Offline GATE Mock -6 _ Solutions

General Aptitude (GA)

One Mark Solutions:

01. Ans: (A)

02. Ans: (C)

03. Ans: (D)

Sol: Though most people disregarded or made fun of her book, some appreciated it.

04. Ans: (B)

05. Ans: (D)

Sol: The sequence is a combination of two series; (I): 19, 38, 114, (----) and (II): 2, 3, 4

The pattern followed in (I) is × 2, × 3, …….

$\therefore$ Missing number = 114 × 4 = 456

06. Ans: (B)

Sol: $\log_{10} 5+\log_{10}(5x+1)=\log_{10}(x+5)+1$

$\log_{10} 5 + \log_{10}(5x+1)=\log_{10}(x+5)+\log_{10}10$

$\log_{10}(5(5x+1)=\log_{10}(10(x+5))$

$5(5x+1) = 10(x+5)$

$25x+5 = 10x+50$

$15x = 45$

$x = 3$

07. Ans: (A)

Sol: LCM = 44 HCF $\Rightarrow l = 44H$

LCM + HCF = 1125 $\Rightarrow$ 44 H + H = 1125

45H = 1125

$\therefore$ L = 44 × 25

= 1100

a × b = L × H

25 × b = 1100 × 25

b = 1100

08. Ans: (C)

Sol: Both friends are coming to meet each other

Distance travelled by them on first day

= 20 + 10 = 30km

Distance travelled by them on 2nd day

= 19+12 = 31km

Distance travelled by them on third day

= 18+14 = 32km

So, he distances travelled by them for ms an A.P, with first term (A) = 30 and common difference (D) = 1

Let they meet after n days, then

$$S_n=\frac{n}{2}\left[29+(n-1)d\right]$$

$$385 = \frac{n}{2}[2\times 30 + (n-1)\times 1]$$

$$385 = \frac{n}{2}[60 + (n-1)]$$

$770 = n\,(59+n)$

$n^2 + 59n - 770 = 0$

$n^2 + 70n - 11n - 770 = 0$

$n(n+70) - 11(n+70) = 0$

$(n-11)\,(n+70) = 0$

But $n \neq -70$

Hence, they will meet after 11 days.

09. Ans: (D)

Sol: The total monthly budget of an average household

$= 4000+1200+2000+1500+1800$

$=$ Rs. 10500

Percentage of the monthly budget spent on savings

$$= \frac{\text{savings amount}}{\text{Total expenses}}$$

$$= \frac{1500}{10500}\times 100 = 14.285\%$$

$\therefore$ The approximate percentage of the

$= 100 - 14.285 = 85.714 \approx 86\%$

monthly budget NOT spent on savings

10. Ans: (B)

Specific Section (EE)

One mark Solutions:

01. Ans: (A)

Sol: $\frac{dy}{dx} = y + x$

$x_o = 0,\ y_o = 1$

$x_1 = x_o + h = 0.1$

$x_2 = x_o + 2h = 0.2$

$y_1 = y_o + h\,f(x_o, y_o)$

$= 1 + (0.1)\,(1)$

$= 1.1$

$y_2 = y_1 + h\,f(x_1\,,\,y_1)$

$= 1.1 + 0.1\,[0.1 + 1.1]$

$= 1.1 + 0.12$

$= 1.22$

02. Ans: (D)

Sol: To perform the given operation, both operands must have same number of bits.

