# Offline GATE Mock-1 - Solutions

## General Aptitude (GA)

**One Mark Questions:**

**01. Ans: (D)**

**Sol:** When you read the sentence, you might have anticipated that a word like patiently could be used in the blank. Patiently does not appear as an answer choice, but there is one choice that is close to that meaning: calmly, in other words, none has a meaning that is appropriate in the context of the sentence.

**02. Ans: (A)**

**03. Ans: (B)**

see through: Realization of truth verification of something.

A Look at : conformation

C Attend to : taking care

**04. 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

**05. Ans: (B)**

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

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

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

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

$25x+5 = 10x+50$

$15x = 45$

$x = 3$

**One Mark Questions:**

**06. Ans: (D)**

**Sol:** Candidate can select 5 questions in any one of the following ways.

| | Part A | Part B | Part C |
|---|---|---|---|
| (i) | 2 | 1 | 2 |
| (ii) | 2 | 2 | 1 |
| (iii) | 3 | 1 | 1 |

In case (i), the number of ways of selecting 5 questions are $4C_2 \times 3C_1 \times 3C_2 = 54$

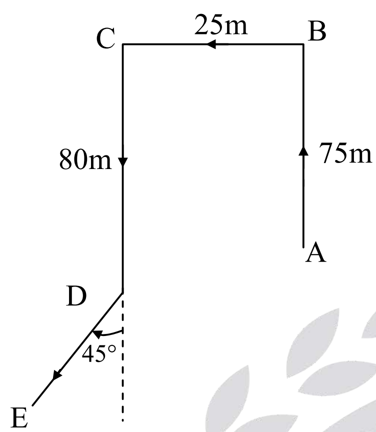
In case (ii), the number of ways of selecting 5 questions are $4C_2 \times 3C_2 \times 3C_1 = 54$

In case (iii), the number of ways of selecting 5 questions are $4C_3 \times 3C_1 \times 3C_1 = 36$

$\therefore$ Total number of ways = 54 + 54 + 36 = 144

**07. Ans: (D)**

**Sol:** From the given data, the following diagram is formed.




Deepa started from A, moved 75m upto B, turned left and walked 25m upto C. She then turned left again and moved 80m upto D. Turning to the right at an angle of 45°, she was finally moving in the direction DE (i.e) south-west.

Hence, the answer is (D).

**08. Ans: (B)**

**09. Ans: (D)**

**Sol:** (Dawan + Rohith + Kohli + Dhoni + Rayudu) make = 39 × 5 = 195 runs

With respect to scoring runs

Dhoni = Rayudu + 7

Dawan = Rayudu + 9

Rohith = Dhoni + Rayudu

Rohith + Kohli = 110

⇒ Dawan, Dhoni, Rayudu, Rohith and Kohli scored 32, 30, 23, 53 and 57 runs respectively.

**10. Ans: (A)**

**Sol:** The percentage increase in the amount invested in raw materials as compared to the previous year, for different years are:

$$\text{For 1996} = \left[\frac{(225-120)}{120}\times 100\right]\% = 87.5\%$$

$$\text{For 1997} = \left[\frac{(375-225)}{225}\times 100\right]\% = 66.67\%$$

For 1998 there is a decrease.

$$\text{For 1999} = \left[\frac{(525-330)}{330}\times 100\right]\% = 59.09\%$$

For 2000 there is a decrease

∴ There is maximum percentage increase in 1996

## Specific section (EE)

**One Mark Questions:**

**01. Ans: 7958 Hz (range 7950 to 7960)**

**Sol:** For a series RLC, $V_L$ is maximum when

$$f_L = \frac{f_0}{\sqrt{1-\frac{R^2C}{2L}}}$$

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$= \frac{1}{2\pi\sqrt{0.04\times 0.01\times 10^{-6}}}$$

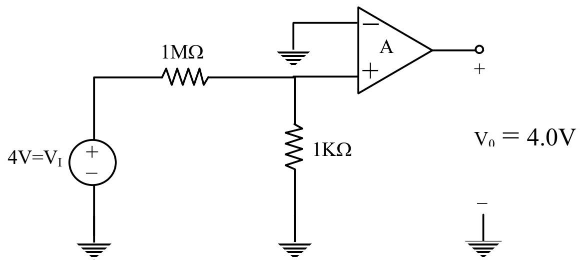
= 7957.7 Hz

$$f_L = \frac{7957.7}{\sqrt{1-\frac{625\times 0.01\times 10^{-6}}{2\times 0.04}}}$$

= 7958 Hz

**02. Ans: (B)**

**Sol:** Given $V_0 = 4.0$ V & $V_I = 4.0$V




We know, $V_0 = A\,V_d$

$$= A\,(V_+ - V_-)$$

$$= A\,(V_+ - 0)\ [\because V_- = 0V]$$

$$4 = A\left[4 \times \frac{1K}{1K + 1M}\right]$$

$$\Rightarrow A = \frac{1K + 1M}{1K} = \frac{1001K}{1K}$$

$\therefore$ A = 1001 V/V

**03. Ans: (C)**

**Sol:** Output is more sensitive to feedback path parameter changes than the forward path parameter changes.

**04. Ans: (B)**

**Sol:** $P = \dfrac{EV}{X}\sin(\delta_1 - \delta_2)$

i.e., power flows from high load angle to lower load angle.

