DETAILED SOLUTIONS

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ESE 2023 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 24

Full Syllabus Test 8 : Paper-II

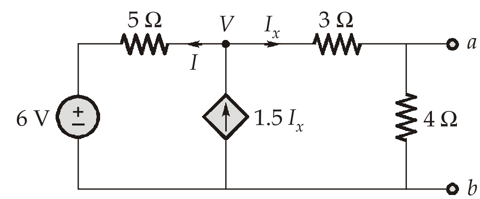
1.	(b)	**26.**	(c)	**51.**	(d)	**76.**	(c)	**101.**	(a)	**126.**	(b)
2.	(c)	**27.**	(d)	**52.**	(c)	**77.**	(d)	**102.**	(b)	**127.**	(c)
3.	(b)	**28.**	(b)	**53.**	(a)	**78.**	(c)	**103.**	(a)	**128.**	(c)
4.	(b)	**29.**	(d)	**54.**	(b)	**79.**	(b)	**104.**	(c)	**129.**	(c)
5.	(a)	**30.**	(d)	**55.**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

DETAILED EXPLANATIONS

1. (b)

To get V_{th} we determine voltage drop in 4 Ω resistance

Applying KCL at node, we get



$$I = 0.5\, I_x$$

$$\frac{V-6}{5} = 0.5\frac{V}{7}$$

$$7V - 42 = 2.5\text{ V}$$

$$4.5\text{ V} = 42$$

$$V = \frac{84}{9}\text{Volt}$$

Applying voltage division rule,

$$V_{th} = V_{ab} = \frac{84}{9}\times\frac{4}{7} = 5.33\text{ V}$$

2. (c)

Lap connected, $A = P = 4$

The generated voltage, $E_g = \dfrac{\phi ZNP}{60\,A}$

Given, $Z = 480,\ N = 500,\ E_g = 400\text{ V}$

$$400 = \frac{\phi\times480\times500\times4}{60\times4},$$

$$\phi = \frac{400\times60}{480\times500} = 0.1\text{ Wb}$$

Emf induced in the coil of 100 turns in 0.05 sec

$$\text{Emf} = N\frac{d\phi}{dt} = 100\times\frac{0.1}{0.05}$$

$$\text{Emf} = 200\text{ V}$$

4. (b)

$$\text{Capacitance, C} = \frac{\varepsilon A}{d}$$

Displacement sensitivity,

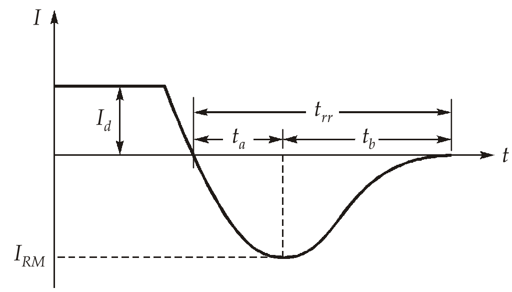
$$\frac{\partial C}{\partial d} = \frac{-\varepsilon A}{d^2} = \frac{-C_0}{d}$$

$$= \frac{-1}{0.25} = -4\text{ pF/mm} = -40\text{ pF/cm}$$

5. (a)

Given, reverse recovery time,

$$t_{rr} = 5 \text{ μsec}$$



Let softness factor is s,

$$\delta = \frac{t_b}{t_a} \quad \text{...(i)}$$

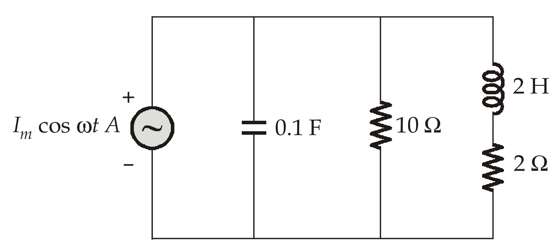
So, $t_{rr} = t_a + t_b = 5$ ...(ii)

$$t_a = \frac{240}{60} = 4 \text{ μsec}$$

So from equation (ii), $t_b = 5 - 4 = 1$ μsec

So, $s = \frac{1}{4} = 0.25$

6. (b)



The input admittance is,

$$Y = j\omega 0.1 + \frac{1}{10} + \frac{1}{2 + j2\omega}$$

$$= 0.1 + j\omega 0.1 + \frac{2 - j2\omega}{4 + 4\omega^2}$$

At resonance, $I_m(Y) = 0$

$$0.1\omega_0 - \frac{2\omega_0}{4 + 4\omega_0^2} = 0$$

$$0.1\omega_0 = \frac{2\omega_0}{4 + 4\omega_0^2}$$

$$4 + 4\omega_0^2 = 20$$

$$\omega_0^2 = 4$$

$$\omega_0 = 2 \text{ rad/sec}$$

7. (a)

The probability that A can solve the problem = $\frac{1}{2}$

The probability that A can not solve the problem = $1 - \frac{1}{2} = \frac{1}{2}$

Similarly the probability that B, C and D can not solve the problem are $\left(1 - \frac{3}{4}\right)$, $\left(1 - \frac{1}{4}\right)$ and $\left(1 - \frac{1}{8}\right)$

$\therefore$ The probability that A, B, C and D can not solve the problem

$$= \left(1 - \frac{1}{2}\right) \times \left(1 - \frac{3}{4}\right) \times \left(1 - \frac{1}{4}\right) \times \left(1 - \frac{1}{8}\right) = \frac{21}{256}$$

Hence the probability that the problem can be solved = $1 - \frac{21}{256} = \frac{235}{256}$.

8. (b)

Given, $|V_R| = |V_L|$ at $f = 120$ Hz

$IR = IX_L = I\omega L$ (as R and L are series connected)

So, $R = \omega L$

$$\text{Current, } I = \frac{V_{IN}}{\sqrt{R^2 + X_L^2}} = \frac{V_{IN}}{\sqrt{2}R}$$

$$V_R = IR = \frac{V_{IN}}{\sqrt{2}} = 10 \text{ V}$$

$\therefore$ $V_{IN} = 10\sqrt{2}$ V

At 60 Hz,

$$X_L' = \frac{X_L}{2} = \frac{R}{2} (X_L \propto f)$$

$$I' = \frac{2V_{IN}}{\sqrt{5}R}$$

$$V_R' = I'R = \frac{2}{\sqrt{5}} V_{IN} = \frac{2}{\sqrt{5}} \times 10\sqrt{2} = 12.65 \text{ V}$$

9. (b)

Its tank circuit consists of "capacitor voltage divider" or split capacitors.

10. (c)

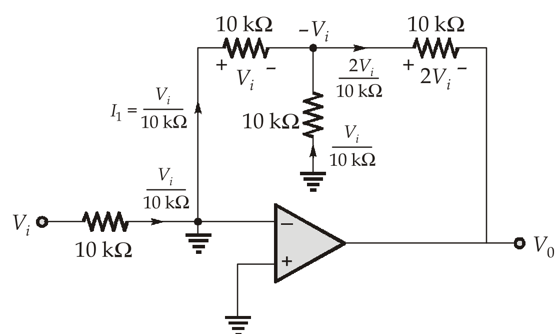
$$\text{Gauge factor } (G) = 1 + 2\nu + \frac{\Delta\rho/\rho}{\Delta l/l}$$

For metallic wire strain gauge, $\frac{\Delta\rho/\rho}{\Delta l/l}$ is very small (negligible)

For semiconductor strain gauge, $\frac{\Delta\rho/\rho}{\Delta l/l}$ is very high

Semiconductor strain gauges are used when a very high gauge factor is required. They have a gauge factor 50 times of metallic wire strain gauge. Semiconductor strain gauges depend for their action upon the piezoresistive effect ; change in value of resistance due to change in resistivity.

