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GATE- 2019 – Offline GATE Mock -3

Electrical Engineering

Solutions

General Aptitude (GA)

Q. 01 to 05 Carry one mark each

01. Ans: (d)

Sol: Let the ages of A and B 10 years ago be x and 2x years respectively.

Then, $\frac{x+10}{2x+10} = \frac{3}{4}$

$\Leftrightarrow 4(x + 10) = 3(2x + 10)$

$\Leftrightarrow 2x = 10 \Leftrightarrow x = 5$

$\therefore$ Sum of their present ages

$= ((x + 10) + 2x + 10)$

$= (3x + 20) = 35$ years

02. Ans: (c)

Sol: Rule m + n is divisible by 10 does not hold true in the given case. Eg. 35, 10 are integers divisible by 5 but 35+10 = 45, which is not divisible by 10.

03. Ans: (b)

04. Ans: (b)

05. Ans: (d)

Q. 06 to 10 carry two marks each

06. Ans: (c)

Sol: The interval of leaving two buses = 30 minutes The time for the next bus = 15 minutes

$\therefore$ The passed = 30 – 15 = 15 minutes

The required time for the information given by enquiry clerk = 9:10+0.15 = 9:25

07. Ans: (c)

Sol: Let one gets = Rs.x

Then, second gets = Rs. (68000–x)

Given, $A_1 = A_2$

$$x + \frac{x\times 10\times 8}{100} = (68000 - x) + \frac{(68000-x)\times 10\times 6}{100}$$

$$x(100+80) = (68000 - x)[100+60]$$

$$\frac{180x}{160} = 68000 - x$$

$34x = 68000\times 16 \Rightarrow x = 32000/-$

$\therefore$ Second gets = Rs.36000

08. Ans: (d)

Sol: The statement mentions the cause of family problems and does not deal with all the problems. So, statement 1 is not implicit. Also, it is mentioned that money is the cause of family problems. But this does not mean that problems always exist in a family. So, statement 2 is also not implicit.

09. Ans: (d)

Sol: → Single Unit Rectangles = 5 + 5 = 10

→ Double Unit Rectangles = 5 + 8 = 13

→ Three Unit Rectangles = 6

→ Four Unit Rectangles = 4 + 4 = 8

→ Six Unit Rectangles = 3

→ Five Unit Rectangles = 2

→ Eight Unit Rectangles = 2

→ Ten Unit Rectangles = 1

45

Hence, option (d) is correct.

10. Ans: (d)

Electrical Engineering (EE)

Q. 01 to 25 carry one mark each

01. 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

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

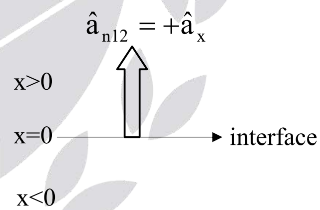
$$= I_2\left[\frac{-36}{4} + 4\right] = -5I_2$$

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

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

02. Ans:(b)

Sol:



Given $\vec{K} = 10\hat{a}_z A/m$

$\vec{H}_1 = 12\hat{a}_y A/m$

As the interface is x = 0 (or) yz-plane, hence y, z are tangential components and x is normal component

$$\vec{H}_{t1} = 12\hat{a}_y, \vec{H}_{n1} = 0$$

$$\vec{H}_{t1} - \vec{H}_{t2} = \hat{a}_{n_{12}} \times \vec{K}$$

$$12\hat{a}_y - \vec{H}_{t2} = \hat{a}_x \times 10\hat{a}_z$$

$$\vec{H}_{t2} = 22\hat{a}_y$$

$$\vec{H}_2 = 22\hat{a}_y A/m$$

03. Ans: (a)

Sol: $Z_{2RB} = 100\% \, Z_{BC} + 50\% \, Z_{CD}$

$= 8+2$

$= 10\Omega$

04. Ans: 3

Sol: The eigen values of A are $\lambda = 2, 2, 2$,

The eigen vectors are given by the system

$[A - 2I]X = 0$

$\Rightarrow (A - 2I)$ is a zero matrix

$\Rightarrow$ Rank of $(A - 2I) = 0$

$\therefore$ The number of linearly independent eigen vectors of A = n – r = 3 – 0 = 3

Where n = order of A and r = rank of [A-2I].