Here $\delta = \tan^{-1}(X/R)$

$\delta$ of transmission line is greater than $\delta$ of load so the real power flows from leading voltage terminal to lagging voltage terminal.

**05. Ans: (A)**

**Sol:** Rank 2 means $|A| = 0$

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

$$\Rightarrow \mu^3 = 1$$

$$\mu = 1$$

**06. Ans: (A)**

**Sol:** For series RLC transient current to be oscillatory

$$\xi < 1$$

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

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

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

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

**07. Ans: (B)**

**Sol:** Energy density in an electrostatic field is considerably smaller than that in electromagnetic field.

**08. Ans: 346.41V [345 to 347]**

**Sol:** $V_{L-L(zig\text{-}zag)} = \dfrac{3}{2}V_{ph}$

$V_{L-L(Y)} = \sqrt{3}\,V_{ph}$

$$\frac{V_{L-L(zg)}}{V_{L-L(Y)}} = \frac{\sqrt{3}}{2}$$

$$V_{L\text{-}L(Y)} = \frac{2}{\sqrt{3}} \times V_{L-L(zg)}$$

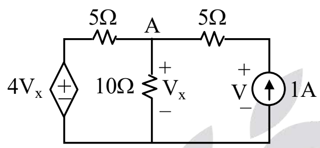
$= \frac{2}{\sqrt{3}} \times 300$

$= 346.41V$

**09. Ans: 9**

**Sol:** $\tau = R_{eq}C$

$R_{eq}$ can be find out by exciting the circuit with 1A source




$R_{eq} = \frac{V}{1}$

$V_x = V - 5$

Apply KCL at A

$$1 = \frac{V_x}{10} + \left(\frac{V_x - 4V_x}{5}\right)$$

$$1 = \frac{V_x}{10} - \frac{3V_x}{5}$$

$$1 = \frac{-5V_x}{10}$$

$V_x = -2$

$V = V_x + 5$

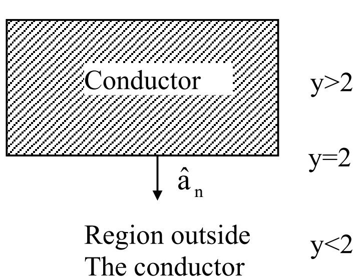
$\therefore V = -2 + 5 = 3V$

$R_{eq} = 3$

$\therefore \tau = 3 \times 3 = 9sec$

**10. Ans: (C)**

**Sol:**




$\vec{D} = \rho_S(-\hat{a}_y)$

$= (-20)(-\hat{a}_y)$

$\therefore \vec{D} = 20\hat{a}_y nC/m^2$

**11. Ans: –40**

**Sol:** f(x) = (x – 2) (x–3) (x–6)

f(0) = (–2) (–3) (–6)

= –36

f(4) = 2× 1 × –2

= – 4

∴ f(0) + f(4) = –36 – 4

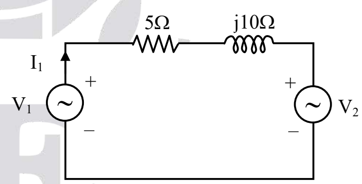
= –40

**12. Ans: (C)**

**Sol:** RST n is software interrupt instruction whose operation is same as unconditional CALL operation.

**13. Ans: (A)**

**Sol:**




Complex power delivered by source $V_1$ is $= V_1 I_1^*$

$$400\angle 10\left(\frac{V_1 - V_2}{5 + j10}\right)^* = 8 \times 10^3 \angle -30°$$

$$(V_1 - V_2)^* = \frac{8000\angle -30°}{400\angle 10}(5 - j10)$$

$$(V_1 - V_2)^* = 20(5 - j10)\angle -40°$$

By apply conjugate on both sides than

$V_1 – V_2 = 20(5+j10) \angle 40°$

$400\angle 10°-V_2 = 20(5+j10)\angle 40°$

$400\angle 10°-V_2 = -51.95+j217.48$

$V_2 = 394+j69.5-(-51.95+j217.48)$

$= 445.95 - j\,148$

$V_2 = 470\ \angle -18.4°$

**14. Ans: (C)**

**Sol:** Now, $f^1(x) = 2ax,\ x \le 1$

$= 2x + a,\ x > 1$

Consider $f^1(1^-) = f'(1^+)$

( $\because$ since f(x) is differentiable at x = 1)

$2a = a + 2 \Rightarrow a = 2$

Consider $f(x) = \begin{cases} ax^2+1 & , x \le 1 \\ x^2+ax+b, & x>1 \end{cases}$

