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ESE 2020 : 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]

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2.	(c)	**17.**	(d)	**32.**	(a)	**47.**	(d)	**62.**	(c)
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DETAILED EXPLANATIONS
Section A : Power Electronics and Drives

1. (a)

$$V_L = L\frac{di}{dt}$$

$$\int_0^{t_2} \frac{V_L}{L} dt = \int_0^{t_2} di$$

$$\frac{1}{L}\int_0^{t_2} V_L = i(t_2) - i(0)$$

$$\int_0^{t_2} V_L = 0$$

$$\int_0^{t_1} V_L dt + \int_{t_1}^{t_2} V_L dt = 0$$

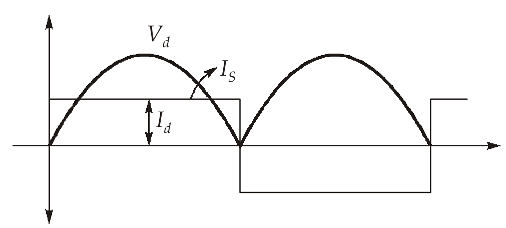
Area A = Area B

2. (c)

$$\text{Input power factor} = \frac{I_{s1}}{I_{sr}} \times DPF$$

$$g = \frac{I_{s1}}{I_{sr}}$$

$$= \left(\frac{2\sqrt{2}}{\pi} I_d\right) \times \frac{1}{I_d} = 0.9$$



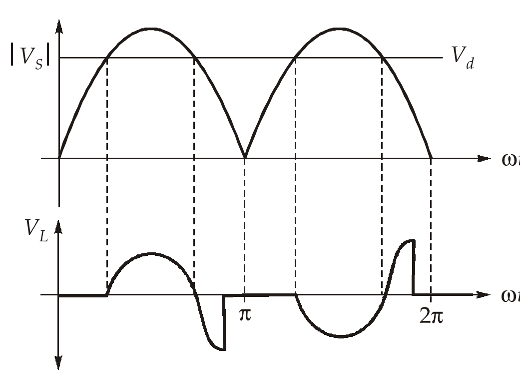
DPF = 1

(Here load is current source i.e. purely resistive)

So, DPF = cos α = 1

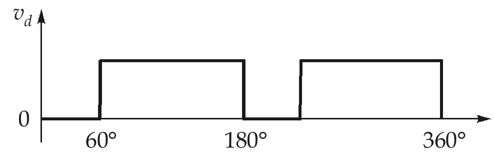
Input power factor = 0.9 × 1 = 0.9

3. (d)



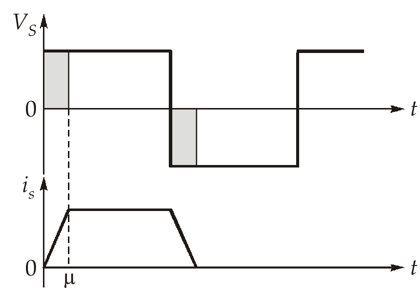
4. (d)

$$V_d = \frac{60° \times 0 + 120° \times 200}{(180°)} = 133.333 \text{ V}$$



$$P_d = V_d I_d$$
$$= 133.333 \times 10 = 1333.33 \text{ W}$$

5. (a)



$$\int_0^{\mu} 200 d(\omega t) = \omega L_s I_d$$

$$200\ \mu = 100\pi \times \frac{5}{1000} \times 10$$

$$\mu = \frac{5\pi}{200}\text{rad} = \frac{5\pi}{200} \times \frac{180}{\pi} = 4.5°$$

6. (a)

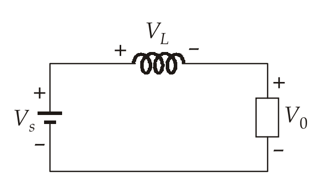
$$V_{d0} = 200 \times \frac{180°}{360°} = 100 \text{ V}$$

$$V_d = 100 - f L_s I_d$$
$$= 100 - 50 \times 5 \times 10^{-3} \times 10 = 97.5 \text{ V}$$

7. (c)

The corner frequency of the low pass filter is selected to be much lower than the switching frequency because lower corner frequency reduces the higher order harmonics.

