GATE 2025

Electrical Engineering

Memory based
Questions & Solutions

Exam held on
02/02/2025 (Afternoon Session)

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SECTION - A GENERAL APTITUDE

Q.1 The value of $\left(\frac{3^{81}}{27^4}\right)^{1/3}$

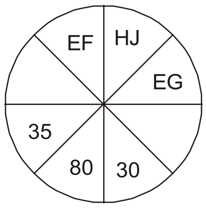
(a) 3^{40}
(b) 3^{23}
(c) 3^{69}
(d) 3^{46}

Ans. (b)

$$\left(\frac{3^{81}}{27^4}\right)^{1/3} = \left(\frac{3^{81}}{(3^3)^4}\right)^{1/3} = \left(\frac{3^{81}}{3^{12}}\right)^{1/3} = (3^{81-12})^{1/3} = (3^{69})^{1/3}$$
$$= 3^{23}$$

End of Solution

Q.2 Blank spaces represent



(a) FG = 72
(b) FG = 42
(c) GH = 52
(d) FJ = 40

Ans. (b)

EF = 5 × 6 = 30; HJ = 8 × 10 = 80; EG = 5 × 7 = 35
From the options only FG = 6 × 7 = 42 satisfies this logic.

End of Solution

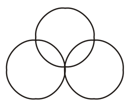
Q.3 Match the venn-diagram:

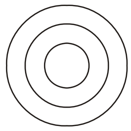
List-I

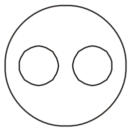
(a) Animal, Zebra, Giraffe

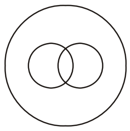
(b) Producer, Director, Actor

List-II

(i) 

(ii) 

(c) Pianist, Guitarist, Instrumentalist (iii) 

(d) Novel, Word, Sentence (iv) 

Ans. ( )
(a) – (iii); (b) – (i); (c) – (iv); (d) – (ii)

End of Solution

Q.4 Good : Evil : : Genuine : ?

(a) Counterfeit
(b) Counterpart
(c) Counterfoil
(d) Contraband

Ans. (a)

End of Solution

■■■■

SECTION - B TECHNICAL

ANALOG ELECTRONICS

Q.5 Which one of the following statements is true about the small signal voltage gain of a MOSFET based single stage amplifier?

(a) Common source and common gate amplifiers are both inverting amplifiers

(b) Common source and common gate amplifiers are both non-inverting amplifiers

(c) Common source amplifiers is non-inverting and common gate amplifier is inverting amplifier

(d) Common source amplifier is inverting and common gate amplifier is non-inverting amplifier

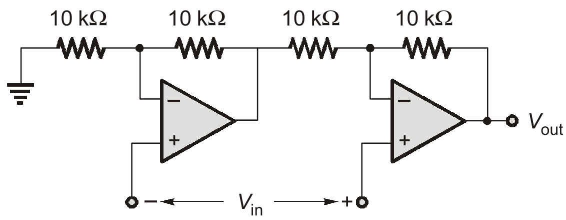
Ans. (d)

MOSFET CS amplifier is inverting.

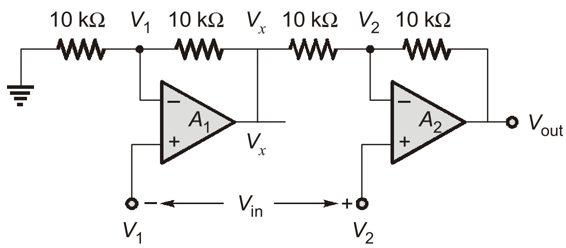
CG amplifier is non-inverting.

End of Solution

Q.6 The op-amps in the following circuit are ideal. The voltage gain of the circuit is ________. (Round off to the nearest integer)



Ans. (2)



Assume $V_{in} = V_2 - V_1$

Op-amp A_1 :

$$V_X = \left(1 + \frac{10k}{10k}\right) V_1 = 2V_1$$

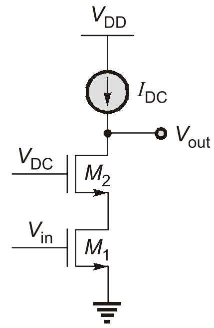
Op-amp A_2 :

KCL at A_2 $\quad \dfrac{V_X - V_2}{10k} = \dfrac{V_2 - V_0}{10k}$

$$V_X = 2V_2 - V_0$$
$$V_0 = 2V_2 - V_X$$
$$= 2V_2 - 2V_1$$
$$= 2(V_2 - V_1)$$
$$\frac{V_0}{V_2 - V_1} = 2$$

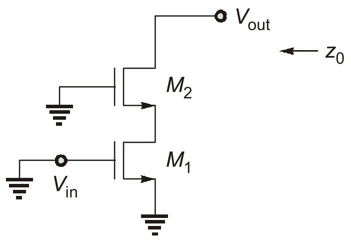
End of Solution

Q.7 In the circuit, I_{DC} is an ideal current source. The transistors M_1 and M_2 are assumed to be biased in saturation, wherein V_{in} is the input signal and V_{DC} is fixed DC voltage. Both transistors have a small signal resistance of r_{ds} and trans-conductance of g_m. The small signal output impedance of this circuit is



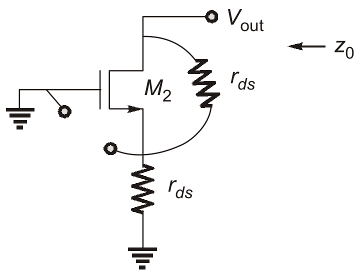
Ans. $(2r_{ds} + g_m r^2_{ds})$

AC Analysis :



To calculate Z_0 $\quad V_{in} = 0$

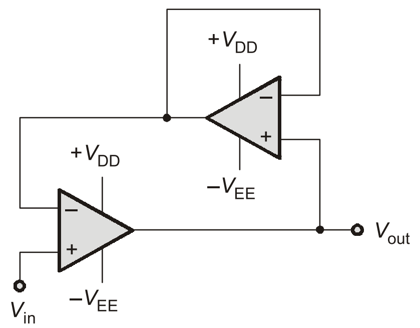
Replace M_1 transistor as active load



$$Z_0 = r_{ds} + r_{ds} + g_m r_{ds} r_{ds}$$
$$= 2r_{ds} + g_m r^2_{ds}$$

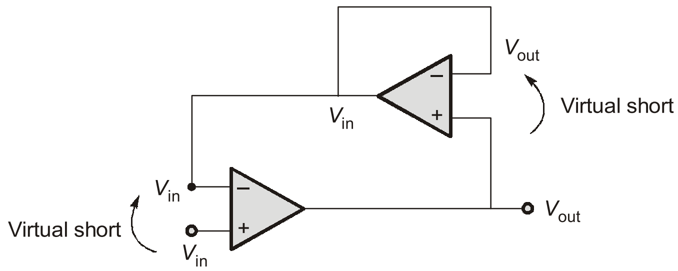
End of Solution

Q.8 Assuming ideal op-smps, the circuit represents is



(a) Summing amplifier
(b) buffer
(c) logarithmic amplifier
(d) difference amplifier

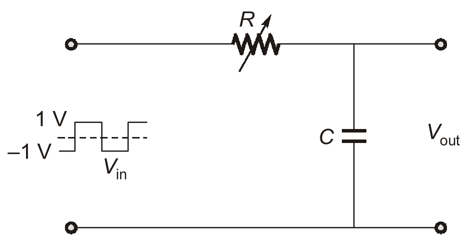
Ans. (b)



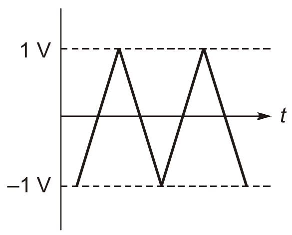
$V_{out} = V_{in}$ (buffer)

End of Solution

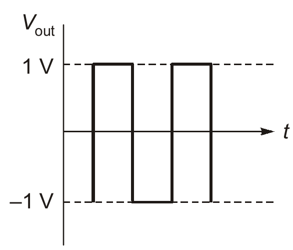
Q.9 In the circuit, shown below, if the values of R and C are very large, the form of the output voltage for a very high frequency square wave input, is best represented by

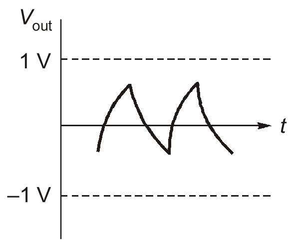


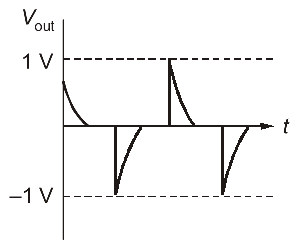
(a)



