DETAILED SOLUTIONS

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ESE 2020 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 22

Full Syllabus Test 6 : Paper-II

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

DETAILED EXPLANATIONS

1. (a)

$$\text{Damping factor, } \alpha = \frac{R_1}{2L_1} s^{-1}$$

$$= \frac{1000}{2 \times 10 \text{ mH}} = 50000\ s^{-1}$$

2. (a)

Let I_0 be the final steady-state current,

$$i = I_0\left(1 - e^{-\frac{t}{\tau}}\right)$$

At $t = 1$ sec, $\quad i = 0.741\ I_0$

$$\therefore \quad 0.741\ I_0 = I_0\left(1 - e^{-\frac{1}{\tau}}\right)$$

or, $\quad 1 - e^{-\frac{1}{\tau}} = 0.741$

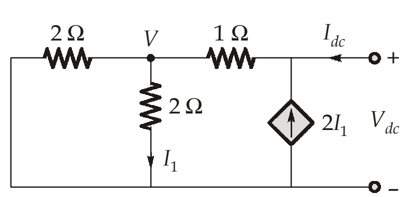
or, $\quad e^{-\frac{1}{\tau}} = 0.259$

$$\text{During decay, } i = I_0 e^{-\frac{t}{\tau}}$$

At $t = 1$ sec, $\quad i = I_0 e^{-\frac{1}{\tau}} = 0.259\ I_0$

3. (b)

To find R_N, let us connect a constant voltage source V_{dc} across the terminals A - B and deactivate the 8 V voltage source



$$\frac{V - V_{dc}}{1} + \frac{V}{2} + \frac{V}{2} = 0$$

or $\quad V = \frac{V_{dc}}{2}$

$$\frac{V_{dc} - V}{1} = 2I_1 + I_{dc} = 2 \times \frac{V}{2} + I_{dc}$$

$$V_{dc} = 2\text{ V} + I_{dc}$$

and $$I_{dc} = 0$$

$\therefore$ $$R_N = \frac{V_{dc}}{I_{dc}} = \infty$$

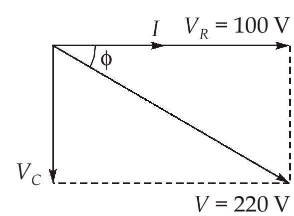
as $$R_{TH} = \infty$$

Thevenin equivalent does not exist.

4. (b)

$$\text{Power factor} = \cos\phi = \frac{V_R}{V} = \frac{100}{220} = 0.454 \text{ (leading)}$$

Alternative Solution:



$$\cos\phi = \frac{100}{220} = 0.45 \text{ (lead)}$$

5. (c)

At resonance, $$20 + R = \frac{25}{0.5} = 50$$

$$R = 30\ \Omega$$

6. (a)

$$L_2 = \frac{N_2\phi_2}{i_2} = \frac{1700\times 0.8\times 10^{-3}}{6} = 0.226\text{ H}$$

$$K = \frac{\phi_{21}}{\phi_2} = \frac{0.5\times 10^{-3}}{0.8\times 10^{-3}} = 0.625$$

Since self inductance $\propto N^2$

$$\frac{L_2}{L_1} = \frac{N_2^2}{N_1^2}$$

$$L_1 = \frac{N_1^2}{N_2^2}\times L_2 = \left(\frac{600}{1700}\right)^2 \times 0.226 = 0.028\text{ H}$$

and $$M = K\sqrt{L_1L_2}$$

$$= 0.625\sqrt{0.028\times 0.226}$$

$$= 0.05\text{ H}$$

Alternative Solution:

$$M = \frac{N_1\phi_{\text{mutual}}}{i_2} = \frac{600\times 0.5\times 10^{-3}}{6}$$
$$= 100 \times 0.5 \times 10^{-3} = 0.05 \text{ H}$$

7. (a)

$$V_1 = h_{11}I_1 + h_{12}V_2$$
$$I_2 = h_{21}I_1 + h_{22}V_2$$
$$h_{11} = \left.\frac{V_1}{I_1}\right|_{V_2=0}$$
$$h_{21} = \left.\frac{I_2}{I_1}\right|_{V_2=0}$$

8. (a)

The total average power is the sum of the harmonic power,

$$P = \frac{1}{2}[25\times 12\cos 60° + 80\times 20\cos 45° + 40\times 15\cos 30°] = 900.50 \text{ W}$$

10. (a)

$$L_{eq} = 8 \text{ H} + 10 \text{ H} + 6 \text{ H} - 8 \text{ H} + 10 \text{ H}$$
$$= 26 \text{ H}$$

11. (a)

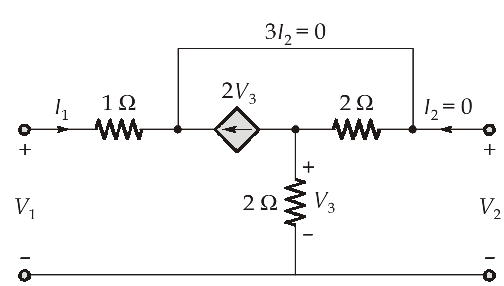
$$\text{Average value, } V_{av} = \frac{1}{2\pi}\left[\int_0^{\pi} V_m \sin\omega t\, d\omega t + \int_{\pi}^{2\pi} 0\, d(\omega t)\right] = 0.318\, V_m$$

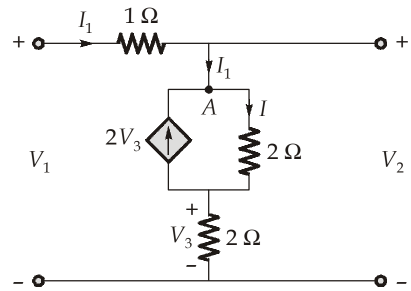
$$V_{\text{rms}}^2 = \frac{1}{2\pi}\int_0^{\pi}(V_m \sin\omega t)^2\, d\omega t = \frac{1}{4}V_m^2$$

$$V_{\text{rms}} = \frac{V_m}{2}$$

$$\text{Form factor} = \frac{V_{\text{rms}}}{V_{av}} = \frac{0.5V_m}{0.318V_m} = 1.572$$

12. (d)





By applying KCL at point A

$$I_1 + 2V_3 = I$$

and by applying KVL in outer loop,

$$V_1 = I_1 + 2(I_1 + 2V_3) + 2I_1$$

$$V_1 = 5I_1 + 4V_3$$

$\because$ $$V_3 = 2I_1$$

$\therefore$ $$V_1 = 5I_1 + 8I_1$$

$$\frac{V_1}{I_1} = 13\ \Omega$$

13. (a)

$$\rho_V = \nabla \cdot D = \frac{\partial D_z}{\partial z} = \rho \cos^2 \phi$$

At $\left(1, \frac{\pi}{4}, 3\right)$, $$\rho_V = 1 \cdot \cos^2\left(\frac{\pi}{4}\right) = 0.5\ \text{C/m}^3$$