$f(1^-) = f(1^+)$ ($\because$ f(x) is continuous at x = 1)

$\Rightarrow a + 1 = 1 + a + b$

$\therefore\ b = 0$

**15. Ans: 80 (Range 79 to 81)**

**Sol:** Given dat: - $P_{in}$ = 10 kW

s = 0.05

Stator losses = 1 kW

Mechanical losses = 550 W

rotor input = 10 k – 1 k = 9 kW

rotor output = [1 – s] rotor i/p

= [1 – 0.05] × 9 k = 8.55 kW

Gross mechanical output = 8.55 k – 0.55 k

= 8 kW

Efficiency $\eta\% = \frac{P_{out}}{P_{in}} \times 100$

$= \frac{8k}{10k} \times 100 = 80\%$

**16. Ans: (B)**

**Sol:** $A = \begin{bmatrix} 1 & 2 \\ 0 & -2 \end{bmatrix}$

C.E $|A - \lambda I| = 0$

$\Rightarrow (\lambda - 1)(\lambda + 2) = 0 \Rightarrow \lambda = 1, -2$

If $\lambda$ is eigen value of A, then $\lambda^{-1}$ is eigen value of $A^{-1}$.

$\therefore$ The eigen values of $A^{-1}$ are $\frac{1}{1}, \frac{-1}{2}$

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

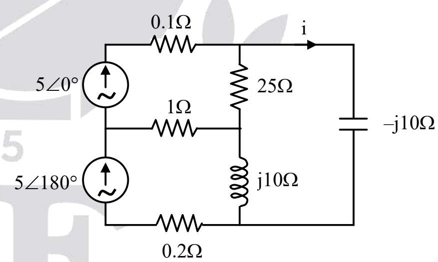
**17. Ans: (B)**

**Sol:** $\overline{K} = 30\hat{a}_z$ mA/m; $\hat{a}_n = \hat{a}_y$

$\overline{H} = \frac{1}{2}\overline{K} \times \hat{a}_n = \frac{1}{2}30\hat{a}_z \times \hat{a}_y = -15\hat{a}_x \text{mA/m}$

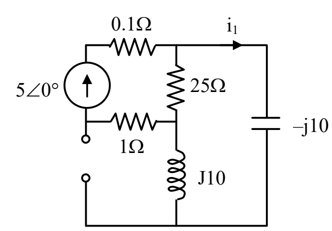
**18. Ans: (B)**

**Sol:**

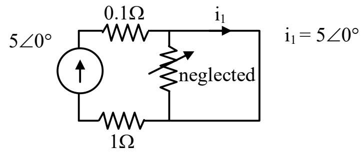



By super position principle $i = i_1 + i_{11}$

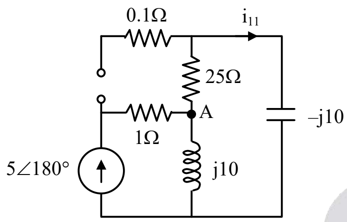
Current $i_1$: 5∠0° source acting alone




$-j10 + j10 = 0\ \Omega$ (short circuit)




Current $i_{11}$: 5∠180° source acting alone




By current division rule at node A

$$i_{11} = 5\angle 180^\circ \times \frac{j10}{25 + j10 - j10}$$

$$= 2j\angle 180^\circ$$

$$= -2j$$

$\therefore$ $i = i_1 + i_{11} = 5 - 2j$

**19. Ans: (B)**

**Sol:** $E = 4.44\, K_p\, K_d\, \phi\, f.T$

$E \propto f \propto N$

$N\uparrow$ by 10% So $E_2$ also Increases by 10%

$I_{SC}$ is independent of speed. So $I_{SC}$ remains constant.

**20. Ans: (C)**

**Sol:** Poynting vector wattmeter is works on the principle of Hall-effect. This wattmeter used for measuring the power loss density at the surface of a magnetic material.

**21. Ans: 2**

**Sol:** Consider the h-parameters:

$V_1 = h_{11} I_1 + h_{12} V_2$

$I_2 = h_{21} I_1 + h_{22} V_2$

From Fig. I, $V_2 = 0$ , $h_{11} = \frac{V_1}{I_1} = \frac{20}{10} = 2\ \Omega$

$$h_{21} = \frac{I_2}{I_1} = -\frac{2}{10} = -0.2$$

From Fig. II,

$$h_{12} = \left.\frac{V_1}{V_2}\right|_{I_1=0} = \frac{V_1}{10}\ ,\ V_1 = 10\, h_{12}$$

For reciprocal NW = $h_{12} = -h_{21}$

$\therefore$ $V_1 = 2$ V

**22. Ans: (A)**

**Sol:** Output power $P_{out} = VI_a$

Armature copper loss = $I_a^2 R_a$

Input power $P_i = VI_a + I_a^2 R_a + P_c$

$$\text{Efficiency } \eta = \frac{P_{out}}{P_{in}} = \frac{VI_a}{VI_a + I_a^2 R_a + P_c}$$