Hence by extending the sign bit, A = 111011

Now, A–B = 111011 – 100101

= 111011 + 2's complement of 100101

= 111011 + 011011

```
      1 1 1 0 1 1
 +    0 1 1 0 1 1
 (1)  0 1 0 1 1 0
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EAC is neglected in 2's complement operation

(EAC – End Around Carry)

Hence A – B = 0 1 0 1 1 0

03. Ans: 2.121 (Range: 2 to 2.4)

Sol: f(x, y, z) = 2y + z

Directional derivate = $(\nabla f)p.\frac{\bar{a}}{|\bar{a}|}$

$$\nabla f = \bar{j}\frac{\partial f}{\partial y} + \bar{k}\frac{\partial f}{\partial z}$$

$$= \bar{j}.2 + \bar{k}.1$$

$$= 2\bar{j} + \bar{k}$$

$\therefore$ Directional derivate = $(2\bar{j}+\bar{k}).\frac{(\bar{j}+\bar{k})}{\sqrt{2}}$

$$= \frac{2+1}{\sqrt{2}}$$

$$= \frac{3}{\sqrt{2}}$$

$$= 2.121$$

04. Ans: (A)

05. Ans: (B)

Sol: We have $\underset{x\to 0}{Lt}\, f(x) = f(0) = 0$

$\therefore$ f(x) is continuous at x = 0

$$f'(0) = \underset{h\to 0}{Lt}\frac{f(0+h)-f(0)}{h}$$

$$= \underset{h\to 0}{Lt}\frac{h^2\sin\left(\frac{1}{h}\right)-0}{h} = 0$$

$\therefore$ f(x) is differentiable at x = 0

06. Ans: (B)

Sol: A ideal PMMC voltmeter will read average voltage.

for 1-ϕ, half wave voltage controller, output voltage, $V_0 = \frac{V_m}{2\pi}[\cos\alpha - 1]$

$$= \frac{V_m}{2\pi}[-1-1]$$

$$= \frac{-V_m}{\pi}$$

07. Ans: (B)

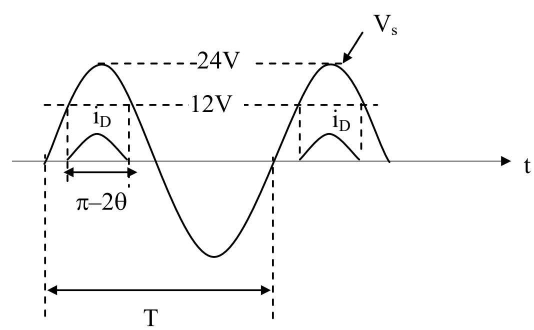
Sol: In figure 'b' all the three systems have the identical damped frequency ω_d

$\therefore$ Peak time is same , $t_p = \frac{\pi}{\omega_d}$

08. Ans: (B)

Sol: The maximum reverse voltage across the diode occurs when V_s is at its negative peak and is equal to 24 + 12 = 36 V

The diode conducts only when V_s exceeds 12 V as shown below



The conduction angle is 2θ, where θ is given by 24sinθ = 12

$\Rightarrow \theta = \sin^{-1}(1/2) = 30^o$

Thus the conduction angle is 120^o which corresponds to one-third of a cycle

Hence the diode conducts for a duration of T/3 s during each cycle.

09. Ans: (C)

Sol: The load current referred to primary is 2A, and the magnetizing current is 1A. These two have a phase difference of 90° w.r.t each other. Hence the primary current is $\sqrt{(2^2+1^2)}$ = 2.24 A.

10. Ans: 50.24 (range 48 to 52)

Sol: $Z = R+j\omega L = 362 + j(100\pi)\,2$

$$i = \frac{V}{Z}$$

$$= \frac{230}{362 + j200\pi} = \frac{230}{725.14\angle 60°}$$

$$= 0.317\angle -60°$$

$\therefore$ The current I = $0.317\times\sqrt{2}\sin(\omega t - 60°)$

Instantaneous voltage is maximum at $\omega t = \frac{\pi}{2}$

$$i = 0.317\times\sqrt{2}\sin(90° - 60°)$$

$$i = 0.317\times\sqrt{2}\cos 60°$$

$$= 0.224A$$

$\therefore$ The energy stored = $\frac{1}{2}LI^2$

$$= \frac{1}{2}\times 2\times(0.224)^2 = 50.2mJ$$

11. Ans: (B)

Sol: Let P be the input, Q_n be present state and Q_{n+1} be next state.

$R = \overline{P\oplus Q_n}$ $\quad S = P\oplus Q_n$

Characteristic equation of SR flip-flop is

$Q_{n+1} = S + \overline{R}\,Q_n$

$$= (P\oplus Q_n) + \left(\overline{\overline{P\oplus Q_n}}\right)Q_n$$

$$= (P\oplus Q_n) + (P\oplus Q_n)\,Q_n$$

$$= (P\oplus Q_n)\,(1 + Q_n)$$

$Q_{n+1} = P\oplus Q_n$

For P = 0, $Q_{n+1} = Q_n$

