DETAILED SOLUTIONS

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ESE 2026 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 14

Section A : Systems & Signal Processing + Communication Systems [All Topics]
Section B : BEE-1 + Analog Electronics-1 + Elec. & Electro. Measurements-1 [Part Syllabus]
Section C : Power Electronics and Drives-2 [Part Syllabus]

ANSWER KEY

1.	(c)	**16.**	(a)	**31.**	(b)	**46.**	(b)	**61.**	(c)
2.	(d)	**17.**	(b)	**32.**	(b)	**47.**	(b)	**62.**	(b)
3.	(d)	**18.**	(c)	**33.**	(b)	**48.**	(c)	**63.**	(c)
4.	(d)	**19.**	(c)	**34.**	(a)	**49.**	(c)	**64.**	(c)
5.	(b)	**20.**	(d)	**35.**	(c)	**50.**	(c)	**65.**	(c)
6.	(b)	**21.**	(b)	**36.**	(c)	**51.**	(d)	**66.**	(c)
7.	(a)	**22.**	(b)	**37.**	(c)	**52.**	(b)	**67.**	(a)
8.	(a)	**23.**	(d)	**38.**	(c)	**53.**	(b)	**68.**	(c)
9.	(c)	**24.**	(d)	**39.**	(d)	**54.**	(a)	**69.**	(c)
10.	(c)	**25.**	(c)	**40.**	(d)	**55.**	(b)	**70.**	(a)
11.	(c)	**26.**	(c)	**41**	(c)	**56.**	(a)	**71.**	(a)
12.	(c)	**27.**	(b)	**42.**	(d)	**57.**	(a)	**72.**	(c)
13.	(d)	**28.**	(b)	**43.**	(c)	**58.**	(a)	**73.**	(a)
14.	(c)	**29.**	(c)	**44.**	(b)	**59.**	(b)	**74.**	(c)
15.	(b)	**30.**	(b)	**45.**	(c)	**60.**	(b)	**75.**	(a)

DETAILED EXPLANATIONS

Section A : Systems & Signal Processing + Communication Systems

1. (c)

$$y(t) = x(\sin t)$$
$$y(-\pi) = x(0) \rightarrow \text{future value} \Rightarrow \text{non-causal}$$
$$y_1(t) = x_1(\sin t)$$
$$y_2(t) = x_2(\sin t)$$
$$y(t) = T[a_1x_1(t) + a_2x_2(t)] = a_1x_1(\sin t) + a_2x_2(\sin t)$$
$$= a_1y_1 + a_2y_2 \Rightarrow \text{linear}$$
$$\Rightarrow \quad y_1(t) = x(\sin(t) - \tau)$$
$$y(t - \tau) = x(\sin(t) - \tau) \neq y_1(t) \Rightarrow \text{time variant}$$

2. (d)

$$\omega_0 = 1$$
$$H(\omega) = \frac{1}{1 + j\omega}$$
$$|H(\omega_0)| = \frac{1}{\sqrt{2}},$$
$$\angle H(\omega_0) = \frac{-\pi}{4}$$
$$y(t) = \frac{2}{\sqrt{2}}\sin\left(t - \frac{\pi}{4}\right)$$
$$\text{Output} = \frac{(\sqrt{2})^2}{2} = 1$$

3. (d)

$$x(t) = \sum_{n=-\infty}^{\infty} C_n e^{jn\omega_0 t} = \sum_{n=-\infty}^{\infty} C_n e^{jn\pi t}$$
$$= \left[j\delta(n-1) - j\delta(n+1) + \delta(n-3) + \delta(n+3)\right]e^{jn\pi t}$$

From shifting property,

$$\sum_{n=-\infty}^{\infty} x(n)\delta(n - n_0) = x(n_0)$$
$$x(t) = je^{j\pi t} - je^{-j\pi t} + e^{j3\pi t} + e^{-j3\pi t}$$
$$x(t) = 2\cos(3\pi t) - 2\sin(\pi t)$$

5. (b)

For a real and even rectangular spectrum,

$$x(t) = 2A\ \text{sinc}(2f_m t)$$
$$= 2 \times 0.004\ \text{sinc}(2 \times 200t)$$
$$= 0.008\ \text{sinc}(400t)$$

6. (b)

An IIR filter is stable only if all poles lies inside unit circle.

