Offline GATE Mock-2 - Solutions

General Aptitude (GA)

One Mark Solutions:

01. Ans: (b)

02. Ans: (b)

03. Ans: (c)

04. **Ans: (c)**

Sol: LCM of 5, 10, 15, 20, 25 and 30 is 300 So, the bell will toll together after every 300 s⇒ 5 min

So, number of times they toll together

$= \frac{6}{5} + 1 = 13$

05. Ans: (a)

Sol: Let A had Rs. x and B had Rs. y in the beginning

If B gives 400 to A, then

$x + 400 = \frac{5}{4}(y - 400)$

$4x + 1600 = 5y - 2000$

$4x - 5y = -3600$ _____(i)

If A gives Rs.200/- to B, then

$y + 200 = \frac{7}{2}(x - 200)$

$2y + 400 = 7x - 1400$

$7x - 2y = 1800$ _____(ii)

on solving equation (i) and (ii), we get

x = Rs.600, and y = Rs.1200

Hence, B had Rs.1200 in the beginning.

Two Mark Solutions:

06. Ans: (a)

Sol: The two persons could have entered at

1^{st} station (ticket for 2^{nd}, 3^{rd}, 4^{th} (or) Lingampally) = 4 tickets

2^{nd} station (ticket for 3^{rd}, 4^{th} (or) Lingampally) = 3 tickets

3^{rd} station (ticket for 4^{th} (or) Lingampally) = 2 tickets

Total number of tickets available

= 4+3+2+1=10

So, different sets of ticket they may had

$= 10C_2 = \frac{10!}{2!(10-20!} = \frac{10!}{2!\times 8!} = \frac{10\times 9}{2} = 45$

07. Ans: (b)

Sol: ∵ Number of boys in the class= 18

Number of girls in the class = 48 – 18 = 30

∵ HCF of 18 and 30 = 6

So, a row can have maximum of 6 students

08. Ans: (b)

Sol: Let the angles of the quadrilateral be 3x, 4x, 5x and 6x respectively

Then, 3x+4x+5x+6x = 360°

18x = 360° ⇒ x = 20°

Smallest angle of the triangle

$= 3\times 20\times\frac{2}{3} = 40°$

Largest angle of the triangle = 40 × 2 = 80°

∴ Second largest angle of triangle

= 180° – (40°+80°) =60°

and largest angle of the quadrilateral

= 6x = 6×20°=120°

∴ Hence, required sum = 60+20°= 180°.

09. Ans: (a)

Sol: Number of pages typed by Ashu in

$1\text{hr} = \frac{42}{7} = 6$

Number of pages typed by Mohan in

$1\text{hr} = \frac{40}{4} = 10$

Number of pages typed by both in

1hr = 6 + 10 = 16

∴ Time taken by both to type 240 pages

$\frac{240}{16} = 15\text{hrs}.$

10. Ans: (b)

Electrical Engineering (EE)

01. Ans: (c)

02. Ans: 0.49 (no range)

Sol: At maximum efficiency, ohmic loss = core loss

Ohmic loss at 70% of full load = $(0.7)^2$ (ohmic loss at full load)

= core loss

$$\frac{\text{core loss}}{\text{ohmic loss at full load}} = 0.49$$

03. Ans: (d)

04. Ans: (a)

Sol: Total charge, $Q = \int_{vol} \rho_v dv$

$$= \int_{r=0.03}^{0.05}\int_{\theta=0}^{\pi}\int_{\phi=0}^{2\pi} 0.2\times10^{-6} r^2 \sin\theta dr d\theta d\phi$$

$$= (0.2)\times(2\pi)\times(2)\times\left.\frac{r^3}{3}\right|_{0.03}^{0.05}\times10^{-6}$$

∴ Q = 82.1pC

05. Ans: (d)

Sol: $f(x) = x^2 + x + 2$

⇒ $f'(x) = 2x + 1$

For getting maximum or minimum values, $f'(x) = 0$

⇒ $x = \frac{-1}{2}$

$f''(x) = 2 > 0$

∴ At $x = \frac{-1}{2}$, f(x) has minimum value.

06. Ans: (b)

Sol: $\frac{dx}{dy} - \frac{x}{y} = ye^y$

$IF = e^{\int -\frac{1}{y}dy} = e^{-\log y} = \frac{1}{y}$

$x.\frac{1}{y} = \int ye^y.\frac{1}{y}dy + c$

$\frac{x}{y} = e^y + c$

$y(1) = 1 \Rightarrow 1 = e + c \Rightarrow c = 1 - e$

$\frac{x}{y} = e^y + 1 - e \Rightarrow x = (e^y + 1 - e)y$

07. Ans: 41.9% (Range: 39% to 43%)

Sol: Before connecting capacitor bank,

$P_1 = 100$ kW, $\cos\phi_1 = 0.8$ lag

Let the voltage is V_1

So, $I_1 = \frac{P_1}{V_1 \cos\phi_1}$

After connecting capacitor bank,

No change in real power = $P_2 = P_1 = 100$ kW

Power factor, $\cos\phi_2 = 1$

Voltage = $V_2 = 1.05\ V_1$

So, $I_2 = \frac{P_2}{V_2 \cos\phi_2}$

Percentage reduction in loss in feeder

$= \frac{P_{loss1} - P_{loss2}}{P_{loss1}} \times 100\%$

$= \frac{I_1^2 r - I_2^2 r}{I_1^2 r} \times 100\%$

Where 'r' is feeder resistance

% reduction in loss = $\frac{I_1^2 - I_2^2}{I_1^2}$

$$= \frac{\left(\frac{P_1}{V_1 \cos\phi_1}\right)^2 - \left(\frac{P_2}{V_2 \cos\phi_2}\right)^2}{\left(\frac{P_1}{V_1 \cos\phi_1}\right)^2}$$

