GATE EE 2010

Q.1 - 25 carry one mark each.

MCQ 1.1 The value of the quantity P, where $P = \int_0^1 xe^x\,dx$, is equal to

(A) 0 (B) 1

(C) e (D) 1/e

SOL 1.1 Hence (B) is correct option.

$$P = \int_0^1 xe^x\,dx$$

$$= \left[x\int e^x\,dx\right]_0^1 - \int_0^1 \left[\frac{d}{dx}(x)\int e^x\,dx\right]dx$$

$$= \left[xe^x\right]_0^1 - \int_0^1 (1)\,e^x\,dx$$

$$= (e^1 - 0) - \left[e^x\right]_0^1$$

$$= e^1 - [e^1 - e^0]$$

$$= 1$$

MCQ 1.2 Divergence of the three-dimensional radial vector field $\vec{\mathbf{r}}$ is

(A) 3 (B) $1/r$

(C) $\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$ (D) $3(\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}})$

SOL 1.2 Hence (A) is correct option.

Radial vector $\vec{\mathbf{r}} = x\hat{\mathbf{i}} + y\hat{\mathbf{j}} + z\hat{\mathbf{k}}$

$$\text{Divergence} = \nabla \cdot \vec{\mathbf{r}}$$

$$= \left(\frac{\partial}{\partial x}\hat{\mathbf{i}} + \frac{\partial}{\partial y}\hat{\mathbf{j}} + \frac{\partial}{\partial z}\hat{\mathbf{k}}\right) \cdot \left(x\hat{\mathbf{i}} + y\hat{\mathbf{j}} + z\hat{\mathbf{k}}\right)$$

$$= \frac{\partial x}{\partial x} + \frac{\partial y}{\partial y} + \frac{\partial z}{\partial z}$$

$$= 1 + 1 + 1 = 3$$

MCQ 1.3 The period of the signal $x(t) = 8\sin\left(0.8\pi t + \frac{\pi}{4}\right)$ is

(A) 0.4π s (B) 0.8π s

(C) 1.25 s (D) 2.5 s

SOL 1.3 Hence (D) is correct option.

Period of $x(t)$,

$$T = \frac{2\pi}{\omega}$$

$$= \frac{2\,\pi}{0.8\,\pi} = 2.5\,\text{sec}$$

MCQ 1.4 The system represented by the input-output relationship

$$y(t) = \int_{-\infty}^{5t} x(\tau)\,d\tau, t > 0$$

(A) Linear and causal (B) Linear but not causal

(C) Causal but not linear (D) Neither liner nor causal

SOL 1.4 Hence (B) is correct option.

Input output relationship

$$y(t) = \int_{-\infty}^{5t} x(\tau)\,d\tau, \qquad t > 0$$

Causality :

$y(t)$ depends on $x(5t), t > 0$ system is non-causal.

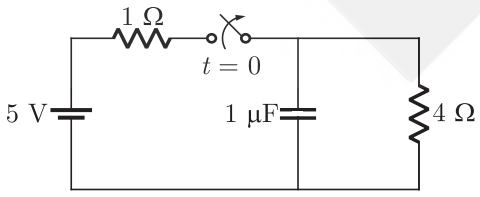
For example $t = 2$

$y(2)$ depends on $x(10)$ (future value of input)

Linearity :

Output is integration of input which is a linear function, so system is linear.

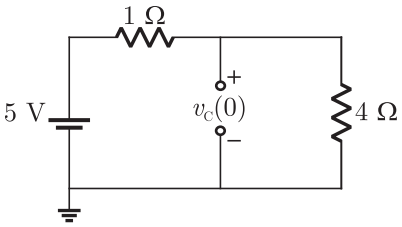
MCQ 1.5 The switch in the circuit has been closed for a long time. It is opened at $t = 0$. At $t = 0^+$, the current through the $1\,\mu$F capacitor is



(A) 0 A (B) 1 A

(C) 1.25 A (D) 5 A

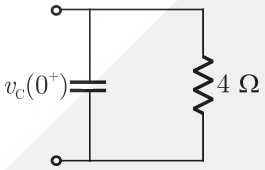
SOL 1.5 For $t < 0$, the switch was closed for a long time so equivalent circuit is



Voltage across capacitor at $t = 0$

$$v_c(0) = \frac{5}{4 \times 1} = 4 \text{ V}$$

Now switch is opened, so equivalent circuit is



For capacitor at $t = 0^+$

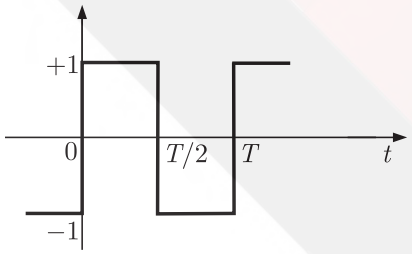
$v_c(0^+) = v_c(0) = 4$ V

current in 4 Ω resistor at $t = 0^+$, $i_1 = \frac{v_c(0^+)}{4} = 1$ A

so current in capacitor at $t = 0^+$, $i_c(0^+) = i_1 = 1$ A

Hence (B) is correct option.

MCQ 1.6 The second harmonic component of the periodic waveform given in the figure has an amplitude of

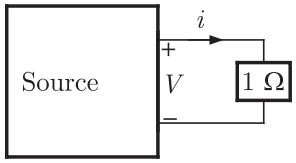


(A) 0 (B) 1

(C) $2/\pi$ (D) $\sqrt{5}$

SOL 1.6 Hence ( ) is correct Option

MCQ 1.7 As shown in the figure, a 1 Ω resistance is connected across a source that has a load line $v + i = 100$. The current through the resistance is



(A) 25 A (B) 50 A

(C) 100 A (C) 200 A

SOL 1.7 Thevenin equivalent across $1\,\Omega$ resistor can be obtain as following

Open circuit voltage $v_{th} = 100$ V $(i = 0)$

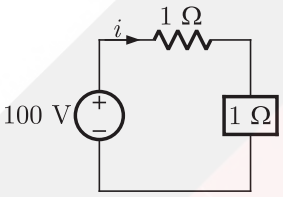
Short circuit current $i_{sc} = 100$ A $(v_{th} = 0)$

So,

$$R_{th} = \frac{v_{th}}{i_{sc}}$$

$$= \frac{100}{100} = 1\,\Omega$$

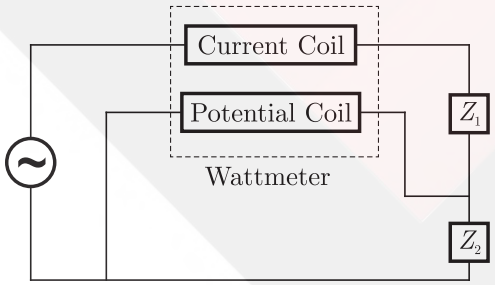
Equivalent circuit is



$$i = \frac{100}{1+1} = 50 \text{ A}$$

Hence (B) is correct option.

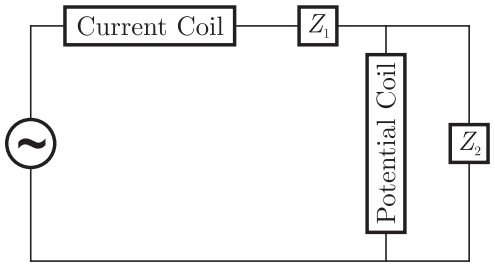
MCQ 1.8 A wattmeter is connected as shown in figure. The wattmeter reads.



(A) Zero always (B) Total power consumed by Z_1 and Z_2

(C) Power consumed by Z_1 (D) Power consumed by Z_2

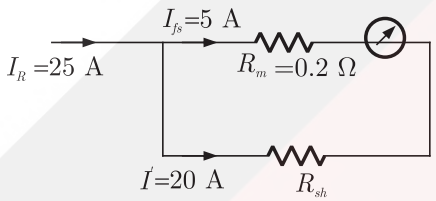
SOL 1.8 Since potential coil is applied across Z_2 as shown below



Wattmeter read power consumed by Z_2
Hence (D) is correct option.

MCQ 1.9 An ammeter has a current range of 0-5 A, and its internal resistance is 0.2 Ω. In order to change the range to 0-25 A, we need to add a resistance of
(A) 0.8 Ω in series with the meter
(B) 1.0 Ω in series with the meter
(C) 0.04 Ω in parallel with the meter
(D) 0.05 Ω in parallel with the meter

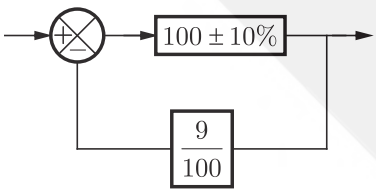
SOL 1.9 Given that full scale current is 5 A



$$\begin{aligned}\text{Current in shunt } I' &= I_R - I_{fs}\\ &= 25 - 5\\ &= 20 \text{ A}\\ 20 \times R_{sh} &= 5 \times 0.2\\ R_{sh} &= \frac{1}{20}\\ &= .05\,\Omega\end{aligned}$$

Hence (D) is correct option.

MCQ 1.10 As shown in the figure, a negative feedback system has an amplifier of gain 100 with $\pm 10\%$ tolerance in the forward path, and an attenuator of value 9/100 in the feedback path. The overall system gain is approximately :



(A) $10 \pm 1\%$ (B) $10 \pm 2\%$
(C) $10 \pm 5\%$ (D) $10 \pm 10\%$

SOL 1.10 Overall gain of the system is

$$g = \frac{100}{1 + 100\left(\frac{9}{100}\right)} = 10 \text{ (zero error)}$$

Gain with error

$$g = \frac{100 + 10\%}{1 + (100 + 10\%)\left(\frac{9}{100}\right)}$$

$$= \frac{110}{1 + \frac{110 \times 9}{100}}$$

$$= 10.091$$

$$\text{error } \Delta g = 10.091 - 10$$

$$\simeq 0.1$$

Similarly

$$g = \frac{100 - 10\%}{1 + (100 - 10\%)\frac{9}{100}}$$

$$= \frac{90}{1 + 90 \times \frac{9}{100}}$$

$$= 9.89$$

$$\text{error } \Delta g = 9.89 - 10$$

$$\simeq -0.1$$

$$\text{So gain } g = 10 \pm 0.1$$

$$= 10 \pm 1\%$$

Hence (A) is correct option.

MCQ 1.11 For the system $2/(s+1)$, the approximate time taken for a step response to reach 98% of the final value is

(A) 1 s (B) 2 s

(C) 4 s (D) 8 s

SOL 1.11 System is given as

$$H(s) = \frac{2}{(s+1)}$$

Step input $R(s) = \frac{1}{s}$

Output $Y(s) = H(s)\,R(s)$

$$= \frac{2}{(s+1)}\left(\frac{1}{s}\right)$$

$$= \frac{2}{s} - \frac{2}{(s+1)}$$

Taking inverse laplace transform

$$y(t) = (2 - 2e^{-t})\,u(t)$$

Final value of $y(t)$,

$$y_{ss}(t) = \lim_{t \to \infty} y(t) = 2$$

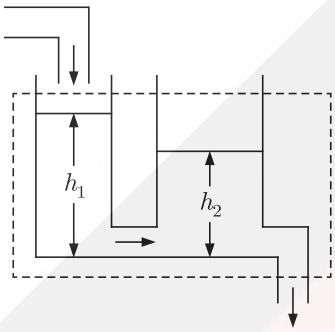
Let time taken for step response to reach 98% of its final value is t_s.

