# ACE
## Engineering Academy

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**ESE- 2018 (Prelims) - Offline Test Series Test-5**

**ELECTRICAL ENGINEERING**

## SUBJECT: Control Systems & Power Electronics and Drives

## SOLUTIONS

**01. Ans: (b)**

**Sol:** $\tau = \frac{1}{50}\text{sec}$

$$t_r \approx 2.2\tau = 2.2 \times \frac{1}{50} = 0.044\,\text{sec}$$

**02. Ans: (d)**

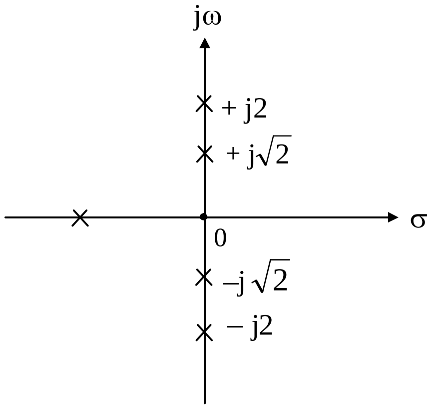
**Sol:** C.E $\Rightarrow s^5 + 7s^4 + 6s^3 + 42s^2 + 8s + 56 = 0$

| | | | | |
|---|---|---|---|---|
| $s^5$ | 1 | 6 | 8 | |
| $s^4$ | 7(1) | 42(6) | 56(8) | |
| $s^3$ | 0(4) | 0(12) | 0 | $\rightarrow$ Row of zero |
| $s^2$ | 3 | 8 | | |
| $s^1$ | 4/3 | | | |
| $s^0$ | 8 | | | |

AE: $1s^4 + 6s^2 + 8 = 0$

Roots of AE $\Rightarrow (s^2+2)(s^2+4) = 0$

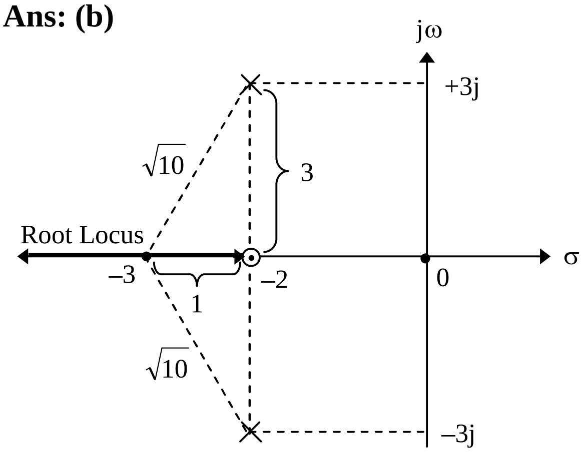
$s = \pm j\sqrt{2}, \pm j2$




$\Rightarrow$ 4-poles on jω-axis.

**03. Ans: (b)**

**Sol:**



$$k = \frac{\sqrt{10}\times\sqrt{10}}{1} = 10$$

**04. Ans: (b)**

**Sol:** $$G(j\omega) = \frac{3(2-j\omega)}{(j\omega+1)(j\omega+5)}$$

$$\Rightarrow M = \frac{3\sqrt{4+\omega^2}}{\sqrt{\omega^2+1}\sqrt{\omega^2+25}}$$

$\omega = 0$ magnitude M =1.2

$$\Rightarrow \phi = -\tan^{-1}\left(\frac{\omega}{2}\right) - \tan^{-1}(\omega) - \tan^{-1}\left(\frac{\omega}{5}\right)$$

$\omega = 0$ ------- $\phi = 0°$

$\omega = \infty$ ------ $\phi = -270°$

The polar starts at $1.2\angle 0°$ and ends at $0\angle -270°$

**05. Ans: (d)**

**Sol:** $$G(s)\big|_{\omega_c} = \frac{50}{(s+4)(s+5)}\left[\frac{s^2k_d + sk_p + k_i}{s}\right]$$

$$= \frac{50(s^2k_d + sk_p + k_i)}{s(s+4)(s+5)}$$

$$\Rightarrow e_{ss} = \frac{A}{K_v} = \frac{1}{\frac{50\times k_i}{4\times 5}}$$