12. (b)



From, the diagram it is clear that $V_0 = -2V_i - V_i = -3V_i$

13. (c)

The probability of getting a correct answer = $\frac{1}{3}$

So, the probability of getting an incorrect answer is

$$= 1 - \frac{1}{3} = \frac{2}{3}$$

The probability of getting 4 or more correct answer

= Probability of 4 correct + Probability of 5 correct

By using Binomial distribution,

Probability of getting 4 correct answer

$$= {}^5C_4\left(\frac{1}{3}\right)^4\left(\frac{2}{3}\right)^{5-4} = 5 \times \left(\frac{1}{3}\right)^4 \times \frac{2}{3}$$

$$= 5 \times \frac{2}{3^5}$$

The probability of getting 5 correct answers

$$= {}^5C_5 \times \left(\frac{1}{3}\right)^5 \times \left(\frac{2}{3}\right)^{5-5} = \left(\frac{1}{3}\right)^5$$

So the probability of getting 4 or more correct answers

$$= 5 \times \frac{2}{3^5} + \frac{1}{3^5} = \frac{10}{3^5} + \frac{1}{3^5} = \frac{11}{3^5}$$

14. (b)

$$I = \frac{100\sqrt{2}\cos 3000t}{1 + j\omega_1 L} + \frac{10\sqrt{2}\sin 1000t}{1 + j\omega_2 L}$$

$$= \frac{100\sqrt{2}\cos 3000t}{1 + j \times 3000 \times 10^{-3}} + \frac{10\sqrt{2}\sin 1000t}{1 + j \times 1000 \times 10^{-3}}$$

$$= \frac{100\sqrt{2}\cos 3000t}{1 + j3} + \frac{10\sqrt{2}\sin 1000t}{1 + j1}$$

$$= \frac{100\sqrt{2}\cos 3000t}{\sqrt{10}\angle\phi_1} + \frac{10\sqrt{2}\sin(1000t)}{\sqrt{2}\angle\phi_2}$$

where, $\phi_1 = \tan^{-1}(3)$ and $\phi_2 = \tan^{-1}(1)$

So, $$I = \frac{100\sqrt{2}}{\sqrt{10}}\cos(3000t - \phi_1) + \frac{10\sin(1000t)}{\sqrt{2}\angle\phi_2}$$

So, RMS of I is

$$I_{\text{rms}} = \sqrt{\frac{1}{2}\left[\frac{10000 \times 2}{10} + 100\right]} = \sqrt{1050}$$

So, power dissipated is

$$P = I_{rms}^2 \times R$$

$$= 1050 \times 1 = 1050 \text{ W}$$

15. (b)

The system possesses non-zero solution,

If $$\begin{vmatrix} 4 & K & 2 \\ K & 4 & 1 \\ 2 & 2 & 1 \end{vmatrix} = 0$$

$$4(4 - 2) - K(K - 2) + 2(2K - 8) = 0$$

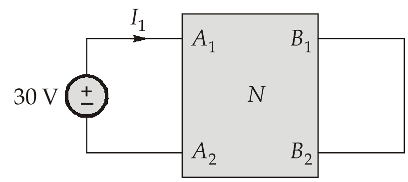
$$8 - K^2 + 2K + 4K - 16 = 0$$

$$K^2 - 6K + 8 = 0$$

$$(K - 2)(K - 4) = 0$$

$$K = 2 \text{ and } 4$$

16. (d)



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

$$\left.\frac{I_1}{V_1}\right|_{V_2=0} = \frac{4}{12} = \frac{1}{3}\mho = Y_{11}$$

$$\left.\frac{I_2}{V_1}\right|_{V_2=0} = \frac{-2}{12} = \frac{-1}{6} = Y_{12} = Y_{21}$$

$$I_1 = \frac{1}{3}\times 30 + \left(\frac{1}{6}\right)\times(6) = 11 \text{ A}$$

17. (a)

The active power, $P = V_0 I_0$

Where, V_0 = Avg. output voltage

I_0 = Average load current

Reactive power, $Q = V_0 I_0 \tan\frac{\alpha}{2}$

$$\frac{P}{Q} = \frac{1}{\tan\frac{\alpha}{2}} = \frac{1}{\tan\left(\frac{60}{2}\right)} = \frac{1}{\tan 30°}$$

$$\frac{P}{Q} = \frac{1}{1/\sqrt{3}} = \sqrt{3}$$

18. (c)

Gauss elimination is most widely used to solve a set of linear algebraic equations.

19. (a)

Stored energy, $W = \frac{1}{2}\vec{P}\cdot\vec{E}$

$\vec{P} \rightarrow$ Polarization

$\vec{E} \rightarrow$ Electric field

20. (a)

Maximum phase lead occurs at geometric mean of corner frequency.

Corner frequency are, $\omega_1 = 0.2$ rad/sec

$\omega_2 = 0.8$ rad/sec

$$\therefore \omega_m = \sqrt{\omega_1\omega_2} = \sqrt{0.2\times 0.8}$$

$\omega_m = 0.4$ rad/sec

21. (a)

A and B are symmetric matrics,

$$\therefore \quad A' = A \text{ ; and } B' = B$$

$$(ABA)' = A'(AB)'$$

$$= A'B'A$$

$$= ABA$$

$$\because \quad (ABA)' = ABA$$

$\therefore$ ABA is symmetric.

22. (d)

Steady state error,

$$e_{ss} = \frac{1}{1+\lim\limits_{s\to 0} G(s)H(s)} = \frac{1}{4}$$

$$\frac{1}{1+\frac{K}{2}} = \frac{1}{4}$$

$$1+\frac{K}{2} = 4$$

$$\frac{K}{2} = 3$$

$$K = 6$$

23. (a)

D_1 and D_2 are ON

$$I_{D1} = \frac{2.4-1.4}{2\,\text{k}\Omega} = 0.5 \text{ mA}$$

$$I_{D2} = \frac{2.6-1.4}{2\,\text{k}\Omega} = 0.6 \text{ mA}$$

$$\Delta I = I_{D2} - I_{D1} = 0.1 \text{ mA}$$

24. (d)

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

$$\frac{25}{s^2+10s+25} = \frac{\frac{25}{s(s+10)}}{1+\frac{25}{s(s+10)}}$$

$$G(s) = \frac{25}{s(s+10)}$$

After adding PD controller, we have

$$G(s) = \frac{25}{s(s+10)} \times 20(0.1s+1) = \frac{50}{s}$$

So, it is a first order system, damping factor will not exist.

25. (d)

	0	1	2	3	0	1	4	0	1	2	3	4
0	0	0	0	3	3	3	4	4	4	4	4	4
1		1	1	1	0	0	0	0	0	2	2	2
2			2	2	2	1	1	1	1	1	3	3
								*	*			*

$*$ = Page hit

Page hit = 3

Page fault = 12 – 3 = 9

26. (c)

$$1 + G(s)H(s) = 0$$

$$1+\frac{K}{s(s+3)^2} = 0$$

$$s^3 + 6s^2 + 9s + K = 0$$

Using R-H criterion

s^3	1	9
s^2	6	K
s^1	$\frac{54-K}{6}$	0
s^0	K	0

Sinusoidal oscillation, s^1 row must be zero,

$$\frac{54-K}{6} = 0$$

$$K = 54$$

Auxiliary equation

$$6s^2 + K = 0$$

$$6s^2 + 54 = 0$$

$$s^2 + 9 = 0$$

$$\omega = 3 \text{ rad/sec}$$

27. (d)

Given logic circuit,

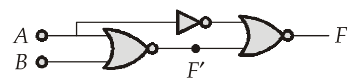
$$F' = \overline{A+B}$$

$$F = \overline{\overline{A+B}+\overline{A}}$$

$$F = \overline{\overline{A+B}}\cdot\overline{\overline{A}} = (A+B)A$$

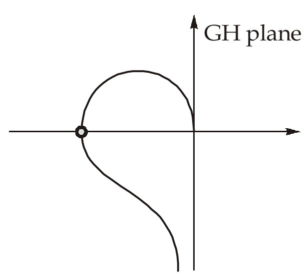
$$F = A + AB$$

$$F = A(1 + B) = A$$



Thus F is equivalent to A.

28. (b)



$$\text{P.M.} = 180° + \phi|_{\omega gc}$$

$$= 180° + (-180°)$$

$$= 0$$

29. (d)

From the circuit, $V_{GS} = V_G - V_S = 0$

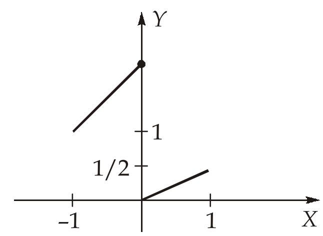
But the threshold voltage,

$$V_T = 0.5 \text{ V}$$

$\because V_{GS} < V_T \Rightarrow$ The device is operated in cutoff region,

$\therefore$ $I_D = 0$ and $V_D = 6$ V

30. (d)



The graph of the function is shown above

Since the function is not continuous at $x = 0$,

$\therefore$ The function has neither maximum nor minimum.

