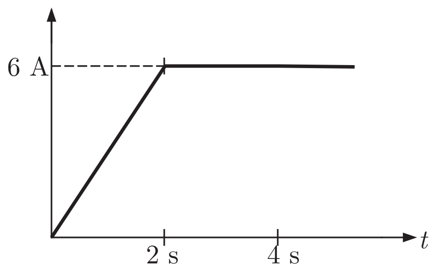
## Q.1 - 30 Carry One Mark Each

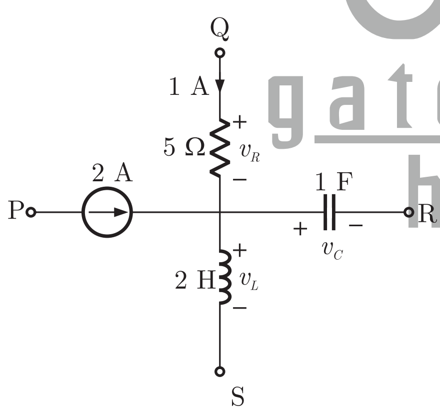
**Q.1** Figure Shows the waveform of the current passing through an inductor of resistance $1\,\Omega$ and inductance 2 H. The energy absorbed by the inductor in the first four seconds is




(A) 144 J (B) 98 J

(C) 132 J (D) 168 J

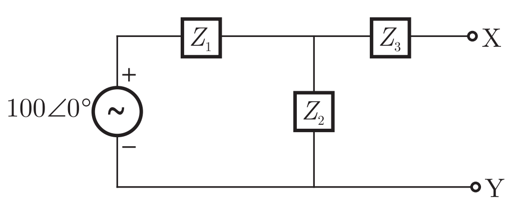
**Q.2** A segment of a circuit is shown in figure $v_R = 5\,V$, $v_c = 4\sin 2t$.The voltage $v_L$ is given by




(A) $3 - 8\cos 2t$ (B) $32\sin 2t$

(C) $16\sin 2t$ (D) $16\cos 2t$

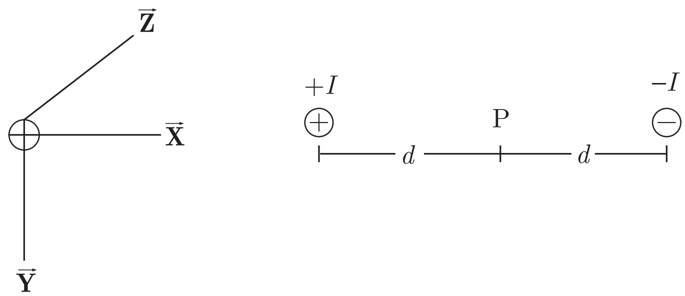
**Q.3** In the figure, $Z_1 = 10\angle -60^\circ, Z_2 = 10\angle 60^\circ, Z_3 = 50\angle 53.13^\circ$. Thevenin impedance seen form X-Y is



(A) $56.66\angle 45^\circ$ (B) $60\angle 30^\circ$

(C) $70\angle 30^\circ$ (D) $34.4\angle 65^\circ$

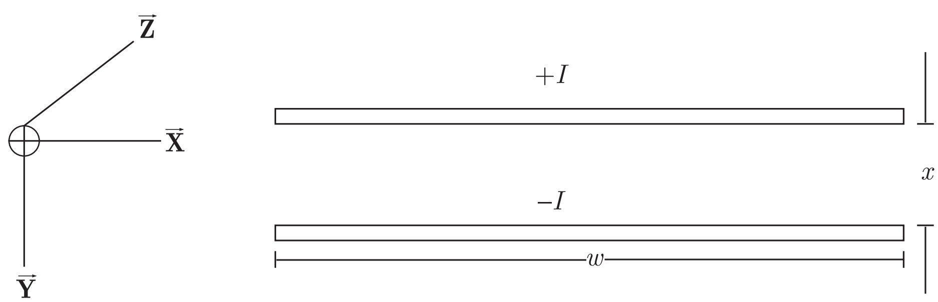
**Q.4** Two conductors are carrying forward and return current of +I and $-I$ as shown in figure. The magnetic field intensity $\vec{\mathbf{H}}$ at point P is




(A) $\frac{I}{\pi d}\vec{\mathbf{Y}}$ (B) $\frac{I}{\pi d}\vec{\mathbf{X}}$

(C) $\frac{I}{2\pi d}\vec{\mathbf{Y}}$ (D) $\frac{I}{2\pi d}\vec{\mathbf{X}}$

**Q.5** Two infinite strips of width w m in $x$-direction as shown in figure, are carrying forward and return currents of +I and $-I$ in the $z$- direction. The strips are separated by distance of x m. The inductance per unit length of the configuration is measured to be $L$ H/m. If the distance of separation between the strips in snow reduced to x/2 m, the inductance per unit length of the configuration is




(A) $2L$ H/m (B) $L/4$ H/m

(C) $L/2$ H/m (D) $4L$ H/m

**Q.6** A simple phase transformer has a maximum efficiency of 90% at full load and unity power factor. Efficiency at half load at the same power factor is