The total charge enclosed by the cylinder,

$$Q = \int_v \rho_v dV = \int_v \rho \cos^2 \phi\, \rho d\phi\, d\rho\, dz$$

$$= \int_{z=-2}^{2} dz \int_{\phi=0}^{2\pi} \cos^2 \phi\, d\phi \int_{\rho=0}^{1} \rho^2 d\rho = 4(\pi)\frac{1}{3} = \frac{4\pi}{3} C$$

14. (b)

Electric flux density, $$D = \varepsilon E$$

Electric field intensity, $$E = \frac{D}{\varepsilon} = \frac{\frac{x}{4} \times 10^{-9}}{6 \times \frac{1}{36\pi} \times 10^{-9}}$$

At $x = \frac{1}{2}$, $$E = \frac{6\pi \times 10^{-9}}{4 \times 10^{-9}} \times \frac{1}{2}$$

$$E = \frac{3}{4}\pi \frac{\text{V}}{\text{m}}$$

15. (c)

$$\text{Divergence (Curl } \vec{A}) = 0$$

16. (c)

From boundary condition of dielectric-dielectric medium.

$$E_{t_1} = E_{t_2}$$

and $$D_{n_1} = D_{n_2}$$

$$\varepsilon_{r_1} E_{n_1} = \varepsilon_{r_2} E_{n_2}$$

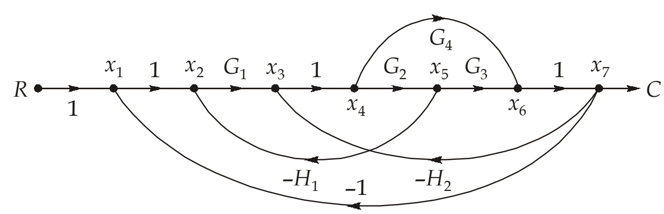
or $$E_{n_2} = \frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} E_{n_1}$$

$$= \frac{2}{8} \times 100 = 25 \text{ V/m}$$

$\therefore$ $$\vec{E}_2 = \left(25\hat{a}_x + 200\hat{a}_y - 50\hat{a}_z\right) \text{V/m}$$

17. (a)

Signal flow graph,



The forward paths and the gains associated with them are given as follows:

Forward path,

$$M_1 = G_1 G_2 G_3, \qquad \Delta_1 = 1$$

Forward path,

$$M_2 = G_1 G_4, \qquad \Delta_2 = 1$$

The loops and the gains associated with them are given as follows:

$$L_1 = -G_2 G_3 H_2$$
$$L_2 = -G_4 H_2$$
$$L_3 = -G_1 G_2 H_1$$
$$L_4 = -G_1 G_2 G_3$$
$$L_5 = -G_1 G_4$$

Applying Mason's gain formula, the transfer function is

$$\frac{C}{R} = \frac{M_1\Delta_1 + M_2\Delta_2}{\Delta}$$

$$\frac{C}{R} = \frac{G_1G_2G_3 + G_1G_4}{1 + G_2G_3H_2 + G_4H_2 + G_1G_2H_1 + G_1G_2G_3 + G_1G_4}$$

18. (d)

$$\frac{C(s)}{R(s)} = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} = \frac{8}{s^2 + 3s + 8}$$

$\therefore$
$$\omega_n^2 = 8$$
$$\omega_n = \sqrt{8} = 2.82$$
$$2\xi\omega_n = 3$$
$$\xi = \frac{3}{2\omega_n} = \frac{3}{2 \times 2.82} = 0.53$$

Since $\xi < 1$, it is an underdamped system.

19. (a)

The transfer function of the system is

$$\frac{V_0(s)}{V_i(s)} = \frac{\frac{1}{Cs}}{R + Ls + \frac{1}{Cs}} = \frac{1}{CLs^2 + RCs + 1}$$

$$= \frac{\frac{1}{LC}}{s^2 + \frac{R}{L}s + \frac{1}{LC}}$$

Comparing the above characteristic polynomial with $s^2 + 2\xi\omega_n s + \omega_n^2$

$$\omega_n = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10 \times 10^{-3} \times 0.01 \times 10^{-6}}} = 10^5 \text{ rad/sec}$$

$$2\xi\,\omega_n = \frac{R}{L}$$

$$\xi = \frac{R}{2}\sqrt{\frac{C}{L}} = \frac{1 \times 10^3}{2}\sqrt{\frac{0.01 \times 10^{-6}}{10 \times 10^{-3}}} = 0.5$$

20. (a)

For the given system, $G(s) = \dfrac{10}{s(s-1)(2s+3)}$

and $H(s) = 1$

The characteristic equation is

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

$$1 + \frac{10}{s(s-1)(2s+3)} = 0$$

$$2s^3 + s^2 - 3s + 10 = 0$$

$$\begin{array}{c|cc} s^3 & 2 & -3 \\ s^2 & 1 & 10 \\ s^1 & \dfrac{1\times(-3)-2\times 10}{1} = -23 & 0 \\ s^0 & \dfrac{-23\times 10 - 1\times 0}{-23} = 10 & \end{array}$$

There are two sign changes in the first column of the routh array. Hence there are two roots of the characteristic equation in the right half of the s-plane.

21. (b)

The characteristic equation is

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

$$\therefore \quad 1+\frac{K}{(s^2+2s+2)(s^2+6s+10)} = 0$$

i.e. $$s^4 + 8s^3 + 24s^2 + 32s + 20 + K = 0$$

The Routh table is as follows:

$$\begin{array}{c|ccc} s^4 & 1 & 24 & 20+K \\ s^3 & 8 & 32 & \\ s^2 & 20 & 20+K & \\ s^1 & \dfrac{480-8K}{20} & 0 & \\ s^0 & 20+K & & \end{array}$$

For stability, all the elements in the first column of the Routh array must be positive

$$480 - 8K > 0$$
$$K < 60$$

The marginal value of K for stability is $K_m = 60$

$$20s^2 + 20 + K_m = 0$$
$$20s^2 = -80$$
$$s = \pm j2$$
$$\omega = 2 \text{ rad/sec}$$

22. (a)

$$G(j\omega) = \frac{1}{j\omega(1+j\omega)(1+j2\omega)} = \frac{1}{-3\omega^2 + j\omega(1-2\omega^2)}$$

At the phase crossover frequency ω_p, the imaginary part of the $G(j\omega)$ is zero. Hence put $\omega = \omega_p$ in the imaginary part and equate it to zero to solve from ω_p.

$$\omega_p(1-2\omega_p^2) = 0$$

$$\omega_p^2 = \frac{1}{2}$$

$$\omega_p = 0.707 \text{ rad/sec}$$

23. (a)

