Branch: Electrical Engineering

Mock- F - Solutions

GATE-2020 General Aptitude (GA)

01. Ans: (d)

Sol: 'Cut out for' means designed to be so. 'Cut up' means 'to be emotionally upset'. 'Cut down' means 'to kill somebody' or 'to make something fall down by cutting it at the base'. 'Cut off' means 'separated from the rest of the world'.

02. Ans: (c)

03. Ans: (a)

04. Ans: (d)

Sol: Let principle be 1. Then amount after 10 years = 3 × 1 = 3

$\therefore$ Simple interest = 3 - 1 = 2

$\therefore$ Rate of interest $= \dfrac{2\times100}{1\times10} = 20\%$

05. Ans: (c)

Sol: Note that

20 – 14 = 6;

25 – 19 = 6;

35 –29 =6;

40 – 34 = 6.

Required number

= L.C.M. of (20, 25, 35 and 40) – 6.

= (2 × 2 × 2 × 5 × 5 × 7) – 6

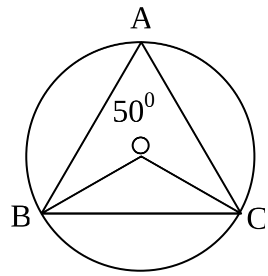
= 1400 – 6 = 1394

20=2*2*5
25=5*5
35=1*5*7
40=2*2*2*5

06. Ans: (c)

Sol: The angle subtended by an arc at the centre of the circle is twice the angle subtended by the arc at any point on the remaining part of the circle.

$\therefore\ \angle BOC = 2\angle BAC = 2 \times 50^0 = 100^0$



Now in ΔBOC

OB = OC [radii of circum centre]

$\therefore\ \angle OBC = \angle OCB = x$ (let)

$\therefore\ x + x + 100^0 = 180°$

$\Rightarrow 2x = 80°$

$\Rightarrow x = 40°$

07. Ans: (a)

Sol: At 4:10 the hour hand is a head of minute hand

Given that n = 4 and x = 10

Then according to the formula required angle

$$= \left\{30\left(n - \frac{x}{5}\right) + \frac{x}{2}\right\}^{\circ}$$

$$= \left\{30\left(4 - \frac{10}{5}\right) + \frac{10}{2}\right\}^{\circ}$$

$= \{(30 \times 2) + 5\}°$

$= (60 + 5)°$

$= 65°$

08. Ans: (b)

Sol: Total cost (in Rs) of journey to Town A

$= 4300 + 3100 + 4000 + 6000 = 17400$

Average cost $= \frac{17400}{4}$ = Rs. 4350

09. Ans: (a)

Sol: Maximum cost (in Rs) of journey from Delhi to town A = By Train 4 = Rs. 6000

Similarly, for town B = Rs. 6300

Town C = Rs. 5600 and Town D = Rs. 5700

$\Rightarrow$ Maximum cost = 6000 + 6300 + 5600

= Rs. 23600

10. Ans: (d)

Specialization (EE)

01. Ans: 0.4

Sol: $\frac{4s+10}{s} = 4 + \frac{10}{s}$

$$= 4\left[1 + \frac{10}{4s}\right]$$

$$= 4\left[1 + \frac{1}{\frac{4}{10}s}\right]$$

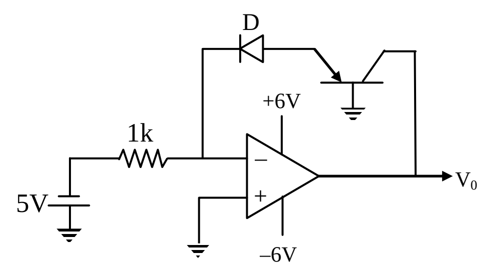
$$= 4\left[1 + \frac{1}{0.4s}\right]$$

$$= 4\left[1 + \frac{1}{T_I s}\right]$$

$\therefore T_I =$ reset time = 0.4 sec

02. Ans: 6

Sol:



In this circuit diode tries to conduct but the transistor which is in cut-off region does not allow any current and hence negative feedback does not exist.

Therefore op-amp acts as comparator. So output voltage V_0 = +6V

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03. Ans: 496 (No range)

Sol: For n-bit comparator,

No. of combinations for which A > B is

$$\frac{2^{2n}-2^{n}}{2}$$

Here n = 5. (It is a 4 bit magnitude comparator)

$$= \frac{2^{2\times5}-2^{5}}{2} = 496$$

04. Ans: (d)

Sol:

$$x(n) \longrightarrow \boxed{\text{L.T.I. system}} \longrightarrow y(n)=kx(n)$$

$x(n)*\delta(n-n_0) = x(n-n_0)$

$$e^{\frac{j\pi}{4}n}u(n)*\frac{1}{2}\delta(n)=\frac{1}{2}e^{\frac{j\pi n}{4}}u(n)$$

So, $h(n)=\frac{1}{2}\delta(n)$

05. Ans: 5Ω (No Range)

Sol: $Z_{11} = 6\Omega$, $Z_{12} = Z_{21} = 4\Omega$

For symmetrical network, $Z_{11} = Z_{22} = 6\Omega$

ABCD parameters

$V_1 = AV_2 - BI_2$

$I_1 = CV_2 - DI_2$

$$B = \left.\frac{-V_1}{I_2}\right|_{V_2=0}$$

Now from Z – parameters

$V_1 = Z_{11}I_1 + Z_{12}I_2 = 6I_1 + 4I_2$ …….. (1)

$V_2 = Z_{21}I_1 + Z_{22}I_2 = 4I_1 + 6I_2$ …….. (2)

By putting $V_2 = 0$ in equation (2)

$4I_1 = -6I_2$

Put value of I_1 in equation (1) than

$$V_1 = 6\left(-\frac{6}{4}\right)I_2 + 4I_2$$

$$= I_2\left[\frac{-36}{4}+4\right] = -5I_2$$

So $\frac{V_1}{I_2} = -5$

$B = -(-5) = 5\Omega$

06. Ans: (b)

Sol: $$C(s)=\left.\frac{50}{(s^2+4)^2(s+2)^2(s+4)}R(s)\right|_{R(s)=\frac{1}{s}(\text{step input})}$$

Initial value = C(0)

$$= \underset{s\to\infty}{\text{Lt}}\ S\ \frac{50}{(s^2+4)^2\,(s+2)^2\,(s+4)}\frac{1}{s} = 0$$

07. Ans: 1 (No Range)

Sol: Let A = $\begin{bmatrix}1 & 2 & 0\\0 & 1 & 3\\0 & 0 & 1\end{bmatrix}$

A is the upper triangular matrix eigen value is 1 only

Consider (A – I) = $\begin{bmatrix}0 & 2 & 0\\0 & 0 & 3\\0 & 0 & 0\end{bmatrix}$

Clearly earth of (A – I) = 2

Geometric multiplicity of eigen value 1 = No. of linearly independent eigen vectors

= n – r

= 3 – 2 = 1

08. Ans: (b)

Sol: x(n) is finite length covering positive index.

