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ESE 2018
Preliminary Examination

Detailed Solutions of
ELECTRICAL ENGINEERING
(Set-A)

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Expected Cutoff Marks (Out of 500)**: ESE 2018 (Pre)**

Dear Students,

We have analysed both the papers of ESE 2018 (Prelims) in all four branch and we have taken in considerations the standard of question in both papers. We have also taken consideration of all expert faculties of MADE EASY, feedback of students after appearing in exam, the level of questions asked in ESE 2017. Based on above facts, MADE EASY Team has projected it's opinion about expected cutoff range required to qualify in ESE 2018 (Prelims) are as follows:

Stream	Gen	OBC	SC	ST
CE	215-225	190-200	160-170	160-170
ME	240-250	215-225	170-180	170-180
EE	225-235	210-220	180-190	180-190
E&T	215-225	200-210	160-170	160-170

Note: The minimum cutoff of each paper for Gen/OBC/SC/ST is 15% (as per ESE 2017) and for PH category it is 10% (as per ESE 2017).

Best wishes to all ESE 2018 Aspirants

B. Singh (Ex. IES)

CMD, MADE EASY Group

ELECTRICAL ENGINEERING

Q.1 Eigen values of the matrix $\begin{bmatrix} 3 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 3 \end{bmatrix}$ are

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

Ans. (c)

$$A = \begin{bmatrix} 3 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Characteristics equation is

$$|A - \lambda I| = 0$$

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

$$(3 - \lambda)((3 - \lambda)^2 - 1) + 1(-3 + \lambda - 1) - 1(1 + 3 - \lambda)$$

$$(3 - \lambda)(\lambda^2 - 6\lambda + 9 - 1) + -4 + \lambda - 4 + \lambda$$

$$(3 - \lambda)(\lambda^2 - 6\lambda + 8) - 8 + 2\lambda = 0$$

$$3\lambda^2 - 18\lambda + 24 - \lambda^3 + 6\lambda^2 - 8\lambda - 8 + 2\lambda$$

$$(-\lambda^3 + 9\lambda^2 - 24\lambda + 16 = 0)$$

$$\lambda^3 - 9\lambda^2 + 24\lambda - 16 = 0$$

$$\lambda = 1, 4, 4$$

End of Solution

Q.2 The solution of the differential equation, $\frac{d^2y}{dx^2} - \frac{dy}{dx} - 2y = 3e^{2x}$, where, $y(0) = 0$ and $y'(0) = -2$ is

(a) $y = e^{-x} - e^{2x} + xe^{2x}$
(b) $y = e^{x} - e^{-2x} - xe^{2x}$
(c) $y = e^{-x} + e^{2x} + xe^{2x}$
(d) $y = e^{x} - e^{-2x} + xe^{2x}$

Ans. (a)

$$(D^2 - D - 2)y = 3e^{2x}$$

$$y(0) = 0$$

A.E is $m^2 - m - 2 = 0$

$$(m - 2)(m + 1) = 0$$

$$m = 2, -1$$

$$\text{C.F.} = C_1 e^{-x} + 12e^{2x}$$

$$y'(0) = -2$$

$$P.I. = \frac{1}{D^2 - D - 2} 3e^{2x}$$

$$= x \cdot \frac{1}{2D - 1} 3e^{2x}$$

Solution is,

$$y = C_1 e^{-x} + C_2 e^{2x} + xe^{2x} \qquad \text{...(i)}$$

$$= x \frac{1}{4-1} 3e^{2x} = xe^{2x}$$

$$y(0) = 0$$

$$\Rightarrow \quad 0 = C_1 + C_2 \qquad \text{...(ii)}$$

$$y' = -C_1 e^{-x} + 2C_2\, e^{2x} + e^{2x} + 2xe^{2x} \qquad \text{...(iii)}$$

$$y'(0) = -2$$

$$-2 = -C_1 + 2C_2 + 1$$

$$= -C_1 + 2C_2 = -3 \qquad \text{...(iv)}$$

From equation (ii) and (iv),

$$C_1 = 1$$

$$C_2 = -1$$

$$y = e^{-x} - e^{2x} + xe^{2x}$$

• • • **End of Solution**

Q.3 If $Z = e^{ax + by} F(ax - by)$; the value of $b \cdot \frac{\partial Z}{\partial x} + a \cdot \frac{\partial Z}{\partial y}$ is

(a) $2Z$ (b) $2a$

(c) $2b$ (d) $2abZ$

Ans. (d)

$$z = e^{ax + by} f(ax - by)$$

$$z = e^{ax+by} f(ax - by) \qquad \text{...(i)}$$

$$\frac{\partial z}{\partial x} = e^{ax+by}(a) \cdot f + e^{ax+by} \cdot f'(a) \qquad \text{...(ii)}$$

From equation (i),

$$f = \frac{z}{e^{ax+by}} \text{ (or) } fe^{ax+by} = z \qquad \text{...(iii)}$$

Sob in (ii),

$$\frac{\partial z}{\partial x} = az + ae^{ax+by} f' \qquad \text{...(iv)}$$

$$\frac{\partial z}{\partial y} = e^{ax+by} \cdot b \cdot f + e^{ax+by} f'(b)$$

$$= bz - be^{ax+by} \cdot f' \text{ (Using equation iii)}$$

$$\frac{\partial z}{\partial y} = bz - be^{ax+by} f'$$

$$f'(e^{ax+by}) = \frac{bz - q}{b} \qquad \text{...(v)}$$

Sub (v) in (iv),

$$P = az + a\left(\frac{bz - q}{b}\right)$$

$$bP + aq = 2abZ$$

End of Solution

Q.4 The general integral of the partial differential equation $y^2p - xyq = x(z - 2y)$ is

(a) $\phi(x^2 + y^2, y^2 - yz) = 0$ (b) $\phi(x^2 - y^2, y^2 + yz) = 0$

(c) $\phi(xy, yz) = 0$ (d) $\phi(x + y, \ln x - z) = 0$

Ans. (a)

$$y^2P - xyq = x(z - 2y)$$

Subsidiary equation is

$$\frac{dx}{y^2} = \frac{dy}{-xy} = \frac{dz}{x(z-2y)}$$

$$\frac{dx}{y^2} = \frac{dy}{-xy}$$

$$\frac{dx}{y} = \frac{dy}{-x}$$

$$-x\,dx = ydy$$

$$-\int x\,dx = \int y\,dy$$

$$\frac{-x^2}{2} = \frac{y^2}{2} + a$$

$$x^2 + y^2 = 2a$$

$$\frac{dy}{-xy} = \frac{dz}{x(z-2y)}$$

$$\frac{dy}{-y} = \frac{dz}{z-2y}$$

$$-ydz = (z - 2y)dy$$

$$ydz + zdy - 2ydy = 0$$

$$d(yz) - 2ydy = 0$$

$$yz - y^2 = 0$$

Hence general solution

$$f(x^2 + y^2, yz - y^2) = 0$$

or $$f(x^2 + y^2, y^2 - yz) = 0$$

End of Solution

Q.5 If $\dfrac{d^2y}{dt^2}+y=0$ under the conditions $y = 1$, $\dfrac{dy}{dt}=0$, when $t = 0$, then y is equal to

(a) $\sin t$ (b) $\cos t$
(c) $\tan t$ (d) $\cot t$

Ans. **(b)**

$$(D^2 + 1)y = 0$$

A.E is $m^2 + 1 = 0$

$$m = \pm i$$

Solution is $y = C_1 \cos t + C_2 \sin t$

$$\begin{aligned}
y(0) &= 1 \\
1 &= C_1 \cos 0 + C_2 \sin 0 \\
1 &= C_1 \\
y' &= -C_1 \sin t + C_2 \cos t \\
y'(0) &= 0 \\
0 &= -C_1 \sin 0 + C_2 \cos 0 \\
0 &= C_2 \\
y &= \cos t
\end{aligned}$$

End of Solution

Q.6 If the system

$$\begin{aligned}
2x - y + 3z &= 2 \\
x + y + 2z &= 2 \\
5x - y + az &= b
\end{aligned}$$

has infinitely many solutions, then the values of a and b, respectively, are

(a) –8 and 6 (b) 8 and 6
(c) –8 and –6 (d) 8 and –6

Ans. **(b)**

$$\text{Consider } (AB) = \begin{bmatrix} 1 & 1 & 2 & 2 \\ 2 & -1 & 3 & 2 \\ 5 & -1 & a & b \end{bmatrix}$$

$R_2 - 2R_1,\ R_3 - 5R_1$

$$= 2\begin{bmatrix} 1 & 1 & 2 & 2 \\ 0 & -3 & -1 & -2 \\ 0 & -6 & a-10 & b-10 \end{bmatrix}$$

$R_3 - 2R_2$

$$= \begin{bmatrix} 1 & 1 & 2 & 2 \\ 0 & -3 & -1 & -2 \\ 0 & 0 & a-8 & b-6 \end{bmatrix}$$

$$a = 8$$
$$b = 6$$

∴ Infinite many solutions.

Q.7 Evaluate $\oint_c \frac{1}{(z-1)^3.(z-3)}dz$ where c is the rectangular region defined by $x = 0$, $x = 4$, $y = -1$ and $y = 1$

(a) 1

(b) 0

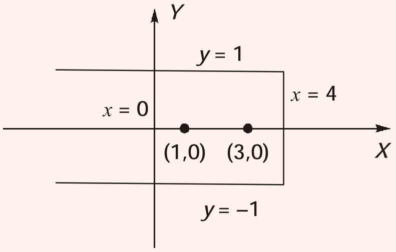
(c) $\frac{\pi}{2}i$

(d) $\pi(3 + 2i)$

Ans. **(b)**

$$\int \frac{1}{(Z-1)^3(Z-3)}dz$$

Where,



$z = 1$ is a pole of order 3 (inside C)

$$\text{Res at } z = 1 = \lim_{z\to1}\frac{1}{2!}\frac{d^2}{dz^2}\left((z-1)^3\cdot\frac{1}{(z-1)^3(z-3)}\right)$$

$$= \lim_{z\to1}\frac{d}{dz}\left(\frac{-1}{(z-3)^2}\right)$$

$$= \lim_{z\to1}\frac{1}{2!}\left(-1\cdot\left(\frac{-2}{(z-3)^3}\right)\right)$$

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

$z = 3$ is a simple pole (inside)

$$\text{Res } f(z) = \lim_{z\to3}(z-3)\frac{1}{(z-1)^3(z-3)} = \frac{1}{8}$$

$$I = 2\pi i\left(-\frac{1}{8}+\frac{1}{8}\right) = 0$$

$$I = 0$$

End of Solution

Q.8 The Fourier Transform of $e^{\frac{-x^2}{2}}$ is

(a) $\frac{1}{2}\cdot e^{\frac{-\omega^2}{2}}$

(b) $e^{\frac{-\omega^2}{2}}$

(c) $\frac{\pi}{2}$

(d) $\sqrt{\pi}$

Ans. (b)

The Fourier transform of $e^{-x^2/2}$ is

$$F(\omega) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-i\omega x}\cdot e^{-x^2/2}dx$$

$$= \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-\frac{(x+i\omega)^2}{2}}\cdot e^{\frac{-\omega^2}{2}}dx$$

Let $\frac{x+i\omega}{\sqrt{2}} = t$

$$\frac{dx}{\sqrt{2}} = dt$$

$$dx = \sqrt{2}dt$$

$$F(\omega) = \frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} e^{-t^2}\cdot e^{\frac{-\omega^2}{2}}\cdot\sqrt{2}dt$$

$$= \frac{e^{\frac{-\omega^2}{2}}}{\sqrt{2}\sqrt{\pi}}\cdot\sqrt{2}\int_{-\infty}^{\infty} e^{-t^2}dt = \frac{1}{\sqrt{\pi}}e^{\frac{-\omega^2}{2}}\cdot 2\int_{0}^{\infty} e^{-t}dt$$

Let $t^2 = y$ $\quad t = 0 \quad y = 0$

$t = \sqrt{y}$ $\quad t = \infty \quad y = \infty$

$$dt = \frac{1}{2\sqrt{y}}dy$$

$$= \frac{1}{\sqrt{\pi}}e^{\frac{-\omega^2}{2}}\cdot 2\int_{0}^{\infty} e^{-y}\frac{1}{2\sqrt{y}}dy$$

$$= \frac{1}{\sqrt{\pi}}e^{\frac{-\omega^2}{2}}\int_{0}^{\infty} e^{-y}y^{\frac{-1}{2}}dy = \frac{1}{\sqrt{\pi}}e^{\frac{-\omega^2}{2}}\int_{0}^{\infty} e^{-y}y^{\frac{1}{2}-1}dy$$

$$= \frac{1}{\sqrt{\pi}}e^{\frac{-\omega^2}{2}}\cdot\sqrt{\frac{1}{2}} = \frac{1}{\sqrt{\pi}}e^{\frac{-\omega^2}{2}}\cdot\sqrt{\pi} = e^{\frac{-\omega^2}{2}}$$

End of Solution

Q.9 In a sample of 100 students, the mean of the marks (only integers) obtained by them in a test is 14 with its standard deviation of 2.5 (marks obtained can be fitted with a normal distribution). The percentage of students scoring 16 marks is

(a) 36	(b) 23
(c) 12	(d) 10

(Area under standard normal curve between $z = 0$ and $z = 0.6$ is 0.2257; and between $z = 0$ and $z = 1.0$ is 0.3413)

Ans. **(c)**

End of Solution

Q.10 Consider a random variable to which a Poisson distribution is best fitted. It happens that $P_{(x=1)} = \frac{2}{3}P_{(x=2)}$ on this distribution plot. The variance of this distribution will be

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

Ans. **(a)**

$$P(x = 1) = \frac{2}{3}P(x = 2)$$

$$3P(x = 1) = 2P(x = 2)$$

$$3\left(\frac{e^{-\lambda}\lambda^1}{1!}\right) = 2\left(\frac{e^{-\lambda}\lambda^2}{2!}\right)$$

$$3\lambda = \lambda^2$$

$$\lambda^2 - 3\lambda = 0$$

$$\lambda(\lambda - 3) = 0$$

$$\lambda = 0$$

$$\lambda = 3$$

$$\therefore \quad \lambda = 3$$

End of Solution

Q.11 In Face-Centered Cubic structure (FCC), what number of atoms is present in each unit cell?