05. Ans: (d)

Sol: (i) Total core loss $\Rightarrow W_i = W_h + w_e$

$V\uparrow, \quad f\uparrow \Rightarrow \dfrac{V}{f} = \text{constant}$

$\therefore \text{as } f\uparrow \Rightarrow W_h\uparrow, W_e\uparrow \Rightarrow W_i\uparrow$

(ii) Magnetizing flux $\phi \; \alpha \; \dfrac{V}{f}$

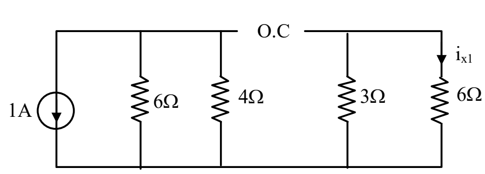
As $\dfrac{V}{f}$ = fixed

$\Rightarrow \phi$ fixed $\Rightarrow I_\mu$ fixed.

06. Ans: (c)

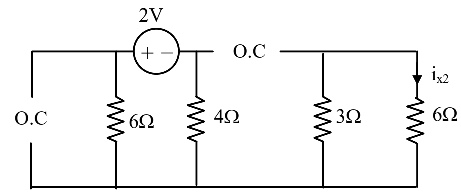
Sol: By super position principle I = i_{x1} due to 1A + i_{x2} due to 2V + i_{x3} due to 1A

1A source alone:



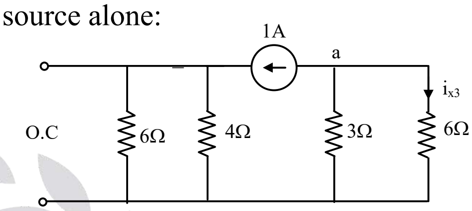
$I_{x1} = 0$

2V source alone:



$I_{x2} = 0$

1A source alone:



By KCL at a branch current leaving = current entering

$$i_{x3} = 1 \times -\left(\frac{3}{3+6}\right)$$

$$= -\frac{3}{9} = -\frac{1}{3}\text{A}$$

$\therefore \; i_x = i_{x1} + i_{x2} + i_{x3}$

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

07. Ans: 900.90 (Range: 899 to 902)

Sol: Given data:

$B_{max} = 1.5 \text{ wb/m}^2$

E/ turn = 30V

E/ turn = $4.44 \times \phi \times f$

E/turn = $4.44 \times B_m \times A \times f$

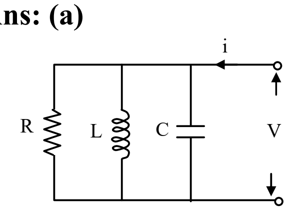
$30 = 4.44 \times 1.5 \times A \times 50$

$A = 0.09009 \text{ m}^2$

$A = 900.90 \text{ cm}^2$

08. Ans: (a)

Sol:



$$i = V.\left(\frac{1}{R}+\frac{1}{SL}+SC\right)$$

$$= V\left(\frac{S^2LCR + R + SL}{RSL}\right)$$

$$i = V.C\frac{\left(S^2+\frac{R}{LCR}+\frac{SL}{RCL}\right)}{RSL}$$

$$V = \frac{i\frac{1}{C}}{S^2+\frac{1}{RC}S+\frac{1}{LC}}$$

Equation is $S^2+\frac{1}{RC}S+\frac{1}{LC}=0$

Roots $S_1,S_2 = \frac{\frac{-1}{RC}\pm\sqrt{\left(\frac{1}{RC}\right)^2-4\left(\frac{1}{LC}\right)^2}}{2}$

$$= \frac{-1}{2RC}\pm\sqrt{\left(\frac{1}{2RC}\right)^2-\left(\frac{1}{LC}\right)^2}$$

By comparing

$$= \frac{1}{2RC} < \frac{1}{LC}$$

$$= \frac{1}{2\times4\times16} < \frac{1}{16\times4}$$

Roots are complex so circuit exhibits under damping

09. Ans: (d)

10. Ans: (c)

Sol: Rate of flickering = beat frequency

$= f - f^l$

$= 50.3 - 50 = 0.3\text{Hz}$

$\Rightarrow$ 0.3 Flickers/sec = 0.3 × 60

= 18 filckers/min

11. Ans: (c)

Sol: Let $I = \int_0^{\frac{\pi}{2}} \frac{1}{1+\sqrt{\tan x}}dx$

$$= \int_0^{\pi/2} \frac{1}{1+\sqrt{\frac{\sin x}{\cos x}}}dx$$

$$= \int_0^{\pi/2} \frac{1}{\frac{\sqrt{\cos x}+\sqrt{\sin x}}{\sqrt{\cos x}}}dx$$

$$I = \int_0^{\frac{\pi}{2}} \frac{\sqrt{\cos x}}{\sqrt{\cos x}+\sqrt{\sin x}}dx$$

$$I = \int_0^{\frac{\pi}{2}} \frac{\sqrt{\sin x}}{\sqrt{\sin x}+\sqrt{\cos x}}dx$$

[$\because \int_0^a f(x)dx = \int_0^a f(a-x)dx$]