So,

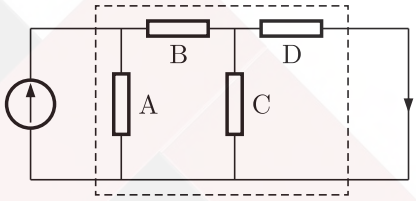
$$2 - 2e^{-t_s} = 2 \times 0.98$$
$$.02 = e^{-t_s}$$
$$t_s = \ln 50 = 3.91 \text{ sec.}$$

Hence (C) is correct option.

MCQ 1.12 If the electrical circuit of figure (B) is an equivalent of the coupled tank system of figure (A), then



(A) Coupled tank



(B) Electrical equivalent

(A) A, B are resistances and C, D capacitances

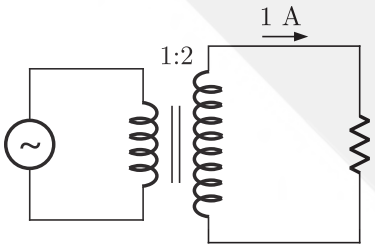
(B) A, C are resistances and B, D capacitances

(C) A, B are capacitances and C, D resistances

(D) A, C are capacitances and B, D resistances

SOL 1.12 Hence ( ) is correct Option

MCQ 1.13 A Single-phase transformer has a turns ratio 1:2, and is connected to a purely resistive load as shown in the figure. The magnetizing current drawn is 1 A, and the secondary current is 1 A. If core losses and leakage reactances are neglected, the primary current is



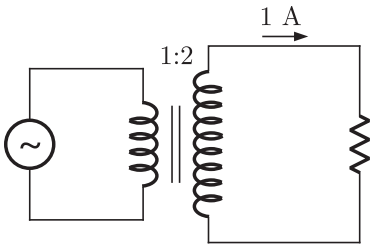
(A) 1.41 A

(B) 2 A

(C) 2.24 A

(D) 3 A

SOL 1.13 Given



$I_0 = 1$ amp (magnetizing current)

Primary current $I_P = ?$

$I_2 = 1$ A

I_2' = secondary current reffered to Primary

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

$I_P = \sqrt{i_0^2 + i_2^2}$

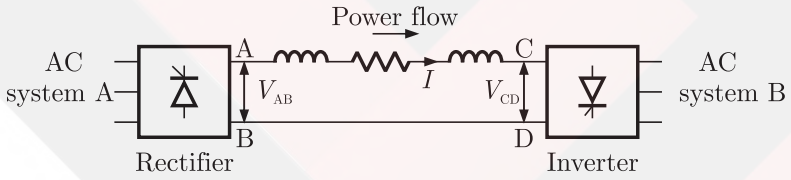
$= \sqrt{1+4}$

$= \sqrt{5}$

$= 2.24$ Amp

Hence (C) is correct option.

MCQ 1.14 Power is transferred from system A to system B by an HVDC link as shown in the figure. If the voltage V_{AB} and V_{CD} are as indicated in figure, and $I > 0$, then



(A) $V_{AB} < 0, V_{CD} < 0, V_{AB} > V_{CD}$ (B) $V_{AB} > 0, V_{CD} > 0, V_{AB} < V_{CD}$

(C) $V_{AB} > 0, V_{CD} > 0, V_{AB} > V_{CD}$ (D) $V_{AB} > 0, V_{CD} < 0$

SOL 1.14 Given that,

$I > 0$

$\because$ $V_{AB} > 0$ since it is Rectifier O/P

$V_{CD} > 0$ since it is Inverter I/P

$\because$ $I > 0$ so $V_{AB} > V_{CD}$, Than current will flow in given direction.

Hence (C) is correct option.

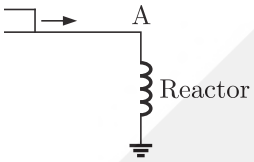
MCQ 1.15 A balanced three-phase voltage is applied to a star-connected induction motor, the phase to neutral voltage being V. The stator resistance, rotor resistance referred to the stator, stator leakage reactance, rotor leakage reactance referred to the stator, and the magnetizing reactance are denoted by r_s, r_r, X_s, X_r and X_m, respectively. The magnitude of the starting current of the motor is given by

(A) $\frac{V_s}{\sqrt{(r_s + r_r)^2 + (X_s + X_r)^2}}$ (B) $\frac{V_s}{\sqrt{r_s^2 + (X_s + X_m)^2}}$

(C) $\dfrac{V_s}{\sqrt{(r_s+r_r)^2+(X_m+X_r)^2}}$ (D) $\dfrac{V_s}{\sqrt{r_s^2+(X_m+X_r)^2}}$

SOL 1.15 Hence ( ) is Correct Option

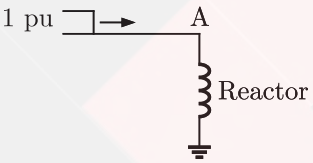
MCQ 1.16 Consider a step voltage of magnitude 1 pu travelling along a lossless transmission line that terminates in a reactor. The voltage magnitude across the reactor at the instant travelling wave reaches the reactor is



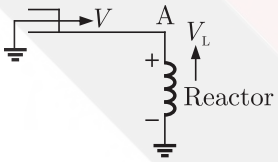
(A) -1 pu (B) 1 pu

(C) 2 pu (D) 3 pu

SOL 1.16 Given step voltage travel along lossless transmission line.



$\because$ Voltage wave terminated at reactor as.



By Applying KVL

$$V + V_L = 0$$
$$V_L = -V$$
$$V_L = -1 \text{ pu}$$

Hence (A) is correct option.

MCQ 1.17 Consider two buses connected by an impedence of $(0+5j)\,\Omega$. The bus '1' voltage is $100\angle 30^\circ$ V, and bus '2' voltage is $100\angle 0^\circ$ V. The real and reactive power supplied by bus '1' respectively are

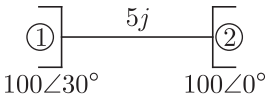
(A) 1000 W, 268 VAr (B) -1000 W, -134 VAr

(C) 276.9 W, -56.7 VAr (D) -276.9 W, 56.7 VAr

SOL 1.17 Given two buses connected by an Impedance of $(0+j5)\,\Omega$

The Bus '1' voltage is $100\angle 30^\circ$ V and Bus '2' voltage is $100\angle 0^\circ$ V

We have to calculate real and reactive power supply by bus '1'



$$\begin{aligned} P + jQ &= VI^* \\ &= 100\angle 30^\circ \left[\frac{100\angle 30^\circ - 100\angle 0^\circ}{5j}\right] \\ &= 100\angle 30^\circ \left[20\angle -60^\circ - 20\angle -90^\circ\right] \\ &= 2000\angle -30^\circ - 2000\angle -60^\circ \\ P + jQ &= 1035\angle 15^\circ \end{aligned}$$

real power $P = 1035\cos 15^\circ = 1000$ W

reactive power $Q = 1035\sin 15^\circ$

$= 268$ VAR

Hence (A) is correct option.

MCQ 1.18 A three-phase, 33 kV oil circuit breaker is rated 1200 A, 2000 MVA, 3 s. The symmetrical breaking current is

(A) 1200 A (B) 3600 A

(C) 35 kA (D) 104.8 kA

SOL 1.18 Given 3-ϕ, 33 kV oil circuit breaker.

Rating 1200 A, 2000 MVA, 3 sec

Symmetrical breaking current $I_b = ?$

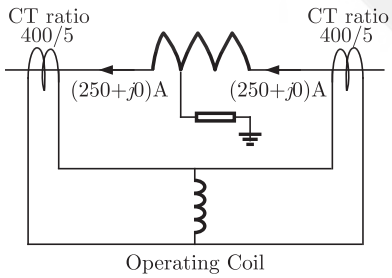
$$I_b = \frac{MVA}{\sqrt{3}\text{ kV}}\text{ kA}$$

$$= \frac{2000}{\sqrt{3}\times 33} = 34.99\text{ kA}$$

$$\simeq 35\text{ kA}$$

Hence (C) is correct option.

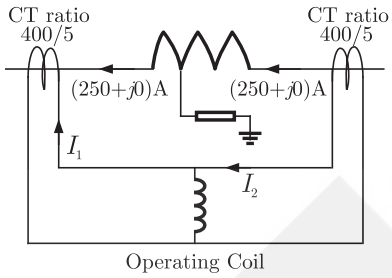
MCQ 1.19 Consider a stator winding of an alternator with an internal high-resistance ground fault. The currents under the fault condition are as shown in the figure The winding is protected using a differential current scheme with current transformers of ratio 400/5 A as shown. The current through the operating coils is



(A) 0.1875 A (B) 0.2 A

(C) 0.375 A (D) 60 kA

SOL 1.19 Given a stator winding of an alternator with high internal resistance fault as shown in figure



Current through operating coil

$$I_1 = 220 \times \frac{5}{400}\ \text{A},\ I_2 = 250 \times \frac{5}{400}\ \text{A}$$

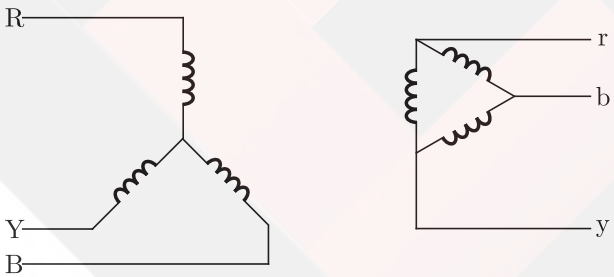
Operating coil current $= I_2 - I_1$

$= (250 - 220) \times 5/400$

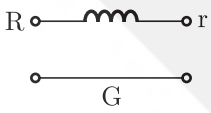
$= 0.375$ Amp

Hence (C) is correct option.

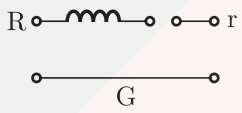
MCQ 1.20 The zero-sequence circuit of the three phase transformer shown in the figure is



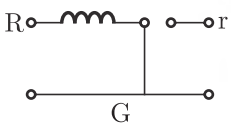
(A)



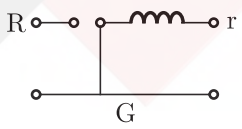
(B)



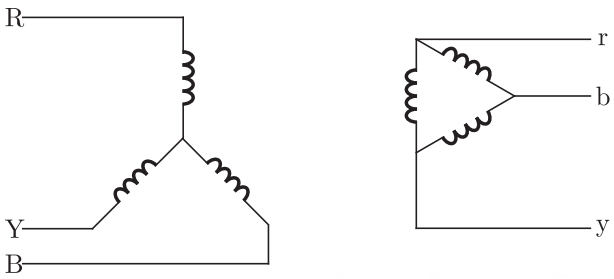
(C)



(D)

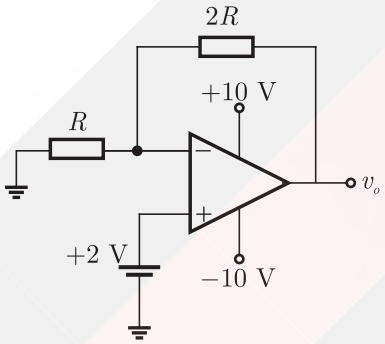


SOL 1.20 Zero sequence circuit of 3-ϕ transformer shown in figure is as following:



No option seems to be appropriate but (C) is the nearest.
Hence (C) is correct option.