8. (c)



When switch is on, by applying KVL,

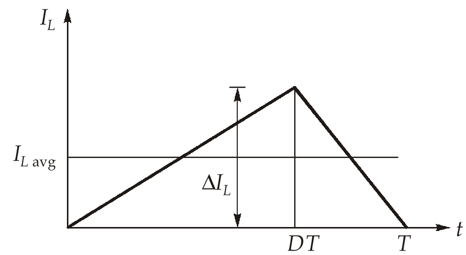
$$-V_s + V_L + V_0 = 0$$

$$V_L = V_s - V_0$$

$$V_L = L\frac{di}{dt}$$

$$\int_0^{T_{on}} \frac{V_L}{L} dt = I_{max}$$

$$I_{max} = \frac{(V_s - V_0)T_{on}}{L}$$



$$I_{L\ avg} = \frac{I_{L\max}}{2}$$

At boundary condition,

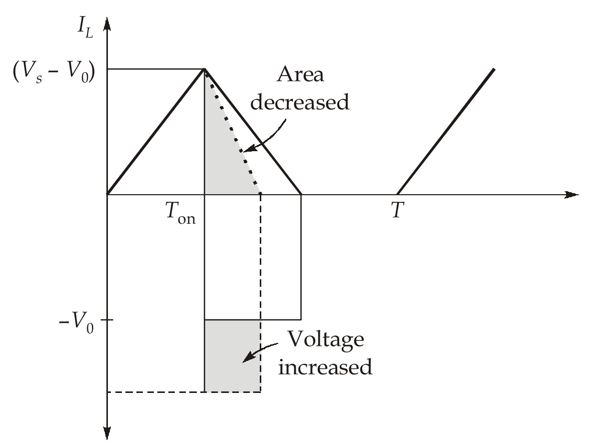
$$\therefore \quad I_{L\ avg} = \frac{(V_s - V_0)T_{on}}{2L}$$

$$= \frac{DT(1-D)V_s}{2L}$$

At boundary condition, $D = 0.5$

$$\text{Maximum, } I_{L\ avg} = \frac{V_s}{8fL}$$

9. (c)



- If load resistance increases then discharging period of inductor decreases.
- Therefore area under one time period of inductor current decreases.

- Therefore average inductor current decreases.
- To discharge in a short period the output voltage increases.

10. (d)

At the boundary condition,

$$I_0 = \frac{DV_0}{2fL}(1-D)^2$$

$$f(D) = D^3 - 2D^2 + D$$

$$f'(D) = (3D^2 - 4D + 1) = 0$$

I_0 is maximum when, $D = \frac{1}{3}$

11. (d)

Switching losses of resonant converter is less due to soft switching (zero current/zero voltage switching). They operate at higher frequency and have less electromagnetic interference. They have higher peak current and voltage so, have more conduction losses.

12. (c)

$$V_{0n} = \frac{2V_s}{n\pi}\sin n\pi\alpha$$

$$V_{01} = \frac{2V_s}{\pi}\sin\frac{\pi}{3} = \frac{\sqrt{3}V_s}{\pi}\text{ V}$$

13. (b)

If V_0 is not controlled during each switching time period at least, energy $\frac{1}{2}Li^2$ is transferred from the input to the output capacitor and to the load. If the load is not able to absorb this energy, the capacitor voltage V_0 would increase until an energy-balance is established. If the load becomes very light, the increase in V_0 may cause a capacitor breakdown or a dangerously high voltage to occur.

