ACE Engineering Academy

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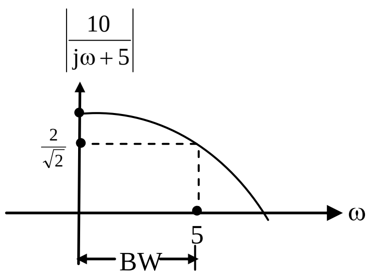
ESE- 2019 (Prelims) - Offline Test Series Test-5

ELECTRICAL ENGINEERING

SUBJECT: Control Systems and Power Electronics
SOLUTIONS

01. Ans: (a)

Sol:



Bandwidth = 5 rad/sec

02. Ans: (d)

Sol: From option (d)

No poles and zeros lies in the right side of s-plane.

03. Ans: (c)

Sol: $TF = \dfrac{\frac{1}{s}}{1+\frac{1}{s}} = \dfrac{1}{s+1}$

$$A = \left|\frac{1}{j\omega+1}\right| = \left.\frac{1}{\sqrt{\omega^2+1}}\right|_{\omega=1} = \frac{1}{\sqrt{2}}$$

$$\phi = \angle\frac{1}{j\omega+1} = -\tan^{-1}\omega\Big|_{\omega=1} = -45°$$

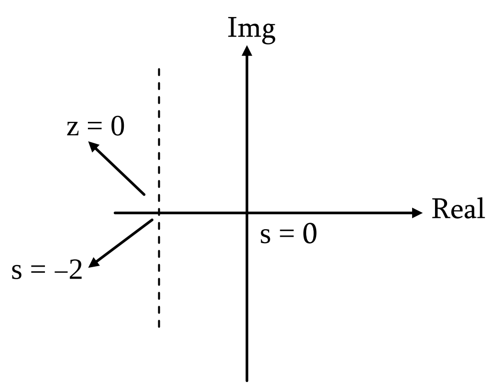
$\therefore$ Output $\quad A\sin(t+\phi) = \dfrac{1}{\sqrt{2}}\sin(t-45°)$

04. Ans: (c)

Sol: $CE = 1+\dfrac{k(s+5)}{s(s+3)(s+7)} = 0$

$$s(s^2+10s+21)+k(s+5) = 0$$

$$s^3+10s^2+(21+k)s+5k = 0$$



Substitute s = (z–2)

$(z-2)^3 + 10(z-2)^2 + (21+k)(z-2) + 5k = 0$

$z^3-6z^2+12z-8+10z^2-40z+40+21z+Kz-42-2K+5K=0$

$z^3+4z^2+(k-7)z+3k-10=0$

z^3	1	k–7
z^2	4	3k–10
z^1	$\frac{4(K-7)-(3K-10)}{4}$	
z^0	3k–10	

$\frac{4(K-7)-(3K-10)}{4} > 0 \Rightarrow k > 18$

And $(3K-10) > 0 \Rightarrow k > \frac{10}{3}$

∴ For k > 18 the closed loop poles lie left side of s = –2

05. Ans: (a)

Sol: $M_r = \frac{2}{2\zeta\sqrt{1-\zeta^2}} = 5 \ldots\ldots 0 \le \zeta \le 0.707$

Solve

$\zeta = 0.2$ and $\zeta = 0.97$

$\therefore \zeta = 0.2$ is valid

06. Ans: (b)

Sol:

Routh Hurwitz	→ Stability
W.R.Evans	→ Root locus
Bode	→ Asymptotic
Nyquist	→ Polar plot

07. Ans: (b)

Sol: No. of forward paths = 1

No. of loops = 2

Two non touching loops =1

$$TF = \frac{G \times 4\left(\frac{1}{4}\right)}{1-(-H_1-H_2)+H_1H_2}$$

$$= \frac{G}{1+H_1+H_2+H_1H_2}$$

08. Ans: (b)

Sol: As k increases, ζ decreases ($\because k \propto \frac{1}{\zeta^2}$)

If ζ decreases, rise time decreases. Hence bandwidth increases ($\because$ Bandwidth $\propto \frac{1}{\text{rise time}}$)

If ζ decreases, ω_d increases ($\because \omega_d = \omega_n\sqrt{1-\zeta^2}$)

∴ Osicillatory nature of response increases.