MCQ 1.21 Given that the op-amp is ideal, the output voltage v_o is



(A) 4 V (B) 6 V
(C) 7.5 V (D) 12.12 V

SOL 1.21 Since the op-amp is ideal

$$v_+ = v_- = +2 \text{ volt}$$

By writing node equation

$$\frac{v_- - 0}{R} + \frac{v_- - v_o}{2R} = 0$$

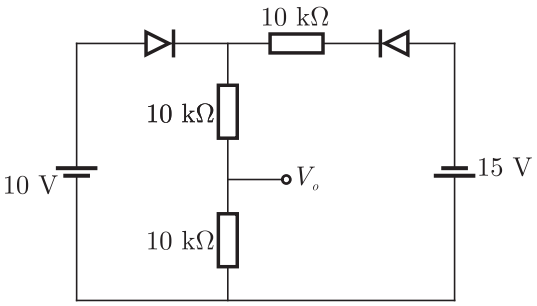
$$\frac{2}{R} + \frac{(2 - v_o)}{2R} = 0$$

$$4 + 2 - v_o = 0$$

$$v_o = 6 \text{ volt}$$

Hence (B) is correct option.

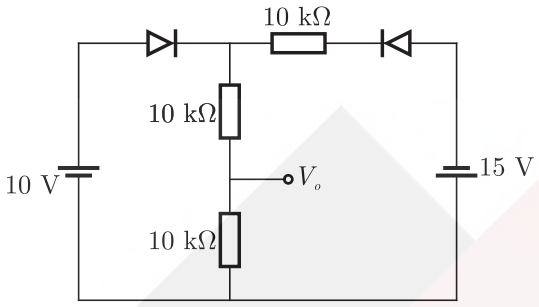
MCQ 1.22 Assuming that the diodes in the given circuit are ideal, the voltage V_0 is



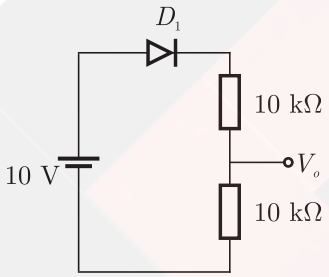
(A) 4 V (B) 5 V

(C) 7.5 V (D) 12.12 V

SOL 1.22 Given circuit is,



We can observe that diode D_2 is always off, whether D_1,is on or off. So equivalent circuit is.



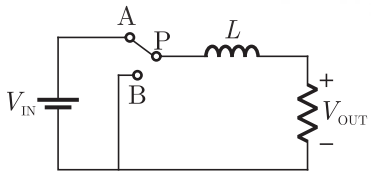
D_1 is ON in this condition and

$$V_0 = \frac{10}{10+10} \times 10$$

$$= 5 \text{ volt}$$

Hence (B) is correct option.

MCQ 1.23 The power electronic converter shown in the figure has a single-pole double-throw switch. The pole P of the switch is connected alternately to throws A and B. The converter shown is a



(A) step down chopper (buck converter)

(B) half-wave rectifier

(C) step-up chopper (boost converter)

(D) full-wave rectifier

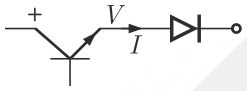
SOL 1.23 The figure shows a step down chopper circuit.

$\because \quad V_{out} = DV_{in}$

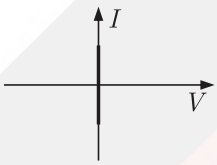
where, $D =$ Duty cycle and $D < 1$

Hence (A) is correct option

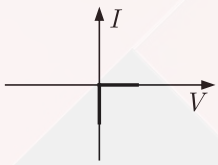
MCQ 1.24 Figure shows a composite switch consisting of a power transistor (BJT) in series with a diode. Assuming that the transistor switch and the diode are ideal, the I-V characteristic of the composite switch is



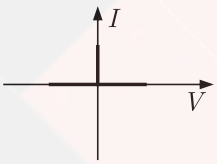
(A)



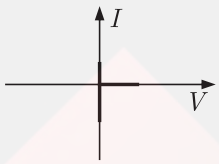
(B)



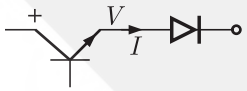
(C)



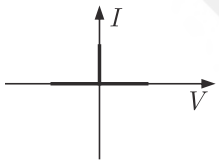
(D)



SOL 1.24 Given figure as



The I-V characteristic are as

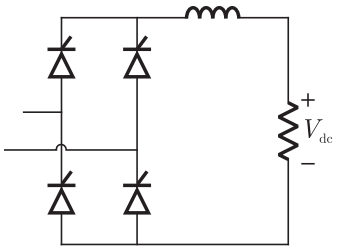


Since diode connected in series so I can never be negative.

When current flows voltage across switch is zero and when current is zero than there may be any voltage across switch.

Hence (C) is correct option.

MCQ 1.25 The fully controlled thyristor converter in the figure is fed from a single-phase source. When the firing angle is 0°, the dc output voltage of the converter is 300 V. What will be the output voltage for a firing angle of 60°, assuming continuous conduction



(A) 150 V (B) 210 V

(C) 300 V (D) 100π V

SOL 1.25 Given fully-controlled thyristor converter, when firing angle $\alpha = 0$, dc output voltage $V_{dc_0} = 300$ V

If $\alpha = 60^\circ$, then $V_{dc} = ?$

we know for fully-controlled converter

$$V_{dc_0} = \frac{2\sqrt{2}\, V_{dc_1}}{\pi}\cos\alpha$$

$\because$ $\alpha = 0$, $V_{dc_0} = 300$ V

$$300 = \frac{2\sqrt{2}\, V_{dc_1}}{\pi}\cos 0^\circ$$

$$V_{dc_1} = \frac{300\pi}{2\sqrt{2}}$$

at $\alpha = 60^\circ$, $V_{dc_2} = ?$

$$V_{dc_2} = \frac{2\sqrt{2}}{\pi} \times \frac{300\pi}{2\sqrt{2}}\cos 60^\circ$$

$$= 300 \times \frac{1}{2} = 150 \text{ V}$$

Hence (A) is correct option.

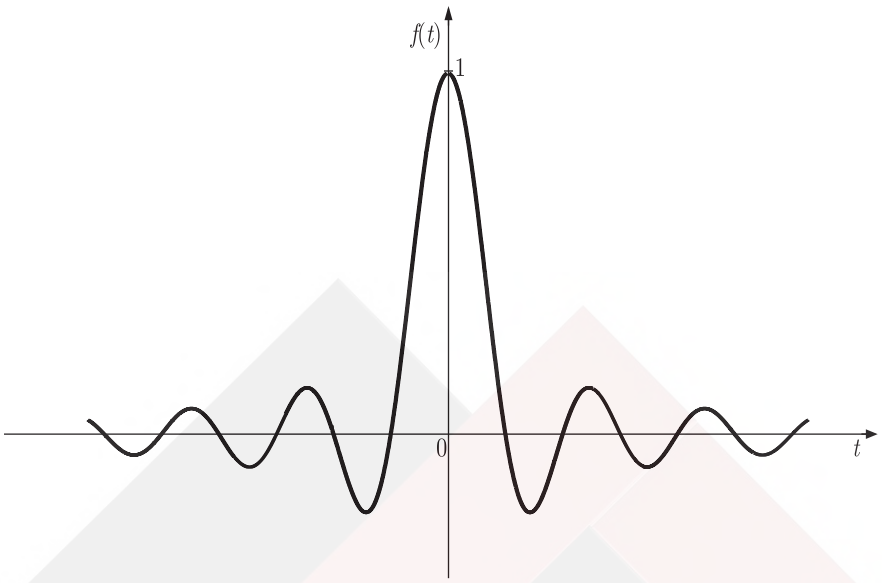
Q. 26 - 51 Carry Two Marks Each

MCQ 1.26 At $t = 0$, the function $f(t) = \dfrac{\sin t}{t}$ has

(A) a minimum (B) a discontinuity

(C) a point of inflection (D) a maximum

SOL 1.26 Function $f(t) = \dfrac{\sin t}{t} = \sin ct$ has a maxima at $t = 0$ as shown below



Hence (D) is correct option.

MCQ 1.27 A box contains 4 white balls and 3 red balls. In succession, two balls are randomly and removed form the box. Given that the first removed ball is white, the probability that the second removed ball is red is

(A) 1/3 (B) 3/7

(C) 1/2 (D) 4/7

SOL 1.27 No of white balls= 4, no of red balls= 3

If first removed ball is white then remaining no of balls= 6 (3 white, 3 red)

we have 6 balls, one ball can be choose in ${}^{6}C_{1}$ ways, since there are three red balls so probability that the second ball is red is

$$P = \frac{{}^{6}C_{1}}{{}^{3}C_{1}}$$

$$= \frac{3}{6}$$

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

Hence (C) is correct option.

MCQ 1.28 An eigenvector of $P = \begin{pmatrix} 1 & 1 & 0 \\ 0 & 2 & 2 \\ 0 & 0 & 3 \end{pmatrix}$ is

(A) $\begin{bmatrix} -1 & 1 & 1 \end{bmatrix}^{T}$ (B) $\begin{bmatrix} 1 & 2 & 1 \end{bmatrix}^{T}$

(C) $\begin{bmatrix} 1 & -1 & 2 \end{bmatrix}^{T}$ (D) $\begin{bmatrix} 2 & 1 & -1 \end{bmatrix}^{T}$

SOL 1.28 Let eigen vector

$$\mathbf{X} = \begin{bmatrix} x_1 & x_2 & x_3 \end{bmatrix}^{T}$$

Eigen vector corresponding to $\lambda_1 = 1$

$$\left[A \;\; -\lambda_1 \;\; I\right]\mathbf{X} = 0$$

$$\begin{bmatrix}0 & 1 & 0\\ 0 & 1 & 2\\ 0 & 0 & 2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} = \begin{bmatrix}0\\ 0\\ 0\end{bmatrix}$$

$$x_2 = 0$$

$$x_2 + 2x_3 = 0 \Rightarrow x_3 = 0 \text{ (not given in the option)}$$

Eigen vector corresponding to $\lambda_2 = 2$

$$\left[A \;\; -\lambda_2 \;\; I\right]\mathbf{X} = 0$$

$$\begin{bmatrix}-1 & 1 & 0\\ 0 & 0 & 2\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} = \begin{bmatrix}0\\ 0\\ 0\end{bmatrix}$$

$$-x_1 + x_2 = 0$$

$$2x_3 = 0 \Rightarrow x_3 = 0 \text{ (not given in options.)}$$

Eigen vector corresponding to $\lambda_3 = 3$

$$\left[A \;\; -\lambda_3 \;\; I\right]\mathbf{X} = 0$$

$$\begin{bmatrix}-2 & 1 & 0\\ 0 & -1 & 2\\ 0 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} = \begin{bmatrix}0\\ 0\\ 0\end{bmatrix}$$

$$-2x_1 + x_2 = 0$$

$$-x_2 + 2x_3 = 0$$

Put $x_1 = 1, x_2 = 2$ and $x_3 = 1$

So Eigen vector

$$\mathbf{X} = \begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} = \begin{bmatrix}1\\ 2\\ 1\end{bmatrix} = \begin{bmatrix}1 & 2 & 1\end{bmatrix}^{\mathrm{T}}$$

Hence (B) is correct option.