(b)



(c) 

(d) 

Ans. **(c)**

$$V_0 = \frac{1}{RC}\int_0^{T/2} V_i dt = \frac{1}{RC}\int_0^{T/2} 1.\, dt = \frac{1}{RC}(t)\Big|_0^{T/2} = \frac{T}{2RC}$$

$\because$ RC >>> T

So, $V_0 < 1$ Volt

End of Solution

CONTROL SYSTEMS

Q.10 Selected data points of the step response of a stable first-order linear time-invariant (LTI) system are given below. The closest value of the time-constan, in sec, of the system is

Time (sec)	0.6	1.6	2.6	10	∞
Output	0.78		2.8	2.98	3

(a) 1
(b) 3
(c) 4
(d) 2

Ans. **(d)**

End of Solution

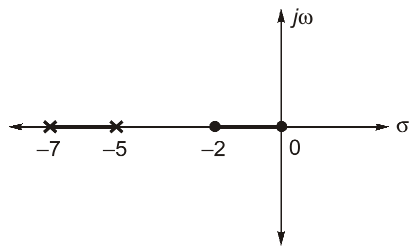
Q.11 The open-loop transfer function of the system shown in the figure, is

$$G(s) = \frac{Ks(s+2)}{(s+5)(s+7)}$$

For K ≥ 0, which of the following real axis point(s) is/are on the rool locus?

Ans. **(–7 to –5 and –2 to 0)**

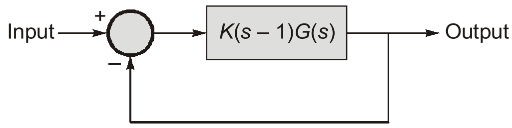
–7 to –5 and –2 to 0



Root locus exist between –7 to –5 and –2 to 0.

End of Solution

Q.12 Let $G(s) = \dfrac{1}{(s+1)(s+2)}$. Then the closed-loop system shown in the figure below,



Find the values of K for stability.

Ans. **($-3 < K < 2$)**

$$G(s)H(s) = \frac{K(s-1)}{s^2+3s+2}$$

Characteristics equation of the system is

$$q(s) = s^2 + s(K+3) + (2-K) = 0$$

The system to be stable

$$-3 < K < 2$$

End of Solution

Q.13 Consider the state-space model

$$\dot{x}(t) = Ax(t) + Bu(t)$$
$$y(t) = Cx(t)$$

$$A = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix},\ B = \begin{bmatrix} 0 \\ 1 \end{bmatrix},\ C = [1 \quad 0]$$

The sum of the magnitudes of the poles is _____.

Ans. **(3)**

Characteristics equation of the system is

$$q(s) = |sI - A| = 0$$

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

$$q(s) = s^2 + 3s + 2 = 0$$

Roots of the equation is $-1, -2$

Sum of the magnitudes of the poles

$$= |-1| + |-2| = 1 + 2 = 3$$

End of Solution

Q.14 A controller $(1 + K_D s)$ is to be designed for the plant $G(s) = \dfrac{1000\sqrt{2}}{s(s+10)^2}$ as shown in the figure. The value of K_D that yields a phase margin of 45° at the gain cross-over frequency of 10 rad/sec is _________ (round off to one decimal place).

Ans. (0.1)

Given compensated system has

$$PM = 180° + \left[-90° - 2\tan^{-1}\left(\frac{10}{10}\right)\right] = 0°$$

But required 45° phase marging has to be provided by compensator

$$\tan^{-1}[K_d\omega]\Big|_{\text{at }\omega=10\text{rad/sec}} = 45°$$

$$\therefore \quad K_D = 0.1$$

End of Solution

Q.15

$$\dot{X}_1 = 2X_2$$

$$\dot{X}_2 = U(t)$$

$U(t)$ is step.

Find $X_1(1)$

Ans. (1)

$$SX_1 = 2X_2$$

$$SX_2 = \frac{1}{s}$$

$$X_2 = \frac{1}{s^2}$$

$$X_1 = \frac{2}{s^3}$$

$$X_1(t) = t^2\,U(t)$$

$$X_1(1) = 1$$

End of Solution

Q.16 Open loop system is stable. Nyquist plot encircles (–1, 0) once in anti-clockwise direction. Find closed loop system stability.

Ans. (#)

$$P = 0, \quad N = +1$$

$$N \neq P$$

$\therefore$ Closed loop system is unstable.

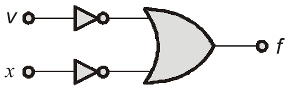
End of Solution

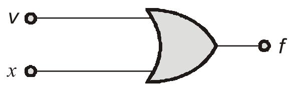
DIGITAL ELECTRONICS

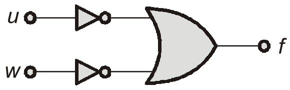
Q.17 A Boolean function is given as

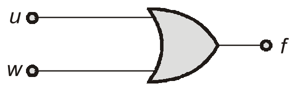
$f = (\bar{u} + \bar{v} + \bar{w} + \bar{x}) \cdot (\bar{u} + \bar{v} + \bar{w} + x) \cdot (\bar{u} + v + \bar{w} + \bar{x}) \cdot (\bar{u} + v + \bar{w} + x)$

The simplified form of this function is represented by

(a)


(b)


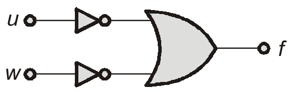
(c)


(d)


Ans. (c)

	$w + x$	$w + \bar{x}$	$\bar{w} + \bar{x}$	$\bar{w} + x$
$u + v$	0	1	3	2
$u + \bar{v}$	4	5	7	6
$\bar{u} + \bar{v}$	12	13	0 (15)	0 (14)
$\bar{u} + v$	8	9	0 (11)	0 (10)

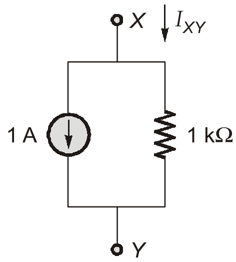
$\bar{u} + \bar{w}$

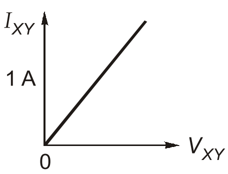


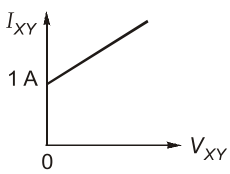
End of Solution

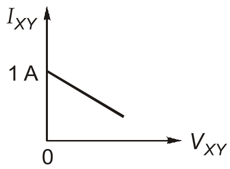
ELECTRIC CIRCUITS

Q.18 The I-V characteristics of the elements between the nodes X and Y is best depicted



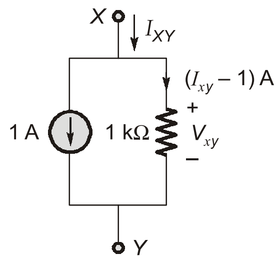
(a)


(b)


(c) 

(d)

Ans. (b)



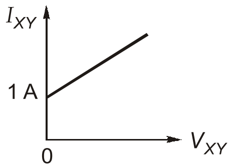
$$V_{xy} = (I_{xy} - 1)1k$$

$V_{xy} = 0$

$$0 = (I_{xy} - 1)1k \Rightarrow I_{xy} = 1$$

$V_{xy} = 1\text{ kV}$

$$1k = (I_{xy} - 1)1k \Rightarrow I_{xy} = 2$$

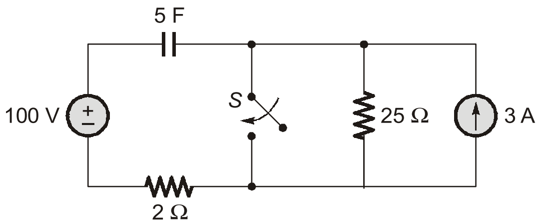


$V_{xy} = 5\text{ kV}$

$$5k = (I_{xy} - 1)1k \Rightarrow I_{xy} = 6$$

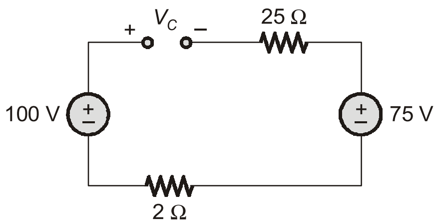
End of Solution

Q.19 The switch (S) closes at $t = 0$ sec. The time, in sec the capacitor takes to charge to 50 V is ________ . (Round off to one decimal places)



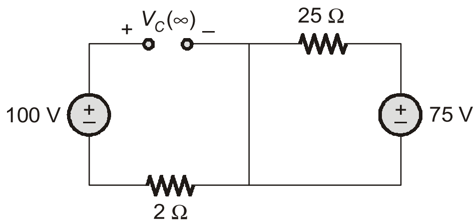
Ans. (4.05)

$t = 0^-$



$$V_C(0^-) = 100 - 75$$
$$V_C(0^-) = 25\text{ V}$$
$$V_C(0^+) = 25\text{ V}$$

$t \to \infty$



$$V_C(\infty) = 100\text{ V}$$
$$T = 2 \times 5 = 10\text{ sec}$$
$$V_C(t) = V_C(\infty) + (V_C(0^+) - V_C(\infty))e^{-t/T}$$
$$V_C(t) = 100 + (25 - 100)e^{-t/10}$$
$$50 = 100 - 75e^{-t/10}$$
$$+50 = +75e^{-t/10}$$
$$e^{-t/10} = \frac{50}{75}$$
$$t = 4.05\text{ sec}$$

End of Solution

Q.20 Consider two coupled circuits having self inductances L_1 and L_2 that carry non-zero currents I_1 and I_2 respectively. The mutual inductance between the circuit is M with unity coupling coefficient. The stored magnetic energy of the coupled circuit is minimum at which of the following value(s) of I_1/I_2?

