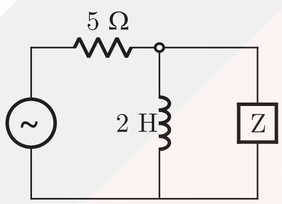
GATE EE
2004

Q.1 - 30 Carry One Mark Each

MCQ 1.1 The value of Z in figure which is most appropriate to cause parallel resonance at 500 Hz is



(A) 125.00 mH (B) 304.20 μF

(C) 2.0 μF (D) 0.05 μF

SOL 1.1 The Correct option is (D).
Resonance will occur only when Z is capacitive, in parallel resonance condition, suseptance of circuit should be zero.

$$\frac{1}{j\omega L} + j\omega C = 0$$

$$1 - \omega^2 LC = 0$$

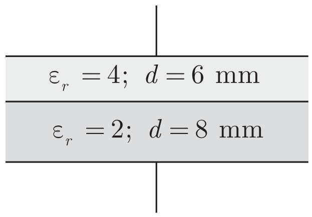
$$\omega = \frac{1}{\sqrt{LC}} \text{ (resonant frequency)}$$

$$C = \frac{1}{\omega^2 L}$$

$$= \frac{1}{4 \times \pi^2 \times (500)^2 \times 2}$$

$$C = 0.05\,\mu\text{F}$$

MCQ 1.2 A parallel plate capacitor is shown in figure. It is made two square metal plates of 400 mm side. The 14 mm space between the plates is filled with two layers of dielectrics of $\varepsilon_r = 4$, 6 mm thick and $\varepsilon_r = 2$, 8 mm thick. Neglecting fringing of fields at the edge the capacitance is



(A) 1298 pF (B) 944 pF

(C) 354 pF (D) 257 pF

SOL 1.2 Here two capacitor C_1 and C_2 are connected in series so equivalent Capacitance is

$$C_{eq} = \frac{C_1 C_2}{C_1 + C_2}$$

$$C_1 = \frac{\varepsilon_0 \varepsilon_{r1} A}{d_1} = \frac{8.85 \times 10^{-12} \times 4(400 \times 10^{-3})^2}{6 \times 10^{-3}}$$

$$= \frac{8.85 \times 10^{-12} \times 4 \times 16 \times 10^{-2}}{6 \times 10^{-3}}$$

$$= 94.4 \times 10^{-11} \text{ F}$$

Similarly

$$C_2 = \frac{\varepsilon_0 \varepsilon_{r2} A}{d_2} = \frac{8.85 \times 10^{-12} \times 2 \times (400 \times 10^{-3})^2}{8 \times 10^{-3}}$$

$$= \frac{8.85 \times 10^{-12} \times 2 \times 16 \times 10^{-12}}{8 \times 10^{-3}}$$

$$= 35.4 \times 10^{-11} \text{ F}$$

$$C_{eq} = \frac{94.4 \times 10^{-11} \times 35.4 \times 10^{-11}}{(94.4 + 35.4) \times 10^{-11}} = 25.74 \times 10^{-11}$$

$$\simeq 257 \text{ pF}$$

Hence (D) is correct option.

MCQ 1.3 The inductance of a long solenoid of length 1000 mm wound uniformly with 3000 turns on a cylindrical paper tube of 60 mm diameter is

(A) 3.2 μH (B) 3.2 mH

(C) 32.0 mH (D) 3.2 H

SOL 1.3 The Correct option is (C).

Inductance of the Solenoid is given as

$$L = \frac{\mu_0 N^2 A}{l}$$

Where $A \rightarrow$ are of Solenoid

$l \rightarrow$ length

$$L = \frac{4\pi \times 10^{-7} \times (3000)^2 \times \pi(30 \times 10^{-3})^2}{(1000 \times 10^{-3})}$$

$$= 31.94 \times 10^{-3} \text{ H}$$

$$\simeq 32 \text{ mH}$$

MCQ 1.4 Total instantaneous power supplied by a 3-phase ac supply to a balanced R-L load is

(A) zero

(B) constant

(C) pulsating with zero average

(D) pulsating with the non-zero average

SOL 1.4 Instantaneous power supplied by 3-ϕ ac supply to a balanced R-L load.

$$P = V_a I_a + V_a I_b + V_c I_c$$
$$= (V_m \sin \omega t) I_m \sin(\omega t - \phi) + V_m \sin(\omega t - 120^\circ) I_m \sin(\omega t - 120^\circ - \phi)$$
$$+ V_m \sin(\omega t - 240^\circ) I_m \sin(\omega t - 240^\circ - \phi)$$
$$= VI[\cos\phi - \cos(2\omega t - \phi) + \cos\phi - \cos(2\omega t - 240 - \phi) + \cos\phi$$
$$- \cos(2\omega t + 240 - \phi)]$$
$$P = 3VI\cos\phi \qquad ...(1)$$

equation (1) implies that total instantaneous power is being constant.
Hence (B) is correct option.

MCQ 1.5 A 500 kVA, 3-phase transformer has iron losses of 300 W and full load copper losses of 600 W. The percentage load at which the transformer is expected to have maximum efficiency is

(A) 50.0% (B) 70.7%

(C) 141.4% (D) 200.0%

SOL 1.5 Hence (B) is correct option.
Given that
transformer rating is 500 kVA
Iron losses = 300 W
full load copper losses = 600 W
maximum efficiency condition

$$W_i = X^2 W_c$$

so,

$$X = \sqrt{\frac{W_i}{W_c}}$$
$$= \sqrt{\frac{300}{600}}$$
$$\sqrt{1/2}$$
$$0.707$$
$$\text{efficiency}\% = 0.707 \times 100$$
$$= 70.7\%$$

MCQ 1.6 For a given stepper motor, the following torque has the highest numerical value

(A) Detent torque (B) Pull-in torque
(C) Pull-out torque (D) Holding torque

SOL 1.6 Stepper motor is rotated in steps, when the supply is connected then the torque is produced in it. The higher value of torque is pull out torque and less torque when the torque is pull in torque.
Hence (C) is correct option.

MCQ 1.7 The following motor definitely has a permanent magnet rotor
(A) DC commutator motor (B) Brushless dc motor
(C) Stepper motor (D) Reluctance motor

SOL 1.7 The stepper motor has the permanent magnet rotor and stator has made of windings, it's connected to the supply.
Hence (C) is correct option.

MCQ 1.8 The type of single-phase induction motor having the highest power factor at full load is
(A) shaded pole type (B) split-phase type
(C) capacitor-start type (D) capacitor-run type

SOL 1.8 1-phase induction motor is not self starting, so it's used to start different method at full load condition, capacitor-run type motor have higher power factor. In this type the capacitor is connected in running condition.
Hence (D) is correct option.

MCQ 1.9 The direction of rotation of a 3-phase induction motor is clockwise when it is supplied with 3-phase sinusoidal voltage having phase sequence A-B-C. For counter clockwise rotation of the motor, the phase sequence of the power supply should be
(A) B-C-A (B) C-A-B
(C) A-C-B (D) B-C-A or C-A-B

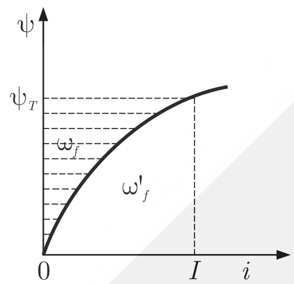
SOL 1.9 Given that if 3-ϕ induction motor is rotated in clockwise then the phase sequence of supply voltage is A-B-C. In counter clock wise rotation of the motor the phase sequence is change so in the counter clockwise rotation the phase sequence is A-C-B.
Hence (C) is correct option.

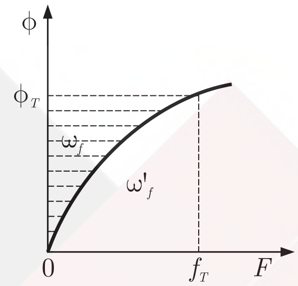
MCQ 1.10 For a linear electromagnetic circuit, the following statement is true
(A) Field energy is equal to the co-energy
(B) Field energy is greater than the co-energy
(C) Field energy is lesser than the co-energy
(D) Co-energy is zero

SOL 1.10 In linear electromagnetic circuit the field energy is equal to the co-energy.

$$W_f = W_f' = \frac{1}{2}Li^2 = \frac{1}{2}\psi_i = \frac{1}{2L}\psi^2$$

$$W_f = \text{field energy}$$
$$W_f' = \text{co energy}$$





Hence (A) is correct option.

MCQ 1.11 The rated voltage of a 3-phase power system is given as

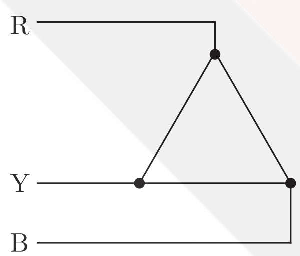
(A) rms phase voltage (B) peak phase voltage

(C) rms line to line voltage (D) peak line to line voltage

SOL 1.11 In 3-ϕ Power system, the rated voltage is being given by RMS value of line to line voltage.

Hence (C) is correct option.

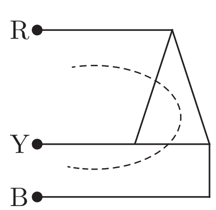
MCQ 1.12 The phase sequences of the 3-phase system shown in figure is



(A) RYB (B) RBY

(C) BRY (D) YBR

SOL 1.12 The Correct option is (B).



In this figure the sequence is being given as RBY.

MCQ 1.13 In the thermal power plants, the pressure in the working fluid cycle is developed by

(A) condenser (B) super heater
(C) feed water pump (D) turbine

SOL 1.13 The Correct option is (C).
In thermal power plants, the pressure in the working fluid cycle is developed by the help to feed water pump.

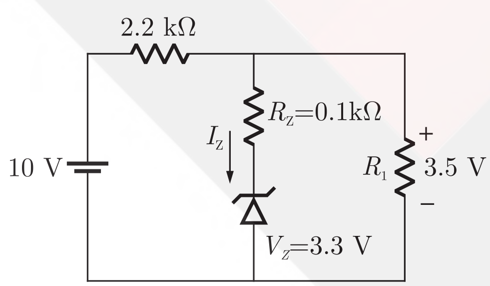
MCQ 1.14 For harnessing low variable waterheads, the suitable hydraulic turbine with high percentage of reaction and runner adjustable vanes is
(A) Kaplan (B) Francis
(C) Pelton (D) Impeller

SOL 1.14 Kaplan turbines are used for harnessing low variable waterheads because of high percentage of reaction and runner adjustable vanes.
Hence (A) is correct option.

MCQ 1.15 The transmission line distance protection relay having the property of being inherently directional is
(A) impedance relay (B) MHO relay
(C) OHM relay (D) reactance relay

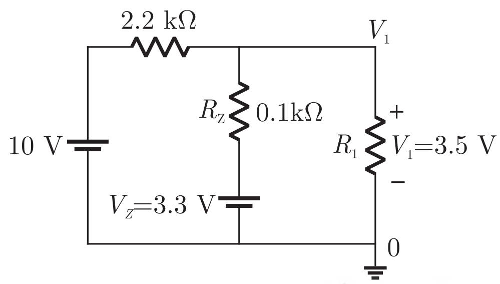
SOL 1.15 MHO relay is the type of distance relay which is used to transmission line protection.
MHO Relay has the property of being inherently directional.
Hence (B) is correct option.

