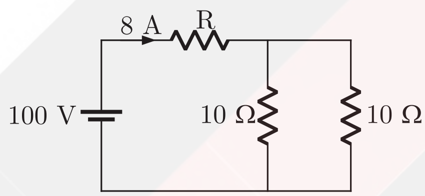
GATE EE
2005

Q.1 - 30 Carry One Mark Each

MCQ 1.1 In the figure given below the value of R is



(A) 2.5 Ω (B) 5.0 Ω
(C) 7.5 Ω (D) 10.0 Ω

SOL 1.1 The Correct option is (C).
Current in the circuit

$$I = \frac{100}{R + (10 \,||\, 10)} = 8 \text{ A} \qquad \text{(given)}$$

$$\Rightarrow \quad \frac{100}{R+5} = 8$$

Or $$R = \frac{60}{8} = 7.5\,\Omega$$

MCQ 1.2 The RMS value of the voltage $u(t) = 3 + 4\cos(3t)$ is
(A) $\sqrt{17}$ V (B) 5 V
(C) 7 V (D) $(3 + 2\sqrt{2})$ V

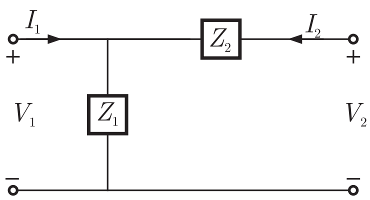
SOL 1.2 Rms value is given as

$$\mu_{rms} = \sqrt{3^2 + \frac{(4)^2}{2}}$$

$$= \sqrt{9+8} = \sqrt{17} \text{ V}$$

Hence (A) is correct option.

MCQ 1.3 For the two port network shown in the figure the Z-matrix is given by



(A) $\begin{bmatrix} Z_1 & Z_1+Z_2 \\ Z_1+Z_2 & Z_2 \end{bmatrix}$ (B) $\begin{bmatrix} Z_1 & Z_1 \\ Z_1+Z_2 & Z_2 \end{bmatrix}$

(C) $\begin{bmatrix} Z_1 & Z_2 \\ Z_2 & Z_1+Z_2 \end{bmatrix}$ (D) $\begin{bmatrix} Z_1 & Z_1 \\ Z_1 & Z_1+Z_2 \end{bmatrix}$

SOL 1.3 By writing KVL in input and output loops

$$V_1 - (i_1 + i_2) Z_1 = 0$$

$$V_1 = Z_1 i_1 + Z_1 i_2 \quad ...(1)$$

Similarly

$$V_2 - i_2 Z_2 - (i_1 + i_2) Z_1 = 0$$

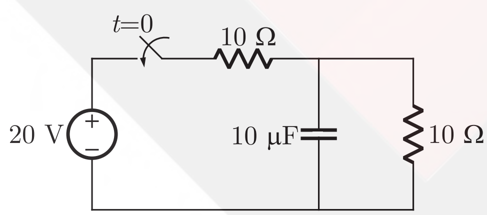
$$V_2 = Z_1 i_1 + (Z_1 + Z_2) i_2 \quad ...(2)$$

From equation (1) and (2) Z-matrix is given as

$$Z = \begin{bmatrix} Z_1 & Z_1 \\ Z_1 & Z_1+Z_2 \end{bmatrix}$$

Hence (D) is correct option.

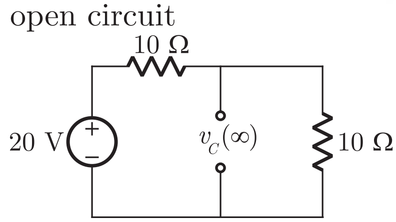
MCQ 1.4 In the figure given, for the initial capacitor voltage is zero. The switch is closed at $t = 0$. The final steady-state voltage across the capacitor is



(A) 20 V (B) 10 V

(C) 5 V (D) 0 V

SOL 1.4 In final steady state the capacitor will be completely charged and behaves as an open circuit



Steady state voltage across capacitor

$$v_c(\infty) = \frac{20}{10+10}(10)$$

$$= 10 \text{ V}$$

Hence (B) is correct option.

MCQ 1.5 If $\vec{E}$ is the electric intensity, $\nabla(\nabla \times \vec{E})$ is equal to

(A) $\vec{E}$ (B) $|\vec{E}|$

(C) null vector (D) Zero

SOL 1.5 We know that divergence of the curl of any vector field is zero

$$\nabla(\nabla \times \vec{\mathbf{E}}) = 0$$

Hence (D) is correct option.

MCQ 1.6 A system with zero initial conditions has the closed loop transfer function.

$$T(s) = \frac{s^2 + 4}{(s+1)(s+4)}$$

The system output is zero at the frequency

(A) 0.5 rad/sec (B) 1 rad/sec

(C) 2 rad/sec (D) 4 rad/sec

SOL 1.6 Closed loop transfer function of the given system is,

$$T(s) = \frac{s^2 + 4}{(s+1)(s+4)}$$

$$T(j\omega) = \frac{(j\omega)^2 + 4}{(j\omega + 1)(j\omega + 4)}$$

If system output is zero

$$|T(j\omega)| = \frac{|4 - \omega^2|}{|(j\omega + 1)(j\omega + 4)|} = 0$$

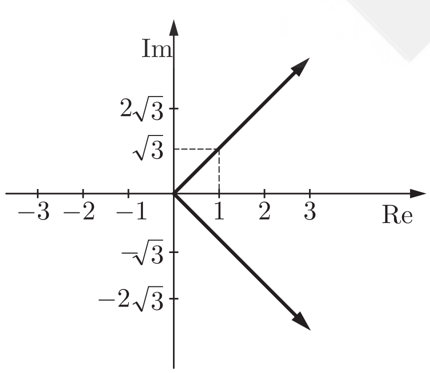
$$4 - \omega^2 = 0$$

$$\omega^2 = 4$$

$$\Rightarrow \omega = 2 \text{ rad/sec}$$

Hence (C) is correct option.

MCQ 1.7 Figure shows the root locus plot (location of poles not given) of a third order system whose open loop transfer function is



(A) $\frac{K}{s^3}$ (B) $\frac{K}{s^2(s+1)}$

(C) $\frac{K}{s(s^2+1)}$ (D) $\frac{K}{s(s^2-1)}$

SOL 1.7 From the given plot we can see that centroid C(point of intersection) where asymptotes intersect on real axis) is 0

So for option (a)

$$G(s) = \frac{K}{s^3}$$

$$\text{Centroid} = \frac{\sum \text{Poles} - \sum \text{Zeros}}{n-m} = \frac{0-0}{3-0} = 0$$

Hence (A) is correct option.

MCQ 1.8 The gain margin of a unity feed back control system with the open loop transfer function

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

(A) 0 (B) $\frac{1}{\sqrt{2}}$

(C) $\sqrt{2}$ (D) ∞

SOL 1.8 Open loop transfer function is.

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

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

Phase crossover frequency can be calculated as.

$$\angle G(j\omega_p) = -180^\circ$$

$$\tan^{-1}(\omega_p) = -180^\circ$$

$$\omega_p = 0$$

Gain margin of the system is.

$$\text{G.M} = \frac{1}{|G(j\omega_p)|} = \frac{1}{\frac{\sqrt{\omega_p^2+1}}{\omega_p^2}}$$

$$\text{G.M} = \frac{\omega_p^2}{\sqrt{\omega_p^2+1}} = 0$$

Hence (A) is correct option.

MCQ 1.9 In the matrix equation $P\mathbf{x} = \mathbf{q}$, which of the following is a necessary condition for the existence of at least on solution for the unknown vector $\mathbf{x}$

(A) Augmented matrix $[P\mathbf{q}]$ must have the same rank as matrix P

(B) Vector $\mathbf{q}$ must have only non-zero elements

(C) Matrix P must be singular

(D) Matrix P must be square

SOL 1.9 The Correct option is (D).

For two random events conditional probability is given by

$$\text{probability}\,(P \cap Q) = \text{probability}\,(P)\,\text{probability}\,(Q)$$

$$\text{probability}\,(Q) = \frac{\text{probability}\,(P \cap Q)}{\text{probability}\,(P)} \leq 1$$

so $\text{probability}\,(P \cap Q) \leq \text{probability}\,(P)$

MCQ 1.10 If P and Q are two random events, then the following is TRUE

(A) Independence of P and Q implies that probability $(P \cap Q) = 0$

(B) Probability $(P \cup Q) \geq$ Probability (P) + Probability (Q)

(C) If P and Q are mutually exclusive, then they must be independent

(D) Probability $(P \cap Q) \leq$ Probability (P)

SOL 1.10 Option (D) is correct.

for two random events conditional probability is given by

$$\text{probability}\,(P \cap Q) = \text{probability}\,(P)\,\text{probability}\,(Q)$$

$$\text{probability}\,(Q) = \frac{\text{probability}\,(P \cap Q)}{\text{probability}\,(P)} \leq 1$$

so $\text{probability}\,(P \cap Q) \leq \text{probability}\,(P)$

MCQ 1.11 If $S = \int_1^\infty x^{-3}\,dx$, then S has the value

(A) $-\frac{1}{3}$

(B) $\frac{1}{4}$

(C) $\frac{1}{2}$

(D) 1

SOL 1.11 Hence (C) is correct option

$$S = \int_1^\infty x^{-3}\,dx$$

$$= \left[\frac{x^{-2}}{-2}\right]_1^\infty$$

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

MCQ 1.12 The solution of the first order differential equation $x'(t) = -3x(t)$, $x(0) = x_0$ is

(A) $x(t) = x_0 e^{-3t}$

(B) $x(t) = x_0 e^{-3}$

(C) $x(t) = x_0 e^{-1/3}$

(D) $x(t) = x_0 e^{-1}$

SOL 1.12 Hence (A) is correct option.

We have $\dot{x}(t) = -3x(t)$

or $\dot{x}(t) + 3x(t) = 0$

A.E. $D + 3 = 0$

Thus solution is $x(t) = C_1 e^{-3t}$

From $x(0) = x_0$ we get $C_1 = x_0$

Thus $x(t) = x_0 e^{-3t}$

MCQ 1.13 The equivalent circuit of a transformer has leakage reactances X_1, X'_2 and magnetizing reactance X_M. Their magnitudes satisfy

(A) $X_1 >> X'_2 >> X_M$

(B) $X_1 << X'_2 << X_M$

(C) $X_1 \approx X'_2 >> X_M$

(D) $X_1 \approx X'_2 << X_M$

SOL 1.13 The Correct option is (D).

The leakage reactances X_1, and X_2' are equal and magnetizing reactance X_m is higher than X_1, and X_2'

$$X_1 \approx X_2' << X_m$$

MCQ 1.14 Which three-phase connection can be used in a transformer to introduce a phase difference of 30° between its output and corresponding input line voltages

(A) Star-Star

(B) Star-Delta

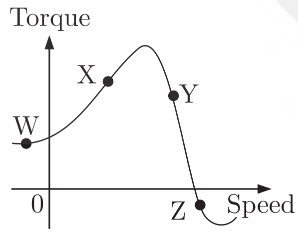
(C) Delta-Delta

(D) Delta-Zigzag

SOL 1.14 The Correct option is (B).

Three phase star delta connection of transformer induces a phase difference of 30° between output and input line voltage.

MCQ 1.15 On the torque/speed curve of the induction motor shown in the figure four points of operation are marked as W, X, Y and Z. Which one of them represents the operation at a slip greater than 1 ?



(A) W

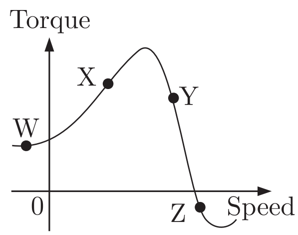
(B) X

(C) Y

(D) Z

SOL 1.15 The Correct option is (A).

Given torque/speed curve of the induction motor



When the speed of the motor is in forward direction then slip varies from 0 to 1 but when speed of motor is in reverse direction or negative then slip is greater then 1. So at point W slip is greater than 1.

MCQ 1.16 For an induction motor, operation at a slip s, the ration of gross power output to air gap power is equal to

(A) $(1-s)^2$ (B) $(1-s)$

(C) $\sqrt{(1-s)}$ (D) $(1-\sqrt{s})$

SOL 1.16 The Correct option is (B).