7. (a)

$$f_L = 1.8\ \text{MHz}$$
$$f_H = 2.2\ \text{MHz}$$
$$\text{Bandwidth} = f_H - f_L = 0.4\ \text{MHz}$$

To avoid aliasing,

$$f_s \geq \frac{2f_H}{K}, \qquad \text{such that, } f_s > 2\text{ B}$$
$$f_s \geq \frac{2\times 2.2}{5}$$
$$f_s \geq 0.72$$

So, $$(f_s)_{\min} = 0.8\ \text{MHz}$$

8. (a)

$$\mu = \sqrt{\mu_1^2 + \mu_2^2}$$
$$11.25 = 10\left(1 + \frac{\mu_1^2}{2}\right)$$
$$\Rightarrow \quad \frac{\mu_1^2}{2} = 0.125$$
$$\Rightarrow \quad \mu_1 = 0.5$$
$$\mu_2 = 0.6\ \text{(given)}$$
$$\mu = \sqrt{0.5^2 + 0.6^2} = 0.78$$
$$P_T = 10\left(1 + \frac{0.78^2}{2}\right) = 13.05\ \text{kW}$$

9. (c)

$$f_m = 20\ \text{kHz}$$
$$f_s = 40\ \text{kHz}$$
$$R_b = nf_s$$
$$n = \text{bits/sample}$$

$$n = \log_2 L = \log_2 256 = 8 \text{ bits/sample}$$

$$R_b = 8 \times 40 \text{ kbps} = 320 \text{ kbps}$$

$$\text{Minimum BW} = \frac{R_b}{2}(1+\alpha) = \frac{320}{2}(1.5) = 240 \text{ kHz}$$

11. (c)

Time duration of one time frame,

$$T_s = \frac{1}{f_s} = \frac{1}{8\times 10^3} = 125 \text{ µs}$$

In one frame,

$$\text{Total pulses} = (24 \times 1) + 1 = 25/\text{frame}$$

Time utilized by all pulse in a frame

$$= 25 \text{ µs}$$

∴ Each pulse of 1 µs duration frame duration = 125 µs

Time spacing between successive pulse

$$= \frac{125-25}{25} = \frac{100}{25} = 4 \text{ µs}$$

12. (c)

$$x(t) = \frac{1+\cos(8000\pi t)}{2(\pi t)^2}$$

$$f_m = 4 \text{ kHz}$$

$$(f_s)_{\min} = 2f_m = 8 \text{ kHz}$$

13. (d)

The given system is,

$$y[m] = \sum_{k=-\infty}^{m+1} x[k]$$

$$y[m] = \ldots.. + x[-1] + x[0] + x[1] + \ldots\ldots.. + x[m] + x[m+1]$$

⇒ $y[m]$ depends on $x[m+1]$ i.e. the output depends on the future values of the input. Hence, the given system is "non-causal".

If $x[k] = 1$, $$y[m] = \sum_{k=-\infty}^{m+1} (1) = \ldots. + 1 + 1 + 1 + \ldots\ldots = \infty \text{ (for very large } m)$$

⇒ For a bounded input, the output is unbounded. Hence, the given system is "**unstable**".

14. (c)

From the property of impulse signal,

$$\int_{-\infty}^{\infty} t\cos(3t)\delta'(t)dt = -x'(0)$$

Here, $x(t) = t\cos(3t)$

$$x'(t) = -3t\sin(3t) + \cos 3t$$

$$x'(0) = -0 + 1 = 1$$

$$-x'(0) = -1$$

15. (b)

The periodic signal can be expressed using Fourier series as

$$x(t) = \sum_{n=-\infty} C_n e^{jn\omega_0 t}$$

We know that,

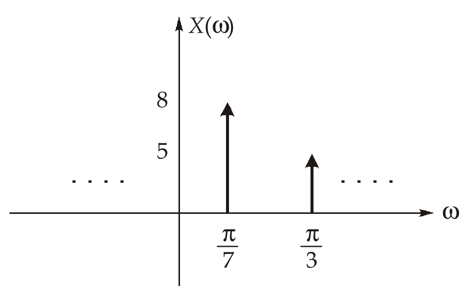
$$e^{jn\omega_0 t} \longleftrightarrow 2\pi\delta(\omega - n\omega_0)$$

