DETAILED SOLUTIONS

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ESE 2025 : Prelims Exam
CLASSROOM TEST SERIES

ELECTRICAL ENGINEERING

Test 10

Section A : Power Electronics and Drives [All Topics]
Section B : Power Systems-1 [Part Syllabus]
Section C : Electrical Machines-2 [Part Syllabus]

ANSWER KEY

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

DETAILED EXPLANATIONS

Section A : Power Electronics and Drives

1. (c)

- Since power MOSFET is majority carrier device but body diode is both majority as well as minority carrier device which will reduce the overall switching speed of the power MOSFET.
- Since TRIAC has low forward and reverse voltage blocking capability compared to SCR hence, it is used for low and medium power application.

2. (a)

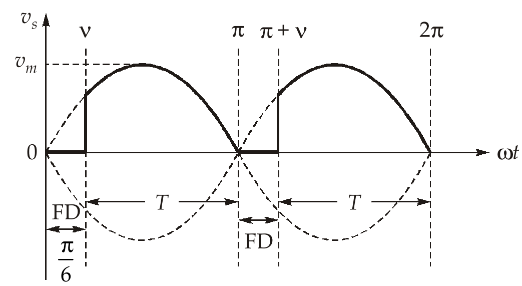
$$2\pi - \nu = \frac{11\pi}{6}$$

$$\Rightarrow \qquad \nu = \frac{\pi}{6}$$

Conduction time of F.D. over one cycle of the supply

$$= 2\nu$$

$$= 2\times\frac{\pi}{6} = \frac{\pi}{3}\text{rad}$$



3. (c)

The on-state voltage drop is higher than that of the SCR.

4. (b)

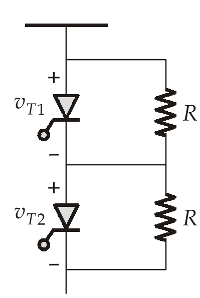
t_{rr} is defined as the time between the instant forward diode current becomes zero and the instant the reverse recovery current decays to 25% of its reverse peak value.

5. (d)

Forward voltage triggering is used to turn-ON the SCR.

6. (a)

Static equalising circuit overcomes the problem of voltage sharing by SCR during On-state in series operation,



7. (a)

High $\frac{di_A}{dt}$ will definitely turn-ON the SCR faster but it may damage the SCR also if it is more than the specified limit. Hence, it is not preferred to turn-ON the SCR using high $\frac{di_A}{dt}$ to avoid creating localize hot-spot near gate junction.

8. (b)

Total Harmonics distortion on ac side,

$$\text{THD} = \sqrt{\frac{1}{g^2} - 1}$$

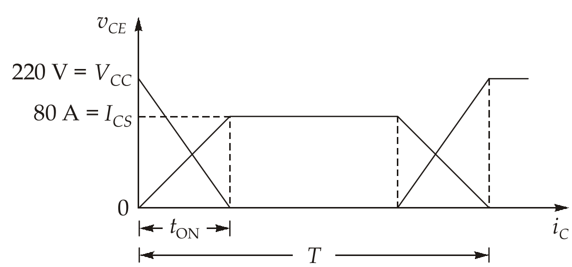
As g approaches unity,

$$\text{THD} \to 0$$

$$\text{Ripple factor} = \sqrt{(\text{Form factor})^2 - 1}$$

Higher the FF (Form Factor) higher will be the ripple factor on dc side waveform.