For P = 1 $Q_{n+1} = \overline{Q}_n$

Hence the circuit functions as T flip-flop.

12. Ans: (B)

Sol: Inertia constant (H) =

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

$$H_1 = \frac{400}{100} = 4\ ;\ H_2 = \frac{900}{150} = 6$$

$$H_{eq} = \frac{H_1H_2}{H_1+H_2} = \frac{4\times 6}{4+6} = 2.4$$

13. Ans: (A)

Sol: Probability that there are exactly 2 defectives in the first 5 selected articles = $\frac{3C_2.7C_3}{10C_5} = \frac{5}{12}$

Probability that 6^{th} article is defective = $\frac{1}{5}$ Required probability = $\frac{5}{12}.\frac{1}{5} = \frac{1}{12}$

14. Ans: 11 (11 to 11)

Sol: The rms value of the square-wave voltage is

$$E_{rms} = \sqrt{\frac{1}{T}\int_0^T e^2dt} = E_m$$

And the average value is

$$E_{av} = \frac{2}{T}\int_0^{T/2} e.dt = E_m$$

So that the form factor equals, by definition,

$$k = \frac{E_{rms}}{E_{av}} = 1$$

The meter scale is calibrated in terms of the rms value of a sine-wave voltage, where $E_{rms} = k \times E_{av} = 1.11E_{av}$. For the square-wave voltage, $E_{rms} = E_{av}$, since $k = 1$. Therefore the meter indication for the square-wave voltage is high by a factor $k_{sine\ wave}/k_{square\ wave} = 1.11$. The percentage error equals

$$\frac{1.11-1}{1}\times 100\,\% = 11\%.$$

15. Ans: 6

Sol: If the system has a non-zero solution then determinant of coefficient matrix is zero.

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

$$\Rightarrow (6-\lambda)(\lambda^2 + 3\lambda + 3) = 0$$

$$\Rightarrow \lambda = 6$$

16. Ans: -10

Sol: $\dfrac{V_0}{V_{in}} \cong \dfrac{-R_C}{R_E} \cong \dfrac{-1k}{100} \cong -10$

17. Ans: 0.02 (No range)

Sol: $D = \dfrac{1.25\times 80}{1\times 50}\,\text{MW/Hz}$

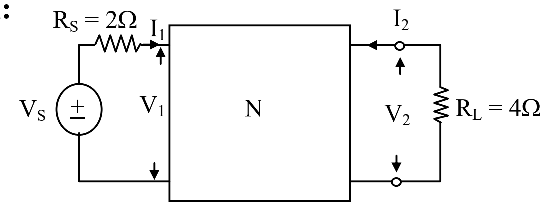
$= 2$ MW/Hz

$= \dfrac{2}{100}$ pu MW/Hz

$= 0.02$ pu MW/Hz

18. Ans: 58 (Range: 58 to 58)

Sol:



From h-parameter equations are

$V_1 = h_{11}I_1 + h_{12}V_2 = 2I_1 + 4V_2$ ….. (1)

$I_2 = h_{21}I_1 + h_{22}V_2 = -5I_1 + 2V_2$ …… (2)

But $V_2 = -4I_2$

$I_2 = -5I_1 + 2(-4I_2)$

$9I_2 = -5I_1$

Power dissipated is 4Ω resistor = 25W

$$\frac{V_2^2}{R_L} = 25\text{W}$$

$$V_2 = \sqrt{25\times 4} = 10\text{V}$$

$$I_2 = \frac{-V_2}{4} = -\frac{10}{4} = -2.5$$

$$\therefore I_1 = -\frac{9}{5}(I_2)$$

$$= -\frac{9}{5}(-2.5)$$

$= 4.5$A

$\therefore V_1 = 2(4.5) + 4(10) = 49$V

$V_s = V_1 + I_1R_s$

$= 49 + (4.5\times 2)$

$V_s = 58$V

19. Ans: (A)

Sol: $\displaystyle\int_2^{2i} \frac{dz}{z}$

$= [\log z]_2^{2i}$

$= \log 2i - \log 2$

$= \log 2 + \log i - \log 2$

$= \log i$

$= \log e^{\frac{i\pi}{2}}$

$= \frac{i\pi}{2}$

20. Ans: (B)

Sol: Sending end voltage is given as

$V_S = AV_r + BI_r$

Receiving end current under open condition is zero

$I_R = 0$

$V_S = AV_R$

$V_R = \frac{V_S}{A} \Rightarrow \frac{400}{0.8} = 500 \text{ kV}$

21 Ans: (A)

22. Ans: (D)

23. Ans: (C)

Sol: For ripple counter,

Maximum frequency of operation, $f \le \frac{1}{n.t_{pd}}$

n $\rightarrow$ number of flip-flops

$t_{pd} \rightarrow$ propagation delay of flip-flop

$(12 \times 10^6) \le \frac{1}{n(12\times10^{-9})}$

$n \le \frac{1}{(12\times12\times10^{-3})}$

$n \le 6.94$