As k increases ζ decreases ⇒ stability decreases.

09. Ans: (c)

Sol:

$$\frac{C(s)}{R(s)} = \frac{G_1G_2}{1-G_1G_2}(G_3 - X)$$

$$= \frac{G_1G_2G_3}{1-G_1G_2} - \frac{XG_1G_2}{1-G_1G_2}$$

$$\frac{C(s)}{R(s)} = \frac{G_1G_2G_3 - 1 + G_1G_2}{1 - G_1G_2}$$

10. Ans: (c)

Sol: CLTF is

$$\frac{C(s)}{R(s)} = \frac{\frac{20}{s^2}}{1+\frac{20}{s^2}(s+5)} = \frac{20}{s^2+20s+100}$$

$$C(s) = \frac{20R(s)}{s^2+20s+100} = \frac{20}{s(s^2+20s+100)}$$

Steady state output $c(\infty) = \underset{s\to 0}{\text{Lt}}\ s\,C(s)$

$$= \underset{s\to 0}{\text{Lt}}\ s\frac{20}{s(s^2+20s+100)} = \frac{20}{100} = 0.2$$

11. Ans: (c)

Sol: Output is more sensitive to feedback path parameter changes than the forward path parameter changes.

12. Ans: (a)

Sol: $\text{OLTF} = \frac{\text{CLTF}}{1-\text{CLTF}} = \frac{1}{10s}$

$$k_v = \underset{s\to 0}{\text{Lt}}\ sG(s) = \frac{1}{10}$$

Steady state error $e_{ss} = \frac{1}{k_v} = 10$

13. Ans: (b)

Sol: $M_P = \frac{11.63-10}{10}\times 100 = 16.3\%$

i.e $\zeta = 0.5$

settling time t_s (± 2% tolerance) = $\frac{4}{\zeta\omega_n} = 4$

$\zeta\omega_n = 1$

$\omega_n = 2$

$\omega_d = \omega_n\sqrt{1-\zeta^2}$

$= 2\sqrt{1-0.5^2}$

= 1.73 rad/sec

14. Ans: (a)

Sol: G(s) is type-1 system

By introducing integral controller

It becomes type-2 system

And for the step input to type-2 system steady state error is zero.

15. Ans: (a)

Sol: C.E = $s^3 + 11s^2 + 10s + 2k = 0$

110 = 2k

$k_{marginal} = 55$

$11s^2 + 110 = 0$

$s = \pm j10$

$\omega_n = \sqrt{10}$ = 3.16 rad/sec

16. Ans: (c)

Sol: $G(s)=\frac{K(s+2)^3}{s^2}$

Two poles at the origin

$\therefore$ Type 2 system

CE = 1 + G(s) = 0

$s^2 + K(s+2)^3 = 0$, three roots

$\therefore$ order is '3'.

17. Ans: (d)

Sol: Ex: Consider 2nd order system $as^2 + bs + c = 0$

In R-H tabulation,

s^2	a	c
s^1	b	
s^0	c	

For all positive values of a, b, c system is stable

18. Ans: (b)

Sol: R-H tabulation

s^4	1	11	18
s^3	2	18	
s^2	2	18	
s^1	0(2)		
s^0	18		

No sign changes

2- Imaginary poles

2-left side poles

19. Ans: (c)

Sol: $(TF)_{PD} = k_p\,(1+T_Ds)$

One zero at $-\frac{1}{T_D}$

20. Ans: (a)

Sol: $(TF)_{PI} = k_p\left(1+\frac{1}{T_Is}\right)$

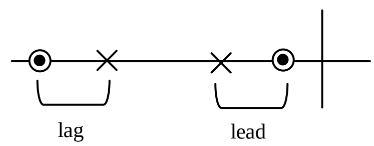
$$= \frac{k_p}{T_I}\left(\frac{1+T_Is}{s}\right)$$