(a) 18	(b) 16
(c) 14	(d) 12

Ans. **(c)**

End of Solution

Q.12 If (n) is lattice points per unit cell of the cubic system, (N) and (M) are the Avogadro's number and atomic weight, respectively, and (ρ) is the density of the element, then the lattice constant (a) is

(a) $\left(\frac{M\rho}{nN}\right)^{\frac{1}{3}}$ (b) $\left(\frac{NM}{n\rho}\right)^{\frac{1}{3}}$

(c) $\left(\frac{nM}{N\rho}\right)^{\frac{1}{3}}$ (d) $\left(\frac{N\rho}{nM}\right)^{\frac{1}{3}}$

Ans. **(c)**

End of Solution

Q.13 The magnetic susceptibility of aluminium is 2.1×10^{-5}. The permeability and relative permeability are, respectively

(a) 12.6×10^{-7} and 1.0021 (b) 1.26×10^{-7} and 1.0021

(c) 12.6×10^{-7} and 1.000021 (d) 1.26×10^{-7} and 1.000021

Ans. **(c)**

End of Solution

Q.14 An iron rod of 10^{-3} m^3 volume and relative permeability of 1150 is placed inside a long solenoid wound with 5 turns/cm. If a current of 0.5 A is allowed to pass through the solenoid, the magnetic moment of the rod is

(a) 2.87×10^4 A.m^2 (b) 28.7×10^3 A.m^2

(c) 2.87×10^2 A.m^2 (d) 28.7×10^2 A.m^2

Ans. **(*)**

End of Solution

Q.15 When an alternating voltage of a given frequency is applied to a dielectric material, dissipation of energy occurs due to

1. Continual change in the orbital paths of the electrons in the atomic structure.
2. A small conduction current through the dielectric.
3. Eddy currents.

Which of the above statements are correct?

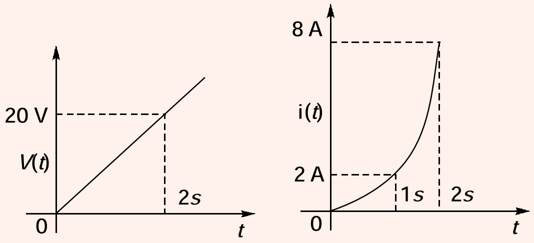
(a) 1, 2 and 3 (b) 1 and 2 only

(c) 1 and 3 only (d) 2 and 3 only

Ans. **(b)**

End of Solution

Q.16 The voltage and current characteristic of an element is as shown in figure. The nature and value of the element are



(a) Capacitor of 3.3 μF
(b) Inductor of 2.5 H
(c) Capacitor of 6.7 μF
(d) Inductor of 5.0 H

Ans. (b)

$$V(t) = 10t$$

$$i = \frac{1}{L}\int idt$$

$$i = \frac{1}{L}\int 10tdt$$

$$i = \frac{10t^2}{L2}$$

From plot at $t = 1$ sec $i = 2$ A

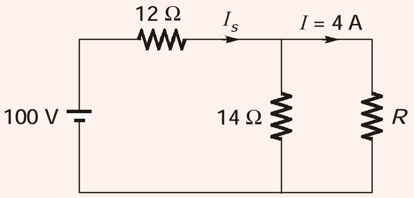
$$2 = \frac{(10)}{2L}$$

$$\Rightarrow \quad L = \frac{10}{4} = 2.54$$

∴ Inductors of 2.5 H

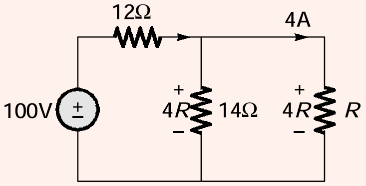
End of Solution

Q.17 In the circuit shown, what value of R will result in $I = 4$ A?



(a) 9 Ω
(b) 7 Ω
(c) 5.5 Ω
(d) 3.5 Ω

Ans. (b)



$$I_S = 4+\frac{4R}{14} \qquad \text{...(1)}$$

KVL: $100 = 12I_S + 4R$

Using (1) equation,

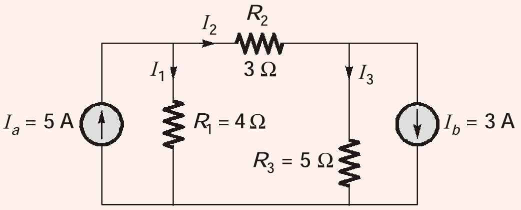
$$100 = 12\left[4+\frac{4R}{14}\right]+4R$$

Solving, $R = 7.008$

$R \simeq 7\ \Omega$

End of Solution

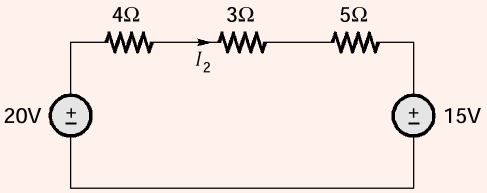
Q.18 In the circuit as shown, the currents I_1, I_2 and I_3 through three resistors are, respectively.



(a) 2.08 A, 2.92 A and –0.08 A
(b) 3.08 A, 2.5 A and –0.06 A
(c) 2.08 A, 2.5 A and –0.08 A
(d) 3.08 A, 2.92 A and –0.06 A

Ans. (a)

Using source transformation :



$$I_2 = \frac{35}{12} = 2.92A$$

$I_2 = 2.92$ A

$5 = I_1 + I_2$

⇒ $I_1 = 5 - 2.92$

⇒ $I_1 = 2.08$ A

⇒ $I_2 = I_3 + 3$

$I_3 = 2.92 - 3 = -0.08A$

⇒ $I_3 = -0.08A$

End of Solution

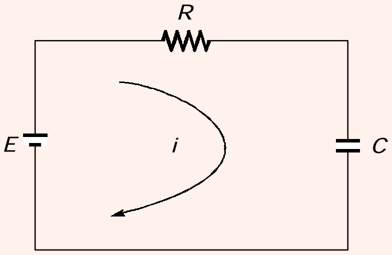
Q.19 The $v - i$ relationship for a circuit containing R and C and a battery of voltage E, all in series is

1. $\frac{1}{C}\int i\,dt + iR = E$
2. $\frac{1}{RC}i + \frac{di}{dt} = 0$
3. $\frac{1}{C}i + R\int i dt = E$

Which of the above relationships are correct?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1 , 2 and 3

Ans. (a)



KVL:

$$E = iR + \frac{1}{C}\int i dt \quad ...(i)$$

Differentiating equation (i),

$$\therefore \quad D = R\frac{di}{dt} + \frac{i}{C}$$

$$\Rightarrow \quad \frac{di}{dt} + \frac{i}{RC} = 0 \quad ...(ii)$$

End of Solution

Q.20 The flux-density at a distance of 0.1 m from a long straight wire, carrying a current of 200 A is

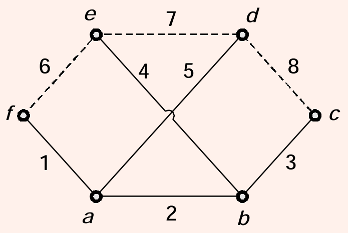
(a) 5×10^{-4} Wb/m^2
(b) 4×10^{-4} Wb/m^2
(c) 3×10^{-4} Wb/m^2
(d) 2×10^{-4} Wb/m^2

Ans. **(b)**

$$r = 0.1 \text{ m}$$
$$I = 200 \text{ A}$$
$$B = \mu H = \frac{\mu I}{2\pi\rho}$$
$$B = \mu H = \frac{\mu_0 I}{2\pi\rho} = \frac{4\pi \times 10^{-7}(200)}{2\pi(0.1)}$$
$$= 2 \times 200 \times 10^{-6} = 4 \times 10^{-4} \text{ Wb/m}^2$$

End of Solution

Q.21 A network graph with its tree shown by firm lines is given in the figure. The fundamental cut-set for the tree-branch number 2 is



(a) 1, 2, 3, 4 and 5
(b) 1, 2 and 5
(c) 2, 6, 7 and 8
(d) 2, 3 and 4

Ans. **(c)**

As fundamental cut set consistis of only one tree branch, thereofre by looking at the options we can find that option which contains only one tree branch and rest links.

End of Solution

Q.22 A bipolar transistor has $\alpha = 0.98$, $I_{CO} = 10\ \mu$A. If the base current is 100 μA, then collector current would be

(a) 2.91 mA
(b) 3.49 mA
(c) 4.91 mA
(d) 5.49 mA

Ans. **(d)**

$$I_C = \beta I_B + (1 + b)I_{CO}$$

Where,
$$\beta = \frac{\alpha}{1-\alpha} = \frac{0.98}{1-0.98} = 49$$
$$I_C = 49 \times 100\ \mu\text{A} + (50) \times 10\ \mu\text{A}$$
$$= 10\ \mu\text{A}\ [490 + 50]$$
$$= 5.4 \text{ mA}$$

End of Solution

Q.23 The reduced incidence matrix for a network is given as

$$A = \begin{array}{c} \\ a \\ b \\ c \end{array}\begin{array}{c} \begin{array}{cccccc} 1 & 2 & 3 & 4 & 5 & 6 \end{array} \\ \begin{bmatrix} 1 & -1 & -1 & -1 & 0 & 0 \\ 0 & 1 & 0 & 0 & -1 & 1 \\ 0 & 0 & -1 & 0 & 1 & 0 \end{bmatrix} \end{array}$$

Which of the following sets constitute a tree?

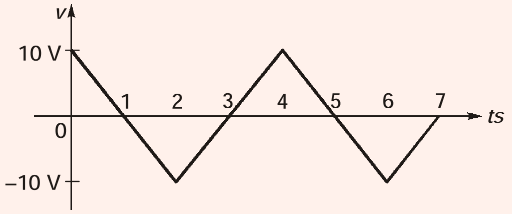
(a) 2, 3 and 5
(b) 1, 2 and 6
(c) 1, 2 and 4
(d) 1, 2 and 3

Ans. (*)

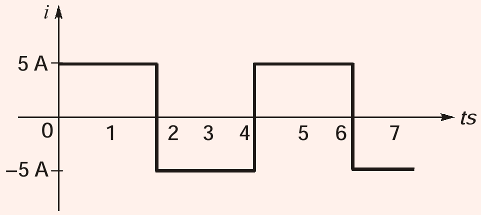
Question wrong because branch 3 has both entires (–1) which is not possible because a branch is connected between 2 nodes and it starts from one node and end at the other so at one node –1 and at the other +1.

End of Solution

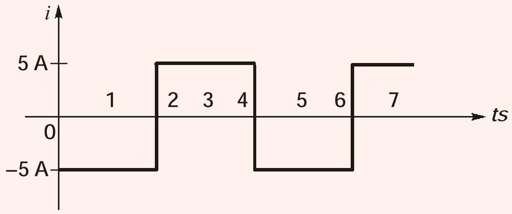
Q.24 A triangular wave voltage, as shown in figure, is applied across the terminals of a 0.5F pure capacitor at time t = 0. The corresponding current-wave is



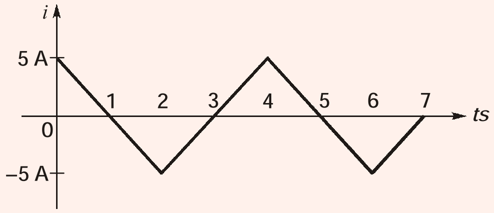
(a)



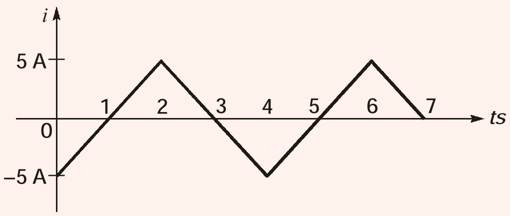
(b)



(c)



(d)



Ans. (b)

$$m = \frac{10-(-10)}{0-2} = \frac{20}{-2} = -10$$

$$m = -10$$

$$V(t) = -10t + c \qquad 0 < t < 2$$

At, $t = 1 \quad V(t) = 0$

$$0 = -10 + C$$

$\Rightarrow$ $C = 10$

$\therefore$ $V(t) = -10t + 10 \qquad [0 < t < 2]$

As, $i = C\frac{dv}{dt}$

$\Rightarrow$ $i = (0.5)\frac{d}{dt}[-10t+10]$

$$i = (0.5)[-10]$$

$\Rightarrow$ $i = -5A$

$\therefore$ $i = -5A \;\; 0 < t < 2$

End of Solution

Q.25 Consider the following statements for Norton's theorem:

1. Short the branch resistance through which current is to be calculated
2. Obtain the current through this short-circuited branch, using any of the network simplification techniques
3. Develop Norton's equivalent circuit by connecting current source I_N with the resistance R_N in series with it.

Which of the above statements are correct?

(a) 1, 2 and 3
(b) 1 and 3 only
(c) 1 and 2 only
(d) 2 and 3 only

Ans. (c)

End of Solution

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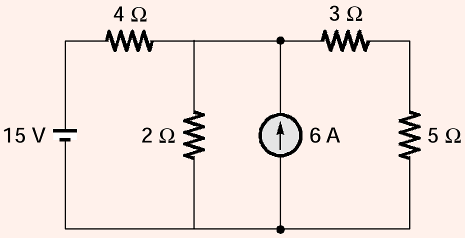
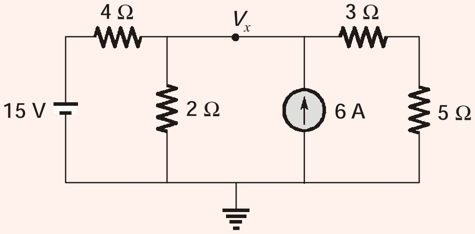
Q.26 For the network shown in the figure, the current flowing through the 5 Ω resistance will be



(a) $\frac{37}{25}$ A (b) $\frac{40}{28}$ A

(c) $\frac{39}{28}$ A (d) $\frac{41}{28}$ A

Ans. (c)



$$\frac{V_x - 15}{4} + \frac{V_x}{2} + \frac{V_x}{8} = 6$$

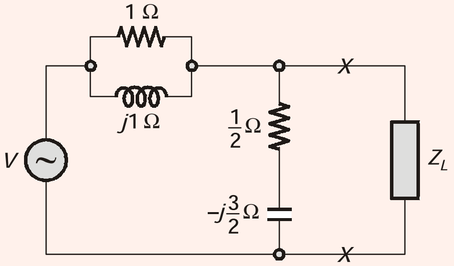
$$\frac{7}{8}V_x = \frac{39}{4}$$

$$\Rightarrow \quad V_x = \frac{39 \times 2}{7}$$

$$\therefore \quad I = \frac{V_x}{8} = \frac{39 \times 2}{7 \times 8} = \frac{39}{28} \text{ A}$$

End of Solution

Q.27 The circuit as shown in figure is connected to a load Z_L across $X - X$. For a maximum power transfer to the load, Z_L should be



(a) $\frac{3-j}{4}\Omega$ (b) $\frac{3+j}{4}\Omega$

(c) $\frac{3j}{4}\Omega$ (d) $\frac{-3-j}{4}\Omega$

Ans. (a)

$$Y_{TH} = 1 + \frac{1}{j1} + \frac{R}{R^2 + X_C^2} + j\frac{X_C}{R^2 + X_C^2}$$

$$Y_{\text{TH}} = 1 + \frac{1}{j1} + \frac{\frac{1}{2}}{\frac{1}{4} + \frac{9}{4}} + j\frac{\frac{3}{2}}{\frac{1}{4} + \frac{9}{4}}$$

$$= 1 - j1 + \frac{\frac{1}{2}}{\frac{10}{4}} + j\frac{\frac{3}{2}}{\frac{10}{4}}$$

$$= 1 - j1 + \frac{1}{5} + j\frac{3}{5}$$

$$= \frac{6}{5} - j\frac{2}{5}$$

$$Y_{TH} = \frac{6 - j2}{5}$$

$$Z_{TH} = \frac{5}{6 - j2} \times \frac{6 + j2}{6 + j2} = \frac{30 + j10}{36 + 4} = \frac{30 + j10}{40}$$

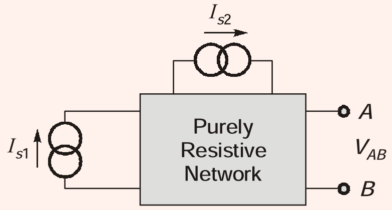
$$Z_{TH} = \frac{3 + j}{4}$$

For maximum power transfer,

$$Z_L = Z_{TH}^{*} = \frac{3 - j}{4}\,\Omega$$

● ● ● **End of Solution**

Q.28 In the network as shown, with I_{S1} = 5 A, I_{S2} = 10 A, V_{AB} = 120 V, and with I_{S1} = 10 A, I_{S2} = 5 A, V_{AB} = 15 V. What is the value of k to describe $I_{S1} = kI_{S2}$, such that $V_{AB} = 0$?