(A) 86.7% (B) 88.26%

(C) 88.9% (D) 87.8%

**Q.7** Group-I lists different applications and Group-II lists the motors for these applications. Match the application with the most suitable motor and choose the right combination among the choices given thereafter

| Group-I | Group-II |
|---|---|
| P. Food mixer | 1. Permanent magnet dc motor |
| Q. Cassette tape recorder | 2. Single-phase induction motor |
| R. Domestic water pump | 3. Universal motor |
| S. Escalator | 4. Three-phase induction motor |
| | 5. DC series motor |
| | 6. Stepper motor |

**Codes:**

| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 3 | 6 | 4 | 5 |
| (B) | 1 | 3 | 2 | 4 |
| (C) | 3 | 1 | 2 | 4 |
| (D) | 3 | 2 | 1 | 4 |



**Q.8** A stand alone engine driven synchronous generator is feeding a partly inductive load. A capacitor is now connected across the load to completely nullify the inductive current. For this operating condition.

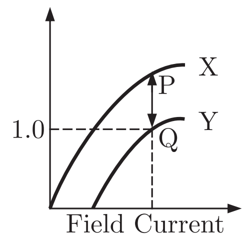
(A) the field current and fuel input have to be reduced

(B) the field current and fuel input have to be increased

(C) the field current has to be increased and fuel input left unaltered

(D) the field current has to be reduced and fuel input left unaltered

**Q.9** Curves X and Y in figure denote open circuit and full-load zero power factor(zpf) characteristics of a synchronous generator. Q is a point on the zpf characteristics at 1.0 p.u. voltage. The vertical distance PQ in figure gives the voltage drop across




(A) Synchronous reactance
(B) Magnetizing reactance
(C) Potier reactance
(D) Leakage reactance

**Q.10** No-load test on a 3-phase induction motor was conducted at different supply voltage and a plot of input power versus voltage was drawn. This curve was extrapolated to intersect the y-axis. The intersection point yields

(A) Core loss
(B) Stator copper loss
(C) Stray load loss
(D) Friction and windage loss

**Q.11** Bundled conductors are mainly used in high voltage overhead transmission lines to

(A) reduces transmission line losses

(B) increase mechanical strength of the line

(C) reduce corona

(D) reduce sag

**Q.12** A power system consist of 300 buses out of which 20 buses are generator bus, 25 buses are the ones with reactive power support and 15 buses are the ones with fixed shunt capacitors. All the other buses are load buses. It is proposed to perform a load flow analysis in the system using Newton-Raphson method. The size of the Newton Raphson Jacobian matrix is

(A) $553 \times 553$
(B) $540 \times 540$
(C) $555 \times 555$
(D) $554 \times 554$

**Q.13** Choose two appropriate auxiliary components of a HVDC transmission system from the following

P. D.C line inductor

Q. A.C line inductor

R. Reactive power sources

S. Distance relays on D.C line

T. Series capacitance on A.C. line

(A) P and Q (B) P and R

(C) Q and S (D) S and T

**Q.14** A round rotor generator with internal voltage $E_1 = 2.0$ pu and $X = 1.1$ pu is connected to a round rotor synchronous motor with internal voltage $E_2 = 1.3$ pu and $X = 1.2$ pu. The reactance of the line connecting the generator to the motor is 0.5 pu. When the generator supplies 0.5 pu power, the rotor angle difference between the machines will be

(A) 57.42° (B) 1°

(C) 32.58° (D) 122.58°

**Q.15** The interrupting time of a circuit breaker is the period between the instant of

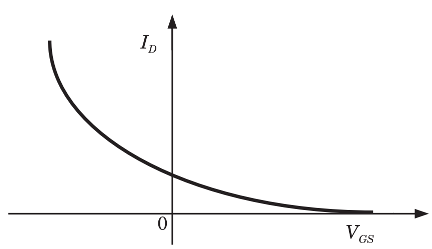
(A) initiation of short circuit and the arc extinction on an opening operation

(B) energizing of the trip circuit and the arc extinction on an opening operation

(C) initiation of short circuit and the parting of primary arc contacts

(D) energizing of the trip circuit and the parting of primary arc contacts

**Q.16** The variation of drain current with gate-to-source voltage ($I_D - V_{GS}$ characteristic) of a MOSFET is shown in figure. The MOSFET is



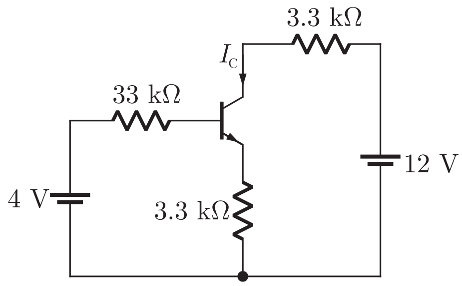

(A) an n-channel depletion mode device

(B) an n-channel enhancement mode device

(C) an p-channel depletion mode device

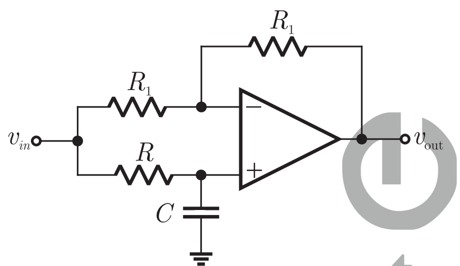
(D) an p-channel enhancement mode device