For the given system matrix-A

$$[sI - A] = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} s-1 & -1 \\ 0 & s-1 \end{bmatrix}$$

$$\therefore \quad \phi(s) = [sI - A]^{-1} = \frac{\text{adj}[sI - A]}{[sI - A]} = \frac{\begin{bmatrix} s-1 & 1 \\ 0 & s-1 \end{bmatrix}}{(s-1)^2}$$

$$L^{-1}[\phi(s)] = L^{-1}\begin{bmatrix} \frac{1}{s-1} & \frac{1}{(s-1)^2} \\ 0 & \frac{1}{s-1} \end{bmatrix} = \begin{bmatrix} e^t & te^t \\ 0 & e^t \end{bmatrix}$$

24. (d)

The transfer function of the PI controller is

$$G_c(s) = K_p + \frac{K_I}{s}$$

25. (a)

The characteristics equation is

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

$$\therefore \quad 1 + \frac{K}{s(s+6)^2} = 0$$

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

$$K = -s(s + 6)^2 = -s(s^2 + 12s + 36) = -(s^3 + 12s^2 + 36s)$$

$$\frac{dK}{ds} = -(3s^2 + 24s + 36)$$

$$\frac{dK}{ds} = -3(s + 2)\,(s + 6)$$

Put, $$\frac{dK}{ds} = 0$$

$$s_1 = -2,\ s_2 = -6$$

$s = -2$ is the breakaway point.

26. (c)

Phonons obey Bose - Einstein distribution. This is because phonons are bosonic particles.

27. (d)

Energy stored in a capacitor, $$E = \frac{1}{2}CV^2$$

So, $$E \propto C$$

Also, $$C = \frac{\varepsilon A}{d}; \qquad C \propto \varepsilon$$

Hence $E \propto \varepsilon$

$\therefore$ As energy stored is increased by 4 times, the dielectric constant of the materials is 4.

28. (a)

Type-1 superconductors are diamagnetic in nature.

30. (d)

Semiconductor have negative temperature coefficient of resistivity over a part of temperature range.

It depends strongly upon illumination and decreases as the illumination increases.

It depends on the intensity of the applied electric field.

31. (d)

$$H_C = H_0\left(1-\left(\frac{T}{T_c}\right)^2\right)$$

$$\frac{H_C}{H_0} = 1-\left(\frac{T}{T_C}\right)^2$$

$$\frac{T}{T_C} = \sqrt{1-\frac{H_C}{H_0}}$$

$$T_C = \frac{T}{\sqrt{1-\frac{H_C}{H_0}}} = \frac{8}{\sqrt{1-\frac{1.1\times10^5}{2.2\times10^5}}} = \frac{8}{\sqrt{1-\frac{1}{2}}}$$

$$T_C = \frac{8}{\sqrt{\frac{1}{2}}} = 8\sqrt{2}\,\text{K}$$

32. (c)

$$B = \mu_0(H+M)$$

$$B = 0 \quad \text{for superconductors}$$

$$\therefore \quad 0 = \mu_0(H+M)$$

$$H = -M$$

$$\therefore \quad \chi = \frac{M}{H} = -1$$

$$\therefore \quad \mu_r = \chi + 1 = -1 + 1 = 0$$

33. (a)

Soft ferrites are used in the construction of cores of transformers and inductors. Rectangular loop ferrites are used for data storage.

34. (d)

We know,

$$\text{Mobility of electrons, } \mu_e = \frac{e\tau}{m}$$

Where, τ : relaxation time of electron
e : charge on a electron
m : mass of electron

$$\mu_e = \frac{1.6\times10^{-19}\times9.1\times10^{-14}}{9.1\times10^{-31}} = 1.6\times10^{-2}\ \text{m}^2\ \text{V}^{-1}\ \text{sec}^{-1}$$

$$\text{Average drift velocity, } v = \frac{e\tau}{m}\cdot E = 1.6\times10^{-2}\times1\times10^{2} = 1.6\ \text{m/sec}$$

Where, E : applied electric field.

35. (b)

Given,

$$E_f\angle\delta = V\angle0° + I_a\angle\phi\ Z_s\angle\phi$$
$$= 200 + 10\angle90°1\angle90°$$
$$= 200 - 10 = 190\ \text{V}$$

$$\text{Voltage regulation} = \frac{|E_f|-|V|}{|V|} = \frac{190-200}{200} = \frac{-10}{200}\times100 = -5\%$$

36. (c)

For given generator,
$$2R_A = \frac{V_{DC}}{I_{DC}}$$

or
$$R_A = \frac{V_{DC}}{2I_{DC}} = \frac{10\text{V}}{2\times25} = 0.2\ \Omega$$

Given internal generated voltage at rated field current,
$$E_A = 300\ \text{V}$$

Short circuit current,
$$I_A = 200\ \text{A}$$

The synchronous reactance at the rated field current,

$$\frac{E_A}{I_A} = \sqrt{R_a^2+X_s^2}$$

$$\frac{300}{200} = \sqrt{(0.2)^2+X_s^2}$$

$$\sqrt{(0.2)^2+X_s^2} = 1.5\ \Omega$$

$$0.04 + X_s^2 = 2.25$$

$$X_s^2 = 2.25 - 0.04$$

$$= 2.21 = 1.48\ \Omega$$

37. (c)

Reliability factor for the power system is more for several generators as compared to single generator system.

38. (b)

For a 6 pole machine,

$$f = \frac{PN}{120} = \frac{6 \times 1000}{120} = 50 \text{ Hz}$$

Given slip frequency, $sf = 2$ Hz

$\therefore$ $s = \frac{2}{50} = 0.04$

In case of induction motor,

Synchronous speed, $N_s = \frac{120f}{P} = \frac{120 \times 50}{10} = 600$ rpm

$$N_r = N_s(1 - s)$$
$$= 600\,(1 - 0.04) = 576 \text{ rpm}$$

39. (c)

The voltage equation is given as

$$V = \sqrt{2}\pi \times f \times \phi \times N$$
$$= \sqrt{2}\pi f \times B_m \times A \times N$$

Initial current, I and kVA rating $= VI$ kVA = old kVA

As f, N, B_m are constant values only variable is area of cross section of core and conductor. The linear dimension of core becomes four times

$\therefore$ Area of cross section becomes 16 times of first transformer,

$$V' = \sqrt{2}\pi \times f \times B_m \times 16A_C N = 16 \text{ V}$$

linear dimension of conductor becomes 4 times

Area of cross section of conductor becomes 16 times

Now for constant current density, $I = Ja_{cu}$

$$I' = J16\,a_{cu} = 16I$$

$\therefore$ New kVA $= V'I' = 256$

$$\frac{\text{New kVA}}{\text{Old kVA}} = 256$$

40. (d)

We know voltage equation, $V = \sqrt{2}\pi f \times B_m \times A_c \times N$

$$B_m = \frac{V}{\sqrt{2}\pi f\, A_C N}$$

As linear dimension of core is tripled. Now area of cross section becomes 9 times the initial value. No. of turns is reduced to one third and input voltage is also increased to 3 times i.e. 600 V

$$B'_m = \frac{3V}{\sqrt{2}\pi f 9A_C \times \frac{N}{3}}$$

$$B_m = B'_m$$

The flux density remains same.