9. (a)



$$P_{\text{loss}} = \frac{V_{CC} I_{CS} \times t_{on}}{6} \times f$$

$$= \frac{220 \times 80 \times 10 \times 10^{-6} \times 5 \times 10^3}{6} = 146.67 \text{ W}$$

10. (d)

$$T_j - T_A = 60°$$

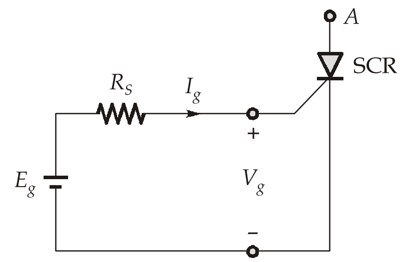
$$\theta_{JC} = 0.15 \text{ °C/W}$$

$$\theta_{CS} = \frac{0.15}{2} = 0.075 \text{ °C/W}$$

$$\theta_{SA} = \frac{0.15}{0.3} = 0.5 \text{ °C/W}$$

$$\therefore \quad P_{\text{avg}} = \frac{T_j - T_A}{(\theta_{JC} + \theta_{CS} + \theta_{SA})} = \frac{60}{0.15 + 0.075 + 0.5} = 82.76 \text{ W}$$

11. (a)



Gate power dissipation, $P_g = V_g I_g = 0.65$ W ...(i)

and slope $= \dfrac{V_g}{I_g} = 130$

$$V_g = 130\, I_g$$

$\therefore$ $130 I_g^2 = 0.65$ [Using equation (i)]

$\Rightarrow$ $I_g = 70.7$ mA

Now, $E_g = V_g + R_s I_g$

$$E_g = 130 I_g + R_s I_g$$

$$R_s = \frac{E_g - 130 I_g}{I_g} = \frac{15 - 130 \times 70.7 \times 10^{-3}}{70.7 \times 10^{-3}}$$

$$= 82.16\ \Omega$$

12. (c)

Derating factor = 1 – η = 0.2

Efficiency, η = 0.8

For series :

$$\eta = \frac{8000}{n_1 \times 800} = 0.8$$

$\Rightarrow$ $n_1 = 12.5$

$$n_1 \approx 13$$

For parallel:

$$\eta = \frac{1.5 \times 10^3}{n_2 \times 150} = 0.8$$

$\Rightarrow$ $n_2 = 12.5 \approx 13$

13. (c)

$$f = 50 \text{ Hz}$$

For single phase full bridge converter,

2 output pulses are obtained over one supply voltage cycle

Harmonic on DC side $= mK$ (where m = no. of pulse per cycle and K = 0, 1, 2, 3...)

⇒ Harmonics on 2 pulse DC side = 2 K

= 2, 4, 6, ... (2 is 1st harmonic and 4 is 2nd harmonic)

∴ 2nd harmonic frequency will be

= $nf = 4f = 4 \times 50 = 200$ Hz (where n = 2, 4, 6, ... harmonic number)

14. (d)

Form factor,
$$FF = \frac{V_{0r}}{V_0} = \frac{\frac{V_m}{\sqrt{2}}}{\frac{2V_m}{\pi}\cos\alpha}$$

$$= \frac{\pi}{2\sqrt{2}\cos\alpha} = \frac{\pi}{2\sqrt{2}\cos\frac{\pi}{4}} = \frac{\pi}{2} = 1.571$$

15. (b)

$$I_0 = \frac{V_0 - E}{R}$$

Where,
$$V_0 = \frac{2V_m}{\pi}\cos\alpha = \frac{2\sqrt{2}\times 240}{\pi}\cos 30° = 187.13 \text{ V}$$

∴
$$I_0 = \frac{187.13 - 25}{10} = 16.213 \text{ A}$$

16. (c)

$$V_0 = \frac{2V_m}{\pi}\cos\alpha = \frac{2\sqrt{2}\times 230}{\pi}\cos\alpha = \left(\frac{2\sqrt{2}}{\pi}\cos\alpha\right)\times 230 \quad ...(i)$$

Given, p.f. = 0.76 = g . F.D.F

where, $g = \frac{2\sqrt{2}}{\pi}$ and FDF = cos α for the single phase fully controlled bridge converter

∴
$$\text{p.f.} = \frac{2\sqrt{2}}{\pi}\cos\alpha \quad ...(ii)$$

Hence, from equation (i) and (ii),

$$V_0 = 230 \times \text{p.f.}$$
$$= 230 \times 0.76$$
$$= 174.80 \text{ volts}$$