MCQ 1.29 For the differential equation $\frac{d^2x}{dt^2} + 6\frac{dx}{dt} + 8x = 0$ with initial conditions $x(0) = 1$ and $\left.\frac{dx}{dt}\right|_{t=0} = 0$, the solution is

(A) $x(t) = 2e^{-6t} - e^{-2t}$ (B) $x(t) = 2e^{-2t} - e^{-4t}$

(C) $x(t) = -e^{-6t} + 2e^{-4t}$ (D) $x(t) = e^{-2t} + 2e^{-4t}$

SOL 1.29 Hence (B) is correct option.

$$\frac{d^2x}{dt^2} + 6\frac{dx}{dt} + 8x = 0$$

Taking Laplace transform (with initial condition) on both sides

$$s^2X(s) - sx(0) - x'(0) + 6\left[sX(s) - x(0)\right] + 8X(s) = 0$$

$$s^2X(s) - s(1) - 0 + 6[sX(s) - 1] + 8X(s) = 0$$
$$X(s)[s^2 + 6s + 8] - s - 6 = 0$$

$$X(s) = \frac{(s+6)}{(s^2+6s+8)}$$

By partial fraction

$$X(s) = \frac{2}{s+2} - \frac{1}{s+4}$$

Taking inverse Laplace transform

$$x(t) = (2e^{-2t} - e^{-4t})$$

MCQ 1.30 For the set of equations, $x_1 + 2x_2 + x_3 + 4x_4 = 2$ and $3x_1 + 6x_2 + 3x_3 + 12x_4 = 6$. The following statement is true.

(A) Only the trivial solution $x_1 = x_2 = x_3 = x_4 = 0$ exists

(B) There are no solutions

(C) A unique non-trivial solution exists

(D) Multiple non-trivial solutions exist

SOL 1.30 Set of equations

$$x_1 + 2x_2 + x_3 + 4x_4 = 2 \quad .....(1)$$
$$3x_1 + 6x_2 + 3x_3 + 12x_4 = 6 \quad .....(2)$$

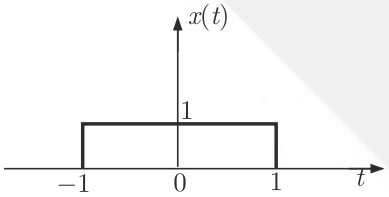
or $3(x_1 + 2x_2 + x_3 + 4x_4) = 3 \times 2$

Equation (2) is same as equation(1) except a constant multiplying factor of 3.

So infinite (multiple) no. of non-trivial solution exists.

Hence (C) is correct option.

MCQ 1.31 $x(t)$ is a positive rectangular pulse from $t = -1$ to $t = +1$ with unit height as shown in the figure. The value of $\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega$ {where $X(\omega)$ is the Fourier transform of $x(t)$} is.



(A) 2 (B) 2π

(C) 4 (D) 4π

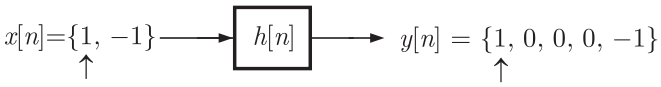
SOL 1.31 By parsval's theorem

$$\frac{1}{2\pi}\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega = \int_{-\infty}^{\infty} x^2(t)\, dt$$

$$\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega = 2\pi \times 2 = 4\pi$$

Hence option (D) is correct

MCQ 1.32 Given the finite length input $x[n]$ and the corresponding finite length output $y[n]$ of an LTI system as shown below, the impulse response $h[n]$ of the system is



(A) $h[n] = \underset{\uparrow}{\{1,0,0,1\}}$ (B) $h[n] = \underset{\uparrow}{\{1,0,1\}}$

(C) $h[n] = \underset{\uparrow}{\{1,1,1,1\}}$ (D) $h[n] = \underset{\uparrow}{\{1,1,1\}}$

SOL 1.32 Given sequences

$$x[n] = \underset{\uparrow}{\{1,-1\}}, \quad 0 \le n \le 1$$

$$y[n] = \underset{\uparrow}{\{1,0,0,0,-1\}}, \quad 0 \le n \le 4$$

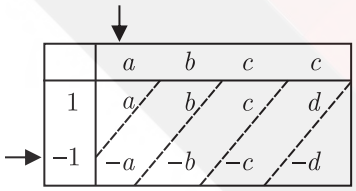
If impulse response is $h[n]$ then

$$y[n] = h[n] * x[n]$$

Length of convolution $(y[n])$ is 0 to 4, $x[n]$ is of length 0 to 1 so length of $h[n]$ will be 0 to 3.

Let $$h[n] = \underset{\uparrow}{\{a,b,c,d\}}$$

Convolution



$$y[n] = \underset{\uparrow}{\{a, -a+b, -b+c, -c+d, -d\}}$$

By comparing

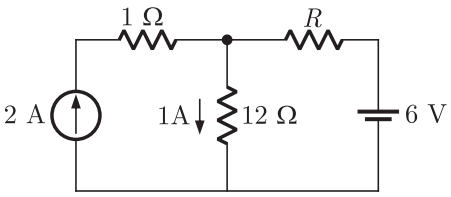
$$\begin{aligned} a &= 1 \\ -a+b &= 0 \Rightarrow b = a = 1 \\ -b+c &= 0 \Rightarrow c = b = 1 \\ -c+d &= 0 \Rightarrow d = c = 1 \end{aligned}$$

So, $$h[n] = \underset{\uparrow}{\{1,1,1,1\}}$$

Hence option (C) is correct.

MCQ 1.33 If the $12\,\Omega$ resistor draws a current of 1 A as shown in the figure, the value of

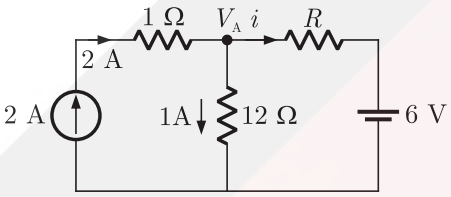
resistance R is



(A) $4\,\Omega$ (B) $6\,\Omega$

(C) $8\,\Omega$ (D) $18\,\Omega$

SOL 1.33 The circuit is



Current in $R\,\Omega$ resistor is

$$i = 2 - 1 = 1 \text{ A}$$

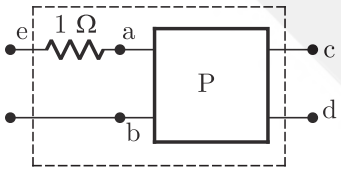
Voltage across $12\,\Omega$ resistor is

$$V_A = 1 \times 12 = 12 \text{ V}$$

So,
$$i = \frac{V_A - 6}{R} = \frac{12 - 6}{1} = 6\,\Omega$$

Hence (B) is correct option.

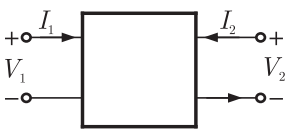
MCQ 1.34 The two-port network P shown in the figure has ports 1 and 2, denoted by terminals (a,b) and (c,d) respectively. It has an impedance matrix Z with parameters denoted by Z_{ij}. A $1\,\Omega$ resistor is connected in series with the network at port 1 as shown in the figure. The impedance matrix of the modified two-port network (shown as a dashed box) is

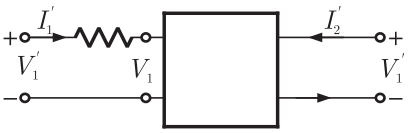


(A) $\begin{pmatrix} Z_{11}+1 & Z_{12}+1 \\ Z_{21} & Z_{22}+1 \end{pmatrix}$ (B) $\begin{pmatrix} Z_{11}+1 & Z_{12} \\ Z_{21} & Z_{22}+1 \end{pmatrix}$

(C) $\begin{pmatrix} Z_{11}+1 & Z_{12} \\ Z_{21} & Z_{22} \end{pmatrix}$ (D) $\begin{pmatrix} Z_{11}+1 & Z_{12} \\ Z_{21}+1 & Z_{22} \end{pmatrix}$

SOL 1.34 Hence (C) is correct option.





$V_1 = Z_{11}I_1 + Z_{12}I_2$ $\qquad V'_1 = Z'_{11}I'_1 + Z'_{12}I'_2$

$V_2 = Z_{21}I_1 + Z_{22}I_2$ $\qquad V'_2 = Z'_{21}I'_1 + Z'_{22}I'_2$

Here, $I_1 = I'_1,\ I_2 = I'_2$

When $R = 1\,\Omega$ is connected

$$V'_1 = V_1 + I'_1 \times 1,$$
$$V'_1 = V_1 + I_1$$
$$V'_1 = Z_{11}I_1 + Z_{12}I_2 + I_1$$
$$V'_1 = Z_{11}I_1 + Z_{12}I_2 + I_1$$
$$V'_1 = (Z_{11}+1)I_1 + Z_{12}I_2$$
$$V'_1 = (Z_{11}+1)I'_1 + Z_{12}I'_2$$

So, $\quad Z'_{11} = Z_{11} + 1$

$$Z'_{12} = Z_{12}$$

Similarly for output port

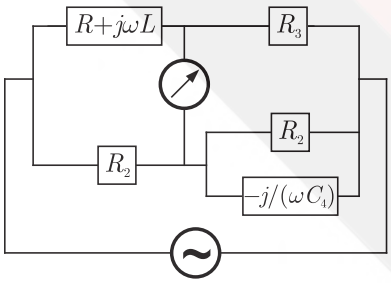
$$V'_2 = Z'_{21}I'_1 + Z'_{22}I'_2$$
$$V'_2 = Z'_{21}I_1 + Z'_{22}I_2$$

So, $Z'_{21} = Z_{21},\ Z'_{22} = Z_{22}$

Z-matrix is

$$Z = \begin{bmatrix} Z_{11}+1 & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}$$

MCQ 1.35 The Maxwell's bridge shown in the figure is at balance. The parameters of the inductive coil are.