So, the ROC is entire z- plane except at z = 0.

i.e., $|z| > 0$.

09. Ans: 96 (No range)

Sol: Characteristic equation is $|A-\lambda I| = 0$

$$\begin{vmatrix} 1-\lambda & 0 & 0 \\ 0 & 2-\lambda & 1 \\ 2 & 0 & 3-\lambda \end{vmatrix} = 0$$

$\Rightarrow (1-\lambda)(2-\lambda)(3-\lambda) = 0$

$\therefore \lambda = 1, 2, 3$ are eigen values

Eigen values of A	Eigen values of $A^2 - 3A + 6I$
1	$1-3+6=4$
2	$4-6+6=4$
3	$9-9+6=6$

Determinate of $A^2 - 3A + 6I = 4 \times 4 \times 6$

$= 96$

10. Ans: (c)

Sol: As stator impedance neglected the motor equivalent circuit at standstill gives

$Z_2 = r_2 + jx_2$

$$= \frac{230}{60\angle -70^{\circ}} = 3.83\angle 70^{\circ}$$

$= 1.311 + j3.602\ \Omega$

At slip 0.05

$$R_f + jx_f = \frac{r_2}{2s} + j\frac{x_2}{2} = \frac{1.311}{2\times 0.05} + \frac{j3.602}{2}$$

$= 13.11 + j1.801\ \Omega$

$$R_b + jx_b = \frac{r_2}{2(2-s)} + j\frac{x_2}{2}$$

$= 0.3362 + j1.801\ \Omega$

Total input impedance at 0.05 slip

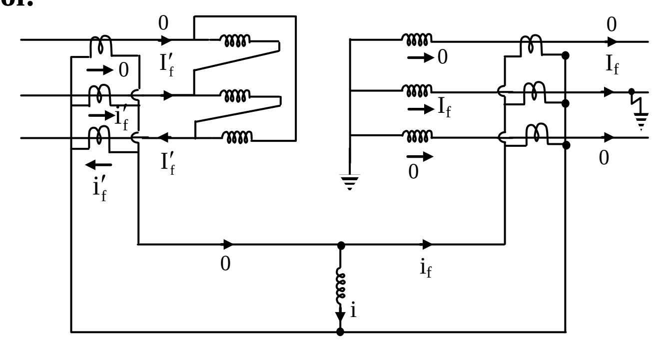
$Z = R_f + jr_f + R_b + jx_b$

$= 13.4462 + j3.602$

$= 13.92\angle 15^{\circ}\ \Omega$

11. Ans: (c)

Sol:



$i = -I_f$

$$= -300 \times \frac{1}{3}$$

$= -100$ A

$|i| = 100$ A

12. Ans: 53 (No range)

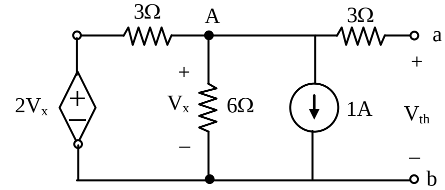
Sol: $V(2x + 3y) = 2^2 V(x) + 3^2 V(y)$

$= (4 \times 2) + (9 \times 5)$

$= 53$

13. Ans: (d)

Sol:



Current flowing through 3Ω is zero so

$V_{th} = V_x$

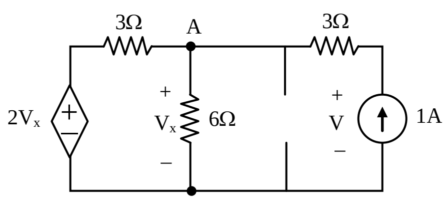
Apply KCL at node A, then

$$\frac{V_x - 2V_x}{3} + \frac{V_x}{6} + 1 = 0$$

$-2V_x + V_x + 6 = 0$

$V_x = 6V$

R_{th} can be find out by exciting the circuit with 1A, replace all independent sources by their internal resistances



By KCL at node A

$$\frac{V_x}{6} + \frac{(V_x - 2V_x)}{3} - 1 = 0$$

$V_x - 2V_x - 6 = 0$

$V_x = -6V$

$V = 3 + V_x = 3 - 6 = -3V$

$$R_{th} = \frac{V}{I} = \frac{-3}{1} = -3\Omega$$

14. Ans: (a)

Sol: $M = \chi_m H$

Where, $\chi_m = \mu_r - 1 = 50 - 1 = 49$ and

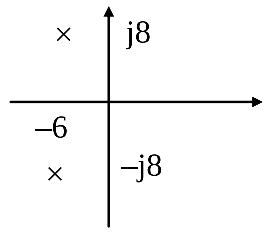
$$H = \frac{B}{\mu_0 \mu_r}$$

$$\Rightarrow M = \frac{49B}{\mu_0 \mu_r} = \frac{49 \times 0.04}{4\pi \times 10^{-7} \times 50}$$