**Q.17** In the circuit of figure, assume that the transistor has $h_{fe} = 99$ and $V_{BE} = 0.7$ V. The value of collector current $I_C$ of the transistor is approximately



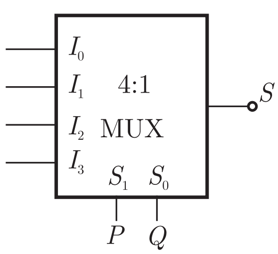

(A) [3.3/3.3] mA
(B) [3.3/(3.3+3.3)] mA
(C) [3.3/.33] mA
(D) [3.3(33+3.3)] mA

**Q.18** For the circuit of figure with an ideal operational amplifier, the maximum phase shift of the output $v_{out}$ with reference to the input $v_{in}$ is




(A) 0°
(B) −90°
(C) +90°
(D) ±180°

**Q.19** Figure shows a 4 to 1 MUX to be used to implement the sum $S$ of a 1-bit full adder with input bits $P$ and $Q$ and the carry input $C_{in}$. Which of the following combinations of inputs to $I_0, I_1, I_2$ and $I_3$ of the MUX will realize the sum $S$ ?




(A) $I_0 = I_1 = C_{in}; I_2 = I_3 = \overline{C_{in}}$
(B) $I_0 = I_1 = \overline{C}_{in}; I_2 = I_3 = C_{in}$
(C) $I_0 = I_3 = C_{in}; I_1 = I_2 = \overline{C_{in}}$
(D) $I_0 = I_3 = \overline{C}_{in}; I_1 = I_2 = C_{in}$

**Q.20** When a program is being executed in an 8085 microprocessor, its Program Counter contains

(A) the number of instructions in the current program that have already been executed

(B) the total number of instructions in the program being executed.

(C) the memory address of the instruction that is being currently executed

(D) the memory address of the instruction that is to be executed next

**Q.21** A control system is defined by the following mathematical relationship

$$\frac{d^2x}{dt^2} + 6\frac{dx}{dt} + 5x = 12(1 - e^{-2t})$$

The response of the system as $t \to \infty$ is

(A) $x = 6$ (B) $x = 2$

(C) $x = 2.4$ (D) $x = -2$

**Q.22** A lead compensator used for a closed loop controller has the following transfer function

$$\frac{K(1+\frac{s}{a})}{(1+\frac{s}{b})}$$

For such a lead compensator

(A) $a < b$ (B) $b < a$

(C) $a > Kb$ (D) $a < Kb$

**Q.23** A second order system starts with an initial condition of $\begin{bmatrix} 2 \\ 3 \end{bmatrix}$ without any external input. The state transition matrix for the system is given by $\begin{bmatrix} e^{-2t} & 0 \\ 0 & e^{-t} \end{bmatrix}$. The state of the system at the end of 1 second is given by

(A) $\begin{bmatrix} 0.271 \\ 1.100 \end{bmatrix}$ (B) $\begin{bmatrix} 0.135 \\ 0.368 \end{bmatrix}$

(C) $\begin{bmatrix} 0.271 \\ 0.736 \end{bmatrix}$ (D) $\begin{bmatrix} 0.135 \\ 1.100 \end{bmatrix}$

**Q.24** A Manganin swap resistance is connected in series with a moving coil ammeter consisting of a milli-ammeter and a suitable shunt in order to

(A) minimise the effect of temperature variation

(B) obtain large deflecting torque

(C) reduce the size of the meter

(D) minimise the effect of stray magnetic fields

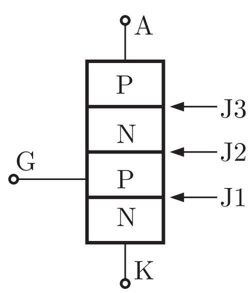
**Q.25** The effect of stray magnetic field on the actuating torque of a portable instrument is maximum when the operating field of the instrument and the stray fields are

(A) perpendicular
(B) parallel
(C) inclined at $60^\circ$
(D) inclined at $30^\circ$

**Q.26** A reading of 120 is obtained when standard inductor was connected in the circuit of a Q-meter and the variable capacitor is adjusted to value of 300 pF. A lossless capacitor of unknown value $C_x$ is then connected in parallel with the variable capacitor and the same reading was obtained when the variable capacitor is readjusted to a value of 200 pF. The value of $C_x$ in pF is

(A) 100
(B) 200
(C) 300
(D) 500

**Q.27** Figure shows a thyristor with the standard terminations of anode (A), cathode (K), gate (G) and the different junctions named J1, J2 and J3. When the thyristor is turned on and conducting



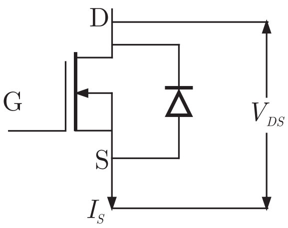

(A) J1 and J2 are forward biased and J3 is reverse biased

(B) J1 and J3 are forward biased and J2 is reverse biased

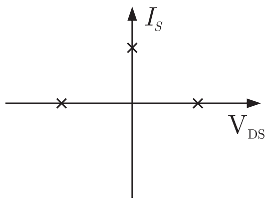
(C) J1 is forward biased and J2 and J3 are reverse biased

