward current gain, $\alpha = 0.97$

and $\alpha = \frac{\beta}{\beta + 1}$

So, $\alpha\beta + \alpha = \beta$

$$\alpha = \beta(1 - \alpha)$$

$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.97}{1-0.97} = 32.33$$

81. (c)

$$C_{AB} = \frac{C_1C_2}{C_1 + C_2} = \frac{2\varepsilon_0 A}{d}\left(\frac{\varepsilon_{r1} \times \varepsilon_{r2}}{\varepsilon_{r1} + \varepsilon_{r2}}\right)$$

$$= 2 \times \frac{10^{-9}}{36\pi} \times \frac{30 \times 10^{-4}}{5 \times 10^{-3}} \times \frac{4 \times 6}{10} = 25.46 \text{ pF}$$

82. (d)

Electrical potential at origin is given as

$$V = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q_1}{r_1}+\frac{Q_2}{r_2}+\frac{Q_3}{r_3}+\frac{Q_4}{r_4}+\frac{Q_5}{r_5}\right]$$

$$= 9\times10^9\times20\times10^{-9}\left(\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}\right) = 261\text{ V}$$

83. (c)

Induced emf, $e = N\dfrac{d\phi}{dt} = 300 \times 2 = 600\text{ V}$

84. (d)

Since vector $\vec{V}$ is solenoidal, therefore

$$\nabla\cdot\vec{V} = 0$$

$$\therefore \left[\hat{i}\frac{\partial}{\partial x}+\hat{j}\frac{\partial}{\partial y}+\hat{k}\frac{\partial}{\partial z}\right]\left[(x+3y)\hat{i}+(y-2x)\hat{j}+(x+bz)\hat{k}\right]$$

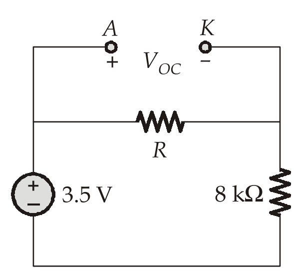
$$1 + 1 + b = 0$$

$$b = -2$$

85. (a)

Let us take the open circuit test,

For diode to be in ON state,



$$V_{OC} > 0.7\text{ V}$$

$$\frac{R}{R+8\text{k}\Omega}(3.5) > 0.7$$

$$\frac{R+8\text{k}\Omega}{R} < 5$$

$$\frac{8\text{k}\Omega}{R} < 4$$

$$R > 2\text{ k}\Omega$$

86. (c)

For the circuit given in the question,

$$S = \frac{\beta+1}{1+\beta\left[\dfrac{R_C}{R_B+R_C}\right]}$$

$$= \frac{100+1}{1+100\times\dfrac{5}{15}} = 2.94$$

87. (c)

For I_{in} positive, we have D_1 = ON and D_2 = OFF

$\therefore \quad V_0 = R_1 I_{in}$

$\therefore \quad V_0 \propto I_{in}$

For I_{in} negative, we have D_1 = OFF and D_2 = ON

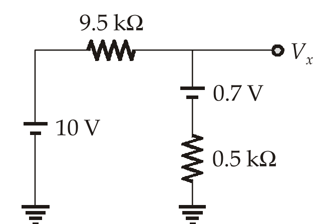
$\therefore \quad V_0 = V_{D2} = 0$ V (since the diode is ideal)

88. (b)

Apply open circuit test for the diodes and voltage across diodes are as follows:

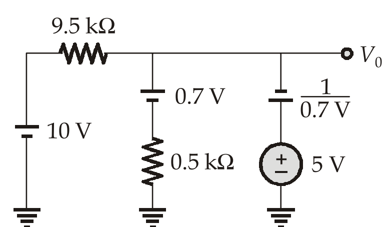
$D_1 \rightarrow 10$ V, $D_2 \rightarrow 5$ V, $D_3 \rightarrow -5$ V