(a) $-\frac{M}{L_2}$ (b) $-\frac{L_2}{M}$

(c) $-\frac{M}{L_1}$ (d) $-\frac{L_1}{M}$

Ans. (b, c)

$$\omega = \frac{1}{2}L_1 I_1^2 + \frac{1}{2}L_2 I_2^2 + MI_1 I_2$$
$$\frac{d\omega}{dI_1} = 0$$
$$\frac{d\omega}{dI_1} = 2I_1\left(\frac{1}{2}L_1\right) + 0 + MI_2$$
$$0 = L_1 I_1 + MI_2$$
$$\frac{I_1}{I_2} = -\frac{M}{L_1}$$
$$\frac{d\omega}{dI_2} = 0$$

$$\frac{d\omega}{dI_2} = 0+\frac{1}{2}L_2(2I_2)+MI_1$$

$$0 = L_2I_2 + MI_1$$

$$\frac{I_1}{I_2} = -\frac{L_2}{M}$$

End of Solution

ELECTRICAL MACHINES

Q.21 A DC series motor with negligible series resistance is running at a certain speed driving a load, where the load torque varies as cube of the speed. The motor is fed from a 400 V DC source and draws 40 A armature current. Assume linear magnetic circuit. The external resistance, in Ω, that must be connected in series with the armature to reduced the speed of the motor by half, is closed to

(a) 0
(b) 23.28
(c) 4.82
(d) 46.7

Ans. (b)

$$T \propto N^3 \text{ (given)}$$

$$I_a = 40 \text{ A},\ 400 \text{ V}$$

$$R_{ext} = ?, \text{ if speed has to reduce half}$$

$$400 \propto 40 \text{ N} \quad ...(1)$$

$$400 - I_a R_{ext} \propto I_a\left(\frac{N}{2}\right) \quad ...(2)$$

as $T \propto N^3$ (given)

and $T \propto I_a^2$ (series motor)

So, $I_a^2 \propto N^3$

$$\frac{40^2}{I_a^2} = \frac{N^3}{\left(\frac{N}{2}\right)^3}$$

$$\frac{40^2}{I_a^2} = 8 \Rightarrow I_a = 10\sqrt{2} \text{ A}$$

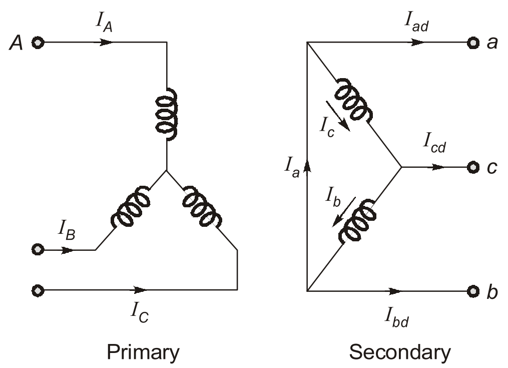
From (1) and (2)

$$\frac{400}{400-10\sqrt{2}(R_{ext})} \propto \frac{40N}{10\sqrt{2}\left(\frac{N}{2}\right)}$$

$$R_{ext} = 23.28\ \Omega$$

End of Solution

Q.22 The transformer connection given in the figure is part of a balanced 3-phase circuit where the phase sequence is "abc". The primary to secondary turns ratio is 2 : 1. If ($I_a + I_b + I_c = 0$), then the relationship between I_A and I_{ad} will be



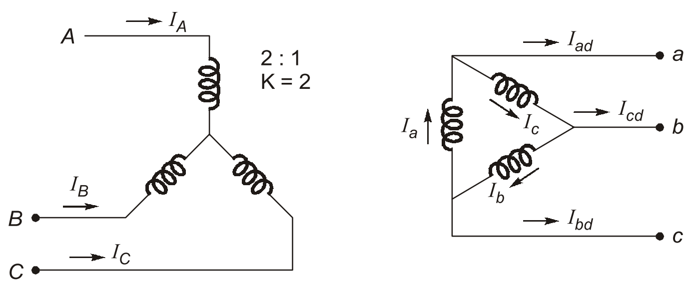
(a) $\dfrac{|I_A|}{|I_{ad}|} = \dfrac{1}{2\sqrt{3}}$ and I_{ad} lags I_A by 30°

(b) $\dfrac{|I_A|}{|I_{ad}|} = \dfrac{1}{2\sqrt{3}}$ and I_{ad} leads I_A by 30°

(c) $\dfrac{|I_A|}{|I_{ad}|} = 2\sqrt{3}$ and I_{ad} lags I_A by 30°

(d) $\dfrac{|I_A|}{|I_{ad}|} = 2\sqrt{3}$ and I_{ad} leads I_A by 30°

Ans. (a)



$$I_a = 2I_A$$

$$I_{ad} = \sqrt{3}I_a = 2\sqrt{3}I_A$$

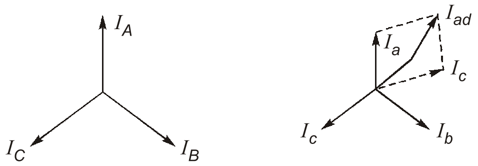
$$\frac{I_A}{I_{ad}} = \frac{1}{2\sqrt{3}}$$

Applying KCL,

$$\bar{I}_a = \bar{I}_c + \bar{I}_{ad}$$

$$\bar{I}_{ad} = \bar{I}_a - \bar{I}_c$$

$$\bar{I}_{ad} = \bar{I}_a - (-\bar{I}_c)$$



I_{ad} lags I_a by 30°.

$\therefore$ I_{ad} lags I_A by 30°.

$\because$ I_A and I_a in phase.

End of Solution

Q.23 A 3-phase, 400 V, 4 pole, 50 Hz star connected induction motor has the following parameters referred to the stator :

$$R'_r = 1\ \Omega,\ X_S = X'_r = 2\ \Omega$$

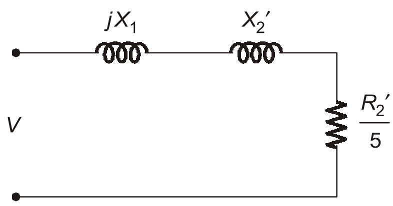
Stator resistance, magnetizing reactance and core loss of the motor are neglected. The moro is run with constant V/f control from a drive. For maximum starting torque, the voltage and frequency output, respectively, from the drive, is closest to,

(a) 400 V and 50 Hz
(b) 300 V and 37.5 Hz
(c) 200 V and 25 Hz
(d) 100 V and 12.5 Hz

Ans. **(d)**

Given : $X_S = X'_r = 2\ \Omega$

$X_1 = X'_2 = 2\ \Omega$



Condition for maximum starting torque :

$$R'_2 = X_1 + X'_2$$

Let a frequency F_m be the frequency.

Corresponding to maximum T_{st}.

$$2\pi f_m L_1 + 2\pi f_m L'_2 = 1$$

$$2\pi f_m (L_1 + L'_2) = 1$$

$$f_m = \frac{1}{2\pi(L_1 + L'_2)}$$

From given data : $X_1 = 2\pi f L_1 = 2\ \Omega$

$X_2 = 2\pi f L'_2 = 2\ \Omega$

$$L_1 = L'_2 = \frac{2}{2\pi(50)} = 6.369 \times 10^{-3}\ \text{H}$$

$$\therefore \quad f_m = \frac{1}{2\pi(2 \times 6.369 \times 10^{-3})} = 12.5\ \text{Hz}$$

V/F Control : V/F Ratio must remain same.

$$\therefore \quad \frac{V_2}{f_2} = \frac{V_1}{f_1} \Rightarrow V_2 = \frac{400}{50} \times 12.5 = 100\ \text{V}$$

End of Solution

Q.24 Instruments required to synchronize an alternator to the grid is/are

(a) Wattmeter
(b) Voltmeter
(c) Synchroscope
(d) Stroboscope

Ans. (c, b)

To synchronise alternator to grid, synchroscope and voltmeter are used.