(D) J1, J2 and J3 are all forward biased

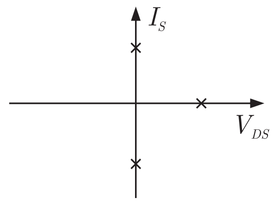
**Q.28** Figure shows a MOSFET with an integral body diode. It is employed as a power switching device in the ON and OFF states through appropriate control. The ON and OFF states of the switch are given on the $V_{DS} - I_S$ plane by



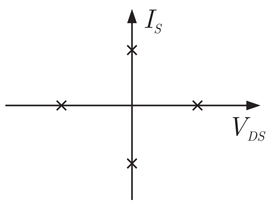

(A)



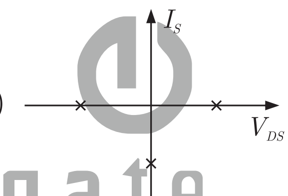

(B)




(C)




(D)




**Q.29** The speed/torque regimes in a dc motor and the control methods suitable for the same are given respectively in List-II and List-I

| **List-I** | **List-II** |
|---|---|
| P. Field Control | 1. Below base speed |
| Q. Armature Control | 2. Above base speed |
| | 3. Above base torque |
| | 4. Below base torque |

**Codes:**

(A) P-1, Q-3 (B) P-2, Q-1

(C) P-2, Q-3 (D) P-1, Q-4

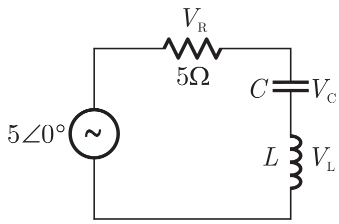
**Q.30** A fully controlled natural commutated 3-phase bridge rectifier is operating with a firing angle $\alpha = 30^\circ$, The peak to peak voltage ripple expressed as a ratio of the peak output dc voltage at the output of the converter bridge is

(A) 0.5 (B) $\sqrt{3}/2$

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

## Q. 31 - 90 carry two marks each

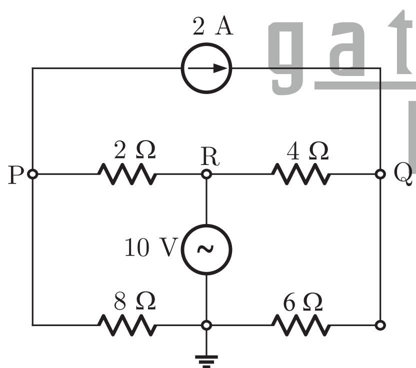
**Q.31** In the circuit of figure, the magnitudes of $V_L$ and $V_C$ are twice that of $V_R$. Given that $f = 50$ Hz, the inductance of the coil is




(A) 2.14 mH (B) 5.30 H

(C) 31.8 mH (D) 1.32 H

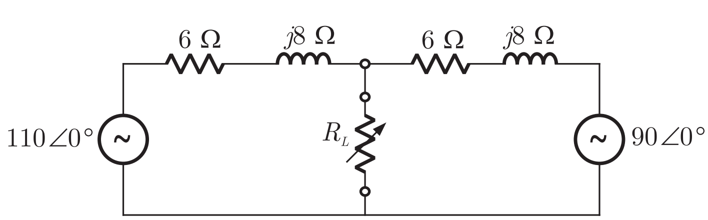
**Q.32** In figure, the potential difference between points P and Q is




(A) 12 V (B) 10 V

(C) −6 V (D) 8 V

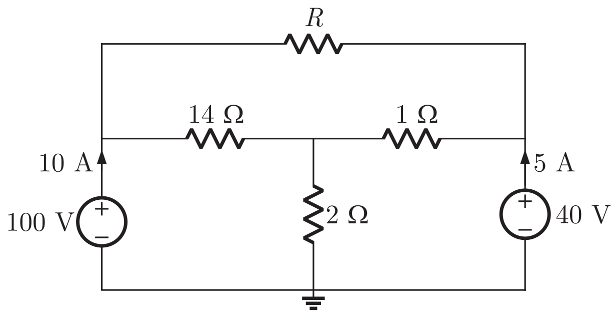
**Q.33** Two ac sources feed a common variable resistive load as shown in figure. Under the maximum power transfer condition, the power absorbed by the load resistance $R_L$ is



(A) 2200 W (B) 1250 W

(C) 1000 W (D) 625 W

**Q.34** In figure, the value of $R$ is




(A) $10\,\Omega$ (B) $18\,\Omega$

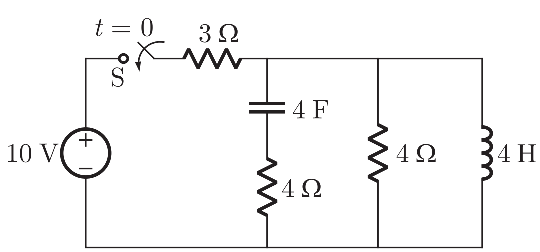
(C) $24\,\Omega$ (D) $12\,\Omega$

**Q.35** A balanced delta connected load of $(8 + j6)\,\Omega$ per phase is connected to a 400 V, 50 Hz, 3-phase supply lines. If the input power factor is to be improved to 0.9 by connecting a bank of star connected capacitor the required kVAR of the of the bank is

