TEST ID: 309

ESE- 2019 (Prelims) - Offline Test Series Test-17

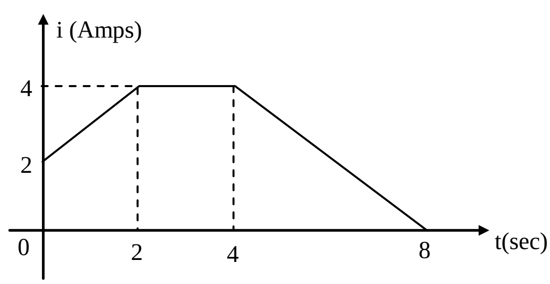
ELECTRICAL ENGINEERING

SUBJECT: ELECTRIC CIRCUITS & FIELDS + MATERIAL SCIENCE AND ELECTRICAL MACHINES SOLUTIONS

01. Ans: (b)

Sol: Given data L = 2H

Current waveform



(i) voltage across the inductor

$$V_L(t) = L\frac{di(t)}{dt}$$

Case (i)

$0 < t < 2$

$i(t) = t + 2$

$$V_L = 2\times\frac{d}{dt}(t+2)$$

$V_L = 2V$

Case (ii)

$2 < t < 4$

$i(t) = 4$

$V_L = 2\times0$

$= 0$

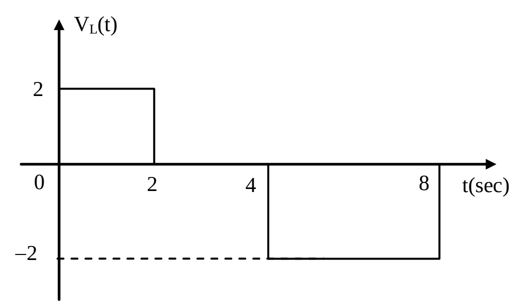
Case (iii)

$4 < t < 8$

$i(t) = 8 - t$

$$V_L = 2\frac{d}{dt}(8-t)$$

$= -2$ V

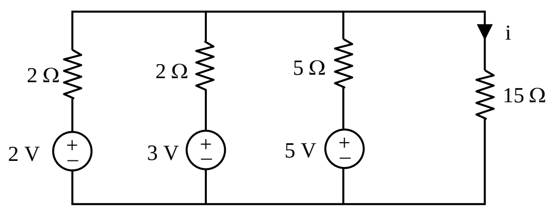


$$\text{Average voltage} = \frac{(2\times2)+(4\times-2)}{8}$$

$= -0.5V$

02. Ans: (a)

Sol: The given circuit



$$V_{eq} = \frac{V_1G_1 + V_2G_2 + V_3G_3}{G_1 + G_2 + G_3}$$

Where G is conductance

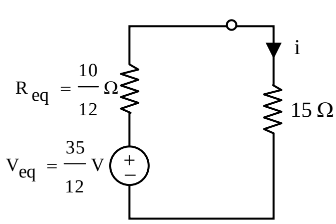
$$= \frac{\frac{2}{2}+\frac{3}{2}+\frac{5}{5}}{\frac{1}{2}+\frac{1}{2}+\frac{1}{5}}$$

$$= \frac{10+15+10}{5+5+2} = \frac{35}{12}\text{V}$$

$$R_{eq} = \frac{1}{G_1 + G_2 + G_3}$$

$$= \frac{1}{\frac{1}{2}+\frac{1}{2}+\frac{1}{5}} = \frac{10}{12}\Omega$$

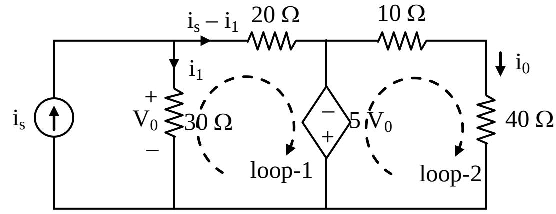
The milliman's equivalent circuit



$$i = \frac{\frac{35}{12}}{\frac{10}{12}+15} = 0.184 \text{ A}$$

03. Ans: (b)

Sol: The given circuit



Apply KVL in loop-(1)

$-V_0 + 20(i_s - i_1) - 5V_0 = 0$

$20(i_s - i_1) - 6V_0 = 0$ ……. (i)

but $V_0 = 30\, i_1$

substitute V_0 in equation (i)

$20(i_s - i_1) - 6(30\, i_1) = 0$

$i_s = 10\, i_1$ …….. (ii)

Apply KVL in loop-(2)

$5V_0 + (10 + 40)i_0 = 0$ …… (iii)

but $V_0 = 30\, i_1$

substitute V_0 in equation (iii)

$5(30\, i_1) + 50\, i_0 = 0$

$150\, i_1 = -50\, i_0$

$i_1 = -\frac{1}{3} i_0$ ……… (iv)

solving equation (ii) and (iv)

$$i_s = 10\left(-\frac{1}{3}\right) i_0$$

$$\frac{i_0}{i_s} \Rightarrow -\frac{3}{10} = -0.3$$

04 . Ans: (b)