(A) $R = R_2R_3/R_4, L = C_4R_2R_3$ $\qquad$ (B) $L = R_2R_3/R_4, R = C_4R_2R_3$

(C) $R = R_4/R_2R_3, L = 1/(C_4R_2R_3)$ $\qquad$ (D) $L = R_4/R_2R_3, R = 1/(C_4R_2R_3)$

SOL 1.35 At balance condition

$$(R + j\omega L)\left(R_4 \parallel \frac{-j}{\omega C_4}\right) = R_2R_3$$

$$(R+j\omega L)\frac{\dfrac{-jR_4}{\omega C_4}}{\left(R_4-\dfrac{j}{\omega C_4}\right)}=R_2R_3$$

$$\frac{-jRR_4}{\omega C_4}+\frac{\omega LR_4}{\omega C_4}=R_2R_3R_4-\frac{jR_2R_3}{\omega C_4}$$

$$\frac{-jRR_4}{\omega C_4}+\frac{LR_4}{C_4}=R_2R_3R_4-\frac{jR_2R_3}{\omega C_4}$$

By comparing real & imaginary parts.

$$\frac{RR_4}{\omega C_4}=\frac{R_2R_3}{\omega C_4}$$

$$R=\frac{R_2R_3}{R_4}$$

similarly,

$$\frac{LR_4}{C_4}=R_2R_3R_4$$

$$L=R_2R_3C_4$$

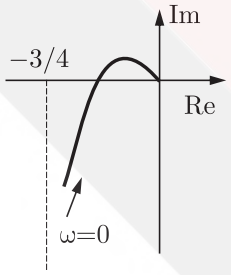
Hence (A) is correct option.

MCQ 1.36 The frequency response of

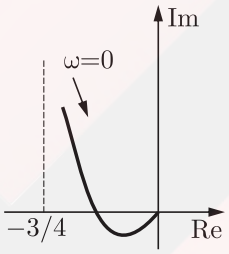
$$G(s)=\frac{1}{s(s+1)(s+2)}$$

plotted in the complex $G(j\omega)$ plane (for $0<\omega<\infty$) is

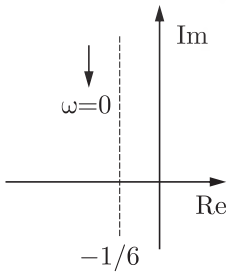
(A)



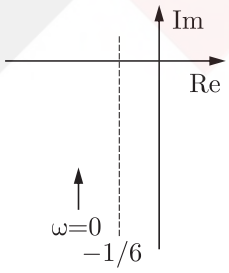
(B)



(C)



(D)



SOL 1.36 Hence (A) is correct option

Given $$G(s)=\frac{1}{s(s+1)(s+2)}$$

$$G(j\omega) = \frac{1}{j\omega(j\omega+1)(j\omega+2)}$$

$$|G(j\omega)| = \frac{1}{\omega\sqrt{\omega^2+1}\sqrt{\omega^2+4}}$$

$$\angle G(j\omega) = -90^\circ - \tan^{-1}(\omega) - \tan^{-1}(\omega/2)$$

In nyquist plot

For $\omega = 0$, $|G(j\omega)| = \infty$

$\angle G(j\omega) = -90^\circ$

For $\omega = \infty$, $|G(j\omega)| = 0$

$\angle G(j\omega) = -90^\circ - 90^\circ - 90^\circ$

$= -270^\circ$

Intersection at real axis

$$G(j\omega) = \frac{1}{j\omega(j\omega+1)(j\omega+2)}$$

$$= \frac{1}{j\omega(-\omega^2+j3\omega+2)}$$

$$= \frac{1}{-3\omega^2+j\omega(2-\omega^2)} \times \frac{-3\omega^2-j\omega(2-\omega^2)}{-3\omega^2-j\omega(2-\omega^2)}$$

$$= \frac{-3\omega^2-j\omega(2-\omega^2)}{9\omega^4+\omega^2(2-\omega^2)^2}$$

$$= \frac{-3\omega^2}{9\omega^4+\omega^2(2-\omega^2)^2} - \frac{j\omega(2-\omega^2)}{9\omega^4+\omega^2(2-\omega^2)^2}$$

At real axis

$$\text{Im}[G(j\omega)] = 0$$

So, $$\frac{\omega(2-\omega^2)}{9\omega^4+\omega^2(2-\omega^2)} = 0$$

$$2-\omega^2 = 0 \Rightarrow \omega = \sqrt{2} \text{ rad/sec}$$

At $\omega = \sqrt{2}$ rad/sec, magnitude response is

$$|G(j\omega)|_{at\ \omega=\sqrt{2}} = \frac{1}{\sqrt{2}\sqrt{2+1}\sqrt{2+4}} = \frac{1}{6} < \frac{3}{4}$$

MCQ 1.37 The system $\dot{\boldsymbol{X}} = A\boldsymbol{X} + B\boldsymbol{u}$ with $A = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$ is

(A) Stable and controllable

(B) Stable but uncontrollable

(C) Unstable but controllable

(D) Unstable and uncontrollable

SOL 1.37 Stability :

Eigen value of the system are calculated as

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

$$A - \lambda I = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix} - \begin{bmatrix} \lambda & 0 \\ 0 & \lambda \end{bmatrix}$$

$$= \begin{bmatrix} -1-\lambda & 2 \\ 0 & 2-\lambda \end{bmatrix}$$

$$|A - \lambda I| = (-1-\lambda)(2-\lambda) - 2 \times 0 = 0$$

$$\Rightarrow \quad \lambda_1, \lambda_2 = -1, 2$$

Since eigen values of the system are of opposite signs, so it is unstable

Controllability :

$$A = \begin{bmatrix} -1 & 2 \\ 0 & 2 \end{bmatrix},\ B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$AB = \begin{bmatrix} 2 \\ 2 \end{bmatrix}$$

$$[B : AB] = \begin{bmatrix} 0 & 2 \\ 1 & 2 \end{bmatrix}$$

$$[B : AB] \neq 0$$

So it is controllable.

Hence (C) is correct option.

MCQ 1.38 The characteristic equation of a closed-loop system is $s(s+1)(s+3)k(s+2) = 0, k > 0$. Which of the following statements is true ?

(A) Its root are always real

(B) It cannot have a breakaway point in the range $-1 < \text{Re}[s] < 0$

(C) Two of its roots tend to infinity along the asymptotes $\text{Re}[s] = -1$

(D) It may have complex roots in the right half plane.

SOL 1.38 Given characteristic equation

$$s(s+1)(s+3) + K(s+2) = 0; \qquad K > 0$$

$$s(s^2 + 4s + 3) + K(s+2) = 0$$

$$s^3 + 4s^2 + (3+K)s + 2K = 0$$

From Routh's tabulation method

s^3	1	$3+K$
s^2	4	$2K$
s^1	$\frac{4(3+K) - 2K(1)}{4} = \frac{12+2K}{4} > 0$	
s^0	$2K$	

There is no sign change in the first column of routh table, so no root is lying in right half of s-plane.

For plotting root locus, the equation can be written as

$$1 + \frac{K(s+2)}{s(s+1)(s+3)} = 0$$

Open loop transfer function $G(s) = \dfrac{K(s+2)}{s(s+1)(s+3)}$

Root locus is obtained in following steps:

- No. of poles $n = 3$, at $s = 0, s = -1$ and $s = -3$
- No. of Zeroes $m = 1$, at $s = -2$
- The root locus on real axis lies between $s = 0$ and $s = -1$, between $s = -3$ and $s = -2$.
- Breakaway point lies between open loop poles of the system. Here breakaway point lies in the range $-1 < \text{Re}[s] < 0$.
- Asymptotes meet on real axis at a point C, given by

$$C = \frac{\sum \text{real part of poles} - \sum \text{real parts of zeroes}}{n - m}$$

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

$$= -1$$

As no. of poles is 3, so two root loci branches terminates at infinity along asymptotes $\text{Re}(s) = -1$

Hence (C) is correct option.

MCQ 1.39 A 50 Hz synchronous generator is initially connected to a long lossless transmission line which is open circuited at the receiving end. With the field voltage held constant, the generator is disconnected from the transmission line. Which of the following may be said about the steady state terminal voltage and field current of the generator ?

(A) The magnitude of terminal voltage decreases, and the field current does not change.

(B) The magnitude of terminal voltage increases, and the field current does not change.

(C) The magnitude of terminal voltage increases, and the field current increases

(D) The magnitude of terminal voltage does not change and the field current decreases.

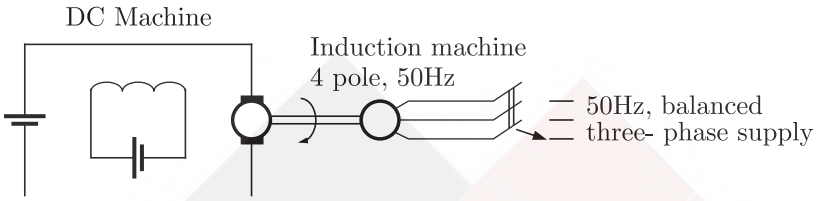
SOL 1.39 Given that

A 50 Hz Generator is initially connected to a long lossless transmission line which is open circuited as receiving end as shown in figure.

Due to ferranti effect the magnitude of terminal voltage does not change, and the field current decreases.

Hence (D) is correct option.

MCQ 1.40 A separately excited dc machine is coupled to a 50 Hz, three-phase, 4-pole induction machine as shown in figure. The dc machine is energized first and the machines rotate at 1600 rpm. Subsequently the induction machine is also connected to a 50 Hz, three-phase source, the phase sequence being consistent with the direction of rotation. In steady state



(A) both machines act as generator

(B) the dc machine acts as a generator, and the induction machine acts as a motor

(C) the dc machine acts as a motor, and the induction machine acts as a generator

(D) both machines act as motors

SOL 1.40 Synchronize speed of induction machine

$$N_s = \frac{120f}{P} = \frac{120 \times 50}{4} = 1500 \text{ rpm}$$

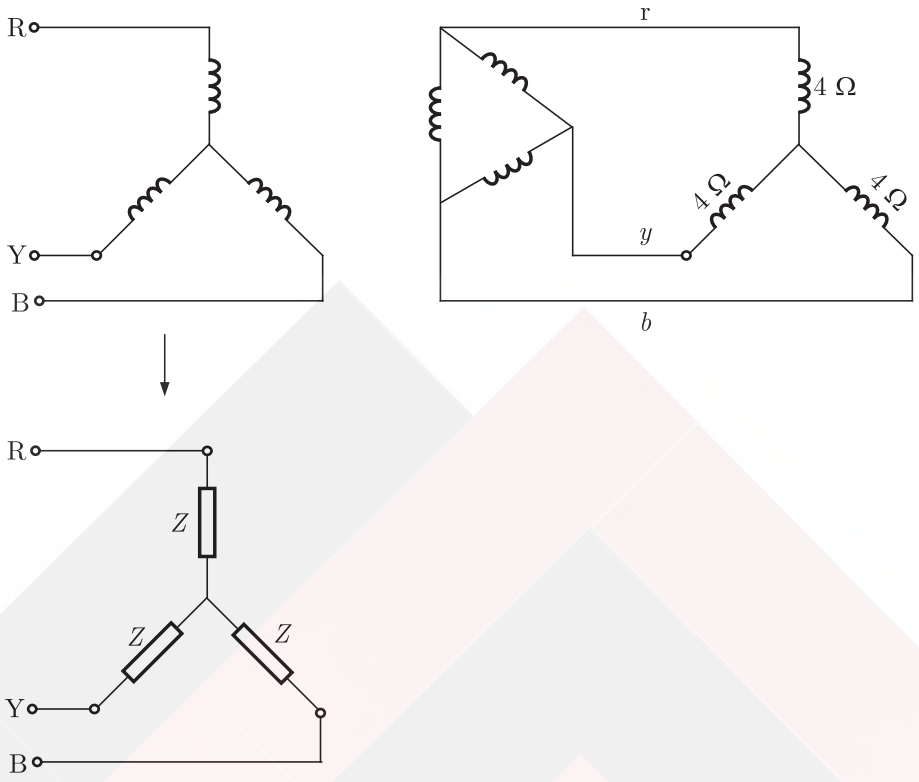
$$\text{Speed of machine} = 1600 \text{ rpm} = \text{Actual speed of induction machine}$$

$$\text{slip} = \frac{1500 - 1600}{1500} = \frac{-1}{15} = -0.066 (\text{negative})$$

Hence induction machine acts as induction generator and dc machine as dc motor. Hence (C) is correct option.