(a) 2.5
(b) 3.5
(c) 5.5
(d) 6.5

Ans. (a)

$$V_{AB} = \alpha I_{S_1} + \beta I_{S_2}$$

$$120 = \alpha(5) + \beta(10)$$

$$\alpha + 2\beta = 24 \qquad \ldots(1)$$

$$15 = \alpha(10) + \beta(5)$$

$$3 = 2\alpha + \beta \qquad \ldots(2)$$

Equation (1) – 2 × equation (2):

$$-3\alpha = 18 \Rightarrow \alpha = -6 \qquad ...(3)$$

Putting (3) in (2), $\beta = 15$

$$-6I_{s_1} + 15I_{s_2} = 0$$

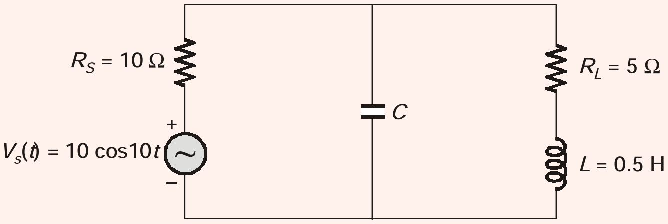
$$-6KI_{s_2} + 15I_{s_2} = 0$$

$$-6\ K + 15 = 0$$

$$K = \frac{15}{6} = \frac{5}{2} = 2.5$$

End of Solution

Q.29 For the circuit as shown, what is the value of C that leads to maximum power transfer to the load, if the value of L is 0.5 H?



(a) 0.1 μF
(b) 0.01 F
(c) 0.001 μF
(d) 0.01 μF

Ans. (b)

Load impedance Z_L:

$$Z_L = \frac{(-jX_C)(R_L + jX_L)}{R_L + jX_L - jX_C}$$

$$Z_L = \frac{(-jX_C)(R_L + jX_L)}{R_L + j(X_L - X_C)} \times \frac{R_L - j(X_L - X_C)}{R_L - j(X_L - X_C)}$$

Separating ZL into real and imaginary terms and equating the imaginary terms to zero for maximum power transfer.

$$\therefore R_L^2 X_C + X_L X_C (X_L - X_C) = 0$$

$$R_L^2 + X_L^2 - X_L X_C = 0$$

$$X_C = \frac{R_L^2 + X_L^2}{X_L} = \frac{25+25}{5} = \frac{50}{5}$$

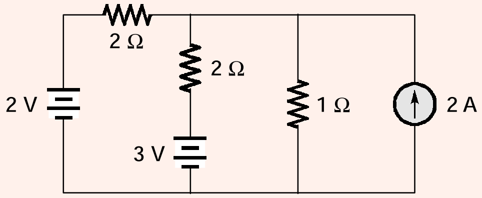
$$X_C = 10$$

$$\Rightarrow \qquad \frac{1}{\omega C} = 10$$

$$\Rightarrow \qquad C = \frac{1}{(10)(10)} = 0.01\text{F}$$

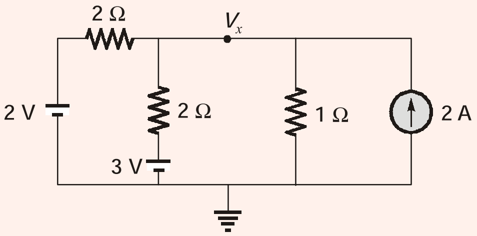
End of Solution

Q.30 The current in the 1 Ω resistor in the network as shown is



(a) 2.00 A
(b) 2.25 A
(c) 2.50 A
(d) 2.75 A

Ans. **(b)**



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

$$4V_x = 9$$

$$\Rightarrow \quad V_x = \frac{9}{4}$$

$$I = \frac{V_x}{1} = \frac{9}{4} = 2.25 \text{ A}$$

End of Solution

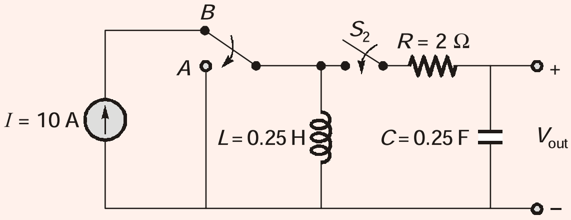
Q.31 Which of the following is considered a time domain technique in control systems?

(a) Nyquist criterion
(b) Bode plot
(c) Root locus plot
(d) Routh-Hurwitz criterion

Ans. **(d)**

End of Solution

Q.32 For the circuit as shown, consider that switch S_1 has been in position B for a very long time and switch S_2 has been open all the time. At time $t = 0$, the switch S_1 moves to position A and switch S_2 closes instantaneously. What is the value of V_{out} at $t = 0^+$, assuming initial charge on $C = 0$?



(a) 2.5 V
(b) 2.0 V
(c) 1.5 V
(d) 0 V

Ans. **(d)**

As capacitor does not allow the sudden change in voltage therefore it will hold its previous value.

$$\therefore \quad V_{out} = 0 \text{ V}$$

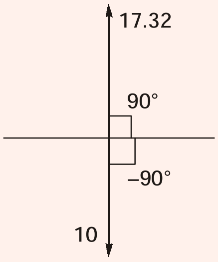
End of Solution

Q.33 What is phasor sum of currents $I_1 = 10(a - a^2)$ and $I_2 = -j10$ for two complex operators which are individually defined by $a^3 = 1$ and $j^2 = -1$?

(a) $17.32\angle 90^\circ$
(b) $7.32\angle 90^\circ$
(c) $17.32\angle 0^\circ$
(d) $7.32\angle 0^\circ$

Ans. **(b)**

$$a = 1\angle 120^\circ,$$
$$a^2 = 1\angle 240^\circ,$$
$$a^3 = 1,$$
$$j^2 = -1$$
$$I_1 = 10(1\angle 120^\circ - 1\angle 240^\circ)$$
$$= 17.32\angle 90^\circ$$
$$I_2 = -j10 = 10\angle -90^\circ$$
$$I = \overline{I}_1 + \overline{I}_2$$
$$= 17.32\angle 90^\circ + 10\angle -90^\circ$$
$$= 7.32\angle 90^\circ$$



End of Solution

Q.34 A series RLC circuit with $R = 2\ \Omega$, $L = \frac{1}{2}H, C = \frac{1}{4}F$ is excited by a 100 V dc source. The circuit is initially in quiescent state. The expression for the current response $i(t)$ due to a dc source will be of the form (K, K_1, K_2 are constants)

(a) $Ke^{-4t}\sin\left(4t + \frac{\pi}{3}\right)$
(b) $Ke^{-2t}\sin\sqrt{8}t$
(c) $(K_1 + K_2t)e^{-2t}$
(d) $K_1e^{-2t} + K_2e^{-4t}$

Ans. **(b)**

$$\xi = \frac{R}{2}\sqrt{\frac{C}{L}} = \frac{2}{2}\sqrt{\frac{1}{4}\cdot 2} = \frac{1}{\sqrt{2}}$$
$$= 0.707 \quad \text{(underdamped)}$$
$$\tau = \frac{2L}{R} = 2\cdot\frac{1}{2}\cdot\frac{1}{2} = \frac{1}{2}\ \text{sec.}$$

End of Solution

Q.35 The impulse response of an LTI system is given by $5u(t)$. If the input to the system is given by e^{-t} then the output of the system is

(a) $5(1 - e^{-t})\ u(t)$
(b) $(1 - 5e^{-t})\ u(t)$
(c) $5 - e^{-t}\ u(t)$
(d) $5u(t) - e^{-t}$

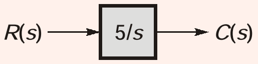
Ans. (a)

$$\text{T.F} = \mathcal{L}(\text{Impulse response})$$

$$= \frac{5}{s}$$

Given, $r(t) = e^{-t}$

$\Rightarrow$ $R(s) = \dfrac{1}{s+1}$



$$C(s) = \frac{5}{s}\cdot R(s) = \frac{5}{s(s+1)}$$

$$C(s) = 5\left[\frac{1}{s} - \frac{1}{s-1}\right]$$

$$C(t) = 5[1 - e^{-1}]\ u(t)$$

End of Solution

Q.36 A series RLC circuit has a resistance of 50 Ω, inductance of 0.4 H and a capacitor of 10 μF. The circuit is connected across a 100 V supply. The resonance frequency and the current through the resistance are

(a) 500 rad/s and 2 A
(b) 1000 rad/s and 2 A
(c) 500 rad/s and 0.5 A
(d) 1000 rad/s and 0.5 A

Ans. (a)

$$\omega_n = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4\times10^{-1}\times10\times10^{-6}}}$$

$$= \frac{1000}{2} = 500 \text{ rad/sec.}$$

$$X_L = \omega L = (500)\ (0.4) = 200\ \Omega$$

$$X_C = \frac{1}{\omega C}$$

$$= \frac{1}{500\times10\times10^{-6}} = 200\ \Omega$$

$$I = \frac{100}{50 + j(200-200)} = \frac{100}{50} = 2\text{ A}$$

End of Solution

Q.37 A pulse of +10 V in magnitude and 2*s* in duration is applied to the terminals of a lossless inductor of 1.0 H. The current through the inductor would

(a) be a pulse of +20 A for the duration of 2*s*.

(b) be a pulse of –20 A for the duration of 2*s*.

(c) increase linearly from zero to 20 A in 2*s*, and in the positive direction, and, from thereon, it remains constant at +20 A.

(d) increase linearly from zero to –20 A in 2*s*, and in the negative direction, and, from thereon, it remains constant at –20 A.

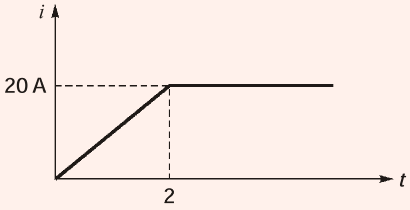
Ans. (c)

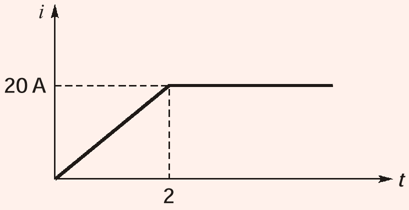
$$i = \frac{1}{L}\int v\,dt$$

As, $L = 1$ H

$$i = \int_0^t v\,dt = 10t$$

∴ $i = 10t$





End of Solution

Q.38 Consider the following statements regarding power measurement of three-phase circuits by two-wattmeter method:

1. Total power can be measured if the three-phase load is balanced and can be represented by an equivalent Y-connection only.
2. Total power can be measured for the three-phase load irrespective of, whether the load is balanced or not and connected in Y or Δ.
3. Power factor can be calculated only if the three-phase load is balanced.

Which of the above statements are correct?

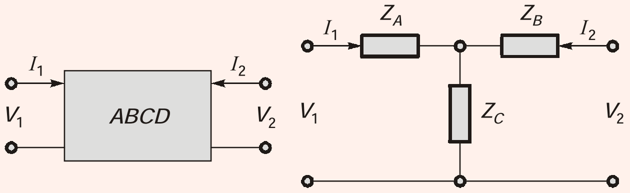
(a) 1 and 2 only (b) 1 and 3 only

(c) 2 and 3 only (d) 1, 2 and 3

Ans. (c)

End of Solution

Q.39 In terms of *ABCD* parameters of a 2-port network, the parameters Z_A, Z_B and Z_C of the equivalent T-network are, respectively



(a) $\frac{A-1}{C}, \frac{D-1}{C}$ and $\frac{1}{C}$

(b) $\frac{A}{C}, \frac{D-1}{C}$ and $\frac{1}{C}$

(c) $\frac{A-1}{C}, \frac{D}{C}$ and $\frac{1}{C}$

(d) $\frac{A}{C}, \frac{D}{C}$ and BC

Ans. (a)

Easiest way is to check the options.

As, $Z_{11} = \frac{A}{C}$ and $Z_{22} = \frac{D}{C}$

and for T-network, $Z_{11} = Z_A + Z_C$,

$Z_{22} = Z_C + Z_B$

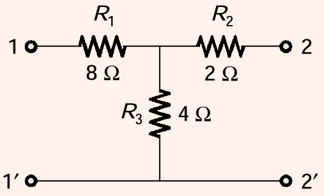
(a) $Z_{11} = \frac{A-1}{C} + \frac{1}{C} = \frac{A}{C}$

$Z_{22} = \frac{D-1}{C} + \frac{1}{C} = \frac{D}{C}$

$\therefore$ option (a) is the correct option.