For an induction motor the ratio of gross power output to air-gap is equal to $(1-s)$

So $$\frac{\text{gross power}}{\text{airgap power}} = (1-s)$$

MCQ 1.17 The p.u. parameter for a 500 MVA machine on its own base are:

inertia, $M = 20$ p.u. ; reactance, $X = 2$ p.u.

The p.u. values of inertia and reactance on 100 MVA common base, respectively, are

(A) 4, 0.4 (B) 100, 10

(C) 4, 10 (D) 100, 0.4

SOL 1.17 The Correct option is (D).

Given that pu parameters of 500 MVA machine are as following

$$M = 20 \text{ pu}, \ X = 2 \text{ pu}$$

Now value of M and X at 100 MVA base are

for inertia (M)

$$(\text{pu})_{\text{new}} = (\text{pu})_{\text{old}} \times \frac{\text{old MVA}}{\text{new MVA}}$$

$$(M_{\text{pu}})_{\text{new}} = (M_{\text{Pu}})_{\text{old}} \times \frac{500}{100}$$

$$= 20 \times \frac{5}{1} = 100 \text{ pu}$$

and for reactance (X)

$$(\text{pu})_{\text{new}} = (\text{pu})_{\text{old}} \times \frac{\text{new MVA}}{\text{old MVA}}$$

$$(X_{\text{pu}})_{\text{new}} = (X_{\text{pu}})_{\text{old}} \times \frac{100}{500}$$

$$(X_{Pu})_{new} = 2 \times \frac{1}{5} = 0.4 \text{ pu}$$

MCQ 1.18 An 800 kV transmission line has a maximum power transfer capacity of P. If it is operated at 400 kV with the series reactance unchanged, the new maximum power transfer capacity is approximately

(A) P
(B) $2P$
(C) $P/2$
(D) $P/4$

SOL 1.18 The Correct option is (D).

800 kV has Power transfer capacity $= P$

At 400 kV Power transfer capacity $= ?$

We know Power transfer capacity

$$P = \frac{EV}{X}\sin\delta$$

$$P \propto V^2$$

So if V is half than Power transfer capacity is $\frac{1}{4}$ of previous value.

MCQ 1.19 The insulation strength of an EHV transmission line is mainly governed by

(A) load power factor
(B) switching over-voltages
(C) harmonics
(D) corona

SOL 1.19 The Correct option is (B).

In EHV lines the insulation strength of line is governed by the switching over voltages.

MCQ 1.20 High Voltage DC (HVDC) transmission is mainly used for

(A) bulk power transmission over very long distances
(C) inter-connecting two systems with same nominal frequency
(C) eliminating reactive power requirement in the operation
(D) minimizing harmonics at the converter stations

SOL 1.20 The Correct option is (A).

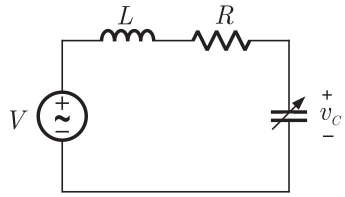
For bulk power transmission over very long distance HVDC transmission preferably used.

MCQ 1.21 The Q-meter works on the principle of

(A) mutual inductance
(B) self inductance
(C) series resonance
(D) parallel resonance

SOL 1.21 The Correct option is (C).

Q-meter works on the principle of series resonance.



$$\text{At resonance } V_C = V_L$$
$$\text{and } I = \frac{V}{R}$$
$$\text{Quality factor Q} = \frac{\omega L}{R} = \frac{1}{\omega CR}$$
$$Q = \frac{\omega L \times I}{R \times I} = \frac{V_L}{E} = \frac{V_C}{E}$$

Thus, we can obtain Q.

MCQ 1.22 A PMMC voltmeter is connected across a series combination of DC voltage source $V_1 = 2$ V and AC voltage source $V_2(t) = 3\sin(4t)$ V. The meter reads

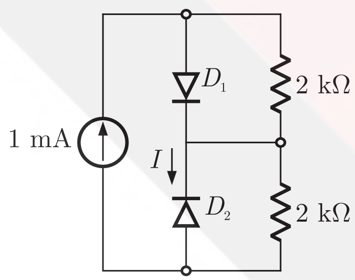
(A) 2 V (B) 5 V

(C) $(2 + \sqrt{3}/2)$ V (D) $(\sqrt{17}/2)\ V$

SOL 1.22 The Correct option is (A).

PMMC instruments reads DC value only so it reads 2 V.

MCQ 1.23 Assume that D_1 and D_2 in figure are ideal diodes. The value of current is



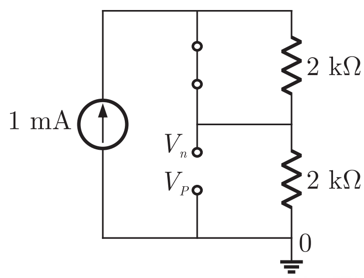
(A) 0 mA (B) 0.5 mA

(C) 1 mA (D) 2 mA

SOL 1.23 The Correct option is (A).

From the circuit we can observe that Diode D_1 must be in forward bias (since current is flowing through diode).

Let assume that D_2 is in reverse bias, so equivalent circuit is.



Voltage V_n is given by

$$V_n = 1 \times 2 = 2 \text{ Volt}$$
$$V_p = 0$$

$V_n > V_p$ (so diode is in reverse bias, assumption is true)

Current through D_2 is

$$I_{D2} = 0$$

MCQ 1.24 The 8085 assembly language instruction that stores the content of H and L register into the memory locations 2050_H and 2051_H, respectively is

(A) SPHL 2050_H
(B) SPHL 2051_H
(C) SHLD 2050_H
(D) STAX 2050_H

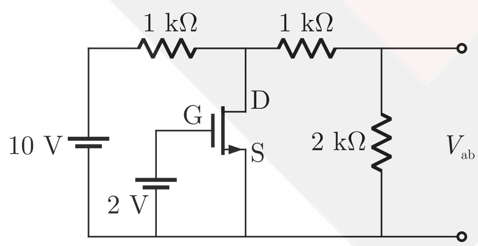
SOL 1.24 The Correct option is (C).

SHLD transfers contain of HL pair to memory location.

SHLD 2050 $\Rightarrow$ L $\rightarrow$ M[2050H]

H $\rightarrow$ M[2051H]

MCQ 1.25 Assume that the N-channel MOSFET shown in the figure is ideal, and that its threshold voltage is +1.0 V the voltage V_{ab} between nodes a and b is



(A) 5 V
(B) 2 V
(C) 1 V
(D) 0 V

SOL 1.25 The Correct option is (D).

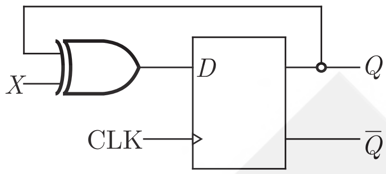
This is a N-channel MOSFET with

$$V_{GS} = 2 \text{ V}$$
$$V_{TH} = +1 \text{ V}$$
$$V_{DS(\text{sat})} = V_{GS} - V_{TH}$$
$$V_{DS(\text{sat})} = 2 - 1 = 1 \text{ V}$$

Due to 10 V source $V_{DS} > V_{DS(\text{sat})}$ so the NMOS goes in saturation, channel conductivity is high and a high current flows through drain to source and it acts as a short circuit.

So, $V_{ab} = 0$

MCQ 1.26 The digital circuit shown in the figure works as



(A) JK flip-flop
(B) Clocked RS flip-flop
(C) T flip-flop
(D) Ring counter

SOL 1.26 The Correct option is (C).

Let the present state is Q(t), so input to D-flip flop is given by,

$$D = Q(t) \oplus X$$

Next state can be obtained as,

$$Q(t+1) = D$$
$$Q(t+1) = Q(t) \oplus X$$
$$Q(t+1) = Q(t)\overline{X} + \overline{Q}(t)X$$
$$Q(t+1) = \overline{Q}(t), \quad \text{if } X = 1$$
and $$Q(t+1) = Q(t), \quad \text{if } X = 0$$

So the circuit behaves as a T flip flop.

MCQ 1.27 A digital-to-analog converter with a full-scale output voltage of 3.5 V has a resolution close to 14 mV. Its bit size is

(A) 4
(B) 8
(C) 16
(D) 32

SOL 1.27 The Correct option is (B).

Resolution of n-bit DAC $= \dfrac{V_{fs}}{2^n - 1}$

So $$14\,mv = \frac{3.5\text{ V}}{2^n - 1}$$
$$2^n - 1 = \frac{3.5}{14 \times 10^{-3}}$$
$$2^n - 1 = 250$$
$$2^n = 251$$
$$n = 8 \text{ bit}$$

MCQ 1.28 The conduction loss versus device current characteristic of a power MOSFET is best approximated by

(A) a parabola

(B) a straight line

(C) a rectangular hyperbola

(D) an exponentially decaying function

SOL 1.28 The Correct option is (A).
The conduction loss v/s MOSFET current characteristics of a power MOSFET is best approximated by a parabola.

MCQ 1.29 A three-phase diode bridge rectifier is fed from a 400 V RMS, 50 Hz, three-phase AC source. If the load is purely resistive, then peak instantaneous output voltage is equal to

(A) 400 V (B) $400\sqrt{2}$ V

(C) $400\sqrt{\frac{2}{3}}$ V (D) $\frac{400}{\sqrt{3}}$ V

SOL 1.29 The Correct option is (B).
In a 3-ϕ bridge rectifier

$$V_{rms} = 400 \text{ V}, \ f = 50 \text{ Hz}$$

This is purely resistive then

instantaneous voltage $V_0 = \sqrt{2}\, V_{rms} = 400\sqrt{2}$ V

MCQ 1.30 The output voltage waveform of a three-phase square-wave inverter contains

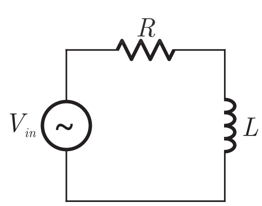
(A) only even harmonics (B) both odd and even harmonic

(C) only odd harmonics (D) only triple harmonics

SOL 1.30 The Correct option is (C).
A 3-ϕ square wave (symmetrical) inverter contains only odd harmonics.

Q.31 - 80 Carry Two Marks Each

MCQ 1.31 The RL circuit of the figure is fed from a constant magnitude, variable frequency sinusoidal voltage source V_{in}. At 100 Hz, the $R$and L elements each have a voltage drop μ_{RMS}.If the frequency of the source is changed to 50 Hz, then new voltage drop across R is



(A) $\sqrt{\frac{5}{8}}\,u_{RMS}$ (B) $\sqrt{\frac{2}{3}}\,u_{RMS}$

(C) $\sqrt{\frac{8}{5}}\,u_{RMS}$ (D) $\sqrt{\frac{3}{2}}\,u_{RMS}$

SOL 1.31 The Correct option is (C).

At $f_1 = 100$ Hz, voltage drop across R and L is μ_{RMS}

$$\mu_{RMS} = \left|\frac{V_{in}.R}{R + j\omega_1 L}\right| = \left|\frac{V_{in}(j\omega_1 L)}{R + j\omega_1 L}\right|$$

So, $R = \omega_1 L$

at $f_2 = 50$ Hz, voltage drop across R

$$\mu'_{RMS} = \left|\frac{V_{in}.R}{R + j\omega_2 L}\right|$$

$$\frac{\mu_{RMS}}{\mu'_{RMS}} = \left|\frac{R + j\omega_2 L}{R + j\omega_1 L}\right|$$

$$= \sqrt{\frac{R^2 + \omega_2^2 L^2}{R^2 + \omega_1^2 L^2}}$$

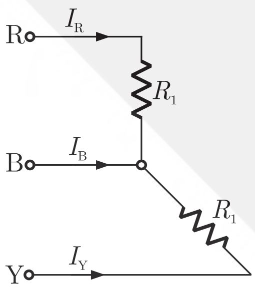
$$= \sqrt{\frac{\omega_1^2 L^2 + \omega_2^2 L^2}{\omega_1^2 L^2 + \omega_1^2 L^2}}, \quad R = \omega_1 L$$

$$= \sqrt{\frac{\omega_1^2 + \omega_2^2}{2\omega_1^2}} = \sqrt{\frac{f_1^2 + f_2^2}{2f_1^2}}$$

$$= \sqrt{\frac{(100)^2 + (50)^2}{2(100)^2}} = \sqrt{\frac{5}{8}}$$

$$\mu'_{RMS} = \sqrt{\frac{8}{5}}\mu_{RMS}$$

MCQ 1.32 For the three-phase circuit shown in the figure the ratio of the currents $I_R : I_Y : I_B$ is given by



(A) $1:1:\sqrt{3}$

(B) $1:1:2$

(C) $1:1:0$

(D) $1:1:\sqrt{3/2}$

SOL 1.32 The Correct option is (A).

