DETAILED SOLUTIONS

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ESE 2024 : Prelims Exam CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 20

Full Syllabus Test 4 : Paper-II

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

Note: In Q. no. 83 answer key has been updated.

DETAILED EXPLANATIONS

1. (d)

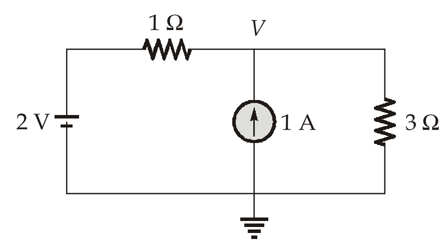
Let the voltage across current source be V. Using nodal analysis,

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

$$\frac{4\text{ V}}{3} = 3$$

$$V = \frac{9}{4}$$

$$V = 2.25 \text{ Volt}$$



2. (c)

We have, $I = 2$ A, $t = 10$ sec, V = 115 Volt

$$\text{Charge } (q) = I \times t$$

$$= 2 \times 10 = 20 \text{ Coulomb}$$

Since,

$$\text{Energy } (E) = qV$$

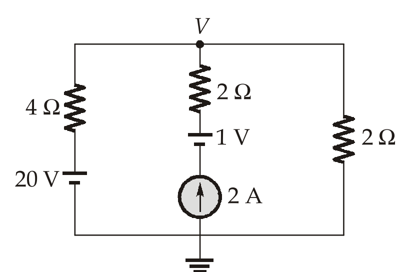
$$= 20 \times 115 = 2300 \text{ J} = 2.3 \text{ kJ}$$

3. (d)

In the given circuit,

6 Ω and 3 Ω resistors are in parallel.

$$\therefore \quad R' = \frac{6\times 3}{6+3} = \frac{18}{9} = 2\ \Omega$$



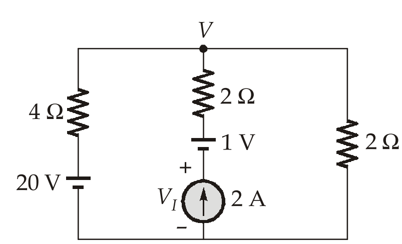
Using nodal analysis,

$$\frac{V-20}{4} - 2 + \frac{V}{2} = 0$$

$$\frac{V}{4}+\frac{V}{2} = 2+5$$

$$\frac{3\text{ V}}{4} = 7$$

$$V = \frac{28}{3}\text{volt}$$



$V = 1 + V_I - 2 \times 2$ (where, V_I is voltage across current source)

$$V = V_I - 3$$

$$V_I = \frac{28}{3} + 3 = \frac{37}{3} \text{ volt}$$

Power delivered by current source $= V_I \cdot 2$

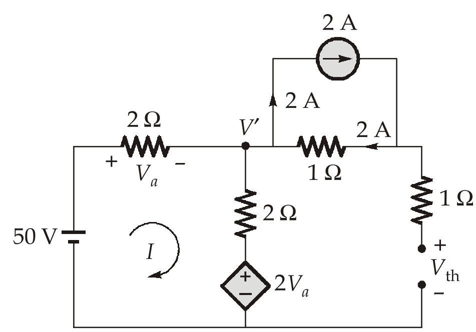
$$= 2 \times \frac{37}{3} = \frac{74}{3} = 24.67 \text{ W}$$

4. (b)

Conductance: "It is the ability of an element to conduct electric current."

5. (c)

Disconnecting the load resistance, we calculate the Thevenin voltage across the open circuit terminals.



$$2I = V_a$$

by using KVL, $50 - 2V_a = 4I$

$$50 = 4I + 4I$$

$$8I = 50$$

$$I = \frac{50}{8} = \frac{25}{4} \text{ A}$$

$$V' = 2I + 2V_a = 2I + 4I = 6I$$

$$V' = \frac{25}{4} \times 6 = 37.5 \text{ volt}$$

$$V_{th} = 2 + V' = 2 + 37.5$$

$$V_{th} = 39.5 \text{ V}$$

6. (c)

We have, $V = -2\sin(314t + 10°) = 2\cos(314t + 10° + 90°)$

$$V = 2\cos(314t + 100°) \text{ Volt}$$

$$V = 2\angle 100° \text{ Volt}$$

Now, $I = 5\cos(314t + 160°) = 5\angle 160° \text{ Amp}$

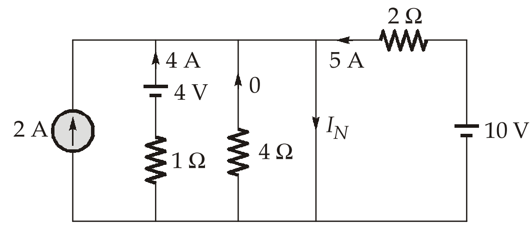
Here ; $\theta = \theta_V - \theta_I = 100 - 160° = -60°$

Power factor $\Rightarrow$ $\cos\theta = \cos(-60°) = 0.5\text{(leading)}$

Note: Leading because current is leading with voltage.

7. (c)

For Norton current, I_N, load R_L is short circuited.



by using KCL,
$$I_N = 2 + 4 + 5$$
$$I_N = 11 \text{ A}$$

8. (c)

For a two port network to be symmetrical, in transmission parameter matrix, $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$

$$A = D \quad \text{...(i)}$$

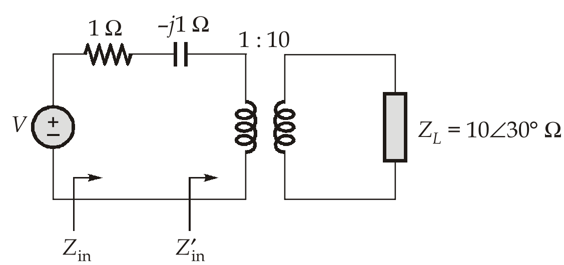
For a two port network to be bilateral, in transmission parameter matrix, $\begin{bmatrix} A & B \\ C & D \end{bmatrix}$

$$AD - BC = 1 \quad \text{...(ii)}$$

∴ Option (c) will satisfy the above two conditions.

9. (b)

Given, Circuit



The impedance seen by the source,

$$Z_{in} = 1 - j1 + Z'_{in}$$

where,
$$Z'_{in} = \left(\frac{N_1}{N_2}\right)^2 Z_L = \left(\frac{1}{10}\right)^2 10\angle 30°$$

$$Z'_{in} = 0.087 + j0.05$$

$$Z_{in} = 1 - j1 + 0.087 + j0.05$$

∴ $$Z_{in} = 1.087 - j0.95\ \Omega$$

10. (a)

When all the nodes are connected to each other and there is no repeated path existing between any two node then;

Total number of possible tress = N^{N-2}

$$N = \text{Number of nodes} = 4$$

Total number of possible tress = $4^{4-2} = 16$

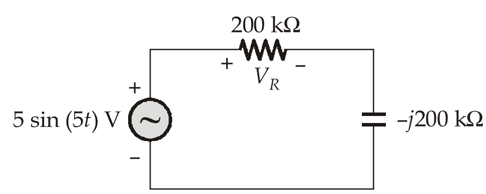
11. (b)

Duality means, the mathematical representation of both the networks should be identical (KVL and KCL).

∴ For dual networks, Loop equations of one network are analogous to the node equations of the other.