So D_1 becomes on first



$$V_x = 0.7 + \left(\frac{9.3}{10}\right) \times 0.5 = 1.165 \text{ V}$$

This V_x makes D_2 OFF and D_3 ON



$$V_0 = -0.7 + 5 \text{ V} = 4.3 \text{ V}$$

89. (b)

$$R = \overline{P \oplus Q_n}, \quad S = P \oplus Q_n$$

$$Q_{n+1} = S + \bar{R} Q_n$$

$$= (P \oplus Qn) + (\overline{P \odot Q_n}) Q_n$$

$$= (P \oplus Qn) + (P \oplus Q_n) Q_n$$

$$= (P \oplus Q_n)\,(1 + Q_n)$$

$$Q_{n+1} = P \oplus Q_n$$

For $P = 0$, $\quad Q_{n+1} = Q_n$

For $P = 1$, $\quad Q_{n+1} = \bar{Q}_n$

Hence the circuit functions as T flip-flop.

90. (b)

K-map of given function f

$S_1 \leftrightarrow w$, $S_0 \leftrightarrow x$

$S_1 S_0$	$\bar{y}\bar{z}$	$\bar{y}z$	yz	$y\bar{z}$	
00 $\bar{w}\bar{x}$					$I_0 = 0$
01 $\bar{w}x$	1	1	1		$I_1 = \bar{y} + z$
11 wx	1		1		$I_3 = \bar{y}\bar{z} + yz = y \odot z$
10 $w\bar{x}$	1			1	$I_2 = \bar{z}$

91. (d)

- 10 bit Ring counter is a MOD-10

  so output frequency at $w = \frac{160}{10} = 16$ kHz
- The four bit parallel counter $\rightarrow$ MOD-16

  so output frequency at $x = \frac{16 \text{ kHz}}{16} = 1$ kHz
- Mod-25 ripple counter $\rightarrow$ Mod-25

  output frequency at $y = \frac{1000}{25} = 40$ Hz
- 4-bit Johnson counter $\rightarrow$ Mod-8

  output frequency at $z = \frac{40}{8} = 5$ Hz

92. (a)

If either one or both the inputs are 0 V, the corresponding FET will be OFF, the voltage across load FET is 0 V, hence the output is V_{DD}.

If both inputs are ON, both M_1, M_2 are ON and the output $V(0)$ = 0 V, it satisfies NAND gate.

93. (c)

$$(211)_x = (152)_8$$

$$2 \times x^2 + 1 \times x^1 + 1 \times x^0 = 1 \times 8^2 + 5 \times 8^1 + 2 \times 8^0$$

$$2x^2 + x + 1 = 64 + 40 + 2$$

$$2x^2 + x - 105 = 0$$

On solving $\Rightarrow$ $x = 7$

94. (a)

Let the capacity of fully filled tank is y litres.

Meter reading when tank is 80% filled is $(110A0)_{12}$.

In decimal, $0.8\,y = 1 \times 12^4 + 1 \times 12^3 + 0 + 10 \times 12^1 + 0$

$= 20736 + 1728 + 120$

$$0.8\, y = 22584$$
$$y = 28230 \text{ litres}$$

95. (d)

To address 8K bit of memory we require 13 bit S.P.

96. (d)

$$\begin{aligned}\text{Starting address} &= 1001 \text{ H}\\ \text{Ending address} &= 2016 \text{ H}\\ \text{Size of memory} &= (2016 - 1001)\text{H} + 1 \text{ H}\\ &= 1016 \text{ H}\\ &= 4118 \text{ bytes}\end{aligned}$$

98. (c)

READY is an active. High pin used to interface slow peripheral devices with 8085.