[Given $\%e_{ss}$ = 10%, $e_{ss}$ = 0.1]

$$\Rightarrow 0.1 = \frac{20}{50k_i} \Rightarrow 5k_i = \frac{2}{0.1} = 20$$

$k_i = 4$

**06. Ans: (c)**

**Sol:** $\Rightarrow \dfrac{C(s)}{R(s)} = \dfrac{G_1G_2G_3G_4}{1+G_4+G_3G_4+G_2G_3G_4+1+G_4+G_3G_4}$

$$\frac{C(s)}{R(s)} = \frac{G_1G_2G_3G_4}{2+2G_4+2G_3G_4+G_2G_3G_4}$$

**07. Ans: (c)**

**Sol:** CE is $1+G(s)=0$

$$3s^3+10s^2-as+ks+2k=0$$

$$3s^3+10s^2+s(k-a)+2k=0$$

| | | |
|---|---|---|
| $s^3$ | 3 | (k-a) |
| $s^2$ | 10 | 2k |
| $s^1$ | $\dfrac{10(k-a)-6k}{10}$ | |
| $s^0$ | 2k | |

For marginally stable

$\Rightarrow \dfrac{10(k-a)-6k}{10}=0$

10k–10a–6k =0

4k = 10a ⇒k=2.5a……… (1)

AE is $10s^2+2k=0$

s = j2

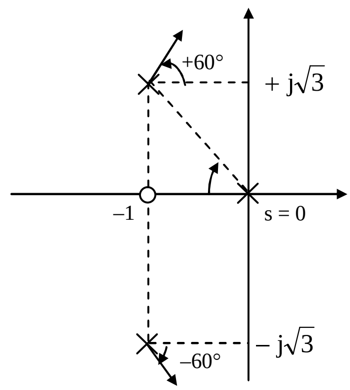
–40 +2k = 0 ⇒k=20……. (2)

(1) = (2)

20 =2.5 a ⇒ a = 8

**08. Ans: (a)**

**Sol:**




$$\angle GH(s)\big|_{s=-1+j\sqrt{3}} = \frac{\angle k \angle(s+1)}{\angle s \angle(s+1-j\sqrt{3})\angle(s+1+j\sqrt{3})}$$

$$= \frac{\angle k \angle j\sqrt{3}}{\angle(-1+j\sqrt{3})\angle 0 \angle j2\sqrt{3}}$$

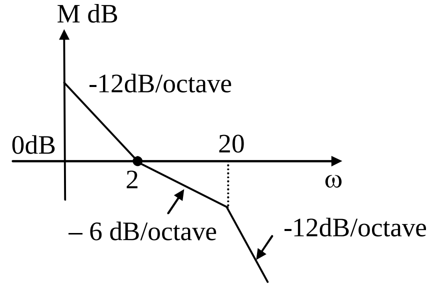
$$= \frac{0^\circ+90^\circ}{120^\circ+0^\circ+90^\circ} = -120^\circ$$

$\phi_d = 180^\circ + \angle GH = 180^\circ - 120^\circ = +60^\circ$

$\phi_d = \pm 60^\circ$

**09. Ans: (c)**

**Sol:**




± 20 dB/decade= ± 6 dB/octave

Initial slope = – 12 dB/octave = – 40 dB/decade

$\Rightarrow$ two poles at origin

$$T.F = G(s) = \frac{K\left(1+\frac{s}{2}\right)}{s^2\left(1+\frac{s}{20}\right)}$$

At $\omega = 2 \Rightarrow M_{dB} = 0dB$

$20 \log K - 20 \log\omega^2|_{\omega=2} = 0dB$

$20 \log K - 20 \log 2^2 = 0$

$20 \log K = 20 \log 4$

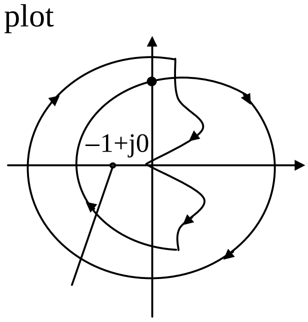
$\Rightarrow K = 4$

$$G(s) = \frac{4\frac{(s+2)}{2}}{\frac{s^2(s+20)}{20}} = \frac{40(s+2)}{s^2(s+20)}$$