MCQ 1.41 A balanced star-connected and purely resistive load is connected at the secondary of a star-delta transformer as shown in figure. The line-to line voltage rating of the transformer is 110 V/200 V.

Neglecting the non-idealities of the transformer, the impedance Z of the equivalent star-connected load, referred to the primary side of the transformer, is

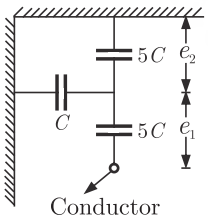


(A) $(3+j0)\,\Omega$ (B) $(0.866-j0.5)\,\Omega$

(C) $(0.866+j0.5)\,\Omega$ (D) $(1+j0)\,\Omega$

SOL 1.41 Hence ( ) is correct Option

MCQ 1.42 Consider a three-phase, 50 Hz, 11 kV distribution system. Each of the conductors is suspended by an insulator string having two identical porcelain insulators. The self capacitance of the insulator is 5 times the shunt capacitance between the link and the ground, as shown in the figures. The voltages across the two insulators are



(A) $e_1 = 3.74\,\text{kV}, e_2 = 2.61\,\text{kV}$ (B) $e_1 = 3.46\,\text{kV}, e_2 = 2.89\,\text{kV}$

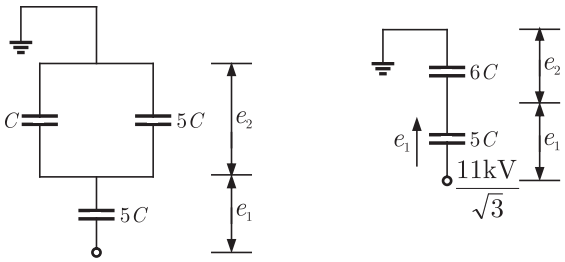
(C) $e_1 = 6.0\,\text{kV}, e_2 = 4.23\,\text{kV}$ (D) $e_1 = 5.5\,\text{kV}, e_2 = 5.5\,\text{kV}$

SOL 1.42 Given

3-ϕ, 50 Hz, 11 kV distribution system

We have to find out $e_1, e_2 = ?$

Equivalent circuit is as following



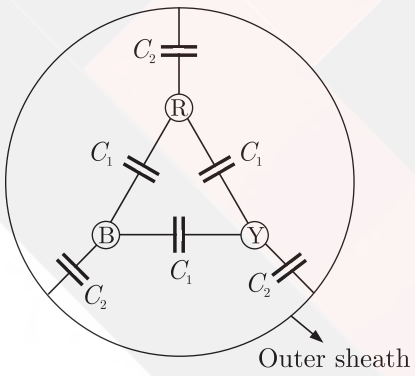
$$e_1 = \frac{\frac{11}{\sqrt{3}}(6C)}{6C+5C} = \frac{11}{\sqrt{3}} \times \frac{6}{11} = 3.46 \text{ kV}$$

$$e_2 = \frac{11}{\sqrt{3}} \times \frac{5}{11}$$

$$= 2.89 \text{ kV}$$

Hence (B) is correct option.

MCQ 1.43 Consider a three-core, three-phase, 50 Hz, 11 kV cable whose conductors are denoted as R, Y and B in the figure. The inter-phase capacitance(C_1) between each line conductor and the sheath is $0.4\,\mu\text{F}$. The per-phase charging current is



(A) 2.0 A (B) 2.4 A

(C) 2.7 A (D) 3.5 A

SOL 1.43 Given

3-ϕ, 50 Hz, 11 kV cable

$$C_1 = 0.2\,\mu\text{F}$$

$$C_2 = 0.4\,\mu\text{F}$$

Charging current I_C per phase = ?

Capacitance Per Phase $C = 3C_1 + C_2$

$$C = 3 \times 0.2 + 0.4 = 1\,\mu\text{F}$$

$$\omega = 2\pi f = 314$$

$$\text{Changing current } I_C = \frac{V}{X_C} = V(\omega C)$$

$$= \frac{11 \times 10^3}{\sqrt{3}} \times 314 \times 1 \times 10^{-6}$$

$$= 2 \text{ Amp}$$

Hence (A) is correct option

MCQ 1.44 For the power system shown in the figure below, the specifications of the components are the following :

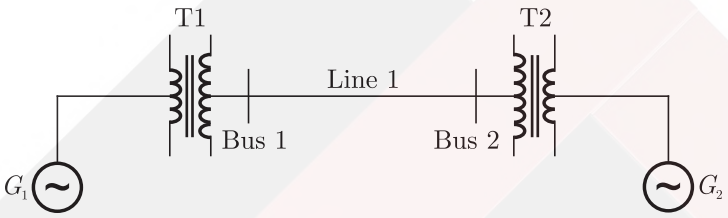
G_1: 25 kV, 100 MVA, $X = 9\%$

G_2: 25 kV, 100 MVA, $X = 9\%$

T_1: 25 kV/220 kV, 90 MVA, $X = 12\%$

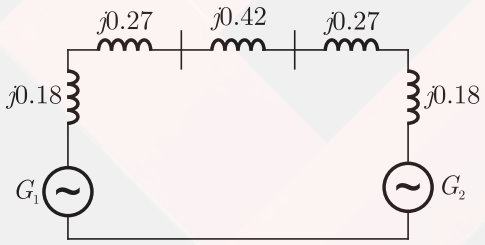
T_2: 220 kV/25 kV, 90 MVA, $X = 12\%$

Line 1: 200 kV, $X = 150$ ohms

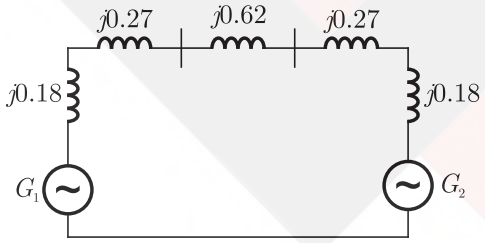


Choose 25 kV as the base voltage at the generator G_1, and 200 MVA as the MVA base. The impedance diagram is

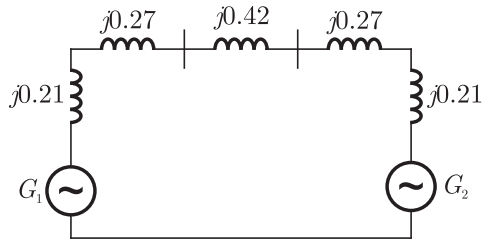
(A)



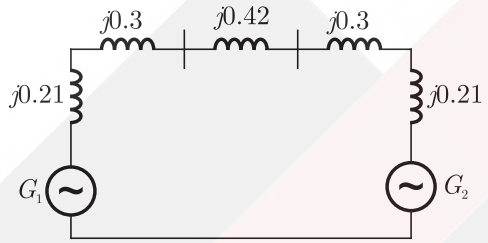
(B)



(C)



(D)



SOL 1.44 Generator G_1 and G_2

$$X_{G1} = X_{G2} = X_{\text{old}} \times \frac{\text{New MVA}}{\text{Old MVA}} \times \left(\frac{\text{Old kV}}{\text{New kV}}\right)^2$$

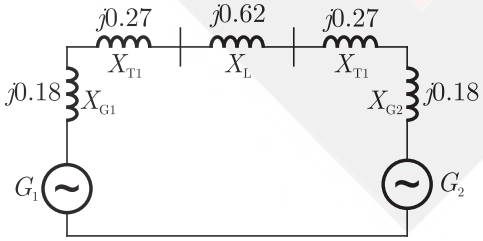
$$= j0.9 \times \frac{200}{100} \times \left(\frac{25}{25}\right)^2 = j0.18$$

$$\text{Same as } X_{T1} = j0.12 \times \frac{200}{90} \times \left(\frac{25}{25}\right)^2 = j0.27$$

$$X_{T2} = j0.12 \times \frac{200}{90} \times \left(\frac{25}{25}\right)^2 = j0.27$$

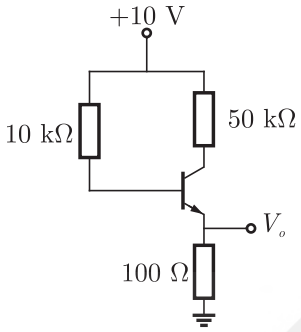
$$X_{\text{Line}} = 150 \times \frac{220}{(220)^2} = j0.62$$

The Impedance diagram is being given by as



Hence (B) is correct option.

MCQ 1.45 The transistor circuit shown uses a silicon transistor with $V_{BE} = 0.7, I_C \approx I_E$ and a dc current gain of 100. The value of V_0 is



(A) 4.65 V (B) 5 V

(C) 6.3 V (D) 7.23 V

SOL 1.45 By writing KVL equation for input loop (Base emitter loop)

$$10 - (10\,\text{k}\Omega)\,I_B - V_{BE} - V_0 = 0 \qquad ...(1)$$

Emitter current $I_E = \dfrac{V_0}{100}$

$$I_C \simeq I_E = \beta I_B$$

So, $$\frac{V_0}{100} = 100 I_B$$

$$I_B = \frac{V_0}{10 \times 10^3}$$

Put I_B into equation (1)

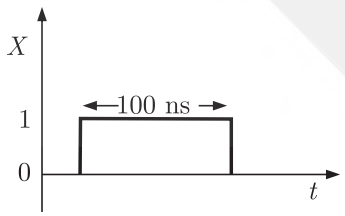
$$10 - (10 \times 10^3)\frac{V_0}{10 \times 10^3} - 0.7 - V_0 = 0$$

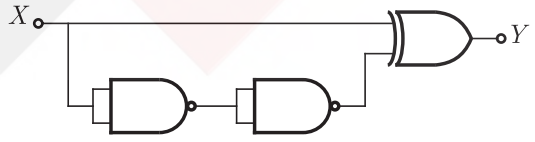
$$9.3 - 2V_0 = 0$$

$\Rightarrow$ $$V_0 = \frac{9.3}{2} = 4.65 \text{ A}$$

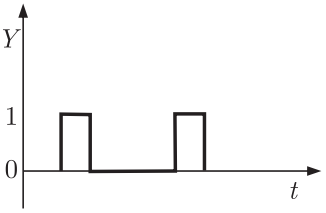
Hence (A) is correct option

MCQ 1.46 The TTL circuit shown in the figure is fed with the waveform X (also shown). All gates have equal propagation delay of 10 ns. The output Y of the circuit is