12. (b)

$$X_C = \frac{1}{\omega C} = \frac{1}{5 \times 10^{-6}} = 200\ \text{k}\Omega$$



$$\therefore \qquad V_R = \frac{5\angle 0^\circ}{(200 - j200)} \times 200$$

$$= \frac{5\angle 0^\circ}{(1-j)} = \frac{5\angle 0^\circ}{\sqrt{2}\angle -45^\circ}$$

$$= 2.5\sqrt{2}\ \angle 45^\circ$$

$$V_R = 2.5\sqrt{2}\sin(5t + 0.25\pi)\ \text{volt}$$

13. (b)

We know,

$$\text{Quality factor } (Q) = \frac{\text{Resonant frequency } (\omega_o)}{\text{Bandwidth}}$$

Here, $\quad$ Resonance frequency $(\omega_o) = \sqrt{\omega_1 \cdot \omega_2} = 2\omega_1$

$$\text{Bandwidth (B.W.)} = \omega_2 - \omega_1 = 3\omega_1$$

$$\therefore \qquad Q = \frac{2\omega_1}{3\omega_1} = \frac{2}{3}$$

14. (a)

$$\text{Load factor} = \frac{\text{Average load}}{\text{Maximum demand}}$$

$$= \frac{15\times8+10\times8+5\times8}{24\times15} = \frac{240}{15\times24} = \frac{10}{15}$$

$$\text{Load factor} = 0.667$$

15. (a)

Total load, $P_{G_1} + P_{G_2} = 250$ MW

For optimum load sharing,

$$\frac{dC_1}{dP_{G_1}} = \frac{dC_2}{dP_{G_2}}$$

$$0.20P_{G_1} + 40.0 = 0.25P_{G_2} + 30.0$$

$$5P_{G_1} - 4P_{G_1} = 200 \quad \text{...(i)}$$

$$P_{G_1} + P_{G_2} = 250 \quad \text{...(ii)}$$

On solving equations (i) and (ii), we obtain

$$P_{G_1} = \frac{350}{3}\text{ MW}$$

and $$P_{G_2} = \frac{400}{3}\text{ MW}$$

16. (b)

Nuclear power stations have very high capital cost and very low fuel cost. Thus they are considered as base load power stations.

17. (a)

Geometric mean radius = GMR = D_s

$$D_s = \sqrt[4]{D_{aa}.D_{ab}.D_{ac}.D_{ad}}$$

$$= \sqrt[4]{r'\times2r\times2r\times2\sqrt{2}\times r}$$

$$D_s = \sqrt[4]{8.8}\,r$$

18. (a)

The distance between the phase conductors in underground cable is very small as the result of which proximity effect is dominant.

19. (a)

Let ΔV = Voltage fluctuation

ΔQ = Reactive power variation (i.e. the size of the compensator)

$S_{s/c}$ = System short circuit capacity

Then, $$\Delta V = \frac{\Delta Q}{S_{s/c}}$$

or, $$\Delta Q = \Delta V \times S_{s/c}$$
$$= \pm (0.05 \times 5000)$$
$$= \pm 250 \text{ MVAR}$$

∴ The capacity of the static VAR compensator is 250 MVAR.

20. (c)

Corona effects can be minimized in a transmission line by using large diameter conductors which may be accomplished by using hollow conductors.

21. (b)

Since the generators are in parallel, they will operate at same frequency at steady load.

Let,

load on generator 1 (200 MW) = x MW

load on generator 2 (400 MW) = $(600 - x)$ MW

Reduction in frequency = Δf

Then, $$\frac{\Delta f}{x} = \frac{0.04 \times 50}{200}$$

$$\frac{\Delta f}{600 - x} = \frac{0.05 \times 50}{400}$$

Also, Equating $\Delta f = \frac{0.04 \times 50}{200}(x) = \frac{0.05 \times 50}{400}(600 - x)$, we have

$x \approx 231$ MW (load on generator 1)

∴ System frequency $= 50 - \left(\frac{0.04 \times 50}{200}\right) \times 231 = 47.69$ Hz

22. (d)

Three phase fault current is given as

$$(I_f)_{3-\phi} = \frac{V_3^0}{Z_{33}} = \frac{1}{j0.3} = -j\,3.33 \text{ p.u.}$$

23. (d)

The diagonal element Y_{22} of Y_{bus} is obtained by,

$$Y_{22} = y_{12} + y_{23} + y_{20}$$
$$= \frac{1}{Z_{12}} + \frac{1}{Z_{23}} + \frac{1}{Z_{20}}$$
$$= \frac{1}{j0.1} + \frac{1}{j0.1} + \frac{1}{-j20} = -j19.95 \text{ p.u.}$$

24. (d)

In general for a n bus system having p-number of pV buses the size of the Jacobian matrix will be

$$= (2n - 2 - p) \times (2n - 2 - p)$$
$$= (2 \times 15 - 2 - 3) \times (2 \times 15 - 2 - 3)$$
$$= 25 \times 25$$

25. (a)

Insulation resistance is inversely proportional to length of the line

$$R \propto \frac{1}{l}$$
$$\frac{R_1}{R_2} = \frac{l_2}{l_1}$$
$$\frac{200}{R_2} = \frac{5}{1}$$
$$R_2 = 40 \text{ M}\Omega$$

26. (a)

$$I_S = CV_r + DI_R$$
$$V_r = \frac{220}{\sqrt{3}}, \quad I_r = 0$$

$\therefore$
$$I_S = 0.5 \times 10^{-4} \times \frac{220}{\sqrt{3}} \times 10^3$$
$$I_S = \frac{11}{\sqrt{3}} \text{A}$$

27. (b)

Kinetic energy = GH

If Kinetic energy is constant then $G \propto \frac{1}{H}$

$\therefore$
$$\frac{G_1}{G_2} = \frac{H_2}{H_1}$$

or,
$$\frac{100}{50} = \frac{H_2}{5}$$
$$H_2 = 10 \text{ MJ/MVA}$$

28. (d)

Steady state error due to unit step input for type-0 system:

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

where, $K_p = \lim_{s\to 0} G(s)H(s) = \lim_{s\to 0} \frac{K}{(s+1)(0.1s+1)} = K$

given $e_{ss} = \frac{1}{1+K} = 0.1$

$$1 + K = \frac{1}{0.1} = 10$$

$$K = 9$$

29. (c)

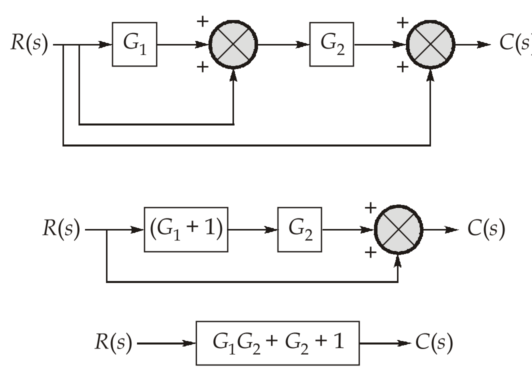
For a state transition matrix:

$$\phi(0) = I$$

and $[\phi(t)]^{-1} = \phi(-t)$

only option (c) satisfies above conditions.

30. (d)



$$\frac{C(s)}{R(s)} = 1 + G_2 + G_1G_2$$

31. (d)

Output $Y(s)$ is given as, $Y(s) = [[R(s) - Y(s)]K + X(s)]\frac{1}{(s+1)}$

$$Y(s) + \frac{K}{(s+1)}Y(s) = \frac{KR(s) + X(s)}{(s+1)}$$

$$Y(s) = \frac{K[R(s)]}{(s+K+1)} + \frac{X(s)}{s+(K+1)}$$

Output due to disturbance, $Y_1(s)$

$$Y_1(s) = \frac{X(s)}{s+K+1}$$

Let $X(s) = \frac{A}{s}$

$$\lim_{t\to\infty} y_1(t) = \lim_{s\to 0} s\,Y_1(s) = \frac{A}{(K+1)}$$

As K increases, value of output due to disturbance decreases.

∴ K should be very high value.

