Practice Paper EE A

Q.1- Q.25 carry one mark each.

MCQ 1.1 Consider a LTI discrete time system shown in figure below

If input $x[n]$ is a periodic sequence with period N then which of the following statement regarding output $y[n]$ in true ?

(A) $y[n]$ is a aperiodic

(B) $y[n]$ is periodic with periiod $N' = 2N$

(C) $y[n]$ is periodic with period $N' = N$

(D) $y[n]$ is periodic with period $N' = \frac{N}{2}$

SOL 1.1 Option (C) is correct.

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

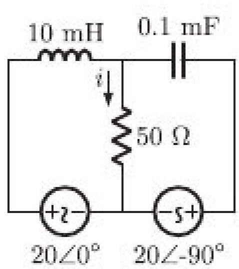
$$y[n] = \sum_{m=-\infty}^{\infty} h[m]\,x[n-m] \qquad k \to \text{any integer}$$

$$y[n+kN] = \sum_{m=-\infty}^{\infty} h[m]\,x[n+kN-m]$$

$$\because \quad x[n+kN-m] = \sum_{m=\infty}^{\infty} h[m]\,x[n-m] = y[n]$$

So $y[n]$ is also periodic with period $N' = N$

MCQ 1.2 In the circuit shown below what is the value of current i in the figure ?



(A) $(2+2j)$ A

(B) $(2-2j)$ A

(C) $(-2-2j)$ A (D) $(-2+2j)$ A

SOL 1.2 Option ( ) is correct.

MCQ 1.3 In synchronous motor minimum armature current corresponds to

(A) lagging power factor (B) leading power factor

(C) zero power factor (D) unity power factor

SOL 1.3 Option ( ) is correct.

MCQ 1.4 A 3-phase, 10,000 kVA, 11 kV alternator has a subtransient reactance of 8%. A 3-phase short-circuit occurs at its terminals. The fault MVA and fault current are

(A) 13.75 MVA, 7.21 kA (B) 125 MVA, 11.36 kA

(C) 125 MVA, 6.56 kA (D) 13.75 MVA, 6.56 kA

SOL 1.4 Option ( ) is correct.

MCQ 1.5 Following table gives the set of 10 measurements that were recorded by a student working on an experiment in the laboratory.

Measurement number	Measurement value X_n
1	98
2	101
3	102
4	97
5	101
6	100
7	103
8	98
9	106
10	99

The precision of the 6th measurement is

(A) 0.01 (B) 0.1

(C) 0.995 (D) .0049

SOL 1.5 Option (C) is correct.

The average value for the set of measurements is given by

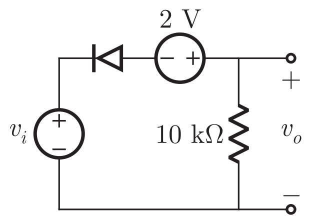
$$\overline{X}_n = \frac{\sum X_n}{10} = \frac{1005}{10} = 100.5$$

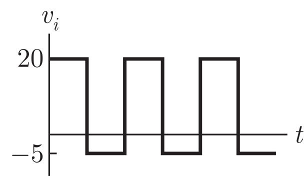
$$\text{Precision} = 1 - \left|\frac{X_n - \overline{X}_n}{\overline{X}_n}\right|$$

For the 6th reading

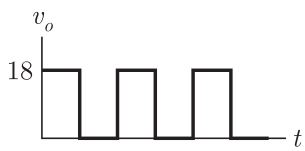
$$\text{Precision} = 1 - \left|\frac{100 - 100.5}{100.5}\right| = 1 - \frac{0.5}{100.5} = \frac{100}{100.5} = 0.995$$

MCQ 1.6 Consider the given circuit and a waveform for the input voltage. Assume the diode is ideal, the waveform of output voltage v_o is

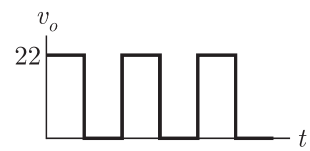




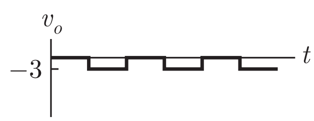
(A)



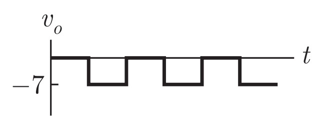
(B)



(C)



(D)



SOL 1.6 Option (C) is correct.

Diode will be off if $v_i + 2 > 0$. Thus $v_o = 0$

For $v_i + 2 < 0$ V, $v_i < -2, v_o = v_i + 2 = -3$ V

MCQ 1.7 A new Binary Coded Pentary (BCP) number system is proposed in which every digit of a base-5 number 24 will be represented by its BCP code 010100. In this numbering system, the BCP code 10001001101 corresponds of the following number is base-5 system

(A) 423 (B) 1324

(C) 2201 (D) 4231

SOL 1.7 Option ( ) is correct.

MCQ 1.8 A three phase bridge inverter is fed from a 500 V dc source. The inverter is operated in 180° conduction mode and it is supplying a purely resistive, star-connected load. The RMS value of the output (line) voltage is

(A) 450 V (B) 259.80 V

(C) 408 V (D) 235.56 V

SOL 1.8 Option (C) is correct.

For a three phase bridge inverter, rms value of output line voltage

$$V_{\text{line(rms)}} = \sqrt{\frac{2}{3}}\,V_{dc} \quad V_{dc} = 500 \text{ V}$$
$$= 0.816 \times 500 = 408 \text{ V}$$

MCQ 1.9 In pumped storage scheme, the generator is also used as

(A) induction generator or synchronous condenser.

(B) induction generator or synchronous motor.

(C) synchronous generator or induction generator.

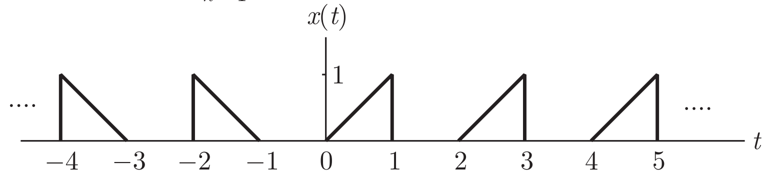
(D) synchronous motor or synchronous condenser.

SOL 1.9 Option (D) is correct.

The pumped storage scheme has the advantage that synchronous machine can be used as synchronous condenser for VAR compensation. During light load period the generator works as synchronous motor.

MCQ 1.10 Trigonometric Fourier series for a periodic function shown in figure below is given as

$$f(t) = k + \sum_{n=1}^{\infty} a_n \cos 2\pi nt + b_n \sin 2\pi nt$$



The constant k, a_n and b_n are

(A) $k = 0, a_n = 0, b_n = \frac{-1}{\pi n}$

(B) $k = \frac{1}{2}, a_n = 0, b_n = 0$

(C) $k = \frac{1}{2}, a_n = \frac{1}{\pi n}, b_n = \frac{1}{\pi n}$

(D) $k = \frac{1}{2}, a_n = 0, b_n = \frac{-1}{\pi n}$

SOL 1.10 Option (D) is correct.

$$f(t) = 1 + \sum_{n=1}^{\infty} a_n \cos 2\pi nt + b_n \sin 2\pi nt$$

$$\omega_0 = \frac{2\pi}{T_0} = 2\pi$$

$$k = 1\int_0^1 f(1)\,dt = \int_0^t t dt = \frac{1}{2}$$

$$a_n = 2\int_0^1 f(t)\cos 2\pi nt dt \qquad n \geq 1 \text{ (integer)}$$

$$= 2\int_0^1 t\cos 2\pi nt dt = 0$$

$$b_n = 2\int_0^1 t\sin 2\pi nt dt = \frac{-1}{\pi n}$$

MCQ 1.11 In the circuit shown in fig (a) if current $I_1 = 2.5$ A then current I_2 and I_3 in fig (b) and fig (c) respectively are

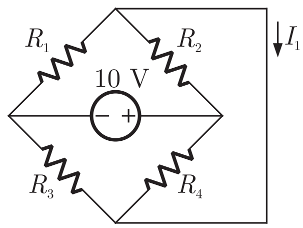


fig (a)

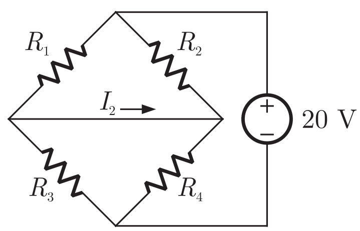


fig (b)

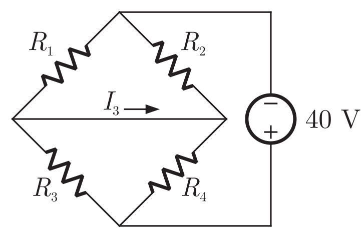


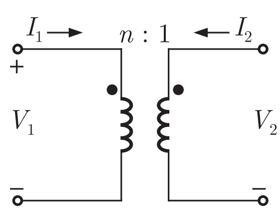
fig (c)

(A) 5 A, 10 A (B) -5 A, 10 A

(C) 5 A, -10 A (D) -5 A, -10 A

SOL 1.11 Option ( ) is correct.

MCQ 1.12 Consider an ideal transformer as shown in figure. Which of the following statement is true ?



(A) z-parameters exist for the network

(B) Both z and y-parameters exist for the network

(C) Neither z nor y-parameters exist for the network

(D) y-parameters exist for the network

SOL 1.12 Option ( ) is correct.

MCQ 1.13 The starting torque of a $3-\phi$ induction motor can be increased by increasing

(A) the rotor resistance (B) the rotor reactance

(C) the stator resistance (D) the stator reactance

SOL 1.13 Option ( ) is correct.

MCQ 1.14 A PMMC instrument with a 100 turn coil has magnetic flux density in its air gaps of $B = 0.2\,\text{T}$. The coil diameter is $D = 1\,\text{cm}$ and length is $l = 1.5\,\text{cm}$. For a current of 1 mA, the torque on the coil will be

(A) $3 \times 10^{-6}\,\text{Nm}$ (B) $6 \times 10^{-6}\,\text{Nm}$

(C) $1.5 \times 10^{-6}\,\text{Nm}$ (D) $12 \times 10^{-6}\,\text{Nm}$

SOL 1.14 Option (A) is correct.

Deflecting torque

$$\begin{aligned} T_D &= NIlBD \\ &= 0.2\,\text{T} \times 1.5 \times 10^{-2} \times 1\,\text{mA} \times 100 \times 1 \times 10^{-2} \\ &= 3 \times 10^{-6}\,\text{Nm} \end{aligned}$$

MCQ 1.15 The forward transfer function of a unity feedback system is

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

The system is stable for

(A) $K < -1$ (B) $K > -1$

(C) $K < -2$ (D) $K > -2$

SOL 1.15 Option (B) is correct.

Closed loop transfer function is

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

$$\left.\begin{aligned} 1+K > 0 \;&\Rightarrow\; K > -1 \\ 2+K > 0 \;&\Rightarrow\; K > -2 \end{aligned}\right\} \Rightarrow K > -1$$

MCQ 1.16 The positive sequence bus impedance matrix of a 4-Bus power system network is given below :

$$Z_{1,BUS} = \begin{bmatrix} j0.724 & j0.620 & j0.656 & j0.644 \\ j0.620 & j0.738 & j0.642 & j0.660 \\ j0.656 & j0.642 & j0.702 & j0.676 \\ j0.664 & j0.660 & j0.676 & j0.719 \end{bmatrix}$$

If a symmetrical fault occurs on Bus-2, then positive sequence component of fault current is

(A) $-j1.61$ pu (B) $-j0.375$ pu

(C) $-j1.51$ pu (D) $-j1.35$ pu

SOL 1.16 Option (D) is correct.

Positive sequence component of fault current at Bus-2 is

$$I_{f1\,\text{BUS}\,2} = \frac{1\angle 0^\circ}{Z_{22}^1} = \frac{1\angle 0^\circ}{j0.738} = -j1.35\,\text{p.u}$$

MCQ 1.17 A 4 pole generator, having wave wound armature winding has 55 slots, each slot containing 19 conductors. What will be the voltage generated in the machine when driven at 1500 rpm assuming the flux per pole is 3.0 mWb?

(A) 78.375 V (B) 940.5 V
(C) 156.75 V (D) 470.25 V

SOL 1.17 Option ( ) is correct.

MCQ 1.18 The figures show two different sets of input and output variables for the same two-port resistive network N. Value of I_o is

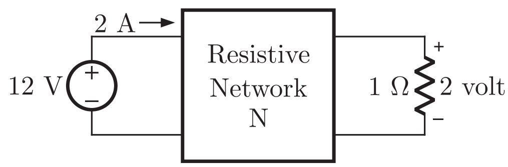


fig (a)

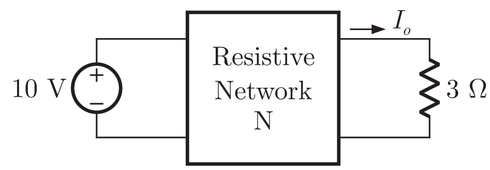


fig (b)

(A) 2 A (B) 1.25 A
(C) 2.4 A (D) 1 A

SOL 1.18 Option ( ) is correct.

MCQ 1.19 A 220 V d.c. shunt motor runs at 500 r.p.m. when the armature current is 50 A. The armature resistance of the motor is 0.2 Ω. If the torque is doubled, then speed of the motor will be
(A) 476 rpm (B) 479 rpm
(C) 454 rpm (D) remains same

SOL 1.19 Option (A) is correct.

$$T \propto \Phi I_a$$

Since Φ is constant so

$$T \propto I_a$$

When torque is doubled, armature current drawn by the motor will also be doubled.

$$I_{a1} = 50 \text{ A and } I_{a2} = 2 \times 50 = 100 \text{ A}$$

Now
$$\frac{E_{a2}}{E_{a1}} = \frac{N_2}{N_1} \qquad \therefore \Phi \text{ is constant}$$

$$N_2 = \frac{E_{a2}}{E_{a1}} \times N_1$$

$$= \left(\frac{V - I_{a2}R_a}{V - I_{a1}R_a}\right) \times N_1 = \frac{220 - 100 \times 0.2}{220 - 50 \times 0.2} \times 500$$

$$= \frac{200}{210} \times 500 = 476 \text{ rpm}$$

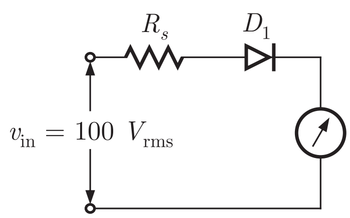
MCQ 1.20 When a fault occurs in a high voltage transmission line, first the
(A) circuit breaker operates then the relay.
(B) relay operates then the circuit breaker.
(C) relay operates, then successively the isolator and the circuit breaker.

(D) isolator operates, then successively the relay and the circuit breaker.

SOL 1.20 Option (B) is correct.

Circuit breakers are the final link in fault removal process of a power system. The decision made by relays that a fault has been occurred on the line causes tripping of circuit breakers.

MCQ 1.21 An ac voltmeter using half-wave rectifier circuit is used to measure a 10 V rms ac voltage as shown in the figure. The PMCC instrument has an internal resistance of 100 Ω and full-scale deflection at 1 mA. What is the required value of series resistance ?



(A) 450 kΩ (B) 449.5 kΩ

(C) 500 Ω (D) 500 kΩ

SOL 1.21 Option (B) is correct.

$$R_s = \frac{V_m}{\pi I_{dc}} = \frac{\sqrt{2} \times V_{rms}}{\pi I_{dc}} - R_m$$

$$= \frac{0.45 \times 100}{100\,\mu\text{A}} - 500\,\Omega = 449.5\,\text{k}\Omega$$

MCQ 1.22 The phenomena of crawling in a $3-\phi$ cage rotor induction motor may be due to

(A) stator circuit 3rd harmonic

(B) stator circuit 3rd space harmonic

(C) rotor circuit 3rd time harmonic

(D) rotor circuit 3rd space harmonic

SOL 1.22 Option ( ) is correct.

MCQ 1.23 A three-phase, 33 kV line feeds a per-phase load of 10 MW. If the impedance of the line is $Z = j20\,\Omega$, then the value of load angle to maintain a line voltage of 33 kV at the load is

(A) 60° (B) 10.58°

(C) 30° (D) 33.43°

SOL 1.23 Option (A) is correct.

Per-phase sending and receiving end voltage

$$V_S = V_R = \frac{33}{\sqrt{3}} = 19\,\text{kV}$$

We know that for a loss-less line($R = 0$), real power is

$$P_S = P_R = \frac{|V_S||V_R|}{X}\sin\delta$$

$$\delta = \sin^{-1}\left(\frac{20 \times 10}{19 \times 19}\right) = 33.6^\circ$$

MCQ 1.24 In a series generator the field resistance is 650 Ω and the load resistance is 800 Ω.
(A) The machine will not excite
(B) The machine will deliver a low voltage
(C) The machine will deliver a high voltage
(D) The machine will deliver a low voltage

SOL 1.24 Option ( ) is correct.

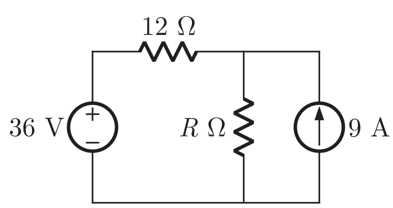
MCQ 1.25 A three-phase motor draws 20 kVA at 0.707 power-factor lagging from a 220 V source. The rating of capacitor bank to make the combined power factor 0.90 lagging is

(A) 7.29 kVAR (B) 6.85 kVAR
(C) 14.14 kVAR (D) 20 kVAR

SOL 1.25 Option ( ) is correct.

Q.26- Q.55 carry two mark each.

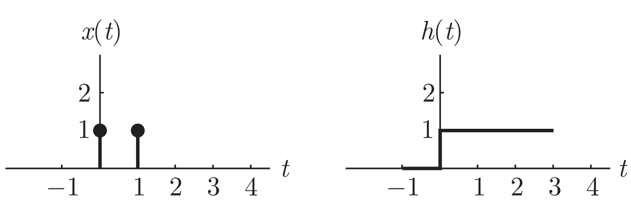
MCQ 1.26 For the given circuit shown in figure power absorbed in $R\,\Omega$ resistor due to voltage source only is 24 W and due to current source only is 216 W. Then total power absorbed in resistor due to both the sources-



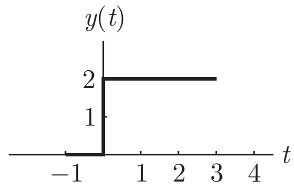
(A) 240 W (B) 20 W
(C) 192 W (D) 384 W

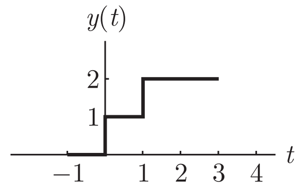
SOL 1.26 Option ( ) is correct.

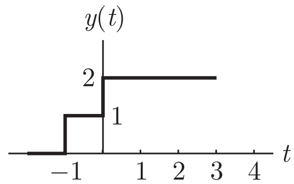
MCQ 1.27 Two CT signals $x(t)$ and $h(t)$ are shown in figure below.

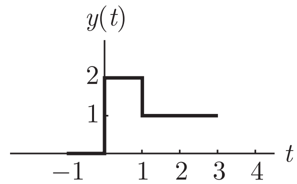


Which of the following plot represents $y(t) = x(t) * h(t)$?

(A) 

(B) 

(C) 

(D) 

SOL 1.27 Option (B) is correct.

$$y(t) = x(t) * h(t)$$
$$x(t) = \delta(t) + \delta(t-1)$$
$$h(t) = u(t)$$

so
$$\begin{aligned} y(t) &= u(t) * [\delta(t) + \delta(t-1)] \\ &= u(t) * \delta(t) + u(t) * \delta(t-1) \\ &= u(t) + u(t-1) \end{aligned}$$

MCQ 1.28 A process with open-loop model

$$G(s) = \frac{Ke^{-sT_D}}{\tau s + 1}$$

is controlled by a PID controller. For this purpose
(P) the derivative mode improves transient performance
(Q) the derivative mode improves steady state performance
(R) the integral mode improves transient performance
(S) the integral mode improves steady state performance.
The correct statements are
(A) (P) and (R) (B) (Q) and (R)
(C) (P) and (S) (D) (Q) and (S)

SOL 1.28 Option ( ) is correct.