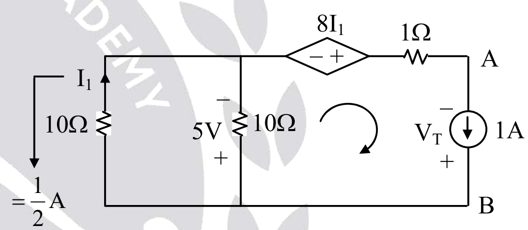
$$= \frac{\frac{1}{V_1^2(0.8)^2} - \frac{1}{(1.05)^2 V_1^2 \times 1}}{\frac{1}{V_1^2 \times (0.8)^2}}$$

$$= \frac{1.5625 - 0.90703}{1.5625} \times 100\%$$

$= 41.9\%$

08. Ans: (a)

Sol:



KVL:

$+5 - 4 + 1 - V_T = 0$

$V_T = 2$ V

So, $R_{TH} = \frac{V_T}{1} = \frac{2}{1} = 2\,\Omega$

09. Ans: (d)

Sol: $\frac{E}{R} = \frac{1}{1 - \left[-\frac{1}{s+1} - \frac{1}{s+1}\right]} = \frac{s+1}{s+3}$

10. Ans: (a)

Sol: RAL instruction rotates the accumulator content left through carry.

After the execution of ORA instruction, carry flag will be cleared.

MVI A, B7H ; CY = X, A = B7H

ORA A ; CY = 0, A = B7H = 1011 0111

RAL ; CY = 1, A = 0110 1110 = 6EH

11. Ans: 0.1 (Range: 0.05 to 0.15)

Sol: Mutually exclusive means $P(A \cap B) = 0$

$\therefore P(A \cup B) = P(A) + P(B)$

$P(A^C \cap B^C) = 1 - P(A \cup B)$

$= 1 - [0.6 + 0.3]$

$= 0.1$

12. Ans: (b)

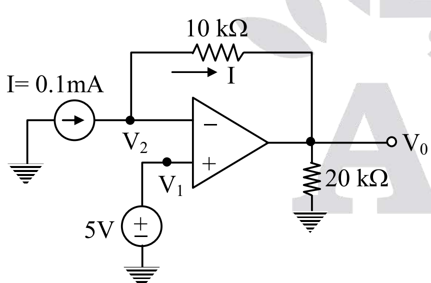
Sol: $R = 0.05 \times \frac{50}{100}$ Hz/MW; D = 0

$$B = D + \frac{1}{R} = 0 + \frac{1}{0.05 \times \frac{50}{100}}$$

$= 40$ MW/Hz

13. Ans: 4

Sol:



By the concept of virtual short,

$V_1 = V_2 = 5$ V

$V_0 = -I(10k\Omega) + V_2$

$= (-0.1\text{mA} \times 10\text{ k}\Omega) + 5$ V

$V_0 = 4$V

14. Ans: (B)

Sol: Let number of coils =T and number of poles = P

Then number of slots per pole = (T/P) Number of slots per pole per phase = m

Slot – pitch = $\pi/(T/P)$ = (pπ/T) elec rad = Ψ.

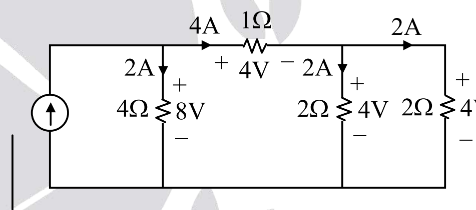
$$\text{Distribution factor} = \frac{\sin\frac{m\psi}{2}}{m\sin\frac{\psi}{2}} = \frac{\sin\left[\frac{T}{P}\frac{P\pi}{T}\frac{1}{2}\right]}{\left(\frac{T}{P}\right)\sin\left(\frac{P\pi}{2T}\right)}$$

Since T is large; $\sin\frac{P\pi}{2T} \approx \frac{P\pi}{2T}$.

Hence distribution factor = $1/(\pi/2)$ = 0.64.