End of Solution

Q.40 The Z parameters Z_{11}, Z_{12}, Z_{21} and Z_{22} for the circuit as shown in figure, respectively, are



(a) 12 Ω, 4 Ω, 4 Ω and 6 Ω

(b) 8 Ω, 6 Ω, 4 Ω and 4 Ω

(c) 12 Ω, 6 Ω, 6 Ω and 4 Ω

(d) 8 Ω, 4 Ω, 6 Ω and 6 Ω

Ans. (a)

$Z_{11} = 8 + 4 = 12\ \Omega$

$Z_{12} = Z_{21} = 4\ \Omega$

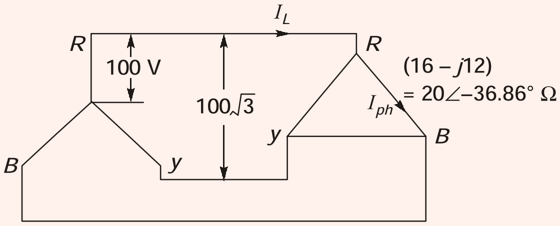
$Z_{22} = 4 + 2 = 6\ \Omega$

End of Solution

Q.41 A balanced 3-phase RYB sequence star-connected supply source with phase voltage 100 V is connected to a delta-connected balanced load 16 – j12 Ω per phase. The phase and line currents are, respectively

(a) $5\sqrt{3}$ A and 30 A
(b) $10\sqrt{3}$ A and 30 A
(c) $5\sqrt{3}$ A and 15 A
(d) $10\sqrt{3}$ A and 15 A

Ans. **(c)**



For Δ:
$$|I_{\text{ph}}| = \frac{100\sqrt{3}}{20} = 5\sqrt{3}\text{ A}$$
$$I_L = \sqrt{3}\,I_{ph} = \left(5\sqrt{3}\right)\sqrt{3} = 15\text{ A}$$

• • • **End of Solution**

Q.42 The maximum potential-gradient that can be imposed in air at atmospheric pressure without breakdown is 30 kV/cm. The corresponding energy density is nearly

(a) 30 J/m^3
(b) 35 J/m^3
(c) 40 J/m^3
(d) 45 J/m^3

Ans. **(c)**

$$E = 10\text{ kV/cm}$$
$$\frac{dW_E}{dV} = \frac{1}{2}\epsilon_0\left|E^2\right|$$
$$= \frac{1}{2}\times 8.854\times 10^{-12}\left(30\times\frac{10^3}{10^{-2}}\right)^2$$
$$= 39.843 \times 10^{-12} \times 10^{12}$$
$$= 40\text{ J/m}^3$$

• • • **End of Solution**

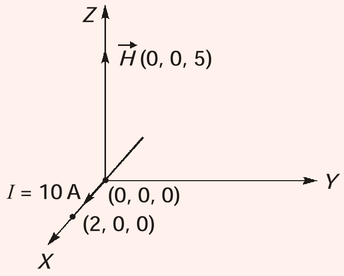
Q.43 A steady flow of 10 A is maintained in a thin wire placed along the *X*-axis from (0, 0, 0) to (2, 0, 0) to find the value of the magnetic field intensity *H* at (0, 0, 5). When end effects are ignored, *H* is

(a) $-59.1\hat{a}_y$ mA/m
(b) $59.1\hat{a}_y$ mA/m
(c) $-118.2\,\hat{a}_y$ mA/m
(d) $118.2\,\hat{a}_y$ mA/m

Ans. (a)

$$\vec{H} = \frac{I}{4\pi\rho}[\sin\alpha_A - \sin\alpha_B]\,\hat{a}_H$$

$$= \hat{a}_x \times \hat{a}_z = -\hat{a}_y$$



$$\sin\alpha_A = \frac{0-0}{5} \Rightarrow \alpha_A = 0$$

$$\sin\alpha_B = \frac{0-2}{5}$$

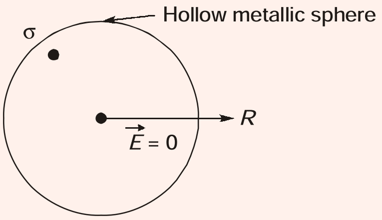
$$\Rightarrow \quad \tan\alpha_B = \frac{-2}{\sqrt{2^2+5^2}}$$

$$\vec{H} = \frac{10}{4\pi(5)}\left[0-\left(\frac{2}{\sqrt{2a}}\right)\right](-\hat{a}_y)$$

$$= \frac{2}{4\pi}\left(\frac{2}{\sqrt{2a}}\right)(-\hat{a}_y) = 0.0591(-\hat{a}_y)$$

End of Solution

Q.44 A hollow metallic sphere of radius *R* is charged to a surface density of σ. The strength of the electric field inside the sphere at a radius *r*(<*R*) is

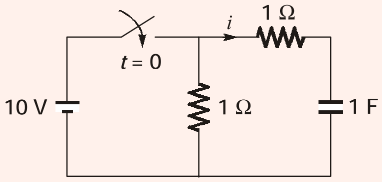


(a) $\frac{\sigma}{\pi r^2}$
(b) $\frac{\sigma}{2\pi r^2}$
(c) $\frac{\sigma}{4\pi r^2}$
(d) zero

Ans. (d)

End of Solution

Q.45 In the circuit as shown in figure, the switch is closed at $t = 0$. The current through the capacitor will decrease exponentially with a time constant of magnitude

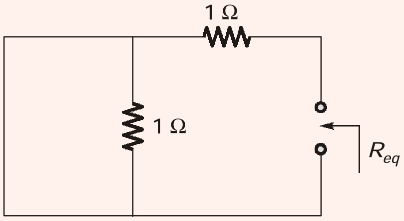


(a) 0.5*s*
(b) 1*s*
(c) 2*s*
(d) 4*s*

Ans. **(b)**

$$\tau = R_{eq} \cdot \tau$$

R_{eq} :



$$R_{eq} = 1\ \Omega$$
$$\tau = (1)(1)$$
$$\tau = 1 \text{ sec.}$$

End of Solution

Q.46 A parallel-plate capacitor with air between the plates has a capacitance of 10 pF. If the distance between the parallel plates is halved and the space between the plates is filled with a material of dielectric constant 5, the newly formed capacitor will have a capacitance of

(a) 10 pF
(b) 50 pF
(c) 100 pF
(d) 150 pF

Ans. **(c)**

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

$$C \propto \frac{\in}{d}$$

$$\frac{C_2}{C_1} = \frac{\in_2 / d_2}{\in_1 / d_1}$$

$$\Rightarrow \quad \frac{C_2}{C_1} = \frac{\in_2 d_1}{\in_1 d_2}$$

$$\Rightarrow \quad \frac{C_2}{10\text{ pF}} = \frac{5\in_1 d}{\in_1 \frac{d}{2}}$$

$$C_2 = 100 \text{ pF}$$

End of Solution

Q.47 Which of the following statements are correct regarding uniform plane waves?

1. Uniform plane waves are transverse.
2. The relation between E and H is $\frac{E}{H} = \sqrt{\frac{\epsilon}{\mu}}$.
3. $E \times H$ gives the direction of the wave travel.
4. For a uniform plane wave travelling in x-direction, $E_x = 0$.

(a) 1, 2 and 3 only
(b) 1, 3 and 4 only
(c) 1, 2 and 4 only
(d) 2, 3 and 4 only

Ans. (b)

End of Solution

Q.48 An energy meter makes 100 revolutions of its disc per unit of energy. The number of revolutions made by the disc during one hour when connected across 210 V source and drawing a current of 20 A at 0.8 p.f. leading is

(a) 336
(b) 316
(c) 286
(d) 256

Ans. (a)

$$V = 210 \text{ V},$$
$$I = 20 \text{ A, p.f.} = 0.8,$$
$$t = 1 \text{ Hr}$$

$$\text{Energy consumed} = \frac{V.I.\cos\phi \times t}{1000} \text{ kWH}$$
$$= \frac{210 \times 20 \times 0.8 \times 1}{1000} = 3.36 \text{ kWH}$$

For 1 kWH of energy → 100 revolution
For 3.36 kWH → ?

$$= 3.36 \times 100 = 336 \text{ rev.}$$

End of Solution

Q.49 Consider the following statements regarding Computer Architecture:

1. The advantage with dedicated bus is decrease in size and cost.
2. In synchronous timing, the occurrence of events on the bus is determined by the clock.
3. Data bus width decides the number of bits transferred at one time.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (c)

- Seperate buses increases the cost and complexity.
- Clock based transmission is called as synchronous transmission.
- Data bus width is the word length of a CPU.

End of Solution

Q.50 Consider the following statements:

1. Better memory utilization is possible with non-contiguous allocation using fixed size pages.
2. Associated memory is used for providing fast access to data stored in cache memory.
3. Direct mapping of cache memory is hard to implement.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3

Ans. (a)

Direct mapping is easy to implement.

End of Solution

Q.51 The decimal value 0.5 in IEEE single precision floating point representation has fraction bits of

(a) 000...000 and exponent value of 0
(b) 000...000 and exponent value of –1
(c) 100...000 and exponent value of 0
(d) 100...000 and exponent value of –1

Ans. (b)

Raw data:

$(0.5)_{10}$
↓
Binary data
↓
(0.1)
↓
Normalized data (1.*bbb*...)
↓
Align to left upto 1 time
↓
$(1.0) \times 2^{-1}$

So, fraction (M) is all 0's and actual exponent is –1.

End of Solution

Q.52 What does the following program print?

```
void  f(int*p,  int*q)
{
      p  =  q;
      *p=2;
}
int  i  =  0,  j  =  1;
int  main( )
{
      f(&i,  &j);
      printf("%d  %d  \n",  i,j);
      getchar  (  );
      return  0;
}
```

(a) 2 2
(b) 2 1
(c) 0 1
(d) 0 2

Ans. **(d)**

$$i\,;\underset{100}{\boxed{0}} \qquad j\,;\underset{200}{\boxed{1}}$$

$f(100,\ 200)$

$f(*p,\ *q)$

$$*p\,;\underset{2000}{\boxed{100}} \qquad *q\,;\underset{3000}{\boxed{200}}$$

$$p=q\,;p\!:\underset{2000}{\boxed{100}}\ 200$$

$$*p=2\,;[\ \underbrace{[p]}_{200}\ ]\leftarrow 2$$

$$j\!:\underset{200}{\boxed{1}}$$

return function

print $(i,\ j)$

i.e. (0, 2)

End of Solution

Q.53 Consider the following set of processes with data thereof as given here:

Process	Arrival time	CPU Burst time
P_1	0 ms	12 ms
P_2	2 ms	4 ms
P_3	3 ms	6 ms
P_4	8 ms	5 ms

An operating system uses shortest remaining time first scheduling alogirthm for pre-emptive scheduling of processes. The average waiting time of the processes is

(a) 7.5 ms (b) 6.5 ms

(c) 5.5 ms (d) 4.5 ms

Ans. (c)

Gantt Chart:

P_1	P_1	P_2	P_2	P_2	P_2	P_3	P_3	P_3	P_4	P_1

0 1 2 3 4 5 6 7 8 12 17 27

	CT	TAT (CT – AT)	WT (TAT – BT)
P_1 :	27	27	15
P_2 :	6	4	0
P_3 :	12	9	3
P_4 :	17	9	4

$$\text{Average WT} = \frac{(15+0+3+4)}{4} = 5.5\text{ ms}$$

End of Solution

Q.54 The length of cable required for transmitting a data at the rate of 500 Mbps in an Ethernet LAN with frames of size 10,000 bits and for signal speed 2,00,000 km/s is

(a) 2.5 km
(b) 2.0 km
(c) 1.5 km
(d) 1.0 km

Ans. **(b)**

Transmission time (T.T.) ≥ 2 × Propagation Time (PT)

$$TT = \frac{\text{Frame size}}{\text{Band width}} = \frac{10,000}{500 \times 10^6}$$

$$PT = \frac{\text{Distance}}{\text{Speed}} = \frac{x}{200000 \times 10^3 \text{ m/sec}}$$

$$TT \geq 2\ PT$$

$$\frac{10000}{500 \times 10^6} \geq 2 \times \frac{x}{200000 \times 10^3}$$

$$x = \frac{10^4 \times 2 \times 10^8}{2 \times 5 \times 10^8}$$

$$\Rightarrow \quad x = 2000 \text{ meter} \Rightarrow 2 \text{ km}$$

End of Solution

Q.55 Consider the following statements:

1. System calls provide the interface between a process and the operating system.
2. PERL implementations include direct system call access.
3. System calls occur in different ways depending on the computer in use.

Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) 1, 2 and 3 only

Ans. **(d)**

End of Solution

Q.56 What is the effective access time, if the average page-fault service time is 25 ms, memory access time is 100 ns and page-fault rate is *P*?

(a) 100 + 24,999,900 × P ns
(b) 100 + 25,000,000 × P ns
(c) 100 + 25,000 × P ns
(d) 25,000,000 + 100 P ns

Ans. **(a)**

$$\begin{aligned} \text{EMT} &= (P \times S) + (1 - P)\ T_m \\ &= (P \times 25 \text{ ms}) + (1 - P)\ 100 \text{ ns} \\ &= (25000000 \text{ ns} \times P) + 100 \text{ ns} - 100P \\ &= 100 \text{ ns} + 24999900\ P \end{aligned}$$

End of Solution

Q.57 Consider the function fun1 shown below:

```
    int fun1 (int num)
{
    int count=0;
    while (num)
    { count ++;
      num>>=1;
    }
    return (count);
}
```

The value returned by fun1 (435) is

(a) 10	(b) 9
(c) 8	(d) 7

Ans. **(b)**

Fun1(435)

$$(435)_{10} = (1\ 1\ 0\ 1\ 1\ 0\ 0\ 1\ 1)_2$$

So, count value 9. i.e., # bits in binary code.

End of Solution

Q.58 Consider the following statements in the relevant context:

1. The two types of currents that flow in semiconductor diodes and transistors are drift and diffusion currents.
2. The junction region is called depletion region or space-charge region.
3. When currents flow through the diode in forward bias, the depletion region current is mostly of 'diffusion' type.

Which of the above statements are correct?

(a) 1, 2 and 3	(b) 1 and 2 only
(c) 1 and 3 only	(d) 2 and 3 only

Ans. **(a)**

1. The two type of current that flow in semi conductor diodes and transistors are drift and diffusion current.
   In forward bias → diffusion current
   In reverse bias → drift current
2. The junction region is called depletion region or space charge region.
3. In forward bias diffusion current will flow.

End of Solution

Q.59 The bandwidth of a control system can be increased by using

(a) Phase-lead network
(b) Phase-lag network
(c) Both phase-lead network and phase-lag network
(d) Cascaded amplifier in the system

Ans. (a)

Bandwidth can be increased by using phase lead network.