17. (a)

Amplitude of fundamental component of the source current

$$\hat{I}_{s1} = 20\sqrt{2}\text{ A}$$

RMS fundamental component of source current

$$I_{s1} = \frac{20\sqrt{2}}{\sqrt{2}} = 20\text{ A}$$

rms supply voltage, $V_{sr} = 250$ V

Fundamental power factor angle

$$\phi_1 = \frac{\alpha}{2}$$

$$\therefore \quad \cos\phi_1 = \cos\left(\frac{\alpha}{2}\right) = \cos\left(\frac{60°}{2}\right) = \cos(30°) = \frac{\sqrt{3}}{2}$$

$$\therefore \quad \text{Input power, } P_1 = V_{sr} I_{s1} \cos\phi_1$$

$$= 250 \times 20 \times \frac{\sqrt{3}}{2} = 4.33\text{ kW}$$

18. (b)

The PIV of centre tap full wave rectifier is $2V_m$ (where V_m is the peak value of secondary side voltage)

i.e. $V_m = 75\sqrt{2}$

$$\therefore \quad (\text{PIV})_{D1} = 2\left(75\sqrt{2}\right)$$

$$= 150\sqrt{2}\text{ V}$$

19. (c)

Average output voltage is

$$V_0 = \frac{2v_m}{\pi}\cos\alpha = 140$$

$$\Rightarrow \quad \frac{2\sqrt{2} \times 230}{\pi}\cos\alpha = 140$$

$$\Rightarrow \quad \cos\alpha = 0.676$$

$$\Rightarrow \quad \alpha \approx 47.46°$$

Average load/output current is

$$I_0 = \frac{V_0 - E}{R} = \frac{140 - 40}{20} = 5\text{ A}$$

A single phase full bridge converter with ripple free load current has source current of square wave whose distortion factor is $\frac{2\sqrt{2}}{\pi} = 0.9$ and THD of 48.34%.

Alternate Solution:

rms fundamental source current,

$$I_{s1r} = \frac{2\sqrt{2}}{\pi} I_0$$

rms source current, $I_{sr} = I_0$

$\therefore$ Distrotion factor, $g = \frac{I_{s1r}}{I_{sr}} = \frac{\frac{2\sqrt{2}}{\pi} I_0}{I_0} = \frac{2\sqrt{2}}{\pi} = 0.9$

and $\text{THD} = \sqrt{\frac{1}{g^2} - 1} = \sqrt{\frac{1}{0.9^2} - 1} = 48.34\%$

20. (b)

Average output voltage,

$$V_0 = E + I_0 R = 143.33 + 20 \times 1 = 163.33 \text{ V}$$

Now, $V_0 = \frac{2V_m}{\pi} \cos\alpha - 4 f L_s I_0$

$$163.33 = \frac{2 \times \sqrt{2} \times 230}{\pi} \cos\alpha - 4 \times 50 \times 4 \times 10^{-3} \times 20$$

$$163.33 = \frac{460\sqrt{2}}{\pi} \cos\alpha - 16$$

$$\cos\alpha = \frac{(163.33 + 16)\pi}{460\sqrt{2}} = 0.866$$

$\Rightarrow$ $\alpha = 30°$

21. (a)

$$f = 50 \text{ Hz}$$

$$\omega = 2\pi f = 2\pi \times 50 = 100\pi \text{ rad/sec}$$

$$\alpha = 45° \text{ or } \frac{\pi}{4}$$

In 3-ϕ full bridge converter, for $\alpha < 60°$, circuit turn-off time is

$$t_c = \frac{\frac{4\pi}{3} - \alpha}{\omega} = \frac{\frac{4\pi}{3} - \frac{\pi}{4}}{100\pi} = \frac{13\pi}{1200\pi} = \frac{13}{1200} = 10.833 \text{ msec}$$

22. (d)

- Extinction angle β may be less than 'π' radians depending upon the load inductance value for inductive loads.
- For continous conduction mode with ripple free load current for (RL) load, the source current is a square wave whose THD is 48.34%.