32. (d)

Here, $A = \begin{bmatrix} 0 & 1 \\ -3 & -a \end{bmatrix}$, $B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$, $C = [1 \quad 1]$

By using characteristic equation,

$$q(s) = |[sI - A]| = 0$$

$$\left\| \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 1 \\ -3 & -a \end{bmatrix} \right\| = 0$$

$$\begin{vmatrix} s & -1 \\ 3 & (s+a) \end{vmatrix} = 0$$

$$s(s + a) + 3 = 0$$

$$s^2 + as + 3 = 0 \quad \ldots(i)$$

Comparing it with standard second order characteristic equation, we get

$$\omega_n = \sqrt{3}$$

$$2\xi\omega_n = a \quad \xi = 0.5, \qquad \text{given } a = \sqrt{3}$$

$$a = 1.732$$

33. (a)

Open loop transfer function $G(s) = \dfrac{25}{s(s+5)}$

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

$$q(s) = \frac{25}{s(s+5)} + 1 = 0$$

$$s^2 + 5s + 25 = 0$$

Comparing it with standard 2nd order system characteristic equation, we get,

$$\omega_n = 5 \text{ rad/sec}$$

$$\xi = 0.5$$

Quality factor, $Q = \dfrac{1}{2\xi} = \dfrac{1}{2\times 0.5}$

$$Q = 1$$

34. (b)

Using R-H criterion for characteristic equation:

$$s^2(s+2)(s+5) + K(2s+1) = 0$$
$$(s^3+2s^2)(s+5) + K(2s+1) = 0$$
$$s^4 + 5s^3 + 2s^3 + 10s^2 + 2sK + K = 0$$
$$s^4 + 7s^3 + 10s^2 + 2sK + K = 0$$

s^4	1	10	K
s^3	7	$2K$	0
s^2	$\frac{70-2K}{7}$	K	
s^1	$\frac{\left(\frac{70-2K}{7}\right)2K-7K}{\left(\frac{70-2K}{7}\right)}$		
s^0	K		

For stable system, $K > 0$,

$$\frac{70-2K}{7} > 0$$
$$K < 35$$

and
$$\frac{\left(\frac{70-2K}{7}\right)2K-7K}{\left(\frac{70-2K}{7}\right)} > 0$$
$$(70-2K)2K - 49K > 0$$
$$K < \frac{91}{4}$$
$$K < 22.75$$

∴ Range of K, $0 < K < 22.75$

35. (a)

Angle of asymptotes = 180°

∴ $P - Z = 1$

Only option (a) satisfies this condition.

36. (b)

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

For phase cross over frequency; phase should be – 180°

$$-180° = \angle G(j\omega) = -90° - \tan^{-1}(2\omega_{pc}) - \tan^{-1}(\omega_{pc})$$

$$90° = \tan^{-1}(2\omega_{pc}) + \tan^{-1}(\omega_{pc})$$

$$90° = \tan^{-1}\left(\frac{3\omega_{pc}}{1-2\omega_{pc}^2}\right)$$

$$1-2\omega_{pc}^2 = 0$$

$$2\omega_{pc}^2 = 1$$

$$\omega_{pc} = \pm\frac{1}{\sqrt{2}}$$

$$\therefore \quad \text{Gain margin} = \frac{1}{|G(j\omega)|_{\omega=\omega_{pc}}}$$

$$= \frac{1\times 1\times\sqrt{(4\omega_{pc}^2+1)}\times\sqrt{\omega_{pc}^2+1}}{1\times\sqrt{2}\times 1}$$

$$= \frac{1}{\sqrt{2}}\times\sqrt{3}\times\frac{\sqrt{3}}{\sqrt{2}} = \frac{3}{2}$$

37. (a)

$$\text{Initial slope} = 6\ \text{dB/oct} = 20\ \text{dB/dec}$$

$$\frac{a-0}{\log_{10}20-\log_{10}2} = 20$$

$$\frac{a}{\log_{10}\left(\frac{20}{2}\right)} = 20$$

$$\frac{a}{\log_{10}10} = 20$$

$$a = 20\ \text{dB}$$

38. (c)

Primary bonds are interatomic bonds, these bonds are stable and strong.

39. (a)

The dielectric strength for different dielectric materials in decreasing order is given below:
Mica > Glass > Bakelite > Rubber > Polystyrene > Impregnated paper > Mineral oil > Air

40. (b)

- Burger's vector of an edge dislocation is perpendicular to dislocation line.
- Burger's vector of an screw dislocation is parallel to screw dislocation line.

41. (b)

Properties of hard magnetic materials:

- High value of residual flux density.
- High permeability.
- High coercive force.
- High curie temperature.
- Broad hysteresis loop.

42. (b)

The area of B-H curve = Hysteresis loss per cycle

= Area of parallelogram

= Base × Height

$= 400 \times 10^3 \times 2 = 8 \times 10^5\ J/m^3$

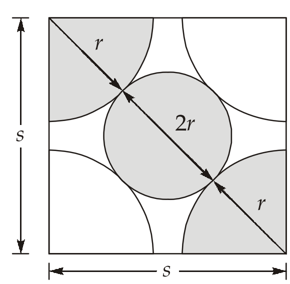
43. (d)

Atomic radius of FCC = r

In right angle triangle at any face

$$(r + 2r + r)^2 = s^2 + s^2 = 2s^2$$

$$r = \frac{s\sqrt{2}}{4}$$



$$\text{Atomic packing factor} = \frac{\text{Total volume of atom}}{\text{Volume of unit cell}}$$

Number of atoms in unit cell = 4

$$\text{Volume of each sphere} = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi\left(\frac{s\sqrt{2}}{4}\right)^3$$

$$\text{Volume of unit cell} = s^3$$

$$\therefore \quad \text{Atomic packing factor} = \frac{4\times\frac{4}{3}\pi\left(\frac{s\sqrt{2}}{4}\right)^3}{s^3} = \frac{\pi}{3\sqrt{2}}$$

44. (d)

Soft magnetic material have low eddy current losses, narrow hysteresis loop, low coercive force and can be easily demagnetized in other direction.

45. (c)

We know, Dielectric loss = $\frac{E^2 f \varepsilon_r \tan\delta}{1.8\times10^{12}}$ W/cm^3

Given, E = 50 kV/cm,

f = 50 Hz,

$\tan\delta$ = 0.001

Dielectric loss = 0.48 mW/cm^3 = 0.48 × 10^{-3} W/cm^3

$$0.48 \text{ mW/cm}^3 = \frac{60^2\times10^6\times50\times\varepsilon_r\times0.001}{1.8\times10^{12}}$$

$$\epsilon_r = \frac{0.48\times10^{-3}\times1.8\times10^{12}}{60\times60\times10^6\times50\times0.001}$$

$$= \frac{48\times18}{36\times5} = \frac{24}{5} = 4.8$$

46. (a)

Silsbee's rule suggest that current cannot exceed a critical value to maintain the superconducting state. If current goes higher to this critical value the superconductivity is lost and normal state of material appears.

47. (b)

arr =

M	a	d	e	e	a	s	y	%
1000	1001	1002	1003	1004	1005	1006	1007	1008

$*$ str [1000] (2000)

= str + str [3] – str [1]

= 1000 + ASCII [*e*] – ASCII [*a*]

= 1000 + 101 – 97

= 1000 + 4

= 1004

printf function print string from address 1004 to 1008 i.e., easy.

48. (b)

Number of sets = 64/8 = 8 = 3 bits required

Number of blocks in main memory = 2

1 block = 512 words = 9 bits required

Tag	Set	Word
8	3	9

Tag = Total – (Set + Word)

Tag bits = 20 – (9 + 3) = 8 bits for Tag

49. (c)

From at

1 bit	8 bit	23 bit
Sign	Exponent	Mantissa

← 32 →

1	10000011	11110000 . . . 0

$= (-1)^s\ (1.E) \times 2^{E-127}$

$= (-1)^1\ (1.1111) \times 2^{131-127}$

$= -(1.1111) \times 2^4$

$= -[2^0 \times 1 + 2^{-1} \times 1 + 2^{-2} \times 1 + 2^{-3} \times 1 + 2^{-4} \times 1] \times 2^4$

$= -[2^4 + 2^3 + 2^2 + 2^1 + 2^0]$

$= -(31)_{10}$

50. (c)

Execution time for pipeline = $(k + n - 1) \times tp$

where k = Number of stages

n = Number of instruction

tp = Execution time = Max (all stages)

$P_1 = [8 + 500 - 1] \times 8 = 4056$

$P_2 = [5 + 500 - 1] \times 5 = 2520$

Time saved using P_2 = 4056 – 2520 = 1536 nsec = 1.536 μsec

51. (d)

All the above statements are correct.