$= 31194$ A/m

15. Ans: 10

Sol: $c(t) = 12.5e^{-6t} \sin 8t$



ω_n is radial distance from origin

$$\omega_n = \sqrt{6^2 + 8^2}$$

$\omega_n = 10$ rad/sec

16. Ans: (A)

Sol: For N-MOS, we know that,

$V_{GS} > V_{Th}$ & $V_{DS} \geq V_{DS_{SAT}} \rightarrow$ Saturation region

$V_{GS} > V_{Th}$ & $V_{DS} < V_{DS_{SAT}} \rightarrow$ Linear region

$V_{GS} \leq V_{Th} \rightarrow$ Cutoff region

Where, $V_{DS_{SAT}} = V_{GS} - V_{Th}$

$V_{GS} = 1.5 - 0.5 = 1V$

$V_{DS} = 0.5 - 0.5 = 0V$

$V_{GS} - V_{Th} = 1 - 0.4 = 0.6V$

$\therefore V_{DS} < V_{GS} - V_{Th} \Rightarrow$ linear region

17. Ans: (a)

Sol: Given $x(t) = 3e^{-t}u(t)$, $h(t) = 2e^{-2t}u(t)$

Apply L.T

$$X(s) = \frac{3}{s+1}, H(s) = \frac{2}{s+2}$$

$$Y(s) = X(s).H(s) = \frac{6}{(s+1)(s+2)}$$

$$Y(s) = \frac{6}{s+1} - \frac{6}{s+2}$$

Apply ILT

$y(t) = 6\,[e^{-t} - e^{-2t}]u(t)$

18. Ans: 4 (No range)

Sol: $\underset{x\to 0}{\text{Lt}} \frac{\sin x}{x(x-1)} = \underset{x\to 0}{\text{Lt}} \frac{1}{x-1} . \underset{x\to 0}{\text{Lt}} \frac{\sin x}{x}$

$= -1 \times 1$

$= -1$

19. Ans: (d)

Sol:

Bag -1	**Bag- 2**
5 Red	4 Red
7 Green	8 Green

By total probability $= \frac{1}{2} \times \frac{7}{12} + \frac{1}{2} \times \frac{8}{12}$

$= \frac{15}{24}$

20. Ans: (b)

Sol: If load pf is lead

First half of main transformer power factor is $\cos(30-\phi)$ lead when ϕ is more than 30° and $\cos(30-\phi)$ lag when ϕ is less than 30°.

Given load Power factor, $\cos \phi = 0.5$

$\Rightarrow \phi = 60°$

First half of main transformer power factor is $\cos(30-\phi)$ lead,

$\therefore \cos(30-60) = 0.866$ lead

Second half of main transformer power factor is $\cos(30 + \phi)$ lead

$\therefore \cos(30+60) =$ Zero lead

21. Ans: (a)

Sol: Voltage impedance of uncompensated line,

$Z_{C_1} = 300\ \Omega$

Shunt compensation, $Z_{C_2} = Z_{C_1}\sqrt{\frac{1-K_{se}}{1-K_{sh}}}$

Where $K_{se} = 0.45$, $K_{sh} = 0.6$

$Z_{C_2} = 300\sqrt{\frac{1-0.45}{1-0.6}}$

$= 351.78\ \Omega$

Maintain flat profile, loading on line = SIL

$= \frac{(400)^2}{351.78}$ MW

$= 454.83$ MW

22. Ans: (b)

Sol: Power factor meter, Megger have no controlling torque

23. Ans: (a)

24. Ans: (a)

Sol: For series RLC transient current to be oscillatory

$\xi < 1$

$\frac{R}{2}\sqrt{\frac{C}{L}} < 1$

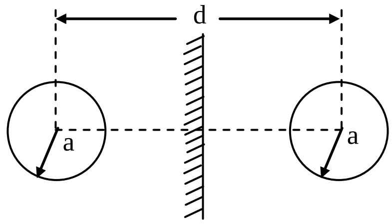
$R < 2\sqrt{\frac{L_{eq}}{C_{eq}}}$

$R < 2\sqrt{\frac{1}{9}}$

$R < \frac{2}{3}\ \Omega$

25. Ans: (b)

Sol:



$C = 4\pi\varepsilon_0 a$ for an isolated spherical shell because, $V = \dfrac{Q}{4\pi\varepsilon_0 a} \Rightarrow \dfrac{Q}{V} = 4\pi\varepsilon_0 a = C$

As d >> a, their capacitance appears to be in series. Hence, $C = 2\pi\varepsilon_0 a$

26. Ans: (b)

Sol: Given $y''(t) - y'(t) - 6y(t) = e^t u(t)$

Apply L.T

$$s^2.Y(s) - sy(0) - y'(0) - sY(s) + y(0) - 6Y(s) = \frac{1}{s-1}$$

Given y(0) = 1, $y'(0) = 0$

$$s^2Y(s) - s - sY(s) + 1 - 6Y(s) = \frac{1}{s-1}$$

$$Y(s)[s^2 - s - 6] = s - 1 + \frac{1}{s-1}$$

$$Y(s)[s^2 - s - 6] = \frac{s^2 - 2s + 2}{s-1}$$

$$Y(s) = \frac{s^2 - 2s + 2}{(s-1)(s-3)(s+2)}$$

$$Y(s) = \frac{A}{s-1} + \frac{B}{s-3} + \frac{C}{s+2}$$

$$Y(s) = -\frac{1}{6}\frac{1}{s-1} + \frac{1}{2}\frac{1}{s-3} + \frac{2}{3}\frac{1}{s+2}$$

Apply ILT

$$y(t) = -\frac{1}{6}e^t + \frac{1}{2}e^{3t} + \frac{2}{3}e^{-2t} \quad t > 0$$

27. Ans: (b)

Sol: Given f_i = 100 kHz

$$\text{Frequency at } A = f_A = \frac{100\text{kHz}}{10} = 10\text{kHz}$$

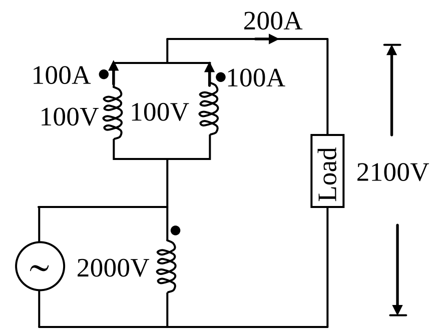
$$\text{Frequency at } B = f_B = \frac{10\text{kHz}}{20} = 500\text{Hz}$$

$$\text{Frequency at } C = f_C = \frac{500\text{Hz}}{16} = 31.25\text{Hz}$$

$$\text{Frequency at } D = f_D = \frac{31.25\text{Hz}}{8} = 3.9\text{Hz}$$

28. Ans: (d)

Sol: In 2000/2100 V auto transformer,



$$K_{auto} = \frac{2000}{2100} = \frac{20}{21}$$

$$kVA_{auto} = \left(\frac{1}{1-K_{auto}}\right)kVA_{TW}$$

$$= \left[\frac{1}{1-\frac{20}{21}}\right] \times 20\text{kVA} = 420 \text{ kVA}$$

(or) From figure, kVA rating of auto transformer

= rated load voltage × rated load current

= 200 × 2100

= 420 kVA

29. Ans: 40°

Sol: the deflecting torque is proportional to the product of currents through fixed and moving coils.