15. Ans: (c)

Sol:



16. Ans: (a)

Sol: Resonance frequency

$$f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$= \frac{1}{2\pi}\sqrt{\frac{1}{(0.2)\,100\times10^{-6}} - \left(\frac{20}{0.2}\right)^2}$$

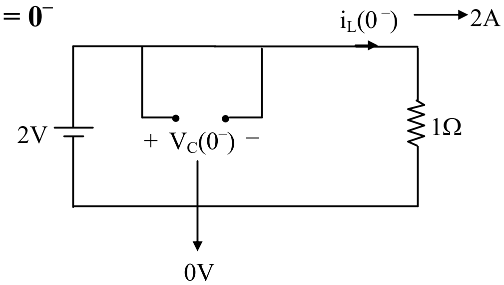
= 31.83 Hz

17. Ans: (d)

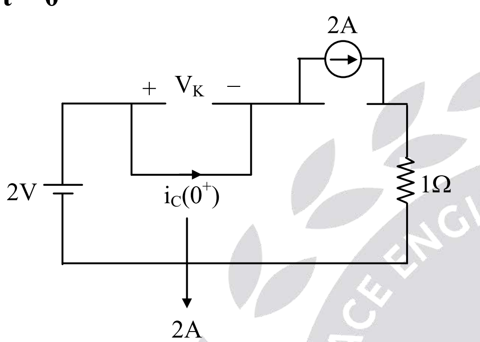
Sol: System is unstable for any value of 'K' hence it will not oscillate with fixed amplitude.

18. Ans: (d)

Sol: **t = 0^-**



t = 0^+



So, $V_k = \frac{1}{c}\int i_c dt$

$$\frac{dV_k}{dt} = \frac{i_c}{c}$$

at $t = 0^+$,

$$\frac{dV_k(0^+)}{dt} = \frac{i_c(0^+)}{c} = \frac{2}{0.5} = 4\,V/sec$$

19. Ans: (c)

Sol: Rotor efficiency = 1 – s

= 1 – 0.08 = 92%

∴ Efficiency of 3-ϕ induction motor is less than 92% since stator losses and mechanical losses are also included.

20. Ans: (d)

Sol: In poisson distribution, mean = variance

V(3X – 7Y) = 9V(X) + 49V(Y) = 321

21. Ans: 3

Sol: Normal means multiplication of slopes = –1

$$x + y = P \Rightarrow 1 + \frac{dy}{dx} = 0$$

$$\Rightarrow \frac{dy}{dx} = -1$$

$x^2 = 4y$

$\Rightarrow 2x.dx = 4dy$

$$\Rightarrow \frac{2x}{4} = \frac{dy}{dx}$$

$$\Rightarrow \frac{2x}{4} = 1 \Rightarrow x = 2 \Rightarrow y = 1$$

∴ P = x + y = 2+1 = 3

22. Ans: (d)

23. Ans: 97 (95 to 98)

Sol: $I = \int_s \vec{J}.d\vec{S}$ [ρ = 2.2]

$$= \int_{\phi=0}^{0.1}\int_{z=6}^{6.1}\left(2\rho\cos^2\phi\,\hat{a}_\rho - \rho\sin 2\phi\,\hat{a}_\phi\right)_{(\rho=\text{constant})}.\rho d\phi dz\hat{a}_\rho$$

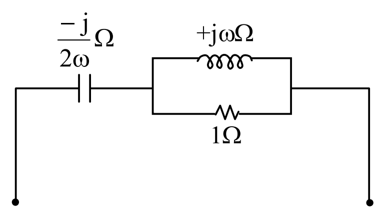
$$= 2\times(2.2)^2\left[\frac{\phi}{2} + \frac{\sin 2\phi}{4}\right]_0^{0.1}[z]_6^{6.1}$$

∴ I = 0.0964 Amp (or)

I = 96.4 mA

24. Ans: 1 (Range: 1 to 1)

Sol:



$$Z_T = -\frac{j}{2\omega} + [1 // j\omega] = \frac{-j}{2\omega} + \frac{j\omega}{1+j\omega}$$

$$= -\frac{j}{2\omega} + \frac{j\omega}{1+j\omega} \times \frac{1-j\omega}{1-j\omega}$$

$$= -\frac{j}{2\omega} + \frac{j\omega+\omega^2}{1+\omega^2}$$

$$Z_T = \frac{\omega^2}{1+\omega^2} + j\left[\frac{\omega}{1+\omega^2} - \frac{1}{2\omega}\right]$$

At resonance, $X_{net} = 0$

So, $\frac{\omega}{1+\omega^2} = \frac{1}{2\omega}$

$\Rightarrow 2\omega^2 = 1 + \omega^2$

$\omega^2 = 1$

So, $\omega = 1$ rad/sec

25. Ans: 5.5A (5.45 to 5.60)

Sol: The armature reaction and leakage reactance effects at rated phase currents are equivalent to 3A of field current, from the short-circuit test. This result will be true, no matter at what field current the machine operates.

Since saturation and residual magnetism are neglected, the open-circuit characteristic is linear, passing through the points

($E = 0$, $I_f = 0$), and ($E = 300$ V, $I_f = 5$A).

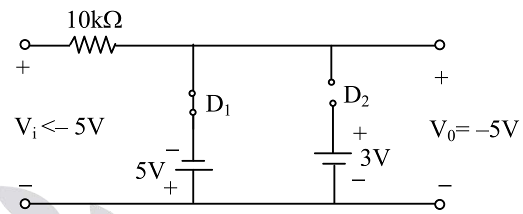
So to induce a voltage of 150 V on open-circuit, I_f needed is (150/300)(5) = 2.5A.

But we want a voltage of 150 V at the terminals when the machine is delivering purely lagging rated phase currents. These currents directly oppose the field current, and so to cancel their effect, an additional field current of 3A is needed. Total field current needed = 5.5A.