End of Solution

Q.60 Applications of negative feedback to a certain amplifier reduced its gain from 200 to 100. If the gain with the same feedback is to be raised to 150, in the case of another such appliance, the gain of the amplifier without feedback must have been

(a) 400
(b) 450
(c) 500
(d) 600

Ans. (d)

Open loop gain, $A = 200$

Closed loop gain, $A_f = 100$

$$A_f = \frac{A}{1 + A\beta}$$

$$100 = \frac{200}{1 + 200\beta}$$

$$100 + 20000\ \beta = 200$$

$$20000\ \beta = 100$$

$$\beta = \frac{1}{200} = 0.005 = 0.005$$

$$A_f' = 150$$

$$A' = ?$$

$$A_f' = \frac{A'}{1 + A'\beta}$$

$$150 = \frac{A'}{1 + A' \times 0.005}$$

$$150 + A' \times 0.75 = A'$$

$$150 = A'(1 - 0.75) = A'(0.25)$$

$$A' = \frac{150}{0.25} = 600 \text{ (Open loop)}$$

End of Solution

Q.61 Consider the following statements for a network graph, if B_f is its fundamental tie set matrix, and B_t and B_l are its sub-matrices corresponding to twigs and links, respectively:

1. B_t is a unit matrix.
2. B_l is a rectangular matrix.
3. Rank of B_f is $(b - n - 1)$.

where b is the number of branches n is the number of nodes.

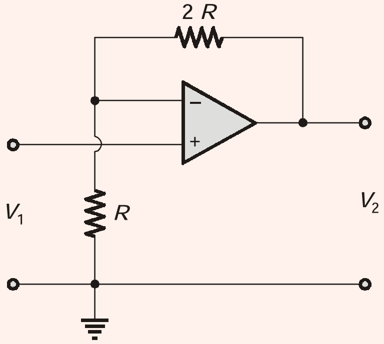
Which of the above statements are correct?

(a) 1 and 2 only
(b) 1 and 3 only
(c) 2 and 3 only
(d) None of the above

Ans. (d)

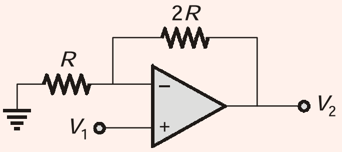
End of Solution

Q.62 An ideal operational amplifier is connected as shown in figure. What is the output voltage V_2?



(a) $3V_1$
(b) $2V_1$
(c) $1V_1$
(d) $\frac{V_1}{3}$

Ans. (a)



It is non invertin amplifier

$$V_2 = V_1\left(1+\frac{2R}{R}\right)$$

$$V_2 = 3V_1$$

End of Solution

Q.63 The modulating index of an AM-signal is reduced from 0.8 to 0.5. The ratio of the total power in the new modulated signal to that of the original signal will nearly be

(a) 0.39
(b) 0.63
(c) 0.85
(d) 1.25

Ans. (c)

$$\mu_1 = 0.8$$
$$\mu_2 = 0.5$$
$$\frac{P_{t2}}{P_{t1}} = \frac{P_c\left(1+\frac{\mu_2^2}{2}\right)}{P_L\left(1+\frac{\mu_1^2}{2}\right)} = \frac{1+\frac{(0.5)^2}{2}}{1+\frac{(0.8)^2}{2}} = 0.85$$

End of Solution

Q.64 The truth table for the function, $f(ABCD) = \Sigma m(0, 1, 3, 4, 8, 9)$ is

A	0	0	0	0	1	1	1	1
B	0	0	1	1	0	0	1	1
C	0	1	0	1	0	1	0	1
f	*W*	*X*	*Y*	0	*Z*	0	0	0

where *W*, *X*, *Y*, *Z* are given by (*d* is the complement of *D*)

(a) *D*, *d*, 1, 1
(b) 1, *d*, *D*, 1
(c) 1, 1, *D*, *d*
(d) 1, *D*, *d*, 1

Ans. (d)

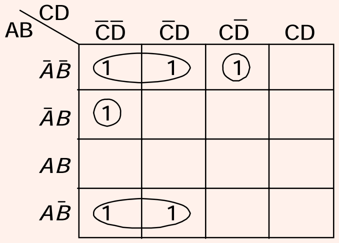
From the given truth table, the function *f* can be written as,

$$f = \bar{A}\bar{B}\bar{C}W + \bar{A}\bar{B}CX + \bar{A}B\bar{C}Y + A\bar{B}\bar{C}Z$$

The given function is,

$$f(A, B, C, D) = \Sigma m(0, 1, 3, 4, 8, 9)$$

The given function can be simplified using K–map as follows :



AB \ CD	$\bar{C}\bar{D}$	$\bar{C}D$	$C\bar{D}$	CD
$\bar{A}\bar{B}$	1	1	1	
$\bar{A}B$	1			
AB				
$A\bar{B}$	1	1		

∴ $$f = \bar{A}\bar{B}\bar{C} + \bar{A}\bar{B}CD + \bar{A}B\bar{C}\bar{D} + A\bar{B}\bar{C}$$

Comparing the above function from the function obtained from the truth table,

$$f = \bar{A}\bar{B}\bar{C}W + \bar{A}\bar{B}CX + \bar{A}B\bar{C}y + A\bar{B}\bar{C}Z$$

we obtain,
$W = 1$
$X = D$
$y = \bar{D} = d$
$Z = 1$

End of Solution

Q.65 An 8-bit DAC uses a ladder network. The full-scale output voltage of the converter is +10 V. The resolution expressed in percentage and in volts is, respectively

(a) 0.25% and 30 mV
(b) 0.39% and 30 mV
(c) 0.25% and 39 mV
(d) 0.39% and 39 mV

Ans. **(d)**

$$n = 8$$

$$V_{FS} = +10 \text{ volts}$$

$$\text{Resolution} = \frac{V_{FS}}{2^n - 1}$$

$$= \frac{10}{2^8 - 1}$$

$$= 0.0392 \text{ volts} = 39 \text{ mV}$$

$$\% \text{ resultion} = \frac{\text{Resolution}}{V_{FS}} \times 100\%$$

$$= \frac{0.0392}{10} \times 100\% = 0.39\%$$

End of Solution

Q.66 Consider the following statements:

1. Flash type ADCs are considered the fastest.
2. In successive approximation type ADCs, conversion time depends upon the magnitude of the analog voltage.
3. Counter-type ADCs work with fixed conversion time.
4. Dual slope ADCs are considered the slowest.

Which of the above statements are correct?

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

Ans. **(c)**

Statement 2 is incorrect.

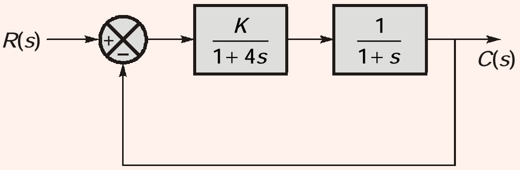
The correct statemnet is that in successive approximation type ADCs, the conversion time is always a constant value and is independent of the amplitude/magnitude of the analog voltage.

Statement 3 is incorrect.

The correct statement is that in counter-type *ADC*s, the conversion time depends on the amplitude/magnitude of the analog voltage.

End of Solution

Q.67 For the feedback control system shown, if the steady-state error is 20% for the unit step input signal, then the value of K must be



(a) 80
(b) 40
(c) 20
(d) 4

Ans. (d)

$$e_{ss}\big|_{\text{Type-0 System}} = \frac{1}{1+K}$$

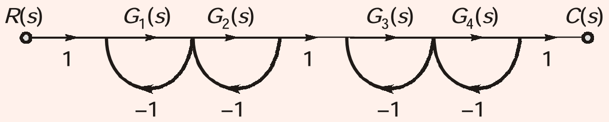
$$0.2 = \frac{1}{1+K}$$

$$K = 4$$

$$\Rightarrow \quad K = K_p = \underset{s\to 0}{Lt}\frac{K}{(1+4s)} = K$$

End of Solution

Q.68 The closed-loop transfer function $C(s)/R(s)$ of the system represented by the signal flow graph as shown in figure is



(a) $\dfrac{G_1 G_2 G_3 G_4}{(1+G_1+G_2)}$
(b) $\dfrac{G_1 G_2 G_3 G_4}{(1+G_3+G_4)}$
(c) $\dfrac{G_1 G_2 G_3 G_4}{(1+G_1+G_2)(1+G_3+G_4)}$
(d) $\dfrac{G_1 G_2 G_3 G_4}{(1+G_1 G_2)(1+G_3 G_4)}$

Ans. (c)

$$\frac{C(s)}{R(s)} = \frac{P_1\Delta_1}{\Delta}$$

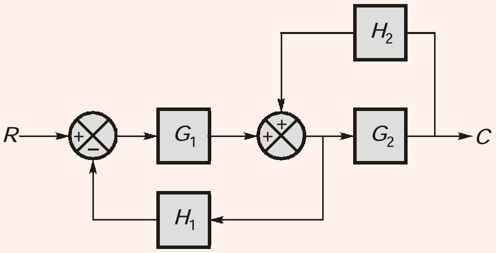
$$\frac{C(s)}{R(s)} = \frac{G_1G_2G_3G_4[1]}{1-[-G_1-G_2-G_3-G_4]+[G_1G_3+G_1G_4+G_2G_3+G_2G_4]}$$

$$= \frac{G_1G_2G_3G_4}{1+G_1+G_2+G_3+G_4+G_1G_3+G_1G_4+G_2G_3+G_2G_4}$$

$$= \frac{G_1G_2G_3G_4}{(1+G_1+G_2)(1+G_3+G_4)}$$

End of Solution

Q.69 For the block diagram as shown in figure, the overall transfer function *C*/*R* is



(a) $\dfrac{G_1 G_2 H_1}{(1-G_1 H_1 - G_2 H_2)}$ (b) $\dfrac{G_1 G_2}{(1-G_1 H_1 + G_2 H_2)}$

(c) $\dfrac{G_1 G_2 H_2}{(1+G_1 H_1 + G_2 H_2)}$ (d) $\dfrac{G_1 G_2}{(1+G_1 H_1 - G_2 H_2)}$

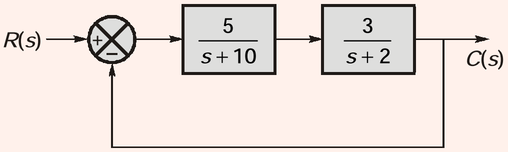
Ans. **(d)**

$$\frac{C}{R} = \frac{P_1\Delta_1}{\Delta} = \frac{G_1G_2[1]}{1-[-G_1H_1 + G_2H_2]}$$

$$= \frac{G_1G_2}{1+G_1H_1 - G_2H_2}$$

End of Solution

Q.70 The block diagram shows a unity feedback closed-loop system. The steady-state error in the response to a unit step input is



(a) 14% (b) 28%

(c) 42% (d) 57%

Ans. **(d)**

$$e_{ss}\Big|_{\text{step input}} = \frac{1}{1+K}$$

$$K = K_p$$

$$= \lim_{s\to 0}\frac{15}{(s+10)(s+2)} = \frac{15}{20} = \frac{3}{4}$$

$$e_{ss} = \frac{1}{1+\frac{3}{4}} = \frac{4}{7} = 0.57$$

$$\%e_{ss} = 0.57 \times 100 = 57\%$$

End of Solution

Q.71 The open-loop transfer function of a negative feedback is

$$G(s)H(s) = \frac{K}{s(s+5)(s+12)}$$

For ensuring system stability the gain K should be in the range

(a) $0 < K < 60$ (b) $0 < K < 600$

(c) $0 < K < 1020$ (d) $K > 1020$

Ans. **(c)**

$$s^3 + 17s^2 + 60s + K = 0$$

$$K = 17 \times 60 = 1020$$

• • • **End of Solution**

Q.72 The characteristic polynomial of a feedback control system is given by

$$R(s) = s^5 + 2s^4 + 2s^3 + 4s^2 + 11s + 10$$

For this system, the numbers of roots that lie in the left hand and right hand s-plane respectively, are

(a) 5 and 0 (b) 4 and 1

(c) 3 and 2 (d) 2 and 3

Ans. **(c)**

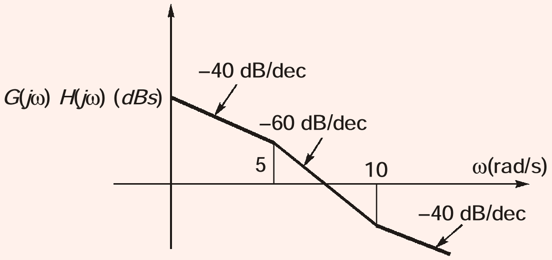
$$\begin{array}{c|cccc}
s^5 & 1 & 1 & 2 & 11 \\
s^4 & 2 & 1 & 4 & 10 \\
s^3 & \in & 1 & 6 & 0 \\
s^2 & \dfrac{4\in-12}{\in} & 1 & 10 & 0 \\
s^1 & \dfrac{24\in-72-10\in^2}{4\in-12} & 1 & 0 & 0 \\
s^0 & 10 & 1 & 0 & 0
\end{array}$$

Two sign changes.

3 in ltrs/2 in RHS.

• • • **End of Solution**

Q.73 The open-loop transfer function $G(s)H(s)$ of a Bode's plot for feedback system as shown in figure is



(a) $\dfrac{K(s+5)}{s^2(s+10)}$ (b) $\dfrac{K(s+5)}{s(s+10)}$

(c) $\dfrac{K(s+10)}{s^2(s+5)}$ (d) $\dfrac{K(s+10)}{s(s+5)}$

Ans. **(c)**

$$G(s) = \frac{K(1+0.1s)}{s^2(1+0.2s)} = \frac{K(s+10)}{s^2(s+5)}$$

● ● ● *End of Solution*

Q.74 A system with characteristic equation, $s^4 + 2s^3 + 11s^2 + 18s + 18 = 0$, will have closed-loop poles such that,

(a) all poles lie in the left half of the s-plane and no pole lies on imaginary axis.
(b) all poles lie in the right half of the s-plane.
(c) two poles lie symmetrically on the imaginary axis of the s-plane.
(d) all four poles lie on the imaginary axis of the s-plane.

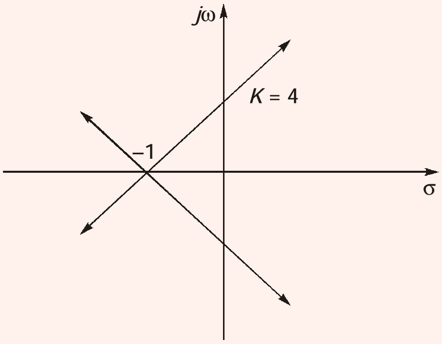
Ans. **(c)**

s^4	1	11	18
s^3	2	18	0
s^2	2	18	0
s^1	0	0	0
s^0			

Since s^1 row is zero.