Sol: R = 150 Ω, L = 30 mH,

V_S = 12 V, I = 50 mA

The current through coil is given by

$i(t) = i(\infty) + [i(0) - i(\infty)]e^{-t/\tau}$

$$i(t) = \frac{V_S}{R} + \left(0 - \frac{V_S}{R}\right)e^{-\frac{t}{\tau}}$$

$$\tau = \frac{L}{R} = \frac{30\times10^{-3}}{150} = \frac{1}{5000}$$

$$50\times10^{-3} = \frac{12}{150} - \frac{12}{150}e^{-5000t}$$

$$e^{-5000t} = \frac{3}{8}$$

$$-5000t = \ell n\left(\frac{3}{8}\right)$$

t = 0.196 msec

Relay delay time t = 0.196 msec

05. Ans: (a)

Sol: $Z_{11} = \frac{A}{C} = \frac{4}{3}$

06. Ans: (b)

Sol: Since maximum current is 5 A

$$E_{max} = \frac{1}{2}LI^2_{max} = \frac{1}{2}(2m)(25) = 25 \text{ mJ}$$

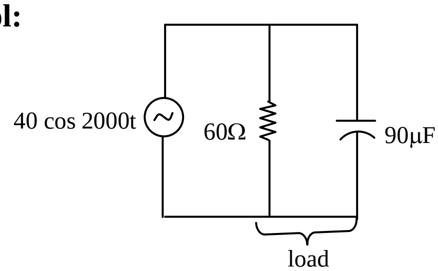
07. Ans: (b)

Sol: $I_L = I_{ph} = \frac{V_{ph}}{|Z_{ph}|} = \frac{440/\sqrt{3}}{\sqrt{100+400}} = \frac{440}{10\sqrt{15}}$

$$= \frac{44}{\sqrt{15}} \approx 11.4 \text{ A}$$

08. Ans: (b)

Sol:



P_{avg} = Active power = Real power

$$P = \frac{V_{Rms}^2}{R} = \frac{\left[\frac{40}{\sqrt{2}}\right]^2}{60}$$

$$= \frac{40\times40}{2\times60} = \frac{80}{6} \approx 13.33 \text{ W}$$

09. Ans: (a)

Sol: $V_L = \frac{V}{R_1 + j\omega L}(j\omega L)$

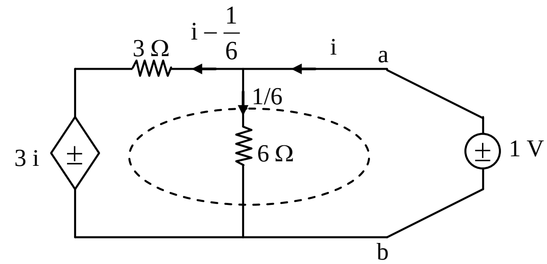
$$= \frac{V}{1+\left(\frac{1}{j\omega\sqrt{LC}}\right)} \qquad \because R_1 = \sqrt{\frac{L}{C}}$$

$$V_{R2} = \frac{V}{R_2 + \frac{1}{j\omega c}}R_2$$

$$= \frac{V}{1+\left[\frac{1}{j\omega\sqrt{LC}}\right]} \qquad \because R_2 = \sqrt{\frac{L}{C}}$$

10. Ans: (b)

Sol:



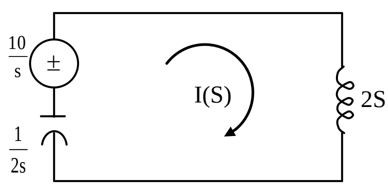
$$-1+3i-\frac{1}{2}+3i=0$$

$$6i=\frac{3}{2}\Rightarrow i=\frac{1}{4}$$

$$\text{So, } R_{th}=\frac{1}{i}=\frac{1}{1/4}=4\ \Omega$$

11. Ans: (a)

Sol :



$$I(s)\left[2s+\frac{1}{2s}\right]=\frac{10}{s}$$

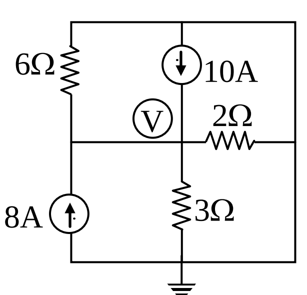
$$\Rightarrow I(s)\left[\frac{4s^2+1}{2s}\right]=\frac{10}{s}$$

$$I(s)=\left[\frac{20}{4s^2+1}\right]=\frac{5}{s^2+\left(\frac{1}{2}\right)^2}$$

$$i(t)=10\sin\frac{t}{2}$$

12. Ans: (b)

Sol:



By nodal analysis $\frac{V}{3}+\frac{V}{2}+\frac{V}{6}=10+8$

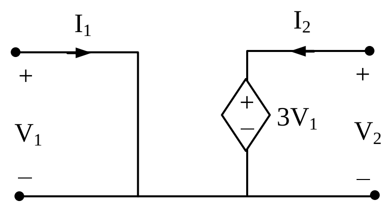
V = 18V

Power delivered by source

= (18×8)+(10×18) = 324W

13. Ans: (d)

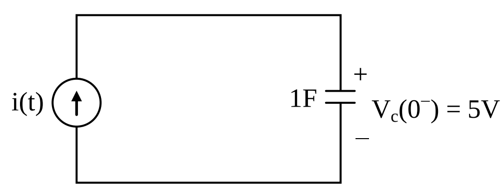
Sol: Given network



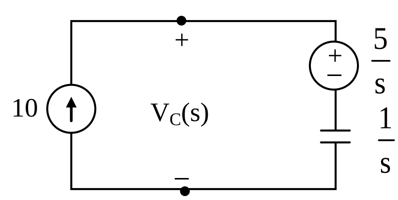
As we are unable to write I_1 interms of V_1 and V_2 therefore Y parameters doesn't exist.

14. Ans: (d)

Sol: At t= 0^+ the circuit is



Convert into Laplace domain



$$\Rightarrow V_C(s)=\frac{5}{s}+\frac{1}{s}\times 10=\frac{15}{s}$$

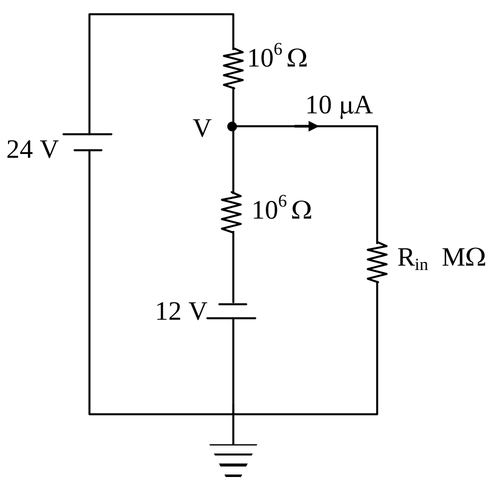
$\Rightarrow v_C(t) = 15\,u(t)$

At $t = 0^+ \Rightarrow u(t=0^+) = 1$

$\Rightarrow v_C(0^+) = 15$ V

15. Ans: (c)

Sol: Redrawn the given circuit as shown



By applying Nodal at V

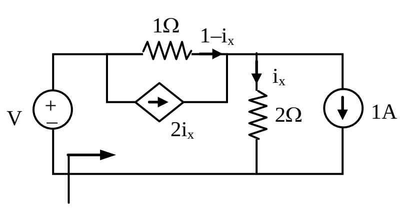
$$\frac{V+12}{1M} + \frac{V-24}{1M} + 10\,\mu A = 0$$

$\Rightarrow V = 1$

$$R = \frac{1}{10\mu} = 100\,k\,\Omega$$

16. Ans: (a)

Sol:



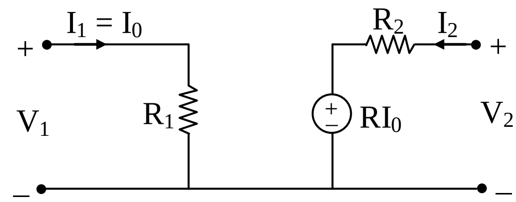
$$R_{eff} = \frac{V}{i_T} = \frac{V}{(1+i_x)}$$

KVL: $-V+1(1-i_x) + 2\,i_x = 0$

$$\Rightarrow \frac{V}{(1+i_x)} = 1\Omega$$

17. Ans: (a)

Sol:



By KVL $V_1 = I_1R_1$ ------(1)

Here $I_0 = I_1$

By KVL

$V_2 = I_2R_2 + RI_1$

$V_2 = RI_1 + R_2I_2$ -----(2)

Compare equation (1) and (2) with general of Z-Parameters.

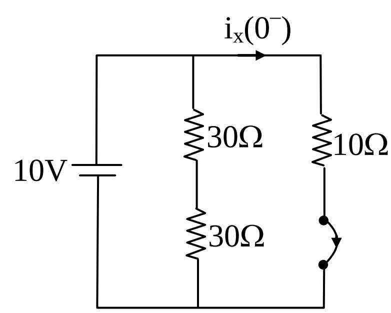
$V_1 = Z_{11}I_1 + Z_{12}I_2$

$V_2 = Z_{21}I_1 + Z_{22}\,I_2$

$$\text{Z-Parameters} = \begin{bmatrix} R_1 & 0 \\ R & R_2 \end{bmatrix}\Omega$$

18. Ans: (a)

Sol: Circuit at $t = 0^-$



$$\therefore i_x(0^-) = \frac{10}{10} = 1A$$

19. Ans: (c)

Sol: From Faraday's law

$$\oint \overline{E}.d\bar{l} = -\frac{d}{dt}\int_S \overline{B}.d\bar{s}$$

$$E_\phi(2\pi\rho) = -\frac{d}{dt}\int_{\rho=0}^{\rho}\int_{\phi=0}^{2\pi} B_0 e^{kt}\rho d\rho d\phi$$