MCQ 1.16 The current through the Zener diode in figure is



(A) 33 mA (B) 3.3 mA
(C) 2 mA (D) 0 mA

SOL 1.16 The Correct option is (C).
Given circuit,



In the circuit

$$V_1 = 3.5\text{ V (given)}$$

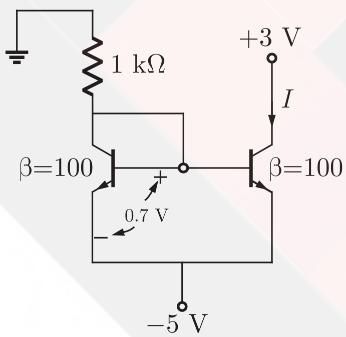
Current in zener is.

$$I_Z = \frac{V_1 - V_Z}{R_Z}$$

$$I_Z = \frac{3.5 - 3.3}{0.1 \times 10^3}$$

$$I_Z = 2\text{ mA}$$

MCQ 1.17 Two perfectly matched silicon transistor are connected as shown in figure. The value of the current I is



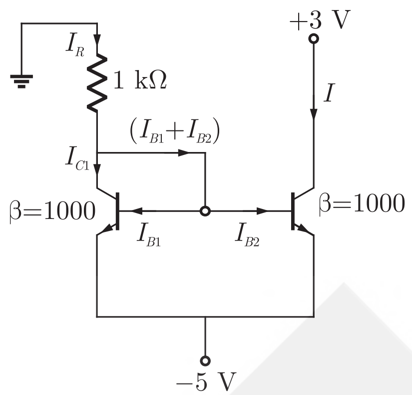
(A) 0 mA (B) 2.3 mA

(C) 4.3 mA (D) 7.3 mA

SOL 1.17 This is a current mirror circuit. Since V_{BE} is the same in both devices, and transistors are perfectly matched, then

$$I_{B1} = I_{B2} \quad \text{and} \quad I_{C1} = I_{C2}$$

From the circuit we have,



$$I_R = I_{C1} + I_{B1} + I_{B2}$$

$$I_R = I_{C1} + 2I_{B2} \qquad \because I_{B1} = I_{B2}$$

$$I_R = I_{C2} + \frac{2I_{C2}}{\beta} \qquad \because I_{C1} = I_{C2}, I_{C2} = \beta I_{B2}$$

$$I_R = I_{C2}\left(1 + \frac{2}{\beta}\right)$$

$$I_{C2} = I = \frac{I_R}{\left(1 + \frac{2}{\beta}\right)}$$

I_R can be calculate as

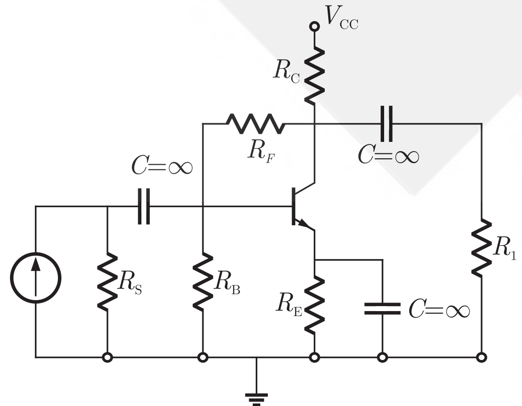
$$I_R = \frac{-5 + 0.7}{1 \times 10^3} = -4.3 \text{ mA}$$

So,

$$I = \frac{4.3}{\left(1 + \frac{2}{100}\right)} \simeq 4.3 \text{ mA}$$

Hence (C) is correct option.

MCQ 1.18 The feedback used in the circuit shown in figure can be classified as

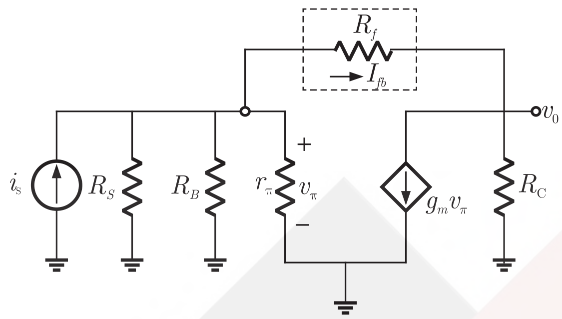


(A) shunt-series feedback (B) shunt-shunt feedback

(C) series-shunt feedback (D) series-series feedback

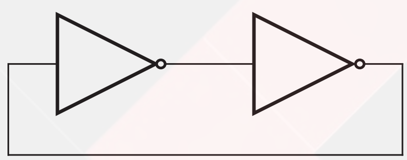
SOL 1.18 The Correct option is (B).

The small signal equivalent circuit of given amplifier



Here the feedback circuit samples the output voltage and produces a feed back current I_{fb} which is in shunt with input signal. So this is a shunt-shunt feedback configuration.

MCQ 1.19 The digital circuit using two inverters shown in figure will act as

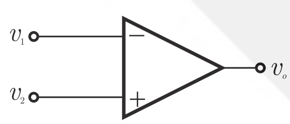


(A) a bistable multi-vibrator (B) an astable multi-vibrator

(C) a monostable multi-vibrator (D) an oscillator

SOL 1.19 In the given circuit output is stable for both 1 or 0. So it is a bistable multi-vibrator. Hence (A) is correct option.

MCQ 1.20 The voltage comparator shown in figure can be used in the analog-to-digital conversion as



(A) a 1-bit quantizer (B) a 2-bit quantizer

(C) a 4-bit quantizer (D) a 8-bit quantizer

SOL 1.20 Since there are two levels ($+V_{CC}$ or $-V_{CC}$) of output in the given comparator circuit.

For an n-bit Quantizer

$$2^n = \text{No. of levels}$$
$$2^n = 2$$
$$n = 1$$

Hence (A) is correct option.

MCQ 1.21 The Nyquist plot of loop transfer function $G(s)H(s)$ of a closed loop control system passes through the point $(-1, j0)$ in the $G(s)H(s)$plane. The phase margin of the system is

(A) $0°$ (B) $45°$

(C) $90°$ (D) $180°$

SOL 1.21 Phase margin of a system is the amount of additional phase lag required to bring the system to the point of instability or $(-1, j0)$

So here phase margin $= 0°$

Hence (A) is correct option.

MCQ 1.22 Consider the function,

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

where $F(s)$ is the Laplace transform of the of the function $f(t)$. The initial value of $f(t)$ is equal to

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

(C) $\frac{5}{3}$ (D) 0

SOL 1.22 Given transfer function is

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

$$F(s) = \frac{5}{s(s+1)(s+2)}$$

By partial fraction, we get

$$F(s) = \frac{5}{2s} - \frac{5}{s+1} + \frac{5}{2(s+2)}$$

Taking inverse laplace of $F(s)$ we have

$$f(t) = \frac{5}{2}u(t) - 5e^{-t} + \frac{5}{2}e^{-2t}$$

So, the initial value of $f(t)$ is given by

$$\lim_{t \to 0} f(t) = \frac{5}{2} - 5 + \frac{5}{2}(1)$$

$$= 0$$

Hence (D) is correct option.

MCQ 1.23 For a tachometer, if $\theta(t)$ is the rotor displacement in radians, $e(t)$ is the output voltage and K_t is the tachometer constant in V/rad/sec, then the transfer function, $\frac{E(s)}{Q(s)}$ will be

(A) $K_t s^2$ (B) K_t/s

(C) $K_t s$ (D) K_t

SOL 1.23 In A.C techo-meter output voltage is directly proportional to differentiation of rotor displacement.

$$e(t) \propto \frac{d}{dt}[\theta(t)]$$

$$e(t) = K_t \frac{d\theta(t)}{dt}$$

Taking Laplace tranformation on both sides of above equation

$$E(s) = K_t s\theta(s)$$

So transfer function

$$\text{T.F} = \frac{E(s)}{\theta(s)} = (K_t) s$$

Hence (C) is correct option.

MCQ 1.24 A dc potentiometer is designed to measure up to about 2 V with a slide wire of 800 mm. A standard cell of emf 1.18 V obtains balance at 600 mm. A test cell is seen to obtain balance at 680 mm. The emf of the test cell is

(A) 1.00 V (B) 1.34 V

(C) 1.50 V (D) 1.70 V

SOL 1.24 (check)

for the dc potentiometer $E \propto l$

so, $$\frac{E_1}{E_2} = \frac{l_1}{l_2}$$

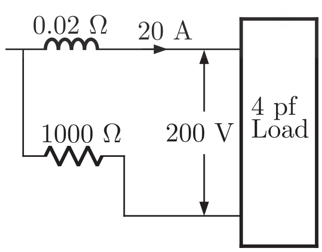
$$E_2 = E_1\left(\frac{l_1}{l_2}\right)$$

$$= (1.18) \times \frac{680}{600}$$

$$= 1.34 \text{ V}$$

Hence (B) is correct option.

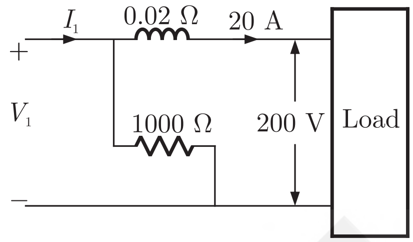
MCQ 1.25 The circuit in figure is used to measure the power consumed by the load. The current coil and the voltage coil of the wattmeter have 0.02 Ω and 1000Ω resistances respectively. The measured power compared to the load power will be



(A) 0.4 % less (B) 0.2% less

(C) 0.2% more (D) 0.4% more

SOL 1.25 Let the actual voltage and current are I_1 and V_1 respectively, then



Current in CC is 20 A

$$20 = I_1\left(\frac{1000}{1000+0.02}\right)$$

$$I_1 = 20.0004 \text{ A} \simeq 20 \text{ A}$$

$$200 = V_1 - .02 \times 20$$

$$= 200.40$$

Power measured $P_m = V_1 I_1 = 20\,(200.40)$

$$= 4008 \text{ W}$$

Load power $P_L = 20 \times 200 = 4000$ W

$$\% \text{ Change} = \frac{P_m - P_L}{P_L} = \frac{4008 - 4000}{4000} \times 100$$

$$= 0.2\% \text{ more}$$

Hence (C) is correct option.

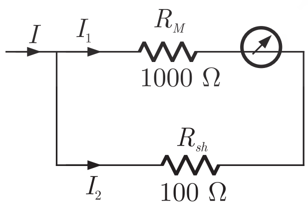
MCQ 1.26 A galvanometer with a full scale current of 10 mA has a resistance of 1000 Ω. The multiplying power (the ratio of measured current to galvanometer current) of 100 Ω shunt with this galvanometer is

(A) 110 (B) 100

(C) 11 (D) 10

SOL 1.26 The Correct option is (C).

We have to obtain $n = \frac{I}{I_1}$



$$\frac{I_1}{I_2} = \frac{R_{sh}}{R_m} = \frac{100}{1000} = \frac{1}{10}$$

$$I_1 + I_2 = I$$

$$I_1 + 10 I_1 = I$$

$$11 I_1 = I$$

$$n = \frac{I}{I_1} = 11$$

MCQ 1.27 A bipolar junction transistor (BJT) is used as a power control switch by biasing it in the cut-off region (OFF state) or in the saturation region (ON state). In the ON state, for the BJT

(A) both the base-emitter and base-collector junctions are reverse biased

(B) the base-emitter junction is reverse biased, and the base-collector junction is forward biased

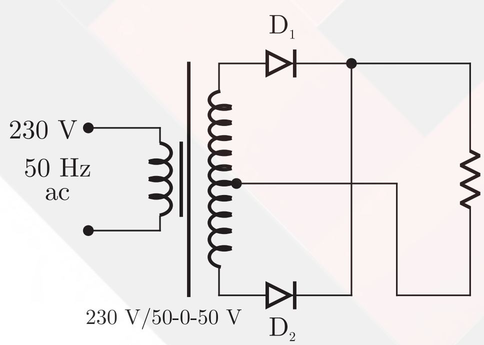
(C) the base-emitter junction is forward biased, and the base-collector junction is reverse biased

(D) both the base-emitter and base-collector junctions are forward biased

SOL 1.27 When we use BJT as a power control switch by biasing it in cut-off region or in the saturation region. In the on state both the base emitter and base-collector junction are forward biased.

Hence (D) is correct option.

MCQ 1.28 The circuit in figure shows a full-wave rectifier. The input voltage is 230 V (rms) single-phase ac. The peak reverse voltage across the diodes D_1 and D_2 is



(A) $100\sqrt{2}$ V (B) 100 V

(C) $50\sqrt{2}$ V (D) 50 V

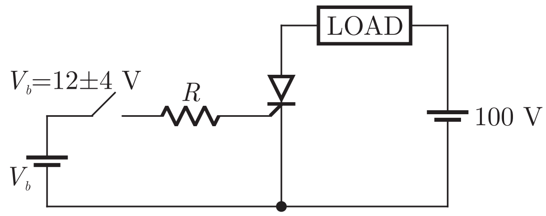
SOL 1.28 Peak Inverse Voltage (PIV) across full wave rectifier is $2V_m$

$$V_m = 50\sqrt{2} \text{ V}$$

so, $$\text{PIV} = 100\sqrt{2} \text{ V}$$

Hence (A) is correct option.