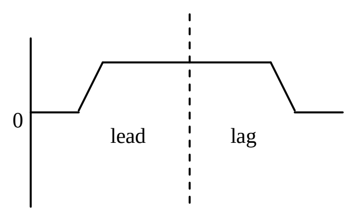
Pole: s = 0

Zero: $s = -\frac{1}{T_I}$

21. Ans: (c)

Sol: Pole zero plot of lead-lag compensator





22. Ans: (c)

Sol: $K_p = \underset{s\to 0}{Lt}\frac{K}{s+A} = \frac{K}{A}$

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

$$S_K^{e_{ss}} = \frac{\partial e_{ss}}{\partial K}\frac{K}{e_{ss}} = \frac{\partial}{\partial K}\left[\frac{A}{K+A}\right]\frac{K}{e_{ss}}$$

$$= \frac{A(-1)}{(K+A)^2}\frac{K}{\left(\frac{A}{K+A}\right)}$$

$$S_K^{e_{ss}} = \frac{-K}{(K+A)}$$

23. Ans: (a)

Sol: It is a lead compensator

Transfer function of lead compensator is

$$G_C(s) = \frac{(1+aTs)}{(1+Ts)} \quad \text{where } (a > 1)$$

Maximum phase angle lead provided by the compensator is

$$\phi_m = \sin^{-1}\left(\frac{a-1}{a+1}\right) \quad (a>1)$$

From above transfer function, T = 1, aT= 3,

$\therefore$ a = 3

$$\phi_m = \sin^{-1}\left(\frac{3-1}{3+1}\right) = \sin^{-1}\left(\frac{1}{2}\right) = 30^0$$

24. Ans: (b)

Sol: By using Laplace Transform on both the sides

$$(s^3+4s^2+5s+2)Y(s) = (s+1)X(s)$$

$$\frac{Y(s)}{X(s)} = \frac{(s+1)}{s^3+4s^2+5s+2}$$

s^3	1	5
s^2	4	2
s^1	18/4	0
s^0	2	

Number of sign changes = 0

$\therefore$ All the three poles are in LHP.

25. Ans: (b)

Sol: System is critically damped at A and B

26. Ans: (a)

Sol: Number of forward paths = 2

Number of loops = 3

There is no two non touching loops

27. Ans: (b)

Sol: Two poles at origin and one pole at s = –T

$\therefore$ Loop transfer function = $\frac{k}{s^2(s+T)}$

28. Ans: (b)

Sol: System will not oscillations when $\zeta \geq 1$.

29. Ans: (d)

Sol: $\left|\frac{k}{s}\right|_{\omega=1} = 36\text{dB}$

$$\frac{k}{\omega} = 2^6$$

k = 2^6 (ω)

k = 2^6 = 64

$\therefore K_V = k = 64$

30. Ans: (c)

Sol: Given $A = 10^3$

$dA = 200$

$\beta = 0.4\%$

$$A_f = \frac{A}{1+\beta A} = \frac{1000}{1+\frac{4}{1000}\times 1000}$$

$$= \frac{1000}{5}$$

$A_f = 200$

% change in gain of feedback amplifier A_f =

$$\left(\frac{1}{1+A\beta}\right) \text{(\% change in A)}$$

$$= \frac{1}{5}\times\frac{200}{10^3}\times 100$$

$= 4$

31. Ans: (c)

Sol: $2k > -1 \;\Rightarrow k > \frac{-1}{2}$

and $\frac{k}{5} < 1 \Rightarrow k < 5$

$\therefore$ Range $-\frac{1}{2} < k < 5$

32. Ans: (d)

Sol: CE = $s^2 + 0.5s + k = 0$

Compare with $s^2 + 2\zeta\omega_n s + \omega_n^2 = 0$

$2\zeta\omega_n = 0.5$

$$\omega_n = \frac{1}{4}$$

$$k = \left(\frac{1}{4}\right)^2 = \frac{1}{16}$$

$= 0.0625$

33. Ans: (a)

Sol: $\frac{dk}{ds} = 0 \Rightarrow \frac{d}{ds}\left[s^2 + 2s\right] = 0$

$\Rightarrow 2s+2 = 0$

$\therefore s = -1$

Breakaway point is $s = -1$.