For $\eta$ to be maximum $\frac{d\eta}{dI_a} = 0$

$V(VI_a + I_a^2 R_a + P_c) - VI_a(V + 2I_aR_a) = 0$

$$I_a = \sqrt{\frac{P_c}{R_a}}$$

**23. Ans: 231.7 ( Range 230 to 233)**

**Sol:** When duty cycle less than 30% it acts as buck converter

$\therefore$ $V_0 = \alpha\, V_s$

$$\Rightarrow V_s = \frac{35}{0.3} = 116.7\, V$$

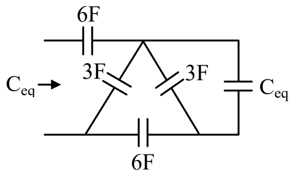
$\therefore$ Blocking voltage of the switch element is

$= 116.7 + 115$ V

$\approx 232$

**24. Ans: 3**

**Sol:**




$C_{eq}$ = [[($C_{eq}$+3)||+6F]+3F] || 6F

$$C_{eq} = \frac{(C_{eq}+3)6}{C_{eq}+9}+3$$

$$C_{eq} = \frac{\frac{9C_{eq}+45}{C_{eq}+9}.6}{\frac{9C_{eq}+45}{C_{eq}+9}+6}$$

$$C_{eq} = \frac{(9C_{eq}+45)6}{15C_{eq}+99} = \frac{(9C_{eq}+45)6}{3(5C_{eq}+33)}$$

$$5C_{eq}^2 + 33C_{eq} - 18C_{eq} - 90 = 0$$

$$5C_{eq}^2 + 15C_{eq} - 80 = 0$$

$$C_{eq}^2 + 3C_{eq} - 18 = 0$$

$(C_{eq}+6)\ (C-3) = 0$

C = 3 F

**25. Ans: (B)**

**Sol:** $\eta = \frac{kVA \times \cos\phi}{kVA \times \cos\phi + W_1 + W_{Cu}}$

$W_i = 60W$

$W_{Cu} \propto I^2$

$I_1 = \frac{4000}{400} = 10A$

$W_{Cu} = \left(\frac{10}{6}\right)^2 \times 21.6 = 60W$

$W_i + W_{Cu} = 120$ W

$$\%\eta = \frac{4\times10^3\times1}{4\times10^3\times1+120}\times100 = 97.08\%$$

**Two Marks Questions:**

**26. Ans: 21**

**Sol:** $\frac{C}{R}$ = (1) (1–1+3)(1)(4–2+5)(1) = 21

**27. Ans: 3.13 (Range: 2 to 4)**

**Sol:** $V_2 = 200\angle0°$

Power absorbed by 10Ω = $I^2 \times 10$

$= (12)^2\times10 = 1440$ W

$1440 = V_2 I \cos\phi_2$ ($\phi_2$-angle between $V_2$ and I)

$\cos\phi_2 = \frac{1440}{200\times12} = 0.6$

$\phi_2 = 53.13$

$\tan\phi_2 = \frac{X_2}{10}$

$X_2 = 10.\tan(53.13) = 13.33\ \Omega$

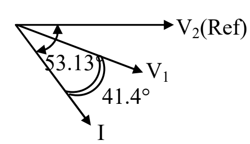
$\therefore\ I = 12\angle-53.13°$

Power factor of source = $\frac{1800}{200\times12} = 0.75$

$\phi_1 = 41.4°$

($\phi_1$ – angle between

$V_1$ and I)




So, $V_1 = 200\angle-11.73°$

$$I_C = \frac{V_1 - V_2}{-j20} = \frac{200\angle-11.73-200}{20\angle-90}$$

$= 10\angle78.27 - 10\angle90$

$I_1 = I - I_C = 12\angle-53.13 -$

$(10\angle78.27 - 10\angle90)$

$= 7.2 - j9.59 - (2 + j9.8 - j10)$

$= 5.2 - j9.39$

$$Z_1 = \frac{V_1 - V_2}{I_1} = \frac{40.87\angle -95.86}{10.718\angle -61.18}$$

$$= 3.813\angle -34.68$$

$$= 3.13 - j2.169$$

$R_1 = 3.13\ \Omega$

**28. Ans: (C)**

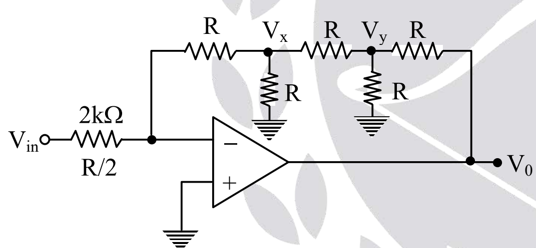
**Sol:** Heat equivalent current is RMS current of fault

$$I_F = I_R = I_{R_1} = \frac{E_{R_1}}{Z_{eq}} = \frac{E_{R_1}}{X'_d} = \frac{10}{0.25} = 4.0\,\text{p.u}$$

$$I(a) = I(pu)\,I_b = 4.0 \times \frac{100}{\sqrt{3} \times 11} = 21\text{ kA}$$

**29. Ans: (B)**

**Sol:** Let R = 4kΩ




Applying KCL at inverting terminal,

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

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)