23. (d)

- During the operation, the negative part of the output voltage waveform is removed by the use of freewheeling diode.
- As energy stored in L is transferred to R during freewheeling period, the overall converter efficiency improves.

24. (c)

Rms value of source current is

$$I_{s2} = \sqrt{\frac{2}{3}}I_0 \qquad (\because \text{ load current is constant})$$

$$= \sqrt{\frac{2}{3}} \times 35 = 28.577 \text{ A}$$

25. (d)

For highly inductive load the source current is quasi-square wave of pulse width $\frac{2\pi}{3}$

$\therefore$
$$\text{p.f.} = g\,.\,\text{FDF}$$

$$= \frac{3}{\pi}\cos\alpha = \frac{3}{\pi}\cos 45° = 0.6752 \text{ lagging}$$

26. (d)

- 1-ϕ semiconverter with freewheeling diode removes the negative portion of the output voltage waveform and hence improves the p.f..
- PIV of 3-ϕ full bridge converter thyristors is exactly equal to v_{mL}.
- As pulse no. increases, the ripple in the voltage waveform reduces resulting in reduced form factor and voltage ripple factor.

27. (a)

A dual converter has two functional modes - one is circulating current mode and other one is non-circulating current mode.

28. (a)

Average output voltage,

$$V_0 = V_{01} = -V_{02}$$

$$\frac{2V_m}{\pi}\cos\alpha_1 = -\frac{2V_m}{\pi}\cos\alpha_2$$

$$\cos\,\alpha_1 = -\cos\,\alpha_2$$

$\Rightarrow$
$$\cos\,\alpha_1 = \cos\,(180° - \alpha_2)$$

$\Rightarrow$
$$\alpha_1 + \alpha_2 = 180°$$

29. (c)

Both the statements are correct and for $\alpha \geq 60°$ a three-phase semiconverter works as 3-pulse converter.

30. (a)

$$t_{off} = 65\ \mu\text{sec}$$
$$V_s = 250\ \text{V}$$
$$V_0 = 750\ \text{V}$$

It is a step-up chopper:

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

$$750 = \frac{1}{(1-\alpha)}\times 250$$

$\Rightarrow$ $$\alpha = \frac{2}{3}$$

$\therefore$ $$t_{off} = (1-\alpha)T = (1-\alpha)\left(\frac{t_{on}}{\alpha}\right) = \left(\frac{1}{\alpha}-1\right)t_{on}$$

$\Rightarrow$ $$t_{on} = \frac{t_{off}}{\left(\frac{1}{\alpha}-1\right)} = \frac{65\mu\sec}{\left(\frac{1}{2/3}-1\right)} = \frac{65\mu\sec}{\left(\frac{3}{2}-1\right)} = 130\ \mu\text{sec}$$

31. (b)

$$f = 2\ \text{kHz}$$
$$V_s = 90\ \text{V}$$
$$L = 30\ \text{mH}$$
$$\frac{T_{on}}{T} = \alpha = 40\% = 0.4$$

$\therefore$ ΔI_L = ripple in load current/inductor current

$$= \frac{\alpha V_s}{fL} = \frac{0.4\times 90}{2\times 10^3\times 30\times 10^{-3}} = 0.60\ \text{A}$$

32. (a)

$$V_S = 160\ \text{V}$$
$$R = 0.1\ \Omega$$
$$I_0 = 5\ \text{A}$$
$$E_b = 100\ \text{V}$$