34. Ans: (a)

Sol: CE = $|sI-A| = 0$

$$\begin{vmatrix} s-2 & -1 \\ -4 & s-5 \end{vmatrix} = 0$$

$(s-2)(s-5) - 4 = 0$

$s^2 - 7s + 10 - 4 = 0$

$s^2 - 7s + 6 = 0$

$(s-6)(s-1) = 0$

$s = 1, 6$

Poles of system are 1, 6.

35. Ans: (b)

Sol: By applying Gilbert's test, X_1 is not controllable

36. Ans: (b)

Sol: TF = $C[SI - A]^{-1}B$

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

$$= \begin{bmatrix} s & -1 \\ -4 & s-3 \end{bmatrix}$$

$$(sI-A)^{-1} = \frac{1}{s(s-3)-4}\begin{bmatrix} s-3 & 1 \\ 4 & s \end{bmatrix}$$

$$TF = [1 \quad 0]\frac{1}{s(s-3)-4}\begin{bmatrix} s-3 & 1 \\ 4 & s \end{bmatrix}\begin{bmatrix} 0 \\ 2 \end{bmatrix}$$

$$TF = \frac{2}{s^2-3s-4}$$

37. Ans: (a)

Sol: As inductance is added to the load, the current waveform is improved; i.e., waveform becomes smooth. So, the form factor decreases and as a waveform higher average on state current I_{rms} can be handled by the device.

38. Ans: (b)

Sol: Without the application of gate currents the thyristor can be turned ON by applying peak working off state forward voltage (V_{DWM}).

39. Ans: (a)

Sol: In the figure, the voltage across device decreases and current increases from zero. So, it is turn ON of device.

$$E = \int V(t).i(t)\,dt$$

From ($O < t < t_1$)

$$E_1 = \int_0^{t_1}(V).I\left(\frac{t}{t_1}\right)dt$$

$$= \left(\frac{VI}{t_1}\right).\int_0^t t\,dt$$

$$= \left(\frac{VI}{t_1}\right)\left(\frac{t_1^2}{2}\right) = \frac{VI\,t_1}{2}$$

From $t_1 < t < t_1 + t_2$ (or) $0 < t' < t_2$

$I(t') = I$; $v(t') = V(1 - t'/t_2)$

$$E_2 = \int_0^{t_2} V(t).i(t)dt$$

$$= \int_0^{t_2} V\left(1-\frac{t'}{t_2}\right)I\,dt'$$

$$= (VI).\left[t_2 - \left(\frac{1}{t_1}\right).\frac{t_2}{2}\right]$$

$$= \left(\frac{VI}{2}\right).t_2$$

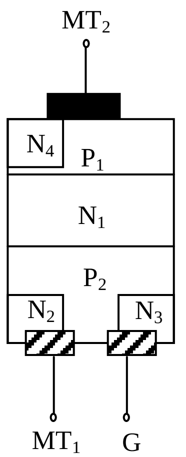
$$\therefore\ E = E_1 + E_2 = \left(\frac{VI}{2}\right).(t_1 + t_2)$$

40. Ans: (c)

Sol: While turning off an SCR, as diode is connected in anti parallel, during reverse recovery the diode turn on and negative voltage of 0.7 V appears across SCR. So, because of negative voltage reverse recovery happens much faster and turn off time is decreased. So, turn off power loss is decreased. Similarly due to this negative voltage while turning on it takes more time.

41. Ans: (a)

Sol:



The above figure is the structure of TRIAC and it obeys all the above statements.