S1: Reference bit some times called access bit used in page table entry to show if page is replaced or not.

S2: In hierarchial memory access, CPU perform read and write operation only on level 1 memory. If miss occur then data is first transferred to level 1 then CPU access data.

S3: In simultaneous memory access, CPU perform read and write operation on any level of memory i.e. not necessary to take data first into level 1 memory then access it.

52. (b)

FCFS is non pre-emptive algorithm.

53. (b)

In horizontal form signals are present in decoded form. So number of signal bits

$$= 20 + 70 + 2 + 10 + 23$$
$$= 125 \text{ bits}$$

In vertical form signals are present in encoded form. So, number of signal bits

$$= \log_2(20) + \log_2(70) + \log_2(2) + \log_2(10) + \log_2(23)$$
$$= 5 + 7 + 1 + 4 + 5 = 22$$

So, total bits saved using vertical form

$$= 125 - 22 = 103 \text{ bits}$$

54. (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 it is also the next instruction of the program.

55. (c)

Under maximum efficiency condition

$$P_{cu} = P_i$$
$$\text{Total loss} = 2\,P_i\,;$$
$$= 2 \times 300$$
$$= 600 \text{ W}$$

56. (b)

If the incoming alternator is running slower, then soon after the synchronizing switch is closed, the already loaded alternator gets loaded still further and the incoming alternator starts operating as a synchronous motor, which is undesirable.

57. (c)

$$T_{st} = x^2\left(\frac{I_{sc}}{I_{fl}}\right)^2 S_{fl} \cdot T_{fl}$$
$$0.4T_{fl} = x^2[5]^2 \times 0.035 \times T_{fl}$$
$$x^2 = 0.457$$

Current drawn from supply

$$I_{\text{Line}} = x^2 I_{sc} = 0.457 \times 5 \times I_{fl}$$
$$I_{\text{Line}} = 2.28\,I_{fl}$$

58. (c)

- Voltage regulation is less important in power transformer and less important in distribution transformer.
- Magnetizing current has dominant 3rd harmonics.
- Magnetizing inrush current has dominant 2nd harmonic.

59. (a)

Under maximum efficiency condition

$$W_i = W_{Cu}$$

So, $$W_{Cu\ fL} = 2000 \text{ W}$$

Cu loss at $\frac{3}{4}$ full load.

$$= \left(\frac{3}{4}\right)^2 \times \text{Full load Cu loss}$$

$$= \frac{9}{16} \times 2000 = 1125 \text{ W}$$

60. (d)

All statements are correct.

61. (d)

generated voltage: $$E = \frac{Z\phi NP}{60A}$$

for lap $\Rightarrow$ $$A = P$$

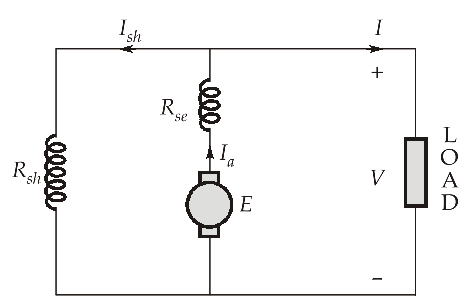
$$E = \frac{Z\phi N}{60}$$

$$500 = \frac{(12 \times 40) \times 50 \times 10^{-3} \times N}{60}$$

$$N = 1250 \text{ rpm}$$

62. (b)

The circuit diagram for long shunt compound D.C generator is shown:



Here, $I = 50$ A; $V = 500$ Volt; $R_a = 0.05\ \Omega$; $R_{se} = 0.03\ \Omega$;

and $R_{sh} = 250\ \Omega$

Brush contact drop, $V_b = 2 \times 1 = 2$ V

$$I_{sh} = \frac{V_{sh}}{R_{sh}} = \frac{500}{250} = 2\text{A}$$

$$I_a = I_{sh} + I = 2 + 50 = 52 \text{ A}$$

Using KVL:

$$E = V + I_a R_a + I_a R_{se} + V_b$$
$$= 500 + (52 \times 0.05) + (52 \times 0.03) + 2$$
$$E = 506.16 \text{ Volt}$$

63. (d)

At V = 250 V; I_{a1} = 50 A; R_a = 0.25 Ω, N_1 = 750 rpm;

$$E_{b1} = V - I_{a1}R_a = 250 - 50 \times 0.25 = 237.5 \text{ V}$$

after reducing the flux,

$$\phi_2 = 0.9\phi_1$$

load torque remains same,

$$T_1 = T_2$$
$$\phi_1 I_{a1} = \phi_2 I_{a2}$$
$$\frac{50}{0.9} = I_{a2}$$
$$I_{a2} = 55.56 \text{ A}$$

Back Emf at I_{a2},

$$E_{b2} = V - I_{a2}R_a = 250 - (55.56)(0.25) = 236.1 \text{ Volt}$$

for DC machine:

$$E_b \propto N\phi$$
$$\frac{E_{b1}}{E_{b2}} = \frac{N_1}{N_2} \times \frac{\phi_1}{\phi_2}$$
$$\frac{237.5}{236.1} = \frac{750}{N_2} \times \frac{1}{0.9}$$
$$N_2 = 828.5 \text{ rpm}$$

64. (a)

$$N \propto \frac{E_b}{\phi} \propto \frac{V - I_a R_a}{\phi}$$

By varying flux, we can increase the speed more than its base speed.

65. (b)

Stator teeth of various stack differ by angular displacement of

$$\theta = \frac{360°}{\eta T}$$

$\eta \rightarrow$ no. of stacks

$T \rightarrow$ no. of teeth

for $\theta = 6°$ and $T = 15$

$$6° = \frac{360°}{\eta \times 15}$$

$$\eta = 4$$

67. **(a)**

If field excitation is such that $E_f \cos\phi > V$ the motor is said to be over-excited and it draws leading current.

68. **(c)**

Given: rotor frequency = 1.5 Hz = f_2

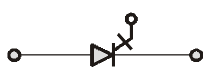
$$f_2 = f_1$$

$$\text{slip, } s = \frac{1.5}{50} = 3\%$$

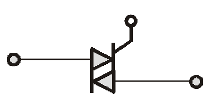
synchronous speed: $N_s = \frac{120f}{P} = \frac{120 \times 50}{4} = 1500 \text{ rpm}$

rotor speed = $N = N_s(1 - s)$ = 1500 (1 – 0.03) = 1455 rpm

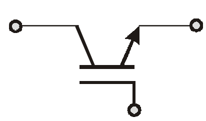
69. **(b)**

- GTO thyristor 

  It can be switched-off by a negative gate pulse.

- Triac 

  Bidirectional device

- IGBT 

  Advantage of both MOSFET and BJT. High input impedance and low on-state power loss.

70. **(b)**

$$\left(\frac{di}{dt}\right)_{max} = \frac{V_m}{L}$$

$$= \frac{230\sqrt{2}}{20\mu\text{H}} = 16.26 \text{ A}/\mu \text{ sec}$$

71. **(c)**

The peak to peak ripple voltage of the capacitor is,

$$\Delta V_c = \frac{V_0(1-\alpha)}{8LCf^2}$$

73. (c)

The given circuit is a Boost regulator,

$$V_0 = \frac{V_s}{1-\alpha}$$

$$15 = \frac{5}{1-\alpha}$$

$$\alpha = 0.6667$$

or,
$$\Delta I = \frac{V_s\,\alpha}{f\,L}$$

$$\Delta I = \frac{5\times 0.6667}{25\times 10^3\times 150\times 10^{-6}} = 0.89 \text{ A}$$

74. (b)

A Cycloconverter is used to step up or step down the frequency.
This operation is not possible with four quadrant chopper.