99. (a)

The equation for AM wave is

$E_K \cos \omega_K t + E_m \cos \omega_m t \cdot \cos \omega_K t$

$$= E_K\left(1+\frac{E_m}{E_K}\cos\omega_m t\right)\cos\omega_K t$$

100. (b)

$$A_m = \frac{A_{\max} - A_{\min}}{2} = \frac{12.5-7.5}{2} = 2.5 \text{ V}$$

101. (d)

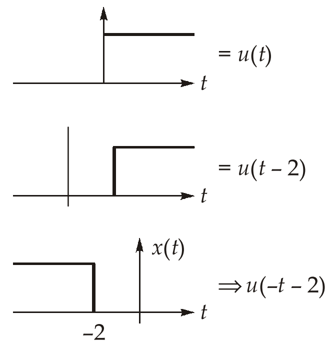
Given, $m = 0.4$

$$P_T = P_C\left(1+\frac{m^2}{2}\right)$$
$$= P_C\left(1+\frac{0.16}{2}\right)$$
$$= 1.08\, P_C$$

Hence, Increase in power $= \dfrac{P_T - P_C}{P_C}\times 100\%$

$$= \frac{1.08-1}{1}\times 100\% = 8\%$$

102. (d)



103. (c)

For QPSK : $M = 4$

$$\text{Baud rate} = \frac{\text{Bit rate}}{\text{Log}_2 M} = \frac{34 \text{ Mbps}}{\log_2 4} = 17 \text{ M symbols/second}$$

104. (b)

Information capacity of a channel is directly proportional to bandwidth and inversely proportional to transmission time.

105. (a)

Given,
$$P_{si} = 150\ \mu\text{W}, \qquad P_{ni} = 1.5\ \mu\text{W}$$
$$P_{s0} = 1.5\ \text{W}, \qquad P_{n0} = 40\ \text{mW}$$

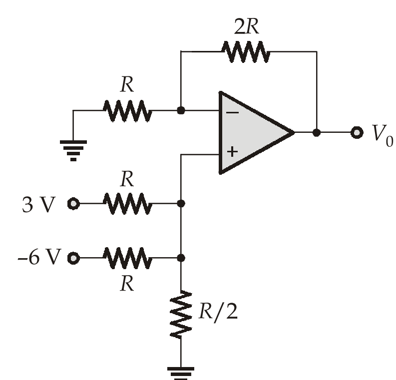
$$\text{Noise factor} = \frac{P_{si}}{P_{ni}} \times \frac{P_{n0}}{P_{s0}} = \frac{150\times10^{-6}}{1.5\times10^{-6}} \times \frac{40\times10^{-3}}{1.5} = 2.66$$

106. (b)

Frequency of oscillation,
$$f_o = \frac{1}{2\pi\sqrt{6}\,RC} = \frac{1}{2\times3.14\times\sqrt{6}\times20\times5.28\times10^{-9}\times10^{3}}$$
$$= 615.3 \text{ Hz}$$

107. (c)

Applying KCL at node V_+ we get,



$$\frac{V_+ - 3}{R} + \frac{V_+ + 6}{R} + \frac{V_+}{R/2} = 0$$
$$4\ V_+ = -3 \text{ V}$$
$$V_+ = -\frac{3}{4} \text{V}$$

Now,
$$V_0 = \left(1 + \frac{2R}{R}\right) V_+$$
$$= -3 \times \frac{3}{4} = \frac{-9}{4} = -2.25 \text{ V}$$

109. (c)

Deflection, $$D = \frac{L l_d E_d}{2 d E_a}$$

∴ Voltage applied to deflecting plates,

$$E_d = \frac{2 d E_a D}{L l_d}$$

∴ $$E_d = \frac{2 \times 5 \times 10^{-3} \times 2500 \times 3 \times 10^{-2}}{0.3 \times 2 \times 10^{-2}} \text{ V} = 125 \text{ V}$$

110. (d)

Given full scale reading is 19.999 V, i.e., $4\frac{1}{2}$ digit DVM is used in 10 V range.