For motoring mode, it will act as step down chopper,

$\therefore$ $$V_0 = \alpha V_s$$

But, $$V_0 = E_b + I_0 R \qquad (\because \text{motoring mode})$$

$\Rightarrow$ $$\alpha V_s = E_b + I_0 R$$

$$\alpha \times 160 = 100 + 5 \times 0.1$$

$$\alpha = 0.628$$

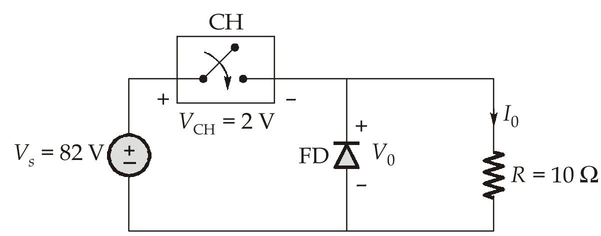
33. (b)

$$V_{CH} = 2\text{ V}$$
$$V_S = 82\text{ V}$$

Duty ratio, $\alpha = 60\% = 0.6$

$$R = 10\ \Omega$$

Output power across the load is



$$P_0 = \frac{V_{0rms}^2}{R}$$

Where, $V_{0\,rms} = \sqrt{\alpha}(V_S - V_{CH})$

∴ $$P_0 = \frac{\left[\sqrt{\alpha}(V_S - V_{CH})^2\right]^2}{R} = \frac{\alpha(V_S - V_{CH})^2}{R}$$

$$= \frac{0.6(82-2)^2}{10} = 384\text{ W}$$

34. (b)

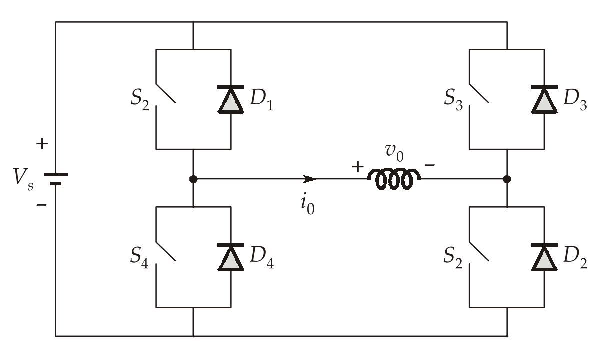
The chopping frequency is given by

$$f = \frac{1}{T} = \frac{\alpha}{T_{on}}$$

35. (a)

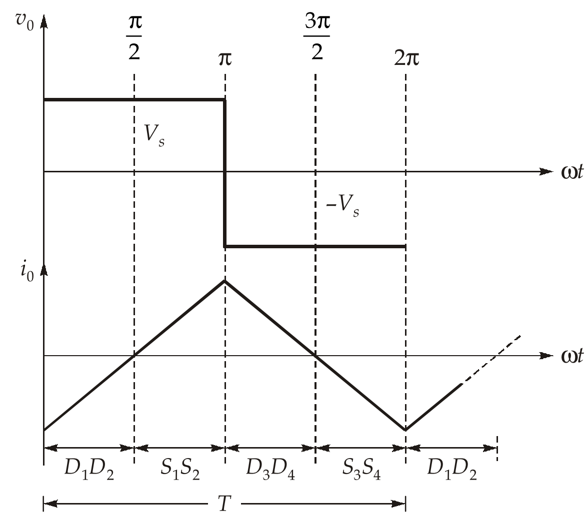
Time period, $T = \frac{1}{60} = 16.66$ msec

For 1-ϕ full bridge VSI, the diode conducts for half of the time period when the inductor releases the stored energy in one half cycle.



Each diode conducts for $\frac{1}{4}$ of time period

So, $$T_D = \frac{T}{4} = 4.17 \text{ msec}$$



36. (d)

During discontinuous mode of operation of chopper, the output current is less than the boundary output current and the inductance value is less than the critical inductance value.

38. (d)

$$f_m = 50 \text{ Hz}$$
$$f_c = 0.9 \text{ kHz}$$

For sinusoidal PWM and 1-ϕ full bridge VSI

No. of pulses per half cycle will be

$$N_p = \left(\frac{f_c}{2f_m} - 1\right) = \frac{0.9 \times 10^3}{2 \times 50} - 1 = 8$$

39. (d)

- Antiparallel diodes in voltage source inverters conducts only when there is stored energy in the load (i.e. inductive or capacitive loads).