14. (a)

At the boundary condition,

$$I_{0B} = \frac{DV_0(1-D)^2}{2Lf}$$

$$I_{0,\,max} = \frac{120}{48} = 2.5\text{ A}$$

For V_d(12 – 36)V, D is in the range of 0.75 – 0.25 corresponding to continuous conduction

I_{0B} has smallest value for $D = 0.75$

For, $I_{0B} = I_{0\,max} = 2.5$ A

$$L = \frac{48\times 0.75(1-0.75)^2}{2\times 50\times 10^3\times 2.5} = 9\ \mu\text{H}$$

To ensure discontinuous mode, a smaller than 9 μH is used.

15. (c)

$$\eta = \frac{R(1-D)^2}{r_L + R(1-D)^2}$$

Where r_L is inductor resistance and R is load resistance,

As the duty ratio increases, efficiency of the boost converter decreases.

16. (c)

$$V_{0n} = \sum_{n=1}^{\infty} \frac{2V_s}{n\pi} \sin n\pi\alpha \cdot \sin(n\omega t + \theta_n)$$

for $n = 3$

$$\sin(3\pi\alpha) = 0$$

$$\alpha = \frac{1}{3}$$

17. (d)

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

$$\left(\frac{1}{D} - 1\right) = \frac{15}{10}$$

$$D = 0.4$$

$$I_0 = \frac{P}{V} = \frac{10}{10} = 1 \text{ A}$$

$$I_S = \frac{10}{15} = \frac{2}{3}\text{A}$$

$$I_L = I_S + I_0 = \left(\frac{2}{3} + 1\right) = \frac{5}{3} = 1.67 \text{ A}$$

$$\Delta I_L = V_S \frac{D}{fL} = \frac{15 \times 0.4}{20 \times 10^3 \times 0.05 \times 10^{-3}} = 6 \text{ A}$$

$$\frac{\Delta I_L}{2} = 3 \text{ A}$$

Since $I_L < \frac{\Delta I_L}{2}$, thefore it is discontinuous mode

$\Rightarrow$ Duty ratio, $D < 0.4$

19. (a)

Asynchronous PWM results in sub-harmonic which are undesirable for ac motor.

20. (d)

In square wave switching, each inverter switch changes its state only twice per cycle, which is of improtance at very high power levels where solid state switches generally have slower turn on and turn off speeds.

21. (c)

Over modulation causes the output voltage to contain many more harmonics in the side bands as compared to the linear range. Over modulation region in UPS is avoided because of stringent requirement on minimizing distortion in the output voltage.

23. (d)

$$V_{01} = \frac{m_a V_{dc}}{\sqrt{2}} = 0.8 \times \frac{300}{\sqrt{2}} = 169.71 \text{ V}$$

24. (c)

$$h = j(2m_f) \pm k$$
$$h = 2 \times 38 - 1 = 75$$
$$f_{75} = 75 \times 47 = 3525 \text{ Hz}$$

25. (a)

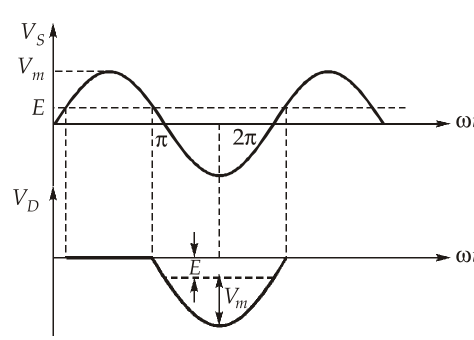
Max switch utilization factor in square wave mode,

$$= \frac{V_{01} I_{0\max}(\text{rms})}{q V_T I_T}$$

$$= \frac{4V_{d\max} \times I_{0\max}(\text{rms})}{2\sqrt{2}\pi \times 2 \times V_{d\max} \times \sqrt{2} I_{0\max}} = \frac{1}{2\pi}$$

27. (a)