41. (b)

Given, 4 pole, 50 Hz, 3-ϕ IM, N_S = 1500 rpm

$$r_2 = 0.3\ \Omega$$

$$T_{max} = 24 \text{ N-m at 1200 rpm}$$

Slip at maximum torque, $$\frac{N_s - N_r}{N_s} = \frac{1500-1200}{1500} = \frac{300}{1500} = \frac{1}{5} = 0.20 = s_{max,\,T}$$

$$s_{max,\,T} = \frac{r_2}{x_2}$$

$$x_2 = \frac{r_2}{s_{max,T}} = \frac{0.3}{\frac{1}{5}} = 1.5\,\Omega$$

42. (c)

When induction motor is delta connected

$$(I_L)_\Delta = \sqrt{3}(I_P)_\Delta$$

When the connection is star, $(I_L)_Y = (I_P)_Y$

and starting torque, $T_{st} \propto (I_{st})^2$

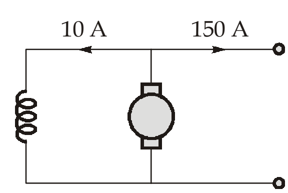
$$\frac{(T_{st})_Y}{(T_{st})_\Delta} = \left(\frac{I_P}{\sqrt{3}I_P}\right)^2$$

$$(T_{st})_Y = \frac{1}{3}\frac{I_p^2}{I_p^2}\times(T_{st})_\Delta = \frac{1}{3}\times 150 = 50 \text{ Nm}$$

43. (c)

Demagnetizing ampere turns can be expressed as

$$(\text{AT})_{demag} = \left(\frac{I_a}{A}\right)\times\left(\frac{Z}{2P}\right)\times\frac{2\beta}{180}$$



Armature current, I_a = 150 + 10 = 160 A

For lap connection = $A = P = 4$

$$(AT)_{demag} = \frac{160}{4}\times\frac{492}{2\times 4}\times\frac{2\times 10}{180^\circ} = 273.33 \text{ AT}$$

44. (b)

Given, ohmic loss = x%

reactance drop = 5%

Also, % ohmic loss = % ohmic voltage drop

$$\% \text{ resistance drop } (V_r) = 0.01x$$
$$\% \text{ reactance drop } (V_x) = 0.05$$

Voltage regulation for lagging power factor

$$\cos\phi = 0.8$$

and $\sin\phi = 0.6$

$$\text{V.R.} = V_r\cos\phi + V_x\sin\phi$$
$$4.8 = [(0.01)x \times (0.8) + 0.05 \times 0.6] \times 100$$

or $0.048 - 0.03 = (0.01)x \times 0.8$

$$0.018 = (0.01)x \times 0.8$$
$$x = 2.25$$

45. (d)

All given statements are correct.

46. (d)

For DC shunt motor,

$$I_f = \frac{V}{R_f}$$

or $\phi = K'V$ as $\left[\frac{1}{R_f} = \text{constant}\right]$

Also, $V = E_b$ (As motor is lossless)

$$V = K\phi N$$

$$N = \frac{V}{K\phi} = \frac{V}{KK'V} = \frac{1}{KK'}$$

∴ Speed remains constant irrespective of voltage.

47. (c)

Spatial locality of reference says that once a location is referenced then there is a high probability that a nearby location will be referenced soon.

Hence option (c) is correct.

48. (a)

a = .5 , b = .7 then the second 'if' becomes false it goes to 'else' portion hence the result is "PSU".

49. (a)

Decimal number is 3.248×10^4 i..e 32480

in binary ⇒ $(111111011100000)_2$

i.e. $[1.11111011100000] \times 2^{14}$

Biased exponent = Actual exponent + bias value

In 32 bit single precision format, bias value = 127

Hence biased exponent = 14 + 127 = 141

Since,positive number, hence sign bit = 0

Representation:

Sign	Biased exponent	Mantissa
1 bit	8 bits	23 bits

i.e.

0	10001101	11111011100000000000000

50. **(c)**

Booth's algorithm is used for floating point multiplication. It is multiplication algorithm that multiplies two signed binary numbers in 2's compliment notation.

51. **(a)**

Since the integer is an unsigned integer, hence, the range will be [0 to $2^{16} - 1$].

52. **(d)**

Time sharing system or multitasking OS provides disk management, file system management as well as enable concurrent execution.

53. **(b)**

$$\text{Speed up} = \frac{t_n}{t_p} = \frac{CPI_n \times \#\,\text{instruction} \times \text{Cycle time}_n}{CPI_P \times \#\,\text{instruction} \times \text{Cycle time}_p}$$

$$4 = \frac{CPI_n \times (1+2+3+4+5)}{1 \times (5)}$$

$$CPI_n = \frac{20}{15} = \frac{4}{3} = 1.33$$

54. **(c)**

Firmware is a software program or set of instructions programmed on a hardware device. It provides the necessary instructions for, how the device communicates with other computer hardware.

55. **(c)**

Run off River, wind farm and nuclear power plants are base load power plants. Gas turbine, pumped storage plant and diesel power plants are suitable for supplying peak loads.

56. **(d)**

The hole in the dielectric will affect the breakdown voltage as the dielectric strength in certain path will become less and it will not be able to withstand actual value of breakdown voltage.

57. **(b)**

When the fault will occur at bus-2 then to disconnect the bus-2 from bus-1, bus-3 and bus-4 we will operate *E*, *F*, *G* circuit breaker.

58. (d)

By using bundled conductors, self GMD of conductor increases.

$$C = \frac{2\pi\varepsilon}{\ln\left(\frac{\text{GMD}}{\text{GMR}}\right)}$$

- As GMR increases, the capacitance increases and inductance decreases.
- Corona reduces.
- Interference is reduced.

59. (a)

$$E' = (2 \times 15) \times \left(\frac{350}{350 + 30}\right) = 27.63 \text{ kV}$$

60. (c)

As $\delta_S > \delta_L$, active power flows from source to load,

$$Q_1 = \frac{|V_1|}{X}\left[|V_1| - |V_2|\cos\delta\right]; \quad Q_1 > 0$$

$$Q_2 = \frac{|V_2|}{X}\left[|V_1|\cos\delta - |V_2|\right]; \quad Q_2 < 0$$

$\therefore$ both source and load delivers reactive power to line.

61. (b)

Metallic sheath prevent moisture from entering dielectric so that dielectric strength is maintained.

62. (c)

String efficiency is independent of frequency. It only depends on the ratio of shunt capacitance between disc and ground to mutual capacitance between the discs.