Adding,

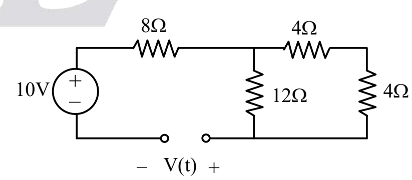
$$2I = \int_0^{\frac{\pi}{2}} dx = \frac{\pi}{2}$$

$$I = \frac{\pi}{4}$$

12. Ans: (a)

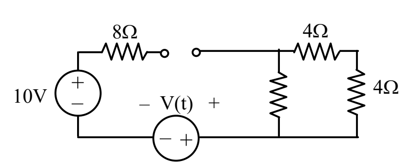
13. Ans: (d)

Sol: At $t=0^-$ switch was closed position



$V_C(0^+) = V(0^-) = 10V$

At $t=0^+$ switch is opened than



V(t) = 10V

14. Ans: (a)

Sol: $\eta = \dfrac{P_0}{P_0 + P_{loss}} \Rightarrow P_0 = \dfrac{\eta}{1-\eta} . \times P_{loss}$

If η = 89%,

$$P_0 = \frac{0.89}{1-0.89} \times 200 \approx 1.6 \text{ kW}$$

If η = 94%,

$$P_0 = \frac{0.94}{1-0.94} \times 200 \approx 3.13 \text{ kW}$$

Hence option 'a' is correct.

15. Ans: (b)

Sol: If rank of A is 2, then $|A| = 0$

$\Rightarrow (x-1)\ (x^2 + x + 1) = 0$

$\Rightarrow x = 1,\ \dfrac{-1 \pm \sqrt{3}\, i}{2}$

$\therefore x = 1$

16. Ans: (a)

Sol: The given limit $= \underset{x\to\infty}{\text{Lt}} \left[\left(\dfrac{x+4}{x+2}\right)^x . \left(\dfrac{x+4}{x+2}\right)^3\right]$

$$= \underset{x\to\infty}{\text{Lt}} \left[\frac{\left(1+\frac{4}{x}\right)^x}{\left(1+\frac{2}{x}\right)^x} \left[\frac{1+\frac{4}{x}}{1+\frac{2}{x}}\right]^3\right]$$

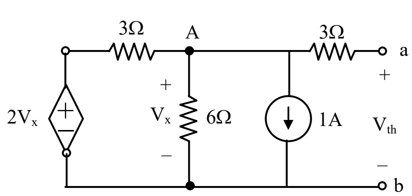
$$= \frac{e^4}{e^2} = e^2$$

17. Ans: (d)

Sol: The error in Simpson's 1/3rd rule is of order h^4

18. Ans: (d)

Sol:



Current flowing through 3Ω is zero so

$V_{th} = V_x$

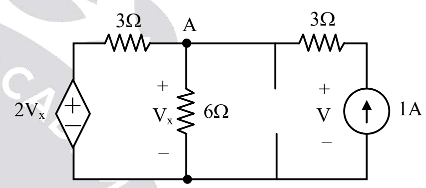
Apply KCL at node A, then

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

$$-2V_x + V_x + 6 = 0$$

$$V_x = 6V$$

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

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

$$V_x - 2V_x - 6 = 0$$

$$V_x = -6V$$

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

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

19. Ans: (d)

Sol: $(1+t)\dfrac{dy}{dt} = 4y$

$$\int \frac{1}{y} dy = \int \frac{4}{1+t} dt$$

Log y = 4 log (1+t) +logc

$y = c(1+t)^4$

y (0) = 1

$\Rightarrow \quad 1 = c(1+0)^4 \Rightarrow c = 1$

$\Rightarrow \quad y = (1+t)^4$

20. Ans: (c)

Sol: Generator buses = 10

Load buses = 90

5 load buses are converted into generator buses total generator buses = 15

Load buses = 85

Generator equations = (15 - 1) × 1 = 14

Load bus equations = 85 × 2 = 170

Total number of equations = 184.

21. Ans: (c)

22. Ans: (b)

Sol: Line address for 4K × 8 memory is 0FFFH.

End address = Starting address + Line address

∴ End Address = AA00H + 0FFFH

= B9FFH

23. Ans: 4.88 (4.8 to 5)

Sol: Smallest increment change in output

$$\Delta V = \frac{1}{2^{10}} = \frac{1}{1024}\,V$$

For 5V, $\Delta V = 5 \times \frac{1}{1024} \approx 5$ mV

24. Ans: (d)

Sol: The switching order of inverter is

$D_1\,D_4 - S_1\,S_4 - D_2\,D_3 - S_2\,S_3$.