Fourier transform of periodic signal is,

$$X_p(\omega) = 2\pi \sum_{n=-\infty}^{\infty} C_n \delta(\omega - n\omega_0)$$

Given spectrum,

$$X(\omega) = 8\delta\left(\omega - \frac{\pi}{7}\right) + 5\delta\left(\omega - \frac{\pi}{3}\right)$$



The frequency components in the spectrum are integer multiples of the fundamental frequency ω_0. Thus, the fundamental frequency,

$$\omega_0 = GCD\left(\frac{\pi}{7}, \frac{\pi}{3}\right) = \frac{\pi}{21}$$

⇒ The fundamental period,

$$T = \frac{2\pi}{\omega_0} = \frac{2\pi}{\left(\frac{\pi}{21}\right)} = 42 \text{ sec}$$

16. (a)

The Laplace transform of $x(t) = e^{-a|t|}$

$$= e^{-at}u(t) + e^{at}u(-t)$$

$$X(s) = \frac{1}{s+a} - \frac{1}{s-a} = \frac{-2a}{s^2 - a^2}$$

and ROC is $(\sigma > -a) \cap (\sigma < a)$, given $a > 0$

So, $\text{ROC} = (\sigma > -a) \cap (\sigma < a)$

$= -a < \sigma < a$

17. (b)

Continuous time systems can be realized by

1. Direct form-I realization.
2. Direct form-II realization.
3. Cascade form realization.
4. Parallel form realization.

18. (c)

Both statements are correct.

19. (c)

Both statements are correct.

20. (d)

$$I_t = I_c\sqrt{1 + \frac{\mu^2}{2}}$$

Given that, $I_t = 5$ A and $I_c = 4$ A

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

$$\mu = \sqrt{2\left[\frac{25}{16} - 1\right]} = \frac{3}{4}\sqrt{2}$$

$$= \frac{3 \times 1.414}{4} = \frac{4.242}{4} = 1.06$$

21. (b)

$$\text{Average power of } x(t) = \frac{A_c^2}{2} = \frac{6^2}{2} = 18\,\text{W}$$

23. (d)

Given that, $f_{LO} > f_c$

IF or $f_{IF} = 450$ kHz

$f_c = 1200$ kHz

$f_{\text{image}} = f_c + 2f_{IF} = 1200 + 2(450)$ kHz $= 2100$ kHz

24. (d)

- Digital communication systems give better noise performance than any analog communication system.
- So, among the given choices, PCM provides better noise performance.

25. (c)

We first apply time-shifting operation to find,

$$y(n) = x(n-1) = \{3, \underset{\uparrow}{4}, 5, 6\}$$

$$y\left(\frac{n}{2}\right) = x(0.5n-1) = \{3, 0, \underset{\uparrow}{4}, 0, 5, 0, 6, 0\}$$

26. (c)

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

$$-2 < R(s) < 1$$

$$x(t) = e^{-2t}\, u(t) + e^{t}\, u(-t)$$

27. (b)

$$E_{x(t)} = \int_{-\infty}^{\infty} |x(t)|^2\, dt$$

$$= \left[\int_{-1}^{0} 2^2\, dt + \int_{0}^{1} (-t+2)^2\, dt + \int_{1}^{2} t^2 dt + \int_{2}^{3} 2^2\, dt\right]$$

$$= 4 + \frac{7}{3} + \frac{7}{3} + 4 = 8 + \frac{14}{3} = \frac{24+14}{3} = \frac{38}{3}$$

So, $$\int_{-\infty}^{\infty} |X(\omega)|^2\, d\omega = 2\pi E_{x(t)} = \frac{2\pi \times 38}{3} = \frac{76\pi}{3}$$

28. (b)

Discrete Fourier transform is discrete and finite in length in both time and frequency.

29. (c)

$x(t) \xleftrightarrow{\text{F.T.}} X(j\omega)$

Aperiodic $\xleftrightarrow{\text{F.T.}}$ continuous

Discrete $\xleftrightarrow{\text{F.T.}}$ periodic

odd + real $\xleftrightarrow{\text{F.T.}}$ odd + imaginary

30. (b)

Given, $x(n) = n^2 u(n)$

We have, $z[u(n)] = \frac{z}{z-1}$

Using the multiplication by n-property, we have

$$z[n\ u(n)] = -z\frac{d}{dz}[z\{u(n)\}] = -z\frac{d}{dz}\left(\frac{z}{z-1}\right)$$

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

Again using the multiplication by n property, we have

$$z[n^2\ u(n)] = -z\frac{d}{dz}\{z[nu(n)]\} = -z\frac{d}{dz}\left[\frac{z}{(z-1)^2}\right]$$

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

31. (b)

When the resultant AM signal is passed through the given filter, the output of the filter will be the sinusoidal carrier signal with 90° phase shift.