63. (d)

Since the load is nearer to plant-2 and hence the transmission loss is only dependent on power generated by plant-1.

$$L_1 = \frac{1}{1 - \frac{dP_L}{dP_{G1}}} \neq 1, \qquad \left[\frac{dP_L}{dP_{G1}} \neq 0\right]$$

$$L_2 = \frac{1}{1 - \frac{dP_L}{dP_{G2}}} = 1, \qquad \left[\frac{dP_L}{dP_{G2}} = 0\right]$$

64. (c)

$$t_c = \sqrt{\frac{2M(\delta_c - \delta_0)}{P_s}}$$

$$\Rightarrow \quad t_c \propto \frac{1}{\sqrt{P_s}}$$

If mechanical input is doubled operation time of C.B. becomes 0.707 × 0.2 = 0.1414 i.e. less than 0.2.

65. (d)

$$\text{Order of Jacobian} = (2n - m - 2) \times (2n - m - 2)$$
$$= (2 \times 183 - 32 - 2) \times (2 \times 183 - 32 - 2)$$
$$= 332 \times 332$$

66. (c)

$$V = i\sqrt{\frac{L}{C}}$$
$$= 13\sqrt{\frac{1}{0.01 \times 10^{-6}}} = 130 \text{ kV}$$

67. (a)

$$Z_C = \sqrt{\frac{L}{C}}$$

For 40% compensation, $Z_{C2} = \sqrt{0.6}Z_{C1}$

$$\text{SIL}_2 = \frac{SIL_1}{\sqrt{0.6}}$$
$$\% \text{ increment in SIL} = \frac{SIL_2 - SIL_1}{SIL_1} = \left(\frac{1}{\sqrt{0.6}} - 1\right) \times 100 = 29.09\%$$

68. (d)

$$g_m = \left.\frac{\partial I_d}{\partial V_{GS}}\right|_{V_{DS}} = \frac{\partial K}{\partial V_{GS}}(V_{GS} - V_T)^2$$
$$= 2K\,(V_{GS} - V_T)$$

69. (c)

Due to presence of fixed positive charge, even though no voltage is applied a very narrow channel of –ve charge (attracted by +ve charge present in gate oxide) will exist in MOSFET. Hence now the channel inversion point occurs at some lower voltage and hence threshold voltage will decreases.

70. (a)

$$\text{lower 3 dB frequency, } \omega_C = \frac{1}{(R_C + R_L)C_C}$$
$$= \frac{1}{10 \times 10^3 \times 0.1 \times 10^{-6}} = 1 \text{ Krad/sec}$$

71. (a)

The characteristics of emitter follower is

1. Voltage gain being less than unity.
2. High input impedance.
3. High current gain.
4. Low output impedance.

72. (d)

$$g_{m1} = \frac{I_{c1}}{V_{BE}},$$

$$g_{m2} = \frac{I_{c2}}{V_{BE}}$$

Overall transconductance, $$g_m = \frac{I_c}{V_i} = \frac{I_{c1} + I_{c2}}{2V_{BE}} = \left(\frac{g_{m1} + g_{m2}}{2}\right)$$

73. (c)

Given,

$$I_L = 10 \text{ mA},$$
$$V_0 = 10 \text{ V}$$
$$V_{in} = 30 \text{ V to } 50 \text{ V}$$
$$V_Z = 10 \text{ V}$$
$$I_{Z\,min} = 1 \text{ mA}$$
$$I_{min} = I_{Z\,min} + I_L = 11 \text{ mA}$$
$$11 \times 10^{-3} = \frac{30 - V_Z}{R}$$

$\Rightarrow$ $$R_{max} = \frac{30 - 10}{11 \times 10^{-3}} = \frac{20 \times 10^3}{11}$$

$\Rightarrow$ $$R_{max} = 1818 \ \Omega$$

$\Rightarrow$ $$R \leq 1818 \ \Omega$$

74. (d)

For case-1,

$$V_i < -1.7 \text{ V}$$
$$D_1 \rightarrow \text{ON and } D_2 \rightarrow \text{OFF},$$
$$V_0 = -1.7 \text{ V}$$

For case-2:

$$-1.7\ V < V_i < 2.7 \text{ V}$$
$$D_1 \rightarrow \text{OFF and } D_2 \rightarrow \text{OFF},$$
$$V_0 = V_i$$

For case-3:

$$V_i > 2.7 \text{ V}$$
$$D_1 \rightarrow \text{OFF and } D_2 \rightarrow \text{ON},$$
$$V_0 = 2.7 \text{ V}$$

75. (c)

Current mirror has high output AC resistance.
Practical op-amp behaves as low pass filter.
In self bias circuit, base voltage is less than the supply voltage.

76. (c)

∵ The given circuit is a voltage doubler circuit

$$\therefore \quad V_{C_1} = V_m$$

$$V_{C_2} = 2V_m$$

$$\therefore \quad \frac{V_{C_1}}{V_{C_2}} = \frac{V_m}{2V_m} = \frac{1}{2} = 0.5$$

77. (a)

Applying KCL at node-1

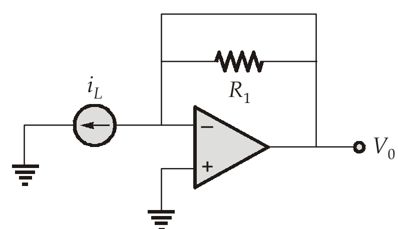
$$\frac{V_2 - V_1}{R} + \frac{V_2}{2R} + \frac{V_2 - V_0}{3R} = 0$$

$$\Rightarrow \quad \frac{6V_2 - 6V_1 + 3V_2 + 2V_2}{2} = V_0$$

$$\Rightarrow \quad V_0 = -3V_1 + \frac{11}{2}V_2$$

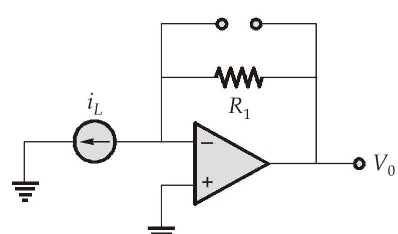
78. (c)

At ω = 0; $X_L = \omega L = \omega L = 0$



$$\therefore \quad V_0 = 0 \text{ V}$$

At ω = ∞; $X_L = \infty$



$$\therefore \quad V_0 = i_L R_1$$

Hence given circuit is high pass filter.