25. Ans: (c)

Sol: Given data,

$R_a = 0.2\Omega$, $N_1 = 1245$ rpm, $I_{a1} = 125$A,

$V_t = 440$V, $\phi_2 = 0.75\phi_1$, τ_L = constant

$\tau \propto \phi I_a$

$I_{a2}\,\phi_2 = I_{a1}\phi_1$

$$\Rightarrow I_{a2} = 125 \times \frac{\phi_1}{0.75\phi_1} = 166.67\text{A}$$

$E_{b1} = V - I_{a1}\,R_a = 440 - 125(0.2) = 415$V

$E_{b2} = V - I_{a2}\,R_a = 440 - 166.67(0.2)$

$= 406.6$V

$$\frac{E_{b1}}{E_{b2}} = \frac{N_1}{N_2} \times \frac{\phi_1}{\phi_2}$$

$$\Rightarrow N_2 = \frac{1245 \times 406.6 \times \phi_1}{415 \times 0.75 \times \phi_1}$$

$= 1626.7$rpm

Q. 26 to 55 carry two marks each

26. Ans: 0.376 (Range: 0.2 to 0.4)

Sol: $\frac{C}{R} = \left(\frac{8}{1+8(2)}\right)\left(\frac{4}{1+4}\right) = \frac{32}{85} = 0.376$

27. Ans: (a)

Sol: $Q = \int dQ = \int \rho_v dv$

$$= \int_0^{0.1}\int_0^{\pi}\int_0^{2\pi} 4r^2 \sin\theta dr\, d\theta d\phi = 4\left[\frac{r^3}{3}\right]_0^{0.1} \left[-\cos\theta\right]_0^{\pi}\left[\phi\right]_0^{2\pi}$$

$=0.016755\mu$C

charge present between 10cm<r<r_0 is

$$Q = \int_{0.1}^{r_0}\int_0^{\pi}\int_0^{2\pi} \frac{-3r^2}{r^3+0.001}\sin\theta dr\, d\theta d\phi$$

$$= -\ln\left[\frac{r_0^3+0.001}{0.002}\right][2][2\pi]\text{nC}$$

Hence total charge present between 0<r<r_0 is

$$Q_{tot} = 16.755\text{nC} - 4\pi\ln\left[\frac{r_0^3+0.001}{0.002}\right]\text{nC} = 0$$

$$\Rightarrow \ln\left[\frac{r_0^3+0.001}{0.002}\right] = 1.33332$$

$$\Rightarrow \left[\frac{r_0^3 + 0.001}{0.002}\right] = e^{1.33332} = 3.79362$$

$$\Rightarrow r_0 = 0.187456 = 18.746\text{cm}$$

28. Ans: (b)

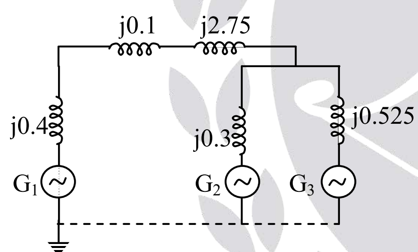
Sol: G_1: $X_{pu(new)} = 0.2 \times \frac{150}{75}\left(\frac{11}{11}\right)^2 = 0.4$

G_2: $X_{pu\,(new)} = 0.1 \times \frac{150}{50}\left(\frac{33}{33}\right)^2 = 0.3$

G_3: $X_{pu(new)} = 0.35 \times \frac{150}{100}\left(\frac{33}{33}\right)^2 = 0.525$

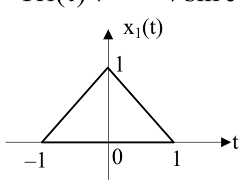
T/F: $X_{(pu)} = X_{s(pu)} = 0.1$

OHTL: $X_{pu} = 20 \times \frac{150}{(33)^2} = 2.75$



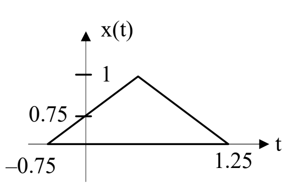
29. Ans: 0.75

Sol: $x_1(t) = \text{Tri}(t) \xleftrightarrow{FT} \text{sinc}^2(f) = X_1(f)$



$X(f) = X_1(f)e^{\frac{-j\pi f}{2}}$

$x(t) = x_1\left(t - \frac{1}{4}\right)$



Area under spectrum = signal value at t=0

$$\int_{-\infty}^{\infty} X(f)df = x(0) = 0.75$$

30. Ans: 4.5 to 4.8

Sol: $V_{LL} = 460\text{V} \Rightarrow V_{ml} = 460\sqrt{2}$

$L_s = 5$ mH; $\omega = 100\pi$ rad/s

$P_0 = V_0 I_0 = 5000$ W

$$\Rightarrow I_0 = \frac{5000}{500} = 10\text{A}$$

$$V_0 = \frac{3V_{ml}}{\pi}\cos\alpha - \frac{3\omega L_s}{\pi} I_0 = 500\text{V}$$

$$\Rightarrow \frac{3\times 460\sqrt{2}}{\pi}\cos\alpha - \frac{3\times 100\pi \times 5\times 10^{-3}}{\pi} \times 10 = 500$$