MCQ 1.29 The triggering circuit of a thyristor is shown in figure. The thyristor requires a gate current of 10 mA, for guaranteed turn-on. The value of R required for the thyristor to turn on reliably under all conditions of V_b variation is



(A) 10000 Ω (B) 1600 Ω

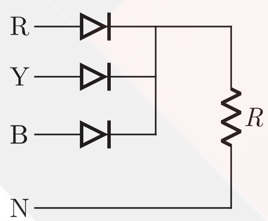
(C) 1200 Ω (D) 800 Ω

SOL 1.29 The Correct option is (D).

$$V_b = 12 \pm 4 \text{ V}$$
$$V_{b\max} = 16 \text{ V}$$
$$V_{b\min} = 8 \text{ V}$$

$$\text{Required value of } R = \frac{V_b(\min)}{I_g} = \frac{8}{10 \times 10^{-3}} = 800\ \Omega$$

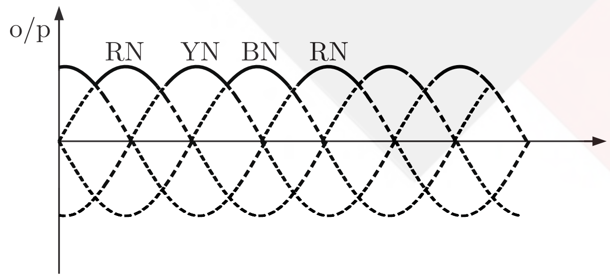
MCQ 1.30 The circuit in figure shows a 3-phase half-wave rectifier. The source is a symmetrical, 3-phase four-wire system. The line-to-line voltage of the source is 100 V. The supply frequency is 400 Hz. The ripple frequency at the output is



(A) 400 Hz (B) 800 Hz

(C) 1200 Hz (D) 2400 Hz

SOL 1.30 The Correct option is (C).

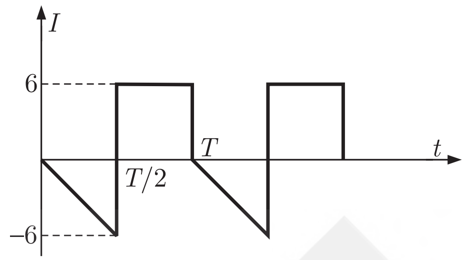


$$\text{Ripple frequency} = 3f = 3 \times 400 = 1200 \text{ Hz}$$

So from V_0 ripple frequency $= 1200$ Hz

Q.31 - 90 Carry Two Marks Each

MCQ 1.31 The rms value of the periodic waveform given in figure is



(A) $2\sqrt{6}$ A

(B) $6\sqrt{2}$ A

(C) $\sqrt{4/3}$ A

(D) 1.5 A

SOL 1.31 Root mean square value is given as

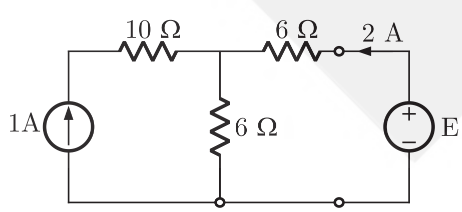
$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T I^2(t)\,dt}$$

From the graph, $I(t) = \begin{cases} -\left(\frac{12}{T}\right)t, & 0 \le t < \frac{T}{2} \\ 6, & T/2 < t \le T \end{cases}$

So
$$\frac{1}{T}\int_0^T I^2\,dt = \frac{1}{T}\left[\int_0^{T/2}\left(\frac{-12t}{T}\right)^2 dt + \int_{T/2}^{T}(6)^2\,dt\right]$$
$$= \frac{1}{T}\left(\frac{144}{T^2}\left[\frac{t^3}{3}\right]_0^{T/2} + 36[t]_{T/2}^{T}\right)$$
$$= \frac{1}{T}\left[\frac{144}{T^2}\left(\frac{T^3}{24}\right) + 36\left(\frac{T}{2}\right)\right]$$
$$= \frac{1}{T}[6T + 18T] = 24$$
$$I_{rms} = \sqrt{24} = 2\sqrt{6}\text{ A}$$

Hence (A) is correct option

MCQ 1.32 In figure, the value of the source voltage is



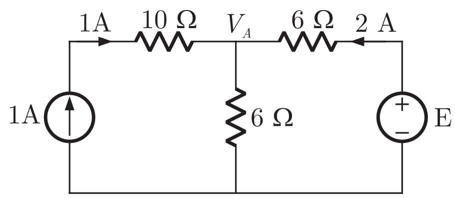
(A) 12 V

(B) 24 V

(C) 30 V

(D) 44 V

SOL 1.32 The Correct option is (C).
In the circuit



Voltage $\quad V_A = (2+1)\times 6$

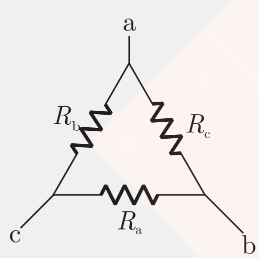
$= 18$ Volt

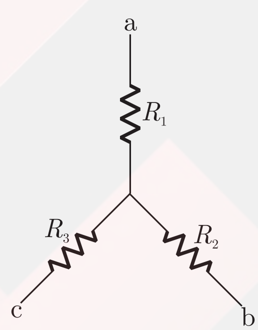
So, $\quad 2 = \dfrac{E - V_A}{6}$

$$2 = \frac{E-18}{6}$$

$$E = 12 + 18 = 30 \text{ V}$$

MCQ 1.33 In figure, R_a, R_b and R_c are $20\,\Omega$, $20\,\Omega$ and $10\,\Omega$ respectively. The resistances R_1, R_2 and R_3 in Ω of an equivalent star-connection are





(A) 2.5, 5, 5 (B) 5, 2.5, 5

(C) 5, 5, 2.5 (D) 2.5, 5, 2.5

SOL 1.33 Delta to star $(\Delta - Y)$ conversions is given as

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}$$

$$= \frac{10 \times 10}{20 + 10 + 10} = 2.5\,\Omega$$

$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c}$$

$$= \frac{20 \times 10}{20 + 10 + 10} = 5\,\Omega$$

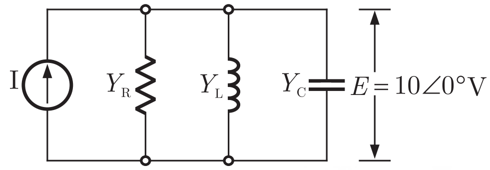
$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c}$$

$$= \frac{20 \times 10}{20 + 10 + 10} = 5\,\Omega$$

Hence (A) is correct option

MCQ 1.34 In figure, the admittance values of the elements in Siemens are

$Y_R = 0.5 + j0$, $Y_L = 0 - j1.5$, $Y_C = 0 + j0.3$ respectively. The value of I as a phasor when the voltage E across the elements is $10\angle 0^\circ$ V



(A) $1.5 + j0.5$ (B) $5 - j18$

(C) $0.5 + j1.8$ (D) $5 - j12$

SOL 1.34 The Correct option is (D).

For parallel circuit

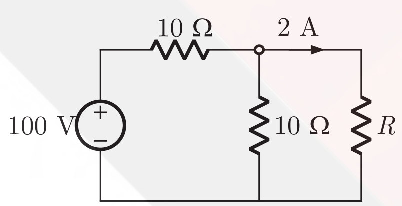
$$I = \frac{E}{Z_{eq}} = EY_{eq}$$

$$Y_{eq} \rightarrow \text{ Equivalent admittance of the circuit}$$

$$\begin{aligned} Y_{eq} &= Y_R + Y_L + Y_C \\ &= (0.5 + j0) + (0 - j1.5) + (0 + j0.3) \\ &= 0.5 - j1.2 \end{aligned}$$

So, current $$\begin{aligned} I &= 10(0.5 - j1.2) \\ &= (5 - j12)\text{ A} \end{aligned}$$

MCQ 1.35 In figure, the value of resistance R in Ω is

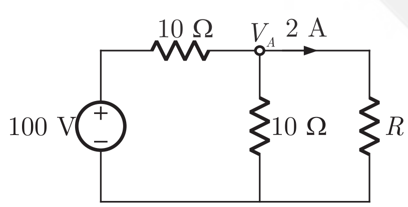


(A) 10 (B) 20

(C) 30 (D) 40

SOL 1.35 The Correct option is (B).

In the circuit



Voltage $$\begin{aligned} V_A &= \frac{100}{10 + (10\,||\,R)} \times (10\,||\,R) \\ &= \left(\frac{100}{10 + \frac{10R}{10 + R}}\right)\left(\frac{10R}{10 + R}\right) \end{aligned}$$

$$= \frac{1000R}{100 + 20R}$$

$$= \frac{50R}{5 + R}$$

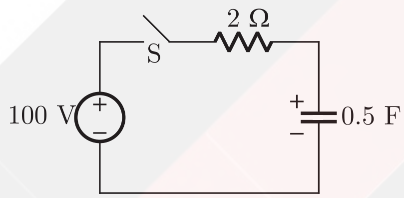
Current in $R\,\Omega$ resistor

$$2 = \frac{V_A}{R}$$

$$2 = \frac{50R}{R(5+R)}$$

or $R = 20\,\Omega$

MCQ 1.36 In figure, the capacitor initially has a charge of 10 Coulomb. The current in the circuit one second after the switch S is closed will be



(A) 14.7 A (B) 18.5 A

(C) 40.0 A (D) 50.0 A

SOL 1.36 Since capacitor initially has a charge of 10 coulomb, therefore

$$Q_0 = Cv_c(0) \qquad v_c(0) \rightarrow \text{initial voltage across capacitor}$$

$$10 = 0.5v_c(0)$$

$$v_c(0) = \frac{10}{0.5} = 20 \text{ V}$$

When switch S is closed, in steady state capacitor will be charged completely and capacitor voltage is

$$v_c(\infty) = 100 \text{ V}$$

At any time t transient response is

$$v_c(t) = v_c(\infty) + [v_c(0) - v_c(\infty)]\, e^{-\frac{t}{RC}}$$

$$v_c(t) = 100 + (20 - 100)\, e^{-\frac{t}{2\times 0.5}}$$

$$= 100 - 80e^{-t}$$

Current in the circuit

$$i(t) = C\frac{dv_c}{dt}$$

$$i(t) = C\frac{d}{dt}[100 - 80e^{-t}]$$

$$= C \times 80e^{-t}$$

$$= 0.5 \times 80e^{-t}$$

$$= 40e^{-t}$$

at $t = 1$ sec,

$$i(t) = 40e^{-1}$$
$$= 14.71 \text{ A}$$

Hence (A) is correct option

MCQ 1.37 The rms value of the resultant current in a wire which carries a dc current of 10 A and a sinusoidal alternating current of peak value 20 is

(A) 14.1 A (B) 10 A

(C) 22.4 A (D) 17.3 A

SOL 1.37 The Correct option is (D).

Total current in the wire

$$I = 10 + 20\sin\omega t$$
$$I_{rms} = \sqrt{10^2 + \frac{(20)^2}{2}}$$
$$= \sqrt{100 + 200} = \sqrt{300} = 17.32 \text{ A}$$

MCQ 1.38 The Z-matrix of a 2-port network as given by $\begin{bmatrix} 0.9 & 0.2 \\ 0.2 & 0.6 \end{bmatrix}$

The element Y_{22} of the corresponding Y-matrix of the same network is given by

(A) 1.2 (B) 0.4

(C) -0.4 (D) 1.8

SOL 1.38 The Correct option is (D).

From Z to Y parameter conversion

$$\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix}^{-1}$$

So,
$$\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{12} & Y_{22} \end{bmatrix} = \frac{1}{0.50}\begin{bmatrix} 0.6 & -0.2 \\ -0.2 & 0.9 \end{bmatrix}$$

$$Y_{22} = \frac{0.9}{0.50} = 1.8$$

MCQ 1.39 The synchronous speed for the seventh space harmonic mmf wave of a 3-phase, 8-pole, 50 Hz induction machine is

(A) 107.14 rpm in forward direction (B) 107.14 rpm in reverse direction

(C) 5250 rpm in forward direction (D) 5250 rpm in reverse direction

SOL 1.39 Given that

8-Pole, 50 Hz induction machine in seventh space harmonic mmf wave.

So,

Synchronous speed at 7^{th} harmonic is $= N_s/7$

$$\text{Speed of motor } N_s = \frac{120f}{P}$$

$$= \frac{120 \times 50}{8} = 750 \text{ rpm}$$

$$\text{Synchronous speed is } = \frac{N_s}{7} = \frac{750}{7}$$

$$= 107.14 \text{ rpm in forward direction}$$

Hence (A) is correct option.

MCQ 1.40 A rotating electrical machine its self-inductances of both the stator and the rotor windings, independent of the rotor position will be definitely not develop

(A) starting torque (B) synchronizing torque

(C) hysteresis torque (D) reluctance torque

SOL 1.40 Rotating electrical machines having its self inductance of stator and rotor windings is independent of the rotor position of synchronizing torque.

synchronizing torque

$$T_{\text{synchronizing}} = \frac{1}{\omega_s} m \frac{dP}{d\delta} \text{ Nm/elect. radian}$$

$$= \left(\frac{1}{\omega_s} m \frac{dP}{d\delta}\right) \frac{\pi P}{180} \text{ Nm/mech.degree}$$

Hence (B) is correct option.