31. (c)

For a unit step input steady state error is given by,

$$e_{ss} = \frac{1}{1+K_P}$$

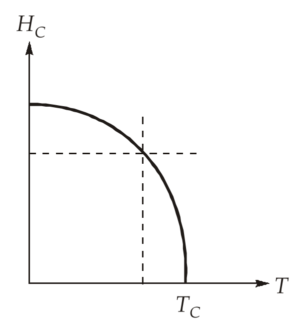
Where, K_P = static positional error coefficient = dc gain

$$0.01 = \frac{1}{1+K_P}$$

$$K_P = 99$$

32. (a)

For superconductor, the temperature versus magnetic field curve is as shown



Where, T_C : Critical temperature ; H_C : Critical magnetic field

33. (b)

Converting differential equation into standard second order transfer function; we get

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

Comparing it with standard second order transfer function

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

and $$2\xi\omega_n = 2$$

$$\xi = \frac{1}{\sqrt{2}}$$

Peak time of second overshoot is given by,

$$t_p = \frac{n\pi}{\omega_d} \qquad n = 3$$

$$t_p = \frac{3\pi}{\sqrt{2}\sqrt{1-\frac{1}{2}}} = 3\pi$$

$$t_p = 3\pi \text{ seconds}$$

34. (b)

Given,

$$A_v = 50, \qquad R_i = 1\ \text{k}\Omega,$$

$$R_0 = 2.5\ \text{k}\Omega, \qquad \beta = 0.2$$

$$A_i = \frac{A_v R_i}{R_L} = \frac{A_v R_i}{R_0} = \frac{50 \times 1\text{k}}{2.5\text{k}} = 20$$

In a current-shunt feedback amplifier

$$R_{ir} = \frac{R_i}{1 + A_i\beta} = \frac{1000}{1 + 20 \times 0.2} = \frac{1}{5}\text{k}\Omega$$

35. (d)

Amplitude limiter can be used in FM receivers but cannot be used in AM receivers.

36. (d)

The load is resistive, so freewheeling diode will not conduct. So rms value of current through D_3 will be zero.

37. (a)

$\because$

$$I_{FSD} = 100\ \mu\text{A}$$

$$R_m = 1\ \text{k}\Omega$$

$$V_{FSD} = V_m = 100\ \mu\text{A} \times 1\ \text{k}\Omega = 100\ \text{mV}$$

$$R_s = (m-1)\, R_m$$

where

$$m = \frac{V}{V_m} = \frac{50\ \text{V}}{100\ \text{mV}} = 500$$

$$R_m = 1\ \text{k}\Omega$$

$$R_s = (500 - 1)\ \text{k}\Omega = 499\ \text{k}\Omega$$

38. (d)

At balance condition

$$(R + j\omega L)\left[\frac{R_4}{1 + j\omega C_4 R_4}\right] = R_2 R_3$$

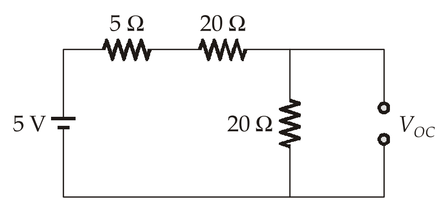
$$RR_4 + j\omega LR_4 = R_2R_3 + j\omega C_4R_2R_3R_4$$

Equating real and imaginary part, we get

$$R = \frac{R_2R_3}{R_4}$$

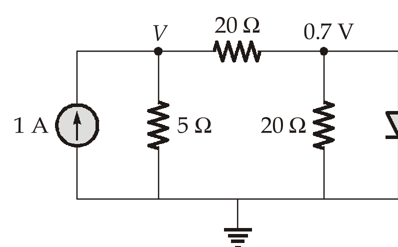
and $$L = R_2R_3C_4$$

39. (a)



$$V_{OC} = 5 \times \frac{20}{20+25} = 2.22 \text{ V}$$

∴ Diode gets turn ON



$$1 = \frac{V}{5} + \frac{V-0.7}{20} = \frac{5\text{V}-0.7}{20}$$

$\Rightarrow$ $$5 \text{ V} = 20.7$$

$\Rightarrow$ $$V = 4.14$$

∴ Power delivered by 1 A source = 4.14 × 1 = 4.14 W

40. (d)

$$\frac{L}{C} = \frac{1}{1/16} = 16 = R^2$$

Hence, circuit is under resonance and the net impedance will be purely resistive.

41. (a)

When two sinusoidal signal of same frequency and amplitude are applied to X and Y plates of the CRO. The Lissajous pattern found on the CRO is a straight line with 45° slope.

42. (c)

$$\lim_{\theta \to 0} \frac{\frac{1}{\sin\theta} - \frac{\cos\theta}{\sin\theta}}{\theta} = \lim_{\theta \to 0} \frac{1-\cos\theta}{\theta\sin\theta}$$

$$= \lim_{\theta \to 0} \frac{\sin^2 \frac{\theta}{2}}{\theta \frac{\sin\theta}{2} \frac{\cos\theta}{2}} = \lim_{\theta \to 0} \left(\frac{\sin \frac{\theta}{2}}{\frac{\theta}{2}} \right) \frac{1}{2} \cdot \frac{1}{\frac{\cos\theta}{2}}$$

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

43. **(c)**

Trans-conductance is the ratio of the output current to input voltage i.e. current depends on the input voltage.

44. **(c)**

Voltage applied to deflecting plates,

$$E_d = \frac{2dE_a D}{L l_d}$$

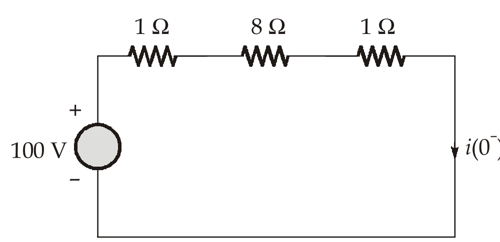
$$= \frac{2 \times 0.5 \times 10^{-2} \times 2500 \times 4 \times 10^{-2}}{20 \times 10^{-2} \times 2.5 \times 10^{-2}} = 200 \text{ V}$$

45. **(c)**

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

46. **(c)**

At $t = 0^-$



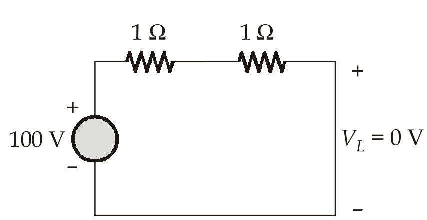
$$i(0^-) = \frac{100}{1+8+1} = 10 \text{ A}$$

At $t = 0^+$ $V_L(0^+) = 100 - (1 + 1) \times 10 = 80$ V

At $t = \infty$

the inductor will be short circuited.

$\therefore$ $V_L(\infty) = 0$ V



47. (b)

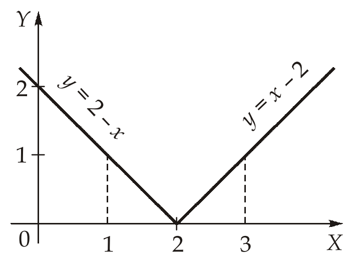
For platinum resistance thermometer

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

$$R_{200} = 100[1 + 0.004(200 - 0)]$$

$$= 180\ \Omega$$

48. (a)



$$\text{Required area} = \int_1^2 (2-x)dx + \int_2^3 (x-2)dx$$

$$= \left[2x - \frac{x^2}{2}\right]_1^2 + \left[\frac{x^2}{2} - 2x\right]_2^3$$

$$= \left[(4-2) - \left(2 - \frac{1}{2}\right)\right] + \left[\left(\frac{9}{2} - 6\right) - (2-4)\right]$$

$$= \left(2 - \frac{3}{2}\right) + \left(\frac{-3}{2} + 2\right)$$

$$= \frac{1}{2} + \frac{1}{2} = 1$$

Alternate Solution:

$$\text{Area} = 2 \times \frac{1}{2} \times 1 \times 1 = 1 \text{ unit}$$

49. (b)

Core loss, bearing friction loss, brush friction loss in wound rotor motors and windage losses are fixed losses. Ohmic loss, rotor ohmic loss, brush contact loss in wound rotor motor and stray load loss are variable losses.