(A) 42.7 (B) 10.2

(C) 28.8 (D) 38.4

**Q.36** In the circuit shown in figure, the switch S is closed at time (t = 0). The voltage across the inductance at $t = 0^+$, is



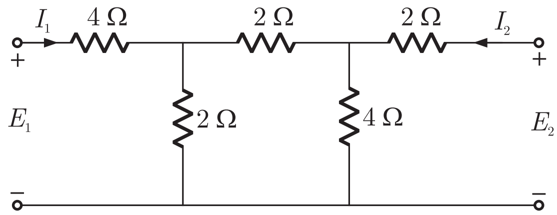

(A) 2 V (B) 4 V

(C) −6 V (D) 8 V

**Q.37** The h-parameters for a two-port network are defined by

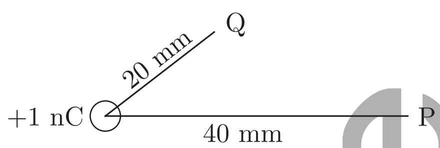
$$\begin{bmatrix} E_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{bmatrix} \begin{bmatrix} I_1 \\ E_2 \end{bmatrix}$$

For the two-port network shown in figure, the value of $h_{12}$ is given by




(A) 0.125
(B) 0.167
(C) 0.625
(D) 0.25

**Q.38** A point charge of +I nC is placed in a space with permittivity of $8.85 \times 10^{-12}$ F/m as shown in figure. The potential difference $V_{PQ}$ between two points P and Q at distance of 40 mm and 20 mm respectively fr0m the point charge is

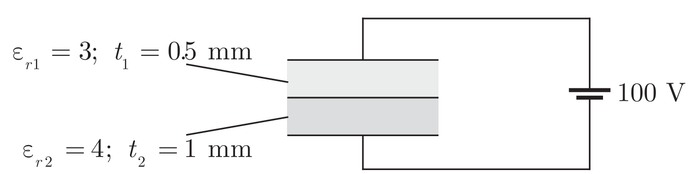



(A) 0.22 kV
(B) −225 V
(C) −2.24 kV
(D) 15 V

**Q.39** A parallel plate capacitor has an electrode area of 100 mm², with spacing of 0.1 mm between the electrodes. The dielectric between the plates is air with a permittivity of $8.85 \times 10^{-12}$ F/m. The charge on the capacitor is 100 V. The stored energy in the capacitor is

(A) 8.85 pJ
(B) 440 pJ
(C) 22.1 nJ
(D) 44.3 nJ

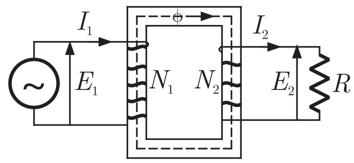
**Q.40** A composite parallel plate capacitor is made up of two different dielectric material with different thickness ($t_1$ and $t_2$) as shown in figure. The two different dielectric materials are separated by a conducting foil F. The voltage of the conducting foil is

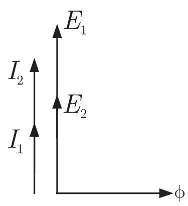


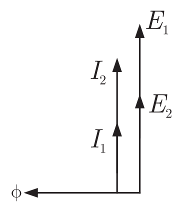

(A) 52 V
(B) 60 V

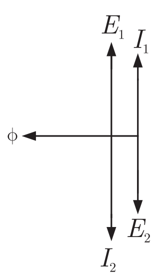
(C) 67 V (D) 33 V

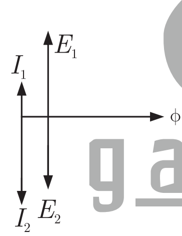
**Q.41** Figure shows an ideal single-phase transformer. The primary and secondary coils are wound on the core as shown. Turns ratio $N_1/N_2 = 2$.The correct phasors of voltages $E_1, E_2$ , currents $I_1, I_2$ and core flux $\Phi$ are as shown in




(A)



(B)



(C)


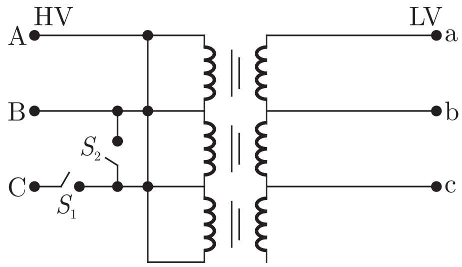

(D)



**Q.42** To conduct load test on a dc shunt motor, it is coupled to a generator which is identical to the motor. The field of the generator is also connected to the same supply source as the motor. The armature of generator is connected to a load resistance. The armature resistance is 0.02 p.u. Armature reaction and mechanical losses can be neglected. With rated voltage across the motor, the load resistance across the generator is adjusted to obtain rated armature current in both motor and generator. The p.u value of this load resistance is