Always n is an integer $\therefore$ n = 6

With n = 6, the modulus of counter = 2^n

$= 2^6$

$= 64$

24. Ans: (d)

Sol: System is unstable, therefore error is unbounded.

25. Ans: (B)

Sol: Deflection of electron beam on the screen in y-direction, $D = \frac{Ll_dE_d}{2dE_a}$ m

Where L $\rightarrow$ distance between the screen and centre of the deflecting plates.

$l_d \rightarrow$ length of deflecting plates

$E_d \rightarrow$ Potential between deflecting plates

d $\rightarrow$ distance between deflecting plates.

$E_a \rightarrow$ Pre-accelerating anode voltage

$D \propto \frac{E_d}{E_a}$

$D_1 = \frac{E_{d1}}{E_{a1}}$

$D_2 = \frac{2E_{d1}}{\frac{1}{2}E_{a1}}$

$D_2 = 4D_1$

$D_2 = 40$ mm

Two marks Solutions:

26. Ans: 2

Sol: Since A is upper triangular matrix the eigen values are same as the diagonal elements of A.

$\therefore$ Eigen values are $\lambda = 1, 1, 1$

The eigen vectors for $\lambda = 1$ are given by

$[A - \lambda I]\, X = 0$

$$\Rightarrow \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

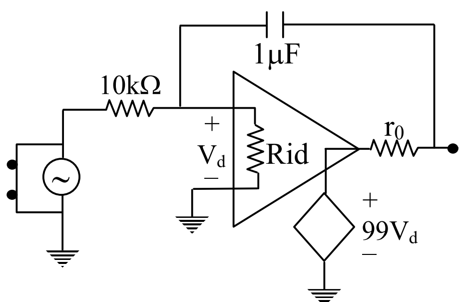
Here rank of $(A - \lambda I) = k = 1$

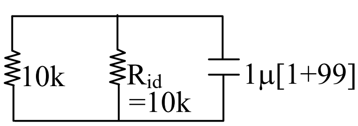
Number of variables = n = 3

Number of linearly independent eigen vectors $= n - k = 2$

27. Ans: (D)

Sol: For the overall time constant of this circuit input voltage source is short circuited





$\tau = R_{th}\, C_{eq}$

$= [10k \| 10k]\ 1\mu\ [1 + 99]$

$= [5k]\ 10^{-6}\ [10^2] = 0.5\text{sec}$

28. Ans: (C)

Sol: $G(s) = \dfrac{k(s+2)(s+3)}{(s+1)(s+4)}$

$$\text{CLTF} = \left.\frac{G(s)}{1+G(s)}\right|_{k=1} = \frac{(s+2)(s+3)}{(s+1)(s+4)+(s+2)(s+3)}$$

29. Ans: (B)

Sol: Turn on cycle $T = \dfrac{1}{f} = \dfrac{1}{60}\text{sec}$

Rate of change of current

$\dfrac{di}{dt} = 0.4$

$= 0.4 \times 60 = 24 A/\text{sec}$

$V_s = L\dfrac{di}{dt}$

Source inductance $L = \dfrac{V_s}{\left(\dfrac{di}{dt}\right)} = \dfrac{240}{24}$

$= 10$ H

Circuit turn off time is given by

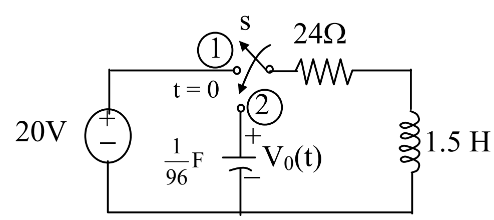
$t_c = R \times C \times ln2$

$2 \times 15 \times 10^{-6} = 12 \times C \times ln2$

$C = 3.6067\mu F$

30. Ans: (B)

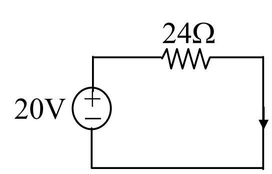
Sol:



For t < 0 switch is at position (1)

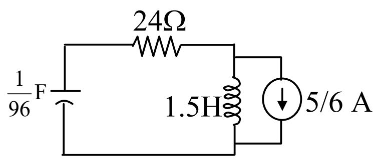
$L \rightarrow 20$ V only

$C \rightarrow V_c(0) = 0$

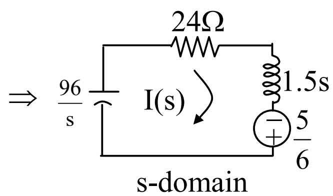


$i_L(0^+) = \dfrac{20}{24} = \dfrac{5}{6}$ A

For $t > 0$ s is in position (2)



t-domain



s-domain

$$\frac{5}{6} = I(s)\left(\frac{96}{s} + 24 + \frac{3}{2}s\right)$$

$$\frac{5}{6} = I(s)\left(\frac{96 + 24s + 1.5s^2}{s}\right)$$

$$I(s) = \frac{5s}{6(1.5s^2 + 24s + 96)}$$

$$s = \frac{-24 \pm \sqrt{(24)^2 - 4(1.5)(96)}}{2(1.5)}$$

$$s = \frac{-24 \pm \sqrt{576 - 576}}{3} = -8$$

$s = -8$

Roots are real & equal i(t) is critically damped.

$$V_0(t) = \frac{96}{s} I(s) = \frac{96}{s}\frac{5s}{6(s+8)^2} = \frac{80}{(s+8)^2}$$

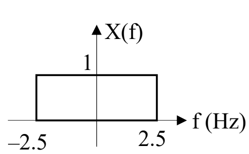
$V_0(t) = (A + Bt)e^{-8t}$

31. Ans: (C)

32. Ans: (A)

Sol: $x(t) = 5\ \text{sinc}(5t)$

$$= \frac{5 \sin 5\pi t}{5\pi t} \overset{FT}{\longleftrightarrow}$$

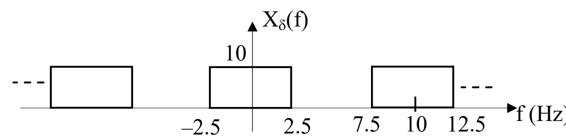