● ● ● *End of Solution*

Q.75 The open-loop transfer function $G(s)\ H(s)$ of a root locus plot of a system as shown in figure is



(a) $\dfrac{4}{(s+1)^1}$ (b) $\dfrac{4}{(s+1)^2}$

(c) $\dfrac{4}{(s+1)^3}$ (d) $\dfrac{4}{(s+1)^4}$

Ans. (d)

End of Solution

Q.76 A transfer function of a compensator is $\dfrac{(1+3sT)}{(1+sT)}$. The maximum possible phase shift is

(a) 30° (b) 45°

(c) 60° (d) 90°

Ans. (a)

$\tan^{-1} 3\ \omega T - \tan^{-1}\ \omega T$

$$\omega = \ \omega_m = \frac{1}{T\sqrt{3}}\ \text{r/s}$$

$$\tan^{-1}\frac{3}{\sqrt{3}} - \tan^{-1}\frac{1}{\sqrt{3}}$$

$60° - 30° = 30°$

End of Solution

Q.77 The steady-state response $c(t)$ for an input $r(t)$ = sin2t to a system transfer function $\dfrac{1}{s+4}$ is

(a) 0.25 sin2t
(b) sin(2t – 45°)
(c) 0.316 sin(2t – 26.5°)
(d) 0.632 cos2t

77. (c)

$$\text{T.F.} = F(s) = \frac{1}{s+4}$$

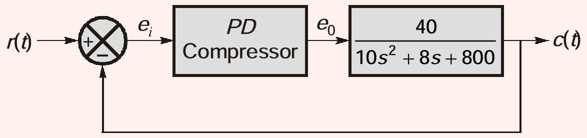
$$F(j\omega) = \frac{1}{j\omega+4}$$

$$|F(j\omega)| = \frac{1}{\sqrt{\omega^2+16}} = \frac{1}{\sqrt{2^2+16}} = 0.316$$

$$\underline{|F(j\omega)} = -\text{Tan}^{-1}\left(\frac{\omega}{4}\right) = -\text{Tan}^{-1}\left(\frac{2}{4}\right) = -26.50°$$

End of Solution

Q.78 Compensation derived from the P-D network whose differential equation is governed by $e_0 = 20\left(e_i + T\dfrac{de_i}{dt}\right)$ as shown in the figure is to be investigated. For what value of T will be closed-loop response be critically damped?



(a) 1.612
(b) 0.806
(c) 0.306
(d) 0.161

78. (c)

$$\text{T.F.} = \frac{80(1+Ts)}{s^2+(0.8+80T)s+160}$$

$$\omega_n = \sqrt{160} = 12.64\text{ r/s}$$

$$2\xi\omega_n = 0.8 + 80T$$

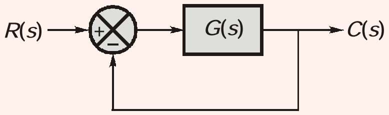
$$2 \times 1 \times 12.64 = 0.8 + 80T$$

$$T = 0.306$$

End of Solution

Q.79 The unity feedback system as shown in the figure is characterized by $G(s) = \dfrac{1}{(s+1)^2}$.

The output time response will have a damping factor ζ, and natural frequency ω_n, respectively as



(a) 0.707 and 1 (b) 0.866 and $\sqrt{2}$

(c) 0.707 and $\sqrt{2}$ (d) 0.866 and 1

79. (c)

$$\text{T.F.} = \frac{1}{(s+1)^2+1} = \frac{1}{s^2+2s+2}$$

$$\omega_n = \sqrt{2}\ \text{r/ s} = 2\xi\sqrt{2} = 2$$

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

End of Solution

Q.80 For a state model $\dot{X} = AX$, where $A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$, the state transition matrix is

(a) $\begin{bmatrix} te^{-t} & 0 \\ e^t & e^t \end{bmatrix}$ (b) $\begin{bmatrix} 0 & t \\ e^t & te^t \end{bmatrix}$

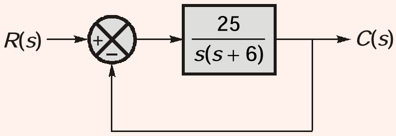
(c) $\begin{bmatrix} e^t & 0 \\ te^t & e^t \end{bmatrix}$ (d) $\begin{bmatrix} t & 0 \\ t^2 & e^t \end{bmatrix}$

80. (c)

$$\begin{bmatrix} e^t & 0 \\ te^t & e^t \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} = I$$

End of Solution

Q.81 A unit step input to a unity feedback system is shown in the figure, the time for peak overshoot is, nearly



(a) 0.35*s*
(b) 0.58*s*
(c) 0.79*s*
(d) 0.96*s*

81. (c)

$$\text{T.F.} = \frac{25}{s^2+6s+25}$$

$$\omega_n = 5 \text{ r/s}$$

$$2\xi \times 5 = 6 \Rightarrow \xi = 0.6$$

$$t_p = \frac{\pi}{5\sqrt{1-(0.6)^2}} = 0.79 \text{ sec}$$

End of Solution

Q.82 The transient response of second order under damped system starting from rest is given by $c(t) = Ae^{-6t}\sin(8t + \theta)$, $t \geq 0$. The natural frequency of the system is

(a) 8
(b) 9
(c) 10
(d) 100

82. (c)

$$c(t) = Ae^{-6t} \sin(8t + \theta)$$

$$\xi\omega_n = 6$$

$$\omega_n\sqrt{1-\xi^2} = 8$$

Since $$\xi = \frac{6}{\omega_n}$$

$$\omega_n\sqrt{1-\left(\frac{6}{\omega_n}\right)^2} = 8$$

$$\omega_n = 10 \text{ r/s}$$

End of Solution

Q.83 For a feedback control system all the roots of the characteristic equation can be placed at the desired location in the s-plane if and only if the system is

1. Observable
2. Controllable

Which of the above statements are correct?

(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Ans. (b)

End of Solution

Q.84 A second order system with a zero at –2 has its poles located at –3 + *j*4 and –3 –*j*4 in the s-plane. The undamped natural frequency and the damping factor of the system respectively are

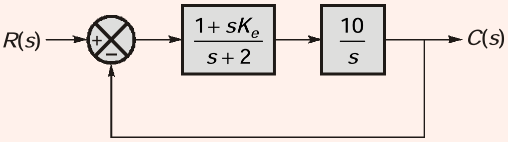
(a) 3 rad/s and 0.80
(b) 5 rad/s and 0.80
(c) 3 rad/s and 0.60
(d) 5 rad/s and 0.60

84. (d)

$$\text{C.E.} = (s+3)^2 + 4^2$$
$$= s^2 + 9 + 6s + 16 = 0$$
$$= s^2 + 6s + 25 = 0$$
$$\omega_n = 5 \text{ r/s}$$
$$\xi = 0.6$$

End of Solution

Q.85 What is the error-rate factor K_e to yield a damping factor of 0.5 for the system shown in the block diagram?



(a) 0.116
(b) 0.232
(c) 0.284
(d) 0.332

85. (a)

$$1+\frac{10(1+sk_e)}{s(s+2)} = 0$$
$$s^2 + 2s + 10s\,K_e + 10 = 0$$
$$s^2 + 2(2 + 10\,K_e) + 10 = 0$$
$$\omega_n = \sqrt{10} \text{ r/s}$$
$$2\xi\sqrt{10} = 2 + 10\,K_e$$
$$2\times 0.5\times\sqrt{10} = 2 + 10\,K_e$$
$$K_e = 0.116$$

End of Solution

Q.86 An ideal transformer is having 150 turns primary and 750 turns secondary. The primary coil is connected to a 240 V, 50 Hz source. The secondary winding supplies a load of 4 A at lagging power factor of 0.8. What is the power supplied by the transformer to the load?

(a) 4200 W (b) 3840 W
(c) 2100 W (d) 1920 W

Ans. (b)

150 *T*/750 *T*, 240 V, 50 Hz,

$$I_2 = 4 \text{ A at } 0.8 \text{ p.f. lag}$$

$$E_2 = \frac{240}{150} \times 750 \text{ V}$$

$$P_2 = \frac{240}{150} \times 750 \times 4 \times 0.8 \text{ W} = 3840 \text{ W}$$

End of Solution

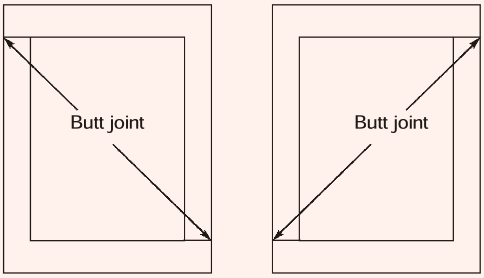
Q.87 In an induction motor for a fixed speed at constant frequency

(a) both line current and torque are proportional to voltage.
(b) both line current and torque are proportional to the square of voltage.
(c) line current is proportional to voltage and torque is proportional to the square of voltage.
(d) line current is constant and torque is proportional to voltage.

Ans. (c)

End of Solution

Q.88 In a core-type single-phase transformer the steel-core is assembled by staggering butt-joints in adjacent layers of laminations vide figures. The purpose served is said to be



1. avoiding continuous air-gap.
2. preventing loss of mechanical strength.
3. reducing eddy-current loss.

Which of the above statements are true?

(a) 1 and 2 only (b) 1 and 3 only
(c) 2 and 3 only (d) 1, 2 and 3

Ans. (a)

End of Solution

Q.89 Which of the following would refer to an ideal transformer?

1. Winding resistances are negligible.
2. Leakage-fluxes are included.
3. Core-losses are negligible.
4. Magnetization characteristic is linear.

(a) 1, 2 and 3 only
(b) 1, 3 and 4 only
(c) 1, 2 and 4 only
(d) 2, 3 and 4 only

Ans. (b)

End of Solution

Q.90 A 24-slot, 2-pole, lap-wound dc machine has 18 turns per coil. The average flux density per pole is 1 Tesla. The effective length of the machine is 20 cm and the radius of the armature is 10 cm. The magnetic poles cover 80% of the armature periphery. For armature angular velocity (ω_m) of 183.2 rad/sec, the induced emf in the armature winding is nearly

(a) 585 V
(b) 1050 V
(c) 1260 V
(d) 1465 V

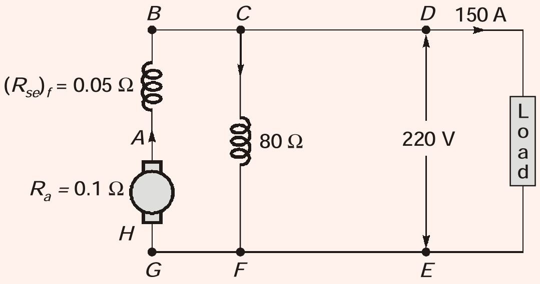
Ans. (c)

End of Solution

Q.91 A 220 V dc compound generator connected in long-shunt mode has the following parameters: R_a = 0.1 Ω, R_{sh} = 80 Ω, R_{series} = 0.05 Ω. For a load of 150 A at rated terminal voltage, the induced emf of the generator should nearly be

(a) 233 V
(b) 243 V
(c) 251 V
(d) 262 V

Ans. (b)



$$(I_f)_{sh} = \frac{220}{80} \qquad \ldots(1)$$

$$I_a = (I_f)_{sh} + I_{\text{load}}$$

$$= \left(\frac{220}{80} + 150\right) = 152.75 \text{ A}$$

Applying KVL in loop, ABDEG,

$$E_g - 152.75 \times (0.1 + 0.05) = 220$$

$$E_g = 242.9125 \text{ V}$$

End of Solution

Q.92 The Laplace transform of $f(t) = t^n e^{-\alpha t} u(t)$ is

(a) $\dfrac{(n+1)!}{(s+\alpha)^{n+1}}$ (b) $\dfrac{n!}{(s+\alpha)^{n}}$

(c) $\dfrac{(n-1)!}{(s+\alpha)^{n+1}}$ (d) $\dfrac{n!}{(s+\alpha)^{n+1}}$

Ans. **(d)**

$$L(\in^n u(t)) = \frac{n!}{s^{n+1}}$$

$$L\left(e^{-\alpha t} t^n u(t)\right) = \frac{n!}{(s+\alpha)^{n+1}}$$

End of Solution

Q.93 A dc shunt motor has the following characteristics, R_a = 0.5 Ω, R_f = 200 Ω, base speed = 1000 rpm, rated voltage = 250 V. On no load it draws a current = 5 A. At what speed will this run while delivering a torque of 150 Nm?

(a) 881 rpm (b) 920 rpm

(c) 950 rpm (d) 990 rpm

Ans. **(a)**

Shunt motor, ϕ = constant

R_a = 0.5 Ω,

R_f = 200 Ω

Base speed = 1000 rpm

V_{rated} = 250 V

I_0 = No load current = 5 A

As we know, $E_b = k\phi\omega$ ...(1)

$T = k\phi I_a$ ...(2)

$T = 150 = k\phi \times I_a$ ...(3)

I_0 = 5 A,

$$250 - 4 \times 0.5 = k\phi \times \frac{2\pi \times 1000}{60}$$

$$k\phi = \frac{248 \times 60}{2\pi \times 1000} = 2.36 \quad ...(4)$$

Putting in equation (3),

$$150 = \frac{248 \times 60}{2\pi \times 1000} \times I_a = 63.33 \text{ A}$$

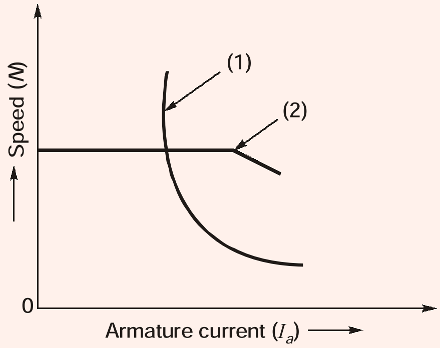
$$250 - 63.33 \times (0.5) = 2.36 \times \omega$$

$$\omega = 92.51$$

$$\Rightarrow \quad N = \frac{60 \times 92.51}{2\pi} = 883.45 \text{ rpm}$$

End of Solution

Q.94 The figure shows plots of speed (N) Vs. armature current (I_a) of a dc motor for two different operating conditions. Which one of the following features is relevant?



(a) (1) represents stronger shunt field, and (2) represents stronger series field of a compound motor.
(b) (1) represents stronger series field, and (2) represents stronger shunt field of a compound motor.
(c) (1) represents only shunt excitation, and (2) represents only series excitation.
(d) (1) represents only series excitation, and (2) represents only shunt excitation.