75. (d)

$$V_r = 4 \text{ V}$$

$$V_c = 6 \text{ V}$$

Total pulse width = $2d$

$$\frac{2d}{N} = \left(1-\frac{V_r}{V_c}\right)\frac{\pi}{N}$$ (Where N is number of pulses per half cycle)

$$2d = \left(1-\frac{V_r}{V_C}\right)\pi = \left(1-\frac{4}{6}\right)180^\circ = 60^\circ$$

76. (b)

For single phase full bridge controlled converter,

Fundamental displacement factor $= \cos\alpha$

$= \cos 45^\circ = 0.707$

77. (c)

Peak Inverse Voltage across FD $= 2\,V_s$

$= 2 \times 230 = 460$ V

Peak Inverse Voltage across main thyristor

$= V_s = 230$ V

78. (d)

In quadrant-II it is working in forward braking mode.

In quadrant-III it is working in reverse motoring mode.

In quadrant-IV it is working in reverse braking mode.

79. (a)

Using multiple pulse modulation (MPM) lower ordered harmonics are reduced but higher ordered harmonics are increased.

80. (c)

$$\beta = 135°/\text{m}$$

$$\pi = 180°$$

$$\beta = \frac{\pi}{180} \times 135 \text{ rad/m}$$

$$\text{Electrical length} = \beta l = \frac{135\pi}{180} \times 5$$

$$= \frac{15\pi}{4} = 3.75\pi \text{ rad}$$

81. (d)

$$\text{Charge density, } \rho_V = \vec{\nabla} \cdot \vec{D}$$

$$\rho_V = \frac{\partial}{\partial x}(x^3 y^2) + \frac{\partial}{\partial y}(x^2 z) + \frac{\partial}{\partial z}(x^2 y^2)$$

$$\rho_V = 3x^2y^2 \text{ C/m}^3$$

Charge enclosed by the cube,

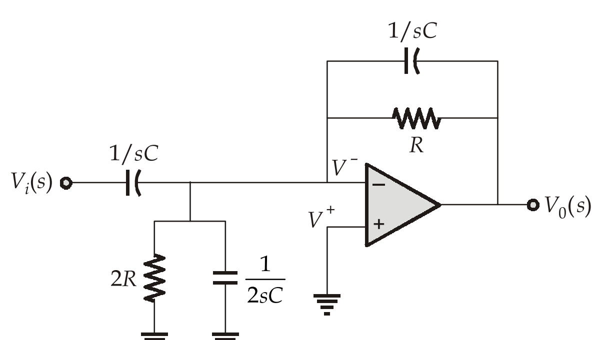
$$Q = \int_{-1}^{1}\int_{-1}^{1}\int_{-1}^{1} \rho_V \, dx\, dy\, dz$$

$$Q = \int_{-1}^{1}\int_{-1}^{1}\int_{-1}^{1} 3x^2y^2 \, dx\, dy\, dz$$

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

$$Q = \frac{8}{3} C$$

82. (b)



Due to virtual ground,

$$V^+ = V^- = 0 \text{ V}$$

KCL at node V^-

$$\frac{0-V_i(s)}{1/Cs}+\frac{0-V_0(s)}{R}+\frac{0-V_0(s)}{1/Cs} = 0$$

$$V_0(s)\left[\frac{1+sCR}{R}\right] = -sC\,V_i(s)$$

$$\frac{V_0(s)}{V_i(s)} = \frac{-sCR}{1+sCR}$$

Putting $s = j\omega$

$$\frac{V_0(j\omega)}{V_i(j\omega)} = \frac{-j\omega CR}{(1+j\omega CR)}$$

When $\omega = 0$; $V_0(j\omega) = 0$

When $\omega = \infty$; $V_0(j\infty) \neq 0$

So, it is a HPF

83. (a)

The Thevenin voltage, $V_{Th} = \frac{30}{30+70}\times 20 = 6 \text{ V}$

The Thevenin resistance $R_{Th} = 30\|70 = 21 \text{ k}\Omega$

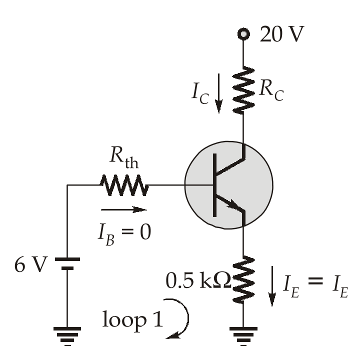
Since, large value of β is given therefore current $I_B = 0$

The equivalent circuit,

Applying KVL in loop-1, we get

$$\frac{6-0.7}{0.5} = I_C$$

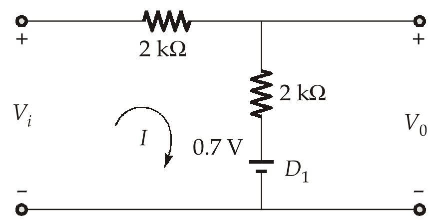
$$\therefore \quad I_C = 10.6 \text{ mA}$$



84. (a)

For positive half cycle,

D_1 ON, D_2 OFF



Maximum input voltage = 5 V

$$I = \frac{5-0.7}{4k}$$

$$I = \frac{4.3}{4k}\text{A}$$

$$V_0 = 2kI + 0.7$$

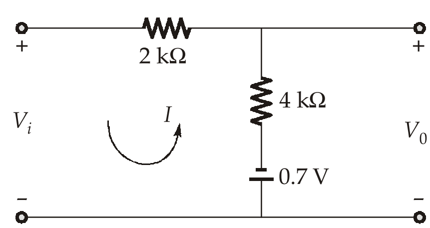
$$= 2k\left(\frac{4.3}{4k}\right)+0.7$$

$$V_0 = 2.15 + 0.7$$

$$V_{0\,max} = 2.85 \text{ V}$$

For negative half cycle,

D_1 OFF, D_2 ON



Minimum input voltage = –5 V

$$I = \frac{5-0.7}{6k} = \frac{4.3}{6k}\text{A}$$

$$V_0 = -0.7 - 4kI$$

$$= -0.7 - 4k\left(\frac{4.3}{6k}\right) = -0.7 - \frac{8.6}{3} = -3.56 \text{ V}$$

85. (a)

$$\frac{dA_f}{A_f}\times 100 = \frac{1}{(1+A\beta)}\left(\frac{dA}{A}\times 100\right)$$

$$2 = \frac{10}{1+A\beta}$$

$$1 + A\beta = 5$$

$$\text{Closed loop gain, } A_f = \frac{A}{1+A\beta} = \frac{100}{5}$$

$$A_f = 20$$

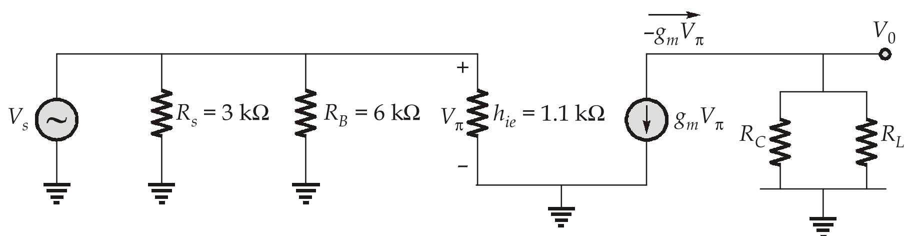
Closed loop gain is having variation of ±2%

$$\therefore \quad \frac{2}{100}\times 20 = 0.4$$

$$\therefore \quad A_f = 20 \pm 0.4$$

86. (b)

Using small-signal analysis,



$$V_0 = -g_m V_\pi (R_C \parallel R_L)$$

$$R_C \parallel R_L = 4\text{ k}\Omega \parallel 4\text{ k}\Omega = \frac{4\times 4}{4+4} = \frac{16}{8}$$

$$= 2\text{ k}\Omega$$

$$V_\pi = V_s$$

$$g_m h_{ie} = h_{fe}$$

$$g_m = \frac{50}{1.1K}\text{A/V}$$

$$V_0 = -g_m V_s (2K)$$

$$= \frac{-50}{1.1K} V_s (2K)$$

$$\frac{V_0}{V_s} = \frac{-100}{1.1} = -90.9 \simeq -91$$

87. (d)

Let both the NMOS be in saturation.