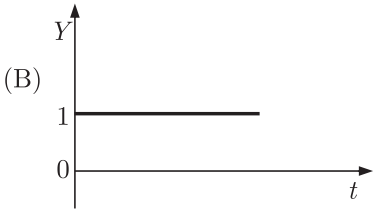




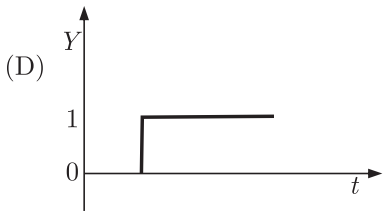
(A)



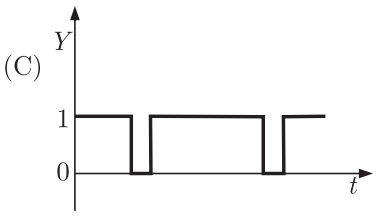
(B)



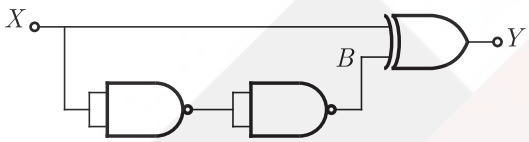
(D)



(C)



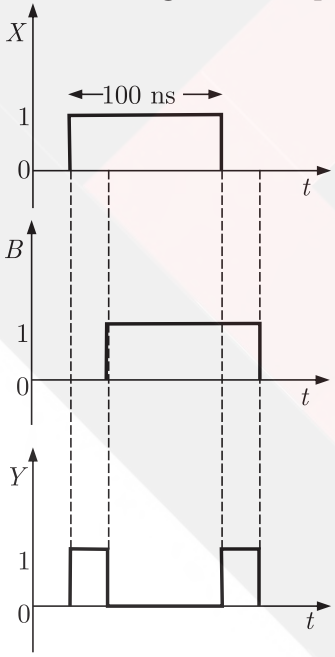
SOL 1.46 The circuit is



Output Y is written as

$$Y = X \oplus B$$

Since each gate has a propagation delay of 10 ns.



Hence (A) is correct option.

MCQ 1.47 When a "CALL Addr" instruction is executed, the CPU carries out the following sequential operations internally :

Note: (R) means content of register R

((R)) means content of memory location pointed to by R.

PC means Program Counter

SP means Stack Pointer

(A) (SP) incremented
(PC)←Addr
((SP))←(PC)

(B) (PC)←Addr
((SP))←(PC)
(SP) incremented

(C) (PC)←Addr
(SP) incremented
((SP))←(PC)

(D) ((SP))←(PC)
(SP) incremented
(PC)←Addr

SOL 1.47 CALL, Address performs two operations

(1) PUSH PC ⇒Save the contents of PC (Program Counter) into stack.

$$SP = SP - 2 \text{ (decrement)}$$
$$((SP)) \leftarrow (PC)$$

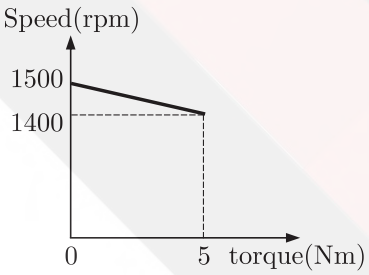
(2) Addr stored in PC.

$$(PC) \leftarrow Addr$$

Hence (D) is correct option.

Common Data Questions : 48 and 49

A separately excited DC motor runs at 1500 rpm under no-load with 200 V applied to the armature. The field voltage is maintained at its rated value. The speed of the motor, when it delivers a torque of 5 Nm, is 1400 rpm as shown in figure. The rotational losses and armature reaction are neglected.



MCQ 1.48 The armature resistance of the motor is

(A) 2 Ω
(B) 3.4 Ω
(C) 4.4 Ω
(D) 7.7 Ω

SOL 1.48 Hence (B) is correct option.

Given no-load speed $N_1 = 1500$ rpm

$$V_a = 200 \text{ V}, T = 5 \text{ Nm}, N = 1400 \text{ rpm}$$

emf at no load

$$E_{b1} = V_a = 200 \text{ V}$$

$$N \propto E_b \Rightarrow \frac{N_1}{N_2} = \frac{E_{b_1}}{E_{b_2}}$$

$$E_{b_2} = \left(\frac{N_2}{N_1}\right) E_{b_1} = \frac{1400}{1500} \times 200 = 186.67 \text{ V}$$

$$\because \quad T = E_b(I_a/\omega) \Rightarrow \frac{186.67 \times 60}{2\pi \times 1400} I_a = 5$$

$$I_a = 3.926 \text{ A}$$

$$\because V = E_b + I_a R_a$$

$$R_a = \frac{V_a - E_b}{I_a} = \frac{200 - 186.67}{3.926} = 3.4\ \Omega$$

MCQ 1.49 For the motor to deliver a torque of 2.5 Nm at 1400 rpm, the armature voltage to be applied is

(A) 125.5 V (B) 193.3 V

(C) 200 V (D) 241.7 V

SOL 1.49 Hence (B) is correct option.

$$T = 2.5 \text{ Nm at } 1400 \text{ rpm}$$

than $V = ?$

$$\because T = \frac{E_b I_b}{\omega}$$

$$2.5 = \frac{186.6 \times I_a \times 60}{2\pi \times 1400}$$

$$I_a = 1.963 \text{ A}$$

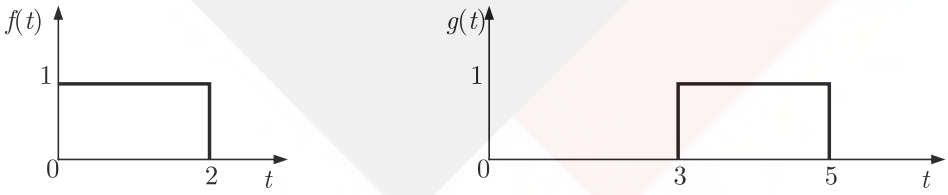
$$V = E_b + I_a R_a$$

$$= 186.6 + 1.963 \times 3.4$$

$$= 193.34 \text{ V}$$

Common Data Questions: 50 and 51

Given $f(t)$ and $g(t)$ as show below



MCQ 1.50 $g(t)$ can be expressed as

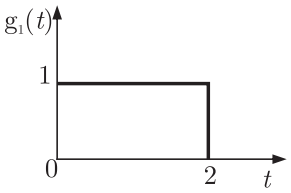
(A) $g(t) = f(2t-3)$ (B) $g(t) = f\left(\frac{t}{2} - 3\right)$

(C) $g(t) = f\left(2t - \frac{3}{2}\right)$ (D) $g(t) = f\left(\frac{t}{2} - \frac{3}{2}\right)$

SOL 1.50 We can observe that if we scale $f(t)$ by a factor of $\frac{1}{2}$ and then shift, we will get $g(t)$.

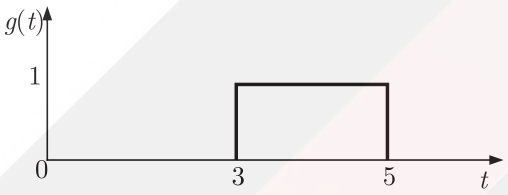
First scale $f(t)$ by a factor of $\frac{1}{2}$

$$g_1(t) = f(t/2)$$



Shift $g_1(t)$ by 3

$$g(t) = g_1(t-3) = f\left(\frac{t-3}{2}\right)$$



$$g(t) = f\left(\frac{t}{2} - \frac{3}{2}\right)$$

Hence option (D) is correct.

MCQ 1.51 The Laplace transform of $g(t)$ is

(A) $\frac{1}{s}(e^{3s} - e^{5s})$ (B) $\frac{1}{s}(e^{-5s} - e^{-3s})$

(C) $\frac{e^{-3s}}{s}(1 - e^{-2s})$ (D) $\frac{1}{s}(e^{5s} - e^{3s})$

SOL 1.51 $g(t)$ can be expressed as

$$g(t) = u(t-3) - u(t-5)$$

By shifting property we can write Laplace transform of $g(t)$

$$G(s) = \frac{1}{s}e^{-3s} - \frac{1}{s}e^{-5s}$$

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

Hence (C) is correct option.

Linked Answer Questions : Q.52 to Q.55 Carry two Marks Each

Statement for Linked Answer Questions: 52 and 53

The following Karnaugh map represents a function F.

F / X \ YZ	00	01	11	10
0	1	1	1	0
1	0	0	1	0

MCQ 1.52 A minimized form of the function F is

(A) $F = \overline{X}\,Y + YZ$ (B) $F = \overline{X}\,\overline{Y} + YZ$

(C) $F = \overline{X}\,\overline{Y} + Y\,\overline{Z}$ (D) $F = \overline{X}\,\overline{Y} + \overline{Y}\,Z$

SOL 1.52 Function F can be minimized by grouping of all 1's in K-map as following.

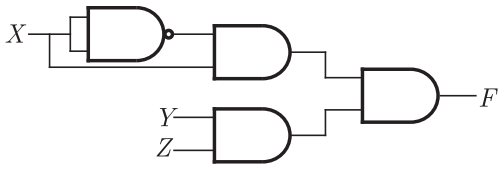
X \ YZ	00	01	11	10
0	1	1	1	0
1	0	0	1	0

$$F = \overline{X}\,\overline{Y} + YZ$$

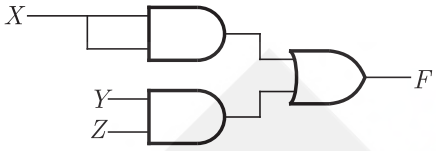
Hence (B) is correct option.

MCQ 1.53 Which of the following circuits is a realization of the above function F ?

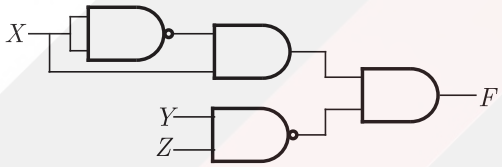
(A)



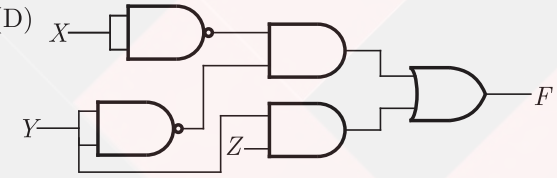
(B)



(C)



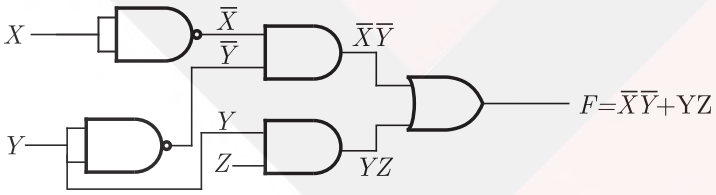
(D)



SOL 1.53 Hence (D) is correct option.