$$\text{Resolution} = \frac{1}{10^N} \times 10 \text{ V} \qquad (\because N = 4 \text{ for } 4\tfrac{1}{2} \text{ DVM})$$

$$= \frac{1}{10^4} \times 10 \text{ V} = \frac{1}{10^3} = 1 \text{ mV}$$

111. (b)

Given, $$I_{\text{MFSD}} = 10 \text{ A}, V_M = 0.1 \text{ V}$$

∴ $$R_M = \frac{0.1}{10} = 10 \times 10^{-3} \Omega$$

$$m = \frac{I_{FSD}}{I_{MFSD}} = \frac{100}{10} = 10$$

∴ $$R_{\text{sh}} = \frac{R_M}{m-1} = \frac{10 \times 10^{-3}}{10-1} = 1.11 \text{ m}\Omega$$

112. (d)

Distributed capacitance, $$C_d = \frac{C_1 - n^2 C_2}{n^2 - 1}$$

where, $$n = \frac{f_2}{f_1} = \frac{2f}{f} = 2$$

$$C_1 = 220 \text{ pF}; C_2 = 10 \text{ pF}$$

∴ $$C_d = \frac{220 - 40}{3} = \frac{180}{3} = 60 \text{ pF}$$

113. (c)

$$I = \frac{I_R}{1+\frac{2}{\beta}}$$

$\therefore$ $$I_R = I\left(1+\frac{2}{\beta}\right) = 4.3\times\left(1+\frac{1}{50}\right) \approx 4.3\text{ mA}$$

now, $$I_R = \frac{5-(0.7)}{R} \Rightarrow R = \frac{4.3}{4.3}\times 10^3 = 1000\,\Omega$$

114. (a)

The deflecting torque is given by

$$\tau_d = B \times A \times N \times I$$
$$= 0.1 \times 30 \times 10^{-3} \times 20 \times 10^{-3} \times 100 \times 10 \times 10^{-3}$$
$$= 600 \times 1000 \times 0.1 \times 10^{-9}$$
$$= 60 \times 10^{-6}\text{ N/m}$$

i.e. $$\tau_c = K\,\theta,$$

As, deflecting torque = restoring torque

$\therefore$ $$\tau_c = 6 \times 10^{-5}\text{ Nm}$$

$$K\,\theta = 6 \times 10^{-5}\text{ Nm}$$

$$\theta = \frac{6\times 10^{-5}}{2\times 10^{-6}} = 30^\circ$$

Therefore, the deflection is 30°.

115. (c)

$$R_s = \frac{V}{I_m} - R_m = \frac{10}{50\mu\text{A}} - 500 = 199.5\text{ k}\Omega$$

116. (d)

There is no controlling torque acting upon the moving system, the currents being led into the coils by fine ligaments which exert no control.

117. (a)

Given that, $$f_2 = 3f_1$$

$$\frac{1}{2\pi\sqrt{L(C_2+C_S)}} = \frac{3}{2\pi\sqrt{L(C_1+C_S)}}$$

$$C_1 + C_S = 9(C_2 + C_S)$$
$$C_1 + C_S = 9C_2 + 9C_S$$
$$C_1 - 9C_2 = 8C_S$$

Therefore, $$C_S = \frac{C_1 - 9C_2}{8} = \frac{800\text{ pf} - 9\times 50\text{ pf}}{8} = 6.25\text{ pf}$$

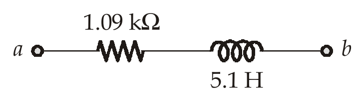
118. (a)

We need to find R_x and L_x

$$R_x = \frac{R_2 R_3}{R_1} = \frac{100\,\text{k} \times 5.1\,\text{k}}{470\,\text{k}} = 1.09\ \text{k}\Omega$$

$$L_x = R_2 R_3 C_1$$
$$= 5.1\ \text{k} \times 100\ \text{k} \times 0.01\ \mu\text{F}$$
$$= 5.1\ \text{H}$$