End of Solution

Q.25 The induced emf in a 3.3 kV, 4-pole, 3-phase, Y-connected synchronous motor is considered to be equal and in phase with the terminal voltage under no load condition. On application of a load (mechanical), the induced emf phasor is deflected by an angle of 2° (mechanical) with respect to the terminal voltage phasor. If the isochronous reactance is 2 Ω and series resistance is negligible than the motor armature current magnitude, an ampere during loaded condition, is closest to _______. (round off two decimal places)

Ans. (66.49)

$$(E_f)_{NL} = |V| = \frac{3.3\times10^3}{\sqrt{3}},\ X_S = 2\ \Omega$$

$$\delta = 2^\circ \text{ mechanical} = 2^\circ\times\frac{4}{2} = 4^\circ \text{ electrical}$$

$$\frac{3.3\times10^3}{\sqrt{3}}\angle-4^\circ = \frac{3.3\times10^3}{\sqrt{3}}\angle0^\circ - j\vec{I}_a(2)$$

$$\vec{I}_a = \frac{\frac{3.3\times10^3}{\sqrt{3}}\angle0^\circ - \frac{3.3\times10^3}{\sqrt{3}}\angle-4^\circ}{j2}$$

$$= 66.49\angle-2^\circ$$

End of Solution

EMT

Q.26 Which one of the following figures represents the radial electric field distribution E_R caused by a spherical cloud of electrons with a volume charge density. $\rho = -3\rho_0$ for $0 \le R \le a$ (both ρ_0, a are positive and R is the radial distance) and $\rho = 0$ for $R > a$?

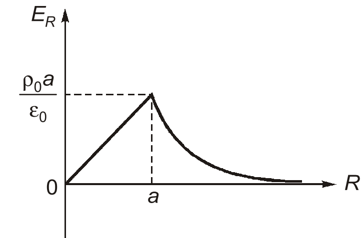


Fig. (i)

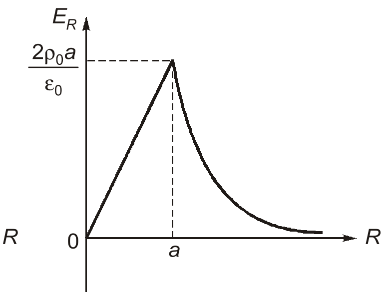


Fig. (ii)

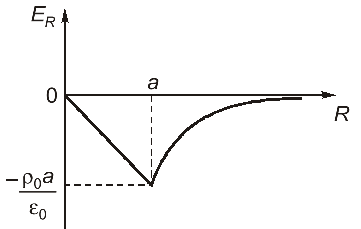


Fig. (iii)

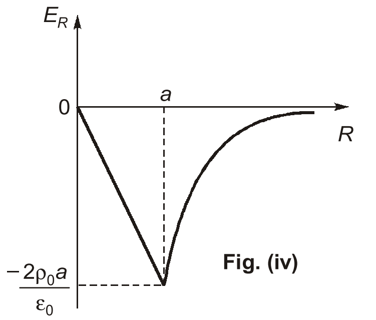
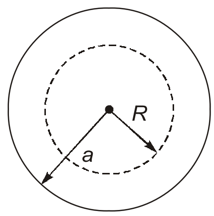


Fig. (iv)

Ans. (c)

Given :
$$\rho_V = \begin{cases} -3\rho_0 \text{ c/m}^3 & 0 \le R \le a \\ 0 & R > a \end{cases}$$

Case (i) : $R \le a$:



$$\oint \bar{D}\cdot d\bar{S} = Q_{enc} = \int \rho_V dv$$

$$Q_{enc} = \int \rho_V dv = -\int 3\rho_0 R^2 \sin\theta\, d\theta\, d\phi\, dR$$

$$\Rightarrow \quad Q_{enc} = -3\rho_0 \int_{R=0}^{R} R^2 dR \int_{\theta=0}^{\pi} \sin\theta d\theta \int_{\phi=0}^{2\pi} d\phi$$

$$\Rightarrow \quad Q_{enc} = -3\rho_0 \cdot \frac{R^3}{3}\Big|_0^R - \cos\theta\Big|_0^\pi \cdot \phi\Big|_0^{2\pi}$$

$$\Rightarrow \quad Q_{enc} = -\rho_0 . a^3.2.2\pi = -(4\pi R^3)\rho_0$$

$$\oint \bar{D}\cdot d\bar{S} = D \times 4\pi R^2$$

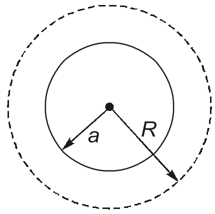
$$= \quad D.4\pi R^2 = -4\pi R^3 \rho_0$$

$$\Rightarrow \quad D = -\rho_0 R$$

$$\Rightarrow \quad E = -\frac{\rho_0 R}{\epsilon_0}$$

$$\Rightarrow \quad \bar{E} = -\frac{\rho_0 R}{\epsilon_0}\hat{a}_r$$

Case (ii) : $R > a$



$$\oint \bar{D}\cdot d\bar{S} = Q_{enc} = \int \rho_v dv$$

$$Q_{enc} = \int -3\rho_0 . R^2 \sin\theta\, d\theta\, d\phi\, dR$$

$$\Rightarrow \quad Q_{enc} = -3\rho_0 \int_{R=0}^{a} R^2 dR \int_{\theta=0}^{\pi} \sin\theta\, d\theta \int_{\phi=0}^{2\pi} d\phi$$

$$\Rightarrow \quad Q_{enc} = -3\rho_0 \cdot \frac{R^3}{3}\bigg|_0^a - \cos\theta\big|_0^{\pi} \cdot \phi\big|_0^{2\pi} = -\rho_0 a^3 \pi . 2\pi = -4\pi a^3 \rho_0$$

$$\oint \bar{D}\cdot d\bar{S} = D \times 4\pi R^2$$

$$\therefore \quad D.4\pi R^2 = -4\pi a^3 \rho_0$$

$$\Rightarrow \quad D = -\frac{\rho_0 a^3}{R^2}$$

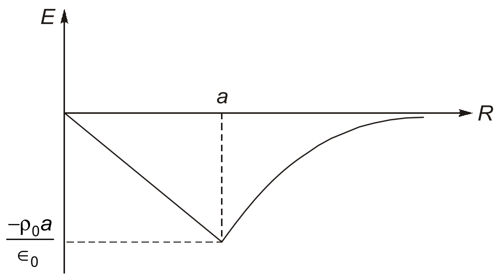
$$\Rightarrow \quad E = -\frac{\rho_0 a^3}{\epsilon R^2}$$

$$\Rightarrow \quad \bar{E} = \frac{-\rho_0 a^3}{\epsilon_0 R^2}\hat{a}_R$$

Hence,

$$\bar{E} = \begin{cases} \dfrac{-\rho_0 R}{\epsilon_0}\hat{a}_r, & 0 \le R \le a \\ \dfrac{-\rho_0 a^3}{\epsilon_0 R^2}\hat{a}_r, & R > a \end{cases}$$

Graph :



End of Solution

Q.27 Let a_R be the unit radial vector in the spherical co-ordinate system. For which of the following value(s) of n, the divergence of the radial vector field $f(R) = a_R \frac{1}{R^n}$ is independent of R?