When this resultant sinusoidal carrier signal is passed through an envelope detector, the output of envelope detector will be a DC signal.

32. (b)

Mean value,

$$\overline{X} = \int_{-\infty}^{\infty} x \cdot \rho_x(x)\,dx = \frac{1}{4}\int_{-1}^{3} x\,dx = \frac{1}{4}\cdot\frac{x^2}{2}\Bigg|_{-1}^{3} = 1$$

Variance, $$\overline{X^2} = \int_{-\infty}^{\infty} x^2\rho_x(x)\,dx = \frac{1}{4}\int_{-1}^{3} x^2\,dx = \frac{1}{4\times 3}\cdot x^3\Bigg|_{-1}^{3} = \frac{1}{12}(27+1)$$

$$V(X) = \frac{28}{12} = \frac{7}{3}$$

Variance, $$\overline{X^2} - \left(\overline{X}\right)^2 = \frac{7}{3} - 1 = \frac{4}{3}$$

33. (b)

Sidebands are $\omega_c \pm \omega_{m_1}$ and $\omega_c + \omega_{m_2}$

$6 \times 10^6 \pm 5 \times 10^3$ and $6 \times 10^6 \pm 9 \times 10^3$

6.005×10^6, 5.995×10^6, 6.009×10^6, and 5.991×10^6

34. (a)

The waveform is periodic with,

$$T = 2\pi$$

$$\therefore \qquad \omega_0 = \frac{2\pi}{T} = 1$$

the given waveform can be written for one period as

$$x(t) = \frac{10}{2\pi}t\,,\ 0 < t < 2\pi$$

$$b_n = \frac{2}{T}\int_0^T x(t)\sin(n\omega_0 t)dt = \frac{2}{2\pi}\int_0^{2\pi}\frac{10}{2\pi}\cdot t\cdot\sin(nt)dt$$

$$b_n = \frac{10}{2\pi^2}\left[-\frac{t}{n}\cos(nt) + \frac{1}{n^2}\sin(nt)\right]_0^{2\pi}$$

$$b_n = -\frac{10}{n\pi}$$

35. (c)

The series interconnection of two non-linear systems also can be a linear system depending on the individual systems.

36. (c)

$$x(t) = s(t)A\cos(\omega_c t + 30°)$$

$$= A^2[\cos(\omega_c t + 30°)\cos(\omega_c t)]m(t)$$

$$= \frac{A^2}{2}[\cos(2\omega_c t + 30°) + \cos 30°]m(t)$$

After passing through LPF, we get,

$$y(t) = \frac{A^2}{2}\cos(30°)\,m(t) = \frac{\sqrt{3}A^2}{4}m(t)$$

Average power of $y(t)$,

$$P_y = \left(\frac{\sqrt{3}}{4}A^2\right)^2 P_m = \frac{3A^4}{16}P_m$$

37. (c)

The transfer function from the given direct form implementation is,

$$H(z) = \frac{a}{1 - abz^{-1} - acz^{-2}} = \frac{1}{1 - 2z^{-1} + 3z^{-2}}$$

$$a = 1$$

$$ab = 2 \Rightarrow b = 2$$

$$ac = -3 \Rightarrow c = -3$$

38. (c)

An invertible system is one which have a unique relation between its input and output.

39. (d)

An energy signal is one whose total energy E = finite value and whose average power $P = 0$. whereas a power signal is the one whose average power P = finite value and total energy E = ∞.

40. (d)

The amplitude of carrier frequency component in the spectrum of a FM signal is $A_C J_0(\beta)$ which is strong function of modulation index (β).