  ∴ For resistive load, no stored energy is there so, diodes doesn't conduct.
- In square wave mode triplen harmonics are also present. Infact, all the odd harmonics are present.

40. (a)

A CSI doesn't require any feedback diodes unlike in VSI.

41. (c)

The line voltage of 3-ϕ, 180° mode VSI is given by

$$V_L = \sqrt{\frac{2}{3}}V_S$$

Where V_S is the dc input voltage.

42. (a)

The given figure is a flyback converter, whose output voltage is given by

$$V_0 = \left(\frac{N_2}{N_1}\right)\cdot\frac{\alpha V_s}{(1-\alpha)} = \frac{1}{5}\times\frac{\left(\frac{2}{3}\right)\times 100}{\left(1-\frac{2}{3}\right)} = 40 \text{ volts}$$

43. (d)

As load are non-linear and output has very less distortion and hence UPS inject larger harmonic currents into the system, hence inverter is needed to control the output instantaneously.

45. (b)

More the thickness of depletion width due to possibility of its expansion in the substrate, more it will block the reverse voltage.

Section B : Power Systems-1

47. (b)

$$Z_S = 400\ \Omega$$

$$Z_L = 70\ \Omega$$

$$T_V = \frac{V''}{V} = \frac{2Z_L}{Z_S + Z_L} = \frac{2\times 70}{400+70} = 0.2979$$

$\therefore$ $$V'' = 10 \times 10^3 \times 0.2979$$

$$V'' = 2.979 \text{ kV}$$

and $$R_I = \frac{Z_S - Z_L}{Z_L + Z_S} = \frac{400-70}{70+400} = \frac{33}{47}$$

48. (a)

$$Q = 50 \text{ m}^3$$

$$H = 150 \text{ m}$$

$$P = 40.25 \text{ MW}$$

$$P = WQH\eta \times 9.81 \times 10^{-3} \text{ kW} \qquad (W \approx 1000 \text{ density of water})$$

$\Rightarrow$ $$40.25 \times 10^6 = 1000 \times 50 \times 150 \times \eta \times 9.81 \times 10^{-3} \times 10^3 \text{ Watt}$$

$\Rightarrow$ $$\eta = 54.71\%$$

49. (b)

Test - 1 : $C_b = 9\ \mu F$

Test - 2 : $C_a = 70\ \mu F$

Per phase capacitance, C_{ph} per meter

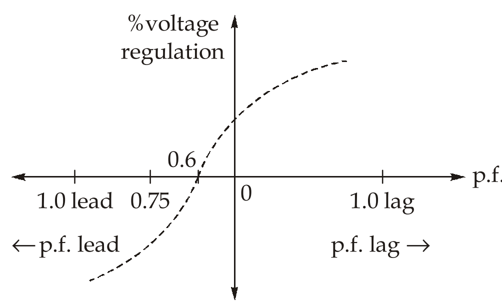
$$C_{ph} = \frac{9C_b - C_a}{6} = \frac{9\times 9 - 70}{6} = \frac{11}{6}\mu F/m$$

$$\tan\delta = \frac{1}{\omega R_i C_{ph}} = \frac{1}{2\pi\times 50\times 50\times 10^3\times\frac{11}{6}\times 10^{-6}}$$

$$= 3.18\times 10^{-3}\times\frac{1}{50\times 10^3\times\frac{11}{6}\times 10^{-6}} \qquad \left[\therefore \frac{1}{\omega} = \frac{1}{100\pi} = 3.18\times 10^{-3}\right]$$

$$= 0.0347$$

50. (c)



As p.f. 0.9 → 0.75 leading

% V_{reg} decreasing from more negative towards zero.

i.e., receiving end voltage is rising.

51. (d)

Peak load power plants are capable of generating power within less time to meet the peak load demand which run-off power plants, nuclear and solar power plants cannot do everytime as and when required.