The equivalent circuit,



119. (b)

We know that, $$\frac{f_Y}{f_X} = \frac{\text{Horizontal tangencies}}{\text{Vertical tangencies}}$$

$$\frac{f_Y}{6} = \frac{4}{2}$$

$\therefore$ $$f_Y = 12\ \text{kHz}$$

120. (a)

Given, emf of standard cell, $E_1 = 2$ V

$l_1 = 800$ mm

Let, test cell emf is E_2, $l_2 = 850$ mm

The voltage of any point along the slide wire is proportional to length of slide wire.

i.e., $$E \propto l$$

$$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

$\therefore$ $$E_2 = \frac{l_2}{l_1} \times E_1 = \frac{850}{800} \times 2 = 2.125\ \text{V}$$

121. (b)

The magnitude of the limiting error for the voltmeter is

$$0.015 \times 100 = 1.5\ \text{V}$$

The limiting error at 70 V

$$\frac{1.5}{70} \times 100 = 2.143\%$$

The magnitude of limiting error of the ammeter is

$$0.015 \times 150\ \text{mA} = 2.25\ \text{mA}$$

The limiting error at 80 mA is

$$\frac{2.25 \text{ mA}}{80 \text{ mA}} \times 100 = 2.813\%$$

Therefore, the limiting error for the power calculation is the sum of the individual limiting errors involved,

Therefore, limiting error $= 2.143\% + 2.813\%$

$$= 4.956\%$$

122. (d)

$$x(t) \xleftrightarrow{\text{CTFT}} X(f)$$

$$x(t+4) \xleftrightarrow{\text{CTFT}} X(f)\ e^{+j8\pi f}$$

$$x(2t+4) \xleftrightarrow{\text{CTFT}} \frac{1}{2} X\left(\frac{f}{2}\right) e^{+j4\pi f}$$

123. (c)

$$x(n) = \left(\frac{1}{5}\right)^{|n|} - (2)^n u(n) = \left(\frac{1}{5}\right)^{-n} u(-n-1) + \left(\frac{1}{5}\right)^{n} u(n) - (2)^n u(n)$$

$$= (5)^n u(-n-1) + \left(\frac{1}{5}\right)^{n} u(n) - (2)^n u(n)$$

$(5)^n u(-n-1) \Rightarrow \text{ROC} : |z| < 5$

$\left(\frac{1}{5}\right)^{n} u(n) \Rightarrow \text{ROC} : |z| > \frac{1}{5}$

$(2)^n u(n) \Rightarrow \text{ROC} : |z| > 2$

So, the ROC of the sequence $x(n)$ can be given as, $\left\{(|z| < 5) \cap \left(|z| > \frac{1}{5}\right) \cap (|z| > 2)\right\} = 2 < |z| < 5$.

124. (d)

If $x(n) = \delta(n)$, then $y(n) = h(n)$ = unit impulse response.

So, for the given system,

$$h(n) = \sum_{k=-\infty}^{n+5} \delta(k) = \begin{cases} 0; & \text{for } n < -5 \\ 1; & \text{for } n \geq -5 \end{cases}$$

$$h(n) = \{1, 1, 1, 1, 1, \underset{\uparrow}{1}, 1, 1, 1, \ldots\}$$

$$h(n) \neq 0 \text{ for } n < 0 \Rightarrow \text{Non causal}$$

$$\sum_{n=-\infty}^{\infty} |h(n)| = \infty \Rightarrow \text{unstable}$$

So, the given system is neither stable nor causal.