MCQ 1.29 When two wattmeters W_1 and W_2 are used to measure power input to a synchronous motor, each of them indicates 60 kW. If the power factor is to be changed to 0.866 leading keeping the total input power same, then reading of W_1 and W_2 are respectively
(A) 90 kW, 30 kW (B) 30 kW, 90 kW
(C) 40 kW, 80 kW (D) 50 kW, 70 kW

SOL 1.29 Option (C) is correct.
Each wattmeter read 60 kW, so total input power

$$P = W_1 + W_2 = 60\text{ kW} \quad ...(1)$$

For leading power factor, we have

$$\tan\phi = -\frac{\sqrt{3}(W_1 - W_2)}{(W_1 + W_2)}$$

It is given that power factor has to be changed to 0.866, so

$$\cos\phi = 0.866$$

$\therefore$ $$\phi = \cos^{-1}0.866 = 30^\circ$$

and, $$\tan\phi = \tan 30^\circ = \frac{1}{\sqrt{3}}$$

$\therefore$ $$\frac{1}{\sqrt{3}} = -\frac{\sqrt{3}(W_1 - W_2)}{120} \qquad \because W_1 + W_2 = 120\text{ kW}$$

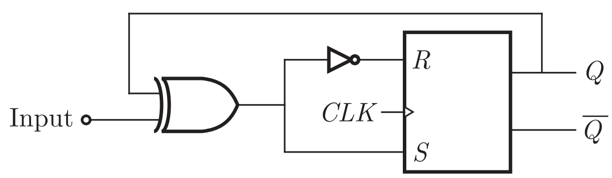
$$W_1 - W_2 = -\frac{120}{3} = -40$$

But $$W_1 + W_2 = 120 \quad ...(2)$$

By solving eq (1) and (2)

$$W_1 = 40\text{ kW}, W_2 = 80\text{ kW}$$

MCQ 1.30 Consider a circuit shown in figure. The circuit functions as



(A) D-flip-flop

(B) T-flip-flop

(C) Output remains stable at '1'

(D) Output remains stable at '0']

SOL 1.30 Option (B) is correct.

From the combinational logic

Let D is input, Q_n is present state, Q_{n+1} is next state, then

$$R = \overline{D \oplus Q}, S = D \oplus Q$$

Characteristic equation of R-S flip-flop is given by

$$Q_{n+1} = S + \overline{R}Q_n$$

So, $$Q_{n+1} = (D + Q_n) + (\overline{\overline{D \oplus Q_n}})\,Q_n$$

$$= (D \oplus Q_n) + (D \oplus Q_n)\,Q_n$$

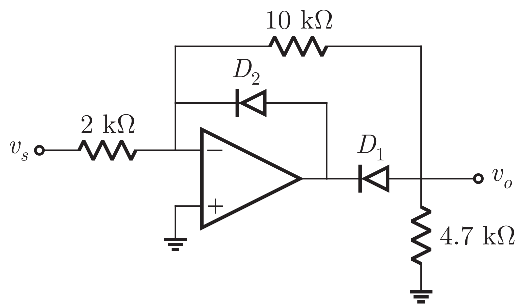
$$= (D \oplus Q_n)(1 \oplus Q_n) = (D \oplus Q_n) = D\overline{Q}_n + \overline{D}Q_n$$

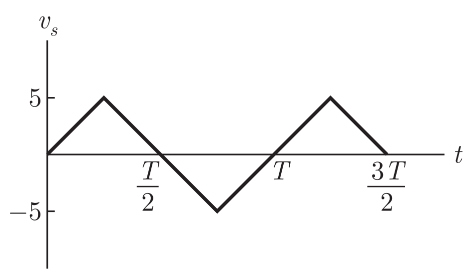
For $D = 0$, $Q_{n+1} = Q_n$

$D = 1$, $Q_{n+1} = \overline{Q}_n$

So, the circuit function as a T-flip flop.

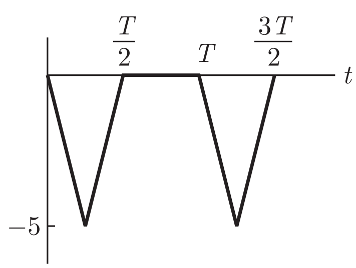
MCQ 1.31 Consider the following circuit and input voltage to it.



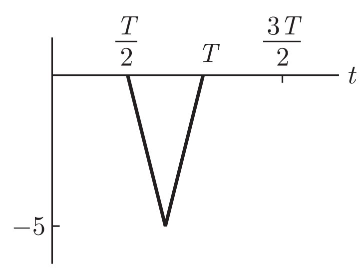


If op-amp and diodes are ideal, the output voltage waveform is

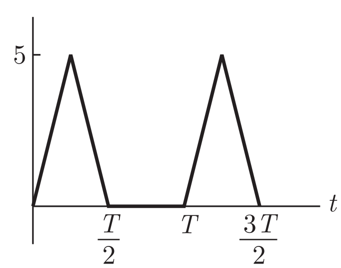
(A)



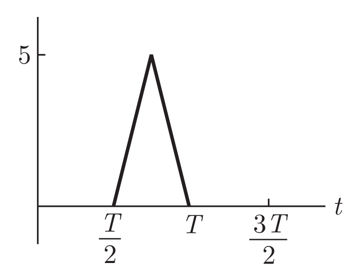
(B)



(C)

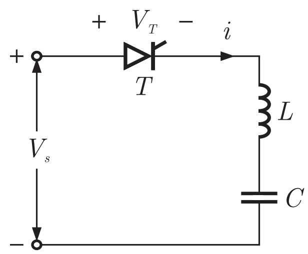


(D)



SOL 1.31 Option ( ) is correct.

MCQ 1.32 The circuit shown in the figure is initially relaxed. If the thyristor is turn on at $t = 0$, what is the conduction time of thyristor ?



(A) $2\pi\sqrt{LC}$ (B) $\pi\sqrt{LC}$

(C) $\frac{\pi}{4}\sqrt{LC}$ (D) $\frac{\pi}{2}\sqrt{LC}$

SOL 1.32 Option (B) is correct.

The thyristor acts as a diode when it is turned-on. By applying KVL in the circuit.

$$L\frac{di}{dt}+\frac{1}{C}\int idt = V_S$$

$$i(t) = V_S\sqrt{\frac{C}{L}}\sin\omega_0 t$$

Here $\omega_0 = \frac{1}{\sqrt{LC}} = \text{resonant frequency}$

Let the conduction time of thyristor is t_0,

at $t = t_0$,

$$i(t) = 0 = V_S\sqrt{\frac{C}{L}}\sin\omega_0 t_0$$

or, $$t_0 = \frac{\pi}{\omega_0}$$

or, $$t_0 = \pi\sqrt{LC}$$

MCQ 1.33 For a 50 MVA, 11 kV, three-phase synchronous generator, it is given that three-phase fault current is 2000 A and line to line fault current is 2600 A. The generator neutral is solidly grounded. The per unit value of negative sequence reactance of the generator is

(A) 0.436 pu (B) 1.056 pu

(C) 1.71 pu (D) 0.524 pu

SOL 1.33 Option (A) is correct.

Let the positive sequence and negative sequence reactances are X_1 and X_2 respectively.

For a three-phase fault

$$I_{a,3-\phi} = \frac{|V_t|}{X_1} \qquad \therefore |V_t| = 1\text{ pu}$$

$$\Rightarrow 2000 = \frac{11000/\sqrt{3}}{X_1}$$

$$X_1 = \frac{11000}{\sqrt{3}\times 2000} = 3.175\,\Omega$$

For a line-to-line fault

$$I_{a,LL} = \frac{\sqrt{3}|V_t|}{X_1 + X_2}$$

$$\Rightarrow 2600 = \frac{\sqrt{3}(11000/\sqrt{3})}{X_1 + X_2}$$

$$X_1 + X_2 = \frac{11000}{2600} = 4.231\,\Omega$$

$$X_2 = 4.231 - 3.175 = 1.056\,\Omega$$

Base impedance

$$Z_{Base} = \frac{(\text{kV})^2_{Base}}{(\text{MVA})_{Base}} = \frac{(11)^2}{50} = 2.42\,\Omega$$

$$X_{2\,pu} = \frac{X_{2\,\Omega}}{Z_{Base}} = \frac{1.056}{2.42} = 0.436 \text{ pu}$$

MCQ 1.34 A DT system has following input-output relationship

$$y[n] = \begin{cases} 3x[n], & x < 0 \\ 0, & x \geq 0 \end{cases}$$

Consider the following properties

P_1 : System is Linear

P_2 : System is causal

P_3 : System is invertible

Which of the above properties are possessed by the system ?

(A) P_1, P_2 (B) only P_1

(C) P_1, P_3 (D) only P_2

SOL 1.34 Option ( ) is correct.

MCQ 1.35 A 10 kW, 250 V shunt generator, having an armature resistance of $0.1\,\Omega$ and a field resistance of $250\,\Omega$, delivers full-load at rated voltage and 800 rpm. The machine is now run as a motor while taking 10 kW at 250 V. What is the speed of the motor?

(A) 827 rpm (B) 774 rpm

(C) 841 rpm (D) 667 rpm

SOL 1.35 Option (B) is correct.

When the machine is running as a generator

Field current $I_{sh} = \frac{250}{250} = 1 \text{ A}$

Load current $I_L = \frac{10 \times 10^3}{250} = 40 \text{ A}$

Armature current $I_a = I_L + I_{sh} = 40 + 1 = 41 \text{ A}$

Induced Emf $E_g = 250 + 41(0.1) = 254.1 \text{ V}$

Now the machine runs as a motor

Load current $I'_L = \frac{10 \times 10^3}{250} = 40 \text{ A}$

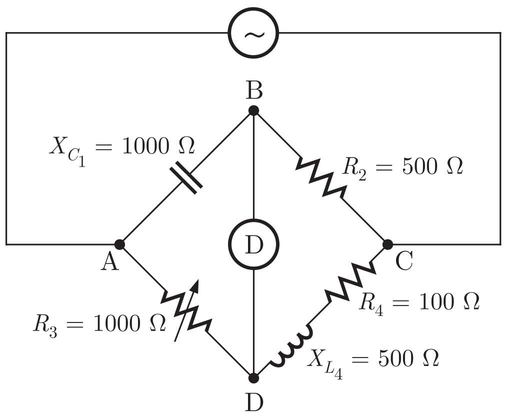
Field current $\quad I'_{sh} = \dfrac{250}{250} = 1\text{ A}$

Armature current $I'_a = 40 - 1 = 39\text{ A}$

Generated emf $\quad E_m = 250 - 39(0.1) = 246.1\text{ V}$

Speed as a motor $N_m = \dfrac{E_m}{E_g} N_g = \dfrac{246.1}{254.4}(800) \approx 775\,\text{rpm}$

MCQ 1.36 The ac bridge shown in the figure is used to measure an unknown inductance connected in CD arm. The bridge can be balanced by



(A) placing a resistor of $5000\,\Omega$ in parallel with capacitor

(B) placing a capacitor of reactance $100\,\Omega$ in series with resistor R_3

(C) placing a resistor of $2000\,\Omega$ in parallel with capacitor

(D) both (A) and (B)

SOL 1.36 Option (A) is correct.

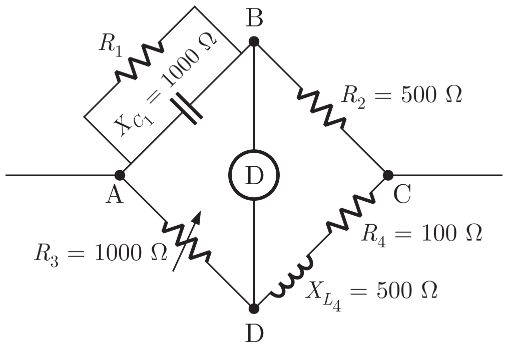
First we balance phase angles. We know that to balance the bridge, the sum of phase angles of opposite arms must be equal. From the figure

Phase angle of arm AB $\quad \theta_{AB} = -90^\circ$ (pure capacitance)

Phase angle of BC & AD $\quad \theta_{BC} = \theta_{AD} = 0^\circ$ (pure resistance)

Phase angle of CD $\quad \theta_{CD} < +90^\circ$ (inductive impedance)

The first option is to modify impedance of branch AB(Z_{AB}) so that its phase angle is decreased to less than 90° (equal to θ_{CD}) by placing a resistor in parallel with the capacitor as shown in the figure



Condition for balance

$$\mathbf{Z}_{AB}\mathbf{Z}_{CD} = \mathbf{Z}_{BC}\mathbf{Z}_{AD}$$

$$\boldsymbol{Y}_{AB} = \frac{1}{\boldsymbol{Z}_{AB}} = \frac{\boldsymbol{Z}_{CD}}{\boldsymbol{Z}_2\boldsymbol{Z}_3}$$

where

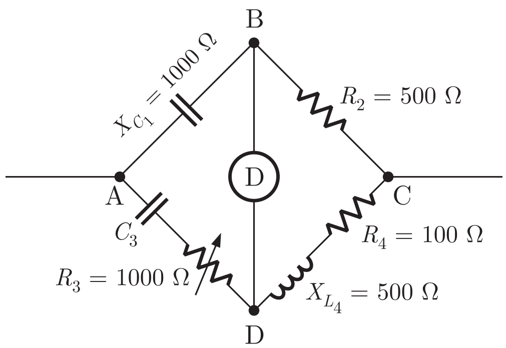
$$\boldsymbol{Y}_{AB} = \frac{1}{R_1} + \frac{j}{1000},\ \mathbf{Z}_{CD} = 100 + j500,\ \mathbf{Z}_{BC} = 500,\ Z_{AD} = 1000$$

Substituting above values, we get

$$\frac{1}{R_1} + \frac{j}{1000} = \frac{100 + j500}{500 \times 1000}$$

and $\qquad R_1 = 5000\,\Omega$

The second option is to modify the phase angle of arm AD by adding a series capacitor, as shown in the figure



Balancing condition

$$\boldsymbol{Z}_{AD} = \frac{\boldsymbol{Z}_{AB}\boldsymbol{Z}_{CD}}{\boldsymbol{Z}_{BC}}$$

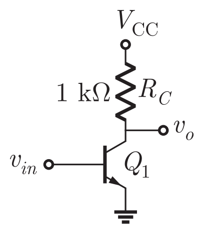
Substituting the values in above equation, we have

$$1000 - jX_C = \frac{-j1000\,(100 + j500)}{500}$$

or $\qquad X_C = 200\,\Omega$

MCQ 1.37 A bipolar amplifier circuit shown below, exhibits the following characteristic

$$I_C = I_S \exp\left(\frac{V_{BE}}{2\,V_T}\right),\ V_T = 25\ \text{mV}$$



(A) 20
(B) 40
(C) 10
(D) 100

SOL 1.37 Option ( ) is correct.

MCQ 1.38 An electron with velocity $V = (3u_x + 12u_y - 4u_z) \times 10^5$ m/s experiences no net forces at a point in a magnetic field $B = u_x + 2u_y + 3u_z$ nWb/m². The electric field E at that point is

(A) $-4.4u_x + 1.3u_y + 0.6u_z$ kV/m
(B) $4.4u_x - 1.3u_y - 0.6u_z$ kV/m
(C) $-4.4u_x + 1.3u_y + 0.6u_z$ kV/m
(D) $4.4u_x - 1.3u_y - 0.6u_y$ kV/m

SOL 1.38 Option ( ) is correct.

MCQ 1.39 Consider the following 8085 instruction

```
XRA    A
MVI    B, 4AH
SUI    4FH
ANA    B
HLT
```

The contents of register A and B are respectively

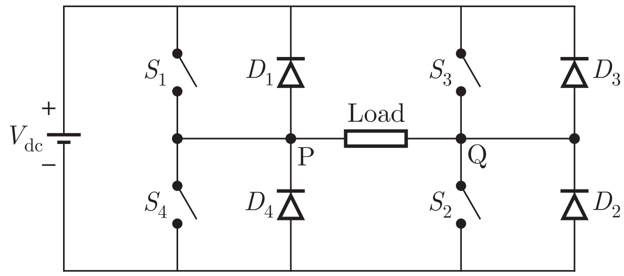
(A) 05, 4A
(B) 4F, 00
(C) B1, 4A
(D) None of the above

SOL 1.39 Option (D) is correct.

```
XRA  A     ;   Clear A
MVI  B     ;   4A → B
SUI  4FH   ;   A - 4FH → A = B1H
ANA  B     ;   A AND B → A = 00
     HTL
```

$A = 00,\ B = 4A$

MCQ 1.40 A single-phase full bridge voltage source inverter feeds a load as shown in figure. If the load current is $I_0 = 540\sin(\omega t - 45^\circ)$, the power delivered to the load is



(A) 103.15 kW (B) 72.94 kW

(C) 36.46 kW (D) 114.55 kW

SOL 1.40 Option (B) is correct.

RMS value of fundamental output voltage.

$$V_{0(\text{fund})} = \frac{4V_{dc}}{\pi\sqrt{2}} \qquad \therefore\ V_{dc} = 300 \text{ V}$$

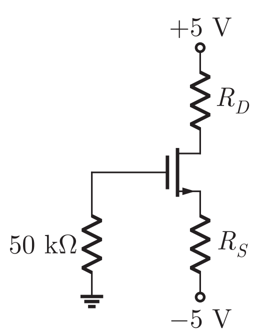
$$= \frac{4 \times 300}{\pi\sqrt{2}} = 270.14 \text{ V}$$

Power delivered

$$P_{out} = V_{01} I_0 \cos\phi$$

$$= 270.14 \times \frac{540}{\sqrt{2}} \cos 45^\circ = 72.94 \text{ kW}$$

MCQ 1.41 In the circuit shown below the transistor parameters are $V_{TN} = 1.7$ V and $K_n = 0.4$ mA/V^2.