42. Ans: (a)

Sol: t_{on} = 30 μs;

$$T = \frac{1}{f} = \frac{1}{2.5}\times 10^{-3} = 400\ \mu s$$

$$\frac{\text{mark}}{\text{spaceratio}} = \frac{T_{on}}{T_{off}} = 1$$

$$\Rightarrow D = \frac{T_{on}}{T_{on}+T_{off}} = \frac{1}{2}$$

∴ Pulse is given for $T_{on} = \left(\frac{1}{2}\right)(400) = 200$ μs > t_{on}

∴ Thyristor is ON.

43. Ans: (a)

Sol: V_T = 500 V, I_T = 75 A

V = 7.5 kV, I = 1 kA

$$\eta = 86\% = 0.86 = \frac{V}{(n)\times V_T}$$

$$\Rightarrow n = \frac{7.5\times 1000}{0.86\times 500} = 18$$

$$n = \frac{I}{\eta\times I_T} = \frac{1000}{0.86\times 75} = 16$$

44. Ans: (d)

Sol: Base emitter junction is a normal p-n junction. When p-n junction is reverse biased, width of depletion region increases. Width of depletion region is directly proportional to reverse voltage. Capacitance of p-n junction depends on depletion region width. Therefore base emitter junction can be represented as voltage dependent capacitor.

45. Ans. (b)

Sol: V_s = 500 V; $\frac{dV}{dt}$ = 200 V/μs;

$\frac{di}{dt}$ = 60 A/μs; ζ = 0.5

$$\left(\frac{dV}{dt}\right) = R\left(\frac{di}{dt}\right)$$

$$\Rightarrow R = \frac{200}{60} = \frac{10}{3} = 3.33\ \Omega$$

$$V_s = L\left(\frac{di}{dt}\right)$$

$$\Rightarrow L = \frac{500}{60}\mu H = 8.33\ \mu H$$

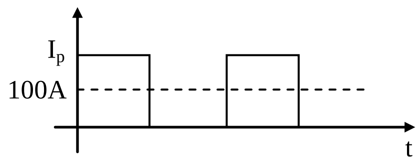
$$R_s = 2\zeta\sqrt{\frac{L}{C_s}}$$

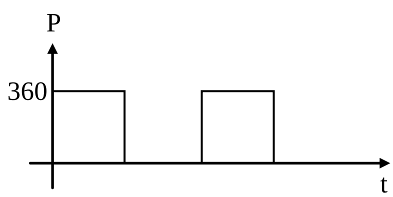
$$\Rightarrow C_s = \left(\frac{2\zeta}{R_s}\right)^2 L = \left(\frac{2\times 0.5}{\left(\frac{10}{3}\right)}\right)^2 \times \left(\frac{25}{3}\right)\mu F$$

$$= 0.75\ \mu F$$

46. Ans: (a)

Sol:





I_{avg} = 100 A;

$I_{avg} = I_p\,(D) = I_p\,(1/2)$

$\Rightarrow I_p = 200$ A

From graph at I_p = 200 A, V_t = 1.8 V

$\therefore$ P(t) = V(t). i(t)

= 200 × (1.8) = 360 W

$$P(t) = \begin{cases} 360\,W;\ 0 < t < T/2 \\ 0\ ;\ T/2 < t < T \end{cases}$$

$\therefore P_{avg}$ = (360).(1/2) = 180 W

47. Ans: (d)

Sol: Load is combination of R and C in parallel

$$i(t) = \frac{V_m \sin\omega t}{R} + C\frac{dv}{dt}$$

$$i(t) = \frac{V_m \sin\omega t}{R} + C.V_m\omega\cos\omega t$$

As 'C' is large, the above waveform is peaky in nature at positive half of input voltage.

48. Ans: (b)

Sol: If the inductance of the load is increased current waveform becomes smooth and ripple content decreases. If resistance of load is increased, the load current decreases, ripple content increases and if inductance is very small, there is a possibility of discontinuity.