MCQ 1.41 The armature resistance of a permanent magnet dc motor is 0.8 Ω. At no load, the motor draws 1.5 A from a supply voltage of 25 V and runs at 1500 rpm. The efficiency of the motor while it is operating on load at 1500 rpm drawing a current of 3.5 A from the same source will be

(A) 48.0% (B) 57.1%

(C) 59.2% (D) 88.8%

SOL 1.41 Given that the armature of a permanent magnet dc motor is

$$R_a = 0.8\,\Omega$$

At no load condition

$$V = 25 \text{ V}, \; I = 1.5 \text{ A}, \; N = 1500 \text{ rpm}$$

$$\text{No load losses} = E \times I$$

$$\because E = V - IR_a$$

So

$$\text{No load losses} = (25 - 1.5 \times 0.8)1.5$$

$$= 35.7 \text{ W}$$

At load condition

$$I = 3.5 \text{ A}$$

$$\text{Iron losses} = I^2 R$$

$$= (3.5)^2 \times 0.8 = 9.8 \text{ W}$$

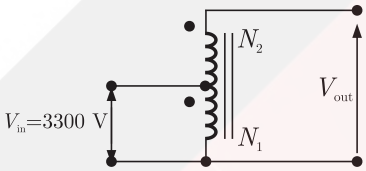
$$\text{Total losses} = \text{No load losses} + \text{iron losses}$$

$$= 35.7 + 9.8 = 45.5 \text{ W}$$

$$\text{Total power } P = VI$$
$$P = 25 \times 3.5$$
$$P = 87.5 \text{ W}$$
$$\text{Efficiency} = \frac{\text{output}}{\text{input}}$$
$$\eta = \frac{\text{total power} - \text{losses}}{\text{total power}}$$
$$= \frac{87.5 - 45.5}{87.5} \times 100 = 48.0\%$$

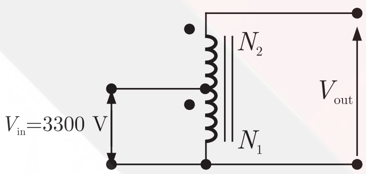
Hence (A) is correct option.

MCQ 1.42 A 50 kVA, 3300/230 V single-phase transformer is connected as an auto-transformer shown in figure. The nominal rating of the auto- transformer will be



(A) 50.0 kVA (B) 53.5 kVA
(C) 717.4 kVA (D) 767.4 kVA

SOL 1.42 Given that 50 kVA, 3300/230 V, 1-ϕ transform



$$V_{\text{in}} = 3300 \text{ V}$$
$$V_{\text{out}} = 3300 + 230 = 3530 \text{ V}$$

Output current I_2 and output voltage 230 V

So

$$I_2 = \frac{50 \times 10^3}{230} = 217.4 \text{ A}$$

When the output voltage is V_{out} then kVA rating of auto transformer will be

$$I_2 = 3530 \times 217.4$$
$$= 767.42 \text{ kVA}$$

Hence (D) is correct option.

MCQ 1.43 The resistance and reactance of a 100 kVA, 11000/400 V, $\Delta - Y$ distribution transformer are 0.02 and 0.07 pu respectively. The phase impedance of the transformer referred to the primary is

(A) $(0.02 + j0.07)\,\Omega$ (B) $(0.55 + j1.925)\,\Omega$

(C) $(15.125 + j52.94)\,\Omega$ (D) $(72.6 + j254.1)\,\Omega$

SOL 1.43 Given that 100 kVA, 11000/400 V, Delta-star distribution transformer resistance is 0.02 pu and reactance is 0.07 pu

So

pu impedance $Z_{pu} = 0.02 + j0.07$

Base impedance referred to primary

$$Z_{Base} = \frac{V_P^2}{V_L I_L/3} = \frac{(11 \times 10^3)^2}{\frac{100 \times 10^3}{3}} = 3630\ \Omega$$

The phase impedance referred to primary

$$\begin{aligned} Z_{primary} &= Z_{pu} \times Z_{Base} \\ &= (0.02 + j0.07)(3630) \\ &= 72.6 + j254.1 \end{aligned}$$

Hence (D) is correct option.

MCQ 1.44 A single-phase, 230 V, 50 Hz 4-pole, capacitor-start induction motor had the following stand-still impedances

Main winding $Z_m = 6.0 + j4.0\,\Omega$

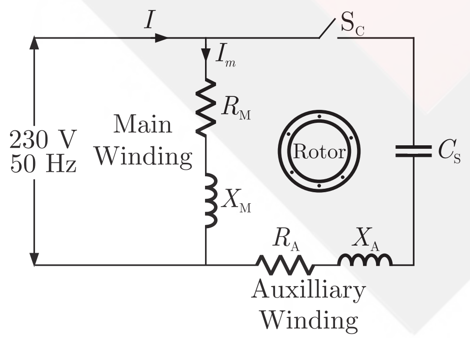
Auxiliary winding $Z_a = 8.0 + j6.0\,\Omega$

The value of the starting capacitor required to produce 90° phase difference between the currents in the main and auxiliary windings will be

(A) 176.84 μF (B) 187.24 μF

(C) 265.26 μF (D) 280.86 μF

SOL 1.44 230 V, 50 Hz, 4-Pole, capacitor-start induction motor



$$\begin{aligned} Z_m &= R_m + X_m \\ &= 6.0 + j4.0\ \Omega \\ Z_A &= R_A + X_A \\ &= 8.0 + j6.0\ \Omega \end{aligned}$$

Phase angle of main winding

$$\begin{aligned} \angle I_m &= \angle - Z_m \\ &= -\angle(6 + j4) \\ &= -\angle 33.7^\circ \end{aligned}$$

So angle of the auxiliary winding when the capacitor is in series.

$$\angle I_A = - \angle (8 + j6) + \frac{1}{j\omega C}$$

$$= \angle (8 + j6) - \frac{j}{\omega C}$$

$$\alpha = \angle I_A - \angle I_m$$

So

$$90 = - \tan^{-1}\left[\left(\frac{6 - \frac{1}{\omega C}}{8}\right) - (-33.7)\right]$$

$$\frac{1}{\omega C} = 18 \qquad \because \omega = 2\pi f$$

So

$$C = \frac{1}{18 \times 2\pi f} = \frac{1}{18 \times 2 \times 3.14 \times 50}$$

$$= 176.8\ \mu\text{F}$$

Hence (A) is corerct option.

MCQ 1.45 Two 3-phase, Y-connected alternators are to be paralleled to a set of common busbars. The armature has a per phase synchronous reactance of 1.7 Ω and negligible armature resistance. The line voltage of the first machine is adjusted to 3300 V and that of the second machine is adjusted to 3200 V. The machine voltages are in phase at the instant they are paralleled. Under this condition, the synchronizing current per phase will be

(A) 16.98 A (B) 29.41 A

(C) 33.96 A (D) 58.82 A

SOL 1.45 Given that the armature has per phase synchronous reactance of 1.7 Ω and two alternator is connected in parallel

So,

both alternator voltage are in phase

So,

$$E_{f1} = \frac{3300}{\sqrt{3}}$$

$$E_{f2} = \frac{3200}{\sqrt{3}}$$

Synchronizing current or circulating current

$$= \frac{E_C}{T_{S1} + T_{S2}}$$

Reactance of both alternator are same

So

$$= \frac{E_{f1} - E_{f2}}{T_{S1} + T_{S2}}$$
$$= \frac{1}{\sqrt{3}}\left(\frac{3300 - 3200}{1.7 + 1.7}\right)$$
$$= 16.98 \text{ A}$$

Hence (A) is correct option.

MCQ 1.46 A 400 V, 15 kW, 4-pole, 50Hz, Y-connected induction motor has full load slip of 4%. The output torque of the machine at full load is

(A) 1.66 Nm (B) 95.50 Nm

(C) 99.47 Nm (D) 624.73 Nm

SOL 1.46 Hence (C) is correct option.

Given $V = 400$ V, 15 kW power and $P = 4$

$$f = 50 \text{ Hz, Full load slip } (S) = 4\%$$

So

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

$$\text{Actual speed} = \text{synchronous speed} - \text{slip}$$
$$N = 1500 - \frac{4}{100} \times 1500$$
$$= 1440 \text{ rpm}$$

Torque developed

$$T = \frac{P}{\omega_s(1-S)}, \qquad \text{where } \omega_s(1-S) = \frac{2\pi N}{60}$$
$$= \frac{15 \times 10^3 \times 60}{2\pi \times 1440}$$
$$= 99.47 \text{ Nm}$$

MCQ 1.47 For a 1.8°, 2-phase bipolar stepper motor, the stepping rate is 100 steps/second. The rotational speed of the motor in rpm is

(A) 15 (B) 30

(C) 60 (D) 90

SOL 1.47 Given 1.8° angle, 2-ϕ Bipolar stepper motor and stepping rate is 100 step/second

So,

Step required for one revolution

$$= \frac{360}{1.8} = 200 \text{ steps}$$

$\because$ Time required for one revolution $= 2$ seconds

$$\text{rev/sec} = 0.5 \text{ rps}$$

and

$$\text{rev/min} = 30 \text{ rpm}$$

Hence (B) is correct option.

MCQ 1.48 A 8-pole, DC generator has a simplex wave-wound armature containing 32 coils of 6 turns each. Its flux per pole is 0.06 Wb. The machine is running at 250 rpm. The induced armature voltage is

(A) 96 V (B) 192 V

(C) 384 V (D) 768 V

SOL 1.48 Given that:

$P = 8$ Pole, DC generator has wave-wound armature containing 32 coil of 6 turns each. Simplex wave wound flux per pole is 0.06 Wb

$$N = 250 \text{ rpm}$$

So,

Induced armature voltage

$$E_g = \frac{\phi Z N P}{60 A}$$

$$Z = \text{total no.of armature conductor}$$

$$Z = 2 C N_C = 2 \times 32 \times 6 = 384$$

$$E_g = \frac{0.06 \times 250 \times 3.84 \times 8}{60 \times 2}$$

$\because$ $A = 2$ for wave winding

$$E_g = 384 \text{ volt}$$

Hence (C) is correct option.

MCQ 1.49 A 400 V, 50 kVA, 0.8 p.f. leading Δ-connected, 50 Hz synchronous machine has a synchronous reactance of 2 Ω and negligible armature resistance. The friction and windage losses are 2 kW and the core loss is 0.8 kW. The shaft is supplying 9 kW load at a power factor of 0.8 leading. The line current drawn is

(A) 12.29 A (B) 16.24 A

(C) 21.29 A (D) 36.88 A

SOL 1.49 Given a 400 V, 50 Hz and 0.8 p.f. loading delta connection 50 Hz synchronous machine, the reactance is 2 Ω. The friction and windage losses are 2 kW and core losses is 0.8 kW and shaft is supply 9 kW at a 0.8 loading power factor

So

$$\text{Input power} = 9 \text{ kW} + 2 \text{ kW} + 0.8 \text{ kW}$$
$$= 11.8 \text{ kW}$$

$\because$ $$\text{Input power} = \sqrt{3}\, V_2 I_2 = 11.8 \text{ kW}$$

$$I_2 = \frac{11.8 \text{ kW}}{\sqrt{3} \times 400 \times 0.8}$$
$$= 21.29 \text{ A}$$

Hence (C) is correct option.

MCQ 1.50 A 500 MW, 3-phase, Y-connected synchronous generator has a rated voltage of 21.5 kV at 0.85 p.f. The line current when operating at full load rated conditions will be

(A) 13.43 kA (B) 15.79 kA

(C) 23.25 kA (D) 27.36 kA

SOL 1.50 Given that 500 MW, 3-ϕ star connected synchronous generator has a rated voltage of 21.5 kV and 0.85 Power factor

So

$$\sqrt{3}\, V_L I_L = 500 \text{ MW}$$
$$I_L = \frac{500 \times 10^6}{\sqrt{3} \times 21.5 \times 10^3 \times 0.85}$$
$$= 15.79 \times 10^3$$
$$I_L = 15.79 \text{ kA}$$

Hence (B) is correct option.