If $I_D = 0.8$ mA and $V_D = 1$ V, then value of resistor R_S and R_D are respectively

(A) 2.36 kΩ, 5 kΩ (B) 5 kΩ, 2.36 kΩ

(C) 6.43 kΩ, 8.4 kΩ (D) 8.4 kΩ, 6.43 kΩ

SOL 1.41 Option (A) is correct.

$$I_D = \frac{5 - V_D}{R_D} = 0.8 \text{ mA}, \ R_D = \frac{6-1}{0.8\text{m}} = 5 \text{ k}\Omega$$

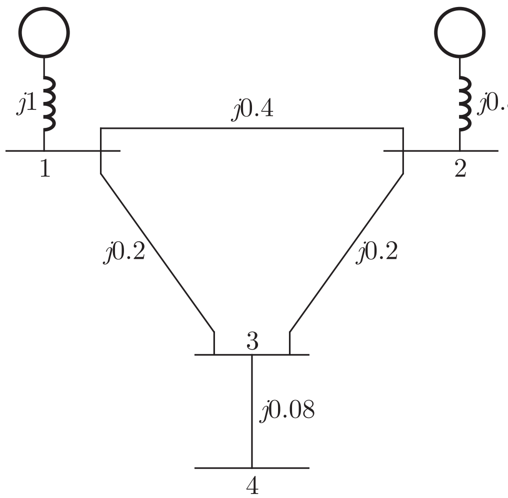
$$I_D = K_n(V_{GS} - V_{TN})^2$$

$$\Rightarrow \qquad 0.8 = (0.4)(V_{GS} - 1.7)^2 \Rightarrow V_{GS} = 3.11 \text{ V}$$

$$V_{GS} = V_G - V_S, V_G = 0, V_S = -3.11 \text{ V}$$

$$I_D = 0.8 \text{ mA} = \frac{-3.11-(-5)}{R_S} \Rightarrow R_S = 2.36 \text{ k}\Omega$$

MCQ 1.42 The impedance diagram of a power system is shown in figure. The bus admittance matrix Y_{BUS} is



(A) $Y_{BUS} = j\begin{bmatrix} -8.5 & 2.5 & 5.0 & 0 \\ 2.5 & -8.75 & 5.0 & 0 \\ 5.0 & 5.0 & -22.5 & 12.5 \\ 0 & 0 & 12.5 & -12.5 \end{bmatrix} S$

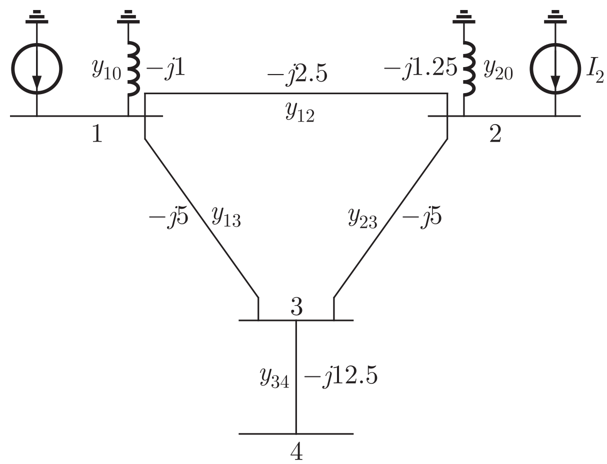
(B) $Y_{BUS} = j\begin{bmatrix} 1.6 & 0.4 & 0.2 & 0 \\ 0.4 & 1.4 & 0.2 & 0 \\ 0.2 & 0.2 & 1.2 & 0.8 \\ 0 & 0 & 0.8 & 0.8 \end{bmatrix} S$

(C) $Y_{BUS} = j\begin{bmatrix} 8.5 & 2.5 & 5.0 & 0 \\ 2.5 & 8.75 & -5.0 & 0 \\ 5.0 & -5.0 & 22.5 & 12.5 \\ 0 & 0 & 12.5 & 12.5 \end{bmatrix} S$

(D) $Y_{BUS} = j\begin{bmatrix} -1.6 & 0.4 & 0.2 & 0 \\ 0.4 & -1.4 & 0.2 & 0 \\ 0.2 & 0.2 & -1.2 & 0.8 \\ 0 & 0 & 0.8 & -0.8 \end{bmatrix} S$

SOL 1.42 Option (A) is correct.

The admittance diagram for the system is shown below:



$$Y_{BUS} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix} = j\begin{bmatrix} -8.5 & 2.5 & 5.0 & 0 \\ 2.5 & -8.75 & 5.0 & 0 \\ 5.0 & 5.0 & -22.5 & 12.5 \\ 0 & 0 & 12.5 & -12.5 \end{bmatrix} \text{S}$$

Where $Y_{11} = y_{10} + y_{12} + y_{13}$; $Y_{22} = y_{20} + y_{12} + y_{23} + y_{24}$

$Y_{33} = y_{30} + y_{13} + y_{23} + y_{34}$; $Y_{44} = y_{40} + y_{24} + y_{34}$

$Y_{12} = Y_{21} = -y_{12}$; $Y_{13} = Y_{31} = -y_{13}$

$Y_{23} = Y_{32} = -y_{23}$

and $Y_{34} = Y_{43} = -y_{34}$; $Y_{24} = Y_{42} = -y_{24}$

$Y_{14} = Y_{14} = -y_{14}$

MCQ 1.43 Let $Q_1 = 4\mu C$ be located at $P_1(3,11,8)$ while $Q_2 = -5\mu C$ is at $P_2(6,15,8)$. The force F_2 on Q_2 will be

(A) $-(4.32u_x + 5.76u_y)\,N$
(B) $4.32u\ + 5.76u_y\,N$
(C) $-(4.32u_x + 5.76u_y)$ mN
(D) $4.32u_x + 5.76y_y$ mN

SOL 1.43 Option (D) is correct.

$$F_2 = \frac{Q_1 Q_2}{4\pi\varepsilon_0}\frac{R_{12}}{|R_{12}|^3}$$
$$= \frac{(4\times10^{-6})(-5\times10^{-6})}{4\pi\varepsilon_0}\times\frac{(3\mathbf{u}_x + 4\mathbf{u}_y)}{5^3}$$
$$= (4.32\mathbf{u}_x + 5.76\mathbf{u}_y)\text{ mN}$$

MCQ 1.44 A numerical solution of the equation $f(x) + \sqrt{x-3} = 0$ can be obtained using Newton- Raphson method. If the starting value is $x = 2$ for the iteration, the value of x that is to be used in the next step is

(A) 0.306
(B) 0.739
(C) 1.694
(D) 2.306

SOL 1.44 Option ( ) is correct.

MCQ 1.45 The residues of a complex function

$$x(z) = \frac{1-2z}{z(z-1)(z-2)}$$

at its poles are

(A) $\frac{1}{2}, -\frac{1}{2}$ and 1

(B) $\frac{1}{2}, -\frac{1}{2}$ and -1

(C) $\frac{1}{2}, 1$ and $-\frac{3}{2}$

(D) $\frac{1}{2}, -1$ and $\frac{3}{2}$

SOL 1.45 Option ( ) is correct.

MCQ 1.46 Given the matrix $\begin{bmatrix} -4 & 2 \\ 4 & 3 \end{bmatrix}$, the eigenvector is

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

(B) $\begin{bmatrix} 4 \\ 3 \end{bmatrix}$

(C) $\begin{bmatrix} 2 \\ -1 \end{bmatrix}$

(D) $\begin{bmatrix} -1 \\ 2 \end{bmatrix}$

SOL 1.46 Option ( ) is correct.

MCQ 1.47 In the Taylor series expansion of $\exp(x) + \sin(x)$ about the point $x = \pi$, the coefficient of $(x-\pi)^2$ is

(A) $\exp(\pi)$

(B) $0.5\exp(\pi)$

(C) $\exp(\pi) + 1$

(D) $\exp(\pi) - 1$

SOL 1.47 Option ( ) is correct.

Common Data Questions

Common Data For Questions 48 and 49:

A 50 kW, 440 V, 50 Hz, 6-pole induction motor has a full load slip of 6% . The friction and windage losses are 300 W, and the core losses are 600 W at full-load conditions.

MCQ 1.48 What is the shaft speed at full load ?

(A) 1000 rpm

(B) 600 rpm

(C) 940 rpm

(D) 870 rpm

SOL 1.48 Option (C) is correct.

The synchronous speed of the motor is

$$n_s = \frac{120 \times f}{P} = \frac{120 \times 50}{6} = 1000 \text{ rpm}$$

The shaft speed is

$$n_m = (1-s)\,n_s \qquad \therefore\ s = 0.06$$

$$= (1-0.06)\,1000 = 940 \text{ rpm}$$

MCQ 1.49 What is the value of load torque ?

(A) 846 N-m (B) 377 N-m

(C) 161 N-m (D) 508 N-m

SOL 1.49 Option (D) is correct.

The load torque is

$$\tau_L = \frac{P_{out}}{\omega_m}$$

$$= \frac{50\,\text{kW}}{940 \times \frac{2\pi}{60}} \simeq 508\,\text{Nm}$$

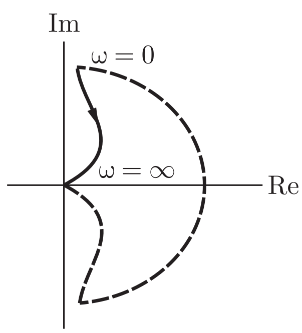
Common Data For Questions 50 and 51:

The open-loop transfer function of a feedback control system is

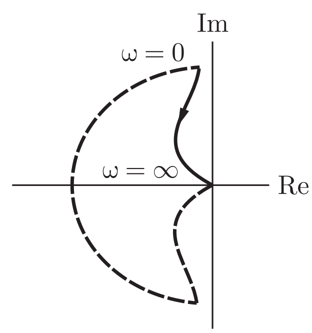
$$G(s)\,H(s) = \frac{-1}{2s(1-20s)}$$

MCQ 1.50 The Nyquist plot for this system is

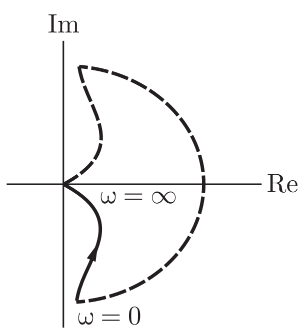
(A)



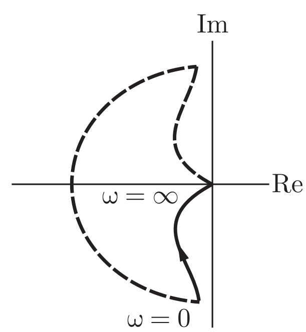
(B)



(C)



(D)



SOL 1.50 Option ( ) is correct.

MCQ 1.51 Regarding the system consider the statements

1. Open-loop system is stable
2. Closed-loop system is unstable
3. One closed-loop poles is lying on the RHP

The correct statements are

(A) 1 and 2 (B) 1 and 3

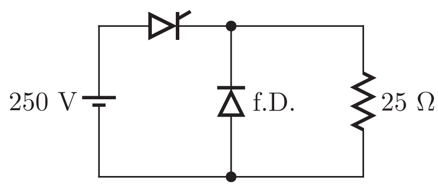
(C) only 2 (D) All

SOL 1.51 Option ( ) is correct.

Linked Answer Questions

Statement For Linked Answer Questions 52 and 53:

For the chopper circuit shown in the figure, duty cycle is 0.4. The voltage drop across the chopper during ON state is 2 volt.



MCQ 1.52 The average and rms output voltages are respectively

(A) 156.8 V, 99.2 V (B) 100 V, 158.1 V

(C) 99.2 V, 156.8 V (D) 158.1 V, 100 V

SOL 1.52 Option (C) is correct.

Average value of output voltage

$$V_{0\,av} = D(V_{dc} - V_T) \qquad \therefore V_{dc} = 250\text{ V}, V_T = 2\text{ V}$$
$$= D(V_{dc} - 2) \qquad \therefore D = 0.4$$
$$= 0.4(250 - 2) = 0.4(248) = 99.2 \text{ volts}$$

RMS value of the output voltage is

$$V_{0\,rms} = \sqrt{D}\,(V_{dc} - V_T)$$
$$= \sqrt{0.4}\,(250 - 2) = \sqrt{0.4} \times 248 = 156.84 \text{ volts}$$

MCQ 1.53 What is the efficiency of the chopper ?

(A) 70.28% (B) 39.36%

(C) 25.1% (D) 99.19%

SOL 1.53 Option (D) is correct.

Output power

$$P_0 = \frac{V_{0\,rms}^2}{R} = \frac{(156.8)^2}{25} = 983.44 \text{ watts}$$

Input power

$$P_i = V_{dc} I_0 = 250 \times \frac{V_{0\,av}}{25} \qquad \therefore I_0 = \frac{V_{0\,av}}{R}$$

$$= 250 \times \frac{99.2}{25} = 992 \text{ watts}$$

Chopper efficiency

$$\eta = \frac{\text{output power}}{\text{input power}} \times 100 = \frac{984.06}{990} \times 100 = 99.19\%$$

Statement For Linked Answer Questions 54 and 55:

A two bus power system is shown in the figure. Incremental fuel costs of the two generators are given as:

$$IC_1 = (0.35 P_{G_1} + 41)\,\text{Rs/MWhr}$$

$$IC_2 = (0.35 P_{G_2} + 41)\,\text{Rs/MWhr}$$

loss expression is

$$P_L = 0.001\,(P_{G_2} - 70)^2\,\text{MW}$$

The total incremental cost of the system is 117.6 Rs/MWhr

MCQ 1.54 The optimal scheduling for generators are given as

(A) $P_{G_1} = 218.857\,\text{MW}, P_{G_2} = 159.029\,\text{MW}$

(B) $P_{G_1} = 200\,\text{MW}, P_{G_2} = 160\,\text{MW}$

(C) $P_{G_1} = 400\,\text{MW}, P_{G_2} = 150\,\text{MW}$

(D) $P_{G_1} = 318.56\,\text{MW}, P_{G_2} = 281.44\,\text{MW}$

SOL 1.54 Option (A) is correct.

$$P_L = 0.001\,(P_{G2} - 70)^2$$

We know that plant factor of plant n is given as

$$L_n = \frac{1}{1 - \partial P_L / \partial P_n}$$

For Plant 1 :

$$\frac{\partial P_L}{\partial P_{G1}} = 0$$

So

$$L_1 = 1$$

For plant 2 :

$$\frac{\partial P_L}{\partial P_{G2}} = 0.002\,(P_{G2} - 70) = 0.002 P_{G2} - 0.14$$

$$L_2 = \frac{1}{1 - \frac{\partial P_L}{\partial P_{G2}}} = \frac{1}{(1.14 - 0.002 P_{G2})}$$

Let λ is the total incremental cost of the system.

Now

$$L_1\frac{dC_1}{dP_{G_1}} = 0.35P_{G1} + 41 = \lambda \qquad ...(i)$$

and

$$L_2\frac{dC_2}{dP_{G2}} = \frac{0.35P_{G2} + 41}{(1.14 - 0.002P_{G2})} = \lambda \qquad ...(ii)$$

From equation (i)

$$P_{G1} = \frac{\lambda - 41}{0.35} \qquad ...(iii)$$

From equation (ii)

$$P_{G2} = \frac{1.14\lambda - 41}{0.35 + 0.002\lambda} \qquad ...(iv)$$

Given that $\lambda = 117.6\,\text{Rs/MWhr}$

Thus,

$$P_{G1} = 218.857\,\text{MW}, \quad P_{G2} = 159.029\,\text{MW}$$

MCQ 1.55 The power loss will be

(A) 8.1 MW

(B) 44.70 MW

(C) 7.92 MW

(D) 6.4 MW

SOL 1.55 Option (C) is correct.

Power loss

$$P_L = 0.001\,(P_{G_2} - 70)^2\,\text{MW}$$

$$P_L = 0.001\,(159.029 - 70)^2\,\text{MW} = 7.926\,\text{MW}$$

Q. 56 TO Q. 60 CARRY ONE MARK EACH

MCQ 1.56 Which one of the following is the Antonym of the word PROFESSIONAL ?

(A) conservative

(B) liberal

(C) amateur

(D) legal

SOL 1.56 Correct option is (C)

MCQ 1.57 Which one of the following is the synonym of the word DISPARAGE ?

(A) separate

(B) compare

(C) refuse

(D) belittle

SOL 1.57 Correct option is (D)

MCQ 1.58 One of the four words given in the four options does not fit the set of words. The odd word from the group is

(A) Smog (B) Marsh

(C) Haze (D) Mist

SOL 1.58 Correct option is (B)

MCQ 1.59 A pair of CAPITALIZED words shown below has four pairs of words. The pair of words which best expresses the relationship similar to that expressed in the capitalized pair is

ATMOSPHERE : STRATOSPHERE

(A) Nimbus : Cloud (B) Instrument : Calibration

(C) Aircraft : Jet (D) Climate : Rain

SOL 1.59 Correct option is (D)

MCQ 1.60 In the following sentence, a part of the sentence is left unfinished. Four different ways of completing the sentence are indicated. The best alternative among the four is

.................., the more they remain the same

(A) The more the merrier

(B) The less the dynamism

(C) The more things change

(D) The more pronounced the transformation.

SOL 1.60 Correct option is (C)

Q.61 TO Q.65 CARRY TWO MARK EACH

MCQ 1.61 $2^{73} - 2^{72} - 2^{71}$ is the same as

(A) 2^{69} (B) 2^{70}

(C) 2^{71} (D) 2^{72}

SOL 1.61 Correct option is (C)

Let
$$\begin{aligned} X &= 2^{73} - 2^{72} - 2^{71} \\ &= 4 \times 2^{71} - 2 \times 2^{71} - 2^{71} \\ &= 2^{71}(4 - 2 - 1) \\ &= 2^{71} \end{aligned}$$

MCQ 1.62 If $n = 1 + x$, where x is the product of four consecutive positive integers, then which of the following is/are true?

1. n is odd

2. n is prime

3. n is a perfect square

(A) A and C only (B) A and B only

(C) A only (D) None of these

SOL 1.62 Correct option is (A)

We have

$$n = 1 + x$$

Where x is the product of four consecutive positive integers

Thus

$$n = 1 + y(y+1)(y+2)(y+3)$$

Where y is a positive integer

If we substitute $y = 2$

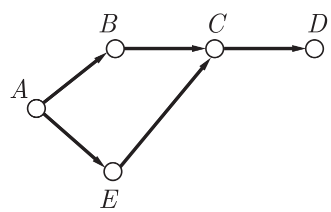
$$n = 1 + 2(2+1)(2+2)(2+3)$$
$$= 1 + 2 \times 3 \times 4 \times 5$$
$$121$$

Which is a odd number and perfect square of 11

Thus n is odd & perfect square.

Direction for q. 63 to q. 65

Answer these questions based on the pipeline diagram given :



The following sketch shows the pipelines carrying material from one location to another. Each location has a demand for material. The demand at B is 800, at C is 800, at D is 1400, and at E is 400. Each arrow indicates the direction of material flow through the pipeline. The flow from B to C is 600. The quantity of material flow is such that the demands at all these location are exactly met. The capacity of each pipeline is 2000.

MCQ 1.63 The quantity moved from A to E is :

(A) 400 (B) 1600

(C) 1400 (D) 2000

SOL 1.63 Correct option is (D)

The capacity of each pipeline is 2000. According to the demand and the flow quantity the block diagram is shown below :

We have $D_B = 800,\ D_C = 800,\ D_D = 1400,\ D_E = 400,\ f_{BC} = 600$

Fig Fig Fig

The flow quantity shown in figure

Thus quantity moved from A to E is 2000

MCQ 1.64 The free capacity available in the A-B pipeline is :

(A) 0 (B) 200

(C) 400 (D) 600

SOL 1.64 Correct option is (D)

Free capacity available in the pipeline $A-B$ is

$$= 2000 - 1400 = 600$$

MCQ 1.65 What is the free capacity available in the E-C pipeline ?

(A) 600 (B) 400

(C) 200 (D) 0

SOL 1.65 Correct option is (B)

The free capacity available in the pipe line $E-C$ is

$$= 2000 - 1600$$
$$= 400$$

Answer Key

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

Practice Paper EE_B

Q.1- Q.25 carry one mark each.

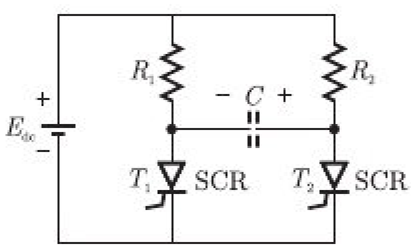
MCQ 1.1 A certain logic family has the following voltage parameters : $V_{IH(\min)} = 3.5$ V, $V_{IL(\max)} = 1.0$ V, $V_{OH(\min)} = 4.9$ V and $V_{OL(\max)} = 0.1$ V. The largest positive-going and negative-going spike, that can be tolerated, is respectively

(A) 1.4 V, 0.9 V (B) 0.9 V, 1.4 V

(C) 3.9 V, 3.4 V (D) None of the above

SOL 1.1 Option ( ) is correct.

MCQ 1.2 A voltage commutation circuit is shown in figure. The turn-off time of the both SCR is 60 μsec and current through R_1 and R_2 is 20 A. What will be the approximate minimum value of capacitor required for proper commutation ?



(A) 10.40 μF (B) 14.4 μF

(C) 1.58 μF (D) 6.93 μF

SOL 1.2 Option (B) is correct.

The resistances $R_1 = R_2 = \frac{V_{dc}}{I} = \frac{120}{20} = 6\,\Omega$

Now, we have the relation for C for successful commutation as

$$C = 1.44\frac{t_{off}}{R_1} = 1.44 \times \frac{60 \times 10^{-6}}{6} = 14.4\,\mu\text{F}$$

MCQ 1.3 A moving-coil instrument gives full deflection at 500 μA and has a resistance of 1 kΩ. The instrument has to be used as a 0-50 V voltmeter. The required value of series resistance is

(A) 100 kΩ

(B) 50 kΩ

(C) 99 kΩ

(D) 101 kΩ

SOL 1.3 Option (C) is correct.