$\theta_1 \propto I_f I_m$

When same current flows through (coils in series) the coils pointer deflection is proportional to the square of current. $\theta_2 \propto I^2$.

$$\frac{\theta_2}{\theta_1} = \frac{I^2}{I_f I_m} \Rightarrow \theta_2 = 60 \times \frac{(2)^2}{3\times 2}$$

$$= 40°$$

30. Ans: 0.983 (Range: 0.9 to 0.988)

Sol: Average output voltage

$$V_0 = \frac{3V_{m\ell}}{\pi} - \frac{3\omega L_s}{\pi} I_0$$

$$= \frac{3\times 400\sqrt{2}}{\pi} - \frac{3\times 100\pi}{\pi} \times \frac{1.5}{1000} \times 20$$

$= 540.19–9$

$= 531.19V$

Rms value of fundamental source current

$$I_{s_1} = \frac{\sqrt{6}}{\pi} I_0$$

$$I_{S1} = \frac{\sqrt{6}}{\pi} \times 20 = 15.594\text{A}$$

As per power balance, $P_{in} = P_0$

$$\Rightarrow \sqrt{3} V_{s1} I_{s1} \cos\phi_1 = V_0 \times I_0$$

$$\Rightarrow \sqrt{3} \times 400 \times 15.594 \times \cos\phi_1 = 531.19 \times 20$$

$$\Rightarrow \cos\phi_1 = \frac{531.19\times 20}{\sqrt{3}\times 400 \times 15.594} = 0.983 \text{ lag}$$

31. Ans: (a)

Sol: Put $x^3 = t \Rightarrow 3x^2\,dx = dt$

$$\Rightarrow x^2\,dx = \frac{dt}{3}$$

$x = 0 \Rightarrow t = 0$

$x = 2 \Rightarrow t = 8$

$$\therefore \int_0^2 x^2 \left[x^3\right] dx = \int_0^8 [t] \frac{dt}{3}$$

$$= \frac{1}{3}\int_0^8 [t]\,dt$$

$$= \frac{1}{3}\frac{8(8-1)}{2} = \frac{28}{3}$$

32. Ans: (b)

Sol: $\displaystyle\int_{-\infty}^{\infty} x\, e^{-x^2}\, dx$

Let $f(x) = xe^{-x^2}$

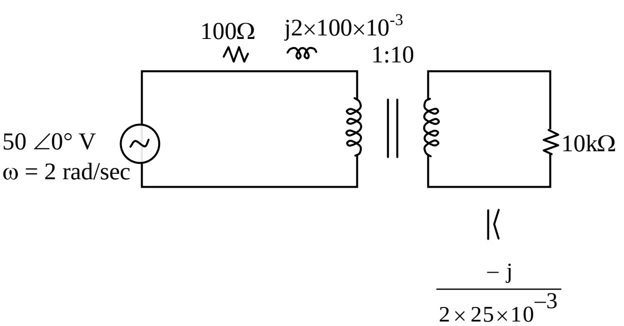
$f(-x) = -xe^{-x^2} = -f(x)$

$\therefore$ f(x) is odd function

$\therefore$ The value of given integral is zero.

33. 6.25

Sol:



By transferring secondary impedance to primary then

$$z_2' = \frac{z_2}{k^2} \qquad k = \frac{10}{1} = 10$$

$$z_2' = \frac{10\,k\Omega - \dfrac{j}{2\times 25\times 10^{-3}}}{100}$$

$$= 100 - \frac{j}{5} = 100 - j0.2$$

$$I_1 = \frac{50}{100 + j0.2 + 100 - j0.2}$$

$$= \frac{50}{200} = \frac{1}{4} = 250\,mA$$

$$I_2 = \frac{I_1}{k} = \frac{I_1}{10} = 25\,mA$$

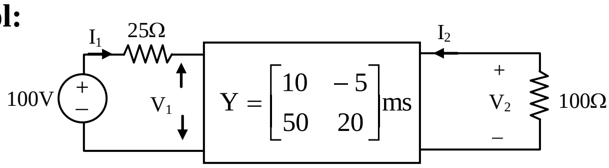
So power dissipated in the 10kΩ resistor is

$P = (25 \times 10^{-3})^2\ 10k\Omega$

$= 6.25$ W

34. Ans: V_1 = 68.6 V (Range: 67.5 to 69.5V)

Sol:



By applying at KVL input side

$V_1 = 100 - 25I_1$ …….. (1)

$V_2 = -100\ I_2$ ……… (2)

From Y-parameters

$I_1 = (10\times10^{-3})\ V_1 - (5\times10^{-3})\ V_2$ …….. (3)

$I_2 = (50\times10^{-3})\ V_1 + (20\times10^{-3})\ V_2$ …….. (4)

By putting value of V_2 in equation (4)

$I_2 = (50\times10^{-3})\ V_1 + (20\times10^{-3})\ (-100.I_2)$

$= (50\times10^{-3})\ V_1 - 2I_2$

$3I_2 = (50\times10^{-3})\ V_1$

And from equation (3)

$I_1 = (10\times10^{-3})\ V_1 - (5\times10^{-3})\ (-100.I_2)$

$$= (10\times10^{-3})V_1 + (5\times10^{-3}\times 100\left(\frac{50\times10^{-3}}{3}\right)V_1$$

$$= (10\times10^{-3})V_1 + \frac{25}{3}\times10^{-3}V_1$$

$$= \frac{55}{3}\times10^{-3}V_1$$

$$\therefore V_1 = 100 - [25\times I_1]$$

$$V_1 = 100 - \left[25\times\frac{55}{3}\times10^{-3}V_1\right]$$

$$V_1\left[1 + 25\times\frac{55}{3}\times10^{-3}\right] = 100$$

$$V_1 = \frac{100}{1.458} = 68.57V$$

35. Ans: 88.34 (Range: 88 to 89)

Sol: Due to current I_2 in coil 2 a magnetic flux is established, a part of which is also linked with the coil 1. Therefore mutual flux that is linked with both the coils is given as