Drain current is same for both MOSFETs,

$$I_{D1} = I_{D2}$$

$$\frac{k_n}{2}(8 - V_x - 1)^2 = \frac{k_n}{2}(3-1)^2$$

$$(7 - V_x)^2 = 4$$

$$49 + V_x^2 - 14V_x = 4$$

$$V_x^2 - 14V_x + 45 = 0$$

$$(V_x - 9)(V_x - 5) = 0$$

$$V_x \neq 9\text{ V},\ V_x = 5\text{ V}$$

For $V_x = 5\text{ V},\ V_{DS2} = V_x = 5$

$$5 > V_{GS} - V_{TN}$$

$$5 > 3 - 1$$

$$5 > 2$$

∴ Our assumption is true.

$$V_x = 5\text{ V}$$

88. (c)

The base of the number is 7.

∴ It can use digits from 0 to 6.

Hence, using 9 is invalid for this number system.

89. (a)

Six bit representation of +10 is 001010

Taking 2's complement → 110101

$$\begin{array}{r} 110101 \\ +1 \\ \hline 110110 \\ \hline \end{array}$$

90. (b)

$$Y = I_1\overline{S_1}S_0 + I_2S_1\overline{S_0}$$

$$S_1 = A\overline{B}, \quad S_0 = \overline{A\overline{B}}$$

$$Y = \overline{A\overline{B}}\ \overline{A\overline{B}} + A\overline{B}\cdot A\overline{B}$$

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

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

$$Y = (\overline{A} + A)(\overline{A} + \overline{B}) + B$$

$$Y = 1(\overline{A} + \overline{B}) + B$$

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

$$Y = \overline{A} + 1$$

$$Y = 1$$

91. (c)

When two numbers are added in excess-3 code and the sum is less than 9, then in order to get the correct answer, we need to subtract 0110 i.e. $(6)_{10}$ from the sum.

92. (c)

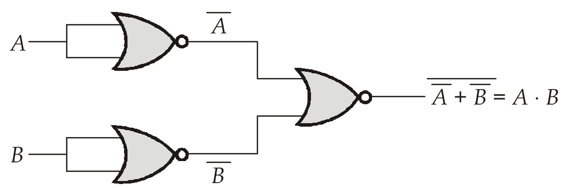
$$Y = A\left[(A+B)(\bar{A}+B) + AB(A+\bar{B})\right]$$

$$= A\left[A\bar{A} + AB + \bar{A}B + B + AAB + AB\bar{B}\right]$$

$$= A\left[AB + B + \bar{A}B + 0\right] = A\left[B + \bar{A}B\right]$$

$$Y = AB$$

Implementing using NOR gate only,



∴ Minimum no. of 2 input NOR gates required is 3.

93. (b)

Non maskable interrupt in 8085 μP → TRAP (RST 4.5)

Starting address of RST 4.5

Step - I. → $4.5 \times 8 = (36)_{10}$

Step - II. → 16 | 36 → 2 | 4 $= (0024)\text{H}$

Starting address → (0024)H

Each interrupt occupies 8 bytes of memory

$$\text{Ending address} = \begin{array}{r} (0024)\text{H} \\ +(0007)\text{H} \\ \hline (002\text{B})\text{H} \end{array}$$

94. (c)

Number of pins in 8085 = 27

95. (a)

For AND operation → $AC = 1$, $CY = 0$

97. (c)

In CALL instruction

Instruction	Machine cycle	T-states
CALL	Opcode fetch	6
	Memory read	3
	Memory read	3
	Memory write	3
	Memory write	3
	5 Machine cycle	18 T-states

98. (a)

In asynchronous TDM, number of slots in each frame is less than that of number of signal sources.

99. (d)

The transmission efficiency of a standard AM signal can be given as,

$$\eta = \frac{k_a^2 P_m}{1 + k_a^2 P_m} \times 100$$

Where, k_a = amplitude sensitivity = 2 V^{-1}

P_m = average power of message signal = 6 W

So, $$\eta = \frac{24}{1+24} \times 100 = 96\%$$

100. (c)

From FM signal,

$$f_i = f_c + k_f m(t)$$

$$\theta_i = 2\pi f_c t + 2\pi k_f \int_{-\infty}^{t} m(t)\,dt$$

Maximum phase deviation,

$$\Delta\phi_{max} = \left|2\pi k_f \int_{-\infty}^{t} m(t)\,dt\right|_{max}$$

$$\left|\int_{-\infty}^{t} m(t)\,dt\right|_{max} = \text{Area under } m(t)$$

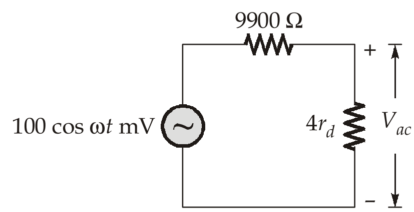
$$= 5 \times 10^{-3} \times 2 \text{ V-sec} = 10 \times 10^{-3} \text{ V-sec}$$

So, $$\Delta\phi_{max} = 2\pi \times 2.5 \times 10^{3} \times 10 \times 10^{-3} \text{ rad}$$

$$= 50\pi \text{ rad}$$

103. (d)

$$I_{DC} = \frac{12.7-(4\times 0.7)}{9900} = 1 \text{ mA}$$



$$r_d = \frac{V_T}{I_{DC}} = \frac{25\,\text{mV}}{1\,\text{mV}} = 25\,\Omega$$

Total resistance of diode, $4r_d = 100\ \Omega$

$$V_{ac} = \frac{100\cos\omega t\times 10^{-3}\times 4r_d}{9900+4r_d}$$

$$= \frac{100\times 10^{-3}\times\cos\omega t\times 100}{9900+100} = 1\cos\omega t \text{ mV}$$

104. (b)

$$\text{Ripple factor} = \sqrt{\left(\frac{I_{\text{rms}}}{I_{dc}}\right)^2 - 1}$$

$$I_{\text{rms}} = \sqrt{\frac{1}{\pi}\int_0^{\pi} I_m^2 \sin^2\omega t\cdot d\omega t}$$

$$I_{\text{rms}} = \frac{I_m}{\sqrt{2}}$$

$$I_{\text{avg}} = \frac{1}{\pi}\int_0^{\pi} I_m \sin\omega t\cdot d\omega t = \frac{2I_m}{\pi}$$

$$\text{Ripple factor} = \sqrt{\left[\frac{\frac{I_m}{\sqrt{2}}}{\frac{2I_m}{\pi}}\right]^2 - 1} = 0.48$$

105. (a)

By applying KVL in base emitter loop,

$$-5 + I_B(200k) + 0.8 = 0$$

$$I_B = \frac{5-0.8}{200\times 10^3} = 21\ \mu\text{A}$$

$$I_C = \beta I_B = 100 \times 21 \times 10^{-6} = 2.1 \text{ mA}$$

$$R_C = \frac{10-0.2}{2.1\times10^{-3}} = 4667\ \Omega$$

106. (a)

By applying KVL in the base emitter loop,

$$-6 + 0.7 + [(\beta + 1)I_B \times R_E] = 0$$

$$\beta = \frac{5.3}{0.5\times10^{-3}\times530} - 1 = 19$$

By KVL in the collector emitter loop,

$$-10 + [19 \times 0.5 \times 10^{-3} \times 200] + V_{CE} + (20 \times 0.5 \times 10^{-3} \times 530) = 0$$

$$V_{CE} = 2.8 \text{ V}$$

108. (a)

$$I_B = \frac{V_{CC}-V_{BE}}{(\beta+1)R_E+R_B} = \frac{10-0.7}{101\times1+270}\times10^{-3}$$

$$= \frac{9.3}{371}\times10^{-3} \text{ A} = 25.06\ \mu\text{A}$$

now, $$I_{C(\text{sat})} = \frac{10}{2}\times10^{-3} = 5 \text{ mA}$$

$\therefore$ $$I_{C(\text{sat})} > \beta I_B$$

Hence, the transistor is in active mode.