In the circuit

$$\overline{I}_B = I_R\angle 0^\circ + I_y\angle 120^\circ$$

$$I_B^2 = I_R^2 + I_y^2 + 2I_R I_y \cos\left(\frac{120^\circ}{2}\right)$$

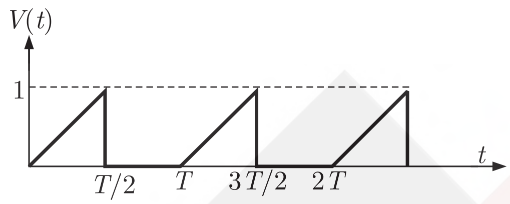
$$I_B^2 = I_R^2 + I_y^2 + I_R I_y$$

$\because$ $I_R = I_y$

so, $I_B^2 = I_R^2 + I_R^2 + I_R^2 = 3I_R^2$

$$I_B = \sqrt{3}\, I_R = \sqrt{3}\, I_y$$
$$I_R : I_y : I_B = 1:1:\sqrt{3}$$

MCQ 1.33 For the triangular wave from shown in the figure, the RMS value of the voltage is equal to



(A) $\sqrt{\frac{1}{6}}$ (B) $\sqrt{\frac{1}{3}}$

(C) $\frac{1}{3}$ (D) $\sqrt{\frac{2}{3}}$

SOL 1.33 The Correct option is (A).
RMS value is given by

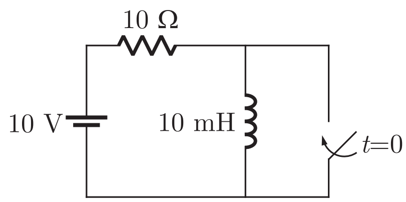
$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T V^2(t)\, dt}$$

Where

$$V(t) = \begin{cases} \left(\frac{2}{T}\right)t, 0 \le t \le \frac{T}{2} \\ 0, \quad \frac{T}{2} < t \le T \end{cases}$$

So
$$\frac{1}{T}\int_0^T V^2(t)\, dt = \frac{1}{T}\left[\int_0^{T/2}\left(\frac{2t}{T}\right)^2 dt + \int_{T/2}^T (0)\, dt\right]$$
$$= \frac{1}{T}\cdot\frac{4}{T^2}\int_0^{T/2} t^2\, dt$$
$$= \frac{4}{T^3}\left[\frac{t^3}{3}\right]_0^{T/2}$$
$$= \frac{4}{T^3}\times\frac{T^3}{24}$$
$$= \frac{1}{6}$$
$$V_{rms} = \sqrt{\frac{1}{6}}\ \text{V}$$

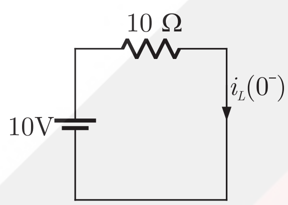
MCQ 1.34 The circuit shown in the figure is in steady state, when the switch is closed at $t = 0$ .Assuming that the inductance is ideal, the current through the inductor at $t = 0^+$ equals



(A) 0 A
(B) 0.5 A
(C) 1 A
(D) 2 A

SOL 1.34 The Correct option is (C).

Switch was opened before $t = 0$, so current in inductor for $t < 0$

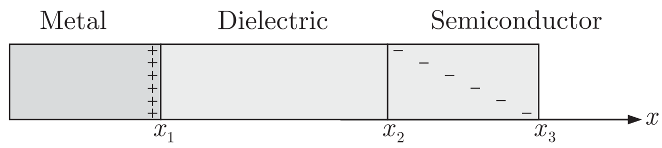


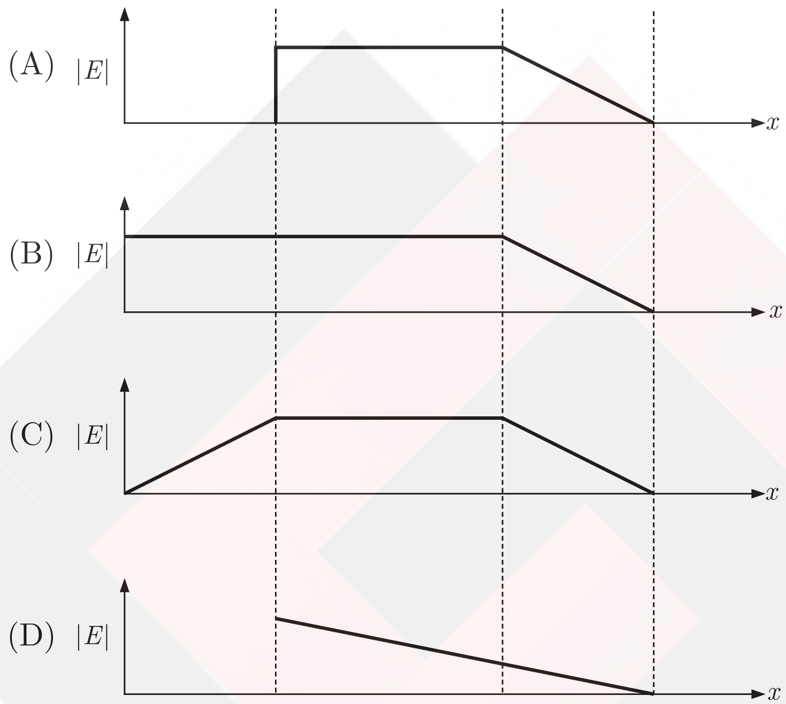
$$i_L(0^-) = \frac{10}{10} = 1 \text{ A}$$

Inductor current does not change simultaneously so at $t = 0$ when switch is closed current remains same

$$i_L(0^+) = i_L(0^-) = 1 \text{ A}$$

MCQ 1.35 The charge distribution in a metal-dielectric-semiconductor specimen is shown in the figure. The negative charge density decreases linearly in the semiconductor as shown. The electric field distribution is as shown in

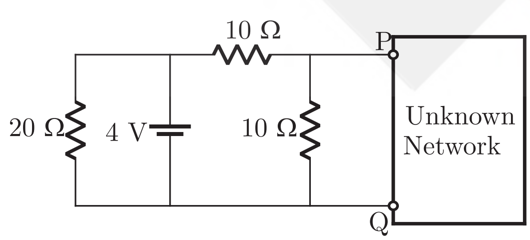




SOL 1.35 The Correct option is (A).

Electric field inside a conductor (metal) is zero. In dielectric charge distribution os constant so electric field remains constant from x_1 to x_2. In semiconductor electric field varies linearly with charge density.

MCQ 1.36 In the given figure, the Thevenin's equivalent pair (voltage, impedance), as seen at the terminals P-Q, is given by

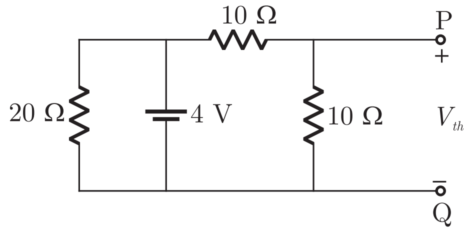


(A) $(2\,\text{V}, 5\,\Omega)$ (B) $(2\,\text{V}, 7.5\,\Omega)$

(C) $(4\,\text{V}, 5\,\Omega)$ (D) $(4\,\text{V}, 7.5\,\Omega)$

SOL 1.36 The Correct option is (A).

Thevenin voltage:



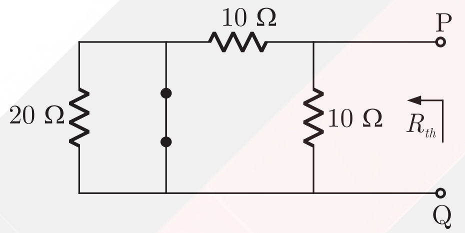
nodal analysis at P

$$\frac{V_{th}-4}{10}+\frac{V_{th}}{10}=0$$

$$2V_{th}-4=0$$

$\Rightarrow$ $$V_{th}=2\text{ V}$$

Thevenin resistance:



$$R_{th}=10\,\Omega\,||\,10\,\Omega=5\,\Omega$$

MCQ 1.37 A unity feedback system, having an open loop gain

$$G(s)H(s)=\frac{K(1-s)}{(1+s)},$$

becomes stable when

(A) $|K|>1$ (B) $K>1$

(C) $|K|<1$ (D) $K<-1$

SOL 1.37 Characteristic equation for the given system

$$1+G(s)H(s)=0$$

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

$$(1+s)+K(1-s)=0$$

$$s(1-K)+(1+K)=0$$

For the system to be stable, coefficient of characteristic equation should be of same sign.

$$1-K>0,\ K+1>0$$

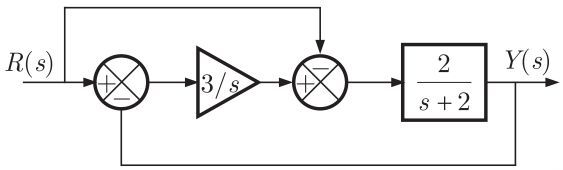
$$K<1,\ K>-1$$

$$-1<K<1$$

$$|K|<1$$

Hence (C) is correct option

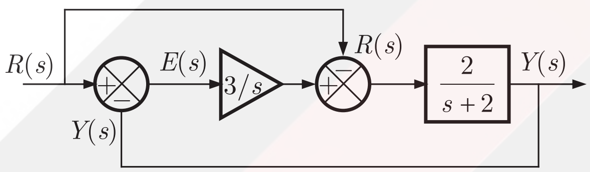
MCQ 1.38 When subject to a unit step input, the closed loop control system shown in the figure will have a steady state error of



(A) -1.0 (B) -0.5

(C) 0 (D) 0.5

SOL 1.38 In the given block diagram



Steady state error is given as

$$e_{ss} = \lim_{s \to 0} sE(s)$$

$$E(s) = R(s) - Y(s)$$

$Y(s)$ can be written as

$$Y(s) = \left[\{R(s) - Y(s)\}\frac{3}{s} - R(s)\right]\frac{2}{s+2}$$

$$Y(s) = R(s)\left[\frac{6}{s(s+2)} - \frac{2}{s+2}\right] - Y(s)\left[\frac{6}{s(s+2)}\right]$$

$$Y(s)\left[1 + \frac{6}{s(s+2)}\right] = R(s)\left[\frac{6-2s}{s(s+2)}\right]$$

$$Y(s) = R(s)\frac{(6-2s)}{(s^2+2s+6)}$$

So, $$E(s) = R(s) - \frac{(6-2s)}{(s^2+2s+6)}R(s)$$

$$E(s) = R(s)\left[\frac{s^2+4s}{s^2+2s+6}\right]$$

For unit step input $R(s) = \frac{1}{s}$

Steady state error $e_{ss} = \lim_{s \to 0} sE(s)$

$$e_{ss} = \lim_{s \to 0}\left[s\frac{1}{s}\frac{(s^2+4s)}{(s^2+2s+6)}\right]$$

$$= 0$$

Hence (C) is correct option.

MCQ 1.39 In the $G(s)H(s)$-plane, the Nyquist plot of the loop transfer function $G(s)H(s) = \frac{\pi e^{-0.25s}}{s}$

passes through the negative real axis at the point

(A) $(-0.25, j0)$ (B) $(-0.5, j0)$

(C) 0 (D) 0.5

SOL 1.39 When it passes through negative real axis at that point phase angle is -180°.