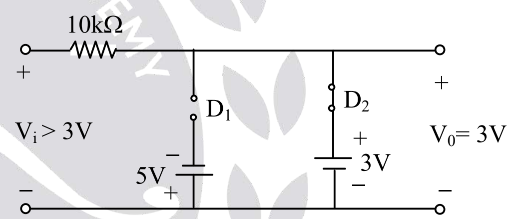
Two Marks Solutions:

26. Ans : (b)

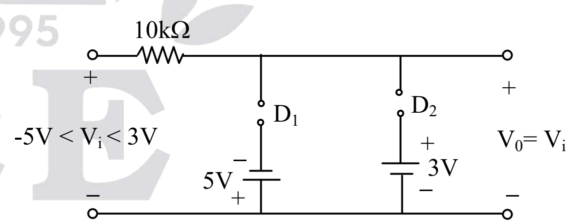
Sol: For $V_i < -5V$, D_1 is forward biased, D_2 is reverse biased and $V_0 = -5V$



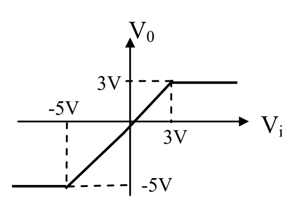
For $V_i > 3V$, D_1 is reverse biased, D_2 is forward biased and $V_0 = 3V$



For $-5V < V_i < 3V$ both D_1 & D_2 are reverse biased and $V_0 = V_i$



Thus, the transfer curve is as shown below :



27. Ans: 4.9 (Range: 4.5 to 5.0)

Sol: Inertia constant (H) =

$$\frac{\text{kinetic energy stored in rotor(MJ)}}{\text{MVA rating of alternator(s)}}$$

Kinetic energy stored in rotor = $\frac{1}{2}I\omega^2$

$$\omega = \frac{2\pi N_s}{60}$$

$$\omega = \frac{2\pi\times 3000}{60} \quad \left(\because N_s = \frac{120\times 50}{2} = 3000\right)$$

= 314.15 rad/sec

$$K.E = \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}\times 10000\times(314.15)^2$$

= 493451112.5 J

= 493.45 MJ

$$H = \frac{493.45}{100} = 4.934 \text{ MJ/MVA}$$

28. Ans: 7.0 to 7.2

Sol: Given circuit is 1-ϕ semi converter (Asymmetric)

$$I_S = I_0\sqrt{\frac{\pi-\alpha}{\pi}} = 10 \text{ A}$$

RMS SCR current

$$I_{Tr} = I_0\sqrt{\frac{\pi-\alpha}{2\pi}} = \frac{10}{\sqrt{2}} = 7.07\text{A}$$

29. Ans: (d)

Sol: Put, $x = \frac{1}{3}$

$$\Rightarrow \frac{1}{x} = 3$$

$$\therefore f(x) = \frac{1}{x} - 3 = 0$$

$$\therefore x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

$$f(x_n) = \frac{1}{x_n} - 3$$

$$\Rightarrow f'(x_n) = \frac{-1}{x_n^2}$$

$$\therefore x_{n+1} = x_n - \frac{\left(\frac{1}{x_n}-3\right)}{\left(\frac{-1}{x_n^2}\right)}$$

$$= x_n + \left[\frac{1}{x_n} - 3\right]x_n^2$$

$$= x_n + x_n - 3x_n^2 = 2x_n - 3x_n^2$$

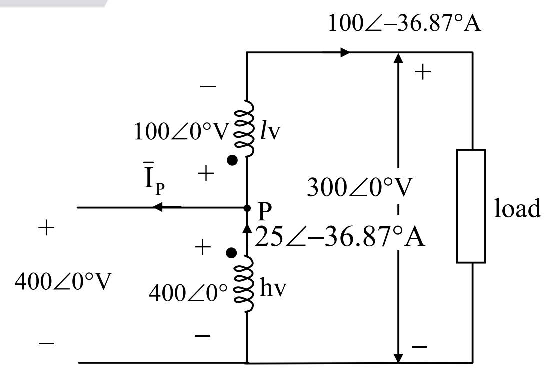
$$\therefore x_1 = 2x_0 - 3x_0^2$$

$$= 2(0.1) - 3(0.1)^2$$

$$= 0.2 - 3(0.01) = 0.17$$

30. Ans: (b)

Sol: The circuit is redrawn with all voltages and currents shown. These are found by using transformer properties and dot convention.

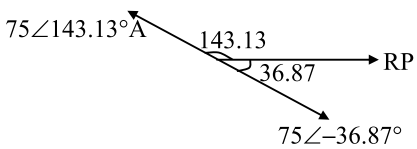


Applying KCL at P;

$$\bar{\bar{I}}_P = -\left[100\angle-36.87^\circ - 25\angle-36.87^\circ\right]$$

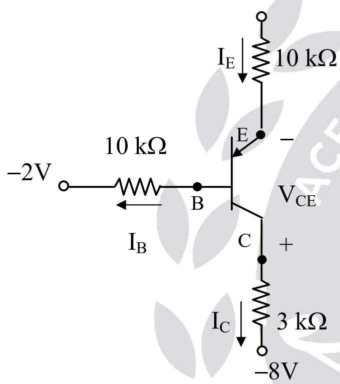
$$= -75\angle-36.87^\circ$$

$$= 75\angle143.13^\circ$$



31. Ans: – 4.1 Range : – 4 to – 4.2

Sol:



By KVL,

$8 = 10k(\beta+1)I_B + V_{EB} + (10k)I_B - 2$

$$I_B = \frac{10-0.7}{(10k)(76)+10k} = 12.08\ \mu A$$

$I_C = \beta I_B = 0.906$ mA

$I_E = (\beta+1)I_B = 0.918$ mA

By KVL,

$8\text{ V} = (10\text{ k}\Omega)I_E + V_{EC} + (3\text{k}\Omega \times I_C) - 8\text{ V}$

$V_{EC} = 16 - (10\text{ k}\times 0.918\text{ m}) - (3\text{k} \times I_C)$

$V_{EC} = 4.102$ V

$V_{CE} = -V_{EC} = -4.102$ V

32. Ans: (c)

Sol: $$600 = \frac{600}{\frac{P}{1000}\times\frac{1800}{3600}} = 2000\text{ W}$$

33. Ans: (d)

Sol: $Z = A + \bar{A}B + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}D + \bar{A}\bar{B}\bar{C}\bar{D}E$

$Z = A + \bar{A}B + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}(D + \bar{D}E)$

$Z = A + \bar{A}B + \bar{A}\bar{B}C + \bar{A}\bar{B}\bar{C}(D + E)$

$[\because X + \bar{X}Y = X + Y]$

$Z = A + \bar{A}B + \bar{A}\bar{B}(C + \bar{C}(D + E))$

$Z = A + \bar{A}B + \bar{A}\bar{B}(C + D + E)$

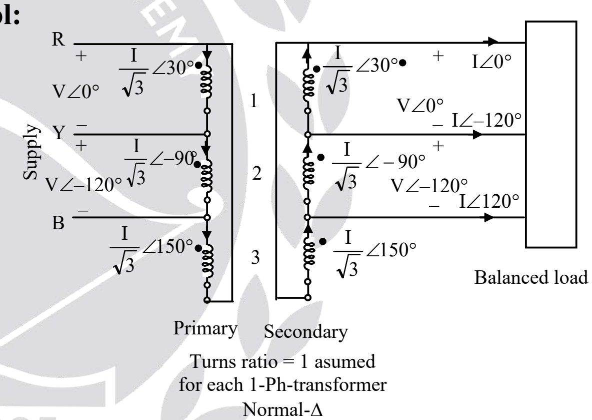
$= A + \bar{A}(B + \bar{B}(C + D + E))$

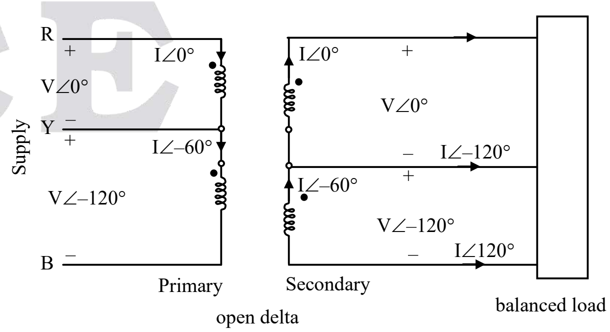
$= A + \bar{A}(B + C + D + E)$

$= A+B+C+D+E$

34. Ans: (b)

Sol:

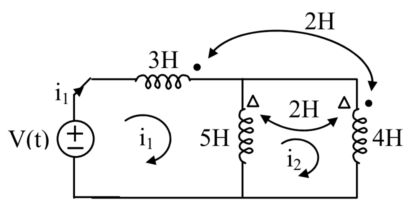




Assuming supply & load to be unchanged, each transformer winding carries $\sqrt{3}$ times its rated current. Hence over loading is 73.2%.

35. Ans: 3 (Range: 3 to 3)

Sol:



$$-v(t)+3\frac{di_1}{dt}+5\left[\frac{di_2}{dt}-\frac{di_2}{dt}\right]-2\frac{di_2}{dt}+2\left[\frac{di_2}{dt}\right]=0$$

$$8\frac{di_1}{dt}-5\frac{di_2}{dt}=v(t)\ \text{.........(1)}$$

$$5\left[\frac{di_2}{dt}-\frac{di_1}{dt}\right]+4\frac{di_2}{dt}-2\frac{di_2}{dt}-2\left[\frac{di_2}{dt}-\frac{di_1}{dt}\right]-2\frac{di_1}{dt}=0$$

$$-5\frac{di_1}{dt}+5\frac{di_2}{dt}=0 \qquad \text{..............(2)}$$

Solving (1) & (2)

$$v(t)=\frac{di_1}{dt}[8-5]$$

$$v(t)=3\frac{di_1}{dt}$$

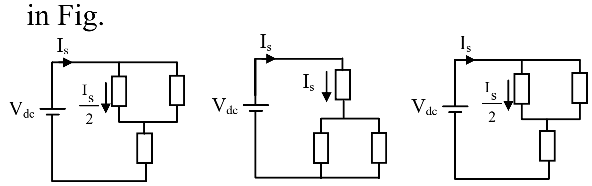
$\Rightarrow L_T = 3H$

36. Ans: 10A

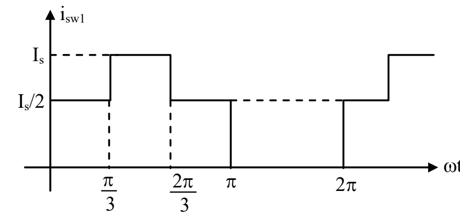
Sol: power balance eq: $P_0 = P_{in}$

$\Rightarrow 6,000 = V_{dc}.\ I_s \Rightarrow I_S = 30A$

Equivalent circuit in first 3 steps are as shown in Fig.