50. (a)

In inverter mode operation of line commutated converter, active power is delivered to source and reactive power is drawn from the ac source.

51. (d)

Base, $(\text{MVA})_B = 500$

$$Z_B = \frac{V_B^2}{(\text{MVA})_B} = \frac{20^2}{500} = 0.8 \text{ ohm}$$

$$V_{OC} = 20 \text{ kVA}, I_{sc} = 16.50 \text{ kA}$$

$$X_{s\,(\text{sat})} = \frac{V_{oc(\text{phase})}}{I_{sc}} = \frac{20/\sqrt{3}}{16.50} = 0.70\,\Omega$$

$$X_{s(\text{sat})} \text{ (in pu)} = \frac{0.70}{0.80} = \frac{7}{8} \text{ p.u.}$$

$$\text{SCR} = \frac{1}{X_{s(\text{sat})\text{pu}}} = \frac{1}{7/8} = 1.142 \text{ p.u.}$$

52. (c)

The magnetostriction is responsible for humming noise.

53. (a)

Operational amplifier has direct coupling.

54. (b)

$\because$ $P = VI$

$$\frac{\delta P}{P} = \frac{\delta V}{V} + \frac{\delta I}{I}$$

$$\left[\frac{\delta P}{P}\right]\% = \left[\frac{\delta V}{V}\% + \frac{\delta I}{I}\%\right] = \pm[2\% + 1\%] = \pm 3\%$$

55. (a)

The sparking at the brushes is excessively in nature.

56. (d)

$$\frac{\text{Upper side band power}}{\text{Carrier power}} = \frac{m^2}{4} = \frac{(0.5)^2}{4} = \frac{1}{16}$$

57. (b)

The output voltage, $V_0 = V_B + I_0(2)$

Given, $V_B = 10 \text{ V}, I_0 = 5 \text{ A}$

So, $V_0 = 10 + 5 \times 2 = 20 \text{ V}$

The chopper is boost type,

So, $V_0 = \alpha V_s$

$$20 = 0.4\, V_s$$

$$V_s = \frac{20}{0.4} = 50 \text{ V}$$

58. (b)

$$N_r = N_s(1 - s)$$

$$N_r = \frac{120 \times f}{P}(1-s)$$

$$855 = \frac{120 \times f}{6}(1-0.05)$$

$$f = \frac{855 \times 6}{120 \times (0.95)} = 45 \text{ Hz}$$

The rotor frequency, $f_r = sf_s = 0.05 \times 45 = 2.25$ Hz

59. (d)

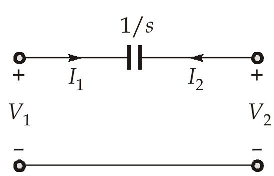
$$\frac{C}{R} = \sum_i P_k \Delta_k$$

$$\frac{C}{R} = \frac{(2\times 3\times 4)(1)+6(1-(-3))}{1-[-2-3-4-6]+[(-2)(-4)]}$$

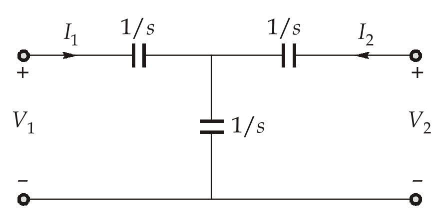
$$= \frac{24+24}{1+15+8} = 2$$

61. (a)

It can be considered as two network in parallel,



(I)



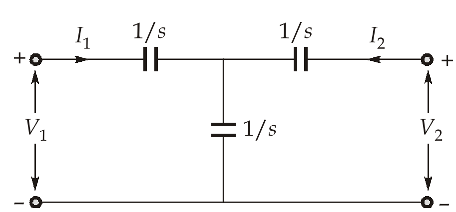
(II)

y-parameter of (I) network

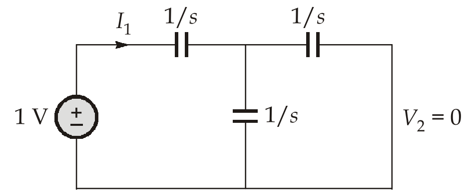
$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = s = y_{22}$$

and $$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = -s = y_{21}$$

y-parameter of (II) network,



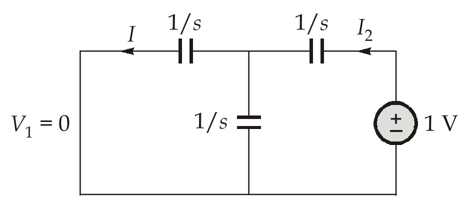
$$y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0}$$



$$I_1 = \frac{1}{\frac{1}{s} + \left(\frac{1}{s} \| \frac{1}{s}\right)} = \frac{2s}{3}$$

$$y_{11} = \frac{2s}{3} = y_{22} \text{ (symmetrical)}$$

$$y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1 = 0}$$



$$I_2 = \frac{2s}{3}$$

$$I = \frac{\frac{2s}{3} \times \frac{1}{s}}{\frac{1}{s} + \frac{1}{s}} = \frac{s}{3}$$

$$I_1 = -I$$

$$y_{12} = \frac{-s}{3} = y_{21} \text{ (reciprocal)}$$

$$[Y_{II}] = \begin{bmatrix} \frac{2s}{3} & \frac{-s}{3} \\ \frac{-s}{3} & \frac{2s}{3} \end{bmatrix} \text{ and } Y_{(I)} = \begin{bmatrix} s & -s \\ -s & s \end{bmatrix}$$

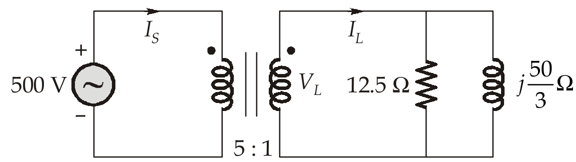
$$[Y]_{\text{for bridge - T}} = [Y_I] + [Y_{II}]$$

$$= \begin{bmatrix} \frac{5s}{3} & \frac{-4s}{3} \\ \frac{-4s}{3} & \frac{5s}{3} \end{bmatrix}$$

62. (b)

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

63. (a)



The load voltage, $V_L = \frac{1}{5}\times 500 = 100$ V

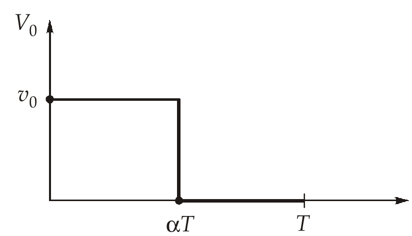
The load current, $I_L = \frac{100}{12.5} + \frac{100}{j50/3} = (8 - j6)\text{Amp}$

$= 10\angle{-36.87°}$ Amp

The source current, $I_S = 10\left(\frac{1}{5}\right) = 2$ A

64. (b)

For buck converter output voltage pulse width is αT



Where, $\alpha = \frac{T_{on}}{T}$

Thus pulse width $= \alpha T = \frac{T_{on}}{T}\cdot T = T_{on}$

Given, $V_s = 150$ V

$V_0 = 100$ V

$T_{off} = 150$ μs

Also, $V_0 = \alpha V_s$

$\therefore$ $\alpha = \frac{100}{150} = \frac{2}{3}$

$\frac{T_{on}}{T} = \frac{2}{3}$

$\frac{T_{on}}{T_{on} + T_{off}} = \frac{2}{3}$

$T_{on} = 2T_{off}$

$\therefore$ $T_{on} = 300$ μs

It is equal to pulse width of output voltage.

65. (b)

The power shared by transformer,

$$P_{\text{transformer}} \propto \frac{1}{z}$$

So transformer with impedance $j2\ \Omega$ shares more power.

66. (b)

Voltage across the capacitor

$$V_c(t) = \frac{1}{C}\int_{-\infty}^{t} I\,dt$$

Hence, on integrating square wave, we will get triangular wave.