MCQ 1.51 A 800 kV transmission line is having per phase line inductance of 1.1 mH/km and per phase line capacitance of 11.68 nF/km. Ignoring the length of the line, its ideal power transfer capability in MW is

(A) 1204 MW (B) 1504 MW

(C) 2085 MW (D) 2606 MW

SOL 1.51 Surge impedance of line is being given by as

$$Z = \sqrt{\frac{L}{C}} = \sqrt{\frac{11 \times 10^{-3}}{11.68 \times 10^{-9}}}$$
$$Z = 306.88\,\Omega$$

Ideal power transfer capability

$$P = \frac{V^2}{Z_0} = \frac{(800)^2}{306.88} = 2085 \text{ MW}$$

Hence (C) is correct option.

MCQ 1.52 A 110 kV, single core coaxial, XLPE insulated power cable delivering power at 50 Hz, has a capacitance of 125 nF/km. If the dielectric loss tangent of XLPE is 2×10^{-4}, then dielectric power loss in this cable in W/km is

(A) 5.0 (B) 31.7

(C) 37.8 (D) 189.0

SOL 1.52 The Correct option is (D).

Given that,

Power cable voltage $= 110$ kV

$C = 125$ nF/km

Dielectric loss tangent $= \tan\delta = 2 \times 10^{-4}$

Dielectric power loss = ?

dielectric power loss is given by

$$P = 2V^2\omega C \tan\delta$$
$$= 2(110 \times 10^3)^2 \times 2\pi f \times 125 \times 10^{-9} \times 2 \times 10^{-4}$$
$$= 2(121 \times 10^8 \times 2 \times 3.14 \times 50 \times 250 \times 10^{-13})$$
$$= 189 \text{ W/km}$$

MCQ 1.53 A lightning stroke discharges impulse current of 10 kA (peak) on a 400 kV transmission line having surge impedance of 250 Ω The magnitude of transient over-voltage travelling waves in either direction assuming equal distribution from the point of lightning strike will be

(A) 1250 kV (B) 1650 kV

(C) 2500 kV (D) 2900 kV

SOL 1.53 The Correct option is (A).

Given data

Lightening stroke discharge impulse current of $I = 10$ kA

Transmission line voltage = 400 kV

Impedance of line $Z = 250\,\Omega$

Magnitude of transient over-voltage = ?

The impulse current will be equally divided in both directions since there is equal distribution on both sides.

Then magnitude of transient over-voltage is

$$V = IZ/2$$
$$= \frac{10}{2} \times 10^3 \times 250$$
$$= 1250 \times 10^3 \text{ V}$$
$$= 1250 \text{ kV}$$

MCQ 1.54 The generalized circuit constants of a 3-phase, 220 kV rated voltage, medium length transmission line are

$A = D = 0.936 + j0.016 = 0.936\angle 0.98°$

$B = 35.5 + j138 = 142.0\angle 76.4°\,\Omega$

$C = (-5.18 + j914) \times 10^{-6}\,\Omega$

If the load at the receiving end is 50 MW at 220 kV with a power factor of 0.9 lagging, then magnitude of line to line sending end voltage should be

(A) 133.23 kV (B) 220.00 kV

(C) 230. 78 kV (D) 246.30 kV

SOL 1.54 The Correct option is (C).

The A, B, C, D parameters of line

$$A = D = 0.936\angle 0.98^\circ$$
$$B = 142\angle 76.4^\circ$$
$$C = (-5.18 + j914)\,10^{-6}\,\Omega$$

At receiving end $P_R = 50\,\text{MW}$, $V_R = 220$ kV

$$\text{p.f} = 0.9 \text{ lagging}$$
$$V_S = ?$$

Power at receiving end is being given by as follows

$$P_R = \frac{|V_S\|V_R|}{|B|}\cos(\beta-\delta) - \frac{|A\|V_R|^2}{|B|}\cos(\beta-\alpha)$$
$$= \frac{|V_S|\times 220}{142}\cos(76.4^\circ-\delta) - \frac{0.936\,(220)^2}{142}\cos 75.6^\circ$$
$$\therefore\ V_S\cos(76.4-\delta) = \frac{50\times 142}{220} + 0.936\times 220\times 0.2486$$
$$= 32.27 + 51.19$$
$$V_S\cos(76.4-\delta) = 83.46 \qquad ...(1)$$

Same as

$$Q_R = P_R\tan\phi$$
$$= P_R\tan(\cos^{-1}\phi) = 50\tan(\cos^{-1}0.9)$$
$$= 24.21 \text{ MW}$$
$$Q_R = \frac{|V_S\|V_R|}{|B|}\sin(\beta-\delta) - \frac{|A\|V_R|^2}{|B|}\sin(\beta-\alpha)$$
$$= \frac{|V_S|\times 220}{142}\sin(76.4^\circ-\delta) - \frac{0.936\times(220)^2}{142}\sin 75.6^\circ$$
$$(24.21)\frac{142}{220} + 0.936\times 220\times 0.9685 = |V_S|\sin(76.4^\circ-\delta) ...(2)$$

from equation (1) & (2)

$$|V_S|^2 = (215)^2 + (83.46)^2$$
$$|V_S| = \sqrt{53190.5716}$$
$$= 230.63 \text{ kV}$$

MCQ 1.55 A new generator having $E_g = 1.4\angle 30^\circ$ pu. [equivalent to $(1.212 + j0.70)$ pu] and synchronous reactance 'X_S' of 1.0 pu on the system base, is to be connected to a bus having voltage V_t, in the existing power system. This existing power system can be represented by Thevenin's voltage $E_{th} = 0.9\angle 0^\circ$ pu in series with Thevenin's impedance $Z_{th} = 0.25\angle 90^\circ$ pu. The magnitude of the bus voltage V_t of the system in pu will be

(A) 0.990 (B) 0.973

(C) 0.963 (D) 0.900

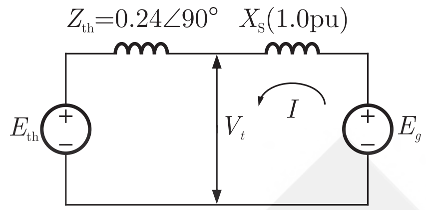
SOL 1.55 The Correct option is (B).

A new generator of $E_g = 1.4\angle 30^\circ$ pu

$X_S = 1.0$ pu, connected to bus of V_t Volt

Existing Power system represented by thevenin's equivalent as

$E_{th} = 0.9\angle 0°$, $Z_{th} = 0.25\angle 90°$, $V_t = ?$



From the circuit given

$$I = \frac{E_g - E_{th}}{Z_{th} + X_S}$$

$$= \frac{1.4\angle 30° - 0.9\angle 0°}{j(1.25)} = \frac{1.212 + j7 - 0.9}{j(1.25)}$$

$$= \frac{0.312 + j7}{j(1.25)} = 0.56 - 0.2496j$$

$$V_t = E_g - IX_S$$

$$= 1.212 + j7 - (0.56 - 0.2496j)(j1)$$

$$= 1.212 - 0.2496 + j(0.7 - 0.56)$$

$$= 0.9624 + j0.14$$

$$V_t = 0.972\angle 8.3°$$

MCQ 1.56 A 3-phase generator rated at 110 MVA, 11 kV is connected through circuit breakers to a transformer . The generator is having direct axis sub-transient reactance $X''_d = 19\%$, transient reactance $X'_d = 26\%$ and synchronous reactance =130%. The generator is operating at no load and rated voltage when a three phase short circuit fault occurs between the breakers and the transformer . The magnitude of initial symmetrical rms current in the breakers will be

(A) 4.44 kA (B) 22.20 kA

(C) 30.39 kA (D) 38.45 kA

SOL 1.56 The Correct option is (C).

Given that

3-ϕ Generator rated at 110 MVA, 11 kV

$$X_d'' = 19\%,\ X_d' = 26\%$$

$$X_S = 130\%, \text{ Operating at no load}$$

3-ϕ short circuit fault between breaker and transformer

symmetrical I_{rms} at breaker = ?

We know short circuit current

$$I_{sc} = \frac{1}{X_d''} = \frac{1}{j0.19}$$

$$= -j5.26 \text{ pu}$$

$$\text{Base current } I_B = \frac{\text{rating MVA of generator}}{\sqrt{3} \times \text{kV of generator}}$$

$$I_B = \frac{110 \times 10^6}{\sqrt{3} \times 11 \times 10^3}$$

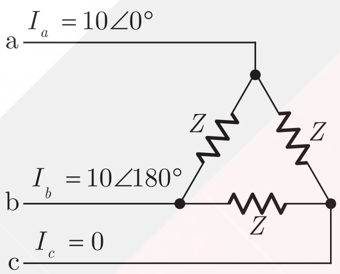
$$I_B = 5773.67 \text{ Amp}$$

$$\text{Symmetrical RMS current} = I_B \times I_{sc}$$

$$= 5773.67 \times 5.26 = 30369.50 \text{ Amp}$$

$$\Rightarrow I_{rms} = 30.37 \text{ kA}$$

MCQ 1.57 A 3-phase transmission line supplies Δ-connected load Z. The conductor 'c' of the line develops an open circuit fault as shown in figure. The currents in the lines are as shown on the diagram. The +ve sequence current component in line 'a' will be



(A) $5.78\angle -30°$ (B) $5.78\angle 90°$

(C) $6.33\angle 90°$ (D) $10.00\angle -30°$

SOL 1.57 The Correct option is (A).

$$\text{+ve sequence current } I_a = \frac{1}{3}[I_a + \alpha I_b + \alpha^2 I_c]$$

$$= \frac{1}{3}[10\angle 0° + 1\angle 120° \times 10\angle 180° + 0]$$

$$= \frac{1}{3}[10\angle 0° + 10\angle 300°]$$

$$= \frac{1}{3}[10 + 5 - j8.66]$$

$$= \frac{1}{3}[15 - j8.66]$$

$$= \frac{17.32\angle -30°}{3}$$

$$= 5.78\angle -30°$$

MCQ 1.58 A 500 MVA, 50 Hz, 3-phase turbo-generator produces power at 22 kV. Generator is Y-connected and its neutral is solidly grounded. It sequence reactances are $X_1 = X_2 = 0.15$ pu and $X_0 = 0.05$ pu.It is operating at rated voltage and disconnected from the rest of the system (no load). The magnitude of the sub-transient line current for single line to ground fault at the generator terminal in pu will be

(A) 2.851 (B) 3.333

(C) 6.667 (D) 8.553

SOL 1.58 Given data 500 MVA , 50 Hz, $3-\phi$ generator produces power at 22 kV

Generator $\rightarrow$ Y connected with solid neutral

Sequence reactance $X_1 = X_2 = 0.15,\ X_0 = 0.05$ pu

Sub transient line current = ?

$$I_{a1} = \frac{E}{Z_1 + Z_2 + Z_0} = \frac{1}{j0.15 + j0.15 + j0.05} = \frac{1}{0.35j} = -2.857j$$

Now sub transient Line current $I_a = 3I_{a1}$

$$I_a = 3(-2.857j) = -8.57j$$

Hence (D) is correct option.

MCQ 1.59 A 50 Hz, 4-pole, 500 MVA, 22 kV turbo-generator is delivering rated megavolt-amperes at 0.8 power factor. Suddenly a fault occurs reducing in electric power output by 40%. Neglect losses and assume constant power input to the shaft. The accelerating torque in the generator in MNm at the time of fault will be

(A) 1.528 (B) 1.018

(C) 0.848 (D) 0.509

SOL 1.59 Given: 50 Hz, 4-Pole, 500 MVA, 22 kV generator

p.f. = 0.8 lagging

Fault occurs which reduces output by 40%.

Accelerating torque = ?

$$\text{Power} = 500 \times 0.8 = 400 \text{ MW}$$

After fault, $\text{Power} = 400 \times 0.6 = 240$ MW

$$\because\ P_a = T_a \times \omega$$

$$T_a = \frac{P_a}{\omega}$$

Where

$$\omega = 2\pi f_{\text{mechanical}}$$

$$f_{\text{mechanical}} = f_{\text{electrical}} \times \frac{2}{P}$$

$$= f_{\text{electrical}} \times \frac{2}{4}$$

$$P_a = 400 - 240 = 160\,\text{MW}$$

$$T_a = \frac{160}{2 \times \pi \times 50/2}$$

$$T_a = 1.018 \text{ MN}$$

Hence (B) is correct option.

MCQ 1.60 A hydraulic turbine having rated speed of 250 rpm is connected to a synchronous generator. In order to produce power at 50 Hz, the number of poles required in the generator are

(A) 6 (B) 12

(C) 16 (D) 24

SOL 1.60 The Correct option is (D).

Turbine rate speed $N = 250$ rpm

To produce power at $f = 50$ Hz.