Substiting (1) in (4)

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

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

**30. Ans: 10.8 ( Range: 10.8 to 10.8)**

**Sol:** $CE = 1 + \dfrac{10(s+A)}{s(s+2)(s+4)} = 0$

$CE = s^3 + 6s^2 + 18s + 10A = 0$

| | | |
|---|---|---|
| $s^3$ | 1 | 18 |
| $s^2$ | 6 | 10A |
| $s^1$ | $\dfrac{6(18) - 10A}{6}$ | |
| $s^0$ | 10A | |

For just stable, $6(18) - 10A = 0$

$$\Rightarrow A = \frac{6(18)}{10} = 10.8$$

A = 10.8

**31. Ans: 20.23 (Range: 19 to 21)**

**Sol:** From thyristor modal, $V_t = 0.8$ V and $R_d = \dfrac{1.2}{100}\,\Omega$ for half time wave, $I_{av} = \dfrac{50}{\pi}$ and

$I_{rms} = 25A$

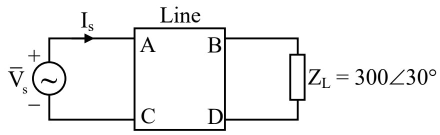
$\therefore$ Power loss $= V_t.I_{av} + R_d I_r^2$

$$= 0.8 \times \frac{50}{\pi} + \frac{1.2}{100}(25)^2$$

= 20.23W

**32. Ans: 10.815 (Range: 9 to 11)**

**Sol:** given data:




If load is also including in ABCD parameters equivalent ABCD are

$$\begin{bmatrix} A_0 & B_0 \\ C_0 & D_0 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} 1 & 0 \\ \frac{1}{Z_L} & 1 \end{bmatrix}$$

$$A_0 = A + \frac{B}{Z_L}$$

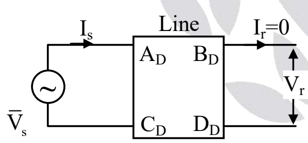
$$= 0.978 + \frac{72.77\angle 90^\circ}{300\angle 30^\circ}$$

$$= 0.978 + 0.2426\angle 60^\circ$$

$$= 0.978 + 0.1213 + j0.21$$

$$= 1.0993 + j0.21$$

$$= |A_0|\angle 10.815$$




Now, $\bar{V}_r = \frac{\bar{V}_S}{A_0}$

$$= \bar{V}_S \times \frac{1}{|A_0|}\angle -10.815^\circ$$

Angle between $V_s$ and $V_r$ is 10.815°

**33. Ans: (D)**

**Sol:** Fourier analysis of wave forms $V_{01}$ and $V_{02}$ are

$$V_{01} = \frac{4V_{dc}}{\pi}\left[\sin\omega t + \frac{1}{3}\sin 3\omega t + \frac{1}{5}\sin 5\omega t + .....\right]$$

$$V_{02} = \frac{4V_{dc}}{\pi}\left[\sin\left(\omega t - \frac{\pi}{3}\right) + \frac{1}{3}\sin 3\left(\omega - \frac{\pi}{3}\right) + .....\right]$$

resultant voltage $V_0$ is

$V_0 = V_{01} + V_{02}$

$$= \frac{4V_{dc}}{\pi}\sqrt{3}\left[\sin\left(\omega t - \frac{\pi}{6}\right) + \frac{1}{5}\sin\left(5\omega + \frac{\pi}{6}\right) + \frac{1}{7}\sin\left(7\omega t - \frac{\pi}{6}\right) + .....\right]$$

$\therefore$ Fundamental component of $V_0$ is

$$\frac{4\times 100}{\pi}\sqrt{3} = 220.53\text{V}$$

**34. Ans: (C)**

**Sol:** MOD-12 asynchronous counter

| $Q_3$ | $Q_2$ | $Q_1$ | $Q_0$ |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |
| 1 | 0 | 1 | 1 |

From the above table we can observe that ,

$$f_{Q_0} = \frac{f}{2},\ f_{Q_1} = \frac{f}{4},\ f_{Q_2} = \frac{f}{12}\ \&\ f_{Q_3} = \frac{f}{12}$$

**35. Ans: (C)**

**Sol:** Matrix [A / B] from is

$$\begin{bmatrix} 3 & 4 & 5 & a \\ 4 & 5 & 6 & b \\ 5 & 6 & 7 & c \end{bmatrix}$$

$R_2 \to R_2 - R_1$

$R_3 \to R_3 - R_1$

$$\begin{bmatrix} 3 & 4 & 5 & a \\ 1 & 1 & 1 & b-a \\ 2 & 2 & 2 & c-a \end{bmatrix}$$