Waveform of voltage across diode is



Maximum voltage across diode

$$= -\left(150 + 230\sqrt{2}\right) = -475.27 \text{ V}$$

$$\text{PIV} = 475.27 \text{ V}$$

28. (b)

$$\text{Drain current, } I_D = \frac{V_{DS}}{(R_L + R_{DSon})} = \frac{100}{(12 + 0.2)}$$

$$I_D = 8.19 \text{ A}$$

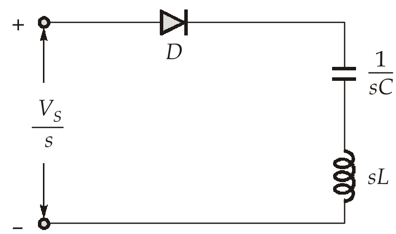
$$\text{Power loss during on time} = \frac{1}{T}\int_0^{t_{on}} I_D^2 R_{DS}\, dt$$

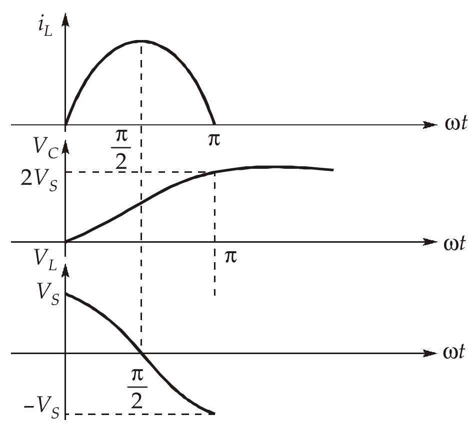
$$= I_D^2 R_{DSon} \times t_{on} \times f$$

$$= (8.19)^2 \times 0.2 \times \frac{0.7 \times T}{T}$$

$$= 9.39 \text{ W} \approx 9.40 \text{ W}$$

29. (d)





In the circuit, $$I(s) = \frac{V_S}{s\left(sL + \frac{1}{sC}\right)}$$

$$i(t) = V_S\sqrt{\frac{C}{L}}\sin \omega t$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$V_L = L\frac{di}{dt}$$

$$V_L = V_S \cos \omega t$$

$$V_C = V_S - V_L$$

$$V_C = V_S\,(1 - \cos\omega t)$$

Diode gets turn off when $i = 0$

i.e. $\omega t = \pi$

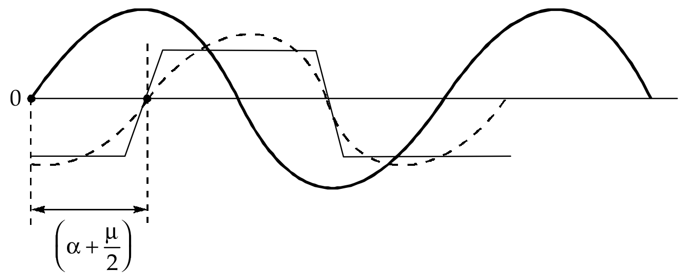
$\therefore$ $V_c = V_s(1 - \cos\pi)$

$= 2\,V_s = 2 \times 200$

$= 400$ V

30. (c)

Input current waveform can be approximated to be trapezoidal.



with this approximation

Displacement power factor,

$$\text{DPF} = \cos\left(\alpha + \frac{\mu}{2}\right) = \cos\left(30 + \frac{10}{2}\right) = \cos 35° = 0.819$$

31. (b)

In 180° mode

$$\text{Output line voltage, } V_L = \sqrt{\frac{2}{3}}V_s$$

$$\text{Phase voltage, } V_{ph} = \frac{V_L}{\sqrt{3}} = \frac{\sqrt{2}V_s}{3}$$

$$V_{\text{ph}} = \frac{\sqrt{2}}{3} \times 600 = 282.84 \text{ V}$$

Power consumed by 3-ϕ load,

$$P = \frac{3V_{ph}^2}{R} = \frac{3(282.84)^2}{80}$$

$$= 3000 \text{ W} = 3 \text{ kW}$$

32. (a)