Sampled spectrum $X_\delta(f) = \frac{1}{Ts}\sum_{n=-\infty}^{+\infty} X(f - nf_s)$

Given $f_s = 10$Hz

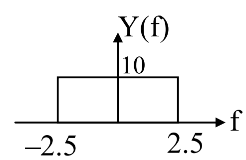
$$T_s = \frac{1}{10}$$

$$= 10 \sum_{n=-\infty}^{+\infty} X(f - 10n)$$



The above signal passed through ideal LPF with cut-off frequency 5Hz

So, the output of the filter is



Y(f) = 10rect(f/5)

33. Ans: 26.18 (Range: 25 to 27)

Sol: Given specifications of synchronous generator are MVA rating = 500 MVA

kV rating = 20 kV

poles (P) = 4

Inertia constant H = 6.0 MJ/MVA

Also given that

Power being delivered to infinite bus $(P_0) = 1$ pu

Maximum power that can be delivered $(P_m) = 2.5$ pu

A fault occurs on the generator such that Output of generator becomes zero.

$\therefore P_e$ = Electrical output of the generator = 0

$\therefore P_e = 0$

P_m = Mechanical input to the generator = 1 pu

$P_a = P_m - P_e = 1 - 0 = 1\text{pu}$

$P_a = 1\text{pu}$

P_a = Accelerating power

Angular acceleration is given by

$$\frac{d^2\delta}{dt^2} = \frac{P_a}{M}$$

M = angular momentum

$$\therefore M = \frac{GH}{\pi f}\ \text{MJ-sec/rad}$$

In pu terms

$$M = \frac{H}{\pi f}\ \text{MJ-sec/rad}$$

$$\therefore \frac{d^2\delta}{dt^2} = \frac{\pi f}{H} \quad [\because P_a = 1\text{ pu}]$$

$$\frac{d^2\delta}{dt^2} = \frac{(3.14)(50)}{6}$$

$$\frac{d^2\delta}{dt^2} = 26.18\ \text{rad/sec}^2$$

34. Ans: –0.535 (Range: –0.5 to– 0.6)

Sol: $G(s)H(s) = \dfrac{K(s+4)}{s(s+1)}$

For break in/away points $\dfrac{dK}{ds} = 0$

$s(s+1) - (s+4)(2s+1) = 0$

$s^2 + s = 2s^2 + 9s + 4$

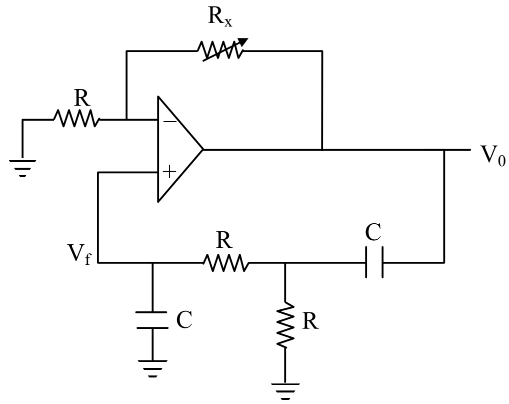
$$s = \frac{-8 \pm \sqrt{64-16}}{2}$$

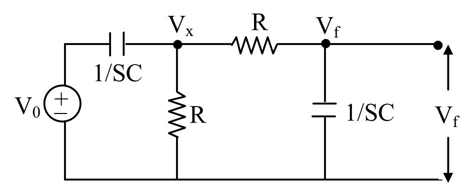
$s_1 = -4 + 3.464$, $s_2 = -4 - 3.464$

$s_1 = -0.535$, $s_2 = -7.464$

35. Ans: (C)

Sol:





$$\frac{V_0 - V_x}{\frac{1}{SC}} = \frac{V_x}{R} + \frac{V_x - V_f}{R} \quad \ldots\ldots\ (1)$$

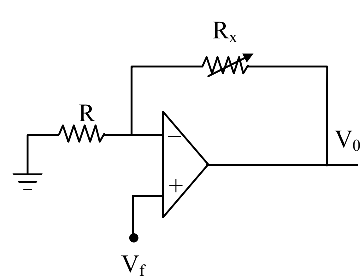
and $$\frac{V_x - V_f}{R} = \frac{V_f}{\frac{1}{SC}} \quad \ldots\ldots\ (2)$$

$\therefore V_x = (1+SRC)\,V_f$ --------(3)

$$\Rightarrow \beta = \frac{V_f}{V_0} = \frac{SCR}{S^2C^2R^2 + 3SCR + 1}$$

[$\because$ from equation (1), (2) & (3)]

$$\therefore \beta = \frac{1}{3 + j\left[\omega CR - \dfrac{1}{\omega CR}\right]}$$



$$\frac{V_0}{V_f} = 1 + \frac{R_x}{R}$$

Since for sustained oscillations βA = 1

$$\Rightarrow A = \frac{1}{\beta}$$

$$\therefore 1 + \frac{R_x}{R} = 3 + j\left[\omega CR - \frac{1}{\omega CR}\right]$$

Equating img., parts

$$\Rightarrow \omega CR - \frac{1}{\omega CR} = 0$$

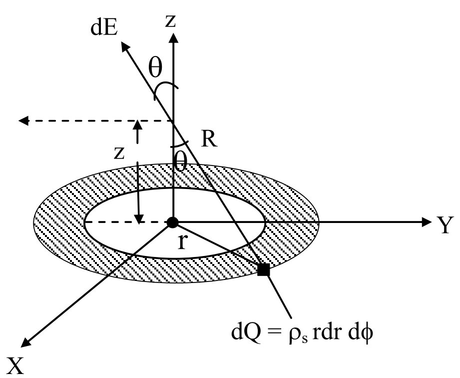
$$\Rightarrow f = \frac{1}{2\pi RC} \text{Hz}$$

$$\& \ 1 + \frac{R_x}{R} = 3$$

$\therefore R_x = 2R$

36. Ans: (B)

Sol: From fig. by symmetry only the z-components of the field exists along the z-axis.



$dQ = \rho_s \, r \, dr \, d\phi$

$$\cos\theta = \frac{z}{R}, \ R = \sqrt{r^2 + z^2}$$

Hence

$$dE_Z = \frac{dQ}{4\pi \epsilon_o R^2} \cos\theta$$

$$= \frac{\rho_s r \, dr d\phi}{4\pi \epsilon_o \left(r^2 + z^2\right)} \cdot \frac{z}{\sqrt{r^2 + z^2}}$$

$$= \frac{\frac{100 \times 10^{-6}}{r} \times r dr d\phi \times z}{4\pi \times \frac{1}{36\pi} \times 10^{-9} \left(r^2 + z^2\right)^{3/2}}$$