$N_1\ \phi_1 \propto I_2$

$N_1\phi_1 = M_{12}\ I_2$

$$M_{12} = \frac{N_1\phi_1}{I_2} \quad \text{………(1)}$$

Also the magnetic flux density due to current in coil 2 can be written with the help of Ampere's law,

$$B_2 = \frac{\mu_0\mu_r N_2 I_2}{\ell}$$

Because,

$$N_1\phi_1 = N_1B_2A_1 = N_1\left(\frac{\mu_0\mu_r N_2 I_2}{\ell}\right)\pi r_1^2$$

$$M_{12} = \frac{N_1\phi_1}{I_2} = \frac{\mu_0\mu_r N_1 N_2 \pi r_1^2}{\ell}$$

from equation (1)

$$\therefore\ M = \frac{\mu_0\mu_r N_1 N_2 \pi r_1^2}{\ell}$$

Where, $\mu_0 = 4\pi \times 10^{-7}$, $\mu_r = 50$, $N_1 = 1400$,

$N_2 = 800$, $r_1 = \frac{4}{2} = 2\,\text{cm}$, $\ell = 100$ cm

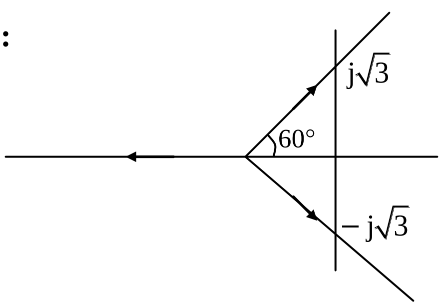
Then, M

$$= \frac{4\pi\times10^{-7}\times50\times1400\times800\times3.14\times\left(2\times10^{-2}\right)^2}{100\times10^{-2}}$$

$= 88.34$ mH

36. Ans: (d)

Sol:



$\tan 60° = \frac{\sqrt{3}}{x} \Rightarrow x = 1$

Pole is at s = –1

Open loop TF $G(s) = \frac{K}{(s+1)^3}$

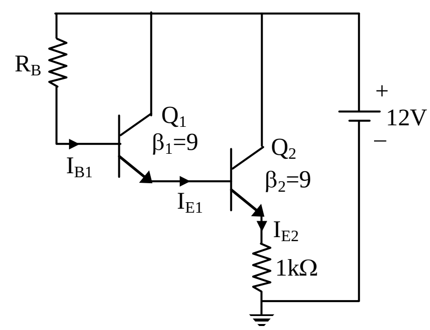
Closed loop TF $= \frac{G(s)}{1+G(s)H(s)}$

H(s) = 1, K = 2

$$\text{CLTF} = \frac{\frac{2}{(s+1)^3}}{1+\frac{2}{(s+1)^3}} = \frac{2}{s^3+3s^2+3s+3}$$

37. Ans: (d)

Sol:



Given $V_{CE_2} = 6V$

$V_{C_2} - V_{E_2} = 6V$

$12 - V_{E_2} = 6V$

$V_{E_2} = 6V$

$$I_{E_2} = \frac{V_{E_2}}{1k} = 6mA$$

$$I_{E_1} = \frac{6mA}{\beta+1} = 0.6mA$$

$$I_{B_1} = \frac{I_{E_1}}{\beta+1} = \frac{0.6mA}{10} = 0.06mA$$

$\therefore$ From the circuit

$$I_{B_1} = \frac{12V - 0.7 - 0.7 - 6V}{R_B}$$

$$R_B = \frac{4.6}{0.06mA} = 76.66k\Omega$$

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38. Ans: (d)

Sol: $\rightarrow$(HL) = 4000H

$\rightarrow$ (SP) = 2500H

$\rightarrow$ (A) = AAH

$\rightarrow$ (A) = AAH $\oplus$ AAH = 00H $\Rightarrow$ (A) = 00H

$\rightarrow$ PSW contents pushed on to top of stack

$\rightarrow$ HL pair contents i.e., 4000H is exchanged with contents of top of stack

Top of stack contains 4000H.

$\rightarrow$ Contents of top of stack i.e., 4000H popped back into PSW

$\Rightarrow$ (PSW) = 4000H

The Flag register contents are 00H

39. Ans: (d)

Sol: Given that 8 KB ROM & 8 KB RAM interfaced to 8085.

ROM is selected when A_{15} is 0

RAM is selected when A_{15} is 1

A_{13} & A_{14} are unused.

MVI	A, 00H	; (A) = 00H
STA	8080H	; (8080H) $\leftarrow$ (A) = 00H
DCR	A	; (A) = FFH
STA	C080H	; (C080H) $\leftarrow$(A) = FFH
		; (8080H) $\leftarrow$(A) = 00H
RET		; (PC) $\leftarrow$ (T0S)

Contents of memory location 8080H is 00H.

40. Ans: (c)

Sol: Given

$$f(x) = \frac{\pi^2}{3} - 4\left(\frac{\cos x}{1^2} - \frac{\cos 2x}{2^2} + ...\right)$$ clearly

f(x) is continuous at x = 0

($\because \underset{x\to 0}{\text{Lt}}$ f(x) = 0) the four series converges to f(0)

$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

$$\frac{\pi^2}{3} - 4\left(\frac{1}{1^2} - \frac{1}{2^2} + \frac{1}{3^2} - .....\right) = 0$$

$$\frac{1}{1^2} + \frac{1}{2^2} - \frac{1}{3^2} + ... = \frac{\pi^2}{12}$$

41. Ans: (b)

Sol: Given f(D) y = Q(x) ....(1)

where f(D) = D^2+3D+2

and Q(x) = cos(x)