125. (d)

$$X(z) = \sum_{n=0}^{\infty} x(n) z^{-n}$$

Let, $$Y(z) = \sum_{n=0}^{\infty} x(n+2) z^{-n}$$

Take $k = n + 2 \Rightarrow n = k - 2$

$$Y(z) = \sum_{k=2}^{\infty} x(k) z^{-k} z^2 = z^2 \sum_{k=2}^{\infty} x(k) z^{-k}$$

$$= z^2 \left[\left(\sum_{k=0}^{\infty} x(k) z^{-k} \right) - x(0) - z^{-1} x(1) \right]$$

$$= z^2[X(z) - x(0) - z^{-1} x(1)] = z^2 X(z) - z^2 x(0) - z x(1)$$

127. (b)

Since $x(n)$ is causal,

$$x(0) = \lim_{z \to \infty} X(z) = \lim_{z^{-1} \to 0} X(z)$$

$$= \lim_{z^{-1} \to 0} \frac{3(2 - 3z^{-1})}{(3 - z^{-1})(2 - z^{-1})} = \frac{3 \times 2}{3 \times 2} = 1$$

128. (c)

We know that,

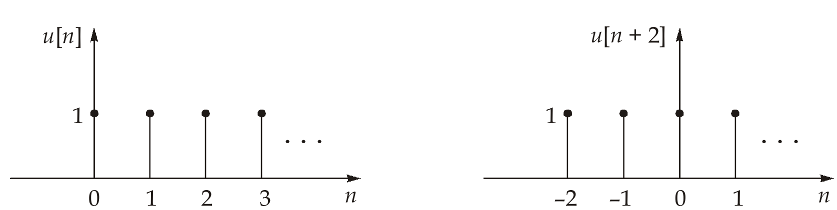
$$a_n = \frac{2}{T} \int_T x(t)(\cos \omega_0 nt)\, dt = \frac{2}{T} \int_T x(t) \left[\frac{e^{j\omega_0 nt} + e^{-j\omega_0 nt}}{2} \right] dt$$

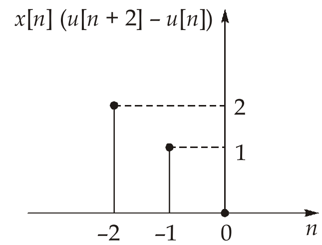
$$= \frac{1}{T} \left[\int_T x(t) e^{j\omega_0 nt} dt + \int_T x(t) e^{-j\omega_0 nt} dt \right]$$

$$a_n = C_n + C_{-n}$$

[By the definition of exponential Fourier series coefficient].

129. (c)





130. **(d)**

The signal $x(t)$ is a power signal. Hence its energy is undefined.

131. **(d)**

The Fourier series expansion of a periodic signal is also periodic.

Among the given signals, $x_4(t)$ is not a periodic signal.

132. **(d)**

$$f(x) = \sqrt{36-4x^2}$$

At $x = 0$, $f(x) = 0$

$\therefore$ f has absolute maximum at $x = 0$

at $x = 3$, $f(x) = c$

$\therefore$ f has absolute minimum at $x = 3$.

133. **(d)**

For a non-trivial solution of homogeneous system of equations,

$$|A| = 0$$

$$A = \begin{vmatrix} 2 & 1 & 2 \\ 1 & 1 & 3 \\ 4 & 3 & b \end{vmatrix}$$

$$2\begin{vmatrix} 1 & 3 \\ 3 & b \end{vmatrix} - 1\begin{vmatrix} 1 & 3 \\ 4 & b \end{vmatrix} + 2\begin{vmatrix} 1 & 1 \\ 4 & 3 \end{vmatrix} = 0$$

$$2(b-9) - 1(b-12) + 2(3-4) = 0$$

$$2b - 18 - b + 12 - 2 = 0$$

$$b = 8$$

134. **(c)**

$$(A^{-1})^{-1} = A$$

135. **(a)**

Substituting $y = e^{mx}$, we obtain the characteristic equation as

$$m^2 - m - 12 = 0$$

$$(m-4)(m+3) = 0$$

$$m = -3, 4$$

The two linearly independent solutions are e^{4x} and e^{-3x}. The general solution is

$$y(x) = A\,e^{4x} + Be^{-3x}$$

136. (b)

$$|z+1| = 1$$
$$|a+ib+1| = 1$$
$$|(a+1)+ib| = 1$$
$$(a+1)^2 + b^2 = 1$$

Centre (–1, 0) radius 1.