$\Rightarrow \cos\alpha = 0.829 \Rightarrow \alpha = 34°$

Now, $\cos(\alpha+\mu) = \cos\alpha - \frac{2\omega L_s}{V_{ml}} I_0$

$$= 0.829 - \frac{2\times 100\pi \times 5\times 10^{-3}}{460\sqrt{2}} \times 10$$

$= 0.7807$

$\Rightarrow \alpha+\mu = 38.67°$

$\mu = 38.67 - 34 = 4.67°$

31. Ans: (a)

Sol: CE = $1 + \frac{4}{s(s+2)}$

$s^2 + 2s + 4 = 0$

$\omega_n = 2$

$2\zeta\omega_n = 2$

$\Rightarrow \zeta = \frac{1}{2}$

$$t_p = \frac{\pi}{\omega_d} = \frac{\pi}{\omega_n\sqrt{1-\zeta^2}} = \frac{\pi}{2\sqrt{1-\frac{1}{4}}} = \frac{\pi}{\sqrt{3}}\text{ sec}$$

32. Ans: (a)

Sol: Given data: 440V, 50Hz and $W_i = 2500$

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

$$W_i = Af + Bf^2$$

For 50Hz: $2500 = A\times50 + B\times2500$ ……… (1)

For 25Hz: $850 = A\times25 + B\times625$ ………… (2)

By solving (1) and (2),

$A = 18$, $B = 0.64$

At 50Hz:

Eddy current loss $= B\times f^2$

$= 0.64 \times 2500$

$= 1600$ W

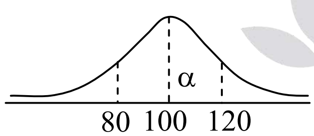
Hysterisis loss $= Af$

$= 18 \times 50$

$= 900$ W.

33. Ans: (c)

Sol: The area under normal curve is 1 and the curve is symmetric about mean.



$\therefore P(100 < X < 120) = P(80 < X < 120) = \alpha$

Now, $P(X < 80) = 0.5 - P(80 < X < 100)$

$$= 0.5 - \alpha = \frac{1}{2} - \alpha$$

$$= \frac{1-2\alpha}{2}$$

34. Ans: 60 (Range 60 to 60)

Sol: $$\frac{y_1 - 30}{\log 2 - \log 0.1} = -40$$

$\Rightarrow \quad y_1 = 30 - 52 = -22$ dB

$$\frac{y_2 - (-22)}{\log 20 - \log 2} = -60$$

$\Rightarrow \quad y_2 = -82$ dB

Therefore $y_1 - y_2 = -22 - (-82)$

$= 60$ dB

35. Ans: 17.65 (Range 16 to 18)

Sol: A 3-ϕ, 11 kV, 10 MW, Y-connected, Alternator

$$V_L = 11\text{ kV} \Rightarrow V_{ph} = \frac{11\times10^3}{\sqrt{3}} = 6351\text{ V}$$

$$Z_s = 0.8 + j8 = 8.04\angle(84.29 = \theta)$$

$$E_L = 14\text{ kV} \Rightarrow E_{ph} = \frac{14\times10^3}{\sqrt{3}} = 8082.9\text{ V}$$

$$\Rightarrow P_{max} = \frac{EV}{Z_s} - \frac{V^2}{Z_s}\cos\theta$$

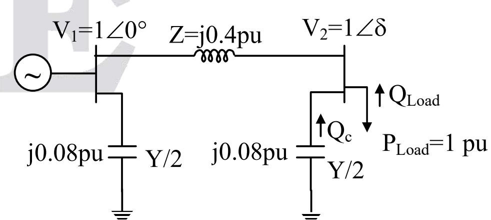
$$= \frac{8082.9\times6351}{8.04} - \frac{6351^2}{8.04}\cos 84.29$$

$= 5.885$ MW

$P_{max(Total)} = 3\times5.885 = 17.6551$ MW

36. Ans: (a)

Sol:



$$P_2 = P_{load} = 1\text{ pu, as } P_2 = \frac{|V_1||V_2|}{X}\sin(0-\delta)$$

$$\text{So, } 1 = \frac{1}{0.4}\sin(-\delta) \rightarrow \delta = -\sin^{-1}(0.4)$$

$$\delta = -23.6°$$

Now, $Q_2 = \frac{|V_2|}{X}\left[|V_1|\cos\delta - |V_2|\right]$

$= \frac{1}{0.4}\left[1\times\cos(-23.6°) - 1\right]$

$= -0.209$ pu

Reactive power balance

$Q_2 + Q_c + Q_{load} = 0$

Where Q_{load} is reactive power injected by load into bus bar and $Q_c = |V_2|^2\left|\frac{Y}{2}\right|$