**10. Ans: (a)**

**Sol:** Given, $G(s)H(s) = \frac{100}{s^3(s+10)}$

Nyquist plot




N = –2

(or) N = 2 in clockwise

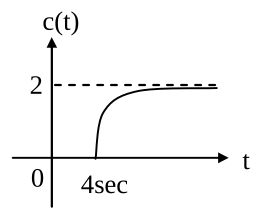
**11. Ans: (d)**

**Sol:** As system has one pole in the right half of s-plane, it is unstable.

$\therefore$ DC gain is infinite.

**12. Ans: (d)**

**Sol:**




$$c(\infty) = \underset{s\to 0}{Lt}\ s\left[\frac{ke^{-0.1sT_D}}{s+2}\right].\frac{e^{-3s}}{s}$$

$$= \frac{k}{2}$$

From the plot, $c(\infty) = 2$

$\Rightarrow k = 4$

Delay $(0.1T_D + 3) = 4$

$$T_D = \frac{1}{0.1} = 10$$

$T_D = 10$

**13. Ans: (a)**

**Sol:** It is a lead controller, which increases the bandwidth.

**14. Ans: (b)**

**Sol:** Break point may exist any where on the s-plane

**15. Ans: (a)**

**Sol:** $\left|\frac{6}{(j\omega_{gc})^2(j\omega_{gc}+1)}\right| = 1$

$\omega_{gc} = \sqrt{3}$

$PM = 180° - 180° - \tan^{-1}\omega_{gc}\,|_{\omega_{gc}=\sqrt{3}} = -60°$

PM = – 60°

**16. Ans: (b)**

**Sol:** $\angle\frac{10}{j\omega-1} = -(180° - \tan^{-1}\omega)$

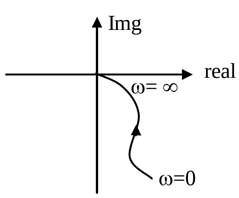
ω = 0 ………. –180°

ω = 1 …….. – 135°

ω = ∞ …….. –90°

**17. Ans: (d)**

**Sol:**




**18. Ans: (c)**

**Sol:** By applying the Gilbert's test system is observable but not controllable.

**19. Ans: (b)**

**Sol:** $\text{PI controller} = K_p\left[1+\frac{1}{T_I s}\right]$

$= K_p\left[\frac{T_I s+1}{T_I s}\right]$

$T_I$ = reset time

Zero at $s = -\frac{1}{T_I} = -2$

$T_I$ = 0.5sec

**20. Ans: (b)**

**Sol:** $G(s)H(s) = \frac{K(s+1)}{s^2(s+10)}$

No. of root loci that terminate at infinite are (P–Z) = 3–1 = 2

**21. Ans: (c)**

**22. Ans: (a)**

**Sol:** From the plot we can find that above system is type –1 system

For unit step input, steady state error of type –1 system is zero.

**23. Ans: (b)**

**24. Ans: (b)**

**Sol:** $\text{OLTF} = \frac{10s+20}{s^2+20s+20-10s-20}$

$= \frac{10s+20}{s^2+10s}$

$k_v = \lim_{s\to 0} sG(s)H(s) = s\frac{10s+20}{s(s+10)} = 2$

$e_{ss} = \frac{A}{K_v}$ (∵ Unit ramp I/P)

$e_{ss} = 0.5$

**25. Ans: (c)**

**26. Ans: (a)**

**Sol:** C.E is 1+G(s) H(s) = 0

$s^2 (s^3+4s^2+8s+8)+7s+4 = 0$

$s^5+4s^4+8s^3+8s^2+7s+4=0$

By Routh's tabulation,

| | | | |
|---|---|---|---|
| $s^5$ | 1 | 8 | 7 |
| $s^4$ | 4(1) | 8(2) | 4(1) |
| $s^3$ | 6(1) | 6(1) | |
| $s^2$ | 1 | 1 | → Row of A.E |
| $s^1$ | 2 | 0 | |
| $s^0$ | 1 | | |

A.E is $s^2+1 = 0$, $\frac{dA}{ds} = 2s$

$s = \pm j$

$\omega = 1$ rad/sec

Two roots are on imaginary axis, 3 left hand Roots, 0 Right hand roots.