(a) –1 (b) –2
(c) 2 (d) 1

Ans. **(a, c)**

Given :

$$\bar{f}(R) = \frac{1}{R^n}\hat{a}_R$$

$$\nabla.\bar{f} = \frac{1}{R^2\sin\theta}\left[\frac{\partial}{\partial R}\left(R^2\sin\theta\cdot\frac{1}{R^n}\right)\right]$$

$$= \frac{1}{R^2}\left[\frac{\partial}{\partial R}(R^{2-n})\right]$$

$$= \frac{(2-n)R^{-n+1}}{R^2} = (2-n)R^{-n-1}$$

For $\nabla.\bar{f}$ to be independent of R,

Case (i) :

$$-n - 1 = 0$$

$\Rightarrow$ $-n = 1$

$\Rightarrow$ $n = -1$

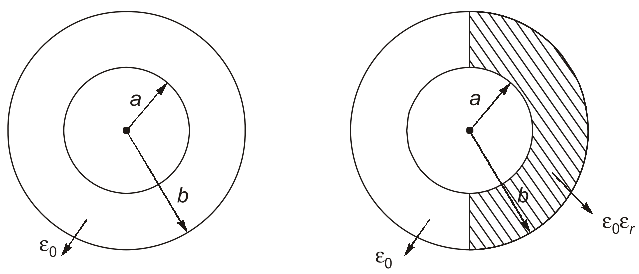
Case (ii) :

$$2 - n = 0$$

$\Rightarrow$ $n = 2$

End of Solution

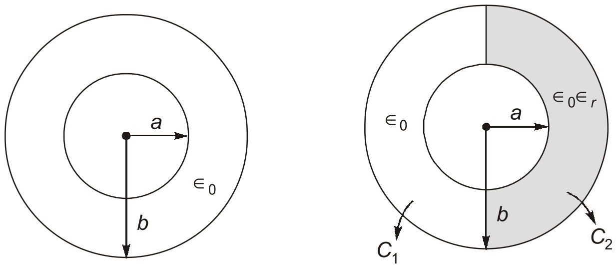
Q.28 An air filled cylindrical capacitor (capacitance C_0) of length L, with a and b as its inner and outer radii, respectively, consists of two coaxial conducting surfaces. Its cross-sectional view is shown in Figure (i). In order to increase the capacitance, a dielectric material of relative permittivity ε_r is inserted inside 50% of the annular region as shown in figure (ii). The value of ε_r for which the capacitance of the capacitor in figure (ii), becomes $5C_0$ is



(i) (ii)

(a) 5 (b) 4
(c) 10 (d) 9

Ans. (d)



Capacitance, $C_0 = \dfrac{2\pi\varepsilon_0 l}{\ln\left(\dfrac{b}{a}\right)}$

Now, capacitance, $C_{eq} = C_1 + C_2$

$$C_1 = \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)} \times \frac{1}{2} = \frac{\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}$$

$$C_2 = \frac{2\pi\varepsilon_0\varepsilon_r l}{\ln\left(\frac{b}{a}\right)} \times \frac{1}{2} = \frac{\pi\varepsilon_0\varepsilon_r l}{\ln\left(\frac{b}{a}\right)}$$

$$\therefore \quad C_{eq} = \frac{\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}[1+\varepsilon_r]$$

According to question,

$$C_{eq} = 5C_0$$

$$\Rightarrow \quad \frac{\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}[1+\varepsilon_r] = 5 \times \frac{2\pi\varepsilon_0 l}{\ln\left(\frac{b}{a}\right)}$$

$$1 + \varepsilon_r = 10$$

$$\Rightarrow \quad \varepsilon_r = 9$$

End of Solution

MATHEMATICS

Q.29 Let $A = \begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 1 & -1 \end{bmatrix}$ and $b = \begin{bmatrix} 1/3 \\ -1/3 \\ 0 \end{bmatrix}$, then the system of linear equations $Ax = b$ has

(a) infinitely many solutions
(b) no solution
(c) a finite number of solutions
(d) a unique solution

Ans. (a)

$$AX = B$$

$$\begin{bmatrix} 1 & 1 & 1 \\ -1 & -1 & -1 \\ 0 & 1 & -1 \end{bmatrix}\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} \frac{1}{3} \\ -\frac{1}{3} \\ 0 \end{bmatrix}$$

$$C = [A : B] = \begin{bmatrix} 1 & 1 & 1 & : & \frac{1}{3} \\ -1 & -1 & -1 & : & -\frac{1}{3} \\ 0 & 1 & -1 & : & 0 \end{bmatrix}$$

$R_2 \to R_2 + R_1$
$$\begin{bmatrix} 1 & 1 & 1 & : & \frac{1}{3} \\ 0 & 0 & 0 & : & 0 \\ 0 & 1 & -1 & : & 0 \end{bmatrix}$$

$R_2 \leftrightarrow R_3$
$$\begin{bmatrix} 1 & 1 & 1 & : & \frac{1}{3} \\ 0 & 1 & -1 & : & 0 \\ 0 & 0 & 0 & : & 0 \end{bmatrix}$$

$\Rightarrow \quad \rho(A) = 2 = \rho(A \mid B) < n = 3$

System has infinite solutions.

End of Solution

Q.30 Consider the set S of points $(x, y) \in R^2$ which minimize the real valued function

$$f(x, y) = (x + y - 1)^2 + (x + y)^2$$

Which of the following statements is true about the set S?

(a) The number of elements in the set S is exactly one.

(b) The set S is empty.

(c) The number of elements in the set S is infinite.

(d) The number of elements in the set S is finite and more than one

Ans. (c)

$$\begin{aligned} f(x, y) &= (x + y - 1)^2 + (x + y)^2 \\ &= x^2 + (y - 1)^2 + 2(x)(y - 1) + x^2 + y^2 + 2xy \\ &= 2x^2 + 2y^2 + 4xy - 2x - 2y + 1 \end{aligned}$$

Finding stationary points :

$$\frac{\partial f}{\partial x} = 4x + 4y - 2 = 0$$

$$\frac{\partial f}{\partial y} = 4y + 4x - 2 = 0$$

$\Rightarrow$ $x + y = 2$

$r = f_{xx} = 4 > 0$

$S = f_{xy} = 0, \; t = f_{yy} = 4$

$rt - S^2 = (4)(4) - 0^2 = 16 > 0$

$\because$ $rt - S^2 > 0, \; r > 0$ at all

The infinite stationary points.

$\therefore$ It is minimum at infinite points.

Solving we get infinite points $P(x, y)$

End of Solution

Q.31 Let v_2 and v_2 be the two eigen vectors corresponding to distinct eigen values of a 3×3 real symmetric matrix. Which one of the following statements is true?

(a) $v_1^T v_2 \neq 0$
(b) $v_1 + v_2 = 0$
(c) $v_1 - v_2 = 0$
(d) $v_1^T v_2 = 0$

Ans. (d)

Eigen vectors of symmetric matrix of 3×3.

Corresponding to distinct λ are orthogonal to each other.

$\therefore$ $V_1^T V_2 = 0$

End of Solution

Q.32 Consider discrete random variable X and Y with probabilities as follows:

$$P(X = 0 \text{ and } Y = 0) = \frac{1}{4}$$

$$P(X = 1 \text{ and } Y = 1) = \frac{1}{8}$$

$$P(X = 0 \text{ and } Y = 1) = \frac{1}{2}$$

$$P(X = 1 \text{ and } Y = 1) = \frac{1}{8}$$

Given X = 1, the expected value of Y is

(a) $\frac{1}{3}$
(b) $\frac{1}{4}$
(c) $\frac{1}{8}$
(d) $\frac{1}{2}$

Ans. (c)

$$P(X = 1, Y = 0) = \frac{1}{8}, \quad P(X = 1, Y = 1) = \frac{1}{8},$$

$$\left(\frac{Y}{X=1}\right) = \sum y_i P(x = 1, y = 1)$$

$$= 0 \times P(X = 1, Y = 0) + 1 \times P(X = 1, Y = 1)$$

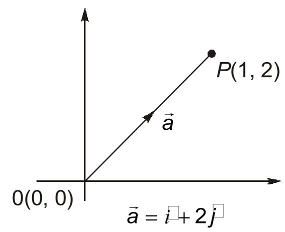
$$= 0 \times \frac{1}{8} + 1 \times \frac{1}{8}$$

$$= \frac{1}{8}$$

End of Solution

Q.33 Let $(x, y) \in R^2$. The rate of change of the real valued function,
$V(x, y) = x^2 + x + y^2 + 1$
at the origin in the direction of the point (1, 2) is ________ (round off to the nearest integer)

Ans. (0)



$$DD = \vec{\nabla V} \cdot \frac{\vec{a}}{|\vec{a}|}$$

$$\vec{\nabla V} = \langle V_x, V_y \rangle$$

$$= \langle 2x + 1, 2y \rangle$$

$$\left(\vec{\nabla V}\right)_{(D,0)} = \langle 1, 0 \rangle$$

$\therefore$ $$D.D = (\hat{i} + 0\hat{j}) \cdot \frac{(\hat{i} + 2\hat{j})}{\sqrt{1^2 + 2^2}}$$

$$= \frac{1}{\sqrt{5}} = 0.447$$

Nearest integer = 0

End of Solution

Q.34 Let X and Y be continous random variables with probability density functions $P_X(x)$ and $P_Y(y)$, respectively. Further, let $Y = X^2$ and $P_X(x) = \begin{cases} 1, & x \in (0,1] \\ 0, & \text{otherwise} \end{cases}$.

Which one of the following options is correct?