137. (d)

$$\frac{dy}{dx} + 2xy^2 = 0$$
$$\frac{dy}{dx} = -2xy^2$$

After one iteration, $y_1^* = y_0 + h\left[-2x_0y_0^2\right]$

$$= 1 + 0.3[-2 \times 0 \times 1^2] = 1$$

$$y_1 = y_0 + \frac{1}{2}\times(0.3)\left[-2x_0y_0^2 - 2x_1y_1^2\right]$$
$$= 1 + 0.15\,[-0 - 0.6]$$
$$= 1 - 0.15 \times 0.6$$
$$= 0.91$$

138. (b)

$$= \lim_{x\to4}\frac{3-\sqrt{x+5}}{x-4}\times\frac{3+\sqrt{x+5}}{3+\sqrt{x+5}}$$

$$\lim_{x\to4} = \frac{9-(x+5)}{(x-4)\left(3+\sqrt{x+5}\right)}$$

$$= \frac{-(x-4)}{(x-4)\left(3+\sqrt{x+5}\right)}$$

$$= \frac{-1}{3+\sqrt{9}} = -\frac{1}{6} = -0.16$$

139. (d)

Given, $\dfrac{d^2y}{dx^2} - 4\left(\dfrac{dy}{dx}\right) + 3y = 0$

A.E. is $m^2 - 4m + 3 = 0$

$$(m-3)(m-1) = 0$$
$$m = 1, 3$$

C.F. is $y = Ae^x + Be^{3x}$ i.e., $p = 1, q = 3$

So, $p + q = 1 + 3 = 4$

140. (b)

Given,
$$f(x) = x^3 - 9x^2 + 24x + 10$$
$$f'(x) = 3x^2 - 18x + 24 = 0$$
$$x^2 - 6x + 8 = 0$$
$$(x-4)(x-2) = 0$$
$$x = 2, 4$$
$$f''(x) = 6x - 18 = 6(x-3)$$
$$f''(2) = -6 \Rightarrow x = 2 \text{ is local maxima}$$
$$f''(4) = 6 \Rightarrow x = 2 \text{ is local minima}$$

Global maximum value of $f(x) = \max[f(1), f(2), f(6)]$
$$= \max[26, 30, 46]$$
$$= 46$$

141. (c)

$$V_s = \sqrt{(V_R)^2 + (V_L - V_C)^2}$$

142. (a)

Mho relay has inherent directional characteristics, thus least affect by frequent power swings of long transmission line.

143. (a)

Due to saturation and hysteresis magnetizing current will be non sinusoidal for sinusoidal flux and sinusoidal supply.

144. (a)

For a 1-ϕ half controlled,

$$\text{IPF} = \frac{\sqrt{2}}{\sqrt{\pi(\pi-\alpha)}}(1+\alpha)$$

For 1-ϕ full converter (IPF) $= \dfrac{2\sqrt{2}}{\pi}\cos\alpha$

So, semi-converters have better power factor on the line side.

145. (c)

In LLG fault, $V_{R1} = V_{R2} = V_{R0}$

and $I_f = 3\, I_{R0}$

So statement (I) is true but statement (II) is false.

147. (a)

- To add SCRs in series, their I-V characteristic should be as close as possible.
- Although practically SCRs in a string have leakage current and hence unequal voltage division takes place.

148. (b)

Both the given statements are correct but statement-II is not correct explanation of statement-I.

149. (a)

Complex poles and zeros exists in pair. They don't have any effect on root locus on real axis as the angle contribution on real axis by the pair is 2π radian angle which means 0° angle. Hence, it cannot change the phase of the system.

150. (c)

Temperature should be less than the transition temperature.

■■■■