$Q_c = 1 \times 0.08$

$= 0.08$ pu

$-0.209 + 0.08 + Q_{load} = 0$

$Q_{load} = 0.129$ pu

37. Ans: (a)

Sol: The given circuit is Wein-bridge oscillator. The gain of the amplifier, $\frac{V_2}{V_1} = \left(1+\frac{2k\Omega}{1k\Omega}\right) = 3$

⇒Oscillations will be sustained Frequency of oscillation, $f = \frac{1}{2\pi RC}$

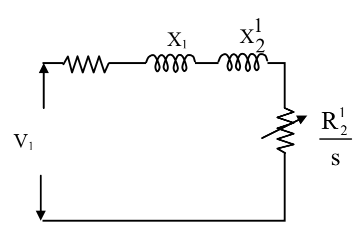
Given : f = 1kHz, R = 1kΩ

$$C = \frac{1}{2\pi Rf} = \frac{1}{2\pi\times10^3\times10^3}$$

$$\therefore\ C = \frac{1}{2\pi}\mu F$$

38. Ans: (c)

Sol:



For maximum slip, $\frac{R_2^1}{s} = \sqrt{R_1^2 + (X_{01})^2}$

$\frac{0.08}{s} = \sqrt{(0.07)^2 + (0.67)^2}$

$s = 0.1187$

39. Ans: 7.29 (Range: 7.28 to 7.30)

Sol: $f_s = 200$ kHz ⇒ T = 5 μs

$V_0 = \frac{V_{in}}{1-D} \Rightarrow 12 = \frac{5}{1-D} \Rightarrow D = 0.5833$

$\Delta I_L = \frac{V_{dc}}{L}DT = 2A$

$\Rightarrow \frac{5}{L}\times0.5833\times5\mu = 2$

$\Rightarrow L = 7.29\ \mu H$

40. Ans: (b)

Sol: Let X = number of accidents between 5 P.M and 6 P.M.

For Poisson distribution,

$\lambda = np = (1000)(0.0001) = 0.1$

$P(X=x) = \frac{e^{-\lambda}.\lambda^x}{\angle x}$ (x = 0, 1, 2,……..)

Required Probability = P(X ≥ 2)

= 1 – P(X < 2)

= 1 – {P(X = 0) + P(X = 1)}

$= 1 - e^{-0.1}(1 + 0.1)$

= 0.0045

41. Ans: (c)

Sol: $P_0 = 20$kW, $V_t = 250$V, $N_1 = 1000$ r.p.m

$\phi\alpha = \frac{I}{50+I}$, $r_s = 0.01\Omega$, $r_a = 0.015\ \Omega$

$I_{a2} = 100A$, $N_2 = 1050$ r.p.m and $V_b = 2V$

$I_{a1} = \frac{20\times10^3}{250} = 80A$

Now field flux $\phi_1 = \frac{80}{50+80} \times 0.94$

(since in total ampere turns, the demagnetizing ampere turns are 6%)

$E_{a_1} = 80(r_s + r_a) + V_b + V_t$

= 80(0.025) +2+250

= 254V

Now $I_{a_2} = 100A$

Net field flux $\phi_2 = \frac{100}{150} \times 0.94$

We know that, $\frac{E_{a1}}{E_{a2}} = \frac{N_1\phi_1}{N_2\phi_2}$

$E_{a2} = \frac{1050 \times 100 \times 0.94 \times 130}{150 \times 1000 \times 80 \times 0.94} \times 254$

= 288.925

$E_{a2} = 100(0.025) + V_b + V_t$

$V_t = E_{a2} - (100 \times 0.025) - 2$

= 284.43V

42. Ans: (c)

Sol: 2k > 1 & 0.01k < 1

$k > \frac{1}{2}$ & $k < 100$

$\therefore \frac{1}{2} < k < 100$

43. Ans: (c)

Sol: Given data

$$H = \frac{\text{K.E stored}}{\text{rating of the generator}}$$

$$5 = \frac{\text{K.E stored}}{100}$$

K.E = 500 MJ

K.E stored in 0.4 sec

50×0.4 = 20 MJ

K.E ∝ f^2

$$\frac{500}{520} = \left(\frac{50}{f_{new}}\right)^2$$

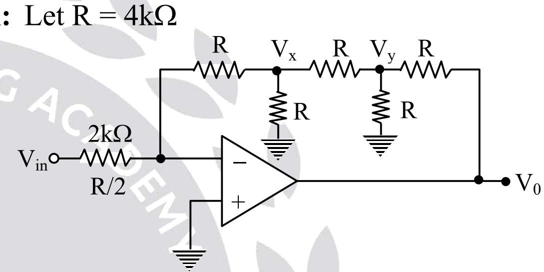
$$\frac{50}{f_{new}} = \sqrt{\frac{50}{52}}$$