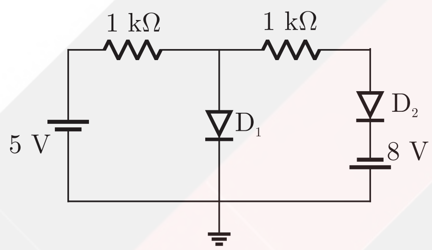
No. of Poles $P = ?$

$$\because N = \frac{120}{P} f$$

$$P = \frac{120}{N} f = \frac{120 \times 50}{250} = 24$$

$$P = 24 \text{ Poles}$$

MCQ 1.61 Assuming that the diodes are ideal in figure, the current in diode D_1 is



(A) 9 mA (B) 5 mA

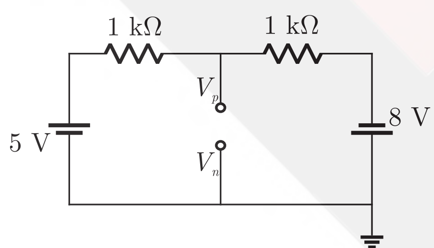
(C) 0 mA (D) -3 mA

SOL 1.61 From the circuit, we can see the that diode D_2 must be in forward Bias.

For D_1 let assume it is in reverse bias.

Voltages at p and n terminal of D_1 is given by V_p and V_n

$V_p < V_n$ (D_1 is reverse biased)



Applying node equation

$$\frac{V_p - 5}{1} + \frac{V_p + 8}{1} = 0$$

$$2V_p = -3$$

$$V_p = -1.5$$

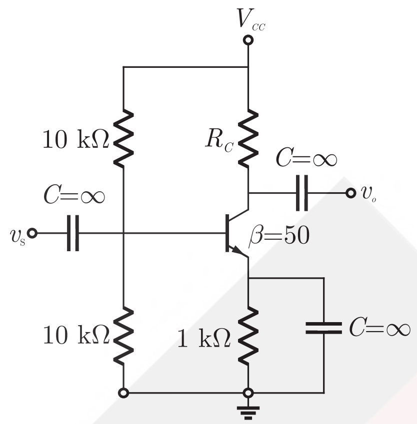
$$V_n = 0$$

$V_p < V_n$ (so the assumption is true and D_1 is in reverse bias) and current in D_1

$$I_{D1} = 0 \text{ mA}$$

Hence (C) is correct option.

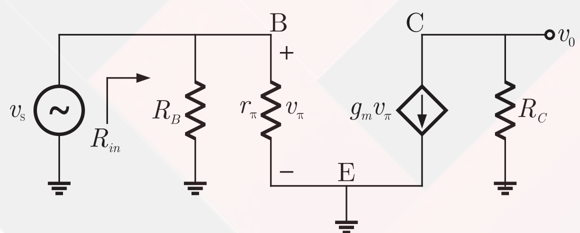
MCQ 1.62 The trans-conductance g_m of the transistor shown in figure is 10 mS. The value of the input resistance R_{in} is



(A) 10.0 kΩ (B) 8.3 kΩ

(C) 5.0 kΩ (D) 2.5 kΩ

SOL 1.62 The small signal ac equivalent circuit of given amplifier is as following.

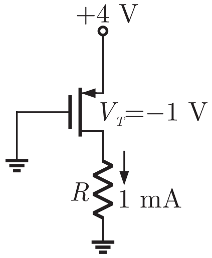


Here
$$R_B = (10\text{ k}\Omega \parallel 10\text{ k}\Omega) = 5\text{ k}\Omega$$
$$g_m = 10\text{ ms}$$
$$\because g_m r_\pi = \beta \Rightarrow r_\pi = \frac{50}{10\times 10^{-3}} = 5\text{ k}\Omega$$

Input resistance
$$R_{in} = R_B \parallel r_\pi$$
$$= 5\text{ k}\Omega \parallel 5\text{ k}\Omega = 2.5\text{ k}\Omega$$

Hence (D) is correct option.

MCQ 1.63 The value of R for which the PMOS transistor in figure will be biased in linear region is



(A) 220 Ω (B) 470 Ω

(C) 680 Ω (D) 1200 Ω

SOL 1.63 For PMOS to be biased in non-saturation region.

$$V_{SD} < V_{SD(\text{sat})}$$

and

$$V_{SD(\text{sat})} = V_{SG} + V_T$$

$$V_{SD(\text{sat})} = 4 - 1 \qquad \{\because \; V_{SG} = 4 - 0 = 4 \text{ volt}$$

$$= 3 \text{ Volt}$$

So,

$$V_{SD} < 3$$

$$V_S - V_D < 3$$

$$4 - I_D R < 3$$

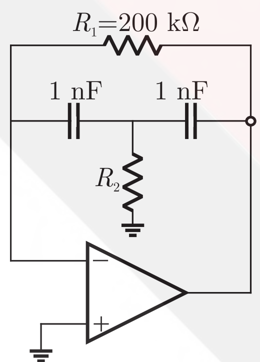
$$1 < I_D R$$

$$I_D R > 1, \qquad I_D = 1 \text{ mA}$$

$$R > 1000 \; \Omega$$

Hence (D) is correct option.

MCQ 1.64 In the active filter circuit shown in figure, if Q = 1, a pair of poles will be realized with ω_0 equal to

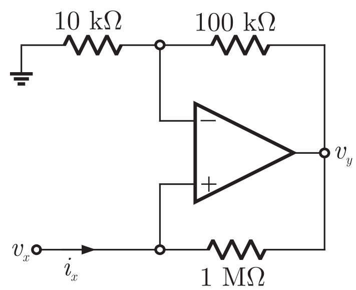


(A) 1000 rad/s (B) 100 rad/s

(C) 10 rad/s (D) 1 rad/s

SOL 1.64 The Correct option is ( ).

MCQ 1.65 The input resistance $R_{in} = v_x/i_x$ of the circuit in figure is



(A) $+100\ \text{k}\Omega$ (B) $-100\,\text{k}\Omega$

(C) $+1\ \text{M}\Omega$ (D) $-1\,\text{M}\Omega$

SOL 1.65 If op-amp is ideal, no current will enter in op-amp. So current i_x is

$$i_x = \frac{v_x - v_y}{1\times 10^6} \quad ...(1)$$

$$v_+ = v_- = v_x \quad \text{(ideal op-amp)}$$

$$\frac{v_x - v_y}{100\times 10^3} + \frac{v_x - 0}{10\times 10^3} = 0$$

$$v_x - v_y + 10v_x = 0$$

$$11v_x = v_y \quad ...(2)$$

For equation (1) & (2)

$$i_x = \frac{v_x - 11v_x}{1\times 10^6}$$

$$i_x = -\frac{10v_x}{10^6}$$

Input impedance of the circuit.

$$R_{in} = \frac{v_x}{i_x} = -\frac{10^6}{10} = -100\,\text{k}\Omega$$

Hence (B) is correct option.

MCQ 1.66 The simplified form of the Boolean expression $Y = (\overline{A}\cdot BC + D)(\overline{A}\cdot D + \overline{B}\cdot\overline{C})$ can be written as

(A) $\overline{A}\cdot D + \overline{B}\cdot\overline{C}\cdot D$ (B) $AD + B\cdot\overline{C}\cdot D$

(C) $(\overline{A} + D)(\overline{B}\cdot C + \overline{D})$ (D) $A\cdot\overline{D} + BC\cdot\overline{D}$

SOL 1.66 The Correct option is (A).

Given Boolean expression,

$$Y = (\overline{A}\cdot BC + D)(\overline{A}\cdot D + \overline{B}\cdot\overline{C})$$

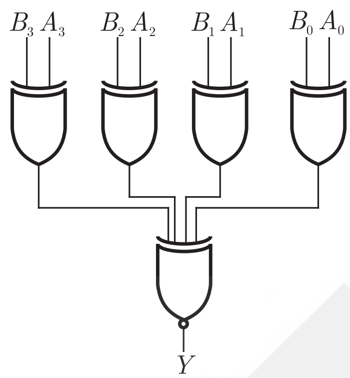
$$Y = (\overline{A}\cdot BCD) + (\overline{A}BC\cdot\overline{B}\cdot\overline{C}) + (\overline{A}D) + \overline{B}\,\overline{C}D$$

$$Y = \overline{A}\,BCD + \overline{A}D + \overline{B}\,\overline{C}\,D$$

$$Y = \overline{A}D(BC + 1) + \overline{B}\,\overline{C}D$$

$$Y = \overline{A}D + \overline{B}\,\overline{C}\,D$$

MCQ 1.67 A digit circuit which compares two numbers $A_3A_2A_1A_0$ and $B_3B_2B_1B_0$ is shown in figure. To get output $Y = 0$, choose one pair of correct input numbers.



(A) 1010, 1010 (B) 0101, 0101

(C) 0010, 0010 (D) 1010, 1011

SOL 1.67 In the given circuit, output is given as.

$$Y = (A_0 \oplus B_0) \odot (A_1 \oplus B_1) \odot (A_2 \oplus B_2) \odot (A_3 \oplus B_3)$$

For option (A)

$$\begin{aligned} Y &= (1 \oplus 1) \odot (0 \oplus 0) \odot (1 \oplus 1) \odot (0 \oplus 0) \\ &= 0 \odot 0 \odot 0 \odot 0 \\ &= 1 \end{aligned}$$

For option (B)

$$\begin{aligned} Y &= (0 \oplus 0) \odot (1 \oplus 1) \odot (0 \oplus 0) \odot (1 \oplus 1) \\ &= 0 \odot 0 \odot 0 \odot 0 \\ &= 1 \end{aligned}$$

For option (C)

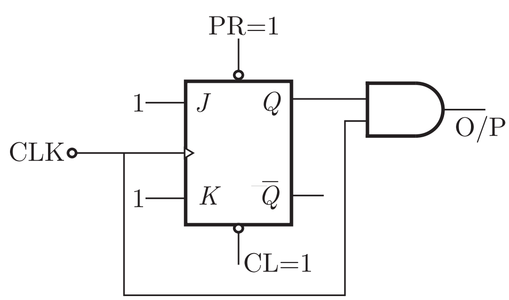
$$\begin{aligned} Y &= (0 \oplus 0) \odot (0 \oplus 0) \odot (1 \oplus 1) \odot (0 \oplus 0) \\ &= 0 \odot 0 \odot 0 \odot 0 \\ &= 1 \end{aligned}$$

For option (D)

$$\begin{aligned} Y &= (1 \oplus 1) \odot (0 \oplus 0) \odot (1 \oplus 1) \odot (0 \oplus 1) \\ &= 0 \odot 0 \odot 0 \odot 1 \\ &= 0 \end{aligned}$$

Hence (D) is correct option.

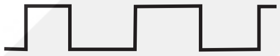
MCQ 1.68 The digital circuit shown in figure generates a modified clock pulse at the output. Choose the correct output waveform from the options given below.



CLK 

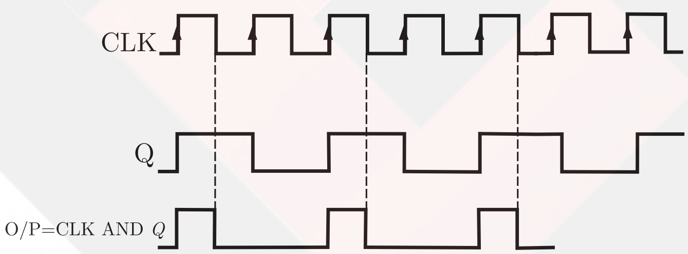
(A) 

(B) 

(C) 

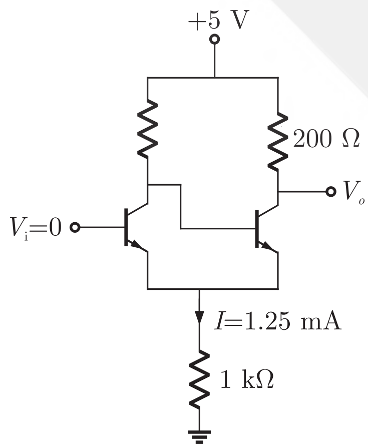
(D) 

SOL 1.68 In the given circuit, waveforms are given as,



Hence (B) is correct option.

MCQ 1.69 In the Schmitt trigger circuit shown in figure, if $V_{CE(\text{sat})} = 0.1\,\text{V}$, the output logic low level (V_{OL}) is



(A) 1.25 V (B) 1.35 V

(C) 2.50 V (D) 5.00 V

SOL 1.69 The Correct option is (B).