**27. Ans: (c)**

**28. Ans: (c)**

**Sol:** C.E is $s^5+4s^4+3s^3+(2+k)s^2+(s+4)k+7k=0$

$s^5+4s^4+3s^3+2s^2+k(s^2+s+11)=0$

$$1+\frac{k(s^2+s+11)}{s^5+4s^4+3s^3+2s^2}=0$$

Number of roots tends to infinity = 5–2 =3 because two roots tends to zeroes corresponding to $s^2+s+11=0$, remaining 3 roots tends to infinity.

**29. Ans: (c)**

**Sol:** Pairs of two non-touching loops are:

(c, mn), (c,lfn), (de, mn)

**30. Ans: (b)**

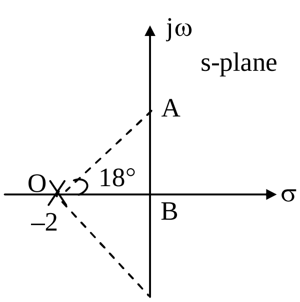
**Sol:** $$G(s)H(s)=\frac{k}{(s+2)^{10}}$$

$$\text{Centroid}=\frac{\Sigma\text{poles}-\Sigma\text{zeroes}}{p-z}$$

$$=\frac{(-2)10-0}{10}=-2$$

$$\text{Angle of asymptotes}=\frac{(2q+1)\pi}{p-z}$$

$= 18^\circ, 54^\circ$………..




$$\cos 18^\circ=\frac{OB}{OA}$$

$$\Rightarrow OA=\frac{OB}{\cos 18^\circ}=\frac{2}{0.95}=2.105$$

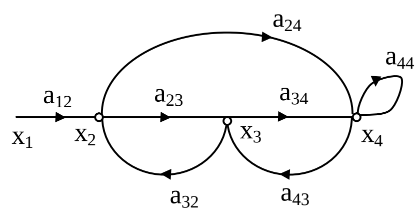
Maximum value of k for stability

$$=\frac{\text{product of distance from poles}}{\text{product of distance from zeroes}}$$

$= (2.105)^{10}$

**31. Ans: (a)**

**Sol:** Given signal flow graph is as below,




$x_4= a_{24}\, x_2 + a_{34}\, x_3 + a_{44}\, x_4$

$x_4\,(1–a_{44})= a_{24}\, x_2+ a_{34}\, x_3$

$$x_4(1-a_{44})=a_{24}\,x_2+a_{34}\,x_3$$

$$x_4=\frac{a_{24}}{1-a_{44}}x_2+\frac{a_{34}}{1-a_{44}}x_3$$

Option 'a' is correct

**32. Ans: (d)**

**Sol:** Lag compensator increases oscillatory response. In lag-lead compensator both lag and lead controllers are cascaded. So, statement 1, 2 are false.

**33. Ans: (c)**

**Sol:** By Final Value Theorem, $\underset{t\to\infty}{Lt}\, f(t)=\underset{s\to 0}{Lt}\, s.F(s)$

$$\frac{1}{2} = \underset{s\to 0}{Lt}\, s.\frac{(s+1)}{s(s+K)}$$

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

$$\therefore K = 2$$

**34. Ans: (d)**

**Sol:** $\phi(t) = e^{At} = \begin{bmatrix} e^{4t} & 0 \\ e^{2t} - e^{4t} & e^{2t} \end{bmatrix}$

$$\left.\frac{d\phi(t)}{dt}\right|_{t=0} = \begin{bmatrix} 4e^{4t} & 0 \\ 2e^{2t} - 4e^{4t} & 2e^{2t} \end{bmatrix}_{t=0}$$