$$f_{new} = 50\sqrt{\frac{52}{50}}$$

= 50.99 ≈ 51 Hz

44. Ans: (b)

Sol: Let R = 4kΩ



Applying KCL at inverting terminal,

$$\frac{V_{in} - 0}{R/2} = \frac{0 - V_x}{R} \Rightarrow V_x = -2V_{in} \quad \text{.............. (1)}$$

Applying KCL at V_x,

$$\frac{V_x}{R} + \frac{V_x}{R} + \frac{V_x - V_y}{R} = 0$$

$\Rightarrow 3V_x - V_y = 0$

i.e. $3V_x = V_y$ .... (2)

Applying KCL at V_y,

$$\frac{V_y}{R} + \frac{V_y - V_x}{R} + \frac{V_y - V_0}{R} = 0$$

$\Rightarrow 3V_y - V_x = V_0$ .... (3)

Substituting (2) in (3),

$3(3V_x) - V_x = V_0$

$8V_x = V_0$ .... (4)

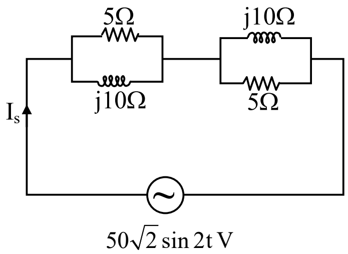
Substituting (1) in (4)

$8(-2V_{in}) = V_0$

$$\Rightarrow \frac{V_0}{V_{in}} = A_V = -16$$

45. Ans: (c)

Sol: If the galvanometer is short circuited then modified bridge circuit is shown below.

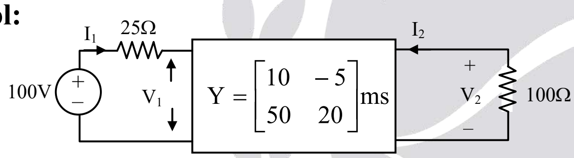


$$Z_{eq} = 2 \times \left(\frac{5\times j10}{5+j10}\right) = 4\sqrt{5}\angle 26.56$$

$$I_s = \frac{50\angle 0°}{4\sqrt{5}\angle 26.56} = 5.59\angle -26.56°$$

46. Ans: V_1 = 68.6 volts (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)

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

$$= (10\times10^{-3})V_1 + (5\times10^{-3}\times100\left(\frac{50\times10^{-3}}{3}\right)V_1$$

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

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

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

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

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

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

47. Ans: (a)

Sol: $P = V_{s1}\, I_{s1}\cos\phi_1 = 950$

$$\Rightarrow DPF = \cos\phi_1 = \frac{950}{120\times10} = 0.792$$

$$IPF = DF \times DPF$$

$$= \frac{DPF}{\sqrt{1+(THD)^2}} = \frac{0.792}{\sqrt{1+(0.75)^2}}$$

$= 0.6336$ lag

48. Ans: (b)

Sol: According to the given data, state table can be prepared as follows.

Control Input	Present State		Next state		Flip-flop Input	
y	Q_1	Q_0	Q_1	Q_0	T_1	T_0
0	0	0	1	1	1	1
0	0	1	0	0	0	1
0	1	0	0	1	1	1
0	1	1	1	0	0	1
1	0	0	0	1	0	1
1	0	1	1	0	1	1
1	1	0	1	1	0	1
1	1	1	0	0	1	1

K-map for T_1: (in terms of present state & control inputs)

y \ Q_1Q_0	00	01	11	10
0	0: 1	1:	3:	2: 1
1	4:	5: 1	7: 1	6:

$$\Rightarrow T_1 = \bar{y}\,\overline{Q_0} + y\,Q_0 = \overline{y \oplus Q_0}$$

49. Ans: (c)

Sol: $V_{PO} = \dfrac{16\times10^{-9}}{4\pi\varepsilon_0}\left[\dfrac{1}{d(PQ)} - \dfrac{1}{d(OQ)}\right]$

$$= \frac{16\times10^{-9}}{4\pi\varepsilon_0}\left[\frac{1}{\sqrt{12}} - \frac{1}{\sqrt{38}}\right] = 18.21\text{V}$$