$$E = -\frac{1}{2}B_0 k e^{kt}\rho\hat{a}_\phi$$

20. Ans: (c)

Sol: $\nabla.\overline{D} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 \times \frac{2\cos\theta}{r^3}\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta \times \frac{\sin\theta}{r^3}\right)$

$$= \frac{-2\cos\theta}{r^4} + \frac{2\cos\theta}{r^4} = 0$$

21. Ans: (c)

Sol: Net flux through S_1= –2Q+Q= –Q C

Net flux through S_2= +Q– Q =0

Net flux through S_3 = –2Q +Q– Q = –2Q C

Net flux through S_4 = +Q C

22. Ans: (c)

Sol: $\bar{v} \,||\, \overline{B}$

So, $V_{emf} = 0$

23. Ans: (d)

Sol: $V_{PQ} = \frac{B\omega(2\ell)^2}{2} = 2B\omega\ell^2 = 100$

$$B\omega\ell^2 = 50V$$

$$V_{PM} = \frac{B\omega\ell^2}{2} = \frac{50}{2} = 25V$$

$V_{PM} + V_{MQ} = V_{PQ}$

$V_{MQ} = 100 - 25$

$V_{MQ} = 75V$

24. Ans: (a)

Sol: $\overline{F} = Q(\bar{v} \times \overline{B})$

$m\bar{a} = Q(\bar{v} \times \overline{B})$

$\bar{a} \perp \bar{v}$

$\bar{a} \perp \overline{B}$

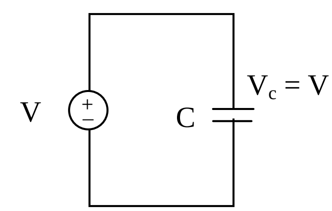
so, $\bar{a}.\overline{B} = 0$

$-6 + 2x + 0 = 0$

$x = 3$

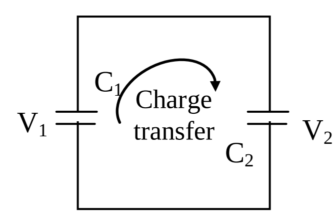
25. Ans: (b)

Sol: (1)



$$W = \frac{1}{2}CV^2$$

(2)



The charge transfer takes place between C_1 and C_2 until $V_1 = V_2 = \frac{V}{2}$.

$\therefore C_{eq} = C_1 + C_2 = 2C$

$\therefore$ Energy stored $W' = \frac{1}{2}C_{eq}\left(\frac{V}{2}\right)^2$

$$= \frac{1}{2}(2C)\frac{V^2}{4}$$

$$W' = \frac{1}{2}\left(\frac{1}{2}CV^2\right)$$

$$W' = \frac{1}{2}W$$

26. Ans: (a)

Sol: Sphere r = 5 encloses the spherical surface r = 1, 2 and 3. Hence Q = charge enclosed by spherical surfaces(r = 5) = charge present on (r = 1) + charge present on (r = 2) + charge present on (r = 3)

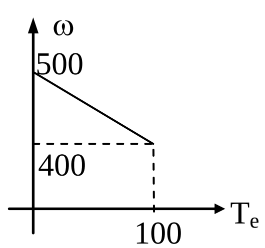
$Q = 20\times 4\pi(1)^2 - 9\times4\pi(2)^2 + 2\times 4\pi(3)^2$

$= 8\pi$ nC= flux leaving through surfaces.

27. Ans: (d)

Sol: Slope = $\frac{r_a}{(k_a\phi)^2}$

$$\frac{100}{100} = \frac{r_a}{(k_a\phi)^2} \quad \text{-------- (1)}$$



No-Load speed

$$\omega_o = \frac{V_t}{k_a\phi} \Rightarrow k_a\phi = \frac{500}{500} = 1$$

From Equation (1), $r_a = (1)\,(1)^2 = 1\Omega$

28. Ans: (b)

Sol: $S_1 = 0.025$, Rotor winding Resistance /ph

$$= \frac{0.06}{2} = 0.03$$

$$S_2 = \frac{600-480}{600} = 0.2,$$

$$N_s = \frac{120\times50}{10} = 600\text{rpm}$$

$\frac{S_1}{R_{21}} = \frac{S_2}{R_{22}}$, for constant torque load

$$R_{22} = R_2 + R_e = \frac{S_2}{S_1}\times R_{21}$$

$$= \frac{0.2}{0.025}\times 0.03 = 0.24$$

$R_e = 0.24 - 0.03 = 0.21\Omega$

29. Ans: (c)

Sol: For the production of steady state torque, one of the requirement is that relative speed between the two fields should be zero.