53. (c)

Plant usage factor, $P_{uf} = \dfrac{\text{Energy produced in used hours}}{\text{Energy able to produce as per } P_c \text{ in used hours.}}$

55. (a)

With $Z = R + jX_L$ where X_L is variable,

For maximum power transfer, $P_{R\,max}$

$$X_L = \sqrt{3}R$$

56. (b)

Transmitted voltage, $v''(t) = 2Ve^{-\frac{Z_s}{L_1}t}$

where $Z_S = \sqrt{\frac{L}{C}}$ surge impedance of the line and L_1 is the load inductance

The transmitted voltage as the surge reaches load is

$$V''(0) = 2Ve^{-\frac{Z_s}{L_1}\times 0} = 2\text{ V} = 2 \times 200 = 400\text{ V}$$

57. (d)

For a nominal π network

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} 1+\frac{YZ}{2} & Z \\ Y\left[1+\frac{ZY}{4}\right] & 1+\frac{YZ}{2} \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix} \quad \text{...(i)}$$

Long transmission line,

$$\begin{bmatrix} V_S \\ I_S \end{bmatrix} = \begin{bmatrix} \cosh \gamma l & z_c \sinh \gamma l \\ \frac{\sinh \gamma l}{z_c} & \cosh \gamma l \end{bmatrix} \begin{bmatrix} V_R \\ I_R \end{bmatrix} \quad \text{...(ii)}$$

By comparing (i) and (ii) matrix,

$$1+\frac{YZ}{2} = \cosh \gamma l$$

$$Z = Z_c \sinh \gamma l$$

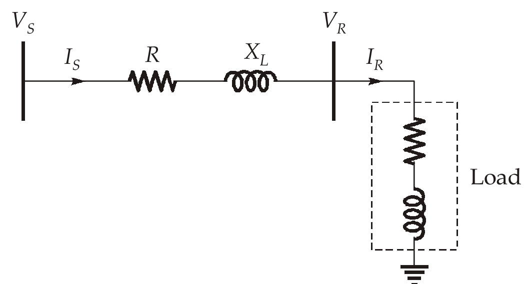
$$\frac{Y}{2} = \frac{\cosh \gamma l - 1}{Z} = \frac{1+2\sinh^2\left(\frac{\gamma l}{2}\right)-1}{Z_c \sinh \gamma l}$$

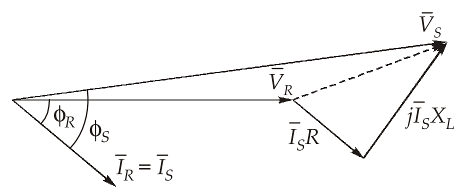
$$= \frac{2\sinh^2\left(\frac{\gamma l}{2}\right)}{Z_c\left[2\sinh\frac{\gamma l}{2}\cosh\frac{\gamma l}{2}\right]}$$

$$\frac{Y}{2} = \frac{1}{Z_c}\tanh\left(\frac{\gamma l}{2}\right)$$

58. (b)

A short transmission line is represented as shown below,





$$\phi_R < \phi_S$$

$$\cos\phi_R > \cos\phi_S$$

∴ receiving end p.f. > sending end p.f.

59. (c)

In short transmission line with upf load only positive voltage regulation is possible.

60. (b)

Both statement-I and statement-II are true but statement-II is not the corret explanation of statement-I.

Section C : Electrical Machines-2

61. (b)

$$P_g = 30 \text{ kW}$$

$$P_{cu} = 2.5 \text{ KW}$$

$$\text{Slip, } s = \frac{P_{cu}}{P_g} = \frac{2.5}{30} = 0.08$$

$$\text{Motor speed, } N_r = 460 \text{ rpm}$$

$$\text{Synchronous speed, } N_s = \frac{Nr}{(1-s)} = \frac{460}{(1-0.08)} = 500 \text{ rpm}$$

$$\because \quad N_s = \frac{120f}{P}$$

$$P = \frac{120f}{N_S} = \frac{120 \times 50}{500} = 12$$

62. (c)

$$P_1 = 500 \text{ kW}$$
$$\cos\phi_1 = 0.8$$
$$\Rightarrow \quad \tan\phi_1 = 0.75$$
$$\cos\phi_2 = 1.0$$
$$\Rightarrow \quad \tan\phi_2 = 0.0$$
$$P_S = 20 \text{ kW}$$