The sensitivity of 500 μA meter movement is given by

$$S = 1/I_m = 1/500\,\mu\text{A} = 2\,\text{k}\Omega/\text{V}$$

The value of the multiplier resistance can be calculated by

$$R_s = S \times \text{range} - R_m \qquad \therefore\ R_m = 1\,\text{k}\Omega$$

$$R_s = 2\,\text{k}\Omega/\text{V} \times 50\text{ V} - 1\,\text{k}\Omega = 100 - 1 = 99\,\text{k}\Omega$$

MCQ 1.4 In a synchronous generator:

(a) The open circuit voltage leads the terminal voltage by an angle known as power angle.

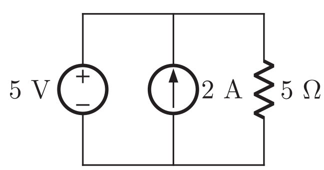
(b) The open circuit voltage leads the terminal voltage by an angle known as overlap angle.

(c) The open circuit voltage lags the terminal voltage by an angle known as power lag

(d) The open circuit voltage lags the terminal voltage by an angle known as overlap angle.

SOL 1.4 Option ( ) is correct.

MCQ 1.5 In the given circuit



(A) Current through 5 Ω resistor is 2 A

(B) Current through 5 Ω resistor is 3 A

(C) Voltage source absorbs power of 10 W

(D) Voltage source absorbs power of 5 W

SOL 1.5 Option ( ) is correct.

MCQ 1.6 The period of signal $x(t) = 10\sin 5t - 4\cos 7t$ is

(A) $\frac{24\pi}{35}$ (B) $\frac{4\pi}{35}$

(C) 2π (D) Not periodic

SOL 1.6 Option (C) is correct.

$\frac{2\pi}{T_1} = 5 \Rightarrow T_1 = \frac{2\pi}{5}$ and $\frac{2\pi}{T_2} = 7 \Rightarrow T_2 = \frac{2\pi}{7}$

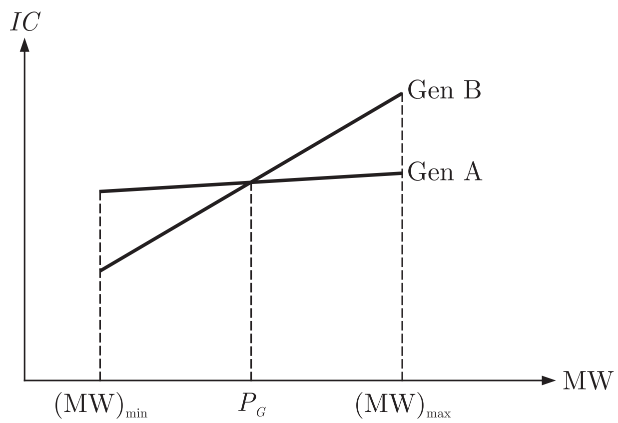
$$\text{LCM}\left(\frac{2\pi}{5}, \frac{2\pi}{7}\right) = 2\pi$$

MCQ 1.7 A 3-ϕ, 4 pole, 50 Hz induction motor has a slip of 2% at no load and 4% at full-load. The no-load speed and full-load speed of the motor (in rpm) are respectively

(A) 1440, 1470
(B) 1500, 1470
(C) 1470, 1440
(D) 1440, 1500

SOL 1.7 Option ( ) is correct.

MCQ 1.8 Figure shows the incremental fuel cost curves of generators P and Q. How would a load more than $2P_G$, be shared between P and Q if both generators are running ?



(A) Gen P will share more load than Gen Q
(B) Gen P and Gen Q will share load of P_G each
(C) Gen P will share more load then Gen Q
(D) Can not be determined

SOL 1.8 Option ( ) is correct.

MCQ 1.9 The electric field component of a time harmonic plane EM wave traveling in a nonmagnetic lossless dielectric medium has an amplitude of 1 V/m. If the relative permittivity of the medium is 4, the magnitude of the time-average power density vector (in W/m^2) is

(A) $\frac{1}{30\pi}$
(B) $\frac{1}{60\pi}$
(C) $\frac{1}{120\pi}$
(D) $\frac{1}{240\pi}$

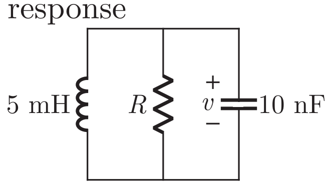
MCQ 1.10 Which one of the following is the most suitable device for a d.c.-d.c. converter ?

(A) BJT
(B) GTO
(C) MOSFET
(D) Thyristor

SOL 1.10 Option (B) is correct.

The gate turn-off thyristor(GTO) has the capability of being turned- off by a negative gate-current pulse. Also GTO has a faster switching speed than thyristor and it can withstand larger voltage and current than power transistor or MOSFET

MCQ 1.11 The value of R that satisfies the following circuit to exhibits critically- damped response



(A) 88.4 Ω (B) 176.8 Ω

(C) 353.6 Ω (D) 125 kΩ

SOL 1.11 Option ( ) is correct.

MCQ 1.12 Compared to a resistor split phase motor, a capacitor start motor has

(A) higher starting torque

(B) lower starting torque

(C) higher running torque

(D) lower running torque

SOL 1.12 Option ( ) is correct.

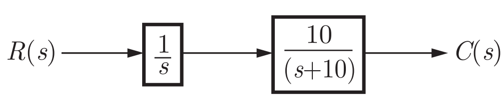
MCQ 1.13 For a 15 bus power system with 3 voltage controlled bus, the size of Jacobian matrix is

(A) 11×11 (B) 12×12

(C) 24×24 (D) 25×25

SOL 1.13 Option ( ) is correct.

MCQ 1.14 For the system shown in figure, the rise time and settling time are respectively



(A) 0.22 s, 0.4 s (B) 0.4 s, 0.22 s

(C) 0.12 s, 0.4 s (D) 0.4 s, 0.12 s

SOL 1.14 Option (A) is correct.

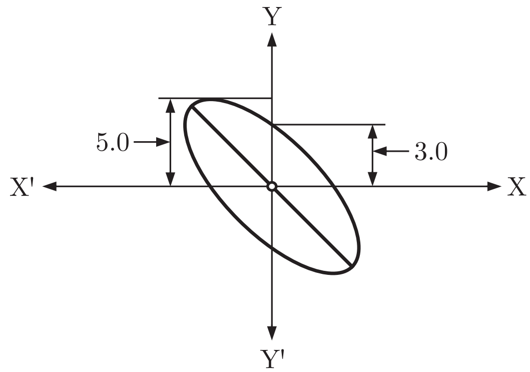
$$C(s) = \frac{10}{s(s+10)} = \frac{1}{s} - \frac{1}{s+10}$$

$$\Rightarrow \qquad c(t) = 1 - e^{-10t}$$

$a = 10$, Rise time $T_r = \frac{2.2}{a} = \frac{2.2}{10} = 0.22\,\text{s}$

Setting time $\qquad T_s = \frac{4}{a} = 0.4\,\text{s}$

MCQ 1.15 Two sinusoidal voltage signals of equal frequency are applied to the vertical and horizontal deflection plates of a CRO. The output observed on the screen is shown in the following figure.



The phase difference between the applied signals is

(A) 31° (B) 53.13°

(C) 143.1° (D) 59°

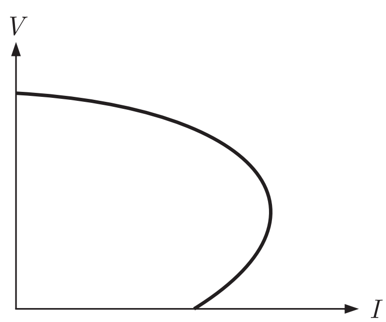
SOL 1.15 Option (C) is correct.

Pattern observed on the screen is an ellipse. So, phase angle

$$\phi = \sin^{-1}\left(\frac{3}{5}\right) = 36.9^\circ \text{ or } 143.1^\circ$$

We can see from the figure that ellipse is in second and fourth quadrants so the valid value of phase angle is 143.1°.

MCQ 1.16 The graph shown below represents which characteristic of a d.c. shunt generator ?



(A) Internal characteristic (B) External characteristic

(C) Open-circuit characteristic (D) Magnetic characteristic

SOL 1.16 Option ( ) is correct.

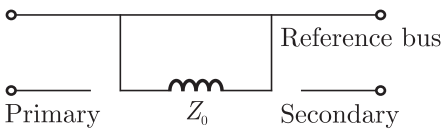
MCQ 1.17 A silicon abrupt junction has dopant concentration $N_a = 2\times10^{16}\text{ cm}^{-3}$ and $N_d = 2\times10^{15}\text{ cm}^{-3}$. The applied reverse bias voltage is $V_R = 8$ V. The maximum electric field $|E_{\max}|$ in depletion region is

(A) 15×10^4 V/cm (B) 7×10^4 V/cm

(C) 3.5×10^4 V/cm (D) 5×10^4 V/cm

SOL 1.17 Option ( ) is correct.

MCQ 1.18 A three-phase transformer having zero-sequence impedance of Z_0 has the zero sequence network as shown in the figure. The connections of its windings are



(A) star-star (B) delta-delta

(C) star-delta (D) delta-star with neutral grounded

SOL 1.18 Option ( ) is correct.

MCQ 1.19 Incidence matrix A of a network-graph is given as

$$A = \begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} \begin{array}{cccccccc} a & b & c & d & e & f & g & h \end{array} \\ \begin{bmatrix} -1 & 0 & 0 & 0 & 1 & 0 & 1 & 0 \\ 0 & -1 & 0 & 0 & 0 & 0 & -1 & 1 \\ 0 & 0 & -1 & -1 & 0 & -1 & 0 & -1 \\ 0 & 0 & 0 & 0 & -1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$$

from above it is concluded that

(A) branches e and g are in parallel

(B) branches c and d are in series

(C) branches a and b are in parallel

(D) branches c and d are in parallel

SOL 1.19 Option ( ) is correct.

MCQ 1.20 A hybrid stepper motor has 50 variable-reluctance rotor teeth. The stepping angle is

(A) 2.16° (B) 1.8°

(C) 3° (D) 3.2°

SOL 1.20 Option ( ) is correct.

MCQ 1.21 A 6-pole, 3-phase alternator running at 1000 rpm supplies to an 8-pole, 3-phase induction motor which has a rotor current of frequency 2 Hz. The speed at which the motor operates is

(A) 1000 rpm (B) 960 rpm

(C) 750 rpm (D) 720 rpm

SOL 1.21 Option ( ) is correct.

MCQ 1.22 A 20 kV transmission line has a series impedance of $(4+j60)\,\Omega$ and a shunt admittance of $j0.5\,\mathrm{S}$. Choose 100 MVA and the line voltage as base values, the per-unit impedance and per-unit admittance of the line respectively are

(A) $(1.6+j2.4), j0.125$

(B) $(1+j15), j2.0$

(C) $(0.8+j12), j2.5$

(D) $(2+j30), j1.0$

SOL 1.22 Option ( ) is correct.

MCQ 1.23 What is the number of output bits required for an A/D converter to give a quantizing error less than 1% ?

(A) 7 (B) 16

(C) 8 (D)5

SOL 1.23 Option ( ) is correct.

MCQ 1.24 The full-load copper loss and iron loss of a transformer are 6400 W and 5000 W, respectively. What are the above copper loss and iron loss, respectively at half-load ?

(A) 3200 W, 2500 W

(B) 3200 W, 5000 W

(C) 1600 W, 1250 W

(D) 1600 W, 5000 W

SOL 1.24 Option ( ) is correct.

MCQ 1.25 In case the characteristic impedance of a transmission line is equal to the load impedance

(A) the system will resonate badly.

(B) all the energy sent will be absorbed by the load.

(C) all the energy sent will pass to earth.

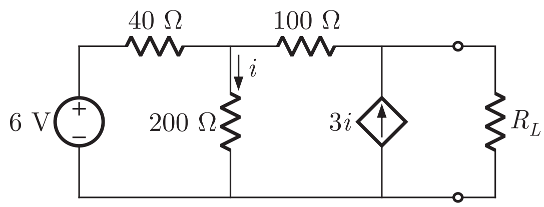
(D) all the energy will be lost in transmission line as transmission losses

SOL 1.25 Option (B) is correct.

If a line is terminated in its characteristic impedance, the refilled voltage will be zero. All the energy sent will be absorbed by the load. It is also called an infinite line.

Q.26- Q.55 two mark each.

MCQ 1.26 In the following circuit the R_L will absorb maximum power if R_L is equal to

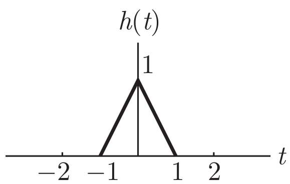


(A) $\frac{400}{3}\Omega$ (B) $\frac{2}{9}$ kΩ

(C) $\frac{800}{3}\Omega$ (D) $\frac{4}{9}$ kΩ

SOL 1.26 Option ( ) is correct.

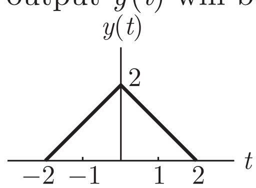
MCQ 1.27 An LTI system has the impulse response shown below.

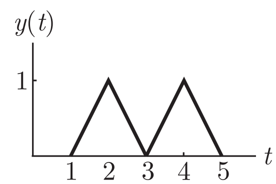


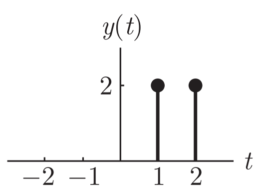
If the system is excited by an input $x(t)$ given as

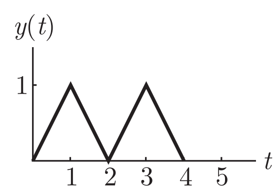
$$x(t) = \delta(t-1) + \delta(t-3)$$

then output $y(t)$ will be

(A)


(B)


(C)


(D)


SOL 1.27 Option (D) is correct.

Output of the system is

$$\begin{aligned} y(t) &= h(t) * x(t) \\ &= h(t) * [\delta(t-1) + \delta(t-3)] \\ &= h(t) * \delta(t-1) + h(t) * \delta(t-3) \\ &= h(t-1) + h(t-3) \end{aligned}$$

MCQ 1.28 The voltage ratio of a single-phase, 50 Hz transformer is 5000/500 V at no-load. The maximum value of the flux in the core is 7.82 mWb . The number of turns in primary and secondary windings are respectively

(A) 1000, 100 (B) 128, 13

(C) 288, 29 (D) 144, 15

SOL 1.28 Option ( ) is correct.

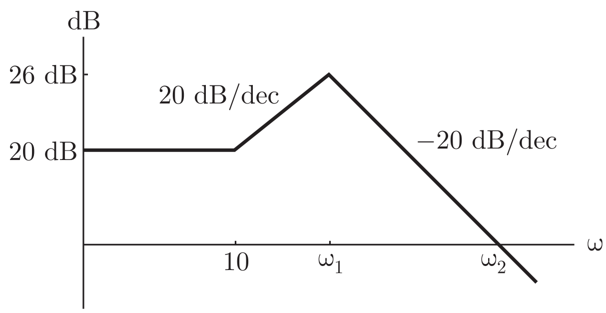
MCQ 1.29 A 10 MVA, 13.8 kV alternator has positive, negative and zero sequence reactances of 30%, 40% and 5% respectively. A reactance X_n must be put in the generator neutral such that the fault current for a line-to-ground fault of zero fault impedance will not exceed the rated line current. The per unit value of X_n is

(A) 0.60 pu (B) 0.25 pu

(C) 0.75 pu (D) 2.25 pu

SOL 1.29 Option ( ) is correct.

MCQ 1.30 The magnitude-frequency response of a control system is given in fig. The value of ω_1 and ω_2 are respectively



(A) 100 and 400 (B) 20 and 400

(C) 20 and 200 (D) 10 and 200

SOL 1.30 Option ( ) is correct.

MCQ 1.31 A ring core transformer with ratio 1000/5 A is operating at full primary current and with a secondary burden of non-inductive resistance of $1\,\Omega$. The exciting current is 1 A at a power factor of 0.4, what is the phase angle error ?

(A) 0.0228° (B) 0.0918°

(C) 0.0525° (D) 0.0758°

SOL 1.31 Option (C) is correct.

Nominal ratio $K_{nom} = \frac{1000}{5} = 200$

Secondary burden $R_e = 1\,\Omega$

Since the burden of secondary winding is purely resistive therefore, secondary winding power factor is unity or $\delta = 0$. The power factor of exciting current is 0.4, so we can write

$$\cos(90^\circ - \alpha) = 0.4$$

or $$\alpha = 90^\circ - \cos^{-1}0.4 = 23.57^\circ$$

Since there is no turn compensation, the turns ratio is equal to nominal ratio or

$$K_t = K_{nom} = 200$$

When the primary winding carries rated current of 1000 A, the secondary winding carries a current of 5 A.

Rated secondary winding current,

$$I_s = 5 \text{ A}$$

and $$K_t I_s = 200 \times 5 = 1000 \text{ A}$$

Phase angle,

$$\theta = \frac{180}{\pi}\left[\frac{I_0 \cos(\delta + \alpha)}{K_t I_s}\right]$$

$$= \frac{180}{\pi}\left[\frac{\cos 23.57^\circ}{1000}\right] = 0.0525^\circ$$

MCQ 1.32 A separately excited d.c. motor is to be controlled from a single- phase half controlled bridge at a speed of 1500 r.p.m. The motor is fed from an ac source of 230 V at 50 Hz. The motor has a back emf of 80 V and the armature has a resistance of $5\,\Omega$. The SCRs are fired symmetrical at $\alpha = 30^\circ$ in every half cycle. The value of average armature current is

(A) 19.86 A (B) 61.28 A

(C) 22.64 A (D) 3.32 A

SOL 1.32 Option ( ) is correct.

MCQ 1.33 If the electric field intensity is given by $E = (xu_x + yu_y + zu_z)$ volt/m, the potential difference between $X(2,0,0)$ and $Y(1,2,3)$ is

(A) +1 volt (B) −1 volt

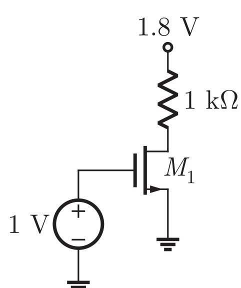
(C) +5 volt (D) +6 volt

SOL 1.33 Option ( ) is correct.

MCQ 1.34 In the given circuit of figure, transistor parameters are given as

$$V_{TH} = 0.4 \text{ V},$$

$$\mu_n C_{ox} = 200 \frac{\mu A}{V^2}$$



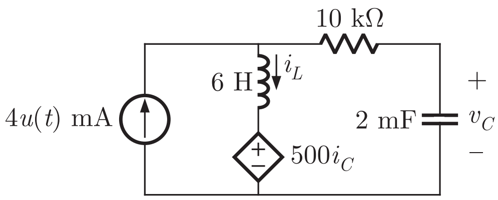
If transistor operates at the edge of saturation then parameter $\frac{W}{L}$ is nearly equal to

(A) 20 (B) 10

(C) 33 (D) 40

SOL 1.34 Option ( ) is correct.

MCQ 1.35 In the given circuit below, value $\frac{dv_c(0^+)}{dt}$ and $v_L(0^+)$ are



(A) 2 V/sec, 20 V (B) 2 V/sec, 40 V

(C) 0, 40 V (D) 2 V/sec, 0 V

SOL 1.35 Option ( ) is correct.

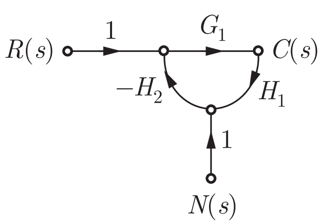
MCQ 1.36 A three-phase, 2-pole, 60 Hz induction motor is operating at a speed of 3502 rev/min with an input power of 15.7 kW and a terminal current of 22.6 A. The stator winding resistance is 0.20 Ω/phase. What is the I^2R power dissipated in the rotor ?

(A) 419 W (B) 427 W

(C) 2.58 kW (D) 832 W

SOL 1.36 Option ( ) is correct.