The speed of rotation of stator flux

$$= \frac{120\times50}{6} = 1000 \text{ rpm}$$

The speed of rotation of rotor flux

$$= \frac{120\times10}{6} = 200 \text{ rpm}$$

$\therefore$ The rotor will have to rotate at a speed of 1000 – 200 = 800 rpm in the same direction of rotating fields.

30. Ans: (b)

Sol: Equation of maximum torque in an induction motor is, $T_{max} = \dfrac{180}{2\pi N_s} \times \dfrac{E_2^2}{2X_2}$

So we can say that, the maximum torque will not depend on rotor resistance but it depends on stand still rotor reactance (i.e. inversely proportional. So option 'c' is wrong).

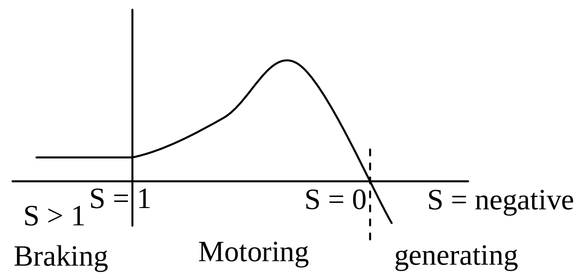
Slip corresponds to maximum torque is, $s_m = \dfrac{R_2}{X_2}$. With the variation of rotor resistance, the slip corresponds to maximum torque varies, so the speed (N_m) at which maximum torque produced is also varies $\left(\because N_m = N_s(1 - s_m)\right)$. (so option 'b' is correct).

So we can say that, although the maximum torque does not depend on rotor resistance, yet the speed at which maximum torque is produced depends on rotor resistance.

In the stable operation region of torque slip characteristics, as slip increases torque increases. We will not operate the induction motor in unstable region of torque slip characteristics.

31. Ans: (d)

Sol:



32. Ans: (b)

Sol: $x_2 \propto (N_{ph})^2 \Rightarrow x_2^1 = 4x_2$

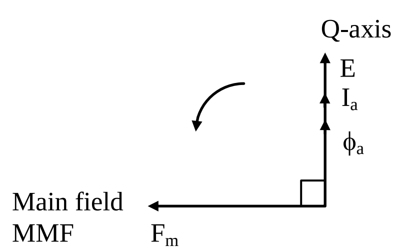
$$T_{max} = \frac{3V^2}{\omega_s}\frac{1}{2x_2}$$

$$T_{max} \propto \frac{1}{x_2}$$

$$T_{max\ new} = \frac{1}{4}\ T_{max\ old}$$

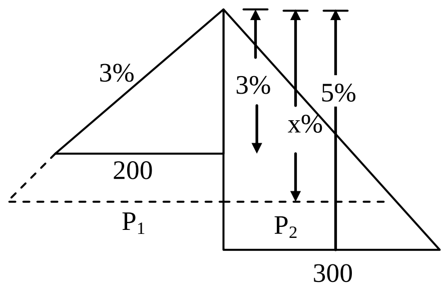
33. Ans: (c)

Sol: From the phasor diagram it can be observed that armature reaction flux will be 90° lag with main field axis.



34. Ans: (c)

Sol:



$$\frac{P_1}{200} = \frac{x}{3} \Rightarrow P_1 = \frac{200}{3}x$$

$$\frac{P_2}{300} = \frac{x}{5} \Rightarrow P_2 = \frac{300}{5}x$$

$P_1 + P_2 = 190$

$$\frac{200}{3}x + \frac{300}{5}x = 190$$

$$\frac{1000x + 900x}{15} = 190$$

$$x = 1.5$$

$$\therefore P_1 = \frac{200}{3}x = \frac{200}{3} \times 1.5 = 100kW$$

$$\therefore P_2 = \frac{300}{5}x = \frac{300}{5} \times 1.5 = 90kW$$

35. Ans: (a)

Sol: We know that voltage Regulation $\propto Z_s$.

In synchronous impedance method, voltage regulation is measured corresponding to un-saturated 'Z_s'value. But from OCC & SCC curves, the unsaturated 'Z_s' value is more than the saturated 'Z_s' value, such that the value of voltage regulation in this method is more than actual value, so called as "pessimistic method".

36. Ans: (d)

Sol: Before the short-circuit, there will be induced emfs in the phases, but no phase currents. After the short-circuit, these emfs circulate currents in the phases. The rotating mmf produced by these phase currents rotates at the same speed and in the same direction as the rotor. Hence the stator mmf and rotor are stationary with respect to each other. It can be shown that the stator mmf axis coincides with the direct-axis or field axis.

Initially, the flux produced by the armature mmf must pass through leakage paths which do not link with either the damper winding or the field winding, since the flux linkages of these closed windings cannot change instantaneously as per the constant flux linkage theorem. (In the steady state, of course, the armature flux is through the direct-axis and links with these windings).