Section B : BEE-1 + Analog Electronics-1 + Electrical & Electronic Measurements-1

41 (c)

$$A_{CL} = \frac{\Delta V_0 / \Delta t}{\Delta V_i / \Delta t} = \frac{\text{Slew rate}}{\Delta V_i / \Delta t} = \frac{2}{\frac{0.5}{10}} = 40$$

42. (d)

$$V_0 = A_1V_1 + A_2V_2$$

$$A_{cm} = 0 = A_1 + A_2$$

$$A_1 = -A_2$$

Where,

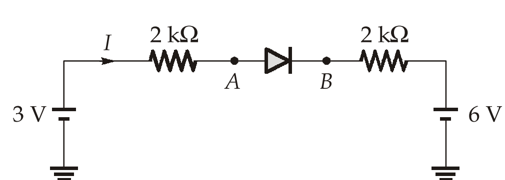
$$A_1 = \left.\frac{V_0}{V_1}\right|_{V_2=0\,\text{V}}$$

$$A_2 = \left.\frac{V_0}{V_2}\right|_{V_1=0\,\text{V}}$$

$$\left(\frac{R_2}{R_1+R_2}\right)\left(1+\frac{R_4}{R_3}\right) = -\left(-\frac{R_4}{R_3}\right)$$

$$\frac{R_1}{R_2} = \frac{R_3}{R_4}$$

43. (c)



The diode is reverse bias,

∴ $I = 0$

$$V_{AB} = \frac{9\times3}{9} - \frac{9\times6}{9} = -3\text{ V}$$

44. (b)

Under open circuit condition,

$$V_A = 6\left(\frac{2k}{4k}\right) = 3 \text{ V}$$

$$V_C = 6\left(\frac{2k}{5k}\right) = 2.4 \text{ V}$$

$$V_A - V_C = 0.6 \text{ V} < 0.7 \text{ V}$$

D-off state

So, $V_x = V_A - V_C = 0.6$ V

45. (c)

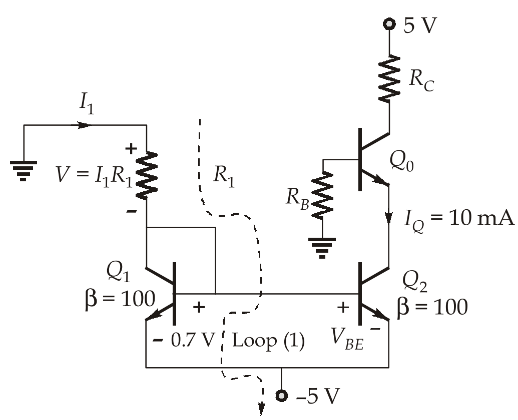
When, $\frac{V_i}{2} > 10$ V

i.e, $V_i > 20$ V

D_2 will be forward biased

$$V_0 = 10 \text{ V}$$

46. (b)



For current mirror circuit formed by transistors Q_1 and Q_2, we can directly write

$$I_Q = \frac{I_1}{\left(1+\frac{2}{\beta}\right)}$$

When β is very large, $I_1 \approx I_Q = 10$ mA

Applying KVL we get in loop (1), we get

$$I_1R_1 + V_{BE} = 5 \text{ V}$$

$$(10 \text{ mA})\, R_1 + 0.7 \text{ V} = 5 \text{ V}$$

$$R_1 = \frac{4.3}{10} \times 10^3 = 430\ \Omega$$

47. (b)

$$V_{GS} = V_G - V_S = 3\text{ V} - I_D(1\text{ k}\Omega)$$

Let us assume that the EMOSFET is in saturation region.

So, $$I_D = K_n(V_{GS} - V_{Th})^2$$

Let us take the numerical value of I_D in mA, then

$$I_D = 1(3 - I_D - 1)^2 = I_D^2 - 4I_D + 4$$

$$I_D^2 - 5I_D + 4 = 0$$

$$(I_D - 4)(I_D - 1) = 0$$

$$I_D = 4\text{ mA or } 1\text{ mA}$$

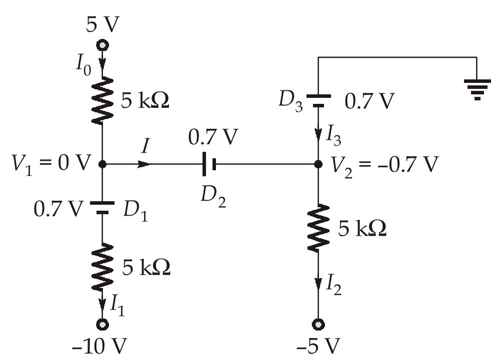
For $I_D = 4\text{ mA} \Rightarrow V_{GS} = 3\text{ V} - 4\text{ V} = -1\text{ V} < V_{Th} \Rightarrow$ not valid