79. (c)

It is a half wave rectifier with op-amp,

When $V_i > 0$, D_2 ON, D_1 OFF

$$V_0 = 0$$

When $V_i < 0$, D_2 OFF, D_1 ON

$$V_0 = \frac{-R_2}{R_1} V_i$$

80. (b)

$$V_0 = A_{0L} V_d$$

$$V_0 = 10^3(-V_i)$$

$$3 - V_- = V_- - V_0$$

$$3 = 2V_- - V_0 = 2\left(\frac{-V_0}{10^3}\right) - V_0 = -V_0\left(1 + \frac{2}{10^3}\right)$$

$\Rightarrow$ $$V_0 = \frac{-3 \times 10^3}{10^3 + 2} = -2.994 \text{ V}$$

81. (d)

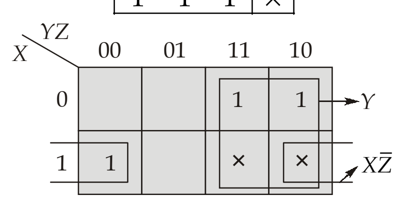
$$F = \bar{X}Y + X\bar{Y}\bar{Z}$$

$$= \bar{X}Y(Z + \bar{Z}) + X\bar{Y}\bar{Z}$$

$$= \bar{X}YZ + \bar{X}Y\bar{Z} + X\bar{Y}\bar{Z}$$

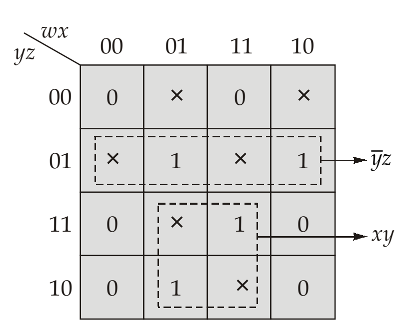
Truth table

X	Y	Z	F
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	×
1	1	1	×



$$F = Y + X\bar{Z}$$

82. (a)



Minimal SOP of the given *K*-map is $xy + \bar{y}z$

83. (c)

$$Y = \bar{A}\bar{B} + B\bar{C}$$

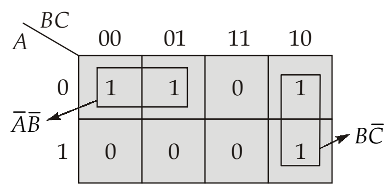
$$Z = Y + \bar{B}$$

$$= \bar{A}\bar{B} + B\bar{C} + \bar{B}$$

$$= \bar{B}(1+\bar{A}) + B\bar{C}$$

$$= \bar{B} + B\bar{C} = (\bar{B}+B)(\bar{B}+\bar{C})$$

$$Z = \bar{B} + \bar{C}$$



84. (b)

If Clk is –ve edge triggered then

up counter, if Q is connected to clk of next flip flop

down counter, if $\bar{Q}$ is connected to clk of next flip flop.

If Clk is +ve edge triggered then

up counter, if $\bar{Q}$ is connected to clk of next flip flop

down counter, if Q is connected to clk of next flip flop.

85. (a)

Source code is a program written either in mnemonics of an assembly language or in English in form of line statements of high level language.

86. (c)

The given program is used to find two's complement of any number.

Given data : 96 H

96 = 1001 0110 (binary form)

1's complement of above number = 0110 1001 = 69

∴ 2's complement of 96 H = +0000 0001

0110 1010 = 6 A

87. (b)

Stack pointer (sp) is 16-bit special function register.

LIFO is last in first out principle and hence its operation is faster compared to normal store/ retrieve of memory location.

88. (c)

'MOV r_1, r_2' instruction affects no flags.

89. (b)

ADI data : (Add immediate data to accumulator) and DAA : (Decimal adjust accumulator) affect all flags but 'LDAX Rp' and STA affects no flags.

91. (a)

$$(BW)_{FM} = \left(1+\frac{\Delta f}{f_m}\right)(2f_m) = \left(1+\frac{A_m k_f}{f_m}\right)(2f_m)$$

$$(BW)_{PM} = (1 + A_m k_p)\,(2f_m)$$

When only f_m is increased, $(BW)_{PM}$ will be increased by higher factor than that of $(BW)_{FM}$.

92. (b)

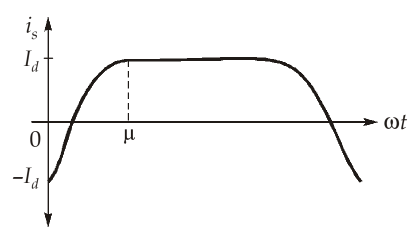
For AWGN channels,

Channel capacity,
$$C = B\log_2(1 + SNR)$$
$$= 5\log_2(1 + 15) \text{ Mbps}$$
$$= 5 \times 4 = 20 \text{ Mbps}$$

93. (d)

FM requires larger bandwidth compared to AM.

94. (b)



$$\int_0^{\mu} \sqrt{2}V_S \sin\omega t\, d\omega t = \int_{-I_d}^{I_d} \omega L_s\, di_s$$

$$\sqrt{2}V_s(1-\cos\mu) = \omega L_s(2I_d)$$

$$1 - \cos\mu = \frac{\sqrt{2}\omega L_s I_d}{V_s}$$

$$\mu = \cos^{-1}\left(1-\frac{\sqrt{2}\omega L_s I_d}{V_s}\right)$$

95. (c)

In unipolar voltage switching, the dominant harmonic voltages centered around m_f disappear, thus resulting in a significantly lower harmonic content.

96. (a)

$$V_0 = \frac{V_S}{(1-\alpha)}$$

$$(1 - \alpha) = \frac{12}{30}$$

$$\alpha = \frac{3}{5} = 0.6$$

$$I_0 = \frac{V_0}{R} = \frac{V_S}{(1-\alpha)R}$$

$$V_0 I_0 = V_S I_S$$

$$I_L = I_S = \frac{I_0}{(1-\alpha)} = \frac{V_S}{(1-\alpha)^2 R}$$

$$I_L = \frac{12}{(1-0.6)^2 \times 50} = 1.5 \text{ A}$$

97. (c)

$$\text{Input voltage} = \frac{V_s}{2} = 96$$

$$V_S = 192 \text{ V}$$

The 1st dominant harmonic is 3rd harmonic,

$$E_{03\,(\text{rms})} = \frac{\sqrt{2}V_s}{3\pi} = \frac{\sqrt{2}\times 192}{3\times\pi} = 28.81 \text{ V}$$

98. (b)

Fundamental frequency output voltage is same in both type of switching.

99. (d)

The high magnitude of current in a power diode leads to ohmic drop that hides the exponential part of *i-v* characteristics. The n^- region or drift region, forms a considerable drop in the ohmic resistance of power diodes.

100. (a)

For continuous conduction,

$$L_{\min} = \frac{D(1-D)^2 R}{2f}$$

$$D = \left(1 - \frac{V_S}{V_0}\right) = \left(1 - \frac{12}{30}\right) = 0.6$$

$$L_{\min} = \frac{0.6\times(1-0.6)^2}{2\times 25000}\times 50 = 96\ \mu\text{H}$$

101. (a)

$$V_0 = V_S\left(\frac{D}{1-D}\right)\frac{N_2}{N_1}$$

$$5 = 24\left(\frac{D}{1-D}\right)\times\frac{1}{3}$$

$$\left(\frac{1}{D} - 1\right) = \frac{8}{5}$$

$$D = \frac{5}{13}$$

103. (b)

A flyback converter is similar to buck-boost converter. So current waveform through diode is trapezoidal.

104. (b)

The meter uses a full wave rectifier circuit and it indicates a value of 2.22 V. The form factor for full wave rectified sinusoidal waveform is 1.11.