So $\angle G(j\omega)H(j\omega) = -180^\circ$

$$-0.25j\omega - \frac{\pi}{2} = -\pi$$

$$-0.25j\omega = -\frac{\pi}{2}$$

$$j0.25\omega = \frac{\pi}{2}$$

$$j\omega = \frac{\pi}{2 \times 0.25}$$

$$s = j\omega = 2\pi$$

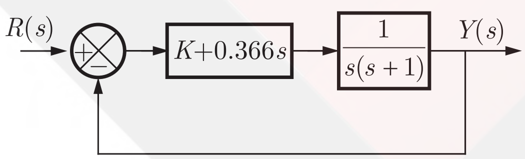
Put $s = 2\pi$ in given open loop transfer function we get

$$G(s)H(s)\big|_{s=2\pi} = \frac{\pi e^{-0.25 \times 2\pi}}{2\pi} = -0.5$$

So it passes through $(-0.5, j0)$

Hence (B) is correct option.

MCQ 1.40 If the compensated system shown in the figure has a phase margin of 60° at the crossover frequency of 1 rad/sec, then value of the gain K is



(A) 0.366 (B) 0.732

(C) 1.366 (D) 2.738

SOL 1.40 Open loop transfer function of the system is given by.

$$G(s)H(s) = (K + 0.366s)\left[\frac{1}{s(s+1)}\right]$$

$$G(j\omega)H(j\omega) = \frac{K + j0.366\omega}{j\omega(j\omega+1)}$$

Phase margin of the system is given as

$$\phi_{PM} = 60^\circ = 180^\circ + \angle G(j\omega_g)H(j\omega_g)$$

Where $\omega_g \to$ gain cross over frequency $= 1$ rad/sec

So,

$$60^\circ = 180^\circ + \tan^{-1}\left(\frac{0.366\omega_g}{K}\right) - 90^\circ - \tan^{-1}(\omega_g)$$

$$= 90^\circ + \tan^{-1}\left(\frac{0.366}{K}\right) - \tan^{-1}(1)$$

$$= 90^\circ - 45^\circ + \tan^{-1}\left(\frac{0.366}{K}\right)$$

$$15^\circ = \tan^{-1}\left(\frac{0.366}{K}\right)$$

$$\frac{0.366}{K} = \tan 15^\circ$$

$$K = \frac{0.366}{0.267} = 1.366$$

Hence (C) is correct option.

MCQ 1.41 For the matrix $p = \begin{bmatrix} 3 & -2 & 2 \\ 0 & -2 & 1 \\ 0 & 0 & 1 \end{bmatrix}$, one of the eigen values is equal to -2

Which of the following is an eigen vector ?

(A) $\begin{bmatrix} 3 \\ -2 \\ 1 \end{bmatrix}$ (B) $\begin{bmatrix} -3 \\ 2 \\ -1 \end{bmatrix}$

(C) $\begin{bmatrix} 1 \\ -2 \\ 3 \end{bmatrix}$ (D) $\begin{bmatrix} 2 \\ 5 \\ 0 \end{bmatrix}$

SOL 1.41 Hence (D) is correct option.

For eigen value $\lambda = -2$

$$\begin{bmatrix} 3-(-2) & -2 & 2 \\ 0 & -2-(-2) & 1 \\ 0 & 0 & 1-(-2) \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 5 & -2 & 2 \\ 0 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

$$5x_1 - 2x_2 + x_3 = 0$$

Only option (D) satisfies this equation

MCQ 1.42 If $R = \begin{bmatrix} 1 & 0 & -1 \\ 2 & 1 & -1 \\ 2 & 3 & 2 \end{bmatrix}$, then top row of R^{-1} is

(A) $\begin{bmatrix} 5 & 6 & 4 \end{bmatrix}$ (B) $\begin{bmatrix} 5 & -3 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} 2 & 0 & -1 \end{bmatrix}$ (D) $\begin{bmatrix} 2 & -1 & 1/2 \end{bmatrix}$

SOL 1.42 Hence (B) is correct option.

$$\begin{aligned} C_{11} &= 2-(-3) = 5 \\ C_{21} &= -(0-(-3)) = -3 \\ C_{31} &= (-(-1)) = 1 \\ |\mathbf{R}| &= (1)\,C_{11} + 2C_{21} + 2C_{31} \\ &= 5-6+2 = 1 \end{aligned}$$

MCQ 1.43 A fair coin is tossed three times in succession. If the first toss produces a head, then the probability of getting exactly two heads in three tosses is

(A) $\frac{1}{8}$ (B) $\frac{1}{2}$

(C) $\frac{3}{8}$ (D) $\frac{3}{4}$

SOL 1.43 If the toss produces head, then for exactly two head in three tosses three tosses there must produce one head in next two tosses. The probability of one head in two tosses will be 1/2.

Hence (B) is correct option.

MCQ 1.44 For the function $f(x) = x^2 e^{-x}$, the maximum occurs when x is equal to

(A) 2 (B) 1

(C) 0 (D) -1

SOL 1.44 Hence (A) is correct option.

We have $f(x) = x^2 e^{-x}$

or $f'(x) = 2xe^{-x} - x^2 e^{-x}$

$= xe^{-x}(2-x)$

$f''(x) = (x^2 - 4x + 2)\,e^{-x}$

Now for maxima and minima, $f'(x) = 0$

$xe^{-x}(2-x) = 0$

or $x = 0, 2$

at $x = 0$ $f''(0) = 1\,(+\text{ve})$

at $x = 2$ $f''(2) = -2e^{-2}(-\text{ve})$

Now $f''(0) = 1$ and $f''(2) = -2e^{-2} < 0$. Thus $x = 2$ is point of maxima

MCQ 1.45 For the scalar field $u = \frac{x^2}{2} + \frac{y^2}{3}$, magnitude of the gradient at the point (1, 3) is

(A) $\sqrt{\frac{13}{9}}$ (B) $\sqrt{\frac{9}{2}}$

(C) $\sqrt{5}$ (D) $\frac{9}{2}$

SOL 1.45 Hence (C) is correct option.

$$\nabla u = \left(\hat{\mathbf{i}}\frac{\partial}{\partial x} + \hat{\mathbf{j}}\frac{\partial}{\partial y}\right)u$$

$$= \hat{\mathbf{i}}\frac{\partial u}{\partial x} + \hat{\mathbf{j}}\frac{\partial u}{\partial y}$$

$$= x\hat{\mathbf{i}} + \frac{2}{3}y\hat{\mathbf{j}}$$

At (1, 3) magnitude is $|\nabla u| = \sqrt{x^2 + \left(\frac{2}{3}y\right)^2}$

$$= \sqrt{1+4}$$

$$= \sqrt{5}$$

MCQ 1.46 For the equation $x''(t) + 3x'(t) + 2x(t) = 5$, the solution $x(t)$ approaches which of the following values as $t \to \infty$?

(A) 0

(B) $\frac{5}{2}$

(C) 5

(D) 10

SOL 1.46 Hence (B) is correct option.

$$\frac{d^2x}{dt^2} + \frac{3dx}{dt} + 2x(t) = 5$$

Taking laplace transform on both sides of above equation.

$$s^2X(s) + 3sX(s) + 2X(s) = \frac{5}{s}$$

$$X(s) = \frac{5}{s(s^2+3s+2)}$$

From final value theorem

$$\lim_{t\to\infty} x(t) = \lim_{s\to 0} X(s)$$

$$= \lim_{s\to 0} s\frac{5}{s(s^2+3s+2)}$$

$$= \frac{5}{2}$$

MCQ 1.47 The Laplace transform of a function $f(t)$ is $F(s) = \frac{5s^2+23s+6}{s(s^2+2s+2)}$ as $t \to \infty$, $f(t)$ approaches

(A) 3

(B) 5

(C) $\frac{17}{2}$

(D) ∞

SOL 1.47 The Correct option is (A).

By final value theorem

$$\lim_{t\to\infty} f(t) = \lim_{s\to 0} s\,F(s)$$

$$= \lim_{s\to 0} s\frac{(5s^2+23s+6)}{s(s^2+2s+2)}$$

$$= \frac{6}{2} = 3$$

MCQ 1.48 The Fourier series for the function $f(x) = \sin^2 x$ is

(A) $\sin x + \sin 2x$

(B) $1 - \cos 2x$

(C) $\sin 2x + \cos 2x$ (D) $0.5 - 0.5\cos 2x$

SOL 1.48 The Correct option is (D).

$$f(x) = \sin^2 x$$
$$= \frac{1-\cos 2x}{2}$$
$$= 0.5 - 0.5 \quad \cos 2x$$
$$f(x) = A_0 + \sum_{n=1}^{\infty} a_n \cos n\omega_0 x + b_n \sin n\omega_0 x$$

$f(x) = \sin^2 x$ is an even function so $b_n = 0$

$$A_0 = 0.5$$
$$a_n = \begin{cases} -0.5, & n = 1 \\ 0 & , \text{ otherwise} \end{cases}$$
$$\omega_0 = \frac{2\pi}{T_0} = \frac{2\pi}{T} = 2$$

MCQ 1.49 If $u(t)$ is the unit step and $\delta(t)$ is the unit impulse function, the inverse z-transform of $F(z) = \frac{1}{z+1}$ for $k > 0$ is

(A) $(-1)^k \delta(k)$ (B) $\delta(k) - (-1)^k$

(C) $(-1)^k u(k)$ (D) $u(k) - (-1)^k$

SOL 1.49 The Correct option is (B).

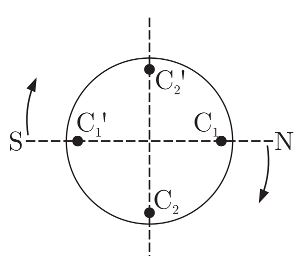
Z-transform $F(z) = \frac{1}{z+1}$

$$= 1 - \frac{z}{z+1} = 1 - \frac{1}{1+z^{-1}}$$

so, $f(k) = \delta(k) - (-1)^k$

Thus $(-1)^k \overset{\mathcal{Z}}{\longleftrightarrow} \frac{1}{1+z^{-1}}$

MCQ 1.50 Two magnetic poles revolve around a stationary armature carrying two coil $(c_1 - c_1', c_2 - c_2')$ as shown in the figure. Consider the instant when the poles are in a position as shown. Identify the correct statement regarding the polarity of the induced emf at this instant in coil sides c_1 and c_2.



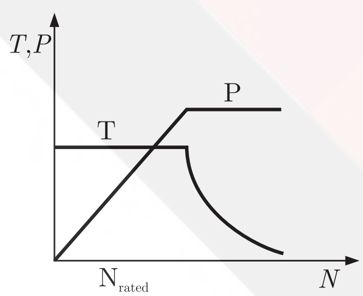
(A) $\odot$ in c_1, no emf in c_2 (B) $\otimes$ in c_1, no emf in c_2
(C) $\odot$ in c_2, no emf in c_1 (D) $\otimes$ in c_2, no emf in c_1

SOL 1.50 The Correct option is (A).
Given that two magnetic pole revolve around a stationary armature.
At c_1 the emf induced upward and no emf induced at c_2 and c_2'

MCQ 1.51 A 50 kW dc shunt is loaded to draw rated armature current at any given speed. When driven
(i) at half the rated speed by armature voltage control and
(ii) at 1.5 times the rated speed by field control, the respective output powers delivered by the motor are approximately.
(A) 25 kW in (i) and 75 kW in (ii)
(B) 25 kW in (i) and 50 kW in (ii)
(C) 50 kW in (i) and 75 kW in (ii)
(D) 50 kW in (i) and 50 kW in (ii)

SOL 1.51 The Correct option is (B).
Given A 50 kW DC shunt motor is loaded, then
at half the rated speed by armature voltage control
So

$$P \propto N$$



$$P_{new} = \frac{50}{2} = 25 \text{ kW}$$

At 1.5 time the rated speed by field control

$$P = \text{constant}$$

So

$$P = 50 \text{ kW}$$

MCQ 1.52 In relation to DC machines, match the following and choose the correct combination

List-I	**List-II**
Performance Variables	Proportional to
P. Armature emf (E)	1. Flux(ϕ), speed (ω) and armature current (I_a)

Q. Developed torque (T)
R. Developed power (P)

2. ϕ and ω only
3. ϕ and I_a only
4. I_a and ω only
5. I_a only

Codes:

	P	Q	R
(A)	3	3	1
(B)	2	5	4
(C)	3	5	4
(D)	2	3	1

SOL 1.52 The Correct option is (D).
In DC motor

$$E = PN\phi\left(\frac{Z}{A}\right)$$

or

$$E = K\phi\omega_n$$

So
Armature emf E depends upon ϕ and ω only.
and torque developed depends upon

$$T = \frac{PZ\phi I_a}{2\pi A}$$

So, torque(T) is depends of ϕ and I_a and developed power(P) is depend of flux ϕ, speed ω and armature current I_a.