In the given circuit

$$V_i = 0 \text{ V}$$

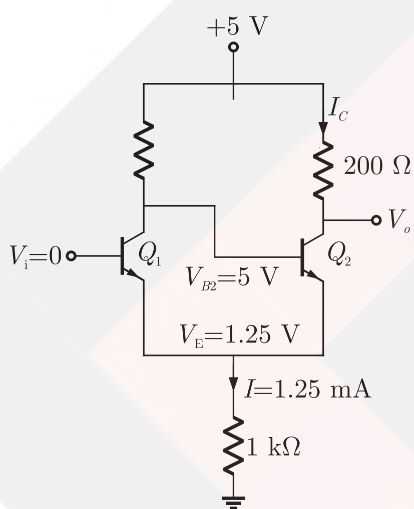
So, transistor Q_1 is in cut-off region and Q_2 is in saturation.

$$5 - I_C R_C - V_{CE(\text{sat})} - 1.25 = 0$$

$$5 - I_C R_C - 0.1 - 1.25 = 0$$

$$5 - I_C R_C = 1.35$$

$$V_0 = 1.35 \qquad \{\because V_0 = 5 - I_C R_C$$



MCQ 1.70 If the following program is executed in a microprocessor, the number of instruction cycle it will take from START to HALT is

START	MVI A, 14H	;	Move 14 H to register A
SHIFT	RLC	;	Rotate left without carry
	JNZ SHIFT	;	Jump on non-zero to SHIFT
	HALT		

(A) 4 (B) 8

(C) 13 (D) 16

SOL 1.70 The program is executed in following steps.

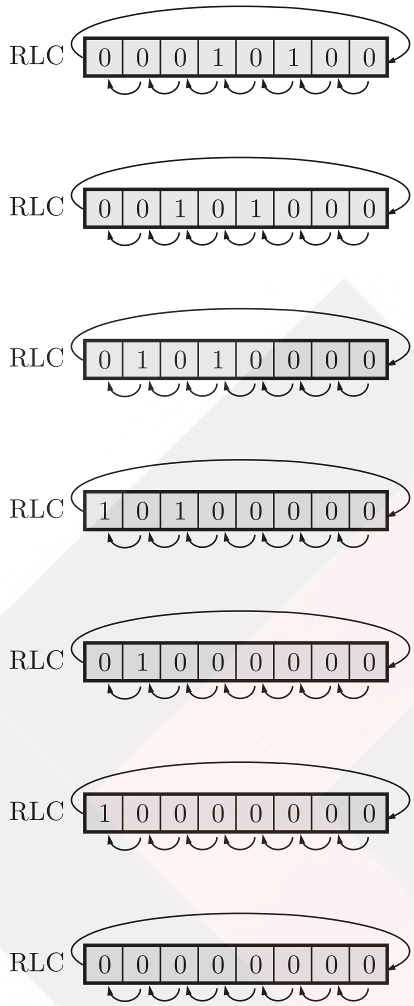
START MVI A, 14H → one instruction cycle.

RLC ⇒ rotate accumulator left without carry

RLC is executed 6 times till value of accumulator becomes zero.

JNZ, JNZ checks whether accumulator value is zero or not, it is executed 5 times.

HALT → 1-instruction cycle.



So total no. of instruction cycles are

$$\begin{aligned} n &= 1+6+5+1 \\ &= 13 \end{aligned}$$

Hence (C) is correct option.

MCQ 1.71 For the equation, $s^3 - 4s^2 + s + 6 = 0$ the number of roots in the left half of s-plane will be

(A) Zero (B) One

(C) Two (D) Three

SOL 1.71 Given characteristic equation,

$$s^3 - 4s^2 + s + 6 = 0$$

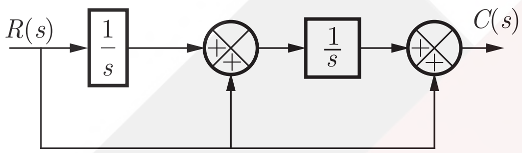
Applying Routh's method,

s^3	1	1
s^2	-4	6

s^1	$\frac{-4-6}{-4} = 2.5$	0
s^0	6	

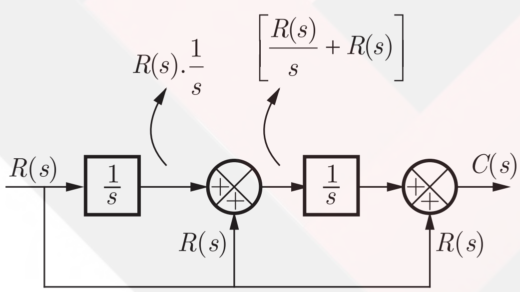
There are two sign changes in the first column, so no. of right half poles is 2.
No. of roots in left half of s-plane $= (3-2) = 1$
Hence (B) is correct option.

MCQ 1.72 For the block diagram shown in figure, the transfer function $\frac{C(s)}{R(s)}$ is equal to



(A) $\frac{s^2+1}{s^2}$
(B) $\frac{s^2+s+1}{s^2}$
(C) $\frac{s^2+s+1}{s}$
(D) $\frac{1}{s^2+s+1}$

SOL 1.72 Block diagram of the system is given as.



From the figure we can see that

$$C(s) = \left[R(s)\frac{1}{s} + R(s)\right]\frac{1}{s} + R(s)$$

$$C(s) = R(s)\left[\frac{1}{s^2} + \frac{1}{s} + 1\right]$$

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

Hence (B) is correct option

MCQ 1.73 The state variable description of a linear autonomous system is, $\dot{\boldsymbol{X}} = A\boldsymbol{X}$ where $\boldsymbol{X}$ is the two dimensional state vector and A is the system matrix given by $A = \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}$. The roots of the characteristic equation are

(A) -2 and $+2$
(B) $-j2$ and $+j2$
(C) -2 and -2
(D) $+2$ and $+2$

SOL 1.73 Characteristic equation is given by,

$$|sI - A| = 0$$

$$(sI - A) = \begin{bmatrix} s & 0 \\ 0 & s \end{bmatrix} - \begin{bmatrix} 0 & 2 \\ 2 & 0 \end{bmatrix}$$

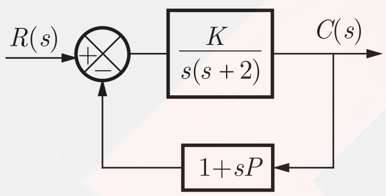
$$(sI - A) = \begin{bmatrix} s & -2 \\ -2 & s \end{bmatrix}$$

$$|sI - A| = s^2 - 4 = 0$$

$$s_1, s_2 = \pm 2$$

Hence (A) is correct option

MCQ 1.74 The block diagram of a closed loop control system is given by figure. The values of K and P such that the system has a damping ratio of 0.7 and an undamped natural frequency ω_n of 5 rad/sec, are respectively equal to



(A) 20 and 0.3 (B) 20 and 0.2

(C) 25 and 0.3 (D) 25 and 0.2

SOL 1.74 For the given system, characteristic equation can be written as,

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

$$s(s+2) + K(1 + sP) = 0$$

$$s^2 + s(2 + KP) + K = 0$$

From the equation.

$$\omega_n = \sqrt{K} = 5 \text{ rad/sec (given)}$$

So, $K = 25$

and $$2\xi\omega_n = 2 + KP$$

$$2 \times 0.7 \times 5 = 2 + 25P$$

or $$P = 0.2$$

so $K = 25,\ P = 0.2$

Hence (D) is correct option.

MCQ 1.75 The unit impulse response of a second order under-damped system starting from rest is given by $c(t) = 12.5e^{-6t}\sin 8t,\ \ t \geq 0$. The steady-state value of the unit step response of the system is equal to

(A) 0 (B) 0.25

(C) 0.5 (D) 1.0

SOL 1.75 Unit - impulse response of the system is given as,

$$c(t) = 12.5e^{-6t}\sin 8t,\ t \geq 0$$

So transfer function of the system.

$$H(s) = \mathcal{L}[c(t)] = \frac{12.5 \times 8}{(s+6)^2 + (8)^2}$$

$$H(s) = \frac{100}{s^2 + 12s + 100}$$ Steady state value of output for unit step input,

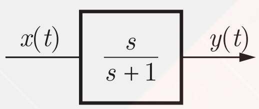
$$\lim_{t \to \infty} y(t) = \lim_{s \to 0} sY(s) = \lim_{s \to 0} sH(s)R(s)$$

$$= \lim_{s \to 0} s\left[\frac{100}{s^2 + 12s + 100}\right]\frac{1}{s}$$

$$= 1.0$$

Hence (D) is correct option.

MCQ 1.76 In the system shown in figure, the input $x(t) = \sin t$. In the steady-state, the response $y(t)$ will be



(A) $\frac{1}{\sqrt{2}}\sin(t - 45^\circ)$ (B) $\frac{1}{\sqrt{2}}\sin(t + 45^\circ)$

(C) $\sin(t - 45^\circ)$ (D) $\sin(t + 45^\circ)$

SOL 1.76 System response is.

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

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

Amplitude response

$$|H(j\omega)| = \frac{\omega}{\sqrt{\omega + 1}}$$

Given input frequency $\omega = 1$ rad/sec.

So $$|H(j\omega)|_{\omega = 1\text{ rad/sec}} = \frac{1}{\sqrt{1+1}} = \frac{1}{\sqrt{2}}$$

Phase response

$$\theta_h(\omega) = 90^\circ - \tan^{-1}(\omega)$$

$$\theta_h(\omega)|_{\omega = 1} = 90^\circ - \tan^{-1}(1) = 45^\circ$$

So the output of the system is

$$y(t) = |H(j\omega)|x(t - \theta_h)$$

$$= \frac{1}{\sqrt{2}}\sin(t - 45^\circ)$$

Hence (A) is correct option.

MCQ 1.77 The open loop transfer function of a unity feedback control system is given as

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

The value of 'a' to give a phase margin of 45° is equal to

(A) 0.141 (B) 0.441

(C) 0.841 (D) 1.141

SOL 1.77 Given open loop transfer function

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

Gain crossover frequency (ω_g) for the system.

$$|G(j\omega_g)| = 1$$

$$\frac{\sqrt{a^2\omega_g^2 + 1}}{-\omega_g^2} = 1$$

$$a^2\omega_g^2 + 1 = \omega_g^4$$

$$\omega_g^4 - a^2\omega_g^2 - 1 = 0 \qquad ...(1)$$

Phase margin of the system is

$$\phi_{PM} = 45^\circ = 180^\circ + \angle G(j\omega_g)$$

$$45^\circ = 180^\circ + \tan^{-1}(\omega_g a) - 180^\circ$$

$$\tan^{-1}(\omega_g a) = 45^\circ$$

$$\omega_g a = 1 \qquad (2)$$

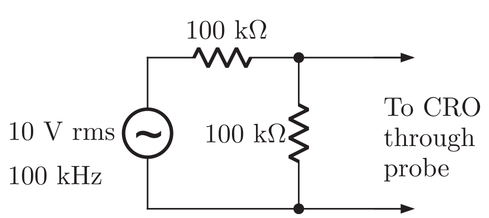
From equation (1) and (2)

$$\frac{1}{a^4} - 1 - 1 = 0$$

$$a^4 = \frac{1}{2} \Rightarrow a = 0.841$$

Hence (C) is correct option.

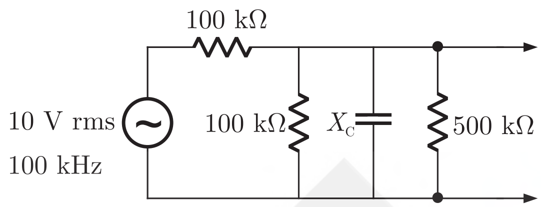
MCQ 1.78 A CRO probe has an impedance of 500 kΩ in parallel with a capacitance of 10 pF. The probe is used to measure the voltage between P and Q as shown in figure. The measured voltage will be



(A) 3.53 V (B) 4.37 V

(C) 4.54 V (D) 5.00 V

SOL 1.78 In the following configuration



rectance $X_c = \frac{1}{j\omega C} = \frac{1}{2\pi \times 100 \times 10^3 \times 10 \times 10^{-12}}$

writing node equation at P

$$\frac{V_P - 10}{100} + V_P\left(\frac{1}{100} + \frac{1}{500} - \frac{j}{159}\right) = 0$$

$$10 - V_P = V_P(1.2 - j0.628)$$

$$10 = (2.2 - j0.628)\,V_P$$

$$V_P \frac{10}{2.28} = 4.38 \text{ V}$$

Hence (B) is correct option.