49. Ans: (b)

Sol: For a 3 pulse rectifier PIV = V_{ml} = 1000 V

For a full bridge rectifier PIV = V_{ml} = 1000 V

For a midpoint 6 pulse rectifier PIV = 2 V_{mp}

$$= \frac{2\times 1000}{\sqrt{3}} = 1155\text{ V}$$

50. Ans: (d)

Sol: $V_0 = \frac{3V_{ml}}{\pi}\cos\alpha = 200\ \ (\alpha = 0°)$

$$\Rightarrow \frac{3V_{ml}}{\pi} = 200$$

$$V_0 = \frac{1}{\left(\frac{\pi}{3}\right)} \int_{\frac{\pi}{3}+\alpha}^{\pi} V_m \sin\omega t\, d\omega t$$

$$= \frac{3V_{ml}}{\pi}\left[1+\cos\left(\alpha+\frac{\pi}{3}\right)\right] \qquad \text{(R-load)}$$

$V_0 = 200\ [1 + \cos(150°)]$

$= 200\ [1 - \sqrt{3}/2\ ]$

$= 200 - 100\sqrt{3}$

$= 26.8$ V

51. Ans: (b)

Sol: For $\alpha = 0°$, the thyristor 'T_1' conducts from 30° to 150°, in a 3-phase converter, so, for firing angle 'α', the thyristor conducts from $30 + \alpha$ to $150 + \alpha$.

So, 'α' can be varied from 0 to 150°. But after 150°, as it is 'R'-load the thyristor will never conduct.

So, $0 < \alpha < 150°$.

52. Ans: (c)

Sol: $$I_0 = \frac{1}{2\pi R}\int_{\theta}^{\pi-\theta}(V_m \sin\omega t - E)\, d\omega t$$

$$= \frac{1}{2\pi R}\left[2V_m\cos\theta - E(\pi - 2\theta)\right]$$

$V_m \sin\theta = E$

$$\Rightarrow \sin\theta = \frac{50}{100} = \frac{1}{2} \Rightarrow \theta = \frac{\pi}{6} = 30°$$

$$\Rightarrow I_0 = \frac{1}{(2\pi)(10)}\left[2\times(100).(\sqrt{3}/2) - E(2\pi/3)\right]$$

$$= \frac{100\sqrt{3}}{20\pi} - \frac{(50).(2\pi)}{(20)3}$$

$$= \frac{5\sqrt{3}}{\pi} - \frac{5}{3}$$

$= 1.09$ A

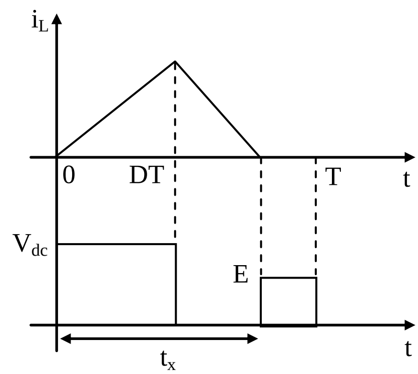
53. Ans: (c)

Sol: By using a free wheeling diode, the output voltage of the circuit increases. So, power factor also increases.

Input power factor = $\dfrac{V_0.I_0}{V_s.I_s}$

54. Ans: (b)

Sol:



$$V_0 = \frac{DTV_{dc} + E(T - t_x)}{T}$$

$$V_0 = DV_{dc} + \left(1 - \frac{t_x}{T}\right)E$$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55 Ans: (d)

Sol: TRC means time ratio control.

f = 2 kHz; T = 0.5 ms

$D = \frac{V_0}{V_{in}} = \frac{170}{220} = \frac{17}{22}$;

$T_{on} = D.T$

$= \left(\frac{17}{22}\right) \times (0.5) = 0.386$ ms.