(a) $Y_Y(y) = \begin{cases} \frac{1}{2\sqrt{y}}, & y \in (0,1] \\ 0, & \text{otherwise} \end{cases}$

(b) $P_Y(y) = \begin{cases} 2y, & y \in (0,1] \\ 0, & \text{otherwise} \end{cases}$

(c) $P_Y(y) = \begin{cases} 1.5\sqrt{y}, & y \in (0,1] \\ 0, & \text{otherwise} \end{cases}$

(d) $P_Y(y) = \begin{cases} 1, & y \in (0,1] \\ 0, & \text{otherwise} \end{cases}$

Ans. (a)

$$Y = X^2$$

$$dy = 2Xdx \Rightarrow \frac{dx}{dy} = \frac{1}{2x}$$

$$g_Y(Y) = 1 \cdot \frac{1}{2x} = \frac{1}{2\sqrt{y}}$$

$$g(Y) = \begin{cases} \frac{1}{2\sqrt{y}}, & y \in (0,1) \\ 0, & \text{otherwise} \end{cases}$$

End of Solution

Q.35 Let C be a clockwise oriented closed curve in the complex plane defined by $|z| = 1$. Further, let $f(x) = jz$ be a complex function, where $j = \sqrt{-1}$. Then, $\int_C f(z)dz$ = ____.

Ans. (0)

$f(z) = iz$ is analytic in $C : |z| = 1$

$$\oint_C iz\,dz = 0 \text{ by C.I.T.}$$

End of Solution

MEASUREMENT

Q.36 The maximum percentage error in the equivalent resistance of two parallel connected resistors of 100 Ω and 900 Ω with each having a maximum 5% error is ________ %. (Round off to nearest integer value)

Ans. (5)

Given resistors : $R_1 = 100 \pm 5\% = (100 \pm 5)\ \Omega$

$R_2 = 900 \pm 5\% = (900 \pm 45)\ \Omega$

$R_{eq} = R_1 \parallel R_2 = 100 \parallel 900 = 90\ \Omega$

For parallel combination,

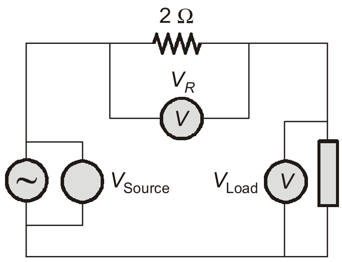
$$\frac{\delta R_{eq}}{R_{eq}} = \pm\left[\frac{R_{eq}}{R_1} \times \frac{\delta R_1}{R_1} \times \frac{R_{eq}}{R_2} \times \frac{\delta R_2}{R_2}\right]$$

$$= \pm\left[\frac{90}{100} \times 5\% + \frac{90}{900} \times 5\%\right]$$

$$= \pm 5\%$$

End of Solution

Q.37 In an experiment to measure the active power drawn by a single-phase RL Load connected to an AC source through a 2 Ω resistor, three voltmeters are connected as shown in the figure below. The voltmeter readings are as follows : V_{source} = 200 V, V_R = 9 V, V_{Load} = 199 V. Assuming perfect resistors and ideal voltmeters, the Load-active power measured in this experiment, in *W*, is _____.



Ans. (79.43)

$$I_L = \frac{V_R}{2} = \frac{9}{2} = 4.5 \text{ A}$$

$$\cos\phi = \frac{V_S^2 - V_R^2 - V_L^2}{2V_RV_L}$$

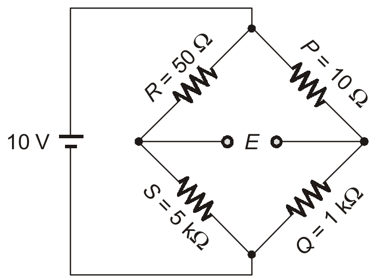
Substitution all the values, we get

$$\cos\phi = 0.0887$$

$$\therefore \quad P_L = 199 \times 4.5 \times 0.0887 = 79.43 \text{ W}$$

End of Solution

Q.38 In the Wheatstone bridge shown below, the sensitivity of the bridge in terms of change in balancing voltage *E* for unit change in the resistance *R*, in mV/Ω, is _______ . (round off to two decimal places)



Ans. (1.96)

$$E = 10\left[\frac{1000}{1000+10} - \frac{5000}{5000+51}\right]$$

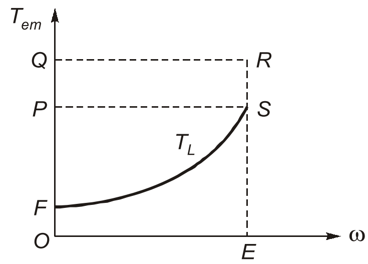
$$= 1.96 \text{ mV}$$

$$\therefore \quad S = 1.96 \text{ mV/}\Omega$$

End of Solution

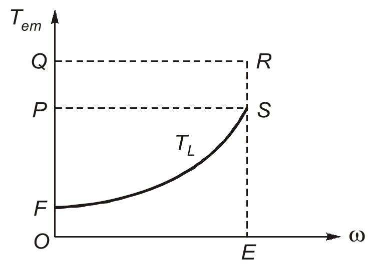
POWER ELECTRONICS

Q.39 The operating region of the developed torque (T_{em}) and speed (ω) of an induction motor drive is given by the shaded region OQRE in the figure. The load torque (T_L) characteristic is also shown. The motor drive moves from the initial operating point O to the final operating point S. Which one of the following trajectories will take the shortes time?



(a) O - P - S
(b) O - Q - R - S
(c) O - E - S
(d) O - F - S

Ans. (b)



The shortest time will be taken if motor follows the path that maximize the net accelerating torque (Tem-T_L) at all points.
Trajectories which takes shortest time.

End of Solution

Q.40 The input voltage $v(t)$ and current $i(t)$ of a converter are given by,

$v(t) = 300 \sin(\omega t)$ V

$$i(t) = 10\sin\left(\omega t - \frac{\pi}{6}\right) + 2\sin\left(3\omega t + \frac{\pi}{6}\right) + \sin\left(5\omega t + \frac{\pi}{2}\right) A$$

where, $\omega = 2\pi \times 50$ rad/s. The input power factor of the converter is closed to

(a) 0.845
(b) 0.867
(c) 0.887
(d)

Ans. (a)

$$v = 300 \sin(\omega t)$$

$$i = 10\sin\left(\omega t - \frac{\pi}{6}\right) + 2\sin\left(3\omega t + \frac{\pi}{6}\right) + \sin\left(5\omega t + \frac{\pi}{2}\right) A$$

$$P_1 = \frac{300}{\sqrt{2}} \times \frac{10}{\sqrt{2}} \times \cos\left(\frac{\pi}{6}\right) = 1299 \text{ W}$$

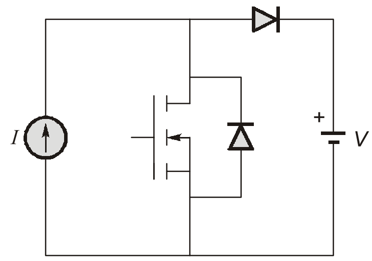
$$I_{RMS} = \sqrt{\frac{1}{2}(10^2 + 2^2 + 1^2)} = 7.245$$

$$S = V_{RMS} \cdot I_{RMS} = \frac{300}{\sqrt{2}} \times 7.245 = 1537.27 \text{ V}$$

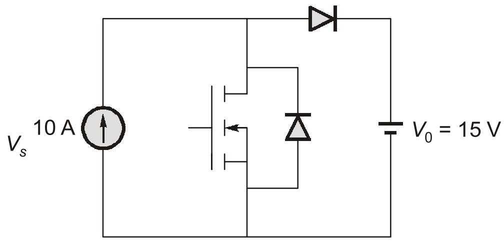
$$\text{PF} = \frac{P}{S} = \frac{P_1}{S} = \frac{1299}{1537.27} = 0.845$$

End of Solution

Q.41 In the circuit with ideal devices, the power MOSFET is operated with a duty cycle of 0.4 in a switching cycle with I = 10 A and V = 15 V. The power delivered by the current source in W is _______________. (round off to the nearest integer)



Ans. (90)



Boost Converter: Continuous condition.