68. (b)

The shaft power, $P_0 = 20.1 \times 746 = 15$ kW

The developed power, $P_m = 15 + 2.1 = 17.1$ kW

The operating slip, $s = \dfrac{N_s - N_r}{N_s} = \dfrac{1800 - 1710}{1800} = 0.05$

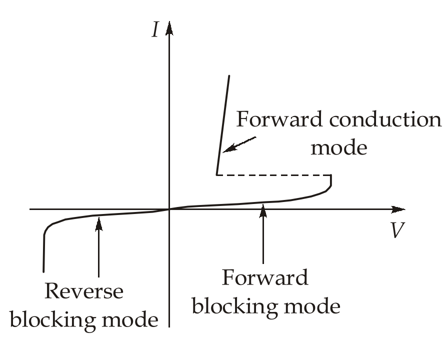
The airgap power, $P_{ag} = \dfrac{P_m}{1-s} = \dfrac{17.1}{0.95} = 18$ kW

69. (c)

5 bits	5 bits

5 bits to identify first and 5 bits to identify second including the case when one of them not present. So total bits required = 10.

70. (a)



71. (b)

$$P_{\text{shaft}} = 20.1 \times 746 = 15 \text{ kW}$$

The motor input, $P_{\text{in}} = P_{\text{shaft}} + P_{\text{losses}} = 15 + 1.0 + 0.8 = 16.8$ kW

So, motor current (phase) $= I_{\text{ph}} = \dfrac{P_{\text{in}}}{3 \times V_{\text{ph}} \cos\phi} = \dfrac{16.8}{3 \times 400 \times 0.8} = 17.5$ Amp

72. (d)

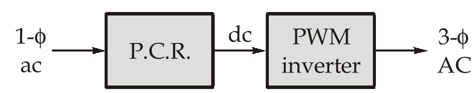
$$\text{Gauge factor} = \frac{\Delta R / R}{\Delta L / L}$$

$$200 = \frac{\Delta R}{2000 \times 10^{-4}}$$

$$\Delta R = 40$$

$$\text{Resistance of gauge} = 2000 + 40 = 2040\ \Omega$$

73. (d)



74. (c)

0.1f results in 0.1 to be stored in floating point representation. Hence output is "equal".

75. (c)

Size of instruction 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.

76. (c)

Amplification factor for $V_{-} = \frac{22}{10}$, through inverting output

$$\text{Amplification factor for } V_{+} = \left(\frac{R_4}{R_4 + 15}\right)\left(1 + \frac{22}{10}\right)$$

$$\frac{22}{10} = \left(\frac{R_4}{R_4 + 15}\right)\left(\frac{32}{10}\right)$$

$$\Rightarrow \quad 11(R_4 + 15) = 16R_4$$

$$\Rightarrow \quad 5R_4 = 165$$

$$\Rightarrow \quad R_4 = 33\ \text{k}\Omega$$

77. (d)

Magnetization, $M = \chi_m H$

where $\chi_m \rightarrow$ magnetic susceptibility

$H \rightarrow$ magnetic field intensity

So, in terms of magnitude, $M \propto H$

According to Curie law,

$$\chi_m = \frac{C}{T}$$

$$\Rightarrow \quad \chi_m \propto \frac{1}{T}$$

So, for constant H, $M \propto \frac{1}{T}$

78. (c)

Inductive Voltage regulation,

$$= \frac{\Delta V_0}{V_0}$$

$$IVR = \frac{\frac{V_m}{\pi}(1-\cos\mu)}{\frac{2V_m}{\pi}}$$

$$IVR = \left(\frac{1-\cos\mu}{2}\right)$$

79. (b)

Data count register = 18 bits

So, Count value = 2^{18} = 256 kbytes

One time control transfer = 256 kbytes

control to transfer = 2048 kbytes

$$\text{\# time bus control required} = \left[\frac{2048\text{ kbytes}}{256\text{ kbytes}}\right] = \frac{2^{11}}{2^8} = 2^3 = 8 \text{ times}$$

80. (b)

→ 4 kB RAM has 12 address lines

→ As such, A_0 to A_{11} of 8085 are connected to A_0 to A_{11} of 4 kB RAM.

→ A_{12} to A_{15} of 8085 are used for chip selection.

→ Select code for b_3 is 11.

A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0	
0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	= 7000 H
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	= 7FFF H

So the valid address range of 4 kB RAM IC is 7000 H to 7FFF H

81. (d)

Given organization is simultaneous access memory organization,

$$h = 0.4,$$

$$T_1 = 15 \text{ ns}, T_2 = 120 \text{ ns}$$

$$T_s = hT_1 + (1-h)T_2$$

$$= 0.4 \times 15 + 0.6 \times 120$$

$$= 78 \text{ ns}$$

82. (c)

Case 1 when switch is closed,

$$x = \frac{V_0}{V_i} = 1 = x$$

Case 2 when switch is open,

$$x' = \frac{V_0}{V_i} = \frac{2R}{R} = 2$$

$$x' = +2x$$

83. (a)

For α > 0.5, chopper acts as boost converter

For α < 0.5, chopper acts as buck converter.

84. (a)

$$\text{Number of lines} = \frac{64K}{32} = 2^{11}$$

$$\text{Number of sets} = \frac{2^{11}}{4} = \frac{2^{11}}{2^2} = 2^9$$

32 bits

Tag	SO	WO
18 bits	$\log_2 2^9 = 9$ bits	$\log_2 32 = 5$ bits

$$\text{Tag memory size} = S \times P \times \#\text{ tag bits}$$

$$= 2^9 \times 4 \times (18 + 1 + 1 + 2) = 2^9 \times 2^2 \times 22 \text{ bits}$$

$$= 2^{10} \times 2 \times 22 \text{ bits} = 44 \text{ K bits}$$

85. (d)

ZCS resonant converter implements soft switching technique.

As ON time is fixed, therefore time period should be varied to vary duty ratio. Hence frequency modulation technique is used.

86. (c)

The real power for salient pole machine

$$P = \frac{E_f V}{2}\sin\delta + \frac{V^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\sin 2\delta$$

Where, $\frac{V^2}{2}\left(\frac{1}{X_q} - \frac{1}{X_d}\right)\sin 2\delta$ is due to saliency of pole.

87. (d)

The PSD of the resultant process will be a rectangular pulse.

So, the ACF of the resultant process will be a "sinc" pulse, which is aperiodic and exists for infinite duration.

89. (a)

$$\text{Baud rate} = 500 \text{ symbols/sec} = 500 \text{ signal elements/sec}$$
$$\text{Bit rate} = 4000 \text{ bits/sec} = 4000 \text{ data elements/sec}$$

Data element per signal elements

$$n = \frac{4000}{500} = 8 \text{ bits}$$

So, signal elements needed $= 2^n = 2^8 = 256$

90. (c)

The generated emf, $E_g = V_t + I_a R_a$

$$E_{g1} = 200 + 100 \times 0.2 = 220 \text{ V}$$

The generated emf for $\phi_{f2} = 0.048$ Wb

$$E_{g2} = \frac{\phi_{f2}}{\phi_{f1}} \times E_{g1}$$

(Since immediately after the change of flux, the speed remains the same)

So, $$E_{g2} = \frac{0.048}{0.05} \times 220 = 211.2 \text{ V}$$

So, armature current in that case

$$I_{a2} = \frac{211.2 - 200}{0.2} = 56 \text{ A}$$

91. (b)

When white noise is passed through a BPF,

$$P_{\text{out}} = \left(\frac{N_0}{2}\right)(2B) = (4)\ (2 \times 2)\ \mu\text{W} = 16\ \mu\text{W}$$

92. (a)

$$f_0 \leq \frac{SR \times 10^6}{2\pi V_m}$$

$$f_0 \leq \frac{2 \times 10^6}{2\pi \times 20}$$

$$f_0 \leq 15.92 \text{ kHz}$$

93. (b)

The given modulated signal is an AM signal.

$$s(t) = (2.5 + 5\cos\omega_m t)\cos\omega_c t$$
$$= 2.5(1 + 2\cos\omega_m t)\cos\omega_c t$$

So, the modulation index of the given AM signal is,

$$\mu = 2$$

As $\mu > 1$, synchronous detector is more suitable.

94. (c)

In CE amplifier, bypass, coupling and blocking capacitors effects low frequency response whereas junction capacitances effects high frequency response.