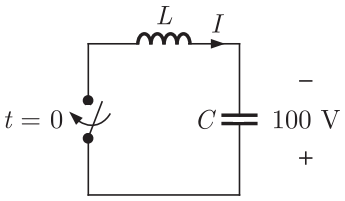
Since $F = \overline{X}\,\overline{Y} + YZ$

In option (D)



Statement for Linked Answer Questions : 54 and 55

The $L-C$ circuit shown in the figure has an inductance $L = 1\,\text{mH}$ and a capacitance $C = 10\,\mu\text{F}$



MCQ 1.54 The initial current through the inductor is zero, while the initial capacitor voltage is 100 V. The switch is closed at $t = 0$. The current i through the circuit is:

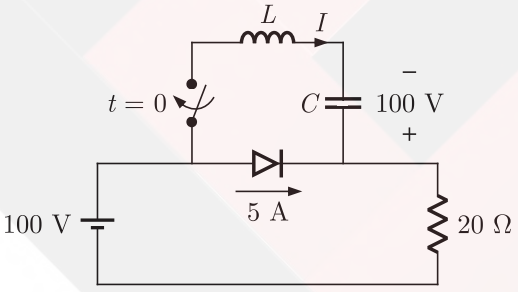
(A) $5\cos(5 \times 10^3 t)$ A (B) $5\sin(10^4 t)$ A

(C) $10\cos(5 \times 10^3 t)$ A (D) $10\sin(10^4 t)$ A

SOL 1.54 Hence ( ) is correct Option

MCQ 1.55 The $L - C$ circuit of Q.54 is used to commutate a thyristor, which is initially carrying a current of 5 A as shown in the figure below. The values and initial conditions of L and C are the same as in Q54. The switch is closed at $t = 0$. If the forward drop is negligible, the time taken for the device to turn off is

SOL 1.55 Hence ( ) is correct Option



(A) 52 μs (B) 156 μs

(C) 312 μs (D) 26 μs

General Aptitude (GA) Questions

Q.56 - 60 Carry One Mark Each

MCQ 1.56 25 persons are in a room. 15 of them play hockey, 17 of them play football and 10 of them play both hockey and football. Then the number of persons playing neither hockey nor football is

(A) 2 (B) 17

(C) 13 (D) 3

SOL 1.56 Number of people who play hockey

$$n(A) = 15$$

Number of people who play football

$$n(B) = 17$$

Persons who play both hockey and football

$$n(A \cap B) = 10$$

Persons who play either hockey or football or both :

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$
$$= 15 + 17 - 10 = 22$$

Thus people who play neither hockey nor football $= 25 - 22 = 3$

Hence (D) is correct option.

MCQ 1.57 The question below consists of a pair of related words followed by four pairs of words. Select the pair that best expresses the relation in the original pair.

Unemployed : Worker

(A) fallow: land (B) unaware: sleeper

(C) wit: jester (D) renovated: house

SOL 1.57 A worker may by unemployed. Like in same relation a sleeper may be unaware.

Hence (B) is correct option.

MCQ 1.58 Choose the most appropriate word from the options given below to complete the following sentence If we manage to _____ our natural resources, we would leave a better planet for our children.

(A) uphold (B) restrain

(C) cherish (D) conserve

SOL 1.58 Here conserve is most appropriate word.

Hence (D) is correct option.

MCQ 1.59 Which of the following options is closest in meaning to the word: **Circuitous**?

(A) cyclic (B) indirect

(C) confusing (D) crooked

SOL 1.59 Circuitous means round about or not direct. Indirect is closest in meaning to this circuitous

(A) Cyclic : Recurring in nature

(B) Indirect : Not direct

(C) Confusing : lacking clarity of meaning

(D) Crooked : set at an angle; not straight

Hence (B) is correct option.

MCQ 1.60 Choose the most appropriate word from the options given below to the complete the following sentence:

His rather casual remarks on politics _____ his lack of seriousness about the subject.

(A) masked (B) belied

(C) betrayed (D) suppressed

SOL 1.60 Betrayed means reveal unintentionally that is most appropriate.
Hence (C) is correct option.

Q. 61 - 65 Carry Two Marks Each

MCQ 1.61 Hari (H), Gita (G), Irfan (I) and Saira (S) are siblings (i.e. brothers and sisters). All were born on 1st January. The age difference between any two successive siblings (that is born one after another) is less than 3 years. Given the following facts:

i. Hari's age + Gita's age > Irfan's age + Saira's age

ii. The age difference between Gita and Saira is 1 year. However Gita is not the oldest and Saira is not the youngest.

iii. There are no twins.

In what order were they born (oldest first)?

(A) HSIG (B) SGHI

(C) IGSH (D) IHSG

SOL 1.61 Let H, G, S and I be ages of Hari, Gita, Saira and Irfan respectively.
Now from statement (1) we have $H+G>I+S$
Form statement (2) we get that $G-S=1$ or $S-G=1$
As G can't be oldest and S can't be youngest thus either GS or SG possible.
From statement (3) we get that there are no twins

(A) HSIG : There is I between S and G which is not possible

(B) SGHI : SG order is also here and $S>G>H>I$ and $G+H>S+I$ which is possible.

(C) IGSH : This gives $I>G$ and $S>H$ and adding these both inequalities we have $I+S>H+G$ which is not possible.

(D) IHSG : This gives $I>H$ and $S>G$ and adding these both inequalities we have $I+S>H+G$ which is not possible.

Hence (B) is correct option.

MCQ 1.62 5 skilled workers can build a wall in 20days; 8 semi-skilled workers can build a wall in 25 days; 10 unskilled workers can build a wall in 30days. If a team has 2 skilled, 6 semi-skilled and 5 unskilled workers, how long will it take to build the wall?

(A) 20 (B) 18

(C) 16 (D) 15

SOL 1.62 Let W be the total work.

Per day work of 5 skilled workers $= \frac{W}{20}$

Per day work of one skill worker $= \frac{W}{5 \times 20} = \frac{W}{100}$

Similarly per day work of 1 semi-skilled workers $= \frac{W}{8 \times 25} = \frac{W}{200}$

Similarly per day work of one semi-skill worker $= \frac{W}{10 \times 30} = \frac{W}{300}$

Thus total per day work of 2 skilled, 6 semi-skilled and 5 unskilled workers is $= \frac{2W}{100} + \frac{6W}{200} + \frac{5W}{300} = \frac{12W + 18W + 10W}{600} = \frac{W}{15}$

Therefore time to complete the work is 15 days.
Hence (D) is correct option.

MCQ 1.63 Modern warfare has changed from large scale clashes of armies to suppression of civilian populations. Chemical agents that do their work silently appear to be suited to such warfare; and regretfully, there exist people in military establishments who think that chemical agents are useful tools for their cause.
Which of the following statements best sums up the meaning of the above passage:
(A) Modern warfare has resulted in civil strife.
(B) Chemical agents are useful in modern warfare.
(C) Use of chemical agents in warfare would be undesirable
(D) People in military establishments like to use chemical agents in war.

SOL 1.63 Hence (D) is correct option.

MCQ 1.64 Given digits 2,2,3,3,4,4,4,4 how many distinct 4 digit numbers greater than 3000 can be formed?
(A) 50 (B) 51
(C) 52 (D) 54

SOL 1.64 As the number must be greater than 3000, it must be start with 3 or 4. Thus we have two case:
Case (1) If left most digit is 3 an other three digits are any of 2, 2, 3, 3, 4, 4, 4, 4.
(1) Using 2, 2, 3 we have 3223, 3232, 3322 i.e. $\frac{3!}{2!} = 3$ no.

(2) Using 2,2,4 we have 3224, 3242, 3422 i.e. $\frac{3!}{2!} = 3$ no.

(3) Using 2,3,3 we have 3233, 3323, 3332 i.e. $\frac{3!}{2!} = 3$ no.

(4) Using 2,3,4 we have $3! = 6$ no.

(5) Using 2,4,4 we have 3244, 3424, 3442 i.e. $\frac{3!}{2!} = 3$ no.

(6) Using 3,3,4 we have 3334, 3343, 3433 i.e. $\frac{3!}{2!} = 3$ no.

(7) Using $3,4,4$ we have $3344,3434,3443$ i.e. $\frac{3!}{2!}=3$ no.

(8) Using $4,4,4$ we have 3444 i.e. $\frac{3!}{3!}=1$ no.

Total 4 digit numbers in this case is
$1+3+3+3+6+3+3+3+1=25$

Case 2 : If left most is 4 and other three digits are any of 2, 2, 3, 3, 3, 4, 4, 4.

(1) Using $2,2,3$ we have 4223, 4232, 4322 i.e. . $\frac{3!}{2!}=3$ no

(2) Using $2,2,4$ we have 4224, 4242, 4422 i.e. . $\frac{3!}{2!}=3$ no

(3) Using $2,3,3$ we have 4233, 4323, 4332 i.e. . $\frac{3!}{2!}=3$ no

(4) Using $2,3,4$ we have i.e. . $3!=6$ no

(5) Using $2,4,4$ we have 4244, 4424, 4442 i.e. . $\frac{3!}{2!}=3$ no

(6) Using $3,3,3$ we have 4333 i.e $\frac{3!}{3!}=1.$ no.

(7) Using $3,3,4$ we have 4334, 4343, 4433 i.e. . $\frac{3!}{2!}=3$ no

(8) Using $3,4,4$ we have 4344, 4434, 4443 i.e. . $\frac{3!}{2!}=3$ no

(9) Using $4,4,4$ we have 4444 i.e. $\frac{3!}{3!}=1.$ no

Total 4 digit numbers in 2nd case $=3+3+3+6+3+3+1+3+1=26$
Thus total 4 digit numbers using case (1) and case (2) is $=25+26=51$
Hence (B) is correct option

MCQ 1.65 If 137+276=435 how much is 731+672?

(A) 534 (B) 1403

(C) 1623 (D) 1513

SOL 1.65 Since $7+6=13$ but unit digit is 5 so base may be 8 as 5 is the remainder when 13 is divided by 8. Let us check.

$$\begin{array}{ll} 137_8 & 731_8 \\ \underline{276_8} & \underline{672_8} \\ 435 & 1623 \end{array}$$

Thus here base is 8. Now

Hence (C) is correct option.

Answer Sheet											
1.	(B)	13.	(C)	25.	(A)	37.	(C)	49.	(B)	61.	(B)
2.	(A)	14.	(C)	26.	(D)	38.	(C)	50.	(D)	62.	(D)
3.	(D)	15.	(*)	27.	(C)	39.	(D)	51.	(C)	63.	(D)
4.	(B)	16.	(A)	28.	(B)	40.	(C)	52.	(B)	64.	(B)
5.	(B)	17.	(A)	29.	(B)	41.	(*)	53.	(D)	65.	(C)
6.	(*)	18.	(C)	30.	(C)	42.	(B)	54.	(*)		
7.	(B)	19.	(C)	31.	(D)	43.	(A)	55.	(*)		
8.	(D)	20.	(B)	32.	(C)	44.	(B)	56.	(D)		
9.	(D)	21.	(A)	33.	(B)	45.	(A)	57.	(B)		
10.	(A)	22.	(B)	34.	(C)	46.	(A)	58.	(D)		
11.	(C)	23.	(A)	35.	(A)	47.	(D)	59.	(B)		
12.	(*)	24.	(C)	36.	(A)	48.	(B)	60.	(C)		

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