For $I_D = 1\text{ mA} \Rightarrow V_{GS} = 3\text{ V} - 1\text{ V} = 2\text{ V} > V_{Th} \Rightarrow$ valid

So, $$I_D = 1\text{ mA}$$

48. (c)

Let us assume all the diodes are in ON state.



$$I_0 = \frac{5\text{ V} - 0\text{ V}}{5\text{ k}\Omega} = 1\text{ mA}$$

$$I_1 = \frac{0\text{ V} - 0.7\text{ V} + 10\text{ V}}{5\text{ k}\Omega} = \frac{9.3}{5}\text{ mA} = 1.86\text{ mA}$$

$$I = I_0 - I_1 = -0.86\text{ mA}$$

$$I_2 = \frac{-0.7\text{ V} + 5\text{ V}}{5\text{ k}\Omega} = 0.86\text{ mA}$$

$$I_3 = I_2 - I = 0.86 + 0.86 = 1.72\text{ mA}$$

$I_1 > 0$ A, $I_3 > 0$ A $\Rightarrow$ So, D_1 and D_3 are in forward biased as we assumed.

$I < 0$ A $\Rightarrow$ So, our assumption regarding D_2 is wrong and it will be in reverse bias.

As D_2 is reverse biased, $I = 0$ A.

49. (c)

No. of turns on moving coil= 200

$$\text{Length} = 5 \text{ mm} = 5 \times 10^{-3} \text{ m}$$
$$\text{Width} = 20 \text{ mm} = 20 \times 10^{-3} \text{ m}$$
$$\text{Area, } A = l \times d = 5 \times 10^{-3} \times 20 \times 10^{-3} = 100 \times 10^{-6} \text{ m}^2$$
$$\text{Magnetic flux density, } B = 30 \times 10^{-3} \text{ Wb/m}^2$$
$$\text{Current, } I = 40 \times 10^{-3} \text{ A}$$
$$\text{Deflecting torque, } T = NBAI$$
$$= 200 \times 30 \times 10^{-3} \times 100 \times 10^{-6} \times 40 \times 10^{-3}$$
$$= 24 \times 10^{6} \times 10^{-12} = 24 \text{ μN-m}$$

50. (c)

Given bridge is De Sauty's Bridge,

At balance, $$\left(\frac{1}{j\omega C_1}\right)R_4 = \left(\frac{1}{j\omega C_2}\right)R_3$$

$\therefore$ $$R_4 = \frac{C_1}{C_2}R_3$$

$\therefore$ $$R_4 = \frac{10\times10^{-6}}{20\times10^{-6}}\times 40 \text{ k}\Omega = 20 \text{ k}\Omega$$

Hence statement-1 is correct.

Voltage drops in arm-4 and arm-1 have phase difference of 90°. The current in arm-1 and arm-2 are in phase with each other as they are purely capacitive branches.

51. (d)

Correction factor is a factor which we multiply with wattmeter reading to get the true power.

Correction factor is $\dfrac{\cos\phi}{\cos\beta\cos(\phi+\beta)}$ for leading load and $\dfrac{\cos\phi}{\cos\beta\cos(\phi-\beta)}$ for lagging load, where ϕ is power factor angle and β is pressure coil angle.

52. (b)

If capacitor is connected across high resistance of megger capacitor damages.

Potentiometer $\rightarrow$ Low resistance measurement

Loss of charge $\rightarrow$ High resistance

54. (a)

Given actual current reading is 2 mA

$$\text{Range of error} = 2 \pm 0.04$$
$$\frac{0.04}{2}\times 100 = \pm 2\%$$

55. (b)

Dynamometer ammeter reads rms value

$$\theta \propto I^2$$

$$\frac{\theta_1}{\theta_2} = \left(\frac{I_1}{I_2}\right)^2$$

$$4 = \frac{100}{I_2^2}$$

$$I_2 = 5 \text{ A}$$

56. (a)

$$\phi = \tan^{-1}\left(\frac{\sqrt{3}(W_1 - W_2)}{W_1 + W_2}\right) = \tan^{-1}\left(\frac{\sqrt{3}(1500 - 500)}{1500 + 500}\right) = 40.89°$$

$$\text{Power factor} = \cos(40.89°) = 0.76 \text{ lagging}$$

57. (a)

$$\text{Energy consumed} = \frac{V_L I_L \cos\phi}{1000} \times t = \frac{230 \times 20 \times 0.8}{1000} \times 1 = 3.68 \text{ kWh}$$