95. (c)

The angle of the modulated signal $s(t)$ can be given as,

$$\theta(t) = 2\pi f_c t + 12\sin(2000\pi t) + 5\cos(2000\pi t)$$

The instantaneous frequency of the modulated signal can be given as,

$$f_i = \frac{1}{2\pi}\frac{d\theta(t)}{dt}$$

$$= f_c + 12000\cos(2000\pi t) - 5000\sin(2000\pi t)$$

$$= f_c + 1000[12\cos(2000\pi t) - 5\sin(2000\pi t)]$$

$$= f_c + 1000[13\cos(2000\pi t + \alpha)]; \qquad \text{Where, } \alpha = \tan^{-1}\left(\frac{5}{12}\right)$$

$$f_i = f_c + 13000\cos(2000\pi t + \alpha)$$

Maximum frequency deviation of the signal $s(t)$ is,

$$(\Delta f)_{max} = |(f_i - f_c)|_{max} = 13000 = 13 \text{ kHz}$$

96. (c)

Static variable is initialized during compile time. Memory is allocated under heap section which lasts until the program does not gets terminated.

97. (b)

SNR $\propto (\beta)^2$

98. (a)

The area of cross section,

$$A = 2000 \text{ cm}^2$$

The number of turns, $N = 50$

Induced emf, $E = 4.44 \times \phi_m \times N \times f$

$$5.5 \times 10^3 = 4.44 \times \phi_m \times 50 \times 50$$

$$\phi_m = \frac{5.5 \times 10^3}{4.44 \times 50 \times 50} = 0.4954 \text{ Wb}$$

$$\phi_m = (B_m)A = 0.4954$$

$$B_m = \frac{0.4954}{2000 \times 10^{-4}} \cong 2.50 \text{ T}$$

99. (d)

All statements are correct.

100. (b)

Overall bandwidth, $BW' = BW\sqrt{2^{\frac{1}{2}}-1} = 20\sqrt{2^{\frac{1}{2}}-1} = 12.9\text{ kHz}$

101. (a)

Solar cell maximum power, $P_{max} = V_{max}I_{max}$

$P_{max\,(output)} = 0.15 \times 5 \times 10^{-3} = 7.5 \times 10^{-4}$ W

The input power to the solar, $P_{input} = (I)$ A

Where, I = intensity of solar radiation, $P_{input} = (I) \times 5 \times 10^{-4}$ Watt

Efficiency, $\eta = \dfrac{P_{out}}{P_{input}} \times 100$

$$10 = \frac{7.5\times10^{-4}}{5I\times10^{-4}}\times100$$

$$I = \frac{7.5\times10^{-4}\times100}{10\times5\times10^{-4}} = 15\text{ W/m}^2$$

102. (b)

Monostable multivibrator is used as pulse stretcher.

103. (a)

$$I_C = \frac{I_{reff}}{\left(1+\dfrac{N}{\beta}\right)}\ ; \quad \text{Here } N = 4$$

$$= \frac{21\times10^{-3}}{1+\left(\dfrac{4}{100}\right)} = \frac{25}{26}\times21\text{ mA} = 20.19\text{ mA}$$

104. (c)

The number of unit delay element requires would be order of filter i.e. 4.

105. (d)

For the motor armature circuit,

$$V_t = \alpha V_s = E_a + I_aR_a$$

and $E_a = K\omega_n$

$$E_a = 0.7\times\frac{2\pi\times900}{60}$$

$$E_a = 21\,\pi\text{ V}$$

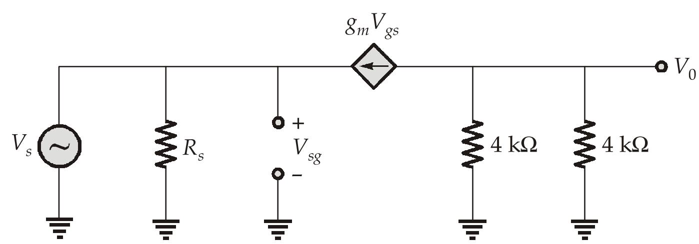
$$V_t = 0.5 \times 150$$

$$= 21\times\frac{22}{7}+I_a\times0.6$$

$$75 - 66 = I_a \times 0.6$$
$$I_a = 15 \text{ A}$$

106. (c)

Drawing the equivalent circuit, we get,



$$V_0 = -g_m V_{gs}(4 \text{ k}\Omega \,||\, 4 \text{ k}\Omega)$$
$$= -g_m V_{gs}(2 \text{ k}\Omega)$$

now, $$V_{gs} = -V_s$$

$\therefore$ $$V_0 = 2 \times 10^{-3} \times 2 \times 10^3 \times V_s$$

$\Rightarrow$ $$A_v = 4$$

107. (b)

The following plants are exclusively used for supplying peak load,

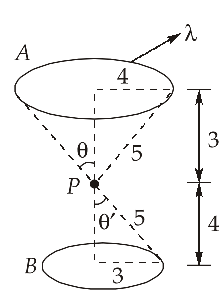
- Pumped storage
- Gas turbine
- Diesel power

108. (a)

- σ is called damping factor.
- $\int_{-\infty}^{\infty} f(t)e^{-\delta t}dt$ converges only if $\int_{-\infty}^{\infty} \left|f(t)e^{-\delta t}\right|dt < \infty$.
- σ is responsible for convergence of integral $\int_{-\infty}^{\infty} \left|f(t)e^{-\delta t}\right|dt$.

109. (a)

Let the rings A and B respectively have charges λ and λ′ (per unit length). As the resultant field at P is to be zero, the magnitude of the field due to each ring should be the same



$$\cos\theta = \frac{3}{5}$$

$$\cos\theta' = \frac{4}{5}$$

$$E_P \text{ due to } A = \int \frac{\lambda}{4\pi\varepsilon_0 5^2} dl(\cos\theta)$$

$$= \frac{\lambda(2\pi \times 4)\frac{3}{5}}{4\pi\varepsilon_0 5^2}$$

$$E_P \text{ due to } B = \int \frac{\lambda'}{4\pi\varepsilon_0 5^2} dl'(\cos\theta') \quad \text{...(i)}$$

$$= \frac{\lambda'}{4\pi\varepsilon_0 5^2}(2\pi \times 3)\frac{4}{5} \quad \text{...(ii)}$$

Equation (i) and (ii) we obtain $\lambda = \lambda'$

Ratio of the charge densities $= \lambda : \lambda' = 1 : 1$.

110. (c)

We know, $\gamma l = \alpha l + j\beta l = \sqrt{yz}\, l$

$$\gamma l = \sqrt{0.48\angle 30° \times 3.333 \times 10^{-5}\angle 90°} \times l$$

$$\gamma l = \sqrt{16 \times 10^{-6}\angle 120°} \times l$$

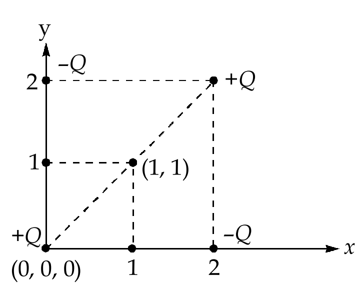
$$\gamma l = 4 \times 10^{-3} l\angle 60° = 4 \times 10^{-3} l[\cos 60° + j\sin 60°]$$

So, given, $\beta l = 1.04 \text{ rad} = 4 \times 10^{-3}\, l \sin 60°$

$$l = \frac{1.04}{4 \times 10^{-3} \times \sin 60°} = 300 \text{ km}$$

111. (a)

The two positive charges Q are diagonally opposite in position and at the same distance from the point (1, 1, 0). Fields produced by them are equal and opposite and so their resultant field is zero. Similarly, the two negative charges at the diagonally opposite corners produce zero field due to mutual cancellation.