56. Ans: (c)

Sol: Conduction time $= \pi\sqrt{LC}$

$= \pi\sqrt{16\mu \times 4\mu}$

$= 8\pi\mu$

$= 25.133\ \mu s$

Capacitor voltage $V_c = V_s.(1 - \cos\omega t)$

$= V_s(1 - \cos\pi)$

$= 2V_s$

$= 400$ V

Thyristor voltage $V_T = V_s\cos\omega t$

$V_T = -200$ V

57. Ans: (c)

Sol: Turn off time of SCR = 50 μs

Safety margin = 4

Circuit turn off time > SCR turn off time for the circuit to work.

$\Rightarrow t_c = (4).(50\ \mu s) = 200\ \mu s$

$R_1 = R_2 = 25\ \Omega$;

$RC \ln 2 = t_c$

$\Rightarrow C = \frac{200\mu F}{25 \times (\ln 2)}$

$= \frac{8}{0.693}\mu F$

$= 11.54\ \mu F$

58. Ans: (c)

Sol: Diode rectifies the secondary voltage in ON state of forward converter and blocks the back propagation of secondary voltage during of state of forward converter.

59. Ans: (b)

Sol: $i_0 = 200 \sin(\omega t - 45°)$ mA

$V(t) = \frac{4V_{dc}}{\pi}\sin\omega t$

$P = \frac{2\sqrt{2}V_{dc}}{\pi} \times \frac{(200)}{\sqrt{2}} \times \cos 45^o \times 10^{-3}$

$= (0.9).(220).(100) \times 10^{-3}$

$= 19.8$ W

60. Ans: (b)

Sol: $V_c = 4$; $f_c = 6$ kHz; $V_r = 1$ V; f = 1 kHz

$N = \frac{f_c}{2f} = \frac{6}{2} = 3$

$m_a = \frac{V_r}{V_c} = \frac{1}{4}$

$\Rightarrow \frac{2d}{N} = (1 - m_a)\left(\frac{\pi}{N}\right)$

$\Rightarrow$ Pulse width, $\frac{2d}{N} = \left(1 - \frac{1}{4}\right)\left(\frac{\pi}{3}\right) = \frac{\pi}{4} = 45°$

61. Ans: (d)

Sol: $V_c = 5V$; $V_r=3V$, $f_c=1kHz$, $f=50Hz$

As peak of triangular carrier coincide with zero of the reference sinusoid

$$N = \frac{f_c}{2f} = \frac{1000}{2\times 50} = 10$$

$\therefore$ Dominate harmonics are $2N\pm1= 19,21$

$$m_a = \frac{V_r}{V_c} = 0.6$$

62. Ans (b)

Sol: To obtain good quality voltage waveform in sinusoidal PWM $m_a \le 1$. Maximum can be obtained for $m_a = 1$.

$V_{dc} = 283$ V

$$\hat{V}_{AN} = (m_a)\times\left(\frac{V_{dc}}{2}\right)$$

$$= (m_a)\times\left(\frac{V_{dc}}{2\sqrt{2}}\right)$$

$$= \left(\frac{283}{2\sqrt{2}}\right)\times(1) = 100V$$

63. Ans: (c)

Sol: Mc Murray inverter works on current commutation when auxiliary thyristor is turned ON, the current through the main thyristor decreases to zero and there after the current flows through anti parallel diode. As the diode is conducting $V_T = -V_D = -0.7$ (–ve). This makes sure that the thyristor is turned OFF. It also provides path to reactive component of load current.

64. Ans: (c)

Sol: A single phase ACVR produces fundamental and harmonics in its output. Heater works as a R load, so it uses both fundamental and harmonic components whereas induction motor works as RLE load, so only fundamental voltage is used for better performance. Because harmonics in induction motor create unnecessary losses and harmonic fluxes.