Model matrix (A) $= \begin{bmatrix} 4 & 0 \\ -2 & 2 \end{bmatrix}$

**35. Ans: (c)**

**Sol:** Given system is in controllable canonical form

$$\frac{C(s)}{R(s)} = \frac{b\,(c_1 s + c_0)}{s^2 + a_1 s + a_0}$$

$$A = \begin{bmatrix} 0 & 1 \\ -a_0 & -a_1 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ b \end{bmatrix} \quad C = [c_0 \quad c_1]$$

$$\therefore \frac{C(s)}{R(s)} = \frac{1(s+4)}{s^2 + 2s + 3}$$

$$\therefore A = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix} \quad B = \begin{bmatrix} 0 \\ 1 \end{bmatrix} \quad C = [4 \quad 1]$$

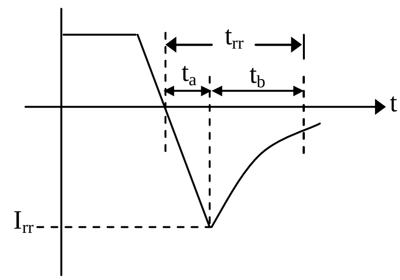
**36. Ans: (b)**

**Sol:** Softness factor $\frac{t_a}{t_b} = 0.3$

$t_a + t_b = t_{rr} = 3.9\ \mu s$

$\therefore 1.3\, t_a = 3.9$

(or) $t_a = 3\ \mu s$.




$$I_{rr} = t_a \times \frac{di_a}{dt} = 3 \times 50 = 150A$$

$$Q_{rr} = \frac{1}{2} \times t_{rr} = 292.5.\mu C$$

**37. Ans: (a)**

**Sol:** $\eta = \frac{P_0}{P_0 + P_{loss}}$

$$\Rightarrow P_0 = \frac{\eta}{1-\eta}.\times P_{loss}$$

If $\eta$ = 80%,

$$P_0 = \frac{0.8}{1-0.8} \times 200 = 0.8\,kW$$

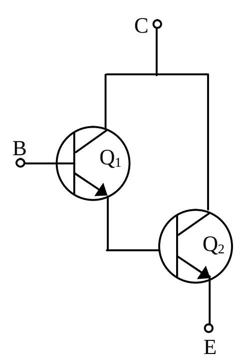
If $\eta$ = 90%,

$$P_0 = \frac{0.90}{1-0.90} \times 200 = 1.8\ kW$$

Hence option 'a' is correct.

**38. Ans: (a)**

**Sol:**



In the darlington pair, $Q_1$ is driven and $Q_2$ is the main transistor. The β of the Darlington pair is $\beta = \beta_1 + \beta_2 + \beta_1\beta_2$

Where $\beta_1$ is for $Q_1$ transistor

$\beta_2$ is for $Q_2$ transistor

$125 = 20 + \beta_2 + \beta_2 (20)$

$$\beta_2 = \frac{125-20}{1+20}$$

$\beta_2 = 5$

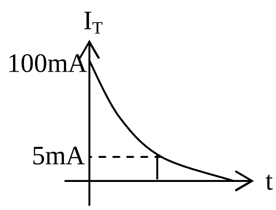
Main transistor current gain $\beta_2 = 5$

**39. Ans: (a)**

**Sol:** When a gate pulse is given to the thyristor

$$I_T = \frac{100}{1000} = 100 \text{ mA}$$

(∵ capacitor is short at $t = 0^+$)




As $I_T(0^+) > 5$ mA

A gate pulse of any possible pulse width can be given.

∴ From given options 1 ms is the lowest possible pulse width

**40. Ans: (b)**

**Sol:** Output voltage of asymmetrical semiconverter

$$V_0 = \frac{V_m}{\pi}(1+\cos\alpha)$$

$$= \frac{\sqrt{2}\times 200}{\pi}(1+\cos 60^o)$$

$V_0 = 135.04$ V

$$I_0 = \frac{135.04}{8.16} \text{A}$$

$$\text{rms current through diode} = I_0\left(\frac{\pi+\alpha}{2\pi}\right)^{\frac{1}{2}}$$