MCQ 1.53 In relation to the synchronous machines, which on of the following statements is false ?

(A) In salient pole machines, the direct-axis synchronous reactance is greater than the quadrature-axis synchronous reactance.
(B) The damper bars help the synchronous motor self start.
(C) Short circuit ratio is the ratio of the field current required to produces the rated voltage on open circuit to the rated armature current.
(D) The V-cure of a synchronous motor represents the variation in the armature current with field excitation, at a given output power.

SOL 1.53 The Correct option is (C).
In synchronous machine, when the armature terminal are shorted the field current should first be decreased to zero before started the alternator.
In open circuit the synchronous machine runs at rated synchronous speed. The field current is gradually increased in steps.
The short circuit ratio is the ratio of field current required to produced the rated voltage on open to the rated armature current.

MCQ 1.54 Under no load condition, if the applied voltage to an induction motor is reduced from the rated voltage to half the rated value,

(A) the speed decreases and the stator current increases

(B) both the speed and the stator current decreases

(C) the speed and the stator current remain practically constant

(D) there is negligible change in the speed but the stator current decreases

SOL 1.54 The Correct option is ( )

MCQ 1.55 A three-phase cage induction motor is started by direct-on-line (DOL) switching at the rated voltage. If the starting current drawn is 6 times the full load current, and the full load slip is 4%, then ratio of the starting developed torque to the full load torque is approximately equal to

(A) 0.24 (B) 1.44

(C) 2.40 (D) 6.00

SOL 1.55 The Correct option is (B).

Given a three-phase cage induction motor is started by direct on line switching at rated voltage. The starting current drawn is 6 time the full load current.

Full load slip $= 4\%$

So

$$\left(\frac{T_{\text{St}}}{T_{\text{Fl}}}\right) = \left(\frac{I_{\text{St}}}{I_{\text{Fl}}}\right)^2 \times S_{\text{Fl}}$$

$$= (6)^2 \times 0.04 = 1.44$$

MCQ 1.56 In a single phase induction motor driving a fan load, the reason for having a high resistance rotor is to achieve

(A) low starting torque (B) quick acceleration

(C) high efficiency (D) reduced size

SOL 1.56 Given single-phase induction motor driving a fan load, the resistance rotor is high

So

$$E_b = V - I_a R_a \qquad ...(1)$$

$$\because \quad P_{\text{mech}} = E_a I_a$$

$$\tau = \frac{P_{\text{mech}}}{\omega_m} \qquad ...(2)$$

From equation (1) and (2) the high resistance of rotor then the motor achieves quick acceleration and torque of starting is increase.

Hence (B) is correct option.

MCQ 1.57 Determine the correctness or otherwise of the following assertion[A] and the reason[R]

Assertion [A] : Under V/f control of induction motor, the maximum value of the developed torque remains constant over a wide range of speed in the sub-

synchronous region.
Reason [R] : The magnetic flux is maintained almost constant at the rated value by keeping the ration V/f constant over the considered speed range.

(A) Both [A] and [R] are true and [R] is the correct reason for [A]

(B) Both [A] and [R] are true and but [R] is not the correct reason for [A]

(C) Both [A] and [R] are false

(D) [A] is true but [R] is false

SOL 1.57 The Correct option is (A).
Given V/f control of induction motor, the maximum developed torque remains same
we have,

$$E = 4.44K_{w_1}f\phi T_1$$

If the stator voltage drop is neglected the terminal voltage E_1. To avoid saturation and to minimize losses motor is operated at rated airgap flux by varying terminal voltage with frequency. So as to maintain (V/f) ratio constant at the rated value, the magnetic flux is maintained almost constant at the rated value which keeps maximum torque constant.

MCQ 1.58 The parameters of a transposed overhead transmission line are given as :
Self reactance $X_S = 0.4\Omega/\text{km}$ and Mutual reactance $X_m = 0.1\Omega/\text{km}$ The positive sequence reactance X_1 and zero sequence reactance X_0, respectively in Ω/km are

(A) 0.3, 0.2 (B) 0.5, 0.2

(C) 0.5, 0.6 (D) 0.3, 0.6

SOL 1.58 The Correct option is (D).
Parameters of transposed overhead transmission line

$$X_S = 0.4\,\Omega/\text{km},\ X_m = 0.1\,\Omega/\text{km}$$

$$+\text{ve sequence reactance } X_1 = ?$$

$$\text{Zero sequence reactance } X_0 = ?$$

We know for transposed overhead transmission line.

$$+\text{ve sequence component } X_1 = X_S - X_m$$
$$= 0.4 - 0.1 = 0.3\,\Omega/\text{km}$$

$$\text{Zero sequence component } X_0 = X_S + 2X_m$$
$$= 0.4 + 2(0.1) = 0.6\,\Omega/\text{km}$$

MCQ 1.59 At an industrial sub-station with a 4 MW load, a capacitor of 2 MVAR is installed to maintain the load power factor at 0.97 lagging. If the capacitor goes out of service, the load power factor becomes

(A) 0.85 (B) 1.00

(C) 0.80 lag (D) 0.90 lag

SOL 1.59 The Correct option is (C).

Industrial substation of 4 MW load $= P_L$

$$Q_C = 2\,\text{MVAR for load p.f.} = 0.97 \text{ lagging}$$

If capacitor goes out of service than load p.f. = ?

$$\cos\phi = 0.97$$

$$\tan\phi = \tan(\cos^{-1}0.97) = 0.25$$

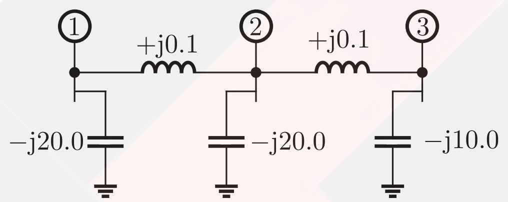
$$\frac{Q_L - Q_C}{P_L} = 0.25$$

$$\frac{Q_L - 2}{4} = 0.25 \Rightarrow Q_L = 3\,\text{MVAR}$$

$$\phi = \tan^{-1}\left(\frac{Q_L}{P_L}\right) = \tan^{-1}\left(\frac{3}{4}\right) = 36^\circ$$

$$\cos\phi = \cos 36^\circ = 0.8 \text{ lagging}$$

MCQ 1.60 The network shown in the given figure has impedances in p.u. as indicated. The diagonal element Y_{22} of the bus admittance matrix Y_{BUS} of the network is



(A) $-j19.8$ (B) $+j20.0$

(C) $+j0.2$ (D) $-j19.95$

SOL 1.60 The Correct option is (D).

$$Y_{22} = ?$$

$$I_1 = V_1 Y_{11} + (V_1 - V_2) Y_{12}$$

$$= 0.05 V_1 - j10(V_1 - V_2) = - j9.95 V_1 + j10 V_2$$

$$I_2 = (V_2 - V_1) Y_{21} + (V_2 - V_3) Y_{23}$$

$$= j10 V_1 - j9.9 V_2 - j0.1 V_3$$

$$Y_{22} = Y_{11} + Y_{23} + Y_2$$

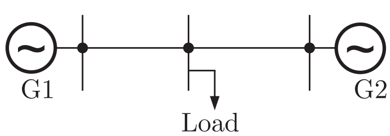
$$= - j9.95 - j9.9 - 0.1j$$

$$= - j19.95$$

MCQ 1.61 A load centre is at an equidistant from the two thermal generating stations G_1 and G_2 as shown in the figure. The fuel cost characteristic of the generating stations are given by

$F_1 = a + bP_1 + cP_1^2$ Rs/hour

$F_2 = a + bP_2 + 2cP_2^2$ Rs/ hour



Where P_1 and P_2 are the generation in MW of G_1 and G_2, respectively. For most economic generation to meet 300 MW of load P_1 and P_2 respectively, are

(A) 150, 150 (B) 100, 200

(C) 200, 100 (D) 175, 125

SOL 1.61 The Correct option is (C).

$$F_1 = a + bP_1 + cP_1^2 \text{ Rs/hour}$$
$$F_2 = a + bP_2 + 2cP_2^2 \text{ Rs/hour}$$

For most economical operation

$$P_1 + P_2 = 300 \text{ MW then } P_1, P_2 = ?$$

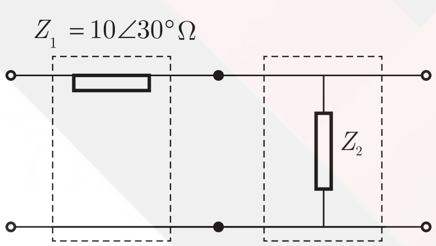
We know for most economical operation

$$\frac{\partial F_1}{\partial P_1} = \frac{\partial F_2}{\partial P_2}$$
$$2cP_1 + b = 4cP_2 + b$$
$$P_1 = 2P_2 \qquad ...(1)$$
$$P_1 + P_2 = 300 \qquad ...(2)$$

from eq (1) and (2)

$$P_1 = 200 \text{ MW}, \ P_2 = 100 \text{ MW}$$

MCQ 1.62 Two networks are connected in cascade as shown in the figure. With usual notations the equivalent A, B, C and D constants are obtained. Given that, $C = 0.025\angle 45°$, the value of Z_2 is



(A) $10\angle 30° \ \Omega$ (B) $40\angle -45° \ \Omega$

(C) $1 \ \Omega$ (D) $0 \ \Omega$

SOL 1.62 The Correct option is (B).

We know that $ABCD$ parameters $\begin{bmatrix} V_1 \\ I_1 \end{bmatrix} = \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} V_2 \\ I_1 \end{bmatrix}$

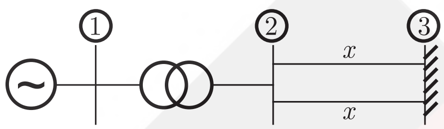
$$B = \frac{V_1}{I_2}\Big|_{V_2 = 0}, \ C = \frac{I_1}{V_2}\Big|_{I_2 = 0}$$

In figure
$$C = \frac{\dfrac{V_1}{Z_1 + Z_2}}{\dfrac{V_1}{Z_1 + Z_2} \times Z_2} = \frac{1}{Z_2}$$

or
$$Z_2 = \frac{1}{C}$$

$$= \frac{1}{0.025\angle 45^\circ} = 40\angle -45^\circ$$

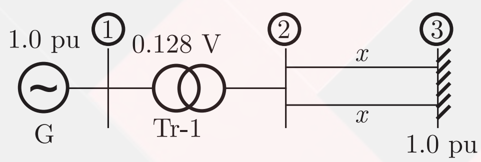
MCQ 1.63 A generator with constant 1.0 p.u. terminal voltage supplies power through a step-up transformer of 0.12 p.u. reactance and a double-circuit line to an infinite bus bar as shown in the figure. The infinite bus voltage is maintained at 1.0 p.u. Neglecting the resistances and suspectances of the system, the steady state stability power limit of the system is 6.25 p.u. If one of the double-circuit is tripped, then resulting steady state stability power limit in p.u. will be



(A) 12.5 p.u. (B) 3.125 p.u.

(C) 10.0 p.u. (D) 5.0 p.u.