109. (a)

$\because$ $$\left|\frac{dv_0(t)}{dt}\right|_{\max} = V_m(2\pi f_m)$$

for distortionless $$\left|\frac{dv_0(t)}{dt}\right|_{\max} \le SR$$

$$V_m \le \frac{10^6}{2\pi\times20\times10^3}$$

$$V_m \le 7.96 \text{ V}$$

110. (d)

$$I_B = \frac{V_B}{R_B} = \frac{1.3}{50}\times10^{-3} = 26\ \mu\text{A}$$

$$V_E = 1.3 + 0.7 = 2 \text{ V}$$

$$I_E = \frac{10-2}{10}\times10^{-3} = 0.8 \text{ mA}$$

$\therefore$ $$\beta + 1 = \frac{I_E}{I_B} = \frac{0.8}{26\times10^{-3}} = 30.77$$

$$\beta = 29.77$$

Now, $$\alpha = \frac{\beta}{1+\beta} = \frac{29.77}{30.77} = 0.968$$

111. (a)

$$\frac{dA_f}{A_f} = 0.2\% = \frac{0.2}{100}$$

$$dA = 150, \quad A = 2000$$

$$\therefore \quad \frac{dA_f}{A_f} = \frac{1}{1+A\beta} \cdot \frac{dA}{A}$$

$$\frac{0.2}{100} = \frac{1}{1+A\beta} \cdot \frac{150}{2000}$$

$$1 + A\beta = 37.5$$

$$A_f = \frac{A}{1+A\beta} = \frac{2000}{37.5} = 53.33$$

112. (d)

Using virtual short concept

$$V_+ = V_-$$

$$\therefore \quad I = \frac{V_1 - V_2}{1K} = \frac{4-6}{1K} = -2 \text{ mA}$$

As op-amp is ideal, input current to op-amp is zero.

$$V_0 = 3K(I)$$

$$= 3K(-2 \times 10^{-3})$$

$$V_0 = -6 \text{ V}$$

113. (b)

As $$R_s = S \times \text{Range} - \text{Internal resistance}$$

and $$S = \frac{1}{I_{fsd}} = \frac{1}{200\mu A} = 5 \text{ k}\Omega/\text{V}$$

The value of multiplier R_S is calculated as

$$R_S = S \times \text{Range} - \text{internal resistance}$$

$$= S \times V - R_m$$

$$= 5k \times 50 - 100$$

$$= 249.9 \text{ k}\Omega$$

114. (d)

$$R_x = \frac{C_1}{C_3} R_2 = \frac{0.5\mu F}{0.5\mu F} \times 2k = 2 \text{ k}\Omega$$

$$C_x = \frac{R_1}{R_2} C_3 = \frac{1k}{2k} \times 0.5 \mu F = 0.25 \mu F$$

The dissipation factor is given by,

$$D = \omega C_x R_x$$
$$= 2 \times \pi \times 1000 \times 2k \times 0.25\ \mu F$$
$$= \pi$$

115. (c)

Most oscilloscopes use electrostatic deflection, since it permits high frequency operation and requires negligible power. Electromagnetic deflection is most common in TV picture tubes.

116. (d)

All statements are correct.

117. (a)

Limitations of thermistor:

- Non-linearity in resistance vs temperature characteristics.
- Unsuitable for wide temperature range.
- Very low excitation current to avoid self heating.
- Need of shielded power lines, filters etc due to high-resistance.

118. (b)

We know, $$\text{Gauge factor} = 1 + 2v + \frac{\Delta\rho / \rho}{\in},$$

$$G_f = +3.6$$

If piezoresistive effect is neglected $G_f = 1 + 2v$

$$\text{Poisson's ratio, } v = \frac{G_f - 1}{2} = \frac{3.6 - 1}{2} = 1.3$$

120. (a)

An additional junction point in Anderson bridge increases difficulty of shielding for the bridge.

121. (d)

Given, $\int_{-1}^{1} t^2 \delta(3t+1) dt$

From the scaling property of impulse,

$$= \frac{1}{3} \int_{-1}^{1} t^2 \delta\left(t + \frac{1}{3}\right) dt$$

from sampling property of impulse,

$$= \frac{1}{3}\left[\left(-\frac{1}{3}\right)^2\right]$$

$$= \frac{1}{3} \times \frac{1}{9} = \frac{1}{27}$$

122. (c)

Given, $x[k] = j\,\delta[K-1] - j[K+1] + \delta[K+3] + \delta[K-3]$

We know that,

$$x(t) = \sum_{k=-\infty}^{\infty} x(k)e^{jk\omega_0 t}$$

Where, $\omega_0 = 2\pi$

$$\therefore \quad x(t) = \sum_{k=-\infty}^{\infty} x(k)e^{jk2\pi t} = -je^{j2\pi t} + je^{-j2\pi t} + e^{j6\pi t} + e^{-j6\pi t}$$

$$x(t) = 2(\cos 6\pi t - \sin 2\pi t)$$

123. (d)

Given,
$$\sum_{n=-\infty}^{\infty} x_1(n) = 8$$

$$\sum_{n=-\infty}^{\infty} x_2(n) = 12$$

$$\therefore \quad \sum_{n=-\infty}^{\infty} [x_1(n) * x_2(n)] = \sum_{n=-\infty}^{\infty} x_1[n] \cdot \sum_{n=-\infty}^{\infty} x_2[n]$$

$$= 8 \times 12 = 96$$

124. (d)

Given, $x[n] = 2\,\delta[n]$

$$Y(e^{j\omega}) = 3X(e^{j\omega}) - \frac{dX(e^{j\omega})}{d\omega}$$

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

$$\therefore \quad Y(e^{j\omega}) = 6 - 0 = 6$$

$$\therefore \quad y[n] = 6\,\delta[n]$$

125. (a)

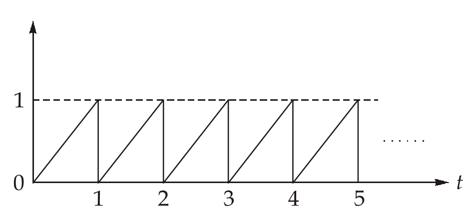
FIR filters are sometimes called "all zero" because of the poles are always located at $z = 0$.

126. (a)

$$x(t) = u(t) - \delta(t-1) - \delta(t-2) - \delta(t-3) - \delta(t-4) \;.....$$

$$\int_{-\infty}^{t} x(t)\,dt = r(t) - u(t-1) - u(t-2) - u(t-3) \;.......$$

The integration of $x(t)$ is shown as



∴ From the figure,

$$\int_{-\infty}^{t} x(t)\,dt \Big|_{t=0.5} = 0.5$$

127. (d)

We know that,

$$e^{-a|t|} \leftrightarrow \frac{2a}{a^2+\omega^2}$$

From duality property,

$$\frac{2a}{a^2+t^2} \leftrightarrow 2\pi e^{-a|-\omega|} = 2\pi e^{-a|\omega|}$$

For $a = 2$,

$$\frac{4}{4+t^2} \leftrightarrow 2\pi e^{-2|\omega|}$$

$$\frac{2}{\pi(4+t^2)} \leftrightarrow e^{-2|\omega|}$$

128. (a)

For signal $x(t)$ $\quad \omega_{NY} = NR = \omega_0$

∴ $\quad 2\omega_m = \omega_0$ (Let ω_m is highest frequency component in $x(t)$)

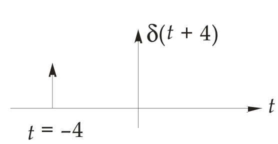
and $\quad Y(\omega) = j\omega\, X(\omega)$

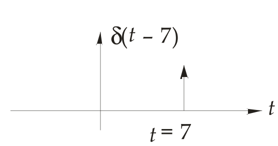
Maximum frequency component is decided by $X(\omega)$.