$$= \frac{135.04}{8.16}\left(\frac{\pi+60^o}{2\pi}\right)^{\frac{1}{2}}$$

$I_{Drms} = 13.504$ A

**41. Ans: (b)**

**Sol:** $$V_0 = \frac{V_m}{\pi}\cos\alpha = \frac{220\sqrt{2}}{\left(\frac{22}{7}\right)}\times\frac{1}{\sqrt{2}} = 70\,\text{V}$$

$$I_0 = \frac{V_0 - E}{R} = \frac{70-35}{5} = \frac{35}{5} = 7 \text{ A}$$

**42. Ans: (a)**

**Sol:** For 3-ϕ full converter

rms output voltage

$$V_{or} = V_{m\ell}\left[\frac{1}{2}+\frac{3\sqrt{3}}{4\pi}\cos 2\alpha\right]^{1/2}$$

$$= \sqrt{2}\times 400\left[\frac{1}{2}+\frac{3\sqrt{3}}{4\pi}\cos 90^o\right]$$

$$= \frac{\sqrt{2}\times 400}{\sqrt{2}}$$

$V_{or} = 400$ V

Output power $P_0 = \frac{V_{or}^2}{R} = \frac{400^2}{50}$

$= 3200$ W

**43. Ans: (b)**

**Sol:** For 3-pulse converter PIV $V_{m\ell} = 1000$ V

For bridge 6 pulse converter PIV = $V_{m\ell}$

= 1000 V

For midpoint 6-pulse converter PIV

= 1.155 $V_{m\ell}$ V

= 1155 V

**44. Ans: (d)**

**Sol:** For a 3-$\phi$ six pulse converter with R-load

(i) Continuous conduction occurs for $0 < \alpha < 60°$.

(ii) Discontinuous conduction for $60° < \alpha < 120°$.

(iii) The maximum firing angle is 120°.

**45. Ans: (c)**

**Sol:** Given $\alpha = 90°$

$$t_c = \frac{(\pi - \alpha)}{\omega} \qquad \alpha > 60°$$

$$= \frac{\pi - \pi/2}{2\pi \times f}$$

$$= \frac{\pi}{2 \times 2 \times \pi \times 50}$$

$$t_c = \frac{1}{200} \quad ;$$

$$t_c = 5 \times 10^{-3}$$

$$\Rightarrow t_c = 5 \text{m sec}$$

**46. Ans: (c)**

**Sol:** In a 12-pulse converter, with resistive load, continuous conduction occurs for

$0 < \alpha < 75°$ and discontinuous conduction for $75° < \alpha < 105°$.

$\therefore$ The maximum possible firing angle is 105°.

In a 6-pulse converter, with resistive load, continuous conduction occurs for

$0 < \alpha < 60°$ and discontinuous conduction for $60° < \alpha < 120°$.

$\therefore$ The maximum possible firing angle is 120°.

In a 3-pulse converter, with resistive load, continuous conduction occurs for

$0 < \alpha < 30°$ and discontinuous conduction for $30° < \alpha < 150°$.

$\therefore$ The maximum possible firing angle is 150°.

**47. Ans: (a)**

**Sol:** $V_0 = \frac{3V_{ml}}{\pi} \cos\alpha$

Maximum possible voltage is obtained, when $\alpha = 0°$

$$V_0 = \frac{3V_{ml}}{\pi}$$

For 86.66% of $V_{max}$, $\alpha$ = ?

$$\frac{\sqrt{3}}{2} \times \frac{3V_{ml}}{\pi} = \frac{3V_{ml}}{\pi}\cos\alpha$$

$$\cos\alpha = \frac{\sqrt{3}}{2}$$

$$\alpha = 30°$$

**48. Ans: (a)**

**49. Ans: (b)**

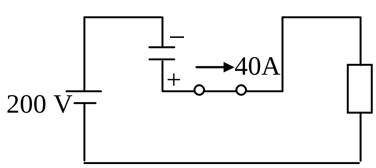
**Sol:** Free wheeling duration

$= 3\,(\alpha - 60^o)$ for $\alpha > 60^\circ$

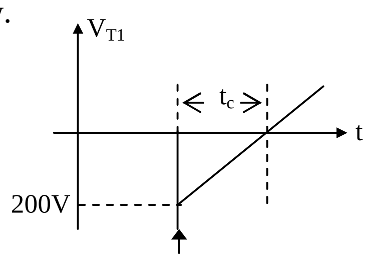
$= 3\,(40^o) = 120^o$

**50. Ans: (b)**

**Sol:** When $T_A$ is ON, equivalent circuit is




Voltage across capacitor will reverse bias $T_1$ as constant current is flowing through C, voltage will change linearly as shown below.