112. (b)

$$F(j\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt = \int_{-\infty}^{\infty} f(t)(\cos\omega t - j\sin\omega t)dt$$

$$= \int_{-\infty}^{\infty} f(t)\cos\omega t - j\int_{-\infty}^{\infty} f(t)\sin\omega t\, dt$$

Given, $f(t)$ is odd function,

So, $f(t)\cos\omega t$ = odd function

and $f(t)\sin\omega t$ = even function

So, $$\int_{-\infty}^{\infty} f(t)\cos\omega t\, dt = 0$$

and $$F(j\omega) = 0 - 2j\int_{0}^{\infty} f(t)\sin\omega t\, dt = -2j\int_{0}^{\infty} f(t)\sin\omega t\, dt$$

114. (b)

The fault current at bus-3, $$I_f = \frac{V_f}{Z_{33}}$$

$$\bar{I}_f = \frac{1\angle 0^\circ}{j0.40} = 2.5\angle -90^\circ \text{ p.u.}$$

The voltage at bus-2 is given by

$$V_2 = V_f - Z_{23}\bar{I}_f$$

$$V_2 = 1\angle 0^\circ - j0.25 \times 2.5\angle -90^\circ$$

$$V_2 = 1 - 0.625 = 0.375 \text{ p.u.}$$

115. (c)

Number of 32 k × 1 RAM chip required = $\dfrac{256\times 2^{10}\times 8}{32\times 2^{10}\times 1} = 64$

116. (c)

For firing angle, $\alpha \geq 60^\circ$

circuit turn off time of thyristor is given by,

$$t_c = \frac{\pi - \alpha}{\omega}$$

$$t_c = \frac{\pi - \frac{\pi}{2}}{100\pi} = 5 \text{ ms}$$

117. (b)

Function F, will be

$$F = \bar{S}_0\bar{S}_1\bar{S}_2(I_0) + \bar{S}_0\bar{S}_1S_2(I_1) + \bar{S}_0S_1\bar{S}_2(I_2) + \bar{S}_0S_1S_2(I_3) + S_0\bar{S}_1\bar{S}_2(I_4)$$

$$+S_0\bar{S}_1S_2(I_5) + S_0S_1\bar{S}_2(I_6) + S_0S_1S_2(I_7)$$

Input to MUX is B and select lines are S_0, S_1, S_2

$$F = \bar{A}\bar{C}\bar{D}(1) + \bar{A}\bar{C}D(0) + \bar{A}C\bar{D}(\bar{B}) + \bar{A}CD(0) + A\bar{C}\bar{D}(\bar{B}) + A\bar{C}D(B) + AC\bar{D}(\bar{B}) + ACD(B)$$

$$F = \bar{A}\bar{C}\bar{D} + \bar{A}\bar{B}C\bar{D} + A\bar{B}\bar{C}\bar{D} + AB\bar{C}D + A\bar{B}C\bar{D} + ABCD$$

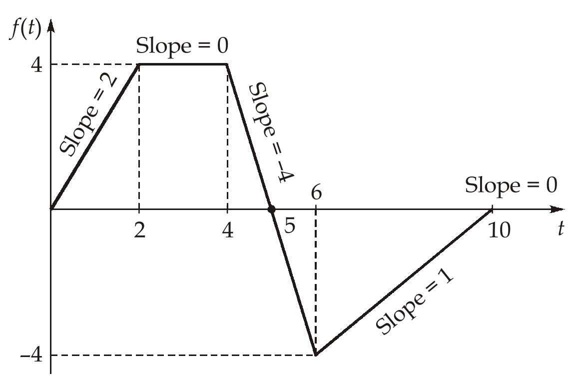
$$F = \bar{A}\bar{C}\bar{D}(B+\bar{B}) + \bar{A}\bar{B}C\bar{D} + A\bar{B}\bar{C}\bar{D} + AB\bar{C}D + A\bar{B}C\bar{D} + ABCD$$

K-map of function F

	$\bar{C}\bar{D}$	$\bar{C}D$	CD	$C\bar{D}$
$\bar{A}\bar{B}$	1 (0)	(1)	(3)	1 (2)
$\bar{A}B$	1 (4)	(5)	(7)	(6)
AB	(12)	1 (13)	1 (15)	(14)
$A\bar{B}$	1 (8)	(9)	(11)	1 (10)

$$F = \Sigma m\ (0, 2, 4, 8, 10, 13, 15)$$

118. (b)



The slopes are mentioned in the figure

The signal, $x(t) = 2\,r(t) + (0-2)\,r(t-2) + (-4-0)\,r(t-4) + (1-(-4))\,r(t-6) + (0-1)\,r(t-10)$

$x(t) = 2\,r(t) - 2r(t-2) - 4r\,(t-4) + 5\,r(t-6) - r(t-10)$

The Laplace transform

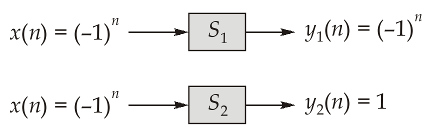
$$X(s) = \frac{2}{s^2} - \frac{2}{s^2}e^{-2s} - \frac{4e^{-4s}}{s^2} + \frac{5e^{-6s}}{s^2} - \frac{e^{-10s}}{s^2}$$

$$= \frac{1}{s^2}\left[2 - 2e^{-2s} - 4e^{-4s} + 5e^{-6s} - e^{-10s}\right]$$

120. (b)

$$x(n) = e^{-j3\pi n} = \left(\cos(-3\pi) + j\sin(-3\pi)\right)^n = (-1)^n$$

Here,



Here for system S, output is replica of input so system S_1 is LTI but S_2 is not LTI.

124. (a)

Application of an electric field causes relative displacement of these charges, leading to the creation of dipoles and hence polarization.

126. (b)

- If time quantum is too large in Round Robin scheduling, then Round Robin degenerate to FCFS scheduling.
- When time quantum is too large, then Round Robin may suffers from convoy effect because scheduling time is high if process with high burst time arrive first and the process with less burst time arrive late.

127. (c)

With reduction in airgap, reluctance of the air gap is decreased.

128. (c)

PCM increases the transmission bandwidth.

129. (c)

The electric field due to the infinite line charge is directed radially. Hence the charge Q in any position in the circular path experiences a force in the radial direction, which is perpendicular to the direction in which the charge Q is carried. Hence no work is done in carrying the positive charge Q about the circular path. The statement no force is exerted on the charge is incorrect.

131. (c)

Due to corona, the effective diameter of the conductor is increased.

133. (a)

We know, $$L \propto \ln\left(\frac{GMD}{GMR}\right)$$

By bundling of the conductors, GMD and GMR are effected,

GMR is increases and GMD is decreased, So L(inductance) is also reduced.

134. (c)

$$\delta(2n - 26) = \frac{1}{2}\delta(n-13)$$

So,
$$y(n) = \sum_{n=-10}^{10} \cos(3n)\left(\frac{1}{2}\delta(n-13)\right)$$

$$y(n) = \frac{1}{2}\sum_{n=-10}^{10} \cos(3n)\delta(n-13)$$

$$y(n) = \frac{1}{2}\sum_{n=-10}^{10} \cos(3\times 13)\delta(n-13)$$

$$y(n) = \frac{1}{2}\cos(39)\sum_{n=-10}^{10} (n-13)$$

Since impulse exists at $n = 13$, which is outside $-10 \le n \le 10$

Hence, $y(n) = 0$

135. (b)

$$y(n) = 2\sum_{m=0}^{n} x(m) = 2x(n) * u(n)$$

So,
$$Y(z) = 2\, X(z) \cdot U(z) = 2X(z)\cdot\left(\frac{z}{z-1}\right)$$

Given,
$$Y(z) = \frac{4}{z(z-1)^2} = 2X(z)\cdot\frac{z}{(z-1)}$$

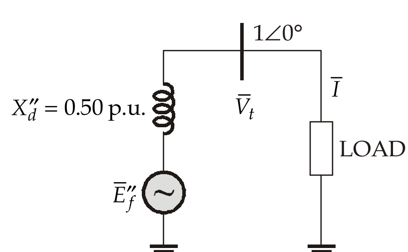
$$X(z) = \frac{2}{z^2(z-1)} = \frac{2z^{-3}}{(1-z^{-1})}$$

$$X(z) = \frac{2z^{-3}}{(1-z^{-1})}$$

Taking inverse Z-transform

$$x(n) = 2\,u(n-3)$$

136. (b)



The current, $$I = \frac{P}{V\cos\phi} = \frac{1}{1\times 0.8} = 1.25 \text{ p.u.}$$

$$\bar{E}_f'' = \bar{V}_t + \bar{I}(jX_d'')$$

$$\bar{E}_f'' = 1\angle 0° + 1.25\angle{-\cos^{-1}0.8}(j0.50)$$

$$\bar{E}_f'' = 1\angle 0° + (1 - j0.75)\,(j0.50)$$

$$= 1 + 0.375 + j0.50$$

$$= (1.375 + j0.5) \text{ p.u.}$$

$$|E_f''| = \sqrt{1.375^2 + 0.50^2} = \sqrt{2.14} = 1.46 \text{ p.u.}$$

137. (a)

If a system output $y(n)$ at time n depends on any post output values $y(n - 1)$, $y(n - 2)$ ..... , it is called a recursive system. So 2 and 3 are non-recursive systems.