$R_3 \to -2R_2 + R_3$

$$\begin{bmatrix} 3 & 4 & 5 & a \\ 1 & 1 & 1 & b-a \\ 0 & 0 & 0 & -2(b-a)+c-a \end{bmatrix}$$

For consistent solution, $\rho(A/B) = \rho(A)$

$\Rightarrow -2(b-a) + c - a = 0$

$\Rightarrow 2(b-a) = c-a$

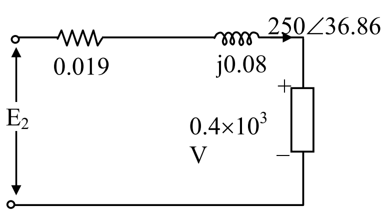
$\Rightarrow 2b = a + c$

**36. Ans: 6.46 ( range 6 to 7)**

**Sol:** $R = 0.012 \times \left(\frac{0.4^2}{0.1}\right) = 0.0192\Omega$

$X = 0.05 \times \left(\frac{0.4^2}{0.1}\right) = 0.08\Omega$.

The equivalent circuit diagram with respect to secondary is




$$I_2 = \frac{kVA}{V} = \frac{100\times10^3}{0.4\times10^3} = 250\angle+36.86$$

And impedance drop = IZ = 20.55∠113.49

Then $E_2 = IZ + (0.4\times10^3)$

$\bar{E}_2 = 392\angle2.75$ V

$$E_1 = \left(\frac{6.6}{0.4}\right)\times 392 = 6468\text{V} = 6.46\text{ kV}$$

**37. Ans: 2000 rev/ kWh (No range)**

**Sol:** I = 15A, V = 250V,

$$K = \frac{rev}{A.-sec} = 0.1388$$

$$K = \frac{rev}{\frac{A.V}{1000}\times\frac{sec}{3600}} = rev/kWh$$

$$= \frac{0.1388\times1000\times3600}{250}$$

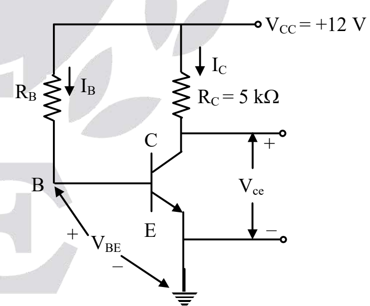
= 2000 rev/ kWh

**38. Ans: (A)**

**39. Ans: (C)**

**Sol:** Given data: $V_{BE} = 0.7\text{ V}$, $\beta = 50$

$V_{CE} = 2V$




$V_{CC} = I_B R_B + V_{BE}$ .......... (1)

$V_{CC} = I_C R_C + V_{CE}$

$$I_C = \frac{V_{CC} - V_{ce}}{R_C}$$

$$I_C = \frac{12-2}{5K} = 2mA$$

$$\frac{I_C}{\beta} = I_B$$

$$\Rightarrow I_B = \frac{2mA}{50} = 0.04 \text{ mA}$$

From (1)

$$R_B = \frac{V_{CC} - V_{BE}}{I_B}$$

$$R_B = \frac{12 - 0.7}{0.04m} = 283 \text{ k}\Omega$$

**40. Ans: (A)**

**Sol:** $R_2$/ph = 0.025Ω, $X_2$/ph=0.12Ω, $T_{st} = \frac{3}{4} T_{max}$

$$\frac{2a}{1 + a^2} = \frac{3}{4}$$

$\Rightarrow 8a = 3 + 3a^2$

$\Rightarrow 3a^2 - 8a + 3 = 0$

a = 2.21, 0.451

For motor operation slip range is 0 to 1

$\therefore$ a = 0.451

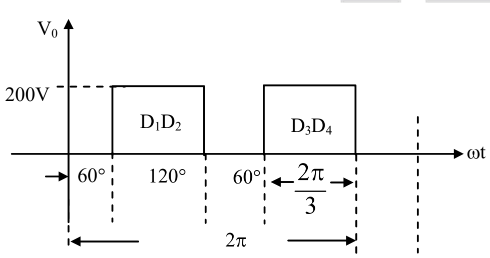
$$\frac{R_2 + R_e}{X_2} = 0.451$$

$$\frac{0.025 + R_e}{0.12} = 0.451$$

$R_e$ = 0.029 Ω / ph.

**41. Ans: 2000**

**Sol:** output voltage of rectifier is shown below




Average output voltage, $V_0 = 200 \times \frac{2\pi/3}{\pi}$

$$= \frac{400}{3} \text{ V}, P_0 = V_0.I_0$$

$$= \frac{400}{3} \times 15 = 2000 \text{ W}$$

**42. Ans: (C)**

**Sol:** $\left|\frac{k}{s^2}\right| = 1$ at ω = 4

$$\frac{k}{\omega^2} = 1$$

$k = \omega^2 = 16$

For a type-2 system $k_a$ = k =16

**43. Ans: (A)**

**Sol:** Power delivered by salient pole motor,

$$P = \frac{E_f.V_t}{X_d}.\sin\delta + \frac{V_t^2}{2}.\left(\frac{X_d - X_q}{X_d \ X_q}\right)\sin 2\delta$$

In the above equation, the second term indicates reluctance power, which is independent on field excitation and would be present even if field is fails or unexcited.