At z = 10 m

$$E_Z = 9 \times 10^6 \int_{r=1}^{2} \int_{\phi=0}^{2\pi} \frac{dr d\phi}{(r^2 + 100)^{\frac{3}{2}}}$$

$$= 18\pi \times 10^6 \int_{r=1}^{2} \frac{dr}{\left(r^2 + 100\right)^{3/2}}$$

$$= 18\pi \times 10^6 \left. \frac{r}{100\sqrt{r^2 + 100}} \right|_{r=1}^{2}$$

= 54.63 kV/m

37. Ans: (B)

Sol: In case of motor

$V = E_b + I_a R_a$

$E_b = V - I_a R_a$

At 900 rpm

$E_b = 60 - (30 \times 0.35)$

$= 60 - 10.5 = 49.5$

The back emf corresponding to speed of 300rpm is

$E_b \ \alpha N\phi$

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

$$E_{b2} = 49.5 \times \frac{300}{900}$$

= 16.5V

$\therefore V = E_{b2} + I_a R_a$

$= 16.5 + (30 \times 0.35) = 27$

For a chopper $V_0 = D \times V$

$27 = D\times 60$

$D = 0.45$

38. Ans: (B)

Sol: $h_c(n)=h_1(n)*h_2(n)=[\delta(n+1)-\delta(n)]*[\delta(n)-\delta(n-1)]$

$= \delta(n+1)-2\delta(n)+\delta(n-1)$

$= \left\{1,-\underset{\uparrow}{2},1\right\}$

$h_c(n) \neq 0,\ n<0$

so,non causal

$\sum_{n=-\infty}^{\infty}|h_c(n)| \neq \infty$, stable

39. Ans: 2.28 (Range 2 to 2.5)

Sol: The phase voltage = $\frac{V_{L-L}}{\sqrt{3}} = \frac{398}{\sqrt{3}} = 230V$

$Z_1 = 20+ j37.7$

$I_1 = \frac{V_1}{Z_1} = \frac{230}{20+j37.7}$

$= 5.39 \angle -62.05$

$= 2.52 - j4.76$

The equivalent star impedance

$(Z_2)_{eg} = \frac{Z_2}{3} = 10 - j53.1$

$I_2 = \frac{V_1}{(Z_2)_{eg}} = \frac{230}{10-j53.1}$

$= 0.79+j4.19$

So total current $I = I_1 + I_2$

$= 2.52-j4.76+0.79+j4.19$

$= 3.31 - j\,0.57$

$= 3.36 \angle -9.8°$

$\therefore$ The power P = 3 × power per phase

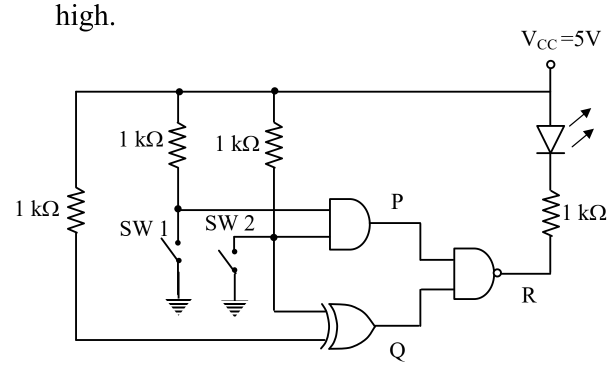
$= 3\times 230\times 3.36\times \cos(9.8)$

$= 2284.6W$

40. Ans: (D)

Sol: Output of NAND gate must be low for LED to emit light.

$\Rightarrow$ Output of AND and Ex-OR gate should be high.



SW1	SW2	P	Q	R
Open	Open	1	0	1
Open	Close	0	1	1
Close	Open	0	0	1
Close	Close	0	1	1

Hence, there can't be both high inputs to NAND gate and hence LED doesn't emit light for any combination.

41. Ans: 260.2 (Range: 258 to 262)

Sol: Loop inductance of the line $d = 7.5 \times 10^{-2}$

$r = \frac{7.5}{2}\times 10^{-2}$

$= 3.75 \times 10^{-2}$

$L = \frac{N\phi}{I} \quad \because N = 1$

$\phi = LI$

$L = 4\times 10^{-7}\left(\frac{GMD}{GMR}\right)$

$\phi = 4 \times 10^{-7} \times 800 \times \ln\left(\frac{0.6}{3.75\times10^{-2}}\right)$

$\phi = 8.87\times 10^{-4}$

Voltage induced in sheath

$\nu = \omega\phi$

$\nu = 2\pi f\phi$

$\nu = 314 \times 8.87 \times 10^{-4}$

$\nu = 0.2602$ V

$\nu = 260.2$ Volt/km

42. Ans: (D)

Sol: total losses = 3[0.01+0.02] = 0.09 pu

The current carried by each transformer in open delta is $\sqrt{3}$ pu and core losses in each transformer remain unchanged

Now Cu losses = $2\left(\sqrt{3}\right)^2(0.02) = 0.12$

Core losses = 2(0.01) = 0.02

Total losses = 0.02+0.12 = 0.14

$\% \text{ increase} = \frac{0.14-0.09}{0.09}\times100 = 55.56\%$

43. Ans: (C)

Sol: $f(x) = \int_0^{\frac{\pi}{2}} \frac{\cos x + i\sin x}{\cos x - i\sin x}dx$

$= \int_0^{\frac{\pi}{2}} \left[\frac{\cos x + i\sin x}{\cos x - i\sin x}\times\frac{\cos x + i\sin x}{\cos x + i\sin x}\right]dx$