$\therefore$ Average value of voltage, $V_{av} = \dfrac{2.22}{1.11} = 2\text{ V}$

For a triangular wave shape, peak value of voltage

$$V_m = 2V_{av} = 4\text{ V}$$

rms value of voltage, $V = \dfrac{V_m}{\sqrt{3}} = \dfrac{4}{\sqrt{3}} = 2.31\text{ V}$

$\therefore$ $\%\text{ Error} = \dfrac{2.22 - 2.31}{2.31} \times 100 = -3.9\%$

105. (a)

In gravity-controlled instruments since controlling torque,

$$T_c \propto \sin\theta$$

$$T_d = T_c \text{ at equilibrium}$$

and $T_d \propto I^2$

$$\sin\theta \propto I^2$$

or $\dfrac{\sin\theta_2}{\sin\theta_1} = \left(\dfrac{I_2}{I_1}\right)^2$

or deflection for 5 A current, $\theta_2 = \sin^{-1}\left[\left(\dfrac{I_2}{I_1}\right)^2 \sin\theta_1\right]$

$$= \sin^{-1}\left[\left(\frac{5}{10}\right)^2 \times 1\right] = \sin^{-1}(0.25) = 14.5°$$

106. (a)

$$\cos\phi = \frac{V_3^2 - V_1^2 - V_2^2}{2V_1V_2}$$

$$= \frac{(300)^2 - (200)^2 - (180)^2}{2 \times 200 \times 180}$$

$$= \frac{90000 - 40000 - 32400}{72000} = 0.244 \text{ (lagging)}$$

107. (b)

Wattmeter reading, $W_1 = 20$ kW

Wattmeter reading, $W_2 = -5$ kW

$$\text{Power factor of the circuit} = \cos\phi = \frac{1}{\sqrt{1+\dfrac{3(W_1-W_2)^2}{(W_1+W_2)^2}}} = \frac{1}{\sqrt{1+\dfrac{3(25)^2}{(15)^2}}}$$

$$= \frac{\sqrt{3}}{\sqrt{28}} = 0.3273 \text{ lagging}$$

108. (b)

Meter constant = 5 A-s/rev

= 5 × 250 W-s/rev with rated voltage of 250 V

$$= \frac{5\times 250}{1000\times 3600}\text{kWh/rev} = \frac{1}{2880}\text{ kWh/rev}$$

Meter constant in terms of revolutions per kWh = 2880

Full load speed = Meter constant in rev/kWh × energy consumption in kWh/minute

$$= 2880\times\frac{1}{48} = 60 \text{ rpm}$$

109. (b)

Total resistance of the potentiometer,

R = Resistance of dial + resistance of slide wire

= 15 × 10 + 10 = 160 Ω

Working current, I = 10 mA = 0.01 A

Voltage range of the potentiometer = working current × total resistance of potentiometer

= 0.01 × 160

= 1.6 V

Voltage drop across slide-wire = Slide wire resistance × working current

= 10 × 0.01 = 0.1 V

Since slide-wire has 100 division, therefore, each division represented $\frac{0.1}{100}$ i.e. 0.001 V

As each division of slide-wire can be read accurately upto $\frac{1}{5}$ of its span, therefore,

$$\text{Resolution of potentiometer} = \frac{0.001}{5} = 0.0002 \text{ V}$$

110. (b)

The Maxwell's inductance bridge is limited to Q coils ($1 < Q < 10$)

111. (a)

A straight line results when the two voltages are equal and are either in phase with each other or 180° out of phase with each other.

112. (a)

$$\text{Length of plates, } l = 20 \text{ mm} = 0.02 \text{ m}$$
$$\text{Distance between plates, } d = 5 \text{ mm} = 0.005 \text{ m}$$

The distance between the screen and centre of plates

$$S = 0.20 \text{ m}$$
$$\text{Accelerating voltage, } V_a = 2500 \text{ V}$$
$$\text{Deflection sensitivity} = \frac{lS}{2dV_a} = \frac{0.02 \times 0.20}{2 \times 0.005 \times 2500} = 0.16 \text{ mm/V}$$

113. (b)

$$x(n) = \begin{cases} 1, & n = 1,2,3 \\ -1, & n = -1,-2,-3 \\ 0, & n = 0 \text{ and } |n| > 3 \end{cases}$$

$$x(n+3) = \begin{cases} 1, & n = 1-3, 2-3, 3-3 \\ -1, & n = -1-3, -2-3, -3-3 \\ 0, & n = 0-3 \text{ and } n > 3-3, n < -3-3 \end{cases}$$

$$x(n+3) = \begin{cases} 1, & n = -2,-1,0 \\ -1, & n = -4,-5,-6 \\ 0, & n = -3 \text{ and } n < -6, n > 0 \end{cases}$$

114. (c)

If $x(t)$ is an odd signal it's average value is definitely zero (Since area under first half cycle + Area under second half cycle = 0)

For even signal average value may be zero but not definitely zero.

115. (a)

$$x(n) = \underbrace{\{1, 2, \underset{\uparrow}{0}, 2, 1\}}_{\text{real + even}} + \underbrace{\{-j, 2j, \underset{\uparrow}{0}, -2j, j\}}_{\text{img + odd}}$$

DTFT of real + even signal is real + even

DTFT of img + odd signal is real + odd

∴ DTFT of $x(n)$ is purely real.

116. (c)

- The mapping from the $j\omega$-axis to the unit circle, $|z| = 1$ should be one to one and onto the unit circle in order to preserve the frequency response characteristics of the analog filter.
- Points in the left-half s-plane should map to points inside the unit circle to preserve the stability of the analog filter.

117. (c)

We can write,

$$\begin{aligned} g(n) &= x(n) - \alpha x(n-1) \\ &= \alpha^n u(n) - \alpha \cdot \alpha^{(n-1)} u(n-1) \\ &= \alpha^n u(n) - \alpha^n u(n-1) \\ &= \alpha^n [u(n) - u(n-1)] \\ &= \alpha^n \delta(n) = \delta(n) \end{aligned}$$

118. (c)

Property of Z-transform

$$x(n) \leftrightarrow X(z)$$

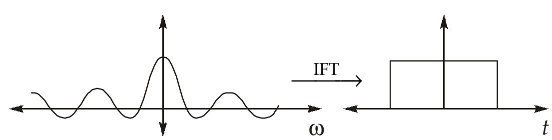
$$e^{-j\omega_0 n} x(n) \leftrightarrow X(e^{j\omega_0} z) \qquad \text{[Using property } a^n x(n) \leftrightarrow X(z/a)]$$

119. (b)

The transfer function of a system describes only zero-state response for the system.

120. (d)

Inverse Fourier transform of sin*c* function is rectangular function.