(A) 1.0 (B) 0.98

(C) 0.96 (D) 0.94

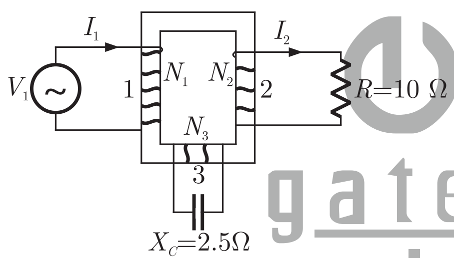
**Q.43** Figure shows a $\Delta - Y$ connected, 3-phase distribution transformer used to step down the voltage from 11000 V to 415 V line-to-line. It has two switches $S_1$ and $S_2$. Under normal conditions $S_1$ is closed and $S_2$ is open. Under certain special conditions $S_1$ is open and $S_2$ is closed. In such a case the magnitude of the voltage across the LV terminals a and c is




(A) 240 V (B) 480 V

(C) 415 V (D) 0 V

**Q.44** Figure shows an ideal three-winding transformer. The three windings 1, 2, 3 of the transformer are wound on the same core as shown. The turns ratio $N_1 : N_2 : N_3$ is 4:2:1. A resistor of 10 $\Omega$ is connected across winding-2. A capacitor of reactance 2.5 $\Omega$ is connected across winding-3. Winding-1 is connected across a 400 V, ac supply. If the supply voltage phasor $V_1 = 400\angle 0^\circ$, the supply current phasor $I_1$ is given by




(A) $(-10 + j10)$ A (B) $(-10 - j10)$ A

(C) $(10 + j10)$ A (D) $(10 - j10)$ A

**Q.45** Following are some of the properties of rotating electrical machines

P. Stator winding current is dc, rotor winding current is ac.
Q. Stator winding current is ac, rotor winding current is dc.
R. Stator winding current is ac, rotor winding current is ac.
S. Stator has salient poles and rotor has commutator.
T. Rotor has salient poles and sliprings and stator is cylindrical.
U. Both stator and rotor have poly-phase windings.

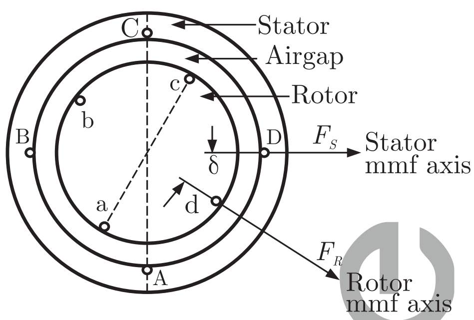
DC machines, Synchronous machines and Induction machines exhibit some of the above properties as given in the following table.

Indicate the correct combination from this table

| DC Machine | Synchronous Machines | Induction Machines |
|---|---|---|

| | | |
|---|---|---|
| (A) P,S | Q,T | R,U |
| (B) Q,U | P,T | R,S |
| (C) P,S | R,U | Q,T |
| (D) R,S | Q,U | P,T |

**Q.46** When stator and rotor windings of a 2-pole rotating electrical machine are excited, each would produce a sinusoidal mmf distribution in the airgap with peal values $F_s$ and $F_r$ respectively. The rotor mmf lags stator mmf by a space angle $\delta$ at any instant as shown in figure. Thus, half of stator and rotor surfaces will form one pole with the other half forming the second pole. Further, the direction of torque acting on the rotor can be clockwise or counter-clockwise.




The following table gives four set of statement as regards poles and torque. Select the correct set corresponding to the mmf axes as shown in figure.

| Stator Surface ABC forms | Stator Surface CDA forms | Rotor Surface abc forms | Rotor surface cda forms | Torque is |
|---|---|---|---|---|
| (A) North Pole | South Pole | North Pole | South Pole | Clockwise |
| (B) South Pole | North Pole | North Pole | South Pole | Counter Clockwise |
| (C) North Pole | South Pole | South Pole | North Pole | Counter Clockwise |
| (D) South Pole | North Pole | South Pole | North Pole | Clockwise |

**Q.47** A 4-pole, 3-phase, double-layer winding is housed in a 36-slot stator for an ac machine with 60° phase spread. Coil span is 7 short pitches. Number of slots in which top and bottom layers belong to different phases is

(A) 24 (B) 18

(C) 12 (D) 0

**Q.48** A 3-phase induction motor is driving a constant torque load at rated voltage and frequency. If both voltage and frequency are halved, following statements relate to the new condition if stator resistance, leakage reactance and core loss are ignored

1. The difference between synchronous speed and actual speed remains same

2. The airgap flux remains same

3. The stator current remains same

4. The p.u. slip remains same

Among the above, current statements are

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

(C) 2, 3 and 4 (D) 1 and 4

**Q.49** A single-phase induction motor with only the main winding excited would exhibit the following response at synchronous speed

(A) Rotor current is zero

(B) Rotor current is non-zero and is at slip frequency

(C) Forward and backward rotaling fields are equal

(D) Forward rotating field is more than the backward rotating field



**Q.50** A dc series motor driving and electric train faces a constant power load. It is running at rated speed and rated voltage. If the speed has to be brought down to 0.25 p.u. the supply voltage has to be approximately brought down to

(A) 0.75 p.u (B) 0.5 p.u

(C) 0.25 p.u (D) 0.125 p.u

**Q.51** The $ABCD$ parameters of a 3-phase overhead transmission line are $A = D = 0.9\angle 0°, B = 200\angle 90°\,\Omega$ and $C = 0.95\times 10^{-3}\angle 90°\,\text{S}$. At no-load condition a shunt inductive, reactor is connected at the receiving end of the line to limit the receiving-end voltage to be equal to the sending-end voltage. The ohmic value of the reactor is