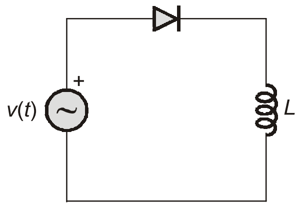
$$V_0 = \frac{V_s}{1-\alpha}$$

$$\frac{V_0}{V_s} = \frac{I_s}{I_0} = \frac{1}{1-\alpha}$$

$$I_0 = (1 - \alpha)I_s = (1 - 0.4)10 = 6 \text{ A}$$
$$P_0 = V_0 I_0 = 15 \times 6 = 90 \text{ W}$$

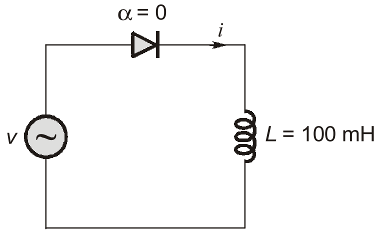
End of Solution

Q.42 An ideal sinusoidal voltage source $v(t) = 230\sqrt{2}\sin(2\pi \times 50t)$ V feeds an ideal inductor L through an ideal SCR with firing angle α = 0°. If L = 100 mH, then the peak of the inductor current, in ampere, is closest to



(a) 10.35
(b) 0
(c) 7.32
(d) 20.71

Ans. (d)



$$v = 230\sqrt{2}\sin(2\pi \cdot 50)$$

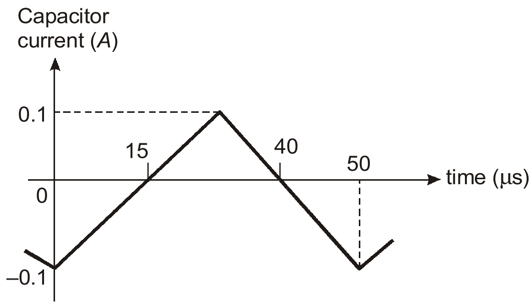
$$i = \frac{V_M}{\omega_L}[1 - \cos\omega t]$$

$$i_{peak} = \frac{2V_m}{\omega L} = \frac{2 \times 230\sqrt{2}}{2\pi \times 50 \times 100 \times 10^{-3}} = 20.7\text{A}$$

at $\omega t = \pi$

End of Solution

Q.43 The steady state capacitor current of a conventional DC-DC buck converter, working in CCM, is shown in one switching cycle. If the input voltage is 30 V, the vlaue of the inductor sued, in mH, is ____ (round off to one decimal place).



Ans. (1.8)

DC-DC Buck Converter:

$$\Delta I_L = \Delta I_C = 0.2\text{ A}$$

$$f = \frac{1}{T} = \frac{1}{50.10^{-6}}$$

$$f = 20 \text{ kHz}$$

$$\alpha = \frac{T_{ON}}{T} = \frac{30}{50} = 0.6$$

$$\Delta I_L = \frac{\alpha(1-\alpha)V_s}{fL}$$

$$L = \frac{\alpha(1-\alpha)V_s}{\Delta I_L \times f} = \frac{0.6(1-0.6)\times 30}{0.2\times 20.10^3}$$

$$L = 1.8 \text{ mH}$$

End of Solution

Q.44 The 3-phase modulating waveforms ($v_a(t)$, $v_b(t)$, $v_c(t)$), used in sinusoidal PWM in a voltage source inverter (VSI) are

$$v_a(t) = 0.8\sin(\omega t) \text{ V}$$

$$v_b(t) = 0.8\sin\left(\omega t - \frac{2\pi}{3}\right)\text{V}$$

$$v_c(t) = 0.8\sin\left(\omega t + \frac{2\pi}{3}\right)\text{V}$$

where $\omega = 2\pi \times 40$ rad/s is the fundamental frequency. The modulating waveforms are compared with a 10 kHz triangular carrier whose magnitude varies between +1 and –1. The VSI has a DC link voltage of 600 V and feeds a star connected motor. The per phase fundamental RMS motor voltage in volts is closest to

(a) 424.26
(b) 300.00
(c) 169.71
(d) 212.13

Ans. **(c)**

3ϕ VSI – Sin PWM:

$$A_M = 0.8 \text{ V} \qquad V_S = 600 \text{ V}$$

$$A_C = 1 \text{ V}$$

$$M_A = \frac{A_M}{A_C} = 0.8$$

$$\hat{V}_{L1} = \sqrt{3}M_A \cdot \frac{V_S}{2}$$

$$V_{L1\,RMS} = \frac{\sqrt{3}}{2\sqrt{2}} \cdot M_A \cdot V_S$$

$$= 0.612 \times 0.8 \times 600 = 293.938 \text{ V}$$

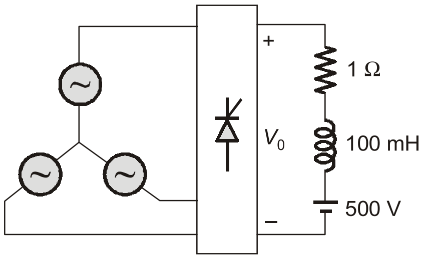
$$V_{Ph1\,RMS} = \frac{V_{L1}}{\sqrt{3}} = \frac{293.938}{\sqrt{3}} = 169.7 \text{ V}$$

End of Solution

Q.45 In the following circuit, the average voltage

$$V_0 = 400\left(1+\frac{\cos\alpha}{3}\right)\text{ V}$$

where α is the firing angle. If the power dissipated in the resistor is 64 W, then the closest value of α in degrees is



(a) 35.9
(b) 46.4
(c) 41.4
(d) 0

Ans. (a)

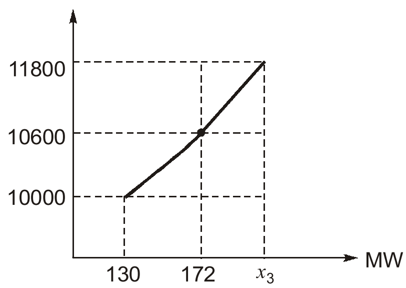
$$P_R = I_{or}^2 R = 64\text{ W}$$
$$I_{or}^2 \times 1 = 64$$
$$I_{or} = 8A = I_0 \qquad (\because \text{ Current is ripple free})$$
$$V_0 = E + I_0 R$$
$$400\left[1+\frac{\cos\alpha}{3}\right] = 500 + 8 \times 1 = 508$$
$$\alpha = 35.9°$$

End of Solution

POWER SYSTEMS

Q.46 Two units, rated at 100 MW and 150 MW, are enabled for economic load dispatch. When the overall incremental cost is 10,000 Rs./MWh, the units are dispatched to 50 MW and 80 MW respectively. At an overall incremental cost of 10,600 Rs./MWh, the power output of the units are 80 MW and 92 MW, respectively. The total plant MW-output (without overloading any unit) at an overall incremental cost of 11,800 Rs./MWh is ________ (round off to the nearest integer)

Ans. (250)



$$\frac{10600-10000}{172-130} = \frac{11800-10600}{x_3-172}$$

$$x_3 = 250 \text{ MW (Limited to max)}$$

$$\text{Proof} = 150 + 100 = 250 \text{ MW}$$

End of Solution

Q.47 A 3-bus system (in pu) has bus impedance matrix

$$Z_{bus} = \begin{bmatrix} j0.059 & j0.061 & j0.038 \\ j0.061 & j0.093 & j0.066 \\ j0.038 & j0.066 & j0.110 \end{bmatrix}$$

A symmetrical fault (through a fault impedance of $j0.007$ p.u.) occurs at bus-2. Neglecting pre-fault loading conditions, the voltage at bus-1, during the fault is ________ p.u.

Ans. (0.39)

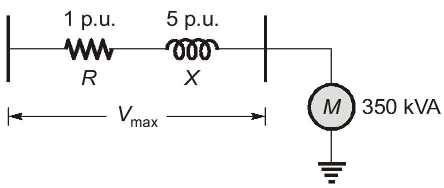
$$V_2 = V_1 - I_f Z_{12} = V_1 - \frac{1}{(Z_{22}+Z_f)} \times Z_{12}$$

$$= 1\angle 0° - \frac{1}{j(0.007+0.93)} \times j0.061 = 0.39$$

End of Solution

Q.48 Consider a feeder, with R/X ratio of 5. Connected with a load of 300 kVA at receiving end. The maximum voltage drop will occur from the sending end to the receiving end, when the power factor of the load is ____________.

Ans. (0.9805)



$$R\cos\phi + \sin\phi = -R\sin\phi + \cos\phi = 0$$

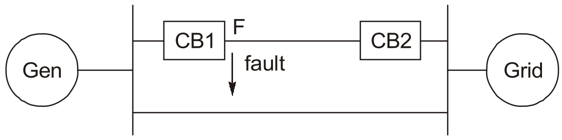
$$\tan\phi = \frac{X}{R}$$

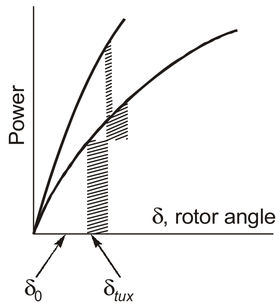
$$\phi = \tan^{-1}\left(\frac{X}{R}\right) = \tan^{-1}\left[\frac{1}{5}\right] = 11.31°$$

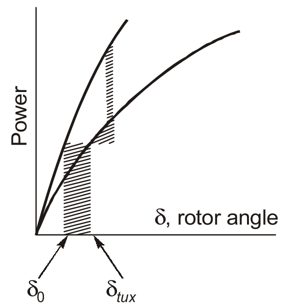
$$\cos\phi = \cos\left[\tan^{-1}\left(\frac{X}{R}\right)\right] = 0.9805$$

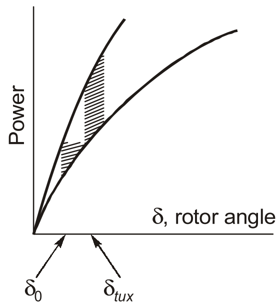
End of Solution

Q.49 The generator was initially supplying power to the grid. A temporary LLLG bolted fault occurs at F very close to circuit breaker auto reclosed. The circuit breakers open to isolate the line. The fault self-clears. The circuit breakers reclose and restore the line. The rotor accelerating and decelerating areas?