C.F: Consider A.E, f(m) = 0

$\Rightarrow m^2+3m+2=0$

$\Rightarrow$ m = –1, –2

$\therefore y_c = c_1e^{-x} + c_2e^{-2x}$

P.I: Here, Q(x) = cos(x) = cos(ax+b)

and f(D) = $\phi(D^2) = \phi(-a^2) = \phi(-1) = (-1) +$ 3D + 2 = 1 + 3D $\neq$ 0

$$\text{Now, } y_p = \frac{1}{1+3D} \times \frac{1-3D}{1-3D}\cos(x)$$

$$= \frac{1-3D}{1-9D^2}\cos(x)$$

$$\Rightarrow y_p = (1-3D)\left[\frac{1}{1-9(-1)}\cos x)\right]$$

$$= (1-3D)\left(\frac{1}{10}\cos(x)\right)$$

$$\therefore\ y_p = \frac{\cos(x)}{10} + \frac{3}{10}\sin x$$

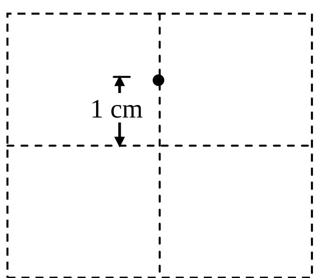
Hence, the general solution of (1) is

$y = y_c + y_p$

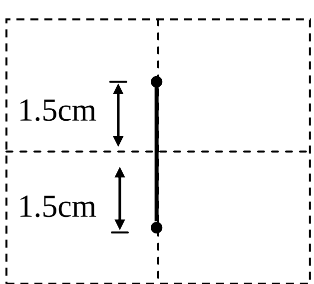
$$\text{i.e., } y = c_1e^{-x} + c_2e^{-2x} + \frac{\cos(x)}{10} + \frac{3}{10}\sin x$$

42. Ans: (b)

Sol: When 20 V dc supply to the vertical deflecting plates, the bright spots moves 1 cm away from the centre. (spot will move vertically when a voltage is applied to vertical deflecting plate and no voltage applied to the horizontal deflecting plates).



When 30 V (peak) ac is applied to the vertical deflecting plates with no voltage applied to the horizontal deflecting plates we will get a straight line (spot moves up and down with ac supply frequency).



Distance travelled by the spot for one cycle $= 4 \times 1.5 = 6$ cm

43. Ans: (a)

Sol: Given $f(D)y = Q(x)$ …………(1)

where $f(D) = D^2 + 4D + 4$

& $Q(x) = x^4\, e^{-2x} = e^{-2x}.x^4 = e^{x}.\, V(x)$

$$\text{Now, } y_P = \frac{1}{f(D)}\left[e^{-2x}\, x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{f(D-2)}x^4\right]$$

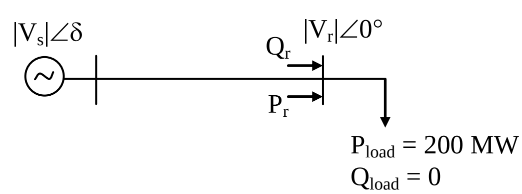
$$\Rightarrow y_P = e^{-2x}\left[\frac{1}{(D-2)^2 + 4(D-2) + 4}x^4\right]$$

$$\Rightarrow y_P = e^{-2x}\left[\frac{1(x^4)}{D^2}\right]$$

$$\therefore y_p = e^{-2x}.\frac{x^6}{30}$$

44. Ans: 215.6 (Range: 214 to 216)

Sol:



L-L sending end voltage, $|V_s|$=220 kV

$P_r = 200$ MW, $Q_r = 0$

For line, $Z_c = 325\ \Omega$, $\beta = 1.16 \times 10^{-3}$ rad/km, ℓ =180 km, $\beta\ell$ =0.2095 rad

Parameter, $A = \cos\beta\ell = 0.978\angle 0°$

$B = jZ_c \sin\beta\ell = 67.597\angle 90°\ \Omega$

As

$$Q_r = \frac{|V_s||V_r|}{|B|}\sin(\beta-\delta) - \frac{|A|}{|B|}|V_r|^2\sin(\beta-\alpha)$$

And $Q_r = 0$

$$\therefore \frac{|V_s||V_r|}{|B|}\sin(90^o - \delta) = \frac{|A|}{|B|}|V_r|^2 \sin(90^o - 0^o)$$

$$|V_s| \cos\delta = |A|\,|V_r| \Rightarrow |V_r| = \frac{|V_s|\cos\delta}{|A|}$$

As

$$P_r = \frac{|V_s||V_r|}{|B|}\cos(\beta - \delta) - \frac{|A|}{|B|}|V_r|^2 \cos(\beta - \alpha)$$

$$= \frac{|V_s||V_r|}{|B|}\cos(90^o - \delta) - \frac{|A|}{|B|}|V_r|^2 \cos(90^o - 0^o)$$

$$= \frac{|V_s||V_r|}{|B|}\sin\delta$$

$$= \frac{|V_s|}{|B|} \times \frac{|V_s|\cos\delta}{|A|}\sin\delta$$

$$P_r = \frac{|V_s|^2}{2|A||B|}\sin 2\delta$$

As $P_r = 200$ MW

$$200 = \frac{(220)^2}{2 \times 0.978 \times 67.597} \times \sin 2\delta$$

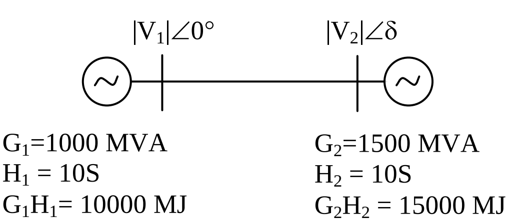
$\delta = 16.5589°$

$$\text{Now, } \underset{(LL)}{|V_r|} = \frac{220 \times \cos(16.5589)}{0.978}$$

$= 215.62$ kV

45. Ans: (c)

Sol: The two areas are not swinging together.