SOL 1.63 The Correct option is (D).
Given



Steady state stability Power Limit = 6.25 pu
If one of double circuit is tripped than
Steady state stability power limit = ?

$$P_{m1} = \frac{EV}{X} = \frac{1\times 1}{0.12+\frac{X}{2}} = 6.25$$

$$\frac{1}{0.12+0.5X} = 6.25$$

$$\Rightarrow X = 0.008 \text{ pu}$$

If one of double circuit tripped than

$$P_{m2} = \frac{EV}{X} = \frac{1\times 1}{0.12+X} = \frac{1}{0.12+0.08}$$

$$P_{m2} = \frac{1}{0.2} = 5 \text{ pu}$$

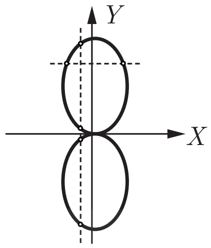
MCQ 1.64 The simultaneous application of signals $x(t)$ and $y(t)$ to the horizontal and vertical plates, respectively, of an oscilloscope, produces a vertical figure-of-8 display. If P and Q are constants and $x(t) = \text{P}\sin(4t+30^\circ)$, then $y(t)$ is equal to

(A) $\text{Q}\sin(4t-30^\circ)$ (B) $\text{Q}\sin(2t+15^\circ)$

(C) $\text{Q}\sin(8t+60^\circ)$ (D) $\text{Q}\sin(4t+30^\circ)$

SOL 1.64 The Correct option is (B).

We can obtain the frequency ratio as following



$$\frac{f_Y}{f_X} = \frac{\text{meeting points of horizontal tangents}}{\text{meeting points of vertical tangents}}$$

$$\frac{f_Y}{f_X} = \frac{2}{4}$$

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

There should exist a phase difference(15°) also to produce exact figure of-8.

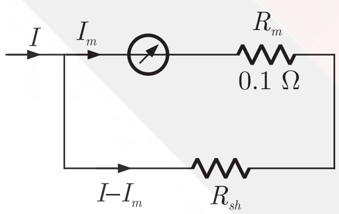
MCQ 1.65 A DC ammeter has a resistance of 0.1 Ω and its current range is 0-100 A. If the range is to be extended to 0-500 A, then meter required the following shunt resistance

(A) 0.010 Ω (B) 0.011 Ω

(C) 0.025 Ω (D) 1.0 Ω

SOL 1.65 The Correct option is (C).

The configuration is shown below



It is given that $I_m = 100$ A

Range is to be extended to $0 - 500$ A,

$$I = 500 \text{ A}$$

So,

$$I_m R_m = (I - I_m) R_{sh}$$

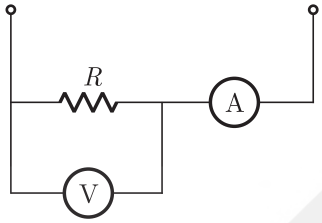
$$100 \times 0.1 = (500 - 100) R_{sh}$$

$$R_{sh} = \frac{100 \times 0.1}{400}$$

$$= 0.025 \ \Omega$$

MCQ 1.66 The set-up in the figure is used to measure resistance R .The ammeter and voltmeter resistances are 0.01Ω and 2000 Ω, respectively. Their readings are 2 A and 180

V, respectively, giving a measured resistances of 90 Ω The percentage error in the measurement is

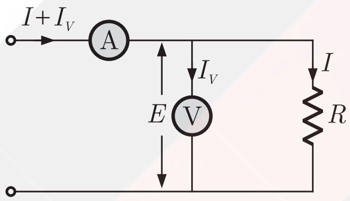


(A) 2.25% (B) 2.35%

(C) 4.5% (D) 4.71%

SOL 1.66 The Correct option is (D).

The configuration is shown below



Current in voltmeter is given by

$$I_V = \frac{E}{2000} = \frac{180}{2000} = .09 \text{ A}$$

$$I + I_V = 2 \text{ amp}$$

So $$I = 2 - .09 = 1.91 \text{ V}$$

$$R = \frac{E}{I} = \frac{180}{1.91} = 94.24 \ \Omega$$

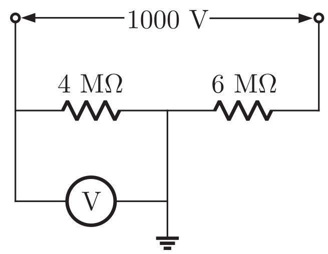
Ideally $$R_0 = \frac{180}{2} = 90 \ \Omega$$

$$\% \text{ error} = \frac{R - R_0}{R_0} \times 100$$

$$= \frac{94.24 - 90 \times 100}{90}$$

$$= 4.71\%$$

MCQ 1.67 A 1000 V DC supply has two 1-core cables as its positive and negative leads : their insulation resistances to earth are 4 MΩ and 6 MΩ, respectively, as shown in the figure. A voltmeter with resistance 50 kΩ is used to measure the insulation of the cable. When connected between the positive core and earth, then voltmeter reads

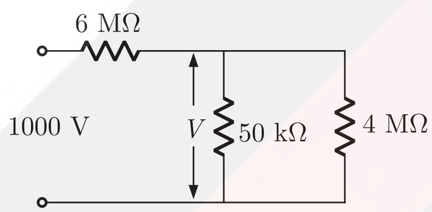


(A) 8 V (B) 16 V

(C) 24 V (D) 40 V

SOL 1.67 The Correct option is (A).

The measurement system is shown below



Voltmeter reading

$$V = \left(\frac{1000}{6\text{ M}\Omega + 50\text{ k}\Omega \parallel 4\text{ M}\Omega}\right)(50\text{ k}\Omega \parallel 4\text{ M}\Omega)$$

$$= \frac{1000}{6 + .049} \times .049$$

$$= 8.10 \text{ V}$$

MCQ 1.68 Two wattmeters, which are connected to measure the total power on a three-phase system supplying a balanced load, read 10.5 kW and -2.5 kW, respectively. The total power and the power factor, respectively, are

(A) 13.0 kW, 0.334 (B) 13.0 kW, 0.684

(C) 8.0 kW, 0.52 (D) 8.0 kW, 0.334

SOL 1.68 The Correct option is (D).

$$\text{Total power } P = P_1 + P_2$$

$$= 10.5 - 2.5$$

$$= 8 \text{ kW}$$

$$\text{Power factor} = \cos\theta$$

Where

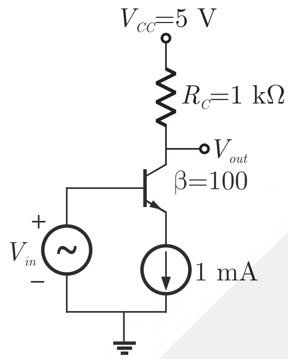
$$\theta = \tan^{-1}\left[\sqrt{3}\left(\frac{P_2 - P_1}{P_2 + P_1}\right)\right]$$

$$= \tan^{-1}\left[\sqrt{3} \times \frac{-13}{8}\right]$$

$$= -70.43^\circ$$

$$\text{Power factor} = \cos\theta = 0.334$$

MCQ 1.69 The common emitter amplifier shown in the figure is biased using a 1 mA ideal current source. The approximate base current value is



(A) 0 μA (B) 10 μA

(C) 100 μA (D) 1000 μA

SOL 1.69 The Correct option is (B).

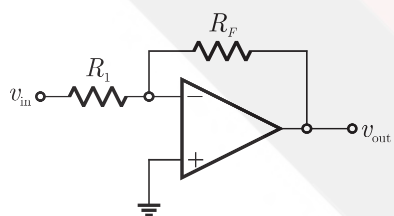
Since the transistor is operating in active region.

$$I_E \approx \beta I_B$$

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

$$= \frac{1 \text{ mA}}{100} = 10\,\mu\text{A}$$

MCQ 1.70 Consider the inverting amplifier, using an ideal operational amplifier shown in the figure. The designer wishes to realize the input resistance seen by the small-signal source to be as large as possible, while keeping the voltage gain between -10 and -25. The upper limit on R_F is 1 MΩ. The value of R_1 should be



(A) Infinity (B) 1 MΩ

(C) 100 kΩ (D) 40 kΩ

SOL 1.70 The Correct option is (C).

Gain of the inverting amplifier is given by,

$$A_v = -\frac{R_F}{R_1}$$

$$A_v = -\frac{1 \times 10^6}{R_1}, \qquad R_F = 1 \text{ M}\Omega$$

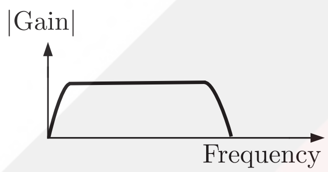
$$R_1 = -\frac{1 \times 10^6}{A_v} \qquad A_v = -10 \text{ to } -25 \text{ so value of } R_1$$

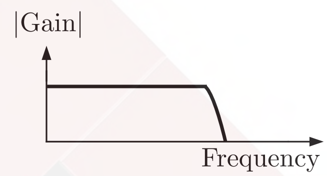
$$R_1 = \frac{10^6}{10} = 100\text{ k}\Omega \qquad \text{for } A_v = -10$$

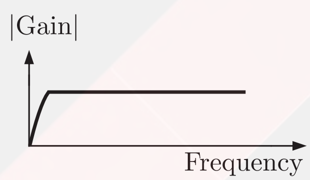
$$R_1^{'} = \frac{10^6}{25} = 40\text{ k}\Omega \qquad \text{for } A_v = -25$$

R_1 should be as large as possible so $R_1 = 100\text{ k}\Omega$

MCQ 1.71 The typical frequency response of a two-stage direct coupled voltage amplifier is as shown in figure

(A) 

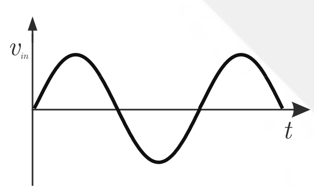
(B) 

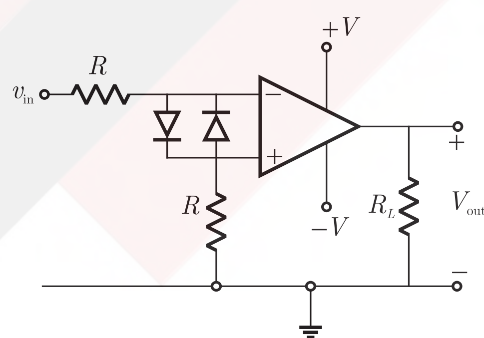
(C) 

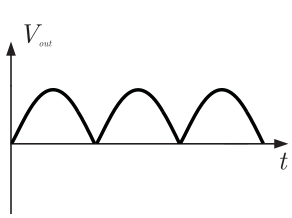
(D) 

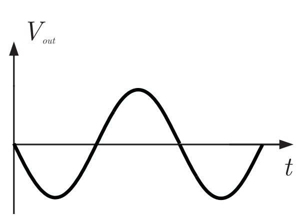
SOL 1.71 The Correct option is (B).
Direct coupled amplifiers or DC-coupled amplifiers provides gain at dc or very low frequency also.

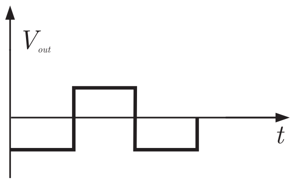
MCQ 1.72 In the given figure, if the input is a sinusoidal signal, the output will appear as shown

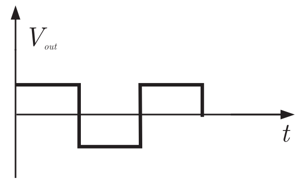




(A) 

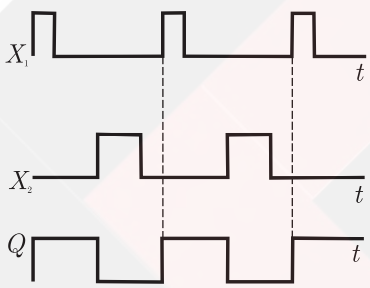
(B) 

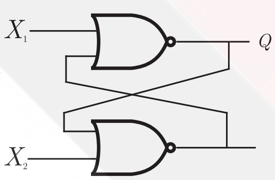
(C) 

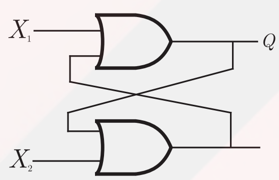
(D) 

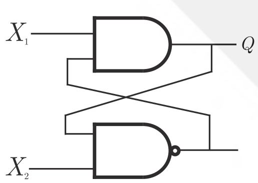
SOL 1.72 The Correct option is (C).
Since there is no feedback in the circuit and ideally op-amp has a very high value of open loop gain, so it goes into saturation (ouput is either $+V$ or $-V$) for small values of input.
The input is applied to negative terminal of op-amp, so in positive half cycle it saturates to $-V$ and in negative half cycle it goes to $+V$.