MCQ 1.79 A moving coil of a meter has 100 turns, and a length and depth of 10 mm and 20 mm respectively. It is positioned in a uniform radial flux density of 200 mT. The coil carries a current of 50 mA. The torque on the coil is

(A) 200 μNm (B) 100 μNm

(C) 2 μNm (D) 1 μNm

SOL 1.79 The torque on the coil is given by

$$\tau = NIBA$$

$N \rightarrow$ no. of turns, N = 100

$I \rightarrow$ current, I = 50 mA

$B \rightarrow$ magnetic field, B = 200 mT

$A \rightarrow$ Area, A = 10 mm × 20 mm

So, $\tau = 100 \times 50 \times 10^{-3} \times 200 \times 10^{-3} \times 200 \times 10^{-3} \times 10^{-3}$

$= 200 \times 10^{-6}$ Nm

Hence (A) is correct option.

MCQ 1.80 A dc A-h meter is rated for 15 A, 250 V. The meter constant is 14.4 A-sec/rev. The meter constant at rated voltage may be expressed as

(A) 3750 rev/kWh (B) 3600 rev/kWh

(C) 1000 rev/kWh (D) 960 rev/kWh

SOL 1.80 Meter constant (A-sec/rev) is given by

$$14.4 = \frac{\text{I}}{\text{speed}}$$

$$14.4 = \frac{\text{I}}{K \times \text{Power}}$$

Where 'K' is the meter constant in rev/kWh.

$$14.4 = \frac{I}{K \times VI}$$

$$14.4 = \frac{15}{K \times 15 \times 250}$$

$$K = \frac{1}{250 \times 14.4}$$

$$K = \frac{1}{\left(\frac{250 \times 14.4}{1000 \times 3600}\right)}$$

$$= \frac{1000 \times 3600}{3600} = 1000 \text{ rev/kWh.}$$

Hence (C) is correct option

MCQ 1.81 A moving iron ammeter produces a full scale torque of 240 μNm with a deflection of 120° at a current of 10 A . The rate of change of self induction (μH/radian) of the instrument at full scale is

(A) 2.0 μH/radian (B) 4.8 μH/radian

(C) 12.0 μH/radian (D) 114.6 μH/radian

SOL 1.81 For moving iron ameter full scale torque is given by

$$\tau_C = \frac{1}{2} I^2 \frac{dL}{d\theta}$$

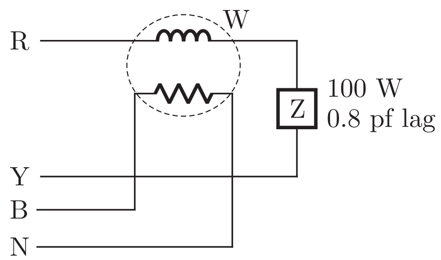
$$240 \times 10^{-6} = \frac{1}{2}(10)^2 \frac{dL}{d\theta}$$

Change in inductance

$$\frac{dL}{d\theta} = 4.8 \ \mu\text{H/radian}$$

Hence (B) is correct option

MCQ 1.82 A single-phase load is connected between R and Y terminals of a 415 V, symmetrical, 3-phase, 4-wire system with phase sequence RYB. A wattmeter is connected in the system as shown in figure. The power factor of the load is 0.8 lagging. The wattmeter will read



(A) -795 W (B) -597 W

(C) $+597$ W (D) $+795$ W

SOL 1.82 The Correct option is (B).

In the figure

$$V_{RY} = 415\angle 30^\circ$$

$$V_{BN} = \frac{415}{\sqrt{3}}\angle 120^\circ$$

Current in current coil

$$I_C = \frac{V_{RY}}{Z}$$

$$= \frac{415\angle 30^\circ}{100\angle 36.87^\circ}$$

$$= 4.15\angle -6.87$$

$\therefore$ power factor $= 0.8$

$\cos\phi = 0.8 \Rightarrow \phi = 36.87^\circ$

$$\text{Power} = VI^*$$

$$= \frac{415}{\sqrt{3}}\angle 120^\circ \times 4.15\angle 6.87^\circ$$

$$= 994.3\angle 126.87^\circ$$

Reading of wattmeter

$$P = 994.3(\cos 126.87^\circ)$$

$$= 994.3(-0.60)$$

$$= -597 \text{ W}$$

MCQ 1.83 A 50 Hz, bar primary CT has a secondary with 500 turns. The secondary supplies 5 A current into a purely resistive burden of 1 Ω. The magnetizing ampere-turns is 200. The phase angle between the primary and second current is

(A) 4.6° (B) 85.4°

(C) 94.6° (D) 175.4°

SOL 1.83 The Correct option is (A).

For small values of phase angle

$$\frac{I_P}{I_S} = n\phi, \quad \phi \rightarrow \text{Phase angle (radians)}$$

$$n \rightarrow \text{turns ratio}$$

Magnetizing ampere-turns $= 200$

So primary current $I_P = 200 \times 1 = 200$ amp

$$\text{Turns ratio } n = 500$$
$$\text{Secondary current } I_S = 5 \text{ amp}$$
So $$\frac{200}{5} = 500\phi$$
$$\phi \text{ (in degrees)} = \left(\frac{180}{\pi}\right)\left(\frac{200}{5 \times 500}\right)$$
$$\simeq 4.58^\circ$$

MCQ 1.84 The core flux in the CT of Prob Q.36, under the given operating conditions is

(A) 0 (B) 45.0 μWb

(C) 22.5 mWb (D) 100.0 mWb

SOL 1.84 Voltage appeared at secondary winding

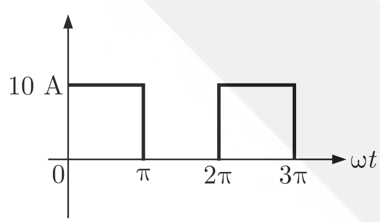
$$E_S = I_S \times Z_L$$
$$= 5 \times 1$$
$$= 5 \text{ Volts}$$

Voltage induced is given by

$$E_S = \sqrt{2}\,\pi f N\phi, \quad \phi \rightarrow \text{flux}$$
$$5 = \sqrt{2} \times 3.14 \times 50 \times 500 \times \phi$$
$$\phi = \frac{5}{\sqrt{2} \times 3.14 \times 25 \times 10^3}$$
$$= 45 \times 10^{-6} \text{ wb}$$

Hence (B) is correct option.

MCQ 1.85 A MOSFET rated for 15 A, carries a periodic current as shown in figure. The ON state resistance of the MOSFET is 0.15 Ω. The average ON state loss in the MOSFET is



(A) 33.8 W (B) 15.0 W

(C) 7.5 W (D) 3.8 W

SOL 1.85 The Correct option is (C).

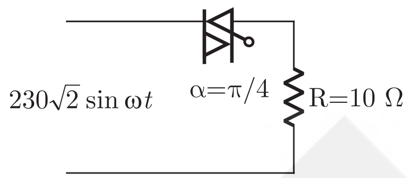
Given that $R = 0.15\ \Omega$

$I = 15$ A

So average power losses $$= \frac{1}{(2\pi/\omega)}\int_0^{\pi/\omega} I^2 R\,dt$$
$$= \frac{\omega}{2\pi} \times 10^2 \times 0.15 \times \pi/\omega$$

$$= 7.5 \text{ W}$$

MCQ 1.86 The triac circuit shown in figure controls the ac output power to the resistive load. The peak power dissipation in the load is



(A) 3968 W (B) 5290 W

(C) 7935 W (D) 10580 W

SOL 1.86 Output dc voltage across load is given as following

$$V_{dc} = \sqrt{2}\, V\left[\frac{1}{\alpha\pi}\left\{(2\pi - \alpha) + \frac{\sin 2\alpha}{2}\right\}\right]^{\frac{1}{2}}$$

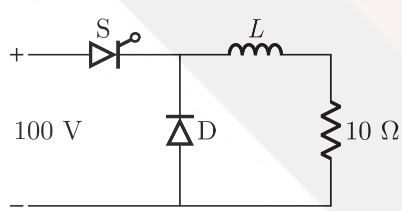
$$= \sqrt{2} \times 230\sqrt{2}\left[\frac{1}{\frac{\pi}{4}\times\pi}\left\{\left(2\pi - \frac{\pi}{4}\right) + \left(\frac{\sin \pi/2}{2}\right)\right\}\right]^{\frac{1}{2}}$$

$$= 317.8 \text{ V}$$

$$\text{losses} = \frac{V_{dc}^2}{R} = \frac{(317.8)^2}{100} = 10100 \text{ W}$$

Hence (D) is correct option.

MCQ 1.87 Figure shows a chopper operating from a 100 V dc input. The duty ratio of the main switch S is 0.8. The load is sufficiently inductive so that the load current is ripple free. The average current through the diode D under steady state is



(A) 1.6 A (B) 6.4 A

(C) 8.0 A (D) 10.0 A

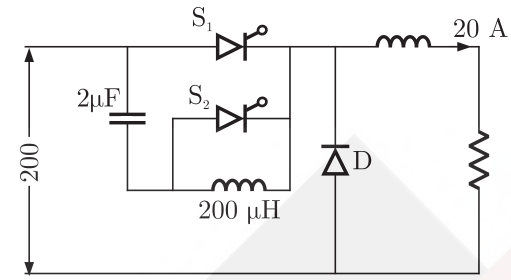
SOL 1.87 The Correct option is (C).

$$V_s = 100 \text{ V, duty ratio} = 0.8,\ R = 10\ \Omega$$

So average current through diode $= \dfrac{\alpha V_s}{R}$

$$= \frac{0.8 \times 100}{10} = 8 \text{ A}$$

MCQ 1.88 Figure shows a chopper. The device S_1 is the main switching device. S_2 is the auxiliary commutation device. S_1 is rated for 400 V, 60 A. S_2 is rated for 400 V, 30 A. The load current is 20 A. The main device operates with a duty ratio of 0.5. The peak current through S_1 is



(A) 10 A
(B) 20 A
(C) 30 A
(D) 40 A

SOL 1.88 The Correct option is (D).
Peak current through S_1

$$I = I_0 + V_S\sqrt{C/L}$$

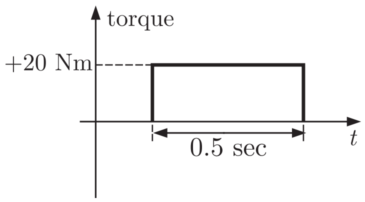
$$= 20 + 200\sqrt{\frac{2\times10^{-6}}{200\times10^{-6}}} = 40 \text{ A}$$

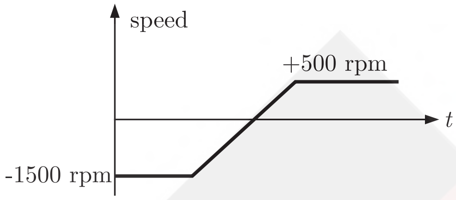
MCQ 1.89 A single-phase half-controlled rectifier is driving a separately excited dc motor. The dc motor has a back emf constant of 0.5 V/rpm. The armature current is 5 A without any ripple. The armature resistance is 2 Ω. The converter is working from a 230 V, single-phase ac source with a firing angle of 30°. Under this operating condition, the speed of the motor will be

(A) 339 rpm
(B) 359 rpm
(C) 366 rpm
(D) 386 rpm

SOL 1.89 The Correct option is ( ).

MCQ 1.90 A variable speed drive rated for 1500 rpm, 40 Nm is reversing under no load. Figure shows the reversing torque and the speed during the transient. The moment of inertia of the drive is

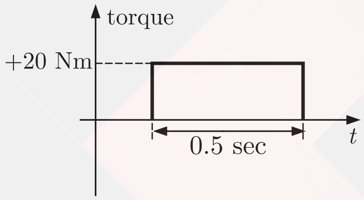


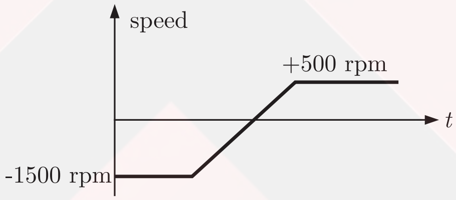


(A) 0.048 kg-m^2 (B) 0.064 km-m^2

(C) 0.096 kg-m^2 (D) 0.128 kg-m^2

SOL 1.90 The Correct option is (C).





so

$$\alpha = \left[\frac{500-(-1500)}{0.5}\right] \times \frac{2\pi}{60} = 418.67 \text{ rad/sec}^2$$

and

$$T = 40 \text{ Nm}$$

$$T = I\alpha$$

$$I = \frac{T}{\alpha} \times \frac{40}{418.67} = 0.096 \text{ kgm}^2$$

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