MCQ 1.37 A closed-loop system is shown in figure. The noise transfer function $C(s)/N(s)$ is approximately



(A) $\frac{1}{G_1(s)H_1(s)}$, for $|G_1(s)H_1(s)H_2(s)| << 1$

(B) $\frac{1}{-H_1(s)}$, for $|G_1(s)H_1(s)H_2(s)| >> 1$

(C) $\frac{1}{H_1(s)H_2(s)}$, for $|G_1(s)H_1(s)H_2(s)| >> 1$

(D) $\frac{1}{G_1(s)H_1(s)H_2(s)}$, for $|G_1(s)H_1(s)| << 1$

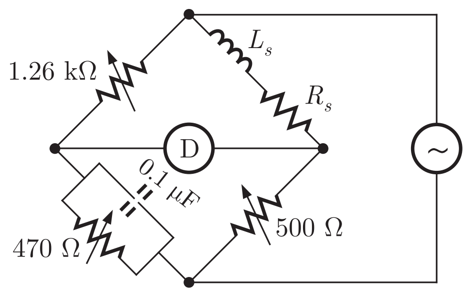
SOL 1.37 Option (B) is correct.

By putting $R(s) = 0$

$$P_1 = -H_2 G_1,$$
$$L_1 = -G_1 H_2 H_1,$$
$$\Delta_1 = 1,$$
$$T_n(s) = \frac{-H_2 G_1}{1 + G_1 H_2 H_1}$$

If $|G_1 H_2 H_1| >> 1$, $\quad T_n(s) = \frac{-H_2 G_1}{G_1 H_2 H_1} = \frac{-1}{H_1}$

MCQ 1.38 The maxwell bridge shown in the figure measures an unknown inductor which is represented by a series combination of resistor R_s and inductance L_s.



If the bridge is balanced at a frequency of 100 Hz, then quality factor of inductor is

(A) 0.03
(B) 1
(C) 0.18
(D) 0.53

SOL 1.38 Option (A) is correct.

For a balanced maxwell's bridge, following conditions are true.

$$L_s = C_3 R_1 R_4 = 0.1\,\mu\text{F} \times 1.26\,\text{k}\Omega \times 500\,\Omega = 63\,\text{mH}$$
$$R_s = \frac{R_1 R_4}{R_3} = \frac{1.26\,\text{k}\Omega \times 500\,\Omega}{470\,\Omega} = 1.34\,\text{k}\Omega$$
$$Q = \frac{\omega L_s}{R_s} = \frac{2\pi \times 100\,\text{Hz} \times 63\,\text{mH}}{1.34\,\text{k}\Omega} = 0.03$$

MCQ 1.39 Consider a DT system whose input-output relationship is given by

$$y[n] = y[n+1] - 3x[n] + 2x[n-1]$$

The system is

(A) Causal and Linear
(B) Linear and Time Invariant
(C) Causal and Time Invariant
(D) Causal

SOL 1.39 Option (B) is correct.

$$y[n] = x[n+1] - 3x[n] + 2x[n-1]$$

Linearity :

For two input $x_1[n]$ and $x_2[n]$

$x_1[b] \to y_1[n]$ and $x_2[n] \to y_2[n]$ here

$$Ax_1[n] + Bx_2[n] \to Ay_1[n] + By_2[n]$$

So, the system is linear.

Casualty :

By taking $z-$transform on both sides

$$Y[z] = zX(z) - 3X(z) + 2z^{-1}X(z)$$

System response is

$$H[z] = \frac{Y[z]}{X[z]} = z - 3 + 2z^{-1}$$

$$h[n] = \delta[n+1] - 3\delta[n] + 2\delta[n-1]$$

$$h[-1] = y[n-n_0]$$

So the system is time invariant.

MCQ 1.40 The sending-end and receiving-end voltages of a three-phase transmission line at a 200 MW load are equal at 230 kV. The per phase line impedance is $j14$ ohm. The maximum steady-state power that can be transmitted over the line would be

(A) 1259.5 MW (B) 2181.5 MW

(C) 419.8 MW (D) 3778.5 MW

SOL 1.40 Option (D) is correct.

$$|V_S| = |V_R| = \frac{230}{\sqrt{3}} = 132.79\,\text{kVolt}$$

Maximum power transferred

$$P_{\max} = \frac{|V_S||V_R|}{X} = \frac{|V_R|^2}{X} = \frac{(132.79)^2}{14}$$

$$= 1259.5\,\text{MW/phase}$$

For all three phases

$$P_{\max} = 3 \times 1259.5\,\text{MW}$$

$$= 3778.5\,\text{MW}$$

MCQ 1.41 A three-phase bridge inverter is operating in 120° conduction mode. The RMS value of the fundamental component of the line voltage is 415 V. What is the value of input dc source ?

(A) 532 V (B) 615 V

(C) 922 V (D) 251 V

SOL 1.41 Option (B) is correct.

For a three phase bridge inverter operating in 120° conduction mode, the n^{th} harmonic component is given by following expression

$$V_{n(\text{line})} = \frac{\sqrt{2}}{n\pi} V_{dc}\left[1 + \cos(n\pi/3)\right]$$

Fundamental component

$$V_{1(\text{line})} = \frac{\sqrt{2}}{\pi} V_{dc}(1.5)$$

$$E_{dc} = \frac{415\pi}{\sqrt{2}(1.5)} = 614.60\,\text{V}$$

MCQ 1.42 A three phase fully controlled bridge converter is fed from a 400 V (line to line) ac source. A resistive load of $100\,\Omega$ draws 400 W of power form the converter, the input power factor will be

(A) 0.5 (B) 0.21

(C) 0.37 (D) 0.86

SOL 1.42 Option (A) is correct.

Load Current

$$I_L = \left(\frac{400}{100}\right)^{0.5} = 2\text{ A}$$

In a three-phase fully controlled bridge converter input rms current I_s or the current in each supply phase exists for $120°$ in every $180°$.

Therefore rms value of input current

$$I_s = \left(\frac{2\times 120}{180}\right)^{0.5} = 1.15\text{ A}$$

$$\text{Input apparent power} = \sqrt{3}\times 400\times 1.15 = 796.72\text{ VA}$$

$$796.72\cos\theta = 400$$

Power factor

$$\cos\theta = 0.5\text{ lagging}$$

MCQ 1.43 If $A = \begin{bmatrix} 0 & 1 & -2 \\ -1 & 0 & 3 \\ 2 & -2 & \lambda \end{bmatrix}$ is a singular matrix, then λ is

(A) 0 (B) -2

(C) 2 (D) -1

SOL 1.43 Option (B) is correct.

$\mathbf{A}$ is singular if $|\mathbf{A}| = 0$

$$\Rightarrow \qquad \begin{bmatrix} 0 & 1 & -2 \\ -1 & 0 & 3 \\ 2 & -2 & \lambda \end{bmatrix} = 0$$

$$\Rightarrow \quad -(-1)\begin{vmatrix} 1 & -2 \\ -2 & \lambda \end{vmatrix} + 2\begin{vmatrix} 1 & -2 \\ 0 & 3 \end{vmatrix} + 0\begin{vmatrix} 0 & 3 \\ -2 & \lambda \end{vmatrix} = 0$$

$$\Rightarrow \qquad (\lambda - 4) + 2(3) = 0$$

$$\Rightarrow \qquad \lambda - 4 + 6 = 0 \Rightarrow \lambda = -2$$

MCQ 1.44 An anti-aircraft gun can take a maximum of 4 shots at an enemy plane moving away from it. The probabilities of hitting the plane at the first, second, third and fourth shot are 0.4, 0.3, 0.2 and 0.1 respectively. The probability that the gun hits the plane is

(A) 0.76

(B) 0.4096

(C) 0.6976

(D) None of these

SOL 1.44 Option (C) is correct.

Let $p_1 = 0.4,\ p_2 = 0.3,\ p_3 = 0.2$ and $p_4 = 0.1$ P(the gun hits the plane)

$$\begin{aligned} &= P(\text{the plane is hit at least once}) \\ &= 1 - P(\text{the plane is hit in none of the shots}) \\ &= 1 - (1-p_1)(1-p_2)(1-p_3)(1-p_4) \\ &= 1 - (0.6 \times 0.7 \times 0.8 \times 0.9) = (1 - 0.3024) = 0.6976 \end{aligned}$$

MCQ 1.45 The area bounded by the curves $y^2 = 9x, x - y + 2 = 0$ is given by

(A) 1

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

(C) $\frac{3}{2}$

(D) $\frac{5}{4}$

SOL 1.45 Option (B) is correct.

The equations of the given curves are

$$y^2 = 9x \qquad \text{...(i)}$$

$$x - y + 2 = 0 \qquad \text{(ii)}$$

The curves (i) and (ii) intersect at

A(1,3) and B(4,6)

If a figure is drawn the from fig. the required area is

$$\begin{aligned} A &= \int_1^4 \int_{x+2}^{3\sqrt{x}} dy dx = \int_1^4 [y]_{x+2}^{3\sqrt{x}} dx \\ &= \int_1^4 [3\sqrt{x} - (x+2)]\, dx = \left[2x^{\frac{3}{2}} - \frac{1}{2}x^2 - 2x\right]_1^4 \\ &= (16 - 8 - 8) - \left(2 - \frac{1}{2} - 2\right) = \frac{1}{2} \end{aligned}$$

MCQ 1.46 The solution of the differential equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = e^{3x}$ is given by

(A) $y = c_1 e^x + c_2 e^{2x} + \frac{1}{2}e^{3x}$

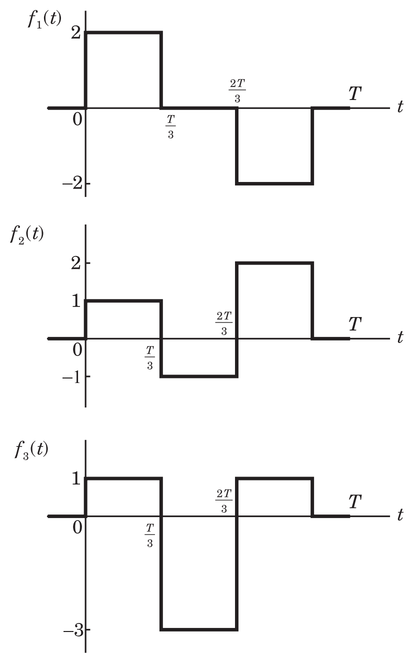
(B) $y = c_1 e^{-x} + c_2 e^{-2x} + \frac{1}{2}e^{3x}$

(C) $y = c_1 e^{-x} + c_2 e^{2x} + \frac{1}{2}e^{3x}$

(D) $y = c_1 e^x + \frac{1}{2}e^{-3x}$

SOL 1.46 Option ( ) is correct.

MCQ 1.47 Three functions $f_1(t), f_2(t)$ and $f_3(t)$ which are zero outside the interval $[0,\ T]$ are shown in the figure. Which of the following statements is correct?



(A) $f_1(t)$ and $f_2(t)$ are orthogonal

(B) $f_1(t)$ and $f_3(t)$ are orthogonal

(C) $f_2(t)$ and $f_3(t)$ are orthogonal

D) $f_1(t)$ and $f_2(t)$ are orthonormal

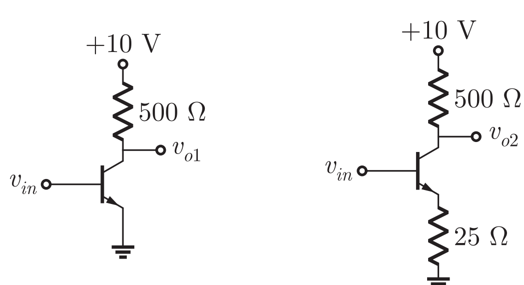
SOL 1.47 Option ( ) is correct.

Common Data Questions

Common Data For Question 48 and 49:

The transistor in following amplifiers circuits has parameters

$$\beta = 100,\ r_\pi = 2.5\ \text{k}\Omega$$



MCQ 1.48 If the input impedances of the two circuits are given as R_1 and R_2 respectively then

(A) $R_1 = 2.5\ \text{k}\Omega,\ R_2 = 2.5\ \text{k}\Omega$

(B) $R_1 = 2.5\ \text{k}\Omega,\ R_2 = 5\ \text{k}\Omega$

(C) $R_1 = 500\ \text{k}\Omega,\ R_2 = 50\Omega$

(D) $R_1 = 50\Omega,\ R_2 = 500\Omega$

SOL 1.48 Option (B) is correct.

For CE configuration given in figure, input impedances calculated in previous question as

$$r_\pi = R_1 = 2.5\ \text{k}\Omega$$

$$R_2 = [r_\pi + (1+\beta)R_E] = r_\pi + \beta R_E \qquad (\because \beta >> 1)$$

$$= 2.5 + 100 \times 25 = 5\ \text{k}\Omega$$

MCQ 1.49 Ratio of voltage gain $\frac{A_{v_1}}{A_{v_2}}$ for the two circuits is

(A) 2 (B) 0.5

(C) 4 (D) 0.5

SOL 1.49 Option (A) is correct.

As calculated in previous question

$$A_{v1} = -g_m R_C \qquad \text{(without emitter resistance)}$$

$$A_{v_2} = -\frac{g_m R_C}{[1 + (\frac{1}{r_\pi} + g_m)] R_E} \qquad \text{(with emitter resistance)}$$

$$\frac{A_{v1}}{A_{v2}} = 1 + \left(\frac{1}{r_\pi} + g_m\right) R_E$$

$$= 1 + \left(\frac{g_m}{\beta} + g_m\right) R_E \qquad (\therefore \beta = g_m r_\pi)$$

$$= 1 + g_m\left(\frac{1}{\beta} + 1\right) R_E \qquad (\because \beta >> 1)$$

So, $$\frac{A_{v_1}}{A_{v_2}} \approx 1 + g_m R_E = 1 + \frac{\beta}{r_\pi} \cdot R_E$$

$$= 1 + \frac{100 \times 25}{2.5 \times 10^3} = 2$$

Common Data For Question 50 and 51:

A Boolean function $Z = A\overline{B}C$ is to be implement using NAND and NOR gate. Each gate has unit cost. Only A, B and C are available.

MCQ 1.50 If both gate are available then minimum cost is

(A) 2 units (B) 3 units

(C) 4 units (D) 6 units

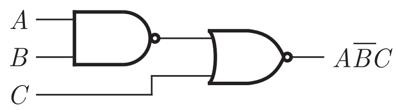
SOL 1.50 Option (A) is correct.

$$Z = A\overline{B}C = \overline{\overline{AC\overline{B}}} = \overline{\overline{AC} + B}$$

If $\overline{AC} = D$

Then $Z = \overline{D + B}$

Therefore one NAND and one NOR gate is required and cost will be 2 unit.



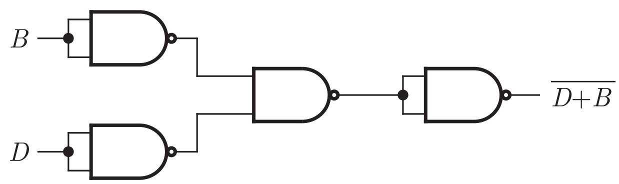
MCQ 1.51 If only NAND gate are available then minimum cost is

(A) 2 units (B) 3 units

(C) 4 units (D) 6 units

SOL 1.51 Option (C) is correct.

The circuit is as shown below



Thus 4 NAND is required to made a NOR

Linked Answer Questions

Statement For Linked Answer Questions 52 and 53:

A single-phase 60 Hz power line is supported on a horizontal cross-arm. The spacing between conductors is 2.5 m. A telephone line is also supported on a horizontal cross-arm in the same horizontal plane as the power line. The conductors of the telephone line are of solid copper spaced 0.6 m between centres. The distance between the nearest conductors of the two lines is 20 m. A current of 150 A is flowing over the power line.

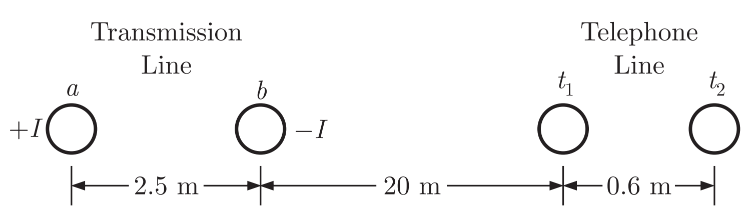
MCQ 1.52 The value of mutual inductance between the circuit is

(A) 0.01 mH/km (B) 0.00067 mH/km

(C) 0.0046 mH/km (D) 0.00033 mH/km

SOL 1.52 Option (B) is correct.

The conductors of both transmission lines are arranged in following diagram



Flux linkage of conductor t_1 due to flux between conductor a and b

$$\lambda_{t1} = 2 \times 10^{-7} I \ln \frac{D_2}{D_1}$$
$$= 2 \times 10^{-7} \times 150 \ln \frac{20}{22.5}$$
$$= -0.353 \times 10^{-5} \text{ Wb-T/m}$$

Flux linkage of conductor t_2 due to flux between conductor a and b

$$\lambda_{t2} = 2 \times 10^{-7} \times 150 \ln \frac{20.6}{23.1}$$
$$= -3.43 \times 10^{-5} \text{ Wb-T/m}$$

Resultant flux linkage

$$\lambda_t = \lambda_{t1} - \lambda_{t2} = -0.01 \times 10^{-5} \text{ Wb-T/m}$$

Mutual inductance

$$L = (0.01 \times 10^{-5}/150) \times 10^3 \times 10^3 \text{ mH/km}$$
$$= 0.00067 \text{ mH/km}$$

MCQ 1.53 What is the value of voltage per kilometer induced in the telephone line ?

(A) 0.01729 V/km (B) 0.04552 V/km

(C) 0.03768 V/km (D) 0.0314 V/km

SOL 1.53 Option (D) is correct.

Induced voltage in telephone line

$$= 377 \times 0.01 \times 10^{-5} \times 10^3$$
$$= 0.0377 \text{ V/km}$$

Statement for Linked Answer Question 54 and 55:

A 230 V, 25 hp dc shunt motor draws an armature current of 90 A at full rated load. The armature resistance is 0.2 Ω and that shunt field resistance is 216 Ω.

MCQ 1.54 At full-load the rotational loss will be

(A) 19 kW (B) 430 W

(C) 3670 W (D) 2294 W

SOL 1.54 Option (B) is correct.

MCQ 1.55 The motor efficiency will be

(A) 91% (B) 76%

(C) 63% (D) 89%

SOL 1.55 Option (D) is correct.

Q.56 TO Q.60 CARRY ONE MARK EACH

MCQ 1.56 Which one of the following is the Antonym of the word SILENCE ?

(A) attune (B) babble

(C) achromatic (D) aurora

SOL 1.56 Correct option is (B)

MCQ 1.57 Which one of the following is the synonym of the word ADMONISH ?

(A) warn (B) escape

(C) worship (D) distribute

SOL 1.57 Correct option is (A)

MCQ 1.58 One of the four words given in the four options does not fit the set of words. The odd word from the group, is

(A) Swim (B) Swill

(C) Ablution (D) Bathe

SOL 1.58 Correct option is (A)

MCQ 1.59 A pair of CAPITALIZED words shown below has four pairs of words. The pair of words which best expresses the relationship similar to that expressed in the capitalized pair, is

NUTS : BOLTS

(A) Nitty : Gritty (B) Bare : Feet

(C) Naked : Surprise (D) Hard : Soft

SOL 1.59 Correct option is (A)

MCQ 1.60 In the following sentence, a part of the sentence is left unfinished. Four different ways of completing the sentence are indicated. The best alternative among the four, is

In pursuance of their decision of resist what they saw as anti-labour policies, the company employee's union launched agitation to..............

(A) Show their virility

(B) reaffirm their commitment of the company

(C) bring down the government

(D) demonstrate their strength.

SOL 1.60 Correct option is (D)

Q.61 TO Q.65 CARRY TWO MARK EACH

MCQ 1.61 Let $N = 1421 \times 1423 \times 1425$. What is the remainder when N is divided by 12 ?