Ans. (d)

End of Solution

Q.95 A 230 V, 50 Hz, 4-pole single-phase induction motor is rotating clockwise (forward) direction at a speed of 1425 rpm. If the rotor resistance at standstill is 7.8 Ω, then the effective rotor resistance in the backward branch of the equivalent circuit will be

(a) 2.0 Ω
(b) 4.0 Ω
(c) 78 Ω
(d) 156 Ω

Ans. (a)

N_r = 1425 rpm; 230 V, 50 Hz, 4-pole, 1-ϕ IM, r_2 = 7.8 Ω

$$\text{Slip} = \frac{1500-1425}{1500} = 0.05$$

The effective rotor resistance

$$= \frac{7.8}{2} \times \frac{1}{2-s} = \frac{7.8}{2} \times \frac{1}{2-0.05}$$

$$= 2\ \Omega$$

End of Solution

Q.96 A 400 V, 50 Hz, 30 hp, three phase induction motor is drawing 50 A current at 0.8 power factor lagging. The stator and rotor copper losses are 1.5 kW and 900 W respectively. The friction and windage losses are 1050 W and the core losses are 1200 W. The air gap power of the motor will be, nearly

(a) 15 kW
(b) 20 kW
(c) 25 kW
(d) 30 kW

Ans. **(c)**

400 V, 50 Hz, 30 hp, 3-ϕ IM,

I_1 = 50 A at 0.8 p.f. lag,

$W_{\text{st cu}}$ = 1.5 kW, $W_{r\ \text{cu}}$ = 900 W

Friction and windage = 1050 W

W_{core} = 1200 W

Airgap power = Stator input – Stator cu loss – Stator core loss

$$= \sqrt{3} \times 400 \times 50 \times 0.8 - 1500 - 1200$$

= 25 kW

End of Solution

Q.97 When the value of slip of an induction motor approaches zero, the effective resistance

(a) is very low and motor is under no-load
(b) of the rotor circuit is very high and the motor is under no-load
(c) is zero
(d) of the rotor circuit is infinity and the motor is equivalent to short-circuited two-winding transformer

Ans. **(b)**

End of Solution

Q.98 A 4-pole, 50 Hz, 3-phase induction motor with a rotor resistance of 0.25 Ω develops a maximum torque of 25 N.m at 1400 rpm. The rotor reactance x_2 and slip at maximum torque $s_{\max, T}$ respectively would be

(a) 2.0 and $\frac{1}{15}$ (b) 3.75 and $\frac{1}{12}$

(c) 2.0 and $\frac{1}{12}$ (d) 3.75 and $\frac{1}{15}$

Ans. (d)

$4P$, 50 Hz, 3-ϕ, IM,

$$r_2 = 0.25\ \Omega$$

$$T_{\max} = 25 \text{ N-m at } 1400 \text{ rpm}$$

$$s_{mT} = \frac{1500-1400}{1500} = 6.67\% \text{ or } \frac{1}{15}$$

$$s_{mT} = \frac{r_2}{x_2}$$

$$\Rightarrow \quad x_2 = \frac{r_2}{s_{mT}} = \frac{0.25}{6.67} \times 100$$

$$= 3.75\ \Omega$$

● ● ● *End of Solution*

Q.99 A 3-phase, 37 kW induction motor has an efficiency of 90% when delivering full load. At this load the stator copper losses and rotor copper losses are equal and are equal to stator iron losses. The mechanical losses are one-third of no-load losses. Then the motor runs at a slip of

(a) 0.01 (b) 0.02

(c) 0.03 (d) 0.04

Ans. (c)

3-ϕ, 37 kW, IM, η = 90% at full load

Let, $W_{\text{st cu}} = W_{r\text{ cu}} = W_{\text{core}} = x$

$$W_{\text{mech}} = \frac{1}{3}\text{ no-load losses}$$

$$\text{No-load loss} = W_{\text{mech}} + W_{\text{core}}$$

$$\Rightarrow \quad 3\ W_{\text{mech}} = W_{\text{mean}} + W_{\text{core}}$$

$$\Rightarrow \quad W_{\text{mech}} = \frac{x}{2}$$

$$\text{Losses} = \left(\frac{1}{\eta} - 1\right) \times \text{output}$$

$$= \left(\frac{1}{0.9} - 1\right) \times 37 \times 10^3 = 4111 \text{ W}$$

$$\text{Losses} = W_{st\ cu} + W_{st\ core} + W_{r\ cu} + W_{mech}$$

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

$$\Rightarrow \quad 3.5x = 4111 \text{ W}$$

$$x = 1174 \text{ W}$$

$$P_{airgap} = P_{output} + W_{r\ cu} + W_{mech}$$

$$= 37 \times 10^3 + 1174 + \frac{1174}{2}$$

$$= 38761 \text{ W}$$

$$\text{Slip} = \frac{W_{r\,cu}}{P_{airgap}} = \frac{1174}{38761} = 0.03\%$$

• • • **End of Solution**

Q.100 The rotor of a 4-pole ac generator is wound with a 200 turns coil. If the flux per pole is 5 m Wb and the rotor runs at a speed of 1500 rpm, the rms value of the induced voltage for this ac generator is nearly

(a) 140 V (b) 157 V
(c) 164 V (d) 200 V

Ans. **(*)**

4P, 200 turns coil, ϕ_{av} = 5 mWb, 1500 rpm, $f = \frac{NP}{120} = 50$ Hz

$$E_{ph} = \sqrt{2} \times \pi \times f \times \phi_{av} \times N_{se}$$

$$= \sqrt{2} \times \pi \times 50 \times 5 \times 10^{-3} \times 200$$

$$= 222 \text{ V}$$

• • • **End of Solution**

Q.101 A 3-MVA, 6-pole, 50 Hz, 3-phase synchronous generator is connected to an infinite bus of 3300 V; and it is run at 1000 rpm. The synchronous reactance of the machine is 0.915 Ω per phase. The synchronizing torque for 1° mechanical displacement of the rotor is

(a) 7500 N-m (b) 7000 N-m
(c) 6000 N-m (d) 4500 N-m

Ans. **(c)**

3 MVA, 6P, 50 Hz, 3-ϕ, infinite bus of 3300 V, 1000 rpm,

$$X_s = 0.915\ \Omega/\text{ph}$$

$$I_a = \frac{3 \times 10^6}{\sqrt{3} \times 3300} = 524.8 \text{ A}$$

$$E_f = V_t + jI_aX_s$$

$$= \frac{3300}{\sqrt{3}} + j(524.8)(0.915) = 1964.9\angle 14.14°$$

$$V_t = \frac{3300}{\sqrt{3}} = 1905.3 \text{ V}$$

$$S_p = \frac{E_f V_t}{X_s}\cos\delta$$

$$= \frac{1964.9 \times 1905.3}{0.915} \times \cos 14.14° \text{ W/elec.rad}$$

$$= 3.967 \text{ MW/elec. rad}$$

$$= 3.967 \times \frac{P}{2} \times \frac{\pi}{180} \text{ MW/°mech}$$

$$= 3.967 \times \frac{6}{2} \times \frac{\pi}{180} \times \frac{1 \times 60}{2 \times \pi \times 1000}$$

$$= 6000 \text{ N-m}$$

End of Solution

Q.102 The second-harmonic component of the power P versus load angle δ characteristic of a synchronous machine, operating at a terminal voltage V_t and having the d-and q-axis reactance per phase of X_d and X_q, respectively, is

(a) $\frac{V_t^2}{2} \cdot \frac{X_d X_q}{X_d + X_q} \sin 2\delta$

(b) $\frac{V_t^2}{2} \cdot \left(\frac{1}{X_q} - \frac{1}{x_d}\right) \sin 2\delta$

(c) $\frac{V_t^2}{2} \cdot \frac{X_d X_q}{X_d + X_q} \cos 2\delta$

(d) $\frac{V_t^2}{2} \cdot \left(\frac{1}{X_q} - \frac{1}{X_d}\right) \cos 2\delta$

Ans. (b)

End of Solution

Q.103 The term Synchronous condenser refers to

(a) A synchronous motor with a capacitor connected across the stator terminals to improve the power factor

(b) A synchronous motor operating at full-load with leading power factor

(c) An over-excited synchronous motor partially supplying mechanical load and also improving the power factor of the system to which it is connected

(d) An over-excited synchronous motor operating at no-load with leading power factor used in large power stations for improvement of power factor

Ans. (d)

End of Solution

Q.104 Which of the following operating aspects necessitate the computation of Regulation of an alternator ?

1. When load is thrown off
2. For designing of an automatic voltage-control equipment
3. For determination of steady-state and transient stability
4. For parallel operation of alternators

(a) 1, 2 and 3 only
(b) 1, 2 and 4 only
(c) 1, 3 and 4 only
(d) 1, 2, 3 and 4

Ans. (a)

End of Solution

Q.105 A 2-phase ac servomotor has a tendency to run as a single-phase induction motor, if the voltage across the control winding becomes zero. To prevent this

(a) Rotor having high mass and moment of inertia is to be used.
(b) Drag-cup type of light rotor and high resistance is to be used.
(c) A low resistance rotor is to be used.
(d) The number of turns in the control winding is to be kept lesser than in the main reference winding.

Ans. (b)

End of Solution

Q.106 A single-stack, 8-phase(stator), multiple-step motor has 6-rotor teeth. The poles are excited one at a time. If excitation frequency is 120 Hz, the speed of the motor is

(a) 3 rps
(b) 5 rps
(c) 10 rps
(d) 15 rps

Ans. (b)

End of Solution

Q.107 An extra high voltage transmission line of length 300 km can be approximated by a lossless line having propagation constant β = 0.00127 rad/km. The percentage ratio of line length to wave-length will nearly be

(a) 24%
(b) 19%
(c) 12%
(d) 6%

Ans. (d)

Propagation constant, $\beta = \dfrac{2\pi f l}{v} = \dfrac{2\pi f l}{\lambda f} = 2\pi\left(\dfrac{l}{\lambda}\right)$

$$\frac{l}{\lambda} = \frac{\beta}{2\pi}$$

For 300 km, $\beta = 0.00127 \times 300 = 0.381$ rad

$$\%\frac{l}{\lambda} = \frac{0.381}{2\pi}\times 100 = 6.06\% \approx 6\%$$

End of Solution

Q.108 A lossy capacitor C_x, rated for operation of 5 kV, 50 Hz is represented by an equivalent circuit with an ideal capacitor C_p in parallel with a resistor R_p. C_p is 0.102 μF; and R_p = 1.25 MΩ. The power loss, and tanδ, of this lossy capacitor. When operating at the rated voltage are respectively.

(a) 20 W and 0.04
(b) 10 W and 0.04
(c) 20 W and 0.025
(d) 10 W and 0.025

Ans. (c)

$$C_p = 0.102\ \mu\text{F},$$
$$R_p = 1.25\ \text{M}\Omega,$$
$$V = 5\ \text{kV},$$
$$f = 50\ \text{Hz}$$

$$\text{Loss tangent} = \tan\delta = \frac{1}{2\pi f C_p R_p} = 0.025$$

$$\text{Power loss} = V^2\left(2\pi f C_p(\tan\delta)\right) = 20\ \text{W}$$

End of Solution

Q.109 The time interval needed for a surge to travel to the end of a 600 km long overhead transmission line is

(a) 6 s
(b) 2 s
(c) 20 ms
(d) 2 ms

Ans. (d)

$$\text{Time} = \frac{\text{Length}}{\text{Velocity}}$$

Surge travels at a speed of light

$$= 3 \times 10^8\ \text{m/s}$$

$$T = \frac{l}{v} = \frac{600 \times 10^3}{3 \times 10^8} = 2\ \text{ms}$$

End of Solution

Q.110 At what power factor will a lossless line with a reactance of 0.6 pu exhibit zero regulation given that the sending end voltage is 1.0 pu?

(a) 0.800 lag
(b) 0.800 lead
(c) 0.954 lead
(d) Unity p.f.

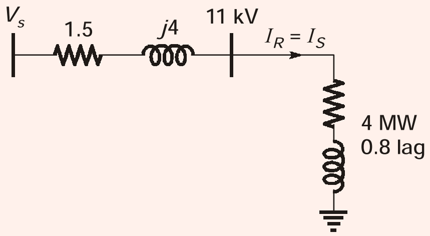
Ans. (d)

End of Solution

Q.111 An 11 kV, 3-phase transmission line has resistance of 1.5 Ω and reactance of 4 Ω per phase. The efficiency of the line when supplying the load of 4 MW at 0.8 lagging power factor is nearly

(a) 99% (b) 95%
(c) 92% (d) 90%

Ans. (c)



$$I_R = I_S = \frac{P_{R3\phi}}{\sqrt{3}\, V_{RL} \cos\phi_R} = \frac{4\times 10^6}{\sqrt{3}\times 11\times 10^3 \times 0.8}$$

$$= 262.43 \text{ A}$$

$$P_S = P_R + 3\left(I_S^2 R\right)$$

$$= 4 \times 10^6 + 3(262.43^2 \times 1.5)$$

$$= 4.309 \text{ MW}$$

$$\%\eta = \frac{P_R}{P_S}\times 100 = \frac{4}{4.309}\times 100 = 92.8\%$$

End of Solution

Q.112 The dielectric loss in the insulation of a lossy underground cable, due to leakage current is (using standard notations)

(a) $\omega CV^2 \cos\delta$ (b) $\omega CV \tan\delta$
(c) $\omega CV^2 \tan\delta$ (d) $\omega CV \sin\delta$

Ans. (c)

Dielectric power loss of a cable

$$= V^2\omega C\,(\tan\delta)$$

Where, $\tan\delta$ = Loss tangent angle

End of Solution

Q.113 A 3-phase, 100 MVA, 11 kV generator has the following p.u. constants. The generator neutral is solidly grounded. $X_1 = X_2 = 3X_0 = 0.15\ \Omega$. The ratio of the fault current due to three-phase dead-short-circuit to that due to L-G fault would be nearly

(a) 0.33
(b) 0.56
(c) 0.78
(d) 1.0

Ans. (c)

$$X_1 = X_2 = 0.15,$$

$$X_0 = \frac{0.15}{3} = 0.05$$

$$I_{f3\phi} = \frac{V_{Th}}{X_1},$$

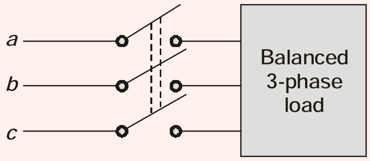
$$I_{F\,LG} = \frac{3 \cdot V_{Th}}{X_1 + X_2 + X_0}$$

$$\frac{I_{f3\phi}}{I_{fLG}} = \frac{X_1 + X_2 + X_0}{3X_1} = \frac{0.15 + 0.15 + 0.05}{3 \times 0.15}$$

$$= 0.777 \approx 0.78$$

End of Solution

Q.114 A balanced 3-phase load is supplied from a 3-phase supply. The contact in line *c* of the triple-pole switch contactor fails to connect when switched on. If the line-currents in lines *a* and *b* record 25 A each, then the positive-sequence component of the current is