$= \int_0^{\frac{\pi}{2}} \frac{\cos^2 x - \sin^2 x + i\sin 2x}{\cos^2 x + \sin^2 x}dx$

$= \int_0^{\frac{\pi}{2}} (\cos 2x + i\sin 2x)dx$

$= \left[\frac{\sin 2x}{2} - \frac{i\cos 2x}{2}\right]_0^{\frac{\pi}{2}}$

$= \frac{-i}{2}[-1-1]$

$= i$

44. Ans: (C)

Sol: when converter circuit is working in an inverter mode,

$V_0 = -E_0 + I_0R$

$= -230+(25\times2)$

$= -180$

$= \frac{3V_{m\ell}}{2\pi}\cos\alpha - \frac{3\omega L_s}{2\pi}I_0 = V_0$

$\frac{3\times\sqrt{2}\times400}{2\pi}\cos\alpha - \frac{3\times100\pi\times2\times10^{-3}\times25}{2\pi} = -180$

$\cos\alpha = -0.63$

$\alpha = 129.7°$

$I_0 = \frac{V_{m\ell}}{2\omega L_s}[\cos\alpha - \cos(\alpha+\mu)]$

$25 = \frac{\sqrt{2}\times400}{2\times100\pi\times2\times10^{-3}}[\cos129.7 - \cos(129.7+\mu)]$

$0.055 = \cos(129.7) - \cos(129.7+\mu)$

$\cos(129.7+\mu) = -0.069$

$\mu = 4.27°$

45. Ans: (B)

Sol: $E_b = V - I_aR_a = 500-60(0.5) = 470$V

$\omega\times\tau_e = E_bI_a$

$\frac{2\pi\times800}{60}\times\tau_e = 470\times60$

$\tau_e = 336.61$Nm

New load torque = 2.5×336.61 = 841.52Nm

Torque developed by the set

$$\Rightarrow 841.52 = \frac{2(250 - I_a \times 0.5) \times I_a}{\frac{(2\pi \times 400)}{60}}$$

$$\Rightarrow I_a^2 - 500 I_a + 35250 = 0$$

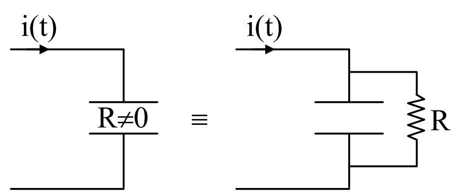
$$I_a = \frac{500 \pm \sqrt{(500)^2 - 4 \times 35250}}{2}$$

$$= \frac{500 \pm 330.15}{2}$$

I_a = 415(or) 84.92 A

46. Ans: (D)

Sol:



$$i(t) = C\frac{dv}{dt} + \frac{v}{R}$$

$$R = \frac{\rho d}{A} = \frac{d}{\sigma A} = \frac{5 \times 10^{-3}}{10^{-3} \times 1m^2} = 5\Omega$$

$$i(t) = C\frac{dv(t)}{dt} + \frac{v(t)}{R}$$

$$\therefore\ i(t) = 8 \times 10^{-6} \times 10\cos(2\pi \times 50t) \times 2\pi \times 50$$

$$+ \frac{10\sin(2\pi \times 50t)}{5}$$

$\therefore$ i(t) = $8\pi \times 10^{-3}$ cos $(2\pi \times 50\ t)$ $+2\sin(2\pi\times50t)$

If $i(t) = A\cos\omega t + B\sin\omega t$

$$i_{rms}(t) = \sqrt{\frac{A^2}{2} + \frac{B^2}{2}}$$

$$i_{rms}(t) = \sqrt{\frac{(8\pi \times 10^{-3})^2}{2} + \frac{2^2}{2}}$$

$$\therefore\ i(t)_{rms} = 1.414\ \text{Amp}$$

47. Ans: 0.568 (Range: 0.45 to 0.7)

Sol: Per phase rotor resistance,

$$r_2 = \frac{0.04}{2} = 0.02\Omega$$

Full–load slip, $s_1 = 0.02$

New slip, $s_2 = \frac{500 - 350}{500} = 0.30$

Now load torque, $T_L \propto n^2$

$T_{L1} \propto [(1–0.02)\ 500]^2$

$T_{L1} \propto (490)^2$

And $T_{L2} \propto (350)^2$

Therefore,

$$R_2 = r_2\left(\frac{s_2}{s_1}\right)\left(\frac{T_{L1}}{T_{L2}}\right) = 0.02\left(\frac{0.30}{0.02}\right)\left(\frac{490}{350}\right)^2$$

$$= 0.588\ \Omega$$

$\therefore$ External resistance that must be inserted in each rotor phase = 0.588 – 0.02 $\Rightarrow$ 0.568 Ω

48. Ans: (A)

Sol: $P = \frac{EV}{X_s}\sin\delta = \text{constant}$

$\Rightarrow$ E = constant $\because$ Excitation is constant

V & f are reduced by 10% i,e V^1=0.9V, f^1=0.9f

$$\frac{P^1}{P} = \frac{\frac{E^1V^1}{X_S^1}\sin\delta^1}{\frac{EV}{X_s}\sin\delta} = \frac{\frac{E \times 0.9V}{0.9X_S}\sin\delta^1}{\frac{E \times V}{X_s}\sin 30^o} = 1$$

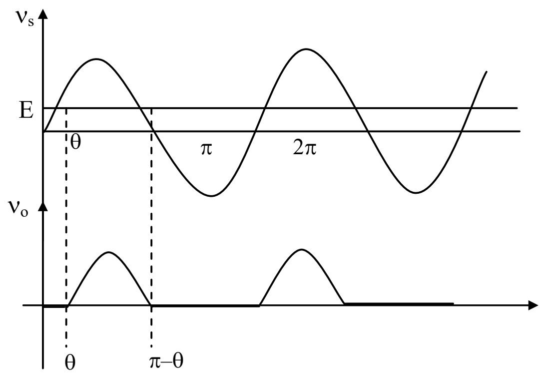