This reluctance power is maximum at,

δ = 45°

$\Rightarrow P_{max}$

When excitation fails $= \frac{V_t^2}{2}\left(\frac{X_d - X_q}{X_d X_q}\right)$

$$= \frac{(6.6)^2}{2} \times \left(\frac{23.2 - 14.5}{23.2 \times 14.5}\right)$$

$P_{max}$ = 563 kW

**44. Ans: 83° range (82° to 84°)**

**Sol:** $P_s = P_{e1} = 1.0$

$$P_{m1} = \frac{EV}{X_{1eq}} = \frac{1.1 \times 1.0}{0.5} = 2.2$$

$P_{m2} = 0$

$P_{m3} = P_{m1} = 2.2$

$$\delta_0 = \sin^{-1}\left(\frac{P_s}{P_{m1}}\right) = \sin^{-1}\left(\frac{1.0}{2.2}\right)$$

$$= 27° = 0.47 \text{ rad}$$

$$\delta_m = 180 - \sin^{-1}\left(\frac{P_s}{P_{m3}}\right) = 180 - \sin^{-1}\left(\frac{P_s}{P_{m1}}\right)$$

$\delta_m = 180 - 27°$

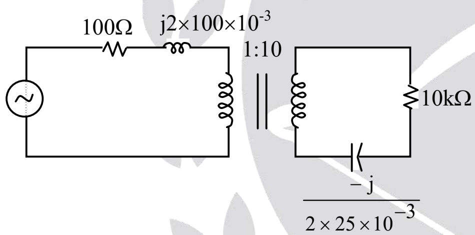
$$\delta_c = \cos^{-1}\left(\frac{1.0(2.7-0.47)+2.2\cos 153°}{2.2}\right)$$

$$\delta_c = \cos^{-1}\left(\frac{1.0(2.7-0.47)-1.96}{2.2}\right)$$

$$= \cos^{-1}(0.122) = 83°$$

**45. Ans: (C)**

**Sol:**




By transferring secondary impedance to primary then

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

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

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

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

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

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

So power dissipated in the 10kΩ resistor is

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

$$= 6.25 \text{ W}$$

**46. Ans: 69.77 ( Range 68 to 71)**

**Sol**: Given data, $R_a = 0.1\ \Omega$, $V_b = 2V$,

$N_1 = 1000$rpm, $I_{a1} = 100$A, $V_{t1} = 250$V, $N_2$=700rpm

$E_{g1} = R_a I_{a1} + V_b + 250$

$= 0.1\times100+2+250$

$= 262$V

Now $N_2 = 700$ rpm

$$\frac{Eg_1}{Eg_2} = \frac{N_1}{N_2}$$

$$E_{g2} = \frac{700\times 262}{1000} = 183.4\text{V}$$

And $R_L = \dfrac{V_{t1}}{I_{a1}} = \dfrac{250}{100} = 2.5\Omega$

Therefore $E_{g2} = I_{a2}R_a + V_b + I_{a2}\times R_L$

$183.4 = I_{a2}\times0.1+2+I_{a2}\times2.5$

$\Rightarrow I_{a2} = 69.769$A

**47. Ans: 0.89 (Range: 0.85 to 0.95)**

**Sol:** $H(z) = \dfrac{z}{z-0.5} \quad \omega = \dfrac{\pi}{2} \quad z = e^{j\omega} = j$

$$\Rightarrow H(z)\big|_{z=j} = \frac{j}{j-0.5}$$

$$A = \frac{1}{\sqrt{1^2 + (0.5)^2}} = 0.8944$$

**48. Ans: (B)**

**Sol:** Characteristic equation = $|SI - A| = 0$

$$\begin{vmatrix} s & -1 \\ 3 & s+4 \end{vmatrix} = 0$$

$s^2 + 4s+3=0$

$\omega_n = \sqrt{3}$ and $2\zeta\omega_n = 4$

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

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

**49. Ans: 2.83 (Range 2 to 3)**

**Sol:** $V = \int \frac{\rho_s dS}{4\pi\varepsilon_0 |\bar{r}_2 - \bar{r}_1|}, \rho_s = \frac{1}{\rho} nC/m^2$

The surface charge density lies in z=0 plane. To this plane $\pm\hat{a}_z$ are perpendicular . hence

$d\bar{S} = \pm(\rho d\rho d\phi)\hat{a}_z$ or dS=ρdρdϕ

Point 2 is that point at which potential is desired. Hence 2(0,0,z).point 1 is the general point in z=0 plane, hence point 1(ρ,ϕ,0).