∴ $Y(\omega)$ will have maximum frequency component same as $X(\omega)$.

∴ $$\text{NR of } y(t) = 2\times\omega_m = 2\times\frac{\omega_0}{2} = \omega_0$$

129. (d)





∴ $\quad \delta(t+4)\cdot\delta(t-7) = \text{zero}$

130. (d)

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

$$\frac{X(z)}{z} = \frac{1}{(z-1)(z-2)} = \frac{A}{(z-1)} + \frac{B}{(z-2)}$$

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

Inverse Z.T $\quad x(n) = -u(n) + 2^n u(n) \quad \text{ROC: } |z| > 2$

131. (a)

$6(13 \times 11 - 4 \times 37) - 3(32 \times 11 - 10 \times 37) + 7(32 \times 4 - 10 \times 13)$

$= -30 + 54 - 14$

$= 10$

132. (d)

$$I = \int_{-2}^{2} |1 - x^4| dx$$

The given function is an even function i.e,

$$f(x) = f(-x)$$

$$I = 2\int_{0}^{2} |1 - x^4| dx = 2\left\{\int_{0}^{1} (1 - x^4)dx + \int_{1}^{2} (x^4 - 1)dx\right\}$$

$$= 2\left\{\left[x - \frac{x^5}{5}\right]_0^1 + \left[\frac{x^5}{5} - x\right]_1^2\right\}$$

$$= 2\left\{\left[1 - \frac{1}{5}\right] + \left[\frac{32}{5} - 2\right] - \left[\frac{1}{5} - 1\right]\right\}$$

$$= 2 \times \left\{\frac{4}{5} + \frac{22}{5} + \frac{4}{5}\right\} = 12$$

133. (a)

$$\frac{dx}{dy} = \frac{1}{x(1+y^2)}$$

$$\int \frac{dy}{1+y^2} = \int x\, dx$$

$$\tan^{-1} y = \frac{x^2}{2} + K$$

$$y = \tan\left(\frac{x^2}{2} + K\right)$$

134. (c)

$$P(x = r) = \frac{e^{-\lambda} \cdot \lambda^r}{r!}, \qquad \text{where } \lambda = np$$

$$\lambda = 500 \times 0.006 = 3$$

$$P(x \le 1) = P(x = 0) + P(x = 1)$$

$$= \frac{e^{-\lambda} \cdot \lambda^0}{0!} + \frac{e^{-\lambda} \cdot \lambda^1}{1!}$$

$$= e^{-3} + e^{-3} \cdot 3 = 4e^{-3}$$

135. (a)

To obtain maximum value of $f(x)$, first $f'(x)$ should be equated to zero

$$f'(x) = 6x^2 - 6x - 36 = 0$$

$$x^2 - x - 6 = 0$$

$$(x - 3)(x + 2) = 0$$

$$f'(x) = 0 \text{ at } x = 3 \text{ and } -2$$

Now, $$f''(x) = 12x - 6$$

$$f''(3) = 30 > 0$$

at $x = 3$, there is local minima and

$$f''(2) = -30 < 0$$

$\therefore$ at $x = -2$, a local maxima is observed.

137. (d)

$$\text{Nullity of } A = \text{No. of Columns of } A - \rho(A)$$

If Nullity of $A \neq 0$ then $\rho(A) <$ order of A

$\therefore$ $$\det A = 0$$

$\Rightarrow \rho(A) < n.$

136. (d)

$$A \cdot \vec{V} = \lambda \cdot \vec{V}$$

$$\begin{bmatrix} \omega & 2 & x \\ 1 & -3 & 0 \\ y & -1 & z \end{bmatrix} \begin{bmatrix} 4 \\ 4 \\ 1 \end{bmatrix} = \lambda \cdot \begin{bmatrix} 4 \\ 4 \\ 1 \end{bmatrix}$$

$$\begin{bmatrix} P \\ -8 \\ q \end{bmatrix} = \lambda \cdot \begin{bmatrix} 4 \\ 4 \\ 1 \end{bmatrix} \qquad (P \text{ and } q \text{ are unknown})$$

$$4 \cdot \lambda = -8$$

$$\lambda = -2$$

138. (a)

$E_1 \rightarrow$ Event of selection of fair win $P(E_1) = \frac{1}{3}$

$E_2 \rightarrow$ Event of selection of two headed coin $P(E_2) = \frac{2}{3}$

$A \rightarrow$ Event of getting both times head

We require,

$$P(E_2/A) = \frac{P(E_2)P(A/E_2)}{P(E_1)P(A/E_1)+P(E_2)P(A/E_2)}$$

$$= \frac{\frac{1}{3}\times 1\times 1}{\left(\frac{2}{3}\times\frac{1}{2}\times\frac{1}{2}\right)+\left(\frac{1}{3}\times 1\times 1\right)} = \frac{2}{3}$$

139. (c)

$$\frac{df}{dx} = \cos|x| \times \frac{|x|}{x}$$

at $x = \frac{-\pi}{4}$

$$\frac{df}{dx} = \cos\left|\frac{-\pi}{4}\right| \times -1 = \frac{-1}{\sqrt{2}}$$

140. (a)

$$\nabla\phi = y^2 i + (2xy + z^3)\, j + 3yz^2 k$$

$$\nabla\phi|_{(2,-1,1)} = i - 3j - 3k$$

Given, $\vec{n} = i + 2j + 2k,$

$$\hat{n} = \frac{i+2j+2k}{3}$$

$\therefore$ Directional derivative $= (\nabla\phi)_p \cdot \hat{n} = \frac{1}{3}(1-6-6) = \frac{-11}{3}$

141. (b)

$$\frac{\sin z}{z^3} = \frac{1}{z^3}\left[z - \frac{z^3}{3!} + \frac{z^5}{5!}......\right]$$

$$= \frac{1}{z^2} - \frac{1}{3!} + \frac{1}{5!}z^2.......$$

$\therefore$ $z = 0$ is a pole of order 2.

143. (b)

$$A \odot B \odot C = A \oplus B \oplus C$$

144. (d)

The discrete time convolution follows associative commutative and distributive properties.

145. (a)

In CSI thyristor is subjected to large reverse voltage upto –V. Hence GTO cannot be used in CSI.

146. (a)

The reactance of bundle conductors is reduced because the self GMD of the conductors is increased and as we know reactance = $K \ln \frac{\text{GMD}}{\text{GMR}}$ and as GMR is increased the reactance is reduced.

Self GMD is also called as geometrical mean radius (GMR).

147. (a)

Due to positive temperature coefficient of resistance, MOSFETs are best suitable for parallel operation.

148. (b)

For parallel resonance circuit,

$$Q = R\sqrt{\frac{C}{L}} \text{ and } \omega = \frac{1}{\sqrt{LC}}$$

So, Q increases as R increases.

149. (c)

Addition of open loop poles shifts the root locus towards the imaginary axis and the system response becomes more oscillatory.

150. (a)

The power factor angle,

$$\phi = \cos^{-1}(\text{p.f.})$$

As power factor decreases, power factor angle increases and since,

angular deflection $\theta \propto VI\cos\phi$

$$\theta \to 0 \text{ as pf decreases.}$$

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