138. (b)

INR and DCR instruction does not affect carry flag but affect remaining 4 flags.

139. (a)

In case of current leaving the protected zone is zero

$$I_2 = 0$$

$$I_{2s} = 0$$

The difference current, $$I_d = I_{1s} - I_{2s} = I_{1s} - 0 = I_{1s}$$

The restraining current, $$I_r = \frac{I_{1s} + I_{2s}}{2} = \frac{I_{1s} + 0}{2} = \frac{I_{1s}}{2}$$

The slope of the characteristics, $$K = \frac{I_d}{I_r} = \frac{I_{1s}}{I_{1s}/2} = 2$$

140. (b)

Taking Laplace transform of both sides of the two differential equations

$$sX(s) = -2Y(s) + 1$$

and $$sY(s) = 2\,X(s)$$

$$sX(s) = -2\cdot\frac{2X(s)}{s} + 1$$

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

from initial value theorem, $$x(0) = \lim_{s\to\infty} sX(s) = \lim_{s\to\infty} \frac{s^2}{s^2 + 4} = 1$$

141. (b)

The reactive power generally flows from higher voltage towards lower voltage size.

142. (b)

$$\frac{Y(z)}{X(z)} = \frac{1+2z^{-1}}{1-z^{-1}}$$

$$Y(z) - z^{-1}Y(z) = X(z) + 2z^{-1}X(z)$$

Taking inverse Laplace transform

$$y(n) = y(n-1) + x(n) + 2x(n-1)$$

For obtaining impulse response

$$x(n) = \delta(n)$$

$$h(n) = h(n-1) + \delta(n) + 2\delta(n-1)$$

$$h(0) = h(-1) + \delta(0) + 2\delta(n-1) = 1$$

$$h(0) = h(0) + \delta(1) + 2\delta(1-1)$$

$$= h(0) + \delta(1) + 2\delta(0)$$

$$h(1) = 1 + 0 + 2(1) = 3$$

$$h(2) = h(1) + \delta(2) + 2\delta(1) = 3 + 0 + 0 = 3$$

143. (d)

With only single resource, there cannot be deadlock.

144. (b)

If stator has balanced 3-ϕ negative sequence currents, the net produced by these currents rotates at nearly twice the synchronous speed with respect to rotor in the direction opposite to it.

145. (b)

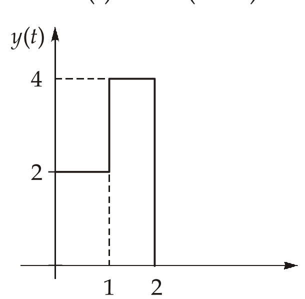
$$x(t) = \delta(t) + \delta(t-1) - 2\,\delta(t-2)$$

$$h(t) = 2\,u(t)$$

The output, $y(t) = x(t) * h(t)$

$$y(t) = [\delta(t)+\delta(t-1)-2\delta(t-2)] * [2u(t)]$$

$$y(t) = 2\,u(t) + 2\,u(t-1) - 4\,u(t-2)$$



146. (c)

$$x(t) = \sum_{k=-\infty}^{\infty} \delta(t-2k)$$

If
$$x(t) = \sum_{k=-\infty}^{\infty} \delta(t-kT) \xrightleftharpoons{\text{F.T.}} \omega_0 \sum_{k=-\infty}^{\infty} \delta(\omega - k\omega_0)$$

Where,
$$\omega_0 = \frac{2\pi}{T} \text{ and } \delta(\omega) = \frac{1}{2\pi}\delta(f)$$

Here, $T = 2$

So
$$X(\omega) = \frac{2\pi}{2} \sum_{k=-\infty}^{\infty} \delta\left(\omega - k\frac{2\pi}{2}\right)$$

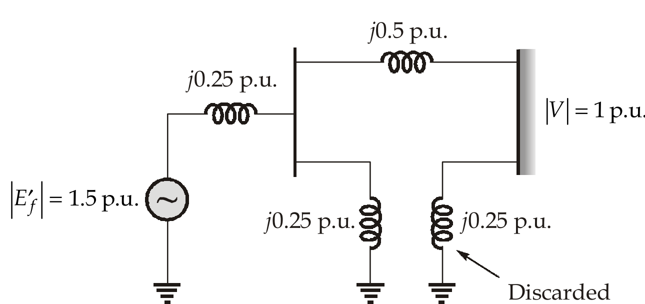
$$X(\omega) = \pi \sum_{k=-\infty}^{\infty} \delta\left(\omega - \frac{k2\pi}{2}\right)$$

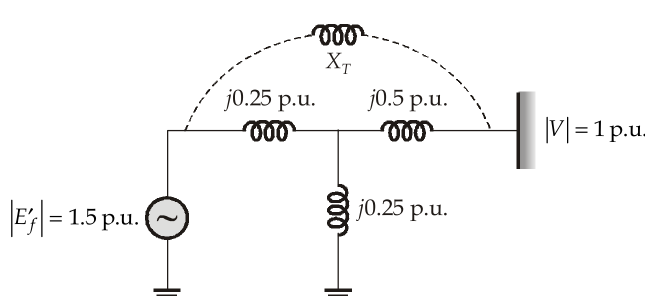
$$X(f) = \pi \sum_{k=-\infty}^{\infty} \delta\left(2\pi f - k\left(\frac{2\pi}{2}\right)\right)$$

$$X(f) = \frac{\pi}{2\pi} \sum_{k=-\infty}^{\infty} \delta\left(f - \frac{k}{2}\right) = \frac{1}{2} \sum_{k=-\infty}^{\infty} \delta\left(f - \frac{k}{2}\right)$$

147. (c)

During the fualt, system is





By star to delta, the transfer reactance X_T

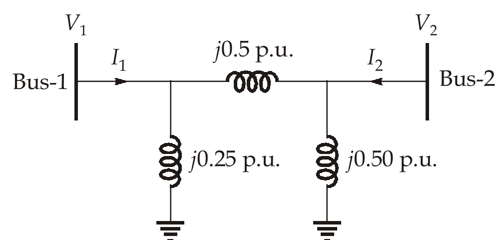
$$X_T = 0.25 + 0.5 + \frac{0.25 \times 0.5}{0.25} = 1.25 \text{ p.u.}$$

The steady state stability limit,

$$P_{max} = \frac{E'_f \times V}{X_T} = \frac{1.5 \times 1}{1.25} = 1.2 \text{ p.u.}$$

148. (c)

$$Z = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$$



$$Z_{11} = \left.\frac{V_1}{I_1}\right|_{I_2=0} = j0.25 \,||\, (j0.50 + j0.50)$$

$$= (j0.25 \,||\, j1) = j\frac{1 \times 0.25}{1.25} = j0.20 \text{ p.u.}$$

$$Z_{22} = \left.\frac{V_2}{I_2}\right|_{I_1=0} = j0.50 \,||\, (j0.5 + j0.25) = \frac{j \times 0.50 \times 0.75}{1.25}$$

$$Z_{22} = j0.30\ \Omega$$

$$Z_{12} = \left.\frac{V_1}{I_2}\right|_{I_1=0} = \frac{j0.25 \times \frac{50}{0.25+0.50+0.50} I_2}{I_2} = j0.10 \text{ p.u.}$$

Similarly, $$Z_{21} = \left.\frac{V_2}{I_2}\right|_{I_2=0} = \frac{j0.50 \times \frac{0.25}{0.50+0.50+0.25} I_1}{I_1} = 0.10 \text{ p.u.}$$

So, $$Z_{bus} \text{ matrix} = j\begin{bmatrix} 0.20 & 0.10 \\ 0.10 & 0.30 \end{bmatrix} \text{p.u.}$$

149. (c)

The impulse response of the analog filter is not preserved.

150. (c)

The inductance of are suppressor coil,

$$L = \frac{1}{3\omega^2 C} = \frac{1}{3(\omega C)(2\pi f)}$$

$$L = \frac{X_C}{6\pi f} = \frac{1000}{6\pi \times 50} = 1.06 \text{ H}$$

■■■■