$$\text{Meter constant} = \frac{\text{No. of revolutions}}{\text{Energy consumed}}$$

$$\text{No. of revolutions} = \text{Meter constant} \times \text{kWh}$$

$$= 100 \times 3.68$$

$$= 368 \text{ revolution}$$

58. (a)

$$\text{Total average power} = \frac{100}{\sqrt{2}} \times \frac{8}{\sqrt{2}} \times \cos(0°) + \frac{40}{\sqrt{2}} \times \frac{6}{\sqrt{2}} \times \cos\left(\frac{2\pi}{3} - \frac{\pi}{3}\right)$$

$$= 400 + 120 \cos 60° = 460 \text{ W}$$

60. (b)

Both statements are individually correct.

Section C : Power Electronics and Drives-2

61. (c)

$$I_{\text{SW, rms}} = \sqrt{D} \cdot I = \sqrt{0.4} \times 20$$

$$= 12.649 \approx 12.65$$

62. (b)

A CSI is fed through a full-wave rectifier so the input (pulsating) frequency is twice the output mains frequency (2 × 50 Hz = 100 Hz)

63. (c)

For 180° mode, $I_{\text{sw, rms}} = \dfrac{V_{dc}}{3R} = 100\text{ A}$

For 120° mode, $I_{\text{sw, rms}} = \dfrac{V_{dc}}{2R\sqrt{3}} = \dfrac{300}{2\sqrt{3}} = 86.6\text{ A}$

64. (c)

$$P_0 = V_0 I_0 = 144$$

$$I_0 = \frac{144}{12} = 12\text{ A}$$

As per power balance equation,

$$V_{dc} I_S = P_0$$

$$V_{dc} = \frac{144}{8} = 18\text{ V}$$

Peak voltage rating of switch

$$= V_{dc} + V_0 = 18 + 12 = 30\text{ V}$$

Peak current of switch $= I_S + I_0 = 8 + 12 = 20\text{ A}$

65. (c)

$$\text{Effective ON period} = T_{on} + \frac{2V_s}{I_0}C$$

$$= 200\times10^{-6} + \frac{2\times230}{100}\times90\times10^{-6} = 614\ \mu\text{sec}$$

Peak current through the main thyristor

$$= 100 + V_s\sqrt{\frac{C}{L}} = 100 + 230\times\sqrt{\frac{90}{30}}$$

$$= 498.37\text{ A}$$

66. (c)

To eliminate n^{th} order harmonic

$$2d = \frac{2\pi}{n}, \frac{4\pi}{n}, \frac{6\pi}{n}, \frac{8\pi}{n}$$

To eliminate 5^{th} order harmonic

$$2d = \frac{2\pi}{5}, \frac{4\pi}{5}, \frac{6\pi}{5}$$

$$2d = 72°, 144°, 216°$$

67. (a)

In type C chopper, output voltage V_0 is always positive because of the presence of freewheeling diode FD across the load.

68. (c)

SMPS are used in dc only.

69. (c)

AC ripple voltage in the output,

$$V_r = \sqrt{V_{0,\text{rms}}^2 - V_0^2}$$

$$V_{0,\text{ rms}} = \sqrt{\alpha}\, V_s$$

$$V_0 = \alpha V_s$$

$$V_r = \sqrt{\alpha V_s^2 - \alpha^2 V_s^2} = V_s\sqrt{\alpha - \alpha^2}\ \text{V}$$

70. (a)

Flyback converter uses inductor transformer which stores energy and then transferred to the load.

$$\text{Energy density} = 0.5\frac{B^2}{\mu}$$

$$\mu \ \alpha \ \frac{1}{R_{\text{(reluctance)}}}$$

∴ To keep the reluctance to desired value, an appropriate length of air-gap is introduced in the flux path.

71. (a)

$$I_{LB} = \frac{D}{2fL}(V_S - V_0) = \frac{V_s}{2fL}D(1-D)$$

72. (c)

In dc-dc converter switch duty ratio controls only the dc output voltage.

74. (c)

SMPS uses control circuit (like PWM or resonant controllers) are generally more complex than single voltage regulation loop in linear power supplies.

75. (a)

If flux does not return to starting value at the end of each switching period then core will get saturated and consequently, it will lead the device current, that is beyond the design limits of the circuit.

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