(A) 0 (B) 9

(C) 3 (D) 6

SOL 1.61 Correct option is (C)

When we divide N by 12, the reminder for the expression will be the same as the reminder for $5 \times 7 \times 9$. Now 35×9, when divided by 12, we get the reminder $11 \times 9 = 99$.Finally divided it by 12, we get the reminder of N as 3.

MCQ 1.62 There are 60 students in a class. These students are divided into three groups A, B, and C of 15, 20 and 25 students each. The groups A and C are combined to form group D. What is the average weight of the students in group D ?

(A) more than the average weight of A

(B) more than the average weight of C

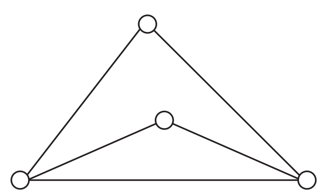
(C) less than the average weight of C

(D) cannot be determined

SOL 1.62 Correct option is (D)

There is no indication of weights of the students in the question i.e. groups A, B and C. Therefore it is not possible to find the relation between the groups A, B, C and D.

MCQ 1.63 Four cities are connected by a road network as shown in the figure. In how many ways can you start from any city and come back to it without travelling on the same road more than once ?



(A) 8 (B) 12

(C) 16 (D) 20

SOL 1.63 Correct option is (B)

Consider a man starts from a city. The condition is that there is no repetition of path during his journey. So two paths are restrict for one pass only. Thus the total number of possible cases

$$= {}^4P_2 = 12$$

MCQ 1.64 The roots of the equation $ax^2 + 3x + 6 = 0$ will be reciprocal to each other if the value of a is

(A) 3 (B) 4

(C) 5 (D) 6

SOL 1.64 Correct option is (D)

We have $ax^2 + 3x + 6 = 0$

The roots of this quadratic equation is

$$x = \frac{-3 \pm \sqrt{9 - 24a}}{2a}$$

It is given that the roots are reciprocal to each other. Thus

$$\frac{-3 + \sqrt{9 - 24a}}{2a} = \frac{2a}{-3 - \sqrt{9 - 24a}}$$

or $$4a^2 = (-3)^2 - (9 - 24a)$$

or $$a = 0, 6$$

But zero is not a possible root because the reciprocal of zero becomes infinity. Thus the correct root is 6.

MCQ 1.65 A man starting at a point walks one km east, then two km north, then one km east then one km north, then one km east and then one km north to arrive at the destination. What is the shortest distance from the starting point to the destination ?

(A) $2\sqrt{2}$ km (B) 7 km

(C) $3\sqrt{2}$ km (D) 5 km

SOL 1.65 Correct option is (D)

Let the man starting from point O and reaches his destination at point A. The shortest distance between O and his destination is

$$OA = \sqrt{(3)^2 + (4)^2} = 5\text{ km}$$

Answer Key

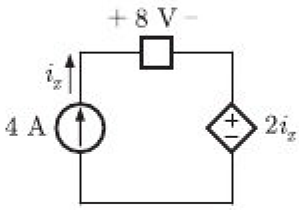
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
B	B	C	A	D	C	C	A	C	B	C	A	D	A	C
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	28.	29.	30.
B	B	B	D	B	D	B	A	D	B	C	D	C	C	B
31.	32.	33.	34.	35.	36.	37.	38.	39.	40.	41.	42.	43.	44.	45.
C	C	C	C	A	A	B	A	B	D	B	A	B	C	B
46.	47.	48.	49.	50.	51.	52.	53.	54.	55.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

END OF THE QUESTION PAPER

Practice Paper EE_C

Q. 1- Q. 25 carry one mark each.

MCQ 1.1 For the circuit shown in figure the dependent source



(A) supplies 16 W

(B) absorbs 16 W

(C) supplies 32 W

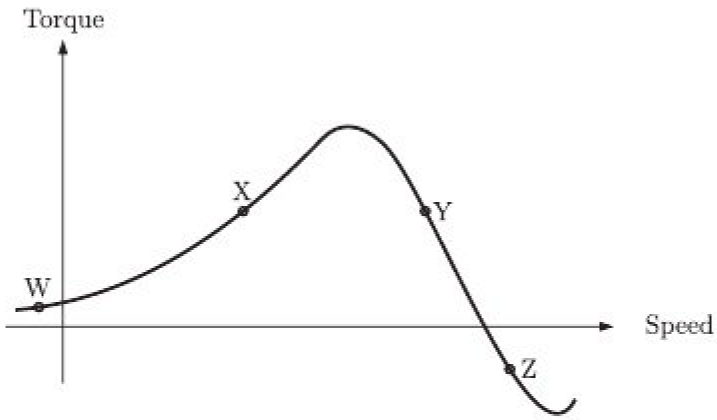
(D) absorbs 32 W

SOL 1.1 Option (D) is correct.

$$\text{Power } P = vi = 2i_z \times i_z = 2i_z^2$$

$$i_z = 4 \text{ A}, \ P = 32 \text{ W (absorb)}$$

MCQ 1.2 Which of the points on the torque-speed curve of the induction motor represents operation at a slip greater than 1 ?



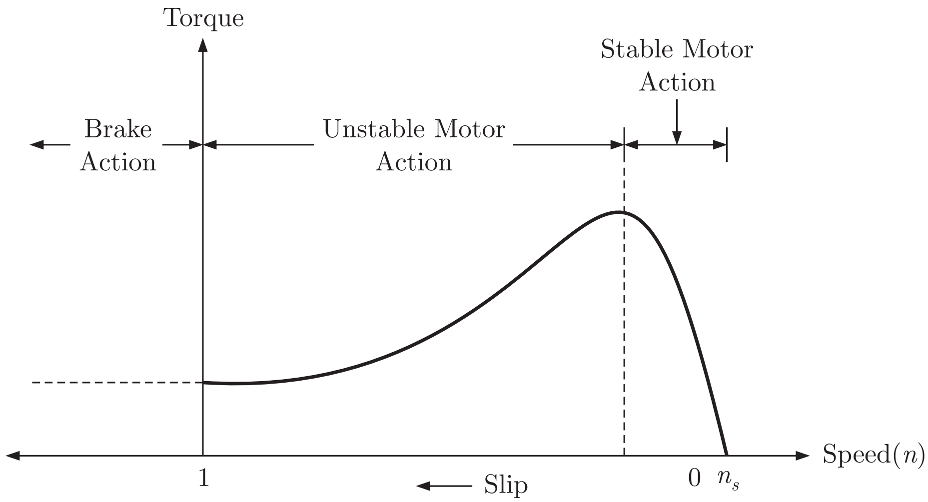
(A) W

(B) X

(C) Y (D) Z

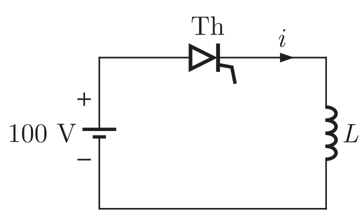
SOL 1.2 Option (A) is correct.

Torque speed curve of a 3-phase induction motor is shown below



To achieve a slip greater than 1, the rotor must be coupled to a prime mover and driven in a direction opposite to that of stator rotating field. Which is shown by point W in the figure.

MCQ 1.3 A thyristor circuit is shown in the figure. The latching current of the thyristor is 80 mA. The minimum width of the gate pulse to trigger the thyristor is



(A) 8 msec (B) 4 msec

(C) 1.25 msec (D) 2.5 msec

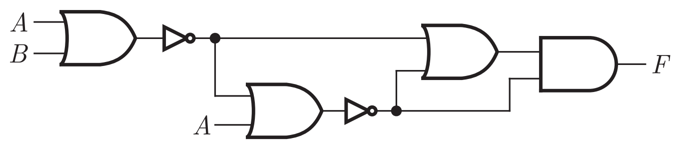
SOL 1.3 Option (A) is correct.

$\therefore$ Circuit turn off time for main thyristor

$$t_c = C\frac{V_s}{I_0}$$

$$= 40 \times 10^{-6}\frac{230}{120} = 76.67\,\mu\text{s}$$

MCQ 1.4 In the following circuit For which of the following input combination output will be ‘1’ ?



(A) $A = 0, B = 0$ (B) $A = 1, B = 0$

(C) $A = 0, B = 1$ (D) Either $A = 1$ or $B = 1$

SOL 1.4 Option (C) is correct.

Boolean expression for the given circuit

$$F = [(\overline{A+B}) + \overline{(A + (\overline{A+B}))}]\,\overline{(A + \overline{(A+B)})}$$

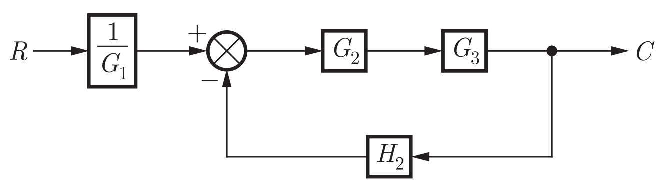
Let $\overline{A+B} = X$ and $\overline{(A + \overline{(A+B)})} = Y$

Then $F = (X + Y)\,Y = XY + Y = Y$

$$F = \overline{(A + \overline{(A+B)})} = \overline{A}(A+B) = \overline{A}B$$

So, $F = 1$ for $A = 0$, $B = 1$

MCQ 1.5 A feedback control system is shown in figure. The transfer function for this system is



(A) $\dfrac{G_1 G_2}{1 + H_1 G_1 G_2 G_3}$ (B) $\dfrac{G_2 G_3}{G_1(1 + H_1 G_2 G_3)}$

(C) $\dfrac{G_2 G_3}{1 + H_1 G_1 G_2 G_3}$ (D) $\dfrac{G_2 G_3}{G_1(1 + H_1 G_2 G_3)}$

SOL 1.5 Option (B) is correct.

Multiply G_2 and G_3 and apply feedback formula and then again multiply with $\dfrac{1}{G_1}$.

$$T(s) = \frac{G_2 G_3}{G_1(1 + G_2 G_3 H_1)}$$

MCQ 1.6 If the prime mover of an alternator supplying load to an infinite bus is suddenly shut down, then it will

(a) stop

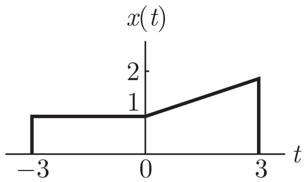
(b) continue to run as an alternator

(c) continue to run as synchronous motor running in the reverse direction

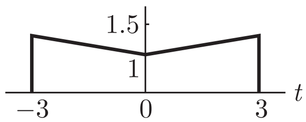
(d) continue to run as a synchronous motor running in the same direction.

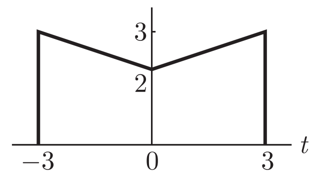
SOL 1.6 Option ( ) is correct.

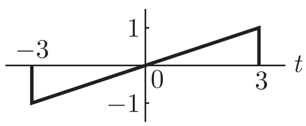
MCQ 1.7 Consider the function $x(t)$ shown in figure

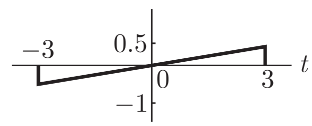


The even part of $x(t)$ is

(A) 

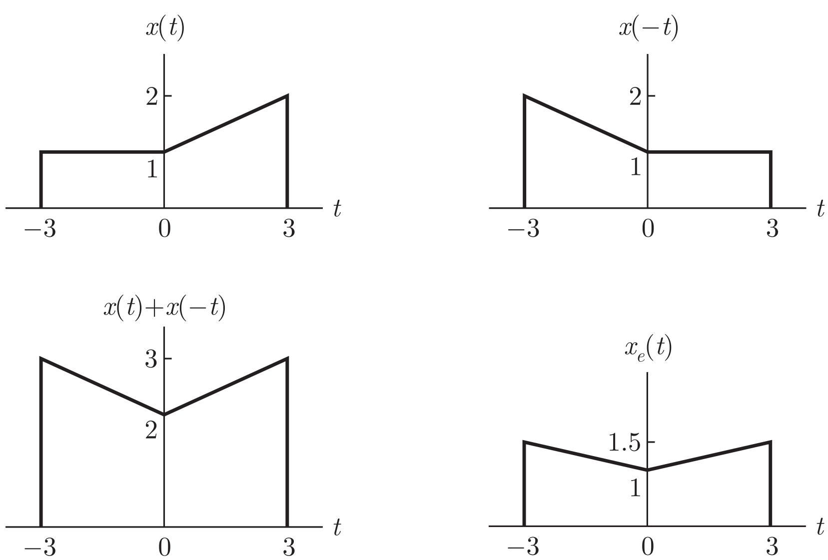
(B) 

(C) 

(D) 

SOL 1.7 Option (A) is correct.

The figure is as shown below



MCQ 1.8 The increased load demand in a synchronous motor is met by

(A) reduction in speed

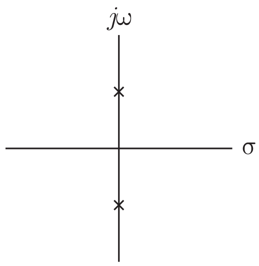
(B) increase in speed

(C) decrease in stator current

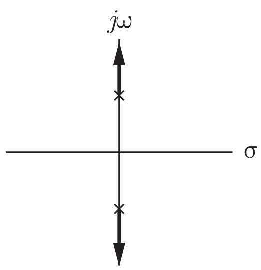
(D) relative shift between stator and rotor poles

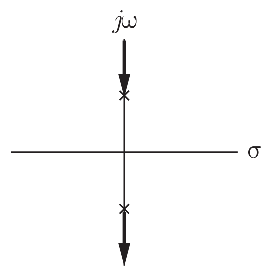
SOL 1.8 Option ( ) is correct.

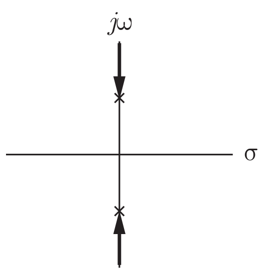
MCQ 1.9 A open-loop pole-zero plot is shown in figure

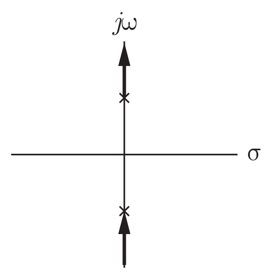


The general shape of the root locus is

(A) 

(B) 

(C) 

(D) 

SOL 1.9 Option (A) is correct.
The following sketch are not root locus due to the given reason.
(B) On real axis root locus exist to the left of even number of finite poles and zero.
(C) Root locus does not start from poles and does not end on origin.
(D) On real axis root locus exist to the left of even number of finite pole and zero.

MCQ 1.10 A power system is supplied by three plants P, Q and R, all of which are operating on economic dispatch. At the bus of Plant P the incremental cost is 10.0 Rs. per MWh, at Plant Q it is 9.0 Rs. per MWh and at Plant R it is 11.0 Rs. per MWh. The plants which has the highest and lowest penalty factor are respectively ?
(A) P and R
(B) Q and R
(C) Q and P
(D) R and P

SOL 1.10 Option ( ) is correct.

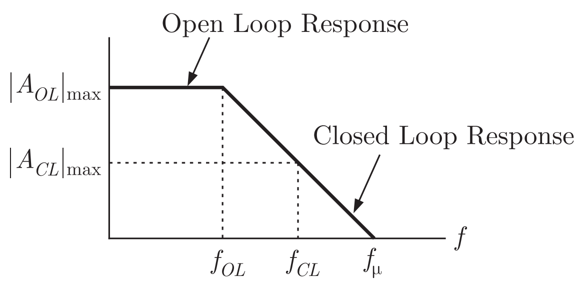
MCQ 1.11 For a logic family if
V_{OH} is minimum output high level voltage
V_{OL} is maximum output low level voltage
V_{IH} is minimum acceptable input high level voltage
V_{IL} is maximum acceptable input low level voltage

The correct relationship among these is
(A) $V_{IH} > V_{OH} > V_{IL} > V_{OL}$
(B) $V_{OH} > V_{IH} > V_{IL} > V_{OL}$
(C) $V_{IH} > V_{OH} > V_{OL} > V_{IL}$
(D) $V_{OH} > V_{IH} > V_{OL} > V_{IL}$

SOL 1.11 Option ( ) is correct.

MCQ 1.12 An audio amplifier is designed to have a small signal bandwidth of 20 kHz. The open loop low-frequency voltage gain of the op-amp is 10^5 and unity gain bandwidth is 1 MHz. What is the maximum closed-loop voltage gain for this amplifier
(A) 500
(B) 5×10^6
(C) 2×10^6
(D) 50

SOL 1.12 Option (D) is correct.
Bode plot for the frequency response of op-amp is given following



Here, $f_{CL} \times |A_{CL}|_{max} = f_{\mu} \times 1$
$f_{CL} \rightarrow$ close loop Band-width
$f_{\mu} \rightarrow$ unity gain bandwidth
$|A_{CL}|_{max} \rightarrow$ maximum closed loop gain

$$(20 \times 10^3)|A_{CL}|_{max} = 1 \times 10^6$$

$$|A_{CL}|_{max} = 50$$

MCQ 1.13 If a voltage of 0.6972 V is being measured by a $4\frac{1}{2}$ digit voltmeter, then which of the following statement is true ?
(C) The voltmeter will display 0.6973 on a 1 V range
(A) The voltmeter will display 0.697 on a 10 V range.
(B) The voltmeter will display 0.697 on a 1 V range
(D) both (A) and (B)

SOL 1.13 Option (D) is correct.

Resolution $R_s = 1/10^n$ $\therefore n = 4$

$= 1/10^4 = 0.001$

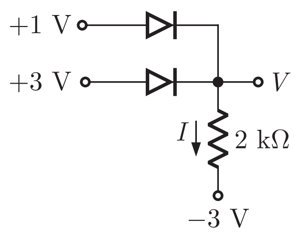
Resolution on 1 V range $= 1\text{ V} \times 0.0001 = 0.0001$

So, any reading up to the 4th decimal can be displayed. Thus 0.6973 will be displayed as 0.6973.

Resolution on 10 V range $= 10\text{ V} \times 0.0001 = 0.001\text{ V}$

So, decimals up to the 3rd decimal place can be displayed. Therefore on a 10 V range, the reading will be 0.697 instead of 0.6973.

MCQ 1.14 For the circuit shown below cutin voltage of diode is $V_\gamma = 0.7$. What is the value of V and I ?



(A) 2.3 V, 2.65 mA (B) 2.65 V, 2.3 mA

(C) 2 V, 0 mA (D) 0 V, 2.3 mA

SOL 1.14 Option (A) is correct.

$$v = 3 - 0.7 = 2.3\text{ V}$$

$$i = \frac{2.3(-3)}{2} = 2.65\text{ mA}$$

MCQ 1.15 If the iron core of a transformer is replaced by an air core, then the hysteresis losses in the transformer will

(A) increase (B) decrease

(C) remain unchanged (D) become zero

SOL 1.15 Option ( ) is correct.

MCQ 1.16 The expected value of the voltage across a resistor is 80 V, and the measured value is 79 V. What is the percentage error and relative accuracy of the measurement ?

(A) 1.265%, 98.735% (B) 1%, 99%

(C) 2.625%, 97.375% (D) 1.25%, 98.75%

SOL 1.16 Option (D) is correct.

$$\text{Absolute error} = \frac{\text{expected value} - \text{measured value}}{\text{expected value}}$$

$$= \frac{80 - 79}{80} \times 100 = 1.25\%$$

$$\text{Relative Accuracy} = \frac{\text{measured value}}{\text{expected value}} \times 100$$

$$\text{or Relative Accuracy} = 100 - \%\text{absolute error}$$
$$= 100\% - 1.25\% = 98.75\%$$

MCQ 1.17 If the fault current is 2,000 A, the relay setting is 50% and CT ratio is 400/5, the plug setting multiplier will be

(A) 25 (B) 15

(C) 50 (D) 10

SOL 1.17 Option ( ) is correct.

MCQ 1.18 In case of a split phase motor, the phase shift between current in two windings is around

(A) 30° (B) 70°

(C) 90° (D) 120°

SOL 1.18 Option ( ) is correct.