Hence, switch current wave form is as shown in fig.



$$I_{sw,av}=\left[\left(\frac{I_S}{2}\times\frac{\pi}{3}\times 2\right)+I_S\times\frac{\pi}{3}\right]\times\frac{1}{2\pi}$$

$$=\frac{I_S}{3}=\frac{30}{3}=10A$$

37. Ans: (c)

Sol: Under normal operation, let the phase currents be $i_a = I\cos\omega t$; $i_b = I\cos(\omega t - 120°)$; and $i_c = I\cos(\omega t+120°)$.

At $\omega t = 0$; $i_a = I$, $i_b = \frac{-I}{2}$ and $i_c = \frac{-I}{2}$. Also, at this instant, the resultant rotating field due to the stator currents will be at some particular space position wrt the stator. Let us call it position 1. Now, if the ac is switched off and simultaneously the dc currents I, $\frac{-I}{2}$ and $\frac{-I}{2}$ switched on; the rotating field stays stationary at position 1. Rotor rotating in this stationary field experiences a torque opposing relative motion & hence a braking torque is produced, and rotor comes to rest

Note: This is the principle involved dynamic braking of induction motors.

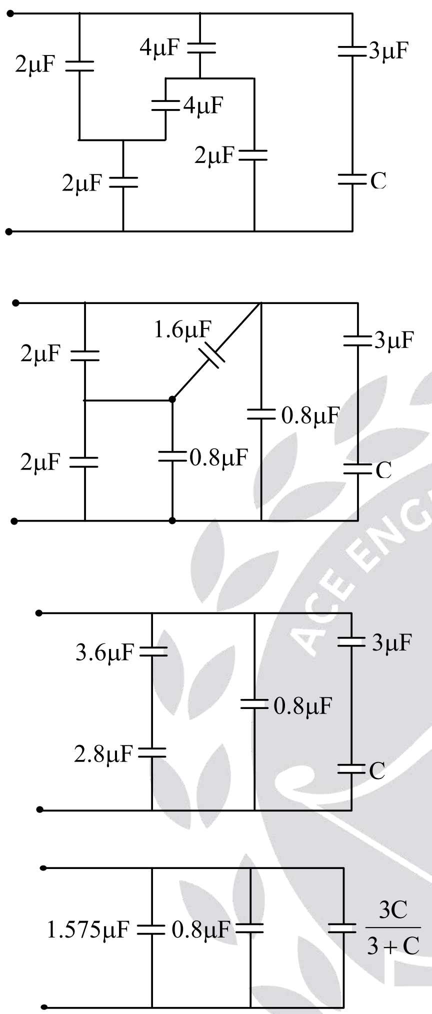
38. Ans: 3819 VAR (3818 to 3220)

Sol: $Q=\sqrt{3}V_{S1}\ I_{s1}\sin\alpha$

$$=\sqrt{3}\times 400\times\left[\frac{\sqrt{6}}{\pi}\times 10\right]\times\frac{1}{\sqrt{2}}=3819VAR$$

39. Ans: 21

Sol:



$$\Rightarrow 1.575 + 0.8 + \frac{3C}{3+C} = 5$$

$$C = 21\mu F$$

40. Ans: (b)

Sol: Speed of DC shunt motor, $N \propto \frac{E_b}{\phi}$ but both

$E_b \propto V$ and $\phi \propto V$.

Since, during unsaturated condition

$\phi \neq$ constant

$\therefore$ As applied voltage 'V' is half

$\Rightarrow$ both E_b & ϕ becomes half, hence new speed of motor is doesn't change (i.e. 1000 rpm only).

41. Ans: (c)

Sol: $\omega = 1$ to $2 \rightarrow$ 6 dB decreases and

$\omega = 2$ to $\omega = 20 \rightarrow$ 40dB decreases

$\therefore -(40+6) = -46$ dB

$\therefore |G(j\omega)|_{\omega = 20} = 20 - 46 = -26$dB

42. Ans: (d)

Sol: Since $\overline{EN} = 0$, the MUX is enabled. The truth table for the given circuit is as shown below.