Average output voltage in semi-converter is

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

Also, $V_0 = E + I_0 R$

$$\therefore \quad \frac{230\sqrt{2}}{\pi}[1 + \cos 60°] = 100 + 5I_0$$

$$I_0 = 11.06 \text{ A}$$

Average value of thyristor current,

$$I_{t,\text{ avg}} = I_0\left(\frac{\pi}{2\pi}\right) = \frac{I_0}{2} = \frac{11.06}{2} = 5.53 \text{ A}$$

Rms value of thyristor current,

$$I_{t,\text{ rms}} = \frac{I_0}{\sqrt{2}} = 7.82 \text{ A}$$

33. (b)

Given,

$$I_0 = 2.5 \text{ A}$$
$$\alpha = 0.75$$
$$f = 25 \text{ kHz}$$

Given circuit is Buck-boost converter,

$$\Delta V = \frac{I_0 \alpha}{fC} = \frac{2.5 \times 0.75}{25 \times 10^3 \times 150 \times 10^{-6}} = 0.5 \text{ V}$$

34. (c)

Value of capacitor, C and the variable resistor R are so selected to give a firing angle range of nearly 0° and 180°. Variable resistor R controls the charging time of capacitor C and therefore the firing angle of triac.

35. (d)

If positive gate voltage is applied between gate and cathode during the reverse blocking of a thyristor, blocking property of junction J_3 disappear as J_3 has low breakdown voltage as a result reverse voltage appears across J_1. Positive charge carriers are now injected into n^- layer of J_1, this causes in reverse leakage current. This result in high power loss across junction J_1 and it may destroy the SCR.

36. (d)

Since commutation is not required in GTO, therefore commutation losses are absent, hence higher efficiency.

37. (d)

$$V_{0n,\text{ rms}} = \frac{4V_s}{n\pi\sqrt{2}} \sin nd \cdot \sin\frac{n\pi}{2}$$

For eliminating third harmonic ($n = 3$)

$$nd = \pi$$

$$d = \frac{\pi}{3} = 60°$$

∴ pulse width $\quad 2d = 120°$

$$V_{01,\text{ rms}} = \frac{2\sqrt{2}V_s}{\pi} \times \sin 60° = \frac{\sqrt{6}V_s}{\pi} \text{ V}$$

38. (b)

For n^{th} harmonic

$$Z_n = R - jX_n$$

$$X_n = \frac{1}{n\omega C}$$

Lowest order harmonic present is 5^{th}

$$Z_n = 5 - j\left(\frac{10}{5}\right) = (5 - j2)\ \Omega$$

39. (c)

Output has three pulse in one cycle of input.

∴ Output frequency = 3 × 400 = 1200 Hz

40. (c)

$$\text{Damping ratio, } \xi = \frac{R}{2}\sqrt{\frac{C}{L}} = \frac{10}{2}\sqrt{\frac{10\times10^{-6}}{10\times10^{-3}}} = \frac{10}{2}\sqrt{\frac{1}{1000}} = \frac{1}{2\sqrt{10}}$$

$\because \xi < 1$

∴ It is an underdamped circuit.

42. (d)

During off period, inductor (L) discharges through path load, diode, i.e. source is not connected during this time

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

For, $0 < \alpha < 0.5;\quad V_0 < V_s$

$0.5 < \alpha < 1;\quad V_0 > V_s$

43. (b)

- In PWM inverters, switching frequency should be higher to filter harmonic voltages easily.
- Statement-II is the disadvantage of higher switching frequency but a correct statements.

Section B : Power Systems-1

46. (d)

All the statements are correct. The earth wire used for tele-communication purpose are called as optical ground wire (OPGW).

47. (d)

An overhead line is terminated near a station by connecting the station equipment to the OHE line through short length cable. Apart from reduction in magnitude of voltage, it also reduces the steepness of the wave. This is because of the capacitance of the cable.

48. (b)

Condenser maintains pressure below atmospheric pressure so that maximum heat energy can be extracted from steam.

49. (d)

- Rectifier consumes reactive power and inverter supplies the reactive power from/to the respective connected AC system due to the fact that reactive power cannot be transmitted over a dc link.
- DC line provides an asynchronous link and thus no need of synchronization unlike AC transmission. This is one of the advantages of DC transmission.
- Without raising fault level and CB rating, more power can be drawn into AC system via DC link.

50. (a)

For loss less line,
$$\beta = \sqrt{\omega L \cdot \omega C} = \sqrt{0.045 \times 1.2} = 0.2324$$
$$\beta = \frac{2\pi f l}{v}$$
$$l = \frac{0.2324 \times 3 \times 10^5}{2\pi \times 50} = 222 \text{ km}$$

51. (b)

Let, P_1 = load shared by 400 MW machine

P_2 = load shared by 300 MW machine

For 400 MW machine drop in frequency from no load to full load
$$= \frac{50 \times 4}{100} = 2 \text{ Hz}$$
$$f_1 = 50 - \frac{2}{400} P_1$$

For 300 MW machine drop in frequency from no load to full load
$$= \frac{50 \times 6}{100} = 3 \text{ Hz}$$

New frequency of operation of 300 MW machine,
$$f_2 = 50 - \frac{3}{300} P_2$$

We also know,
$$P_1 + P_2 = 600$$
$$P_2 = 600 - P_1$$
$$f_1 = f_2 = f \quad \text{...(units operation is in parallel)}$$
$$50 - \frac{2}{400} P_1 = 50 - \frac{3}{300}(600 - P_1)$$

$\Rightarrow$ $P_1 = 400$ MW,

$P_2 = 600 - P_1 = 200$ MW

52. (b)

Taking moments of all currents at A,
$$I_B \times 600 = 200 \times 400 + 75 \times 150 + 50 \times 100$$

$\Rightarrow$ $I_B = 160.4$ Amp

$\therefore$ $I_A = (200 + 50 + 75) - 160.4 = 164.6$ Amp

Therefore, location of point of minimum potential is 320.8 meters from end B.

The potential drop up to the minimum potential is
$$= 2 \times \frac{0.05}{1000}\left[(164.6 \times 100) + (114.6 \times 50) + (39.6 \times 50) + \frac{39.6}{2} \times 39.6\right]$$
$$= 2.5 \text{ Volts}$$
$$V_{min} = 220 - 2.5$$
$$= 217.5 \text{ Volts}$$

53. (b)

Allowing for twist we find that l = 1.05 × 2000 = 2100 m

The cross sectional area of all 19 strands is

$$19 \times \frac{\pi}{4}(1.5 \times 10^{-3})^2 = 33.576 \times 10^{-6} \text{ m}^2$$

$$R = \frac{\rho l}{A} = \frac{1.72 \times 10^{-8} \times 2100}{33.576 \times 10^{-6}} = 1.076\ \Omega$$

54. (b)

On a per phase basis,

$$V_R = 6351 \text{ V}$$

$$V_S = (1 + 0.05)\ 6351 = 6668.6 \text{ V}$$

$$Z = \sqrt{(0.3)^2 + (0.4)^2} = 0.5\ \Omega$$

$$P_{\max} = \frac{V_R^2}{Z^2}\left(\frac{ZV_S}{V_R} - R\right) = \left(\frac{6351}{0.5}\right)^2 \left(\frac{0.5 \times 6668.6}{6351} - 0.3\right) = 36.3 \text{ MW/phase}$$

Total maximum power = 3 × 36.3 = 108.9 MW

55. (a)

$$v = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.97 \times 0.0115 \times 10^{-9}}} = 2.994 \times 10^5 \text{ km/sec}$$

Line wave length is $\lambda = \frac{v}{f} = \frac{1}{50} \times 2.994 \times 10^5 = 5988$ km

56. (b)

$$C_A = 0.90\ \mu\text{F/km},$$

$$C_B = 0.40\ \mu\text{F/km}$$

$$C_1 = \frac{1}{3}C_A = 0.3\ \mu\text{F/km}$$

$$C_2 = \frac{1}{2}(0.4 - 0.3) = 0.05\ \mu\text{F/km}$$

$$C_n = C_1 + 3C_2 = 0.3 + 3 \times 0.05 = 0.45\ \mu\text{F/km}$$

For 20 km, $= 20 \times 0.45 = 9.0\ \mu$F for 20 km

57. (a)

$$P_{\text{out}} = \frac{5000 \times 746}{1000} = 3730 \text{ kW}$$

$$P_{\text{input}} = \frac{P_{\text{out}}}{\eta} = \frac{3730}{0.8} = 4662.5 \text{ kW} = \text{active power drawn}$$

$$\text{Apparent power} = \frac{\text{Active power}}{\text{p.f.}} = \frac{4662.5}{0.85} = 5485.3 \text{ kVA}$$

58. (c)

Given, Maximum demand = 15 MW

$$\text{L.F.} = \frac{\text{Average demand}}{\text{Max. demand}} = 0.5$$

$\Rightarrow$ Average demand = 7.5 MW

$\because$ Reserve capacity = Plant capacity – Maximum demand

4 = Plant capacity – 15

$\Rightarrow$ Plant capacity = 19 MW

$$\because \quad \text{Plant capacity factor} = \frac{\text{Average demand}}{\text{Plant capacity}} = \frac{7.5}{19}$$

$$= 0.395 \approx 39.5\%$$

Section C : Electrical Machines-2

61. (c)

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

62. (c)

A synchronous machine is a constant speed machine, so the real power can be varied by controlling the torque imposed on shaft of machine by prime mover or mechanical load in case of generator and motor respectively. Field current can vary reactive power in synchronous machine.

63. (d)

We know, $E_f^2 = (V_t \cos\theta + I_a r_a)^2 + (V_t \sin\theta + I_a x_s)^2$

As resistance in armature is negligible,

$$r_a = 0$$

$$E_f^2 = (V_t \cos\theta)^2 + (V_t \sin\theta + I_a x_s)^2$$

$$E_f^2 = V_t^2\left[\cos^2\theta + \left(\sin\theta + \frac{I_a x_s}{V_t}\right)^2\right] \quad \text{...(i)}$$

Also synchronous reactance in p.u.

$$x_{\text{p.u.}} = \frac{I_a x_s}{V_t} = 0.10 \text{ p.u.}$$

and power factor, p.f. = cos θ = 0.80 lagging and sin θ = 0.6

Now using relation,

$$E_f^2 = V_t^2\left[(0.8)^2 + (0.6 + 0.1)^2\right]$$

$$E_f = V_t[0.64 + 0.49]^{1/2} = 1.063 V_t$$

$$\text{Voltage regulation} = \frac{E_f - V_t}{V_t} = \frac{1.063V_t - V_t}{V_t} = 0.063 \times 100 = 6.30\%$$

64. (b)

Assuming R_a to be negligible,

$$\vec{E}_f = \vec{V}_t + j\vec{I}_a X_s$$

For a given field current under short circuit condition,

Armature current, $I_a = I_{sc}$

Terminal voltage, $V_t = 0$

$$X_S = \frac{E_f}{I_{sc}}$$

But $E_f = V_{0C}$ at open circuit condition as $I_a = 0$

$$X_S = \left.\frac{V_{0C}}{I_{SC}}\right|_{I_f = \text{constant}} = \frac{1000}{400} = 2.5\Omega$$

Internal voltage drop, $I_a X_s = 300 \times 2.5$
$= 750$ V

65. (d)

All given statements regarding over excited synchronous motor are correct as it behaves as a capacitor consuming leading VARs and has a demagnetizing armature reaction.

66. (a)

Transient d-axis reactance value is smaller compared to synchronous reactance.

67. (c)

$$\text{Slope of first alternator} = \frac{1000}{4} = 250 \text{ kVA/Hz}$$

$$\text{Slope of second alternator} = \frac{1000}{2} = 500 \text{ kVA/Hz}$$

Let the operating frequency of interconnected system by "f"

$$250(50 - f) + 500(50 - f) = 1500$$

$$\frac{250}{1500}(50 - f) + \frac{500}{1500}(50 - f) = 1$$

$$\frac{1}{6}(50 - f) + \frac{1}{3}(50 - f) = 1$$

$$\frac{50}{6} - \frac{f}{6} + \frac{50}{3} - \frac{f}{3} = 1$$

By solving for f value, $f = 48$ Hz

68. (a)

We know,

For duplex winding, $m = 2$

The number of current paths in dc machine,

$$A = mP$$
$$= 2 \times 6 = 12$$

Number of conductors in dc machine,

$$Z = \text{total turns} \times 2$$
$$\text{total turns} = \text{No. of coils} \times \text{No. of turns on each coil}$$
$$= 70 \times 12 = 840$$
$$Z = 2 \times 840 = 1680$$

The induced emf in dc machine,

$$E = \frac{P\phi NZ}{60 \times A}$$
$$= \frac{6 \times 0.05 \times 800 \times 1680}{60 \times 12} = 560 \text{ V}$$

69. (c)

The interpole polarity should be equal to polarity of main pole ahead in generator rotation direction.

70. (b)

- Field weakening method can be used to control speeds above rated speeds.
- In Rheostatic control of speed is possible only below rated speed.

71. (c)

In series motor, $E = V - IR$

Also, $E = K\,\phi\,N$

So, $$N = \frac{V - IR}{K\phi}$$

In series motor, $\phi \propto I$

Given, system is constant power load,

or $E \times I = \tau \times \omega = \text{constant}$

$$\tau = K_a\phi I \text{ or } \tau = K_a I^2$$

If ω is decreased to 0.5 times its rated value torque increases by 2 times for same power as $\tau \propto I^2$

If torque becomes twice of initial value current becomes $\sqrt{2}$ times.

$\therefore$ The supply voltage should be approximate brought down by $\frac{1}{\sqrt{2}}$ times for new speed of 0.5 p.u.

New supply voltage = 0.707 p.u.

72. (c)

Given, At no load

$$I_0 = 0,$$
$$N = 1200 \text{ rpm}$$
$$E_a = V = 200 \text{ V}$$

At speed, $N' = 1000$ rpm so let new back emf be E'

$$N \propto E_a$$
$$\frac{N}{N'} = \frac{200}{E'}$$

or
$$\frac{1200}{1000} = \frac{200}{E'}$$
$$E' = \frac{200 \times 1000}{1200} = \frac{500}{3} \text{V}$$

Armature current,
$$I_a = \frac{T\omega}{E_a} = \frac{\frac{4}{\pi} \times \frac{1000 \times 2\pi}{60}}{\frac{500}{3}} = \frac{4}{\pi} \times \frac{1000 \times 2\pi}{60} \times \frac{3}{500} = 0.8 \text{ A}$$
$$I_a R_a = V - E$$
$$0.8\, R_a = 200 - \frac{500}{3}$$
$$R_a = \frac{100}{3 \times 0.8} = 41.67\ \Omega$$

73. (c)

Swinburne's test is applicable to those machines in which the flux is practically constant, that is shunt machines and level compound generators.

74. (a)

Both statements are correct and statement-II is correct explanation of statement-I.

75. (c)

Terminal voltage is dependent on number of series turns and $I_a(R_A + R_{SE})$ drop which decide under compounded nature for compound dc generator.

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