(i)


(ii)


(iii)


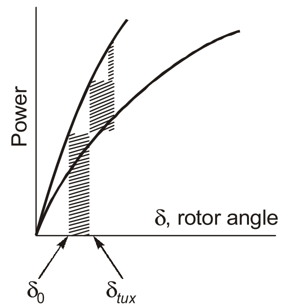
(iv)


Fig. (iv)

(a) Fig. (iii)
(b) Fig. (ii)
(c) Fig. (iv)
(d) Fig. (i)

Ans. (b)

End of Solution

Q.50 During a power failure, a domestic household uninterruptible power supply (UPS) supplies AC power to a limited number of lights and fans in various rooms. As per a Newton-Raphson load-flow formulation, the UPS would be represented as a

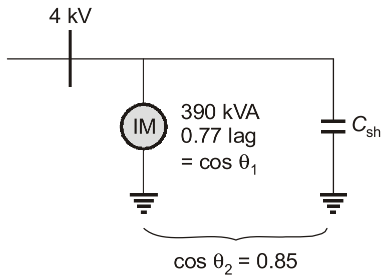
(a) PQ bus
(b) Slack bus
(c) PQV bus
(d) PV bus

Ans. (b)

End of Solution

Q.51 Using shunt capacitors, the power factor of a 3-phase, 4 kV induction motor (drawing 390 kVA at 0.77 pf lag) is to be improved to 0.85 pf lag. The line current of the capacitor bank, in *A*, which is connected in parallel to load is _______ .

Ans. (9.054 A)



$$\cos\theta_1 = 0.77,\ \theta_1 = 39.64°$$
$$\cos\theta = 0.85,\ \theta_2 = 31.79°$$
$$Q_c = P_1\,[\tan\theta_1 - \tan\theta_2]$$
$$= 390 \times 10^3 \times 0.77\,[\tan\cos^{-1}0.77 - \tan\cos^{-1}0.85]$$
$$= 62.73 \text{ KVAR} = 3\,V_{ph}\,I_{ph}\sin\theta_2$$

$$I_{ph} = \frac{62.73\times 10^3}{3\times\frac{4\times 10^3}{\sqrt{3}}\times} = 9.054 \text{ A}$$

End of Solution

SIGNAL AND SYSTEMS

Q.52 A continuous time peridoic signal $x(t)$ is

$$x(t) = 1 + 2\cos 2\pi t + 2\cos 4\pi t + 2\cos 6\pi t$$

If T is the period of $x(t)$, then $\frac{1}{T}\int_0^T |x(t)|^2\,dt$ = _____ (round off to the nearest integer).

Ans. (7)

$$\frac{1}{T}\int_0^T |x(t)|^2\,dt = \text{Power of } x(t)$$
$$= 1+\frac{2^2}{2}+\frac{2^2}{2}+\frac{2^2}{2}$$
$$= 1 + 2 + 2 + 2 = 7$$

End of Solution

Q.53 Consider the LTI system 'S' whre y(n) = S[x(n)]. Let $S\{\delta[n]\} = \begin{cases} 1, & n \in \{0, 1, 2\} \\ 0, & \text{otherwise} \end{cases}$

where $\delta[n]$ is the discrete-time unit impulse function. For an input signal $x[n]$, the output $y[n]$ is

(a) $x[n] + x[n + 1] + x[n + 2]$
(b) $x[n] + x[n - 1] + x[n - 2]$
(c) $x[n + 1] + x[n + 2] + x[n + 3]$
(d) $x[n - 1] + x[n] + x[n + 1]$

Ans. (b)

Given that the system is LTI and for i/p $\delta(n) \xrightarrow{\text{system}}$ O/P = {1, 1, 1}

i.e., $h(n)$ = impulse response of system

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

As we know, $y(n) = x(n) * h(n)$

$= x(n) * [\delta(n) + \delta(n-1) + \delta(n-2)]$

$= x(n) + x(n-1) + x(n-2)$

End of Solution

Q.54 Consider a continuous-time signal

$$x(t) = -t^2 \{u(t+4) - u(t-4)\}$$

where $u(t)$ is the continuous-time unit step function. Let $\delta(t)$ be the continuous-time unit impulse function. The value of

$$\int_{-\infty}^{\infty} x(t)\, \delta(t+3) dt$$

is

(a) 9
(b) 3
(c) –9
(d) –3

Ans. (c)

$$I = \int_{-\infty}^{\infty} x(t)\delta(t+3)dt = x(-3)$$

$= \{-t^2[u(t+4) - u(t-4)]\}_{t=-3}$

$= -(-3)2[u(1) - u(-7)]\}$

$= -9[1 - 0] = -9$

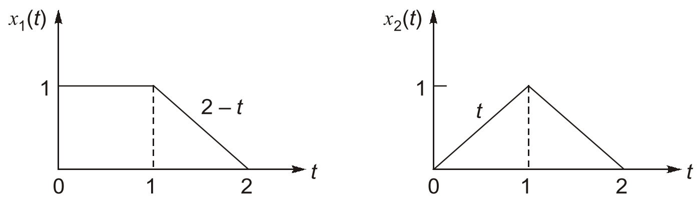
End of Solution

Q.55 Let continous-time signals $x_1(t)$ and $x_2(t)$ be $x_1(t) = \begin{cases} 1, & t \in [0,1] \\ 2-t, & t \in [1,2] \\ 0, & \text{otherwise} \end{cases}$ and $x_2(t) = \begin{cases} t, & t \in [0,1] \\ 2-t, & t \in [1,2] \\ 0, & \text{otherwise} \end{cases}$.

Consider the convolution $y(t) = x_1(t) * x_2(t)$. Then $\int_{-\infty}^{\infty} y(t)\,dt$ is

(a) 1.5
(b) 4
(c) 3.5
(d) 2.5

Ans. (a)



$y(t) = x_1(t) * x_2(t)$

Area property :

$$Ay = Ax_1 Ax_2$$

$$Ax_1 = 1\times 1 + \frac{1}{2}\times 1\times 1$$

$$= 1 + \frac{1}{2} = \frac{3}{2}$$

$$Ax_2 = \frac{1}{2}\times 2\times 1 = 1$$

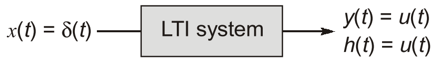
$$Ay = \frac{3}{2}\times 1 = 1.5$$

End of Solution

Q.56 The continuous-time unit impulse signal is applied as an input to a continuous-time linear time-invariant system S. The output is observed to be the continuous-time unit step signal $u(t)$. Which one of the following statement is true?

(a) On applying any input signal to S the output signal is always unbounded.
(b) It is possible to find a bounded input signal which when applied to S results in an unbounded output signal.
(c) Every bounded input signal applied to S results in a bounded output signal.
(d) On apply any input signal to S, the output signal is always bounded.

Ans. (b)



End of Solution

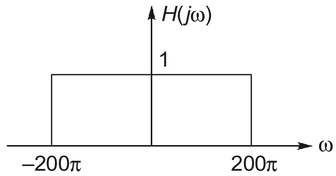
Q.57 An ideal low pass filter has frequency response given by

$$H(j\omega) = \begin{cases} 1, & |\omega| \le 200\pi \\ 0, & \text{otherwise} \end{cases}$$

Let $h(t)$ be its time domain representation. Then $h(0)$ = ________ (round off to the nearest integer)

Ans. (200)

1st Method :



$$H(j\omega) = rec\left(\frac{\omega}{400\pi}\right)$$

$$h(t) = \frac{\sin(200\pi t)}{\pi t} = \frac{200\sin(200\pi t)}{200\pi t}$$

$$h(t)|_{t=0} = 200$$

2nd Method :

$$h(0) = \frac{1}{2\pi}\int_{-\infty}^{+\infty} H(j\omega)d\omega$$

$$h(0) = \frac{1}{2\pi}\int_{-200\pi}^{200\pi} 1d\omega = \frac{1}{2\pi}[400\pi] = 200$$

End of Solution

■■■■