MCQ 1.19 Mho relay is normally used for the protection of

(A) short transmission lines.

(B) medium transmission lines.

(C) long transmission lines.

(D) no length criterion.

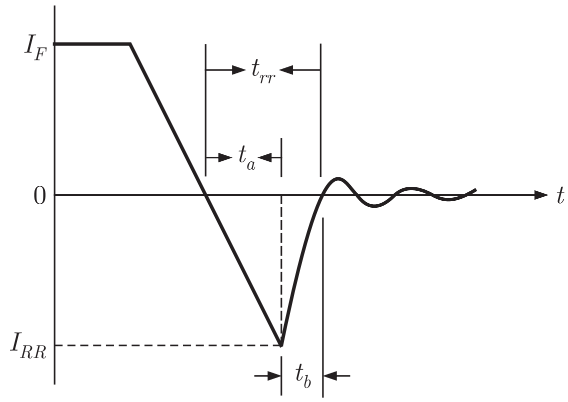
SOL 1.19 Option (C) is correct.
Mho relay is suitable for long EHV lines as its threshold characteristic is quite compact enclosing fault area completely.

MCQ 1.20 A power diode is in the forward conduction mode and the forward current is now decreased. The reverse recovery time of the diode is t_r and the rate of fall of the diode current is di/dt. What is the stored charge ?

(A) $\left(\frac{di}{dt}\right)t_r$ (B) $\frac{1}{2}\left(\frac{di}{dt}\right)t_r^2$

(C) $\left(\frac{di}{dt}\right)t_r^2$ (D) $\frac{1}{2}\left(\frac{di}{dt}\right)t_r$

SOL 1.20 Option (B) is correct.
The reverse recovery characteristic of a power diode is shown below. In the figure reverse recovery time t_{rr} composed of t_a and t_b. t_a is the time between zero crossing and peak reverse current I_{RR} and $t_b$is measured from reverse peak I_{RR} value to $0.25I_{RR}$.



If the characteristics are assumed to be triangular(i.e. abrupt recovery) than from the figure charge stored is

$$Q_R = \text{area}\,\Delta\,\text{ABC} = \frac{1}{2} I_{RR} t_{rr} \qquad ...(1)$$

$$I_{RR} = t_a \frac{di}{dt}$$

$t_a \backsimeq t_{rr}$, than $$I_{RR} = t_{rr} \frac{di}{dt} \qquad ...(2)$$

from eq(1) and (2) $$Q_R = \frac{1}{2}\left(\frac{di}{dt}\right) t_{rr}^2$$

MCQ 1.21 If A and B are square matrices of order 4×4 such that $A = 5\text{B}$ and $|A| = \alpha.|B|$, then α is

(A) 5 (B) 25

(C) 625 (D) None of these

SOL 1.21 Option (C) is correct.

If k is a constant and $\mathbf{A}$ is a square matrix of order $n \times n$ then $|k\mathbf{A}| - k^n|\mathbf{A}|$.

$$\mathbf{A} = 5\mathbf{B} \Rightarrow |\mathbf{A}| = |5\mathbf{B}| = 5^4|\mathbf{B}| = 625|\mathbf{B}|$$

$\Rightarrow$ $$\alpha = 625$$

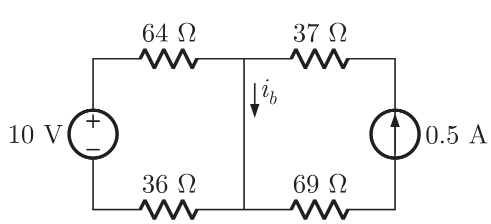
MCQ 1.22 An oriented-graph has 'n' nodes and 'b' branches. The dimension of incident matrix is

(A) $(n-1) \times b$ (B) $n \times (b-1)$

(C) $n \times b$ (D) $(n-1) \times (b-1)$

SOL 1.22 Option ( ) is correct.

MCQ 1.23 In the following circuit the current i_b is



(A) 0.6 A (B) 0.5 A
(C) 0.4 A (D) 0.3 A

SOL 1.23 Option (A) is correct.

$$i_b = \frac{10}{64+36} + 0.5 = 0.6 \text{ A}$$

MCQ 1.24 The z transform of a signal $\left(\frac{1}{4}\right)^4 u[-n]$ is

(A) $\frac{4z}{4z-1}, |z| > \frac{1}{4}$ (B) $\frac{4z}{4z-1}, |z| < \frac{1}{4}$

(C) $\frac{1}{1-4z}, |z| > \frac{1}{4}$ (D) $\frac{1}{1-4z}, |z| < \frac{1}{4}$

SOL 1.24 Option ( ) is correct.

MCQ 1.25 In a clockwise rotating loaded d.c. generator, brushes have to be shifted
(A) clockwise
(B) anti-clockwise
(C) either clockwise or anti-clockwise
(D) none of the above

SOL 1.25 Option ( ) is correct.

Q. 26- Q. 55 carry two mark each.

MCQ 1.26 Two signals $x_1(t)$ and $x_2(t)$ are given as

$$x_1(t) = 6\sin c(100t)\cos(200\pi t)$$

$$x_2(t) = 10\sin c^2(100t)$$

If Nyquist sampling rate for $x_1(t)$ and $x_2(t)$ are N_1 and N_2 respectively, the ratio N_1/N_2 is

(A) $\frac{2}{3}$ (B) 1

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

SOL 1.26 Option (C) is correct.

$$x_1(t) = 6\sin c(100t)\cos(200\pi t)$$

$X_1(f)$ is convolution of two signals whose spectrum covers $f = \pm 50$ Hz and ± 100 Hz. So convolution extends over $f = 150$ Hz and sampling rate $N_1 = 2f = 300$ Hz

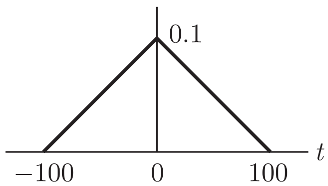
$$x_2(t) = 10\sin c^2(100t)$$

Taking Fourier transform

$$x_2(f) = 0.1\text{tri}\left(\frac{f}{100}\right)$$

$$B = 100 \text{ Hz}$$

Sampling rate $N_2 = 2B = 200$ Hz



$$\frac{N_1}{N_2} = \frac{300}{200} = \frac{3}{2}$$

MCQ 1.27 A three-phase 1500 kVA, 11 kV star connected alternator has armature resistance and synchronous reactance of 1.2 Ω/phase and 24 Ω.phase respectively. What is the percentage regulation for a load of 1200 kW at unity power factors ?

(A) 1.18% (B) 23.83%

(C) 3.95% (D) 17.62%

SOL 1.27 Option (C) is correct.

$$I_a = \frac{1200 \times 10^3}{\sqrt{3} \times 11 \times 10^3 \times 1} = 62.98 \text{ A}$$

$$V_t = \frac{11 \times 10^3}{\sqrt{3}} = 6350.8 \text{ V}$$

$$E_a = \sqrt{(V_t \cos\phi + I_a R_a)^2 + (V_t \sin\phi + I_a X_s)^2}$$

For unity pf, $\cos\phi = 1, \sin\phi = 0$

So $E_a = \sqrt{(6350.8 \times 1 + 62.98 \times 1.2)^2 + (6350.8 \times 0 + 62.98 \times 24)^2}$

$= 6601.74$ V

$$\text{Regulation} = \frac{E_a - V_t}{V_t} \times 100$$

$$= \frac{6601.74 - 6350.8}{6350.8} \times 100 = 3.95\%$$

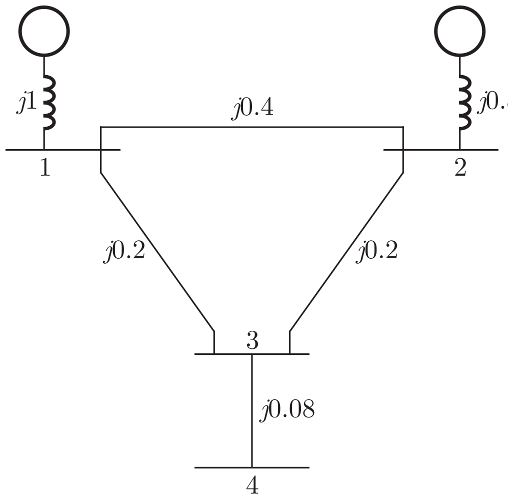
MCQ 1.28 A voltage of 230 V is applied to the armature of a dc motor results in a full-load armature current of 205 A. The armature resistance is 0.2 Ω . If the rotational losses are 1445 W at full-load speed of 1750 rpm, torque will be approximately

(A) 203 N-m (B) 295 N-m

(C) 219 N-m (D) 240 N-m

SOL 1.28 Option ( ) is correct.

MCQ 1.29 The impedance diagram of a power system is shown in figure. The bus admittance matrix Y_{BUS} is



(A) $Y_{BUS} = j\begin{bmatrix} -8.5 & 2.5 & 5.0 & 0 \\ 2.5 & -8.75 & 5.0 & 0 \\ 5.0 & 5.0 & -22.5 & 12.5 \\ 0 & 0 & 12.5 & -12.5 \end{bmatrix} S$

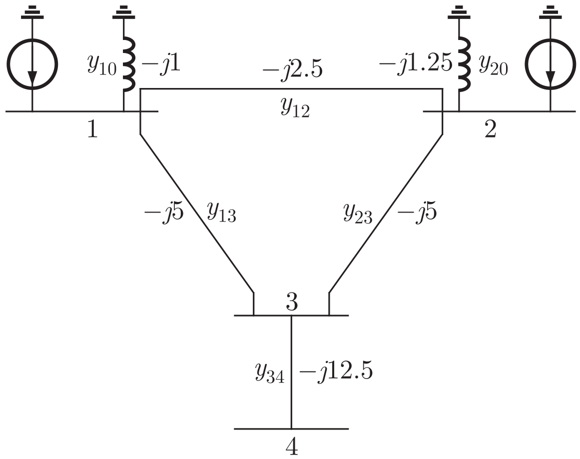
(B) $Y_{BUS} = j\begin{bmatrix} 1.6 & 0.4 & 0.2 & 0 \\ 0.4 & 1.4 & 0.2 & 0 \\ 0.2 & 0.2 & 1.2 & 0.8 \\ 0 & 0 & 0.8 & 0.8 \end{bmatrix} S$

(C) $Y_{BUS} = j\begin{bmatrix} 8.5 & 2.5 & 5.0 & 0 \\ 2.5 & 8.75 & -5.0 & 0 \\ 5.0 & -5.0 & 22.5 & 12.5 \\ 0 & 0 & 12.5 & 12.5 \end{bmatrix} S$

(D) $Y_{BUS} = j\begin{bmatrix} -1.6 & 0.4 & 0.2 & 0 \\ 0.4 & -1.4 & 0.2 & 0 \\ 0.2 & 0.2 & -1.2 & 0.8 \\ 0 & 0 & 0.8 & -0.8 \end{bmatrix} S$

SOL 1.29 Option (A) is correct.

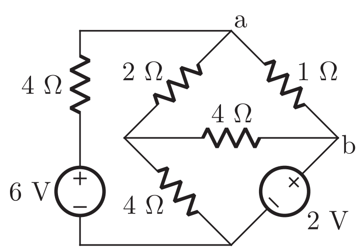
The admittance diagram for the system is shown below:



$$Y_{BUS} = \begin{bmatrix} Y_{11} & Y_{12} & Y_{13} & Y_{14} \\ Y_{21} & Y_{22} & Y_{23} & Y_{24} \\ Y_{31} & Y_{32} & Y_{33} & Y_{34} \\ Y_{41} & Y_{42} & Y_{43} & Y_{44} \end{bmatrix} = j\begin{bmatrix} -8.5 & 2.5 & 5.0 & 0 \\ 2.5 & -8.75 & 5.0 & 0 \\ 5.0 & 5.0 & -22.5 & 12.5 \\ 0 & 0 & 12.5 & -12.5 \end{bmatrix} \text{S}$$

Where
$$Y_{11} = y_{10} + y_{12} + y_{13}; \quad Y_{22} = y_{20} + y_{12} + y_{23} + y_{24}$$
$$Y_{33} = y_{30} + y_{13} + y_{23} + y_{34}; \quad Y_{44} = y_{40} + y_{24} + y_{34}$$
$$Y_{12} = Y_{21} = -y_{12}; \quad Y_{13} = Y_{31} = -y_{13}$$
$$Y_{23} = Y_{32} = -y_{23}$$
and
$$Y_{34} = Y_{43} = -y_{34}; \quad Y_{24} = Y_{42} = -y_{24}$$
$$Y_{14} = Y_{14} = -y_{14}$$

MCQ 1.30 Find out Norton's equivalent across terminal a-b of the following circuit

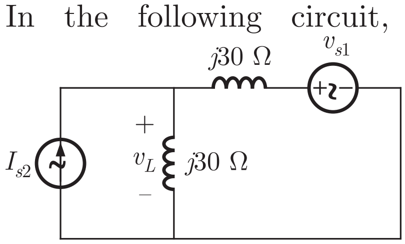


(A) 1.25 A, 4 Ω (B) 0.75 A, 2 Ω

(C) 0.75 A, 4 Ω (D) 1 A, 2 Ω

SOL 1.30 Option ( ) is correct.

MCQ 1.31 In the following circuit, if $v_L = \alpha V_{s_1} + \beta I_{s_2}$, then the value of α, β are



(A) $\alpha = 15j, \beta = 0.5$ (B) $\alpha = 0.5, \beta = 15j$

(C) $\alpha = 1, \beta = 30j$ (D) $\alpha = 0.5, \beta = 15j$

SOL 1.31 Option ( ) is correct.

MCQ 1.32 In a dc motor running at 2000 rpm, the hysteresis and eddy current losses are 500 W and 200 W respectively. If the flux remains constant, the speed at which the total iron losses are halved will be nearly equal to

(A) 1071 rpm (B) 2333 rpm

(C) 933 rpm (D) 2678 rpm

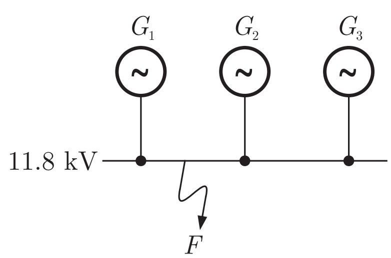
SOL 1.32 Option ( ) is correct.

MCQ 1.33 An 11.8 kV busbar is fed from three synchronous generators is shown in the figure. The generator specifications are as following

Generator G_1: 20 MVA, $X' = 0.08$ pu

Generator G_2: 60 MVA, $X' = 0.1$pu

Generator G_3: 20 MVA, $X' = 0.09$ pu



The voltage base is taken as 11.8 kV and the VA base as 60 MVA. If a three-phase symmetrical fault occurs on the busbars then the fault current is

(A) 1.07 kA (B) 90.75 kA

(C) 40.60 kA (D) 52.40 kA

SOL 1.33 Option (D) is correct.

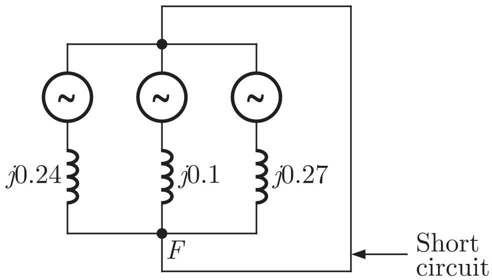
The transient reactance of the generators are

$$X_{G_1} = 0.08 \times \frac{60}{20} = 0.24 \text{ pu}$$

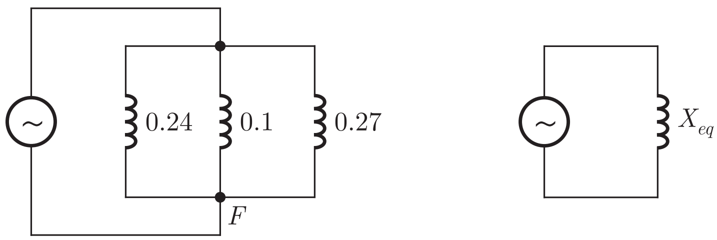
$$X_{G_2} = 0.1 \times \frac{60}{60} = 0.1 \text{ pu}$$

$$X_{G_3} = 0.09 \times \frac{60}{20} = 0.27 \text{ pu}$$

There values are shown in the equivalent circuit in the figure below.



As the generator e.m.f.s are assumed to be equal, one source may be used which is also shown in figure.



The equivalent reactance is

$$X_{eq} = \frac{1}{1/0.24 + 1/0.27 + 1/0.1} = 0.056\,\text{pu}$$

Therefore fault MVA

$$= \frac{60}{0.056} = 1071\,\text{MVA}$$

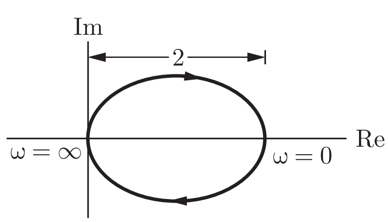
and fault current

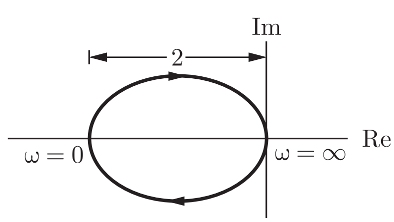
$$= \frac{1071 \times 10^6}{\sqrt{3} \times 1180} = 52402\,\text{A}$$

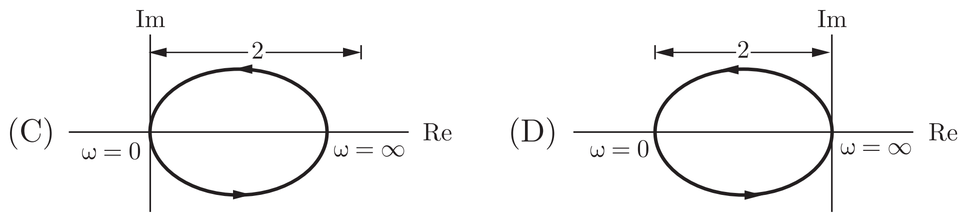
MCQ 1.34 The transfer function of an open-loop system is

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

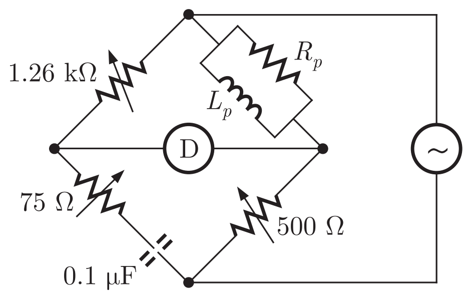
The Nyquist plot will be of the form

(A) 

(B) 



MCQ 1.35 The ac bridge shown in the figure is used to measure the quality factor of a coil which is represented by parallel combination of a resistance (R_p) and an inductor (L_p). The bridge is balanced at 100 Hz supply frequency. The quality factor of coil is



(A) 47.16 (B) 4.77
(C) 209.4 (D) 212.0

SOL 1.35 Option (D) is correct.
Bridge is balanced if

$$L_P = C_3R_1R_4 = 0.1\,\mu\text{F} \times 1.26\,\text{k}\Omega \times 500\,\Omega = 63\,\text{mH}$$

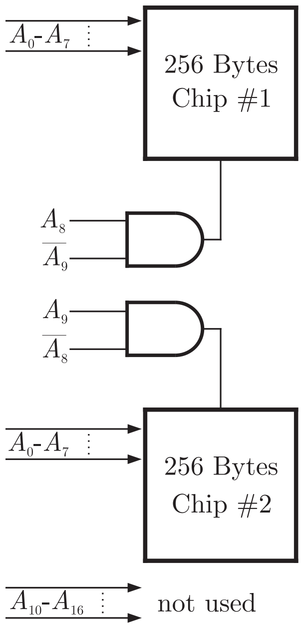
Similarly, at balance the unknown resistance

$$R_p = \frac{R_1R_4}{R_3} = \frac{1.26\,\text{k}\Omega \times 500\,\Omega}{75\,\Omega} = 8.4\,\text{k}\Omega$$

The coil is represented by parallel equivalent, so quality factor is

$$Q = \frac{R_p}{\omega L_P} = \frac{8.4\,\text{k}\Omega}{2\pi \times 100\,\text{Hz} \times 63\,\text{mH}} = 212$$

MCQ 1.36 What memory address range is NOT represents by chip # 1 and chip # 2 in the figure A_0 to A_{15} in this figure are the address lines and CS means chip select.