$$\Rightarrow \frac{\sin\delta^1}{\sin 30^o} = 1$$

$$\Rightarrow \sin\delta^1 = \sin 30^o$$

$$\therefore \delta^1 = 30^o$$

49. Ans: (C)

Sol:



$$\theta = \sin^{-1}\left(\frac{E+1}{V_m}\right)$$

$$= \sin^{-1}\left(\frac{7}{\sqrt{2}\times 30}\right) = 9.49°$$

For a diode rectifier

$$I_0 = \frac{1}{2\pi R}[2V_m\cos\theta - (E+1)(\pi - 2\theta)]$$

$$4 = \frac{1}{2\times\pi\times R}\left[2\times\sqrt{2}\times 30\cos(9.49°) - (6+1)\left(\pi - 2\times 9.49°\times\frac{\pi}{180}\right)\right]$$

$$4 = \frac{1}{2\pi R}(83.69 - 19.67)$$

$$R = 2.54\Omega$$

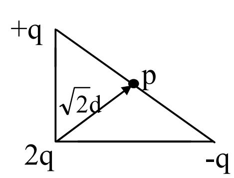
50. Ans: (B)

Sol: The potential at 'p' is $V_p = \dfrac{2q}{4\pi\in_0\left(\sqrt{2}d\right)}$

The work done to bring

(-5Q) from ∞ to 'p' is $= (-5Q)V_p$

$$= (-5Q)\left(\frac{2q}{4\pi\varepsilon_0\sqrt{2}d}\right)$$



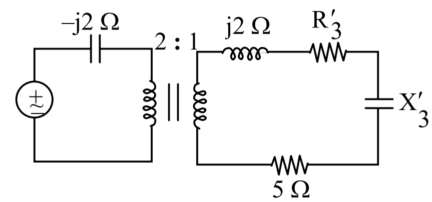
$$W = \frac{-10Qq}{4\pi\in_0\sqrt{2}d}$$

$$= \frac{-10\times 1\times 10^{-3}\times 10^{-6}}{4\pi\times\frac{1}{36\pi}\times 10^{-9}\times\sqrt{2}\times\sqrt{2}}$$

$$= -\frac{90}{2} = -45(J)$$

51. Ans: (C)

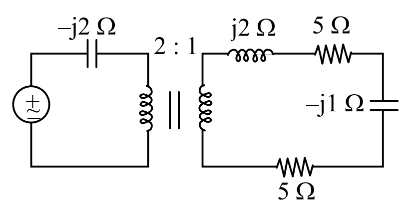
Sol: Reflecting the secondary impedances to the primary side

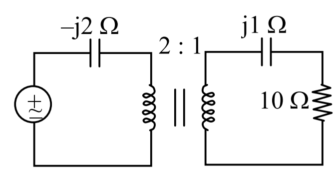


$$R_3' = \frac{R_3}{n^2} = \frac{80}{(4)^2} = 5\Omega \ (n = 4)$$

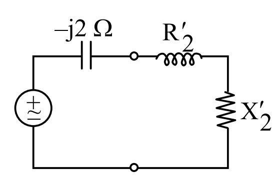
$$X_3' = \frac{X_3}{n^2} = \frac{-j16}{(4)^2} = -j1\ \Omega$$

Now circuit becomes as





Again reflecting the secondary impedance to the primary side



$$X_2' = \frac{j1}{(n)^2} = \frac{j1}{(1/2)^2} = j4\Omega \qquad (n=1/2)$$

$$R_2' = \frac{10}{(n)^2} = \frac{10}{(1/2)^2} = 40\Omega$$

Total impedance seen by source

$$Z_{in} = -j2 + R_2' + X_2' = -j2 + j4 + 40$$

$$= j2 + 40$$

52. Ans: 93.07 (92.5 to 94)

Sol: $\eta_{15\,KVA} = \dfrac{15\times 1}{15\times 1 + 2W_i} = 0.95$

$W_i = W_{cu} = 0.394$Kw at ¾ load.

Copper loss at full

load $= \left(\dfrac{4}{3}\right)^2 \times 0.394 = 0.7$ kW

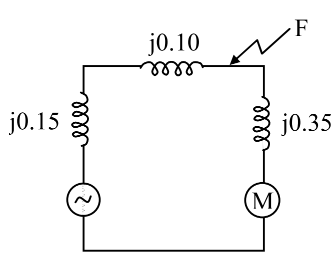
$\eta_{all-day}$

$$= \frac{(12\times 20 + 0)}{(12\times 20 + 0) + (12\times 0.7) + (24\times 0.394)} \times 100$$

= 93.07 %

53. Ans: (A)

Sol: The equivalent circuit shown below



Current $I_L = 1\angle 36.86°$

$= (0.8 + j0.6)$ pu

For the generator

$E_g'' = V_t + jI_L X_d''$

$= 0.9 + (0.8 + j0.6)(j0.15)$

$= 0.81 + j0.12$ pu

For motor

$E_m'' = V_t - jI_L X_d''$

$= 0.9 - (0.8 + j0.6)(j0.45)$

$= 1.17 - 0.36$ pu

Sub transient current in the fault in the generator

$$I_g'' = \frac{E_g''}{X_d''} = \frac{0.81 + j0.12}{j0.25}$$

$= 0.48 - j3.24$ pu

Sub transient current in the fault in the motor

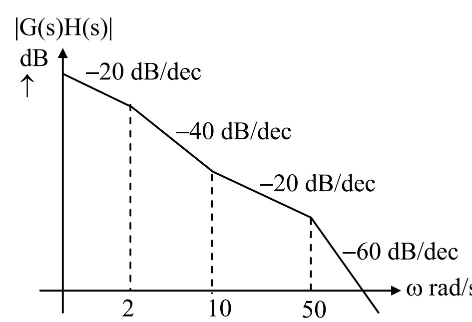
$$I_m'' = \frac{E_m''}{X_d''} = \frac{1.17 - j0.36}{j0.35}$$

$= -1.03 - j3.34$ pu

54. Ans: (D)

Sol: $$G(s) = \frac{5(1+0.1s)}{s(1+0.5s)\left[\left(\frac{s}{50}\right)^2 + \frac{s}{0.65} + 1\right]}$$

Corner frequencies = 2, 10, 50 rad/s



The slope change at ω = 10 rad/sec is –40 dB/dec to –20 dB/dec

55. Ans: (A)

Sol: $x_e(t) = \frac{x(t)+x(-t)}{2} = \frac{1}{2}\left[e^{-2t}\cos t + e^{2t}\cos t\right]$

$x_e(t) = \frac{1}{2}\cos t\left[e^{2t} + e^{-2t}\right]$

$x_e(t) = \cosh(2t)\cos t$