Initial reactive power supplied by the alternator

$$Q_1 = P_1 \tan\phi_1 = 500 \times 10^3 \times 0.75 = 375 \text{ kVAr}$$

After connective the synchronous condenser, reactive power supplied by the alternator

$$Q_2 = (P_1 + P_S)\tan\phi_2 = (500 + 20) \times 10^3 \times 0.0 = 0 \text{ VAr}$$

i.e., Reactive power supplied by the synchronous condenser will be

$$Q_C = Q_1 - Q_2$$
$$= 375 - 0 = 375 \text{ kVAr}$$

63. (d)

All the statements are correct.

64. (b)

In order to avoid saturation in the interpoles, air gap under the interpoles are kept longer than that under the main poles.

65. (c)

Stray load losses are produced by - (i) the distortion of the air gap flux due to the armature reaction and (ii) the currents in the cumutated coil. In small d.c. machines, these losses are neglected but for the d.c. machines of about 150 KW more, they are assumed to be 1% of rated output.

66. (d)

Both the statements are correct.

67. (c)

All the methods are used to improve the commutation process in a d.c. machine.

68. (a)

Compensating winding ampere turns per pole,

$$AT_c = 0.8 \times 15000 = 12000 \text{ ATs}$$

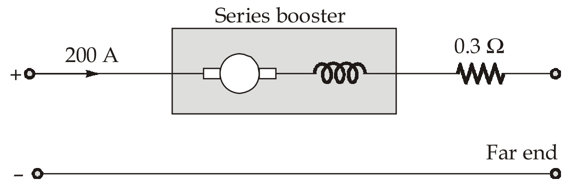
MMF required for the air gap under the interpole

$$= \frac{B}{\mu_0} \times l_g = \frac{0.5}{4\pi \times 10^{-7}} \times 1 \times 10^{-2} = 3978.87 \simeq 3979 \text{ ATs}$$

$\therefore$ Ampere turns furnished by each interpole are

$$= (15000 - 12000) + 3979 = 6979 \text{ ATs}$$

69. (b)



$$\text{Load current} = 200 \text{ A}$$

$$\text{Voltage rise due to booster} = 50 \text{ V}$$

$$\text{Voltage drop in feeder} = I_L \times \text{feeder resistance}$$

$$= 200 \times 0.3 = 60 \text{ V}$$

Voltage difference between station bus bar and far end of the feeder

$$= 60 \text{ V} - 50 \text{ V}$$

$$= 10 \text{ V}$$

70. (d)

$$\phi = (8t^4 - 3t^2) \text{ mWb}$$

$$\Rightarrow \quad \frac{d\phi}{dt} = (32t^3 - 6t) \times 10^{-3}$$

$$\text{EMF, } e = \frac{Nd\phi}{dt} = 50\left[32t^3 - 6t\right] \times 10^{-3}$$

At time $t = 2s$

$$e = 50[32(2)^3 - 6 \times 2] \times 10^{-3} = 12.2 \text{ volts.}$$

71. (c)

Both the statements are correct.

73. (d)

Both the statements are correct.

74. (a)

The difference between electromagnetic torque and prime mover torque is due to losses in iron core, friction and windage.

75. (b)

The undesirable phenomenon of hunting can be guarded against in three ways:

- By using a fly wheel.
- By designing the synchronous machine with suitable synchronizing power coefficient.
- By the employment of damper winding.
- Operating a synchronous machine at its rated load does not guarantee the avoidance of hunting, as hunting is primarily caused by variations in load or system disturbances, not by simply the load level itself.

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