121. (a)

$$\text{The given determinant} = \begin{vmatrix} 1 & \omega & \omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix}$$

By $R_1 \to R_1 + R_2 + R_3$, we get

$$= \begin{vmatrix} 1+\omega+\omega^2 & 1+\omega+\omega^2 & 1+\omega+\omega^2 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix}$$

$$= \begin{vmatrix} 0 & 0 & 0 \\ \omega & \omega^2 & 1 \\ \omega^2 & 1 & \omega \end{vmatrix} = 0$$

122. (d)

The given equations are written in the matrix form as:

$$\begin{bmatrix} 2 & 1 & 2 \\ 1 & 1 & 3 \\ 4 & 3 & b \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$AX = 0$$

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

$R_1 \leftrightarrow R_2$

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

$R_2 \to R_2 - 2R_1$

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 0 & -1 & -4 \\ 4 & 3 & b \end{bmatrix}$$

$R_3 \to R_3 - 4R_1$

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 0 & -1 & -4 \\ 0 & -1 & b-12 \end{bmatrix}$$

$R_3 \to R_3 - R_2$

$$A = \begin{bmatrix} 1 & 1 & 3 \\ 0 & -1 & -4 \\ 0 & 0 & b-8 \end{bmatrix}$$

For non trivial solution,

$$\text{Rank of } A < \text{Number of unknowns}$$

$$b - 8 = 0$$

$$b = 8$$

Alternate Solution:

$$|A| = 0$$

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

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

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

$$b = 8$$

123. (b)

$$\left(\frac{1+i}{1-i}\right)^n = 1$$

$$\left(\frac{1+i}{1-i}\times\frac{1+i}{1+i}\right)^n = 1$$

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

$$(i)^n = 1$$

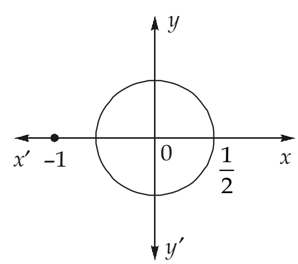
$$n = 4$$

124. (a)

Poles of the integrand are given by putting the denominator equal to zero

$$z+1 = 0$$

$$z = -1$$



The given circle $|z| = \frac{1}{2}$ with centre at $z = 0$ and radius $\frac{1}{2}$ does not enclose any singularity of the given function.

$$\int_C \frac{3z^2+7z+1}{z+1}dz = 0$$

125. (d)

There are three ways of selecting 1 girl and 2 boys.

I-way :

Girl is selected from first group, boy from second group and another boy form third group.

Probability of the selection of (girl + boy + boy)

$$= \frac{3}{4}\times\frac{2}{4}\times\frac{3}{4} = \frac{18}{64}$$

II-way:

Boy is selected from first group, girl from second group and another boy from third group.

Probability of the selection of (boy + girl + boy)

$$= \frac{1}{4}\times\frac{2}{4}\times\frac{3}{4} = \frac{6}{64}$$

III-way:

Boy is selected from first group, another boy from second group and the girl from the third group.

Probability of selection of (boy + boy + girl)

$$= \frac{1}{4}\times\frac{2}{4}\times\frac{1}{4} = \frac{2}{64}$$

$$\text{Total probability} = \frac{18}{64}+\frac{6}{64}+\frac{2}{64} = \frac{26}{64} = \frac{13}{32}$$

126. (d)

Since $f(x)$ is a probability density function, we have

$$\int_0^2 ax\,dx + \int_2^4 a(4-x)dx = 1$$

$$2a + 2a = 1$$

or $$a = \frac{1}{4} = 0.25$$

127. (c)

$$\text{Particular integral} = (D^2 - 5D + 4)^{-1}(65 \sin 2x)$$

$$= 65(-4 - 5D + 4)^{-1}(\sin 2x) \qquad [\because D^2 = -(2)^2 = -4]$$

$$= \frac{-65}{5}D^{-1}(\sin 2x)$$

$$= \frac{13}{2}\cos 2x = 6.5 \cos 2x$$

128. (b)

For, $$y = (C_1 + C_2x)e^{2x}$$

A.E. is $$(m-2)^2 = 0$$

$$m^2 - 4m + 4 = 0$$

can be written,

$$(D^2 - 4D + 4)y = 0$$

Hence, $$P = 4$$

130. (b)

The points of intersection of the two curves are

$$4x^2 = x^3$$

$$x^2(x-4) = 0$$

i.e. $$x = 0$$

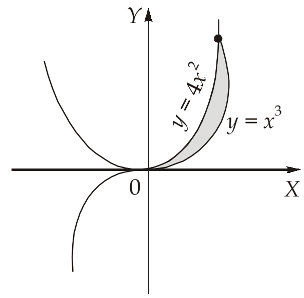
and $$x = 4$$

Since at $x = 1$,

$$y\big|_{x=1} = 4x^2\big|_{x=1} = 4$$

While $$y\big|_{x=1} = x^3\big|_{x=1} = 1$$

So $y = 4x^2$ is the upper curve and $y = x^3$ is the lower curve. The area bounded between the two curves is



$$A = \int_{x=0}^{4} (4x^2 - x^3)dx$$

$$= \left.\frac{4x^3}{3} - \frac{x^4}{4}\right|_{x=0}^{4} = \frac{256}{3} - \frac{256}{4}$$

$$= \frac{256}{12} = \frac{64}{3}$$

132. (d)

A branch represent any two terminal element. A node is the point of connection between two or more branches.

133. (d)

The magnitude of the electric field intensity is given by the maximum value of the rate of change of potential with distance. i.e. electric field intensity is gradient of V or $\vec{E} = -\nabla V$.

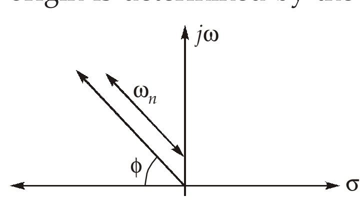
134. (d)

The error constants describe the ability of a unity feedback system to eliminate the steady state error.

135. (a)

$$\xi = \cos\phi$$

The distance of the pole from the origin is determined by the undamped natural frequency ω_n.



136. (c)

Soft magnetic materials have high permeability and low coercivity.

137. (d)

The speed control of induction motor by pole changing is suitable for cage rotor induction motor.

138. (a)

Speed of synchronous motor can be varied by varying the supply frequency fed to synchronous motor for eg inverter fed open loop drive.

139. (d)

In lap wound dc machines, equalizer which are bars located on rotor of machine that short together points at same voltage level in the different parallel path.

140. (b)

Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

142. (b)

Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

143. (b)

Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).

145. (d)

Both the components of message signal are in quadrature form. Hence narrow band FM signal can't be detected by envelope detector.

149. (b)

Fourier transform of periodic signals consisting of train of impulses located at the harmonic frequencies of the periodic signal and with areas proportional to the corresponding Fourier series coefficients.

150. (d)

$$y(n) = 2\,x(n) + 4x(n-1)$$

$$H(z) = \frac{Y(z)}{X(z)} = 2 + 4z^{-1}$$

$h(n)$ is absolutely summable

$\therefore$ system is stable.

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