A	B	C	Y
0	0	0	1
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

K-map:

A \ BC	00	01	11	10
0	[0] 1	[1]	[3] 1	[2]
1	[4]	[5] 1	[7]	[6] 1

$$Y = \bar{A}\,\bar{B}\,\bar{C} + A\,\bar{B}C + \bar{A}BC + AB\bar{C}$$

$$= A(\bar{B}C + B\bar{C}) + \bar{A}(\bar{B}\bar{C} + BC)$$

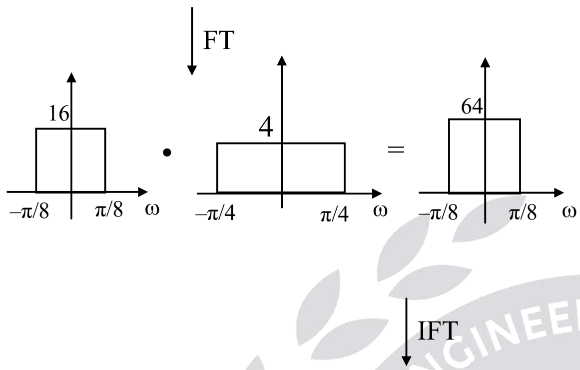
$$= A(B \oplus C) + \bar{A}(\overline{B \oplus C})$$

$$= \overline{A \oplus B \oplus C}$$

43. Ans: 5.09 Range(5 to 5.2)

Sol: $2\sin c(t/8) * \sin c(t/4)$

$$= \frac{2\sin \pi t/8}{\pi t/8} * \frac{\sin \pi t/4}{\pi t/4}$$



$$x(t) = \frac{64\sin(\pi t/8)}{\pi t}$$

$$x(t)\big|_{t=4} = \frac{64\sin(\pi/2)}{4\pi} = \frac{16}{\pi}$$

44. Ans: (c)

Sol:

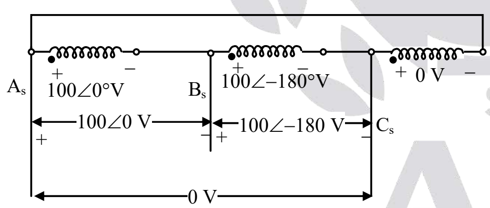


Fig. 2

Figure-2 shows the secondary side with voltages marked.

The line voltages are, $\bar{V}_{AsBs} = 100\angle 0°\,V$

$\bar{V}_{BsCs} = 100\angle -180°\,V$, $\bar{V}_{CsAs} = 0$

Their sum is zero, as it should be (by KVL)

The sequence components are

$$\bar{V}_{AsBs1} = \frac{1}{3}\left(\bar{V}_{AsBs} + a\bar{V}_{BsCs}\right) \text{ and}$$

$$\bar{V}_{AsBs2} = \frac{1}{3}\left(\bar{V}_{AsBs} + a^2\bar{V}_{BsCs}\right)$$

Since $\bar{V}_{CsAs} = 0$. Substituting numerical values,

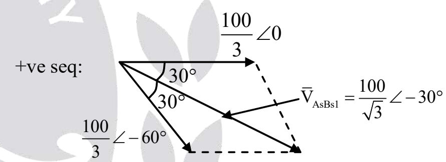
$$\bar{V}_{AsBs1} = \frac{1}{3}\left(100\angle 0 + 1\angle 120°.100\angle -180°\right)$$

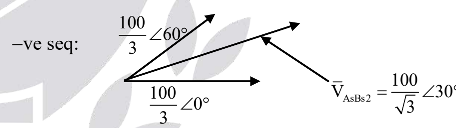
$$= \frac{1}{3}\left(100\angle 0° + 100\angle -60°\right)$$

$$\bar{V}_{AsBs2} = \frac{1}{3}\left(100\angle 0 + 1\angle 240°.100\angle -180°\right)$$

$$= \frac{1}{3}\left(100\angle 0 + 100\angle 60°\right)$$

These are evaluated in the phasor diagrams below.





45. Ans: (c)

Sol: $TF = C[sI - A]^{-1}B = \dfrac{1}{s^2 + 5s + 4}$

$$TF = \frac{1}{(s+1)(s+4)}$$

Poles are located on left side of s – plane

$\therefore$ System is stable

For observability:

$$N = \begin{bmatrix} C \\ CA \end{bmatrix}$$

$$CA = \begin{bmatrix} 0 & 1 \end{bmatrix}\begin{bmatrix} 0 & -4 \\ 1 & -5 \end{bmatrix} = \begin{bmatrix} 1 & -5 \end{bmatrix}$$

$$N = \begin{bmatrix} 0 & 1 \\ 1 & -5 \end{bmatrix}$$

|N| is not equal to zero

$\therefore$ Observable

For controllability

$$M = \begin{bmatrix} B & AB \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$$AB = \begin{bmatrix} 0 & -4 \\ 1 & -5 \end{bmatrix}\begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

|M| is not equal to zero

$\therefore$ Controllable

46. Ans: 3 (Range: 3 to 3)

Sol: $P(X \geq 1) = 1 - P(X = 0)$

$= 1 - n_{c_0} p^0 q^n$

$= 1 - q^n$

Here $p = \frac{1}{3}$

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

$\therefore 1 - \left(\frac{2}{3}\right)^n > \frac{2}{3}$

Apply trial and error method

$\Rightarrow n = 3$

47. Ans: 50

Sol: $A\text{rect}(t/T) \leftrightarrow ATSa\left(\frac{\omega T}{2}\right)$

$$H(\omega) = 0.2Sa(0.01\omega)\, e^{-j\omega(0.01)}$$

$H(\omega) = 0$ only when

$\frac{\omega}{100} = \pm n\pi$

$\omega = \pm 100n\pi$

$f = \pm 50n$

first-null occurs at f = 50

second-null occurs at f = 100

third-null occurs at f = 150

and so on

null-to-null band width is 50Hz.