$$V_{PO} = \frac{-\rho_L}{2\pi\varepsilon_0}\left[\ln(d_p) - \ln(d_o)\right]$$

Co-ordinate of point P are (4, 1, 3). Coordinate of the foot of the perpendicular dropped from P on the line charge (2, 4, 3)

$$\therefore d_p = \sqrt{(4-2)^2 + (1-4)^2} = \sqrt{13}$$

Co-ordinate of point O are(0,0,0). Coordinate of the foot of the perpendicular dropped from O on the line charge (2,4,0)

$$\therefore d_o = \sqrt{(0-2)^2 + (0-4)^2} = \sqrt{20}$$

$$V_{PO} = -\frac{5\times10^{-9}}{2\pi\varepsilon_0}\left[\ln(\sqrt{13}) - \ln(\sqrt{20})\right]$$

$$= 19.3852\text{V}$$

$$V_{PO}(\text{total}) = 18.21 + 19.3852 = 37.5952\text{V}$$

Now $V_{PQ} = V_P - V_O$

$$\Rightarrow V_p = V_{PO} + V_O = 37.5952 + 100$$

$$= 137.5952\text{V}$$

50. Ans: 23040 (23000 to 24000)

Sol: Initial load = (P_1) = 50 ×0.8 = 4kW

P_1 = 4kW

Final load (P_2) = 3 ×0.8= 2.4kW

(P_2 = 2.4kW)

Given meter rotates 400 times in 150 seconds

$\therefore$ Revolutions mode in 1hr = r_1

$$r_1 = 400\times\frac{60\times60}{150} = 9600$$

$\therefore$ meter constant of the meter is

$$(K_1) = \frac{r_1}{p_1} = \frac{9600}{4} = 2400 \text{ rev/kWh}$$

But meter constant $(K) \propto \dfrac{r}{\phi^2 R}$

r = resistance to eddy currents

R = radius of disc

ϕ = flux of brake magnet

Given flux of brake magnet is halved

$$\therefore \phi_2 = \frac{\phi_1}{2}$$

$\Rightarrow K_2$ (new meter constant) = $4K_1$

$\therefore$ K_2 = 9600 rev/kWh

$\therefore$ revolutions the new meter will do in

1hour = 9600 × P_2 ×1 = 9600 × 2.4

= 23040 rev

51. Ans: 4

Sol: Using conjugate symmetry property

$X[k] = X^*[N-k]$. Here, N = 5

$X[1] = X^*[4] = 8.78 + j1.4$

$X[3] = X^*[2] = -1.28 + j4.39$

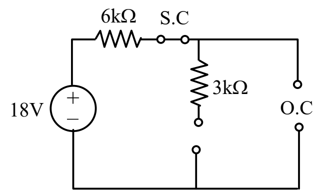
$$x_0 = \frac{1}{N}\sum_{K=0}^{4} X[k]$$

$$= \frac{1}{5}\left[X(0) + X(1) + X(2) + X(3) + X(4)\right]$$

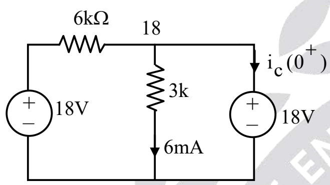
$= 4$

52. 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

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

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

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

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

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

53. Ans: 64 (No Range)

Sol: Since $F_3 = F_1.F_2 = \Sigma m\,(4, 6, 12)$, the function F_2 must have the minterms m_4, m_6 & m_{12}. Since $F_1 = \Sigma m(0,1,2,3,4,6,10,11,12,13)$, the function F_2 may or may not have the remaining minterms viz. m_5, m_7, m_8, m_9, m_{14} and m_{15}.

m_5	m_7	m_8	m_9	m_{14}	m_{15}	F_2
0	0	0	0	0	0	Σm (4,6,12)
0	0	0	0	0	1	Σm (4,6,12,15)
0	0	0	0	1	0	Σm (4,6,12,14)
⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	1	1	1	1	1	Σm (4,5,6,7,8,9,12,14,15)

⇒ Number of possible functions for F_2 is $2^6 = 64$

54. Ans: (a)

Sol: $\dfrac{d^2y}{dx^2} - y = 0$

$m^2 - 1 = 0$

$\Rightarrow m = \pm1$

$y = c_1e^x + c_2e^{-x}$

$y(0) = 2 \Rightarrow 2 = c_1 + c_2$ …..……… (1)

$y' = c_1e^x - c_2e^{-x}$

$y'(0) = 0 \Rightarrow 0 = c_1 - c_2$ ………… (2)

Solving (1) and (2), we get $c_1 = 1$ and $c_2 = 1$

$y = e^x + e^{-x}$

$y = 2\cosh x$

55. Ans: (b)

Sol: D = 0, Load not change

ΔP_D = +ve, so frequency decreases

Δf = –ve, so generation increases.