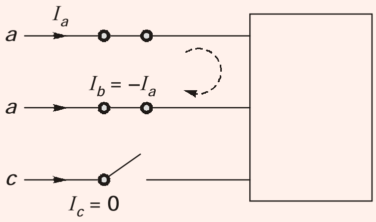


Triple-pole switch

(a) 14.4 ∠+30° A
(b) 25.0 ∠–30° A
(c) 14.4 ∠–30° A
(d) 25.0 ∠+30° A

Ans. (c)

$$\begin{bmatrix} I_0 \\ I_1 \\ I_2 \end{bmatrix} = \frac{1}{3}\begin{bmatrix} 1 & 1 & 1 \\ 1 & a & a^2 \\ 1 & a^2 & a \end{bmatrix}\begin{bmatrix} I_a \\ I_b \\ I_c \end{bmatrix}$$



Positive sequence current,

$$I_1 = \frac{1}{3}\left(I_a + a \cdot I_b + a^2 I_c\right)$$

$$= \frac{1}{3}(I_a + a(-I_a) + 0)$$

$$= \frac{I_a}{3}(1 - a) = \frac{25}{3}(1 - 1\angle 120°)$$

$$I_1 = 14.43\angle{-30°}\text{ A}$$

End of Solution

Q.115 In a circuit-breaker, the arc is produced due to

1. Thermal emission
2. High temperature of air
3. Field emission

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 2 and 3 only

(c) 1 and 2 only (d) 1 and 3 only

Ans. (d)

Arc in *CB* is due to

(a) Thermal emission

(b) Secondary emission

(c) Field emission

End of Solution

Q.116 The line reactances of a power network are as follows:

Line No.	From Bus	To Bus	Reactance
1	0	1	0.2 p.u.
2	1	2	0.4 p.u

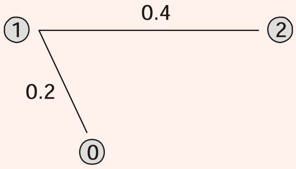
The bus impedance matrix with '0' as ref-bus is

(a) $\begin{bmatrix} 0.2 & 0.4 \\ 0.4 & 0.6 \end{bmatrix}$ (b) $\begin{bmatrix} 0.4 & 0.2 \\ 0.2 & 0.6 \end{bmatrix}$

(c) $\begin{bmatrix} 0.2 & 0.2 \\ 0.2 & 0.6 \end{bmatrix}$ (d) $\begin{bmatrix} 0.6 & 0.2 \\ 0.2 & 0.4 \end{bmatrix}$

Ans. (c)

$$Z_{\text{Bus(new)}} = \begin{bmatrix} Z_{\text{Bus(old)}} & Z_{ij} \\ & \vdots \\ Z_{j1} \quad Z_{j2} \cdots & (Z_{jj} + Z_b) \end{bmatrix}$$



$$= \begin{bmatrix} 0.2 & 0.2 \\ 0.2 & 0.2 + 0.4 \end{bmatrix} = \begin{bmatrix} 0.2 & 0.2 \\ 0.2 & 0.6 \end{bmatrix}$$

End of Solution

Q.117 An alternator is

(a) A polyphase synchronous machine operated with DC exciter
(b) A polyphase synchronous machine operated with AC exciter
(c) A three-phase induction machine with prime mover
(d) Any AC generator

Ans. (a)

End of Solution

Q.118 The stability of a system, when subjected to a disturbance, is assessable by which of the following methods?

1. Swing curve
2. Equal-area criterion
3. Power-angle diagram
4. Power-circle diagram

(a) 1, 2 and 4 only
(b) 1, 3 and 4 only
(c) 2, 3 and 4 only
(d) 1, 2 and 3 only

Ans. (d)

End of Solution

Q.119 Power transmission capacity of a high voltage line can be increased by

(a) Increasing the resistance of the line
(b) Increasing the inductive reactance of the line
(c) Reducing the effective series reactance of the line
(d) Reducing the shunt admittance of the line

Ans. (c)

$$P_S = \left|\frac{V_s^2}{X_L}\right| \sin\delta$$

By regarding X_L, P_S is increased

End of Solution

Q.120 A 40 MVA, 11 kV, 3-phase, 50 Hz, 4-pole turbo-alternator has an inertia constant of 15 sec. An input of 20 MW developed 15 MW of output power (Neglecting losses). Then the acceleration is

(a) 60°/s^2 (b) 65°/s^2
(c) 70°/s^2 (d) 75°/s^2

Ans. (d)

Given,

$$S = 40$$
$$H = 15$$
$$P_m = 20$$
$$P_e = 15$$
$$f = 50 \text{ Hz}$$

From swing equation,

$$M \cdot \frac{d^2\delta}{dt^2} = (P_m - P_e)$$

$$\frac{H \cdot S}{180f} \frac{d^2\delta}{dt^2} = (P_m - P_e)$$

$$\frac{d^2\delta}{dt^2} = \frac{(P_m - P_e) \times 180f}{H \cdot S} = \frac{(20-15) \times 180 \times 50}{15 \times 40}$$

$$\frac{d^2\delta}{dt^2} = 75 \text{ electrical degress/sec}^2$$

End of Solution

Q.121 In a progressive simplex, lap winding for a 4-pole, 14-slot, 2 coil-sides per slot d.c. armature, the back pitch y_b and front pitch y_f will be respectively.

(a) 7 and 5 (b) 5 and 5
(c) 7 and 7 (d) 5 and 7

Ans. (a)

End of Solution

Q.122 The starting current in an induction motor is 5 times the full-load current while the full load slip is 4%. The ratio of starting torque to full-load torque is

(a) 0.6 (b) 0.8

(c) 1.0 (d) 1.2

Ans. (c)

End of Solution

Q.123 When bundle of conductors are used in place of single conductors the effective inductance and capacitance will, respectively

(a) Increase and decrease (b) Decrease and increase

(c) Decrease and remain unaffected (d) Increase and remain unaffected

Ans. (b)

For bundled conductors:

$$L_{ph} = 2 \times 10^{-7} \ln\left(\frac{D_m}{D_s}\right)$$

$$C_{ph} = \frac{2\pi \epsilon_0 \epsilon_r}{\ln\left(\frac{D_m}{D_s}\right)}$$

By using bundled conductor D_s is increased, so L_{ph} is decreased and C_{ph} is increased.

End of Solution

Q.124 A buck regulator has an input voltage of 12 V and the required output voltage is 5 V. What is the duty cycle of the regulator?

(a) $\frac{5}{12}$ (b) $\frac{12}{5}$

(c) $\frac{5}{2}$ (d) 6

Ans. (a)

End of Solution

Directions: Each of the next **Twenty Six (26)** items consists of two statements, one labelled as 'Statement (I)' and the other as 'Statement (II)'. Examine these two statements carefully and select the answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are individually true; and Statement (II) is the correct explanation of Statement (I)

(b) Both Statement (I) and Statement (II) are individually true; but Statement (II) is NOT the correct explanation of statement (I)

(c) Statement (I) is true; but Statement (II) is false

(d) Statement (I) is false; but Statement (II) is true

Q.125 **Statement (I):** An electrolytic capacitor consists of two electrodes immersed in an electrolyte with a chemical film on one of the electrodes acting as the dielectric.

Statement (II): The electrolytic capacitor may be operated with any one of the electrodes as anode positive with respect to the other.

Ans. (c)

End of Solution

Q.126 **Statement (I) :** Two ideal current sources with currents I_1 and I_2 cannot be connected in series.

Statement (II) : Superposition theorem cannot be applied to current sources when one terminal of each of these sources is connected to a common node.

Ans. (c)

End of Solution

Q.127 **Statement (I) :** Both Coupling capacitance and emitter bypass capacitance affect the low frequency response of an R-C-coupled amplifier.

Statement (II) : Both stray capacitances and emitter-to-base diffusion capacitance have a profound effect on the low frequency response of an R-C-coupled amplifier.

Ans. (c)

Statement-I is correct, statement-II is not correct.

End of Solution

Q.128 **Statement (I) :** A 'bedding' is provided over to the metallic sheath in an underground cable.

Statement (II) : The bedding protects the metallic sheath against corrosion.

Ans. (a)

Bedding protects sheath against corrosion and mechanical and chemical damage.

End of Solution

Q.129 **Statement (I) :** Zero-sequence currents are, by definition, in phase with each other in the three windings of any three-phase apparatus.

Statement (II) : They may be caused by magnetic saturation in the transformers.

Ans. (b)

End of Solution

Q.130 **Statement (I) :** 'High resistance' method is used for arc extinction in DC circuit breakers.

Statement (II) : Very little energy is dissipated in the arc in high resistance method of arc extinction.

Ans. (c)

End of Solution

Q.131 **Statement (I) :** A radial main system, circuit experiences a low voltage at the far end under heavy load conditions.

Statement (II) : The voltage at the far end under heavy loading can be corrected by connecting a shunt capacitor compensator there.

Ans. (b)

End of Solution

Q.132 **Statement (I)** : In an HVDC system, the steady-state power transfer from a generator to the infinite bus is dependent on the power angle and the line impedance intervening between them.

Statement (II) : In an HVDC system, the power transfer between the two stations connected by a dc link is much larger than that in a corresponding EHV ac system.

Ans. (d)

HVDC is used for bulk power transfer over long distance compared to HVAC.

End of Solution

Q.133 **Statement (I)** : Conventional diode rectifier circuits have low frequency harmonics.

Statement (II) : Passive techniques used to reduce the current THD in conventional rectifiers require large transformers and/or reactors.

Ans. (c)

End of Solution

Q.134 **Statement (I) :** Resonant inverters are used as electronic balasts for gas discharge lamps, induction heating, etc.

Statement (II) : A DC to high frequency AC resonant inverter may be obtained by applying the square wave voltage obtained from a DC source and switch network operating at frequency f_s to a tuned tank circuit designed for frequency f_0, so as to obtaine variable magnitudes of $v(t)$ and $i(t)$ by matching f_s with f_0.

Ans. (b)

End of Solution

Q.135 **Statement (I) :** In linear commutation, the magnitude of the current in the coils under each pole in a DC generator on a given load remains constant.

Statement (II) : The magnitude of the emfs induced in the coils under each pole of a DC generator on load remains constant.

Ans. (d)

End of Solution

Q.136 **Statement (I) :** A very efficient method of speed control of an induction motor is to vary both V and f in such a way that V/f ratio remains constant.

Statement (II) : Keeping V/f constant allows the magnetic flux to remain constant and a reduced V reduces the inrush of starting current.

Ans. (a)

End of Solution

Q.137 **Statement (I) :** Windings of most power transformers are immersed in a tank of oil.

Statement (II) : Convection currents in the insulating oil help carry the heat away from the windings and the core.

Ans. (a)

End of Solution

Q.138 **Statement (I) :** A large gate pulse is required to turn on a GTO thyristor.

Statement (II) : This thyristor does not need a commutation circuit.

Ans. (c)

End of Solution

Q.139 **Statement (I) :** The decimal-to-BCD encoder digital logic circuit chip IC 74147, is a priority encoder.

Statement (II) : In this circuit, priority is given to the lowest-order input.

Ans. (c)

Statement II is wrong.

The correct statement is that in IC 74147, the priority is given to the highest-order input.

End of Solution

Q.140 **Statement (I) :** Analog to digital conversion is essentially a sampling process.

Statement (II) : A hold element is digital to analog converter.

Ans. (c)

End of Solution

Q.141 **Statement (I) :** High-level programming languages preferred by the scientific community as they are user friendly.

Statement (II) : High level programming languages provide ways of detailing instruction for problem-solving that are translated into low-level language via compilers and interpreters before being executed by the computer.

Ans. (a)

End of Solution

Q.142 **Statement (I) :** The conductivity of an intrinsic semi-conductor increases exponentially with temperature.

Statement (II) : As the temperature rises, more and more covalent bonds are broken resulting in more electron hole pairs.

Ans. (a)

Statement (I) is correct.

Statement (II) is correct.

Statement (II) is a reason for statement (I)

End of Solution

Q.143 **Statement (I) :** Light is capable of transferring electrons to the free-state inside a material, thus increasing the electrical conductivity of the material.

Statement (II) : The increased electrical conductivity produced by light is called photo-conductivity.

Ans. (b)

End of Solution

Q.144 **Statement (I) :** A general purpose dynamometer type wattmeter does not read accurately at low power factors.

Statement (II) : The presence of self-inductance of the pressure coil introduces an error.

Ans. (a)

Due to inductance of potential coil of wattmeter error is more at low p.f. power measurements.

End of Solution

Q.145 **Statement (I) :** A dynamometer type wattmeter has a linear scale while a dynamometer type voltmeter has a non-linear scale.

Statement (II) : Deflecting torque developed in a dynamometer type wattmeter is proportional to the power and that developed in a dynamometer type ammeter is proportional to the square of the current.

Ans. (a)

In dynamometer wattmeter

$$T_d = \frac{P}{R_S} \cdot \frac{dm}{d\theta} = K\theta$$

$$\theta \ \alpha \ P = \text{linear scale}$$

Voltmeter, $$T_d = \frac{V^2}{R_s^2}\frac{d_m}{d\theta} = K\theta$$

$$\theta \ \alpha \ V^2$$

$\Rightarrow$ Non linear scale

End of Solution

Q.146 **Statement (I) :** The rotating disc in an energy meter is made of a magnetic material.

Statement (II) : Braking takes place due to eddy current generated by the braking magnet.

Ans. (d)

Rotating disc of energy meter mode of Aluminium which is non-magnetic materials.

End of Solution

Q.147 **Statement (I) :** When a solid surface is bombarded by electrons of appreciable energy, secondary emission occurs from the surface.

Statement (II) : The major application of the secondary emission is in voltage amplification.

Ans. (b)

End of Solution

Q.148 **Statement (I) :** Electromagnetic flow meter is preferred for flow velocity measurement of slurries in pipes as long as the slurry has adequate electrical conductivity.

Statement (II) : Electromagnetic flow meter does not insert any instrument parts into the body of the fluid flow to cause obstruction as in most of other flow-meters.

Ans. (b)

Electromagnetic flow meter is inserted to measure voltage proportional to velocity of liquid.

Compared to mechanical flow transducers electromagnetic flow meter is noncontact type and loss effects the flow of liquid.

● ● ● *End of Solution*

Q.149 **Statement (I) :** Direct access method is based on a disk model of a file.

Statement (II) : Disks allow random access to any file block.

Ans. (b)

● ● ● *End of Solution*

Q.150 **Statement (I) :** Variables that are defined inside subprograms are local variables.

Statement (II) : Their scope is in the body of the subprogram in which they are defined.

Ans. (a)

● ● ● *End of Solution*

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