$$\therefore \frac{I_0}{C} = \frac{200}{t_c}$$

$$\Rightarrow t_c = \frac{200 \times 10\,\mu}{40} = 50\ \mu s.$$

**51. Ans; (b)**

**52. Ans: (c)**

**Sol:** It is a boost converter. The average output voltage of boost converter is strongly influenced by internal resistance

$$V_0 = V_{dc}\left[\frac{1-D}{\frac{r}{R} + (1-D)^2}\right]$$

$$\frac{dV_0}{dD} = 0$$

$$D_{max} = 1 - \sqrt{\frac{r}{R}}$$

**53. Ans: (a)**

**Sol:** Here $\Delta I_{L1} < \Delta I_{L2} \Rightarrow L_1 > L_2$

If L decreases, then $i_L$ swings between large values of $\Delta I_L$ .

**54. Ans: (a)**

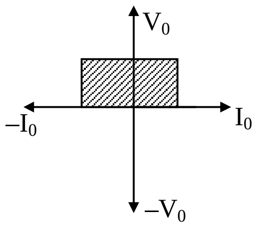
**55. Ans: (d)**

**Sol:** Operating in I quadrant:

$I_a + ve, V_a + ve$

Operating in II quadrant:

$I_a$ – ve, $V_a$ + ve




**56. Ans: (a)**

**Sol:** RMS value of fundamental components of load current

$$I_{01} = \frac{230}{2} = 115\text{ A}$$

The fundamental component of current $i_{01}$ as a function of time is

$$i_{01} = \sqrt{2}\, I_{01} \sin \omega t$$

$$i_{01} = I_m \sin\omega t$$

RMS value of thyristor current at fundamental frequency

$$I_{T1}^2 = \frac{1}{2\pi}\int_0^{\pi} (I_m \sin \omega t)^2 d\omega t$$

$$I_{T1} = \frac{I_m}{2}$$

$$= \frac{\sqrt{2}\times 115}{2}$$

$$= 81.33\text{ A}$$

For R load Diodes will not conduct so $I_{D1}$ = 0 A

**57. Ans: (a)**

**Sol:** To eliminate any harmonic from the output waveform, the amplitude of the waveform should be equal to zero. For that value of n . By referring Fourier analysis expression,

sin nd = 0

$\therefore$ nd = $\pi \Rightarrow$ d = $\frac{\text{®}}{n}$

Width of pulse ($\alpha$) = 2d = $\frac{2\text{®}}{n}$

$= \frac{2\text{®}}{5} = 72^o$

**58. Ans: (a)**

**59. Ans: (c)**

**60. Ans: (b)**

**61. Ans: (c)**

**Sol:** The semi converter voltage never is negative.

**62. Ans: (d)**

**Sol:** For a squirrel cage induction motor.

Constant $\frac{V}{f}$ and at low frequencies, the maximum torque is decreases, and starting torque increases.

Constant voltage and reduced frequencies, starting torque increases.

**63. Ans: (d)**

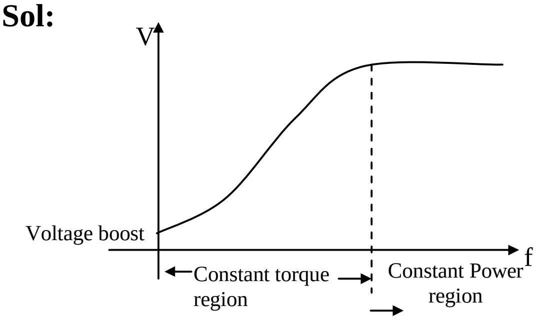
**Sol:** In forward converter when both switch and diode turn off together, the magnetization energy will cause a current to flow through the closely coupled tertiary winding will produce more voltage.