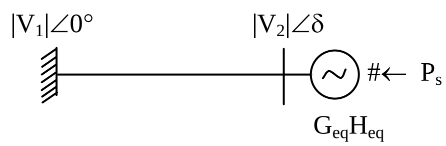


Equivalent kinetic energy,

$$\frac{1}{G_{eq}H_{eq}} = \frac{1}{G_1H_1} + \frac{1}{G_2H_2}$$

$$= \frac{1}{10000} + \frac{1}{15000}$$

$G_{eq} H_{eq} = 6000$ MJ



Initial electrical power transfer, $P_{e_0} = 200$ MW

So, $P_s = 200$ MW

For a 3-ϕ fault on tie line, electrical power output = 0

Accelerating power, $P_a = P_s - 0$

$= 200$ MW

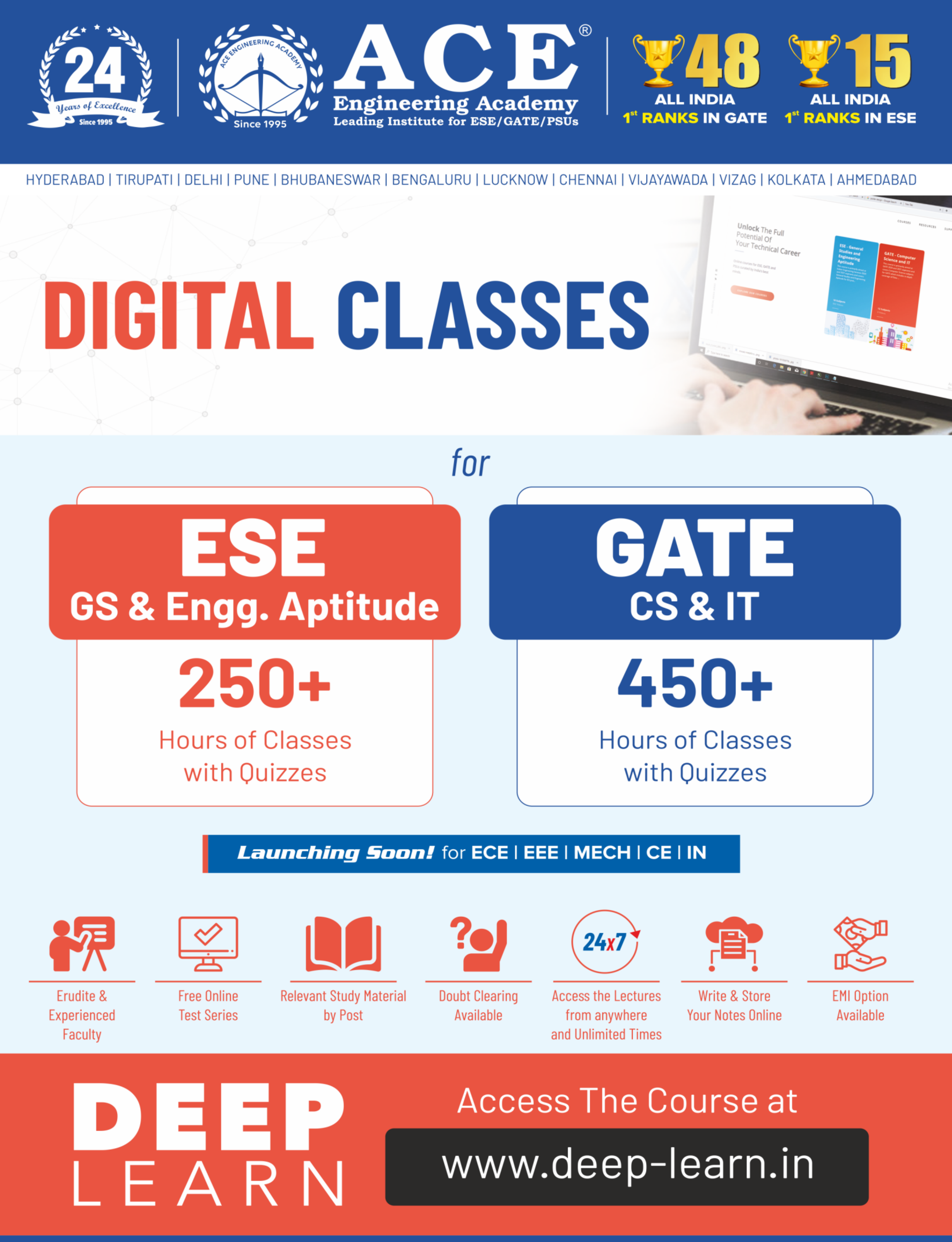
$$\text{Angular acceleration, } \frac{d^2\delta}{dt^2} = \frac{P_a}{M}$$

$$\text{Where, } M = \frac{G_{eq}H_{eq}}{180f}$$

$$= \frac{6000}{180 \times 50}\text{ MJ-s/elec.deg}$$

$$\therefore \frac{d^2\delta}{dt^2} = \frac{200}{\left(\frac{6000}{180 \times 50}\right)}\text{elec.deg/s}^2$$

$= 300$ elec.deg/s^2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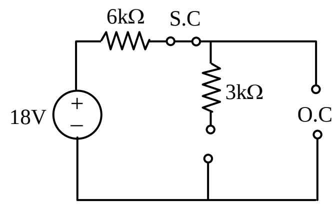
46. Ans: – 60 V/sec (No Range)

Sol: At time $t = 0^-$ switch is in open condition

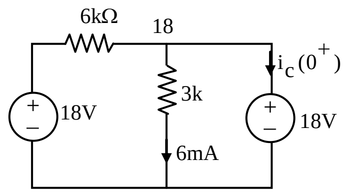


So, L is short circuit, C is open circuit

$i_L(0^-) = 0$

$V_C(0^+) = V_C(0^-) = 18V$

At $t = 0^+$ switch is closed



$$I_C(0^+) = C\frac{dv(0^+)}{dt}$$

$$\frac{dv(0^+)}{dt} = \frac{i_C(0^+)}{C}$$

$$i_C(0^+) = -6\times10^{-3}A$$

$$\frac{dv(0^+)}{dt} = \frac{-6\times10^{-3}}{100\times10^{-6}}$$

$$\frac{dv(0^+)}{dt} = -60V/sec$$

47. Ans: (d)

Sol: One radial element is examined. A general point on this radial element has a velocity