$\bar{R}_{12} = \bar{r}_2 - \bar{r}_1 = z\hat{a}_z - \rho\hat{a}_\rho$

$|\bar{r}_2 - \bar{r}_1| = \sqrt{z^2 + \rho^2}$

$$\therefore V = \frac{1}{4\pi\varepsilon_0}\int_0^{0.01}\int_0^{2\pi} \frac{\rho d\rho d\phi \times 10^{-9}}{\rho\sqrt{z^2+\rho^2}}$$

$$= \frac{10^{-9}}{4\pi\varepsilon_0} \times \ln\left[\frac{\rho + \sqrt{\rho^2 + z^2}}{z}\right]_0^{0.01} [\phi]_0^{2\pi}$$

$$= \frac{10^{-9}}{4\pi \times \frac{10^{-9}}{36\pi}} \times \left[\ln\left[\frac{0.01 + \sqrt{(0.01)^2 + (0.2)^2}}{0.2}\right] - 0\right] \times 2\pi$$

= 2.83V

**50. Ans: (C)**

**Sol:** Given $\bar{F} = 3x\bar{i} + y^2\bar{j}$

Along y –axis , x = 0 ⇒ dx = 0

$$\int_c \bar{F}.dr = \int_c 3xdx + y^2dy$$

$$= \int_2^3 y^2 dy$$

$$= \left[\frac{y^3}{3}\right]_2^3$$

$$= \frac{27-8}{3} = \frac{19}{3}$$

**51. Ans: (B)**

**Sol:**

| x | 1 | 2 | 3 |
|---|---|---|---|
| **f(x)** | 1 | 1/4 | 1/9 |

Simpson's rule

$$= \frac{h}{3}[y_o + 4y_1 + y_2]$$

$$= \frac{1}{3}\left[1 + 4 \times \frac{1}{4} + \frac{1}{9}\right]$$

$$= \frac{1}{3}\left[2 + \frac{1}{9}\right]$$

$$= \frac{19}{27}$$

**52. Ans: (B)**

**Sol:** $x(t) = \text{rect}(t) \Rightarrow C_n \propto \frac{1}{n}$

For the system transfer function $\frac{1}{n}$ dependency is there

$\therefore$ Output coefficient $\propto \frac{1}{n^2}$

**53. Ans: 3**

**Sol:** $P = x \oplus y \oplus xy$

$P = (x \oplus y)\overline{xy} + (\overline{x \oplus y})\, xy$

$= (\bar{x}y + x\bar{y})(\bar{x} + \bar{y}) + (\bar{x}\,\bar{y} + xy)xy$

$= \bar{x}y + x\bar{y} + xy$

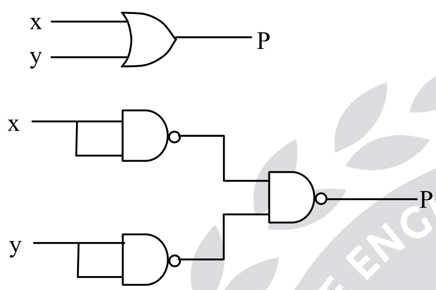
$= \bar{x}y + x(y+\bar{y})$

$= x + \bar{x}y$

$= (x+\bar{x})(x+y)$

$\therefore\ P = x + y$

Since it is an OR operation, 3 NAND gates are required to implement the given Boolean function




**54. Ans: (A)**

**Sol:** point P is above conducting plane z = 2 . If we drop a perpendicular from point P on the plane z = 2, the coordinate of the foot of the perpendicular will be (2,–3,2). Hence the distance of point P from the z=2 plane is

$$\sqrt{(2-2)^2+(-3+3)^2+(5-2)^2} = 3.$$

Consider a point P′ which is mirror image of point P.The distance of point P′ from the plane z=2 will be 3.Hence the co ordinate of point p′ be (2,–3,-1).If a perpendicular is dropped from P′ on plane z=2, the co ordinates of foot of perpendicular will be (2,–3,2). At this point P′, the charge of –25nC(which is image of 25nC) is located.

V at (3,2,4) is = V due to 25nC+V due to –25nC

$$= \frac{25\times10^{-9}}{4\pi\varepsilon_0\sqrt{(3-2)^2+(2+3)^2+(4-5)^2}} + \frac{-25\times10^{-9}}{4\pi\varepsilon_0\sqrt{(3-2)^2+(2+3)^2+(4+1)^2}}$$

= 11.7789V

**55. Ans: (C)**

**Sol:** $\tan\phi = \dfrac{\sqrt{3}(W_1-W_2)}{W_1+W_2}$

Power consumed by load,

$P = W_1 + W_2$

$$= \frac{\sqrt{3}(W_1-W_2)}{\tan\phi}$$

$$= \frac{\sqrt{3}\times50}{\left[\frac{50}{100}\right]} = 100\sqrt{3}\,W$$