48. Ans: (c)

Sol: $y = (Ax + B)e^{-4x}$ ……..(1)

Differentiating (1) w.r.t 'x'

$y' = (Ax + B)(-4)e^{-4x} + e^{-4x}.A$

Use (1) in the above eq.

$y' = (-4)y + Ae^{-4x}$ …… (2)

Differentiating w.r.t 'x'

$y'' = -4y' + A(-4)e^{-4x}$ ….. (3)

Use (2) in (3)

$y'' = -4y' - 4(y' + 4y)$

$y'' = -8y' - 16y$

$y'' + 8y' + 16y = 0$

Is the required differential equation

49. Ans: (d)

Sol: Continuous current rating = 5 kA

Symmetrical breaking capacity = 2000 MVA

$= \sqrt{3} \times V_L \times I_{sy}$

$I_{sy} = 35$ kA

$I_{sy} = 2.55 \times I_{sy} = 89.25$ kA

50. Ans: (A)

Sol: $H_1(s) = s+1 \quad H_2(s) = \frac{1}{s+1}$

$$H(s) = H_1(s)H_2(s) = 1$$

$$Y(s) = X(s)\,H(s)$$

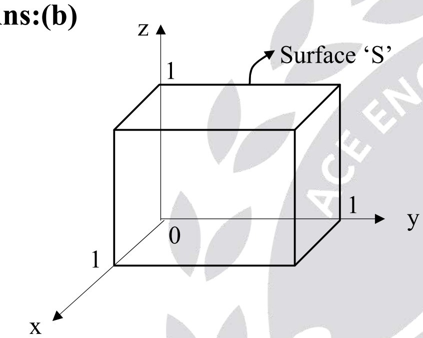
$$= \frac{2}{s+1}.1$$

Apply Inverse Laplace Transform

$$y(t) = 2e^{-t}u(t)$$

51. Ans:(b)

Sol:



Integral $\oint_S \vec{G}.d\vec{S} = \int_{vol} \nabla.\vec{G}\,dv$

$$\vec{G} = 2xy\hat{a}_x + 3\hat{a}_y + z^2y\hat{a}_z$$

$$\nabla.\vec{G} = 2y + 2zy$$

$$\nabla.\vec{G} = 2y(z+1)$$

$$I = \int_{x=0}^{1}\int_{y=0}^{1}\int_{z=0}^{1} 2y(z+1)dxdydz$$

$$= 2\frac{y^2}{2}\Big|_0^1 \left(\frac{z^2}{2} + z\right)\Big|_0^1 x\Big|_0^1$$

$$\therefore I = \frac{3}{2} \qquad (I \rightarrow \text{Integral})$$

52. Ans: 30

Sol: C. E $\Rightarrow$ $s^3 + 4s^2 + 3s + k = 0$

s^3	1	3
s^2	4	k
s^1	$\frac{12-k}{4}$	0
s^0	k	

$$k_{mar} = 12$$

$$GM = \frac{k_{mar}}{k_{operating}} = \frac{12}{0.4} = 30$$

53. Ans: (d)

Sol: At balanced condition,

$T_d = T_c$

In gravity control,

$T_c \propto \sin\theta$

$10\sqrt{2} = \sin 90°$

$? = \sin 45°$

$\therefore$ meter reading $= 10\sqrt{2} \times \frac{1}{\sqrt{2}} = 10\,V$

54. Ans: 4

Sol: If the particle moves with a constant velocity, that means its acceleration is zero. (i.e. particle experiences no net force

we have $\overline{F} = m\overline{a} = Q(\overline{E} + \overline{U} \times \overline{B})$

$$\Rightarrow 0 = Q(20\hat{a}_y + 5\hat{a}_x \times B_0\hat{a}_z)$$

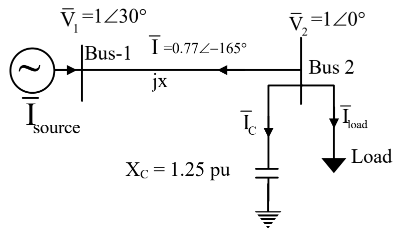
$$\Rightarrow 20\hat{a}_y - 5B_0\hat{a}_y = 0$$

$$\Rightarrow 20 = 5B_0$$

$$\Rightarrow B_0 = \frac{20}{5} = 4$$

55. Ans: (c)

Sol:



Current supplied by source

$\bar{I}_{source} = -(\bar{I})$

$= (1\angle 180°)(0.77\angle -165°)$

$= 0.77\angle 15°$

Power factor of source, $\cos\phi_s = \cos(30° - 15°)$

$= 0.966$ lag

KCL at bus – 2

$\bar{I} + \bar{I}_C + \bar{I}_{load} = 0$

$\bar{I}_{load} = -(\bar{I}_c + \bar{I})$

$$= -\left(\frac{\bar{V}_2}{-jx_c} + 0.77\angle -165°\right)$$

$$= -\left(\frac{1\angle 0°}{-j1.25} + 0.77\angle -165°\right)$$

$= -(0.8\angle 90° + 0.77\angle -165°)$

$= -[j0.8 + (0.77 \times -0.966) - j(0.77 \times 0.259)]$

$= 0.744 - j0.6$

$= 0.956\angle -38.88°$

Pf of load, $\cos\theta_l = \cos(0 + 38.88°)$

$= 0.778$ lag