(A) $\infty\,\Omega$ (B) $2000\,\Omega$

(C) $105.26\,\Omega$ (D) $1052.6\,\Omega$

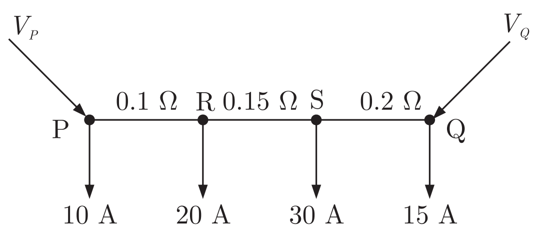
**Q.52** A surge of 20 kV magnitude travels along a lossless cable towards its junction with two identical lossless overhead transmission lines. The inductance and the capacitance of the cable are 0.4 mH and

0.5 $\mu$F per km. The inductance and capacitance of the overhead transmission lines are 1.5 mH and 0.015 $\mu$F per km. The magnitude of the voltage at the junction due to surge is

(A) 36.72 kV (B) 18.36 kV

(C) 6.07 kV (D) 33.93 kV

**Q.53** A dc distribution system is shown in figure with load current as marked. The two ends of the feeder are fed by voltage sources such that $V_P - V_Q = 3$ V. The value of the voltage $V_P$ for a minimum voltage of 220 V at any point along the feeder is




(A) 225.89 V (B) 222.89 V

(C) 220.0 V (D) 228.58 V

**Q.54** A 3-phase 11 kV generator feeds power to a constant power unity power factor load of 100 MW through a 3-phase transmission line. The line-to line voltage at the terminals of the machine is maintained constant at 11 kV. The per unit positive sequence impedance of the line based on 100 MVA and 11 kV is $j0.2$. The line to line voltage at the load terminals is measured to be less than 11 kV. The total reactive power to be injected at the terminals of the load to increase the line-to-line voltage at the load terminals to 11 kV is

(A) 100 MVAR (B) 10.1 MVAR

(C) $-100$ MVAR (D) $-10.1$ MVAR

**Q.55** The bus impedance matrix of a 4-bus power system is given by

$$Z_{\text{bus}} = \begin{bmatrix} j0.3435 & j0.2860 & j0.2723 & j0.2277 \\ j0.2860 & j0.3408 & j0.2586 & j0.2414 \\ j0.2723 & j0.2586 & j0.2791 & j0.2209 \\ j0.2277 & j0.2414 & j0.2209 & j0.2791 \end{bmatrix}$$

A branch having an impedance of $j0.2\,\Omega$ is connected between bus 2 and the reference. Then the values of $Z_{22,\text{new}}$ and $Z_{23,\text{new}}$ of the bus impedance matrix of the modified network are respectively

(A) $j0.5408\ \Omega$ and $j0.4586\ \Omega$

(B) $j0.1260\ \Omega$ and $j0.0956\ \Omega$

(C) $j0.5408\ \Omega$ and $j0.0956\ \Omega$

(D) $j0.1260\ \Omega$ and $j0.1630\ \Omega$

**Q.56** A 20-MVA, 6.6-kV, 3-phase alternator is connected to a 3-phase transmission line. The per unit positive-sequence, negative-sequence and zero-sequence impedances of the alternator are $j0.1$, $j0.1$ and $j0.04$ respectively. The neutral of the alternator is connected to ground through an inductive reactor of $j0.05$ p.u. The per unit positive-, negative- and zero-sequence impedances of transmission line are $j0.1$, $j0.1$ and $j0.3$, respectively. All per unit values are based on the machine ratings. A solid ground fault occurs at one phase of the far end of the transmission line. The voltage of the alternator neutral with respect to ground during the fault is

(A) 513.8 V (B) 889.9 V

(C) 1112.0 V (D) 642.2 V

**Q.57** Incremental fuel costs (in some appropriate unit) for a power plant consisting of three generating units are

$IC_1 = 20 + 0.3P_1, \quad IC_2 = 30 + 0.4P_2, \quad IC_3 = 30$

Where $P_1$ is the power in MW generated by unit $i$ for $i = 1,2$ and 3. Assume that all the three units are operating all the time. Minimum and maximum loads on each unit are 50 MW and 300 MW respectively. If the plant is operating on economic load dispatch to supply the total power demand of 700 MW, the power generated by each unit is

(A) $P_1 = 242.86\,\text{MW}; P_2 = 157.14\,\text{MW}; \text{and } P_3 = 300\,\text{MW}$

(B) $P_1 = 157.14\,\text{MW}; P_2 = 242.86\,\text{MW}; \text{and } P_3 = 300\,\text{MW}$

(C) $P_1 = 300\,\text{MW}; P_2 = 300\,\text{MW}; \text{and } P_3 = 100\,\text{MW}$

(D) $P_1 = 233.3\,\text{MW}; P_2 = 233.3\,\text{MW}; \text{and } P_3 = 233.4\,\text{MW}$