37. Ans: (d)

Sol: **A $\rightarrow$ 4:** Even if field current is true, the salient pole synchronous machine will d evelop the reluctance torque by taking reluctance power from bus bar.

B $\rightarrow$ **6:** The effect of reactance voltage is neutralized by using commutating poles.

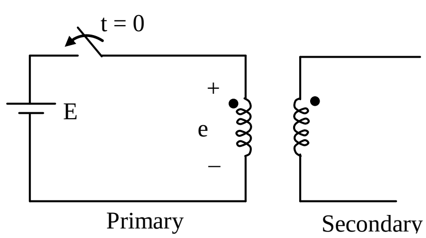
C $\rightarrow$ **7:** The motor cannot accelerate to its full speed but continues to run at a speed a little lower then the $1/7^{th}$ synchronous speed. The motor is now said to be crawling.

D → 3: In plugging mode, armature terminals are reversed so that motor tends to run in the opposite direction speed gradually decreased.

E → 5: Zero power factor method (or) potier method is used for alternator to find voltage regulation.

38. Ans: (c)

Sol:



$e = N\dfrac{d\phi}{dt}$

for $t \geq 0^+$; e = E

$\therefore \dfrac{d\phi}{dt} = \dfrac{E}{N}$

So core flux keeps increasing at a constant rate, and DC voltages are induced primary and secondary. The current drawn by the primary, which is the magnetizing current, keeps increasing to provide the increasing core flux; and so is not DC.

If E is suddenly replaced by a short – circuit at some t > 0; e must be zero. The flux and primary current must remain constant there after, there will be no decay.

39. Ans: (b)

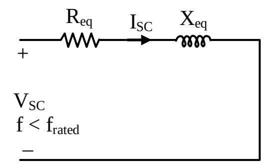
Sol: %R = 6%, % x = 8 %

% Z = 10%

$$I_{pu} = \frac{1}{0.1} = 10\,\text{p.u}$$

40. Ans: (c)

Sol:



R_{eq} = constant

X_{eq} decreases as frequency decrease

Z_{eq} decreases

$I_{SC} = \dfrac{V_{sc}}{Z_{eq}}$ increases. Hence copper losses increase.

Short circuit power factor = $\dfrac{R}{Z_{eq}}$ increases

41. Ans: (c)

Sol: Velocity × time of commutation = brush width

$V \times 0.6 \times 10^{-3} = 2.2 \times 10^{-2}$

$V = \dfrac{220}{6}$ m/sec

= 36.66 m/sec = 3666 cm/sec

42. Ans: (b)

Sol: $I = \dfrac{V}{\sqrt{(r_2/s)^2 + x^2}}$

(neglecting stator resistance)

When slip, s = 0 (rotor speed = synchronous speed) I = 0.

When slip, s = 1 (speed = 0); $I = \dfrac{V}{\sqrt{r_2^2 + x^2}}$.

Larger the value of the rotor resistance r_2; smaller will be the rotor current at stand still. Hence $r_1 < r_2 < r_3$

43. Ans: (a)

Sol: For perfect sharing of load, the per unit impedances of transformers based on respective kVA rating should be equal.

44. Ans: (d)

Sol: As lamination size is thin, resistance offered by the each laminated part of core is increased, hence the magnitude of eddy current will decrease and therefore corresponding loss will be decreased.

45. Ans: (d)

Sol: Speed of dc shunt motor, $N \propto \dfrac{E_b}{\varphi} \propto \dfrac{V - I_a R_a}{\varphi}$,

but generally 'R_a' is small, hence 'I_aR_a' term is neglected

$\Rightarrow E_b \propto V$

Therefore speed, $N \propto \dfrac{E_b}{\varphi} \propto \dfrac{V}{\varphi}$

From data, as 'V' is half, 'ϕ' becomes half $\left(\because \phi = \dfrac{V}{R_{sh}}\right)$,

Therefore, speed becomes constant $\left(\because N \propto \dfrac{V}{\varphi}\right)$.

Also given that torque, $T \propto N^2$; but motor torque, $T \propto \phi.I_a$........(1)

Since speed is not changed even 'V' is half, torque also remain unchanged.

From eqn. (1), to get constant torque with field flux fallen to half, armature current has to be doubled.

i.e., $T \propto \left(\dfrac{\phi}{2}\right)(2.I_a)$ =Torque remain constant.

46. Ans: (d)

Sol: Speed $\propto$ frequency

$$\frac{N_1}{N_2} = \frac{f_1}{f_2}$$

$$\Rightarrow f_2 = \frac{f_1}{2}$$

Given Flux is maintained constant,

$$\Rightarrow \frac{V}{f} \text{ constant}$$

$$W_h \propto f \quad \Rightarrow W_{h2} = W_{h1} \times \frac{f_2}{f_1} = 250 \text{ W}$$

$$W_{e2} = W_{e1} \times \left(\frac{f_2}{f_1}\right)^2 = 50 \text{ W}$$

$\therefore$ Total losses = 250 + 50 = 300 W

47. Ans: (b)

Sol: $R_{path} = 6 \times 0.04$

For wave winding $R_a = \dfrac{R_{path} \times 3}{2}$

$$= 6 \times \frac{0.04 \times 3}{2} = 0.36$$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48. Ans: (d)

Sol: The nano particles from iron and palladium were synthesized and they are used to produce the magnetic storage devices. They produce only tera byte storage capabilities.