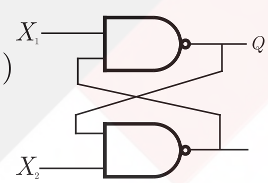
MCQ 1.73 Select the circuit which will produce the given output Q for the input signals X_1 and X_2 given in the figure



(A) 

(B) 

(C) 

(D) 

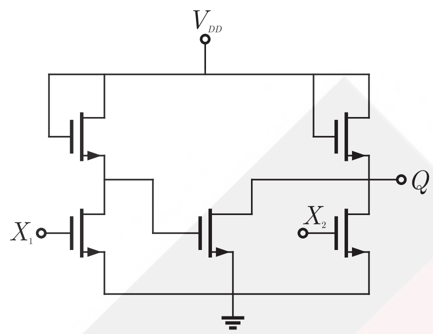
SOL 1.73 (check)
From the given input output waveforms truth table for the circuit is drawn as

X_1	X_2	Q
1	0	1
0	0	1
0	1	0

In option (A), for $X_1 = 1, Q = 0$ so it is eliminated.
In option (C), for $X_1 = 0, Q = 0$ (always), so it is also eliminated.

In option (D), for $X_1 = 0, Q = 1$, which does not match the truth table.
Only option (B) satisfies the truth table.
Hence (B) is correct option.

MCQ 1.74 If X_1 and X_2 are the inputs to the circuit shown in the figure, the output Q is

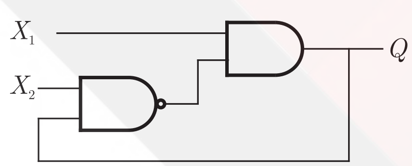


(A) $\overline{X_1 + X_2}$ (B) $\overline{X_1 \bullet X_2}$
(C) $\overline{X_1} \bullet X_2$ (D) $X_1 \bullet \overline{X_2}$

SOL 1.74 The Correct option is (D).
In the given circuit NMOS Q_1 and Q_3 makes an inverter circuit. Q_4 and Q_5 are in parallel works as an OR circuit and Q_2 is an output inverter.
So output is

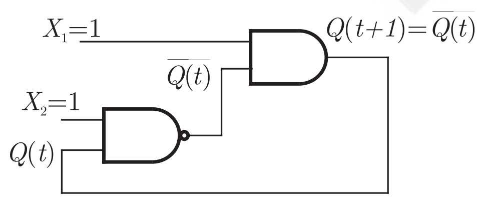
$$Q = \overline{\overline{X_1} + X_2} = X_1 . \overline{X_2}$$

MCQ 1.75 In the figure, as long as $X_1 = 1$ and $X_2 = 1$, the output Q remains



(A) at 1 (B) at 0
(C) at its initial value (D) unstable

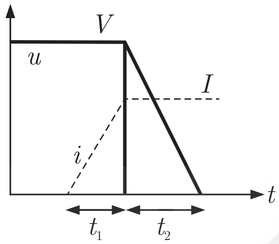
SOL 1.75 The Correct option is (D).
Let $Q(t)$ is the present state then from the circuit,



So, the next state is given by

$$Q(t+1) = \overline{Q}(t) \text{ (unstable)}$$

MCQ 1.76 The figure shows the voltage across a power semiconductor device and the current through the device during a switching transitions. If the transition a turn ON transition or a turn OFF transition ? What is the energy lost during the transition?



(A) Turn ON, $\frac{VI}{2}(t_1 + t_2)$

(B) Turn OFF, $VI(t_1 + t_2)$

(C) Turn ON, $VI(t_1 + t_2)$

(D) Turn OFF, $\frac{VI}{2}(t_1 + t_2)$

SOL 1.76 The Correct option is (A).

In Ideal condition we take voltage across the device is zero.

average power loss during switching $= \frac{VI}{2}(t_1 + t_2)$ (turn ON)

MCQ 1.77 An electronics switch S is required to block voltage of either polarity during its OFF state as shown in the figure (a). This switch is required to conduct in only one direction its ON state as shown in the figure (b)

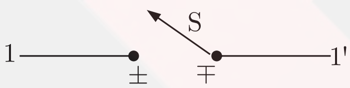


fig (a)

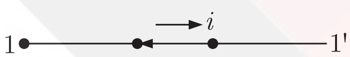
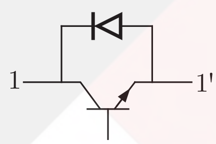
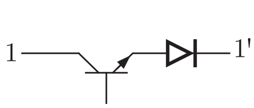


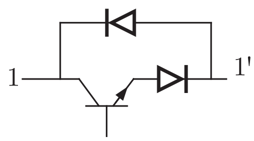
fig (b)

Which of the following are valid realizations of the switch S?

P. 

Q. 

R. 

S. 

(A) Only P

(B) P and Q

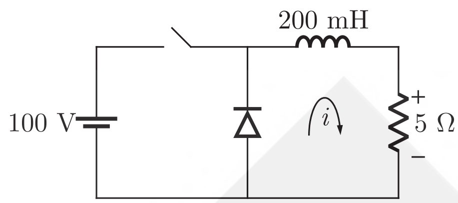
(C) P and R

(D) R and S

SOL 1.77 The Correct option is (C).

So in P thyristor blocks voltage in both polarities until gate is triggered and also in R transistor along with diode can do same process.

MCQ 1.78 The given figure shows a step-down chopper switched at 1 kHz with a duty ratio $D = 0.5$. The peak-peak ripple in the load current is close to



(A) 10 A
(B) 0.5 A
(C) 0.125 A
(D) 0.25 A

SOL 1.78 The Correct option is (C).

$$\text{Duty ratio } \alpha = 0.5$$

here
$$T = \frac{1}{1 \times 10^{-3}} = 10^{-3} \text{ sec}$$

$$T_a = \frac{L}{R} = \frac{200 \text{ mH}}{5} = 40 \text{ msec}$$

$$\text{Ripple} = \frac{V_s}{R}\left[\frac{(1 - e^{-\alpha T/T_s})(1 - e^{-(1-\alpha)T/T_a})}{1 - e^{-T/T_s}}\right]$$

$$(\Delta I)_{\max} = \frac{V_s}{4fL} = \frac{100}{4 \times 10^3 \times 200 \times 10^{-3}}$$

$$= 0.125 \text{ A}$$

MCQ 1.79 An electric motor, developing a starting torque of 15 Nm, starts with a load torque of 7 Nm on its shaft. If the acceleration at start is 2 rad/sec^2, the moment of inertia of the system must be (neglecting viscous and coulomb friction)

(A) 0.25 kg-m^2
(B) 0.25 Nm^2
(C) 4 kg-m^2
(D) 4 Nm^2

SOL 1.79 The Correct option is (C).

$$T_{st} = 15 \text{ Nm}$$

$$T_L = 7 \text{ Nm}$$

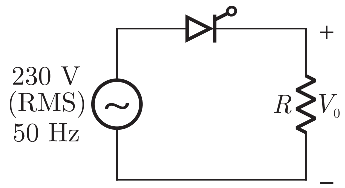
$$\alpha = 2 \text{ rad/sec}^2$$

$$T = I\alpha$$

so
$$T = T_{st} - T_L = 8 \text{ Nm}$$

$$I = \frac{8}{2} = 4 \text{ kgm}^2$$

MCQ 1.80 Consider a phase-controlled converter shown in the figure. The thyristor is fired at an angle α in every positive half cycle of the input voltage. If the peak value of the instantaneous output voltage equals 230 V, the firing angle α is close to



(A) 45° (B) 135°

(C) 90° (D) 83.6°

SOL 1.80 The Correct option is (B).

We know that $V_{rms} = 230$ V

so, $V_m = 230 \times \sqrt{2}$ V

If whether $\alpha < 90°$

Then $V_{peak} = V_m \sin\alpha = 230$

$$230\sqrt{2}\sin\alpha = 230$$

$$\sin\alpha = \frac{1}{\sqrt{2}}$$

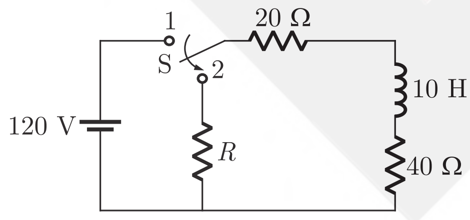
$$\text{angle } \alpha = 135°$$

Linked Answer Questions : Q.81 to Q.90 Carry Two Marks Each

Statement for Linked Answer Questions 81 and 82

A coil of inductance 10 H and resistance 40 Ω is connected as shown in the figure. After the switch S has been in contact with point 1 for a very long time, it is moved to point 2 at, $t = 0$.

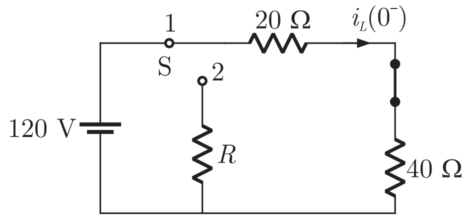
MCQ 1.81 If, at t $= 0^+$, the voltage across the coil is 120 V, the value of resistance R is



(A) 0 Ω (B) 20 Ω

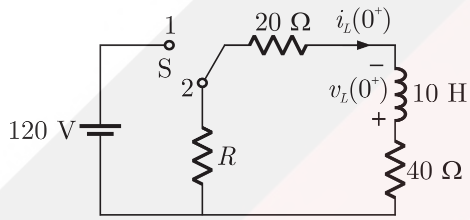
(C) 40 Ω (D) 60 Ω

SOL 1.81 When the switch is at position 1, current in inductor is given as



$$i_L(0^-) = \frac{120}{20+40} = 2 \text{ A}$$

At $t = 0$, when switch is moved to position 1,inductor current does not change simultaneously so



$$i_L(0^+) = i_L(0^-) = 2 \text{ A}$$

Voltage across inductor at $t = 0^+$

$$v_L(0^+) = 120 \text{ V}$$

By applying KVL in loop

$$120 = 2(40 + R + 20)$$
$$120 = 120 + R$$
$$R = 0\,\Omega$$

Hence (A) is correct option.

MCQ 1.82 For the value as obtained in (a), the time taken for 95% of the stored energy to be dissipated is close to

(A) 0.10 sec (B) 0.15 sec

(C) 0.50 sec (D) 1.0 sec

SOL 1.82 Let stored energy and dissipated energy are E_1 and E_2 respectively. Then

Current

$$\frac{i_2^2}{i_1^2} = \frac{E_2}{E_1} = 0.95$$

$$i_2 = \sqrt{0.95}\, i_1 = 0.97 i_1$$

Current at any time t, when the switch is in position (2) is given by

$$i(t) = i_1 e^{-\frac{R}{L}t} = 2e^{-\frac{60}{10}t} = 2e^{-6t}$$

After 95% of energy dissipated current remaining in the circuit is

$$i = 2 - 2 \times 0.97 = 0.05 \text{ A}$$

So, $$0.05 = 2e^{-6t}$$

$$t \approx 0.50 \text{ sec}$$

Hence (C) is correct option.

Statement for Linked Answer Questions 83 and 84

A state variable system $\dot{\boldsymbol{X}}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} \boldsymbol{X}(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} \boldsymbol{u}(t)$ with the initial condition $\boldsymbol{X}(0) = [-1,\ 3]^T$ and the unit step input $u(t)$ has

MCQ 1.83 The state transition matrix

(A) $\begin{bmatrix} 1 & \frac{1}{3}(1-e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}$

(B) $\begin{bmatrix} 1 & \frac{1}{3}(e^{-t}-e^{-3t}) \\ 0 & e^{-t} \end{bmatrix}$

(C) $\begin{bmatrix} 1 & \frac{1}{3}(e^{3-t}-e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}$

(D) $\begin{bmatrix} 1 & (1-e^{-t}) \\ 0 & e^{-t} \end{bmatrix}$

SOL 1.83 Given state equation.

$$\dot{\boldsymbol{X}}(t) = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} \boldsymbol{X}(t) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} \boldsymbol{u}(t)$$

Here

$$A = \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

State transition matrix is given by,

$$\phi(t) = \mathcal{L}^{-1}[(sI-A)^{-1}]$$

$$[sI-A] = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 1 \\ 0 & -3 \end{bmatrix} = \begin{bmatrix} s & -1 \\ 0 & s+3 \end{bmatrix}$$

$$[sI-A]^{-1} = \frac{1}{s(s+3)} \begin{bmatrix} s+3 & 1 \\ 0 & s \end{bmatrix} = \begin{bmatrix} \frac{1}{s} & \frac{1}{s(s+3)} \\ 0 & \frac{1}{(s+3)} \end{bmatrix}$$

$$\phi(t) = \mathcal{L}^{-1}[(sI-A)^{-1}] = \begin{bmatrix} 1 & \frac{1}{3}(1-e^{-3t}) \\ 0 & e^{-3t} \end{bmatrix}$$

Hence (A) is correct option.