Tertiary winding in forward converter will provide fly back action with primary winding. Hence, it will reset the core flux before next switching cycle.

**64. Ans: (a)**

**65. Ans: (b)**

**Sol:**




The region of constant torque can be obtained by volts/ hertz control. In the low frequency range of speed. The effect of stator resistance is compensated by a boost in the stator voltage as shown in figure. In this region the stator current is kept constant at its rated value. Power, equal to the product of constant torque and speed, varies linearly with speed shown in figure. Slip frequency remains constant during constant torque region.

**66. Ans: (c)**

**67. Ans: (b)**

**Sol:** (i) Let $V_0$ = 150 V & $V_s$ = 230 V

For 1-ϕ full converter $V_0 = \frac{2V_m}{\pi}\cos\alpha$

$$\cos\alpha = \frac{V_0\times\pi}{2V_m}$$

$$\alpha = \cos^{-1}\left[\frac{150\times\pi}{2\times\sqrt{2}\times230}\right]$$

$$\alpha = 43.58°$$

Power factor = 0.9 cos α

= 0.9 cos 43.58°

= 0.651 lag

For semiconverter $V_0 = \frac{V_m}{\pi}(1+\cos\alpha)$

$$\alpha = 63.33°$$

$$\text{Power factor} = \sqrt{\frac{2}{\pi(\pi-\alpha)}}(1+\cos\alpha)$$

$$= \sqrt{\frac{2}{\pi\left(\pi-63.33\times\frac{\pi}{180}\right)}}(1+\cos63.33^{o})$$

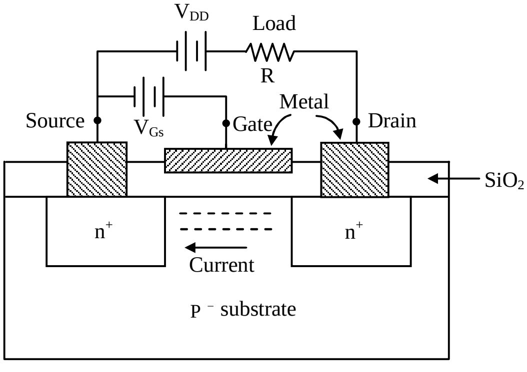
= 0.81 lag

So for the same output voltage , the power factor of 1-ϕ semi converter is better than full converter.

(ii) Semi converter have two diodes and two controlled switches

**68. Ans: (a)**

**Sol:** When gate circuit is open, the junction between $n^+$ region below drain and $P^-$ substrate is reverse biased by input voltage $V_{DD}$. Therefore, no current flows from D to S and load. When gate is made positive with respect to source, an electric field is established. So current can flow from drain to source as shown in figure.




**69 Ans: (a)**

**70. Ans: (b)**

**Sol:** $\text{Time constants} = \frac{1}{2}, \frac{1}{4}$

$= 0.5, 0.25$

$$C(\infty) = \underset{s\to0}{Lt}\frac{s\times10}{(s+2)(s+4)}\times\frac{1}{s}$$

$$= \frac{10}{8} = 1.25$$

**71. Ans: (a)**

**Sol:** $G(s) = \dfrac{K}{(1+sT)^2}$

$K_v = \underset{s\to\infty}{Lt}\ s\times G(s) = 0$

$e_{ss} = \dfrac{1}{K_v} = \infty$

**72. Ans: (d)**

**Sol:** For a second order system, for $0 < \zeta < 1$, system exhibits overshoot.

But for $0 < \zeta < \dfrac{1}{\sqrt{2}}$ only resonance peak exists.

So statement (I) is false.

**73. Ans: (b)**

**Sol:** Block diagram techniques used for simplification of control system, but for complicated systems, the block diagram reduction is tedious and time consuming hence signal flow graph is used.

Signal flow graph is a graphical representation for the variables representing the output of the various blocks of the control system.

**74. Ans: (a)**

**75. Ans: (a)**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