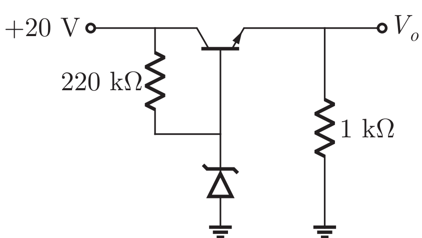


(A) 0100 - 02FF (B) 1500 - 16FF

(C) F900 - FAFF (D) F800 - F9FF

SOL 1.36 Option ( ) is correct.

MCQ 1.37 In the regulator circuit shown below $V_Z = 12$ V, $\beta = 50$, $V_{BE} = 0.7$ V. The Zener current is

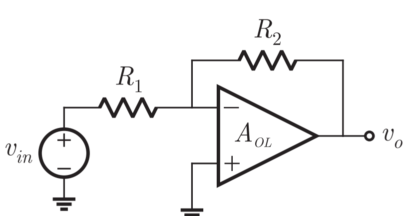


(A) 36.63 mA (B) 36.17 mA

(C) 49.32 mA (D) 49.78 mA

SOL 1.37 Option ( ) is correct.

MCQ 1.38 Consider an ideal op-amp circuit shown in following figure. If open loop gain of op-amp is A_{OL}, then closed loop voltage gain A_v is



(A) $\frac{-R_2}{R_1}\frac{1}{\left[1+\frac{1}{A_{OL}}\left(1+\frac{R_2}{R_1}\right)\right]}$

(B) $\frac{A_{OL}}{1+\frac{A_{OL}}{\left(1+\frac{R_2}{R_1}\right)}}$

(C) $\frac{-R_2}{R_1}\frac{1}{\left[1+A_{OL}\frac{R_2}{R_1}\right]}$

(D) $\frac{A_{OL}}{\left(1+\frac{R_2}{R_1}\right)}$

SOL 1.38 Option ( ) is correct.

MCQ 1.39 A single-phase, 230 V, 50 Hz ac mains fed fully controlled bridge rectifier is feeding a 200 V dc, 1500 rpm, 10 A separately excited dc motor with a ripple free continuos current under all operating conditions. The armature resistance is $1\,\Omega$ and motor torque is 15 Nm. What will the motor speed be at a firing angle of 30° ?

(A) 904 rpm

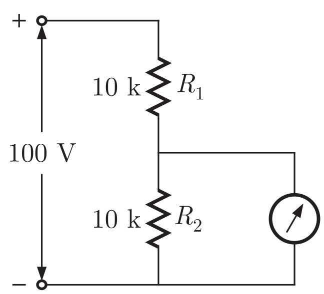
(B) 1428.78 rpm

(C) 1318.5 rpm

(D) 2955.54 rpm

SOL 1.39 Option ( ) is correct.

MCQ 1.40 In the circuit shown in figure, voltage across R_2 is measured by two different voltmeters P and Q having sensitivity of $1\,\text{k}\Omega/\text{V}$ and $20\,\text{k}\Omega/\text{V}$. Both the meters are used on 50 V scale, which of the following statement is true ?



(A) Voltmeter P will read more accurate than voltmeter Q

(B) Both the voltmeters read same voltage

(C) Voltmeter Q will read more accurate than voltmeter P

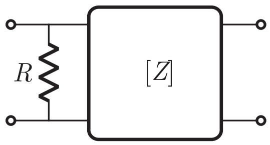
(D) none of above

SOL 1.40 Option ( ) is correct.

MCQ 1.41 The two-port network as shown in figure has z-parameter matrix as

$$[Z]=\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22}\end{bmatrix}$$

now a resistor R is connected across input terminal as shown in figure. What will be the modified parameter z'_{11} of the network is ?



(A) $z'_{11} = z_{11}$

(B) $z'_{11} = z_{11} + R$

(C) $z'_{11} = \dfrac{z_{11}}{\left(1 + \frac{z_{11}}{R}\right)}$

(D) $z'_{11} = \dfrac{z_{11} R}{z_{11} + R}$

SOL 1.41 Option ( ) is correct.

MCQ 1.42 An $X - Y$ flip-flop whose characteristic table is given below is to be implemented using a J-K flip-flop

X	Y	Q_{n+1}
0	0	1
0	1	Q_n
1	0	$\overline{Q}_n$
1	1	0

Where Q_n is the previous state and Q_{n+1} is the next state. This can be done by using

(A) $J = X, K = \overline{Y}$

(B) $J = \overline{X}, K = Y$

(C) $J = Y, K = \overline{X}$

(D) $J = \overline{Y}, K = X$

SOL 1.42 Option (D) is correct.

Let Q_n is the present state and Q_{n+1} is next state of given $X - Y$ flip-flop.

X	Y	Q_n	Q_{n+1}
0	0	0	1
0	0	1	1
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	0
1	1	0	0
1	1	0	0

Solving from K-map we get

Characteristic equation of $X - Y$ flip-flop is

$$Q_{n+1} = \overline{Y}\,\overline{Q}_n + \overline{X} Q_n$$

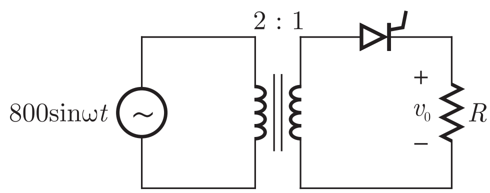
Characteristic equation of a $J-K$ flip-flop is given by

$$Q_{n+1} = J\overline{Q}_n + \overline{K}Q_n$$

By comparing

$J = \overline{Y}$, $K = X$

MCQ 1.43 A single phase half wave rectifier circuit is shown in the figure. The thyristor is fired at $30°$ in each positive half cycle. The values of average load voltage and the rms load voltage will respectively be



(A) 475.2 V, 190.9 V (B) 237.64 V, 194.2 V

(C) 118.8 V, 197.1 V (D) 237.6 V, 197.1 V

SOL 1.43 Option (C) is correct.

Peak value of secondary voltage

$$V_m = \frac{800}{2} = 400 \text{ V}$$

and $\alpha = 30°$

Average dc voltage is given by

$$V_{dc} = \frac{V_m}{2\pi}(1+\cos\alpha) = \frac{400}{2\pi}(1+\cos 30°) = 118.8 \text{ V}$$

RMS voltage

$$V_{rms} = V_m\left(\frac{\pi-\alpha}{4\pi} + \frac{\sin 2\alpha}{8\pi}\right)^{1/2}$$
$$= 400\left(\frac{\pi-30°}{4\pi} + \frac{\sin 60°}{8\pi}\right)^{1/2} = 197.1 \text{ V}$$

MCQ 1.44 The solution of the differential equation $(x-y^2)\,dx + 2xydy = 0$ is

(A) $ye^{2/x} = A$ (B) $xe^{y^2/x} = A$

(C) $xe^{x/y^2} = A$ (D) $ye^{x/y^2} = A$

SOL 1.44 Option ( ) is correct

MCQ 1.45 The probability that a man who is x years old will die in a year is p. Then amongest n persons $A_1, A_2,\ldots, A_n$ each x years old now, the probability that, A_1 will die in one year is

(A) $\frac{1}{n^2}$

(B) $1-(1-p)^n$

(C) $\frac{1}{n^2}[1-(1-p)^n]$

(D) $\frac{1}{n}[1-(1-p)^n]$

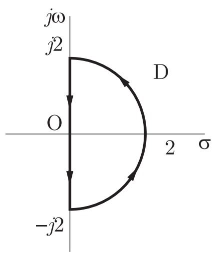
SOL 1.45 Option (D) is correct.

$P(\text{none dies}) = (1-p)(1-p)\dots n \text{ times} = (1-p)^n$

$P(\text{at least one dies}) = 1-(1-p)^n$

$P(A_1 \text{ dies}) = \frac{1}{n}\{1-(1-p)^n\}$

MCQ 1.46 If the semi-circular control D of radius 2 is as shown in the figure, then the value of the integral $\oint_D \frac{1}{(s^2-1)}ds$ is



(A) $j\pi$

(B) $-j\pi$

(C) $-\pi$

(D) π

SOL 1.46 Option ( ) is correct.

MCQ 1.47 Let, $A = \begin{bmatrix} 2 & -0.1 \\ 0 & 3 \end{bmatrix}$ and $A^{-1} = \begin{bmatrix} \frac{1}{2} & a \\ 0 & b \end{bmatrix}$. Then $(a+b) =$

(A) 7/20

(B) 3/20

(C) 19/60

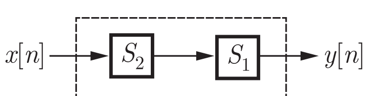
(D) 11/20

SOL 1.47 Option ( ) is correct.

Common Data Questions

Common Data For Questions 48 and 49

Two discrete time systems S_1 and S_2 are connected in cascade to form a new system as shown in figure below



MCQ 1.48 Consider the following statements

1. If S_1 and S_2 are linear, the S is linear
2. If S_1 and S_2 are nonlinear, then S is nonlinear

3. If S_1 and S_2 are causal, then S is causal

4. If S_1 and S_2 are time invariant, then S is time invariant

True statements are

(A) 1, 2, 3 (B) 2, 3, 4

(C) 1, 3, 4 (D) All

SOL 1.48 Option (C) is correct.

Only statement (b) is false. For example

$$S_1 : y[n] = x[n] + b, \text{ and}$$
$$S_2 : y[n] = x[n] - b,$$

where $b \neq 0$

$$S\{x[n]\} = S_2\{S_1\{x[n]\}\} = S_2\{x[n] + b\} = x[n]$$

Hence S is linear.

MCQ 1.49 Consider the following statements

(A) If S_1 and S_2 are linear and time invariant, then interchanging their order does not change the system.

(B) If S_1 and S_2 are linear and time varying, then interchanging their order does not change the system

True statement are

(A) Both 1 and 2 (B) Only 1

(C) Only 2 (D) None of these

SOL 1.49 Option (B) is correct.

For example, consider two LTI system given as

$$S_1 : y[n] = nx[n] \text{ and}$$
$$S_2 : y[n] = nx[n+1]$$

If $x[n] = \delta[n]$ then $S_2\{S_1\{\delta[n]\}\} = S_2[0] = 0$,

$$S_1\{S_2\{\delta[n]\}\} = S_1\{\delta[n+1]\} = -\delta[n+1] \neq 0$$

Common Data For Questions 50 and 51

A 3-ϕ, Y-connected, 60 Hz synchronous motor is rated as 10 hp, 230 V. It delivers full load at a power factor of 0.707 leading. The synchronous reactance of the motor is $j5\,\Omega$/phase. The rotational loss is 230 W and the field-winding loss is 70 W .Neglect the armature-winding resistance.

MCQ 1.50 The efficiency of motor will be

(A) 97% (B) 96.1%

(C) 92.7% (D) 93.3%

SOL 1.50 Option (B) is correct

MCQ 1.51 The generated voltage will be

(A) $248.8\angle -22.8^\circ$ V

(B) $105.5\angle -90^\circ$ V

(C) $103\angle -69.4^\circ$ V

(D) $105.5\angle -45^\circ$ V

SOL 1.51 Option (A) is correct

Linked Answer Questions

Statement For Linked Answer Questions 52 and 53:

A three-phase, 50 Hz overhead transmission line is supplying a 0.8 power factor lagging load with both the sending end and receiving end line voltages held at 110 kV and the former leads by 15°. The line constants are $A = 0.96\angle 1^\circ$, $B = 100\angle 83^\circ\ \Omega$.

MCQ 1.52 How much the active power(P_R) and reactive power(Q_R) are demanded by load ?

(A) $P_R = 265\text{ kW},\ Q_R = 198.53\text{ kVAR}$

(B) $P_R = 24.48\text{ MW},\ Q_R = 18.36\text{ MVAR}$

(C) $P_R = 29.16\text{ MW},\ Q_R = 27.87\text{ MVAR}$

(D) $P_R = 29.16\text{ MW},\ Q_R = 17.50\text{ MVAR}$

SOL 1.52 Option (C) is correct

MCQ 1.53 If a compensating device is required to met the demand of load, then VAR rating of device should be

(A) 24.71 MVAR

(B) 2.84 MVAR

(C) 19.03 MVAR

(D) 21.87 MVAR

SOL 1.53 Option (A) is correct

Statement For Linked Answer Questions 54 and 55

Consider a linear system whose state space representation is $x(t) = Ax(t)$. If the initial state vector of the system is $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, then the system response is $x(t) = \begin{bmatrix} e^{-2x} \\ -2e^{-2t} \end{bmatrix}$. If the itial state vector of the system changes to $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, then the system response becomes $x(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$

MCQ 1.54 The eigenvalue and eigenvector pairs $(\lambda_i v_i)$ for the system are

(A) $\left(-1\begin{bmatrix} 1 \\ -1 \end{bmatrix}\right)$ and $\left(-2\begin{bmatrix} 1 \\ -2 \end{bmatrix}\right)$

(B) $\left(-1,\begin{bmatrix} 1 \\ -1 \end{bmatrix}\right)$ and $\left(2,\begin{bmatrix} 1 \\ -2 \end{bmatrix}\right)$

(C) $\left(-1,\begin{bmatrix}1\\-1\end{bmatrix}\right)$ and $\left(-2,\begin{bmatrix}1\\-2\end{bmatrix}\right)$

(D) $\left(-2\begin{bmatrix}1\\-1\end{bmatrix}\right)$ and $\left(1,\begin{bmatrix}1\\-2\end{bmatrix}\right)$

SOL 1.54 Option (A) is correct

MCQ 1.55 The system matrix A is

(A) $\begin{bmatrix}0 & 1\\-1 & 1\end{bmatrix}$

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

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

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

SOL 1.55 Option (D) is correct

Q.56 TO Q.60 CARRY ONE MARK EACH

MCQ 1.56 Which one of the following is the Antonym of the word HOSTILE ?

(A) alluvial
(B) able
(C) amicable
(D) alterable

SOL 1.56 Correct option is (C)

MCQ 1.57 Which one of the following is the synonym of the word PROTAGONIST ?

(A) prophet
(B) explorer
(C) talented child
(D) leading character

SOL 1.57 Correct option is (D)

MCQ 1.58 One of the four words given in the four options does not fit the set of words. The odd word from the group, is

(A) Coal
(B) Humus
(C) Loam
(D) Clay

SOL 1.58 Correct option is (A)

MCQ 1.59 A pair of CAPITALIZED words shown below has four pairs of words. The pair of words which best expresses the relationship similar to that expressed in the capitalized pair, is

BRAND : PRODUCT

(A) Dalda : Rath
(B) Aircraft : Flying Machine
(C) Ram : Boys
(D) Sports car : Automobile

SOL 1.59 Correct option is (C)

MCQ 1.60 In the following sentence, a part of the sentence is left unfinished. Four different ways of completing the sentence are indicated. The best alternative among the four, is

The highest reward for a man's toil is not what he gets for it but what ....

(A) he makes out of it (B) he gets for others

(C) he has overcome (D) he becomes by it

SOL 1.60 Correct option is (D)

Q.61 TO Q.65 CARRY TWO MARK EACH

MCQ 1.61 If the LCM of first 100 natural numbers is N, then the LCM of first 105 natural number will be

(A) $51 \times N$ (B) $101 \times 103 \times N$

(C) $105N/103$ (D) $4N$

SOL 1.61 Correct option is (B).

If we look at the numbers $100 < N \leq 105$, we see only 101 and 103 do not have their factors in N (because these are primes), So obviously the new LCM will be $101 \times 103 \times N$.

MCQ 1.62 What will be the sum of the factors of 3^{129} ?

(A) $\frac{(3^{132}+1)}{3}$ (B) $\frac{(3^{129}-1)}{2}$

(C) $\frac{(3^{128}+1)}{2}$ (D) $\frac{(3^{130}-1)}{2}$

SOL 1.62 Correct option is (D).

If N is a number such that $N = a^p \times b^q \times c^r$...... where a, b, c are prime number of N and p, q, r are positive integers.

So, Required sum $= \left(\frac{a^{p+1}-1}{a-1}\right) \times \left(\frac{b^{q+1}-1}{b-1}\right) \times \left(\frac{c^{r+1}-1}{c-1}\right)$

MCQ 1.63 If x is the smallest positive integer such that 2880 multiplied by x is the square of an integer, then x must be

(A) 3 (B) 5

(C) 8 (D) 10

SOL 1.63 Correct option is (B).

Arithmetic properties of numbers

To find the smallest positive integer x such that $2880x$ is the square of an integer, first find the prime factorization of 2880 by a method similar to the following:

$$\begin{aligned} 2880 &= 10 \times 288 \\ &= (2 \times 5) \times (2 \times 144) \\ &= 2 \times 5 \times 2 \times (2 \times 72) \\ &= 2 \times 5 \times 2 \times 2 \times (2 \times 36) \\ &= 2 \times 5 \times 2 \times 2 \times 2 \times (2 \times 18) \\ &= 2 \times 5 \times 2 \times 2 \times 2 \times 2 \times (2 \times 9) \\ &= 2 \times 5 \times 2 \times 2 \times 2 \times 2 \times 2 \times (3 \times 3) \end{aligned}$$

$$= 2^6 \times 3^2 \times 5$$

To be a perfect square, $2880x$ must have an even number of each of its prime factors. At a minimum, x must have one factor of 5 so that $2880x$ has even factors of each of the primes 2, 3, and 5. The smallest positive integer value of x is then 5

MCQ 1.64 $\frac{1}{3^8} + \frac{1}{3^9} + \frac{1}{3^9} + \frac{1}{3^9}$ is equal to

(A) $\frac{1}{3^6}$ (B) $\frac{2}{3^8}$

(C) $\frac{2}{3^{36}}$ (D) $\frac{4}{3^8}$

SOL 1.64 Correct option is (B).

Remember that you can only add fraction with the same denominator.

Rearrange $\frac{1}{3^8}$ so that it can be added to $\frac{1}{3^9}$. That is, try and turn $\frac{1}{3^8}$ into a fraction with 3^9 in the denominator.

Multiply $\frac{1}{3^8}$ by $\frac{3}{3}$ to get

$$\frac{1}{3^8} \times \frac{3}{3} = \frac{3}{3^8 \times 3} = \frac{3}{3^9}$$

So $$\frac{1}{3^8} + \frac{1}{3^9} + \frac{1}{3^9} + \frac{1}{3^9} = \frac{3}{3^9} + \frac{1}{3^9} + \frac{1}{3^9} + \frac{1}{3^9} = \frac{6}{3^9}$$

Canceling out a factor of 3 gives

$$\frac{6}{3^9} = \frac{3 \times 2}{3 \times 3^8} = \frac{2}{3^8}$$

MCQ 1.65 If it is given that $(m+1)^{th}$, $(n+1)^{th}$ and $(r+1)^{th}$ terms of an AP are in GP and m, n, r in HP, then the ratio of the first term of the AP to its common difference in terms of will be

(A) $1:n$ (B) $1:2n$

(C) $n:2$ (D) $2n:3$

SOL 1.65 Correct option is (C).

Since the $(m+1)^{th}$, $(n+1)^{th}$ and $(r+1)^{th}$ term of an A.P. are in G.P. so,

$$(a+nd)^2 = (a+md)(a+rd) \quad \text{....(i)}$$

[assume a and d as the first term and common difference of an AP] Also m, n, r, are in HP so,

$$\frac{2n}{2} = \frac{m+r}{mr} \quad \text{....(ii)}$$

By solving the equation you will get

$$\frac{a}{d} = \frac{n^2 - mr}{m+r-2n}, \text{ put the } m+r = 2mr/n \text{ from equation (iii)}$$

You will get $a/d = -n/2 \approx n:2$ [–ve sign indicates that either common difference of first terms is –ve]

Answer Key

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

END OF THE QUESTION PAPER

Space For Rough Work