49. Ans: (b)

Sol: The fabrication of the ceramic is easier through the nano structuring fabrication is the process of producing the things.

50. Ans: (c)

Sol: The extensively used nano particles as catalyst are gold. Some of them are molybdenum, cerium oxide and nickel.

51. Ans: (c)

Sol: Since steels have very small amount of carbon (usually less than 6%) they are considered iron alloy. Hence metallic solid.

52. Ans: (b)

Sol: Void fraction = 1 – packing fraction

Packing fraction is 0.74

= 1 – 0.74

= 0.26

53. Ans: (b)

Sol: Maximum value of incident angle can be 90° for which sine is 1. Hence $d = \lambda/2$

$(n\lambda = 2d.\sin\theta)$

54. Ans: (d)

Sol: Cesium chloride has a simple cubic structure with a coordination number of 8.

55. Ans: (a)

Sol: A linear configuration is formed when two anions bond with cation. This configuration is the only possible stable configuration for $0 < x < 0.155$. The number of nearest neighbour (or) the coordination number is two.

56. Ans: (a)

Sol: For dense silicate ceramic, water absorption percentage should be less than 2% for fine structure and less than 6% for coarse structure.

57. Ans: (c)

Sol: Aluminum oxide reaches fracture point before glass in aluminum oxide for a large amount of stress little strain is produced.

58. Ans: (a)

Sol: Brass which is not a pure metal but combination of copper & zinc. It contains 65% copper and 35% zinc. This non ferrous metal very corrosive, yellow in colour, tarnishes very easily. It is harder than copper and it's good electrical conductor.

59. Ans: (c)

Sol: The minimum amount of current passed through the body of super conductor in order to destroy the superconductivity is called critical current.

60. Ans: (d)

61. Ans: (d)

Sol: The number of nearest neighbors (co-ordination number) of HCP crystal = 12.
The number of nearest neighbors (co-ordination number) of FCC crystal = 12.
So difference is = 12 – 12 = 0.

62. Ans: (a)

Sol: A paramagnetic material is characterized by a very small and positive susceptibility when placed in strong magnetic fields, they display magnetic movement that are parallel to the applied field.

63. Ans: (a)

Sol: Ferrites are organic chemical compounds. They are having following properties.
1. High resistivity
2. Low eddy current losses
3. Soft magnetic in nature.
4. They are used as material in high frequency transformers.

64. Ans: (b)

Sol: $\chi \propto \dfrac{1}{T}$

$$\Rightarrow \frac{\chi_1}{\chi_2} = \frac{T_2}{T_1}$$

$$\Rightarrow \frac{3\times10^{-4}}{\chi_2} = \frac{400}{300}$$

$\chi_2 = 2.25 \times 10^{-4}$

65. Ans: (a)

Sol: A good conductor of electricity is as follows:
1. It's conductivity decreases with increasing temperature
$$\rho_{t2} = \rho_{t1}[1+\alpha(T_2 - T_1)]$$
2. Number of free electrons is around 10^{28} per m^3
3. It's conductivity decreases with addition of impurities
4. There also possess good thermal conductivity.

66. Ans: (c)

Sol: At 0°K, neighbouring atomic magnetic moments are frozen with magnetic dipoles pointing in opposite directions.

67. Ans: (a)

Sol Good conductors like silver, copper and gold do not show the superconductivity.

Based on BCS (Bardeen-cooper-Schrieffer) theory electrons and phonons interaction leads to formation copper pairs in good conducting metals so that do not show the superconductivity.

68. Ans: (b)

Sol: **Statement I** & **Statement II** both are correct. But **Statement II** is not correct explanation, since stray loses are unequal due to field current difference.

69. Ans: (c)

Sol: Statements 1: In squirrel cage rotors, the rotor bars are designed to fit the rotor slots tightly and to extend only a short length at each end of the slots. Hence the dimensions of the overhang are small, and corresponding leakage flux also is small. Thus the net leakage reactance/phase is smaller. Statements I is correct.

(The rotor bars have to fit the slots tightly. Otherwise the bars will be damaged by mechanical vibrations and by repeated heating and cooling).

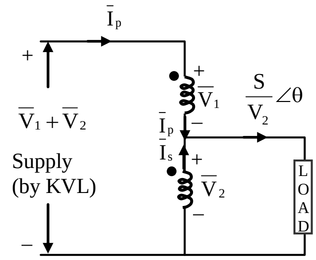
Statements 2: An approximate expression for the maximum torque or pull-out torque is as follows.

$$T_{max} = \frac{3V^2}{2\omega_s X_2}$$

With a smaller X_2, T_{max} (or $T_{pull\text{-}out}$) is larger. Statements II is wrong.