65. Ans: (d)

Sol: $$V_{rms} = \frac{V_m}{\sqrt{2}}\times\sqrt{\frac{N}{N+M}}$$

$$= \frac{230}{\sqrt{2}}\times\sqrt{\frac{2}{2+7}}$$

$= 76.66$ V

66. Ans: (c)

Sol: $k = 0.5V$ /rpm

$I = 5A$, $R = 2\Omega$, $\alpha = 60°$

$$V_o = \frac{V_m}{\pi}(1+\cos 60)$$

$$= \left(\frac{230\sqrt{2}}{\pi}\right)\times\left(\frac{3}{2}\right) = 155.25V$$

$V_o = RI_o + E$

$\Rightarrow E = 155.25 - (2)(5)$

$= 155.25 - 10 = 145.25$

$E = K \times N$

$\Rightarrow N = 145.25 \times 2 = 290.5$ rpm

67. Ans: (d)

Sol: For natural commutation to occur load must be RLC under damped load because for under damped load $X_C > X_L$. Therefore current waveform advances voltage waveform. For a normal full bridge inverter resonant frequency of RLC load must be greater than output frequency because current has to be zero before switch turns off. If sinusoidal PWM is used in inverter then resonant frequency of RLC load must be greater than switching frequency.

68. Ans: (d)

Sol: Triac is a semicontrolled switch. It can be turned on by gate current but can not be turned off by gate. So, statement (I) is false.

69. Ans: (a)

Sol: In series converter, thyristor turn off time $t_{q\,min} = \frac{\pi}{\omega} - \frac{\pi}{\omega_r} > 0$

$\Rightarrow \frac{1}{\omega} > \frac{1}{\omega_r}$

$\Rightarrow \omega < \omega_r$

70. Ans: (a)

Sol:

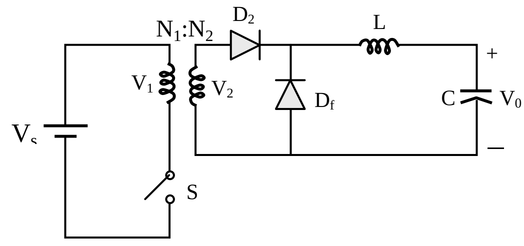


Fig: Under no load condition

Under no load condition, when switch is ON, on secondary side D_2 is ON and it forms a series LC circuit.

$V_0(t) = V_2(1-\cos\omega t)$; $\quad I_s(t) = \frac{V_2}{\omega L}\sin\omega t$

(where I_s is secondary current)

From above equations V_0 can obtain a maximum of $2V_2$. Thus excess voltage is produced.

71. Ans: (a)

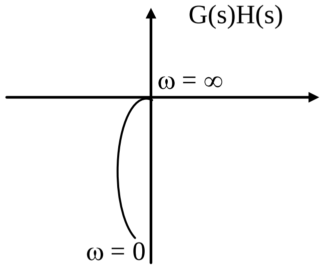
Sol: Given $G(s)H(s) = \frac{10(s+4)}{s(s+2)}$

$|G(j\omega)H(j\omega)| = \frac{10\sqrt{\omega^2+16}}{\omega\sqrt{\omega^2+4}}$

$\angle G(j\omega)H(j\omega) = -90^o - \tan^{-1}\left(\frac{\omega}{2}\right) + \tan^{-1}\left(\frac{\omega}{4}\right)$

$\omega = 0 \quad \infty\angle -90^o$

$\omega = \infty \quad 0\angle -90^o$



Nyquist plot does not intersect the negative real axis hence GM = ∞.

72. Ans: (c)

Sol: Number of right half of s-plane poles can not be found from the Bode plot.

73. Ans: (c)

Sol: By adding pole to the open loop system order increases hence rise time increases.

Rise time is inversely proportional to bandwidth. Hence statement (II) wrong.

74. Ans: (a)

Sol: CE = $s^2 + 4s + 4 = 0$

$2\zeta\omega_n = 4$

$\omega_n = 2$ rad/sec,

$\zeta = 1$

$\therefore M_P = e^{\frac{-\zeta\pi}{\sqrt{1-\zeta^2}}} = 0$

75. Ans: (d)

Sol: If open loop control system is stable we can not say exactly closed loop control system is stable. Closed loop system may or may not be stable.

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