$\vec{V}\times\vec{B} = r\omega B\,\hat{a}r$

now emf reading of the voltmeter

$$V = \int_0^a \vec{E}.\overrightarrow{dr} = \int_0^a r\omega B.dr$$

$$= \frac{a^2\omega B}{2}$$

48. Ans: (a)

Sol: $\angle G(s) = -3\,\omega_{pc} - 90° = -180°$

$$\Rightarrow \omega_{pc} = 30° = \frac{\pi}{6}$$

Magnitude (a) = $\dfrac{k}{\omega_{pc}} = \dfrac{6k}{\pi}$

For stability a < 1

$$\Rightarrow k < \frac{\pi}{6}$$

Therefore Range is $0 < k < \dfrac{\pi}{6}$

49. Ans: 9

Sol: Forward paths: $M_1 = G_1\,G_2\,G_3\,G_4\,G_5\,G_6$

$M_2 = G_1\,G_2\,G_7\,G_6$

$M_3 = G_1\,G_2\,G_3\,G_4\,G_8$

Loops: $L_1 = G_4\,H_2$

$L_2 = G_5\,G_6\,H_3$

$L_3 = G_1\,G_2\,G_3\,G_4\,G_5\,G_6\,H_1$

$L_4 = G_1\,G_2\,G_7\,G_6\,H_1$

$L_5 = G_1\,G_2\,G_3\,G_4\,G_8\,H_1$

$L_6 = G_8\,H_3$

50. Ans: (b)

Sol: Energy stored by the capacitor = $\dfrac{1}{2}CV^2$

Where, V = 27 V and

$$C = \frac{\varepsilon_0 A}{d}$$

$$= \frac{8.85\times10^{-12}\times20\times10^{-4}}{1\times10^{-2}}$$

$$=1.77\times10^{-12}\text{F}$$

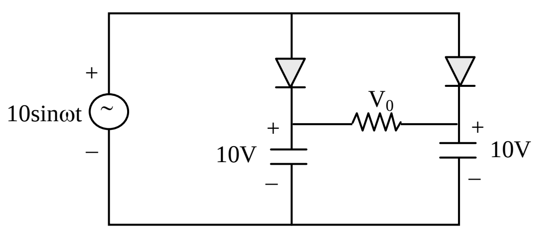
Then, energy stored

$$= \frac{1}{2}\times1.77\times10^{-12}\times(27)^2$$

$$= 64.5 \text{ nJ}$$

51. Ans: 0

Sol:



Diodes are ideal therefore during Positive cycle of input $V_0 = 10 - 10 = 0$V.

During Negative cycle, the diodes are Reverse biased $V_0 = 0$V

$\therefore\ V_0 = 0$ V

52. Ans: (c)

Sol: From Parseval's theorem

$$2\pi\int_{-\infty}^{\infty}|x(t)|^2 dt = \int_{-\infty}^{\infty}|X(\omega)|^2 d\omega$$

$$x(t) = \begin{cases} t+1 & ; -1<t<0 \\ -t+1 & ;\ 0<t<2 \\ t-3 & ;\ 2<t<3 \end{cases}$$

$$\int_{-\infty}^{+\infty}|X(\omega)|^2 d\omega =$$

$$2\pi\left[\int_{-1}^{0}(t^2+2t+1)dt + \int_{0}^{2}(t^2-2t+1)\,dt + \int_{2}^{3}(t^2-6t+9)dt\right]$$

$$=2\pi\left[\left(\frac{t^3}{3}+t^2+t\right)_{-1}^{0} + \left(\frac{t^3}{3}-t^2+t\right)_{0}^{2} + \left(\frac{t^3}{3}-3t^2+9t\right)_{2}^{3}\right]$$

$$=2\pi\left[\frac{1}{3}-1+1+\frac{8}{3}-4+2+9-27+27-\frac{8}{3}+12-18\right]$$

53. Ans: (a)

Sol: Data given: A 3–ϕ Y Alternator 10 kVA, $R_a = 0.5\Omega$/ph, $X_S = 1.2\Omega$/ph and $V_L = 230$V

$$V_{ph} = \frac{230}{\sqrt{3}} = 132.8\text{V}$$

$Z_s = R_a + jX_S = 0.5 + j1.2 = 1.3\angle 67.3$

$$I_L = \frac{10\times10^3}{\sqrt{3}\times230} = 25.1\text{ A}$$

Power factor at which regulation is zero:

Condition for zero regulation

$$\cos(\theta+\varphi) = -\frac{I_a Z_s}{2V}$$

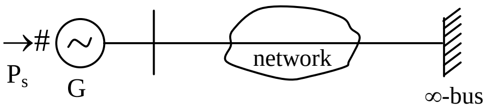
$$\cos(67.3+\phi) = \frac{-25.1\times1.3}{2\times132.8}$$

$$\phi = 29.67^\circ$$

Power factor = $\cos\phi = \cos 29.67 = 0.868$ lead

54. Ans: 1.46 p.u (Range: 1.35 to 1.55)

Sol:



$\delta_0 = 20°$

$P_{max2} = 1$ p.u

$P_{max3} = 2.5$ p.u

$\delta_{cr} = 80°$

$\delta_{max} = 130°$

Transient stability limit is the value of 'P_s' for the fault cleared at critical clearing angle.

$\cos\delta_{cr} =$

$$\frac{P_s(\delta_{max}-\delta_0)+P_{max3}\cos\delta_{max}-P_{max2}\cos\delta_0}{P_{max3}-P_{max2}}$$

$\cos(80°) =$

$$\frac{P_s(130°-20°)\times\frac{\pi}{180°}+2.5\cos(130°)-1\times\cos 20°}{2.5-1}$$

$P_s = 1.46$ p.u

55. Ans: (c)

Sol: $\frac{N_2}{N_1} = \frac{E_{b2}}{E_{bi}} \times \frac{\phi_1}{\phi_2}$

$$\frac{N_2}{N_1} = \frac{E_{b2}}{E_{b1}} \times \left(\frac{I_{a1}}{I_{a2}}\right)$$

$T \propto I_a^2$ since $\phi \propto I_a$

$$\frac{T_2}{T_1} = \left(\frac{I_{a2}}{I_{a1}}\right)^2$$

$$\Rightarrow I_{a2} = \frac{I_{a1}}{\sqrt{2}}$$

$I_{a1} = 100$ A

$I_{a2} = 100/\sqrt{2}$

$E_{b1} = 220 - 100 \times 0.1 = 210$ V

$E_{b2} = 220 - \frac{100}{\sqrt{2}} \times 0.1 = 212.9$ V

$N_2 = N_1 \times \frac{E_{b2}}{E_{b1}} \times \frac{100}{70.7} = 1147$ rpm.