**Q.58** A list of relays and the power system components protected by the relays are given in List-I and List-II respectively. Choose the correct match from the four choices given below:

| | Group I | | Group II |
|---|---|---|---|
| P | Distance relay | 1. | Transformers |
| Q | Under frequency relay | 2. | Turbines |
| R | Differential relay | 3. | Busbars |
| S | Buchholz relay | 4. | Shunt capacitors |
| | | 5. | Alternators |
| | | 6. | Transmission lines |

**Codes:**

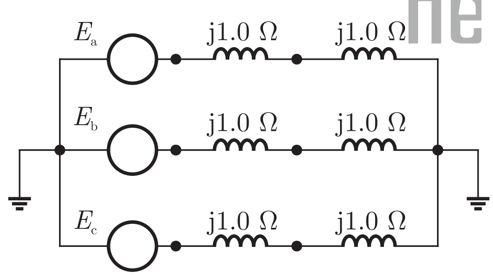
| | P | Q | R | S |
|---|---|---|---|---|
| (A) | 6 | 5 | 3 | 1 |
| (B) | 4 | 3 | 2 | 1 |
| (C) | 5 | 2 | 1 | 6 |
| (D) | 6 | 4 | 5 | 3 |

**Q.59** A generator delivers power of 1.0 p.u. to an infinite bus through a purely reactive network. The maximum power that could be delivered by the generator is 2.0 p.u. A three-phase fault occurs at the terminals of the generator which reduces the generator output to zero. The fault is cleared after $t_c$ second. The original network is then restored. The maximum swing of the rotor angle is found to be $\delta_{max} = 110$ electrical degree. Then the rotor angle in electrical degrees at $t = t_c$ is

(A) 55 (B) 70

(C) 69.14 (D) 72.4

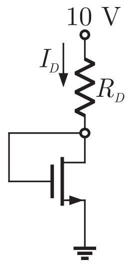
**Q.60** A three-phase alternator generating unbalanced voltages is connected to an unbalanced load through a 3-phase transmission line as shown in figure. The neutral of the alternator and the star point of the load are solidly grounded. The phase voltages of the alternator are $E_a = 10\angle 0^\circ$ V, $E_b = 10\angle -90^\circ$ V, $E_c = 10\angle 120^\circ$ V. The positive-sequence component of the load current is




(A) $1.310\angle -107^\circ$ A (B) $0.332\angle -120^\circ$ A

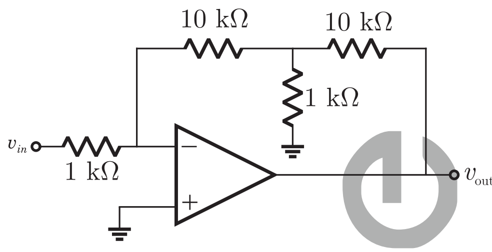
(C) $0.996\angle -120^\circ$ A (D) $3.510\angle -81^\circ$ A

**Q.61** For the n-channel enhancement MOSFET shown in figure, the threshold voltage $V_{th} = 2$ V. The drain current $I_D$ of the MOSFET is 4 mA when the drain resistance $R_D$ is 1 kΩ.If the value of $R_D$ is increased to 4 kΩ, drain current $I_D$ will become



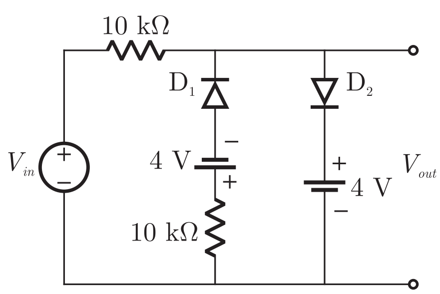

(A) 2.8 mA
(B) 2.0 mA
(C) 1.4 mA
(D) 1.0 mA

**Q.62** Assuming the operational amplifier to be ideal, the gain $v_{out}/v_{in}$ for the circuit shown in figure is




(A) $-1$
(B) $-20$
(C) $-100$
(D) $-120$

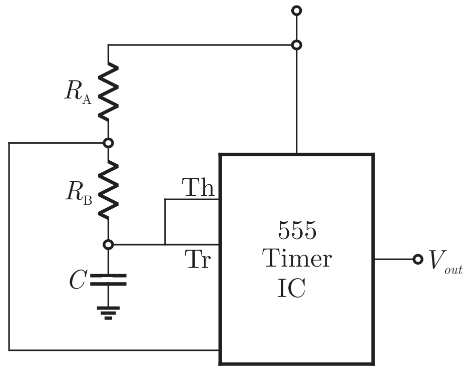
**Q.63** A voltage signal $10 \sin \omega t$ is applied to the circuit with ideal diodes, as shown in figure, The maximum, and minimum values of the output waveform $V_{out}$ of the circuit are respectively




(A) $+10$ V and $-10$ V
(B) $+4$ V and $-4$ V
(C) $+7$ V and $-4$ V
(D) $+4$ V and $-7$ V

**Q.64** The circuit of figure shows a 555 Timer IC connected as an astable multi-vibrator.

The value of the capacitor $C$ is 10 nF. The values of the resistors $R_A$ and $R_B$ for a frequency of 10 kHz and a duty cycle of 0.75 for the output voltage waveform are