MCQ 1.84 The state transition equation

(A) $\boldsymbol{X}(t) = \begin{bmatrix} t-e^{-t} \\ e^{-t} \end{bmatrix}$

(B) $\boldsymbol{X}(t) = \begin{bmatrix} 1-e^{-t} \\ 3e^{-3t} \end{bmatrix}$

(C) $\boldsymbol{X}(t) = \begin{bmatrix} t-e^{3t} \\ 3e^{-3t} \end{bmatrix}$

(D) $\boldsymbol{X}(t) = \begin{bmatrix} t-e^{-3t} \\ e^{-t} \end{bmatrix}$

SOL 1.84 State transition equation is given by

$$\boldsymbol{X}(s) = \boldsymbol{\Phi}(s)\boldsymbol{X}(0) + \boldsymbol{\Phi}(s)B\boldsymbol{U}(s)$$

Here $\Phi(s) \rightarrow$ state transition matrix

$$\Phi(s) = \begin{bmatrix} \frac{1}{s} & \frac{1}{s(s+3)} \\ 0 & \frac{1}{(s+3)} \end{bmatrix}$$

$\boldsymbol{X}(0) \rightarrow$ initial condition

$$\boldsymbol{X}(0) = \begin{bmatrix} -1 \\ 3 \end{bmatrix}$$

$$\text{B} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

So
$$\boldsymbol{X}(s) = \begin{bmatrix} \frac{1}{s} & \frac{1}{s(s+3)} \\ 0 & \frac{1}{(s+3)} \end{bmatrix} \begin{bmatrix} -1 \\ 3 \end{bmatrix} + \begin{bmatrix} \frac{1}{s} & \frac{1}{(s+3)s} \\ 0 & \frac{1}{s+3} \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} \frac{1}{s}$$

$$= \begin{bmatrix} -\frac{1}{s} + \frac{3}{s(s+3)} \\ 0 + \frac{3}{s+3} \end{bmatrix} + \begin{bmatrix} \frac{1}{s} \\ 0 \end{bmatrix} \frac{1}{s}$$

$$= \begin{bmatrix} -\frac{1}{s+3} \\ \frac{3}{s+3} \end{bmatrix} + \begin{bmatrix} \frac{1}{s^2} \\ 0 \end{bmatrix}$$

$$\boldsymbol{X}(s) = \begin{bmatrix} \frac{1}{s^2} - \frac{1}{s+3} \\ \frac{3}{s+3} \end{bmatrix}$$

Taking inverse Laplace transform, we get state transition equation as,

$$\boldsymbol{X}(t) = \begin{bmatrix} t - e^{-3t} \\ 3e^{-3t} \end{bmatrix}$$

Hence (C) is correct option.

Statement for Linked Answer Questions 85 and 86

A 1000 kVA, 6.6 kV, 3-phase star connected cylindrical pole synchronous generator has a synchronous reactance of 20 Ω. Neglect the armature resistance and consider operation at full load and unity power factor.

MCQ 1.85 The induced emf(line-to-line) is close to

(A) 5.5 kV (B) 7.26 kV

(C) 9.6 kV (D) 12.5 kV

SOL 1.85 Given

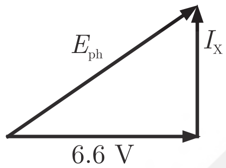
$$P = 1000 \text{ kVA}, 6.6 \text{ kV}$$

Reactance $= 20\ \Omega$ and neglecting the armature resistance at full load and unity power factor

So

$$P = \sqrt{3}\, V_L I_L$$

$$I = \frac{1000}{\sqrt{3} \times 6.6} = 87.47 \text{ A}$$



So,

$$IX = 87.47 \times 20 = 1.75 \text{ kV}$$

$$E_{ph}^2 = \left(\frac{6.5}{\sqrt{3}}\right)^2 + (1.75)^2$$

$$E_{ph} = \sqrt{\left(\frac{6.5}{\sqrt{3}}\right)^2 + (1.75)^2}$$

$$E_{ph} = 4.2 \text{ kV}$$

$$E_L = \sqrt{3}\, E_{ph} \qquad \because \text{Star connection}$$

$$E_L = 1.732 \times 4.2$$

$$E_L = 7.26 \text{ kV}$$

Hence (B) is correct option.

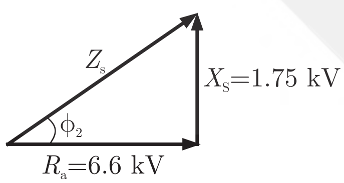
MCQ 1.86 The power(or torque) angle is close to

(A) 13.9° (B) 18.3°

(C) 24.6° (D) 33.0°

SOL 1.86 Hence (C) is correct option.

$$\text{Torque angle } \alpha_z = \tan^{-1}\left(\frac{X_s}{R_a}\right)$$



$$\alpha_z = \tan^{-1}\left(\frac{\sqrt{3} \times 1.75}{6.6}\right)$$

$$\alpha_z = 24.6^\circ$$

Statement for Linked Answer Questions 87 and 88

At a 220 kV substation of a power system, it is given that the three-phase fault level is 4000 MVA and single-line to ground fault level is 5000 MVA Neglecting the resistance and the shunt suspectances of the system.

MCQ 1.87 The positive sequence driving point reactance at the bus is

(A) 2.5 Ω (B) 4.033 Ω

(C) 5.5 Ω (D) 12.1 Ω

SOL 1.87 Given data

$$\text{Substation Level} = 220 \text{ kV}$$
$$3\text{-}\phi \text{ fault level} = 4000 \text{ MVA}$$
$$\text{LG fault level} = 5000 \text{ MVA}$$

Positive sequence reactance:

$$\text{Fault current } I_f = \frac{4000}{\sqrt{3} \times 220}$$
$$X_1 = V_{ph}/I_f$$
$$= \frac{\frac{220}{\sqrt{3}}}{\frac{4000}{\sqrt{3} \times 220}} = \frac{220 \times 220}{4000}$$
$$= 12.1\,\Omega$$

Hence (D) is correct option.

MCQ 1.88 The zero sequence driving point reactance at the bus is

(A) 2.2 Ω (B) 4.84 Ω

(C) 18.18 Ω (D) 22.72 Ω

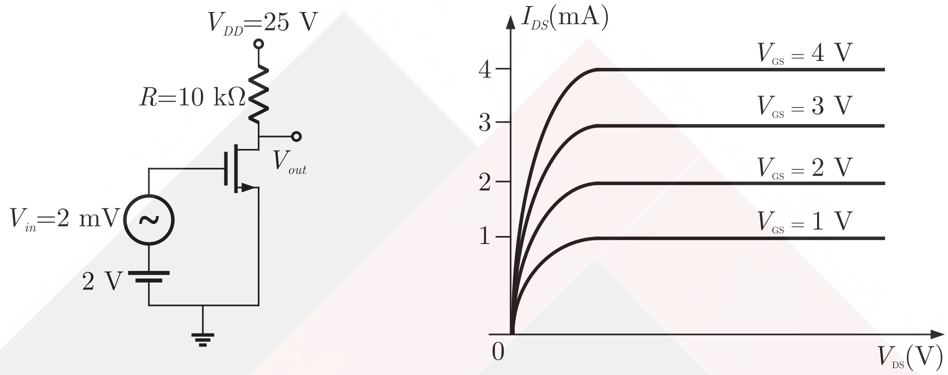
SOL 1.88 Zero sequence Reactance $X_0 = ?$

$$I_f = \frac{5000}{\sqrt{3} \times 220}$$
$$I_{a1} = I_{a2} = I_{a0} = \frac{I_f}{3} = \frac{5000}{3\sqrt{3} \times 220}$$
$$X_1 + X_2 + X_0 = \frac{V_{ph}}{I_{a1}} = \frac{\frac{220}{\sqrt{3}}}{\frac{5000}{220 \times 3\sqrt{3}}}$$
$$X_1 + X_2 + X_0 = \frac{220 \times 220}{3 \times 5000} = 29.04\,\Omega$$
$$X_1 = X_2 = 12.1\,\Omega$$
$$X_0 = 29.04 - 12.1 - 12.1$$
$$= 4.84\,\Omega$$

Hence (B) is correct option.

Statement for Linked Answer Questions 89 and 90

Assume that the threshold voltage of the N-channel MOSFET shown in figure is + 0.75 V. The output characteristics of the MOSFET are also shown



MCQ 1.89 The transconductance of the MOSFET is

(A) 0.75 ms (B) 1 ms

(C) 2 ms (D) 10 ms

SOL 1.89 Trans-conductance of MOSFET is given by

$$g_m = \frac{\partial i_D}{\partial V_{GS}}$$

$$= \frac{(2-1)\text{ mA}}{(2-1)\text{ V}} = 1\text{ mS}$$

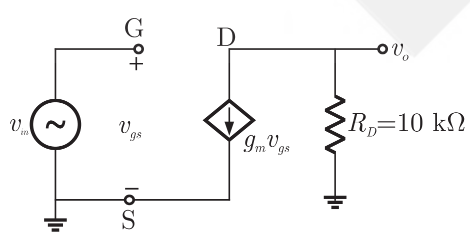
Hence (B) is correct option.

MCQ 1.90 The voltage gain of the amplifier is

(A) +5 (B) −7.5

(C) +10 (D) −10

SOL 1.90 Voltage gain can be obtain by small signal equivalent circuit of given amplifier.



$$v_o = -g_m v_{gs} R_D$$

$$v_{gs} = v_{in}$$

So, $$v_o = -g_m R_D v_{in}$$

Voltage gain $A_v = \frac{v_o}{v_i} = -g_m R_D$

$= -(1\,\text{mS})(10\,\text{k}\Omega)$

$= -10$

Hence (D) is correct option.

Answer Sheet									
1.	(C)	19.	(B)	37.	(C)	55.	(B)	73.	(B)
2.	(A)	20.	(A)	38.	(C)	56.	(B)	74.	(D)
3.	(D)	21.	(C)	39.	(B)	57.	(A)	75.	(D)
4.	(B)	22.	(A)	40.	(C)	58.	(D)	76.	(A)
5.	(D)	23.	(A)	41.	(D)	59.	(C)	77.	(C)
6.	(C)	24.	(C)	42.	(B)	60.	(D)	78.	(C)
7.	(A)	25.	(D)	43.	(B)	61.	(C)	79.	(C)
8.	(A)	26.	(C)	44.	(A)	62.	(B)	80.	(B)
9.	(D)	27.	(B)	45.	(C)	63.	(D)	81.	(A)
10.	(D)	28.	(A)	46.	(B)	64.	(B)	82.	(C)
11.	(C)	29.	(B)	47.	(A)	65.	(C)	83.	(A)
12.	(A)	30.	(C)	48.	(D)	66.	(D)	84.	(C)
13.	(D)	31.	(C)	49.	(B)	67.	(A)	85.	(B)
14.	(B)	32.	(A)	50.	(A)	68.	(D)	86.	(C)
15.	(A)	33.	(A)	51.	(B)	69.	(B)	87.	(D)
16.	(B)	34.	(C)	52.	(D)	70.	(C)	88.	(B)
17.	(D)	35.	(A)	53.	(C)	71.	(B)	89.	(B)
18.	(D)	36.	(A)	54.	(*)	72.	(C)	90.	(D)