70. Ans: (d)

Sol:



The input VA must equal the output VA, since there are no impedances any where.

$\therefore$ $(V_1 + V_2)I_p = S$

$$I_p = \frac{S}{V_1 + V_2}$$

Statement 1 is wrong.

Statement 2: Two winding transformer operation, load receives S VA at V_2 volts:

$$\text{Copper losses in } V_2 - \text{winding} = \left(\frac{S}{V_2}\right)^2 r_2$$

$$\text{Copper losses in } V_1 - \text{winding} = \left(\frac{S}{V_1}\right)^2 r_1$$

$$\text{Total copper losses} = S^2\left[\frac{r_2}{V_2^2} + \frac{r_1}{V_1^2}\right]$$

Auto transformer operations:

$$I_p = \frac{S}{V_1 + V_2}$$

$$I_s = \frac{S}{V_2}$$

Total copper loss

$$= \left(\frac{S}{V_1 + V_2}\right)^2 r_1 + \left(\frac{S}{V_2}\right)^2 r_2$$

$$= S^2\left[\frac{r_1}{(V_1 + V_2)^2} + \frac{r_2}{V_2^2}\right]$$

Thus copper losses in auto transformer operations are lesser. Statement 2 is correct.

71. Ans: (a)

Sol: 1. For a dc separately excited motor,

$V = E - I_a R_a$ ....(1)

Where V is applied voltage, E is the armature induced emf and I_a is the armature current.

2. $E = k\phi\omega$, where ω is the speed (mechanical rad/sec)

$$\therefore\ k\,\phi\,\omega = V - I_a R_a$$

$$\omega = \frac{V}{k\phi} - \frac{R_a}{(k\phi)} I_a$$

3. Developed torque $T = k\phi\, I_a$

$$\Rightarrow I_a = \frac{T}{k\phi}$$

$$\omega = \frac{V}{k\phi} - \frac{R_a}{(k\phi)^2} T$$

The $\omega \sim T$ characteristic is a straight line with an intercept on the ω axis of $\frac{V}{k\phi}$ and

slope $\frac{-R_a}{(k\phi)^2}$.

4. Neglect saturation and armature reaction.

Let field current I_{f1} give flux /pole ϕ_1 and field current I_{f2} give flux/pole ϕ_2. Let $I_{f2} < I_{f1}$. Then $\phi_2 < \phi_1$. The speed torque characteristics for I_{f1} & I_{f2} are shown in fig.1

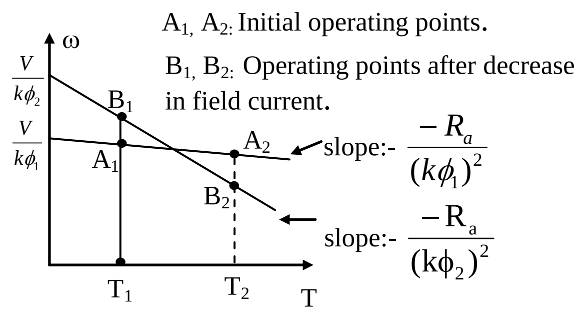


Fig:1

With $\phi_2 < \phi_1$, $\frac{V}{k\phi_2} > \frac{V}{k\phi_1}$

$$\frac{R_a}{(k\phi_2)^2} > \frac{R_a}{(k\phi_1)^2}$$

If the load torque is T_1, speed increases as field current is reduced.

If the load torque T_2 ($T_2 >> T_1$) speed drops as field current is reduced.

Statement-I is correct.

Statement-II is also correct, as seen from the above analysis. The magnitude of the slope increases as field current is reduced, that speed can decrease as field current is decreased (for large load torques).

Statement-II explains Statement-I.

72. Ans: (c)

Sol: An electrostatic field $\overline{E}_e$ cannot maintain a steady current in a closed circuit since $\oint_L \overline{E}_e.\overline{d}\ell = 0 = IR$

An emf-produced field $\overline{E}_f$ is non-conservative.

73. Ans: (d)

Sol: Given the battery is disconnected from the capacitor . So, Q= constant.

$\therefore$ energy= $\frac{Q^2}{2C} = \frac{Q^2 d}{2\varepsilon_0 A}$

$\therefore$ Energy $\propto$ d (since Q, ε_0 and A are constant)

So, as distance between the plate d increases, the potential energy will also increases. Hence statement I is wrong.

Statement (II) is correct. work is to be done in order to charge the capacitor and whatever work that is done that will be stored as potential energy in the capacitor.

74. Ans: (d)

Sol: A resistance does oppose increase or decrease of current through it

Initial current inductor circuit is zero

When the switch is closed current through it will remain as zero.

$\Rightarrow$ Current in wire ‘ab’ will be non zero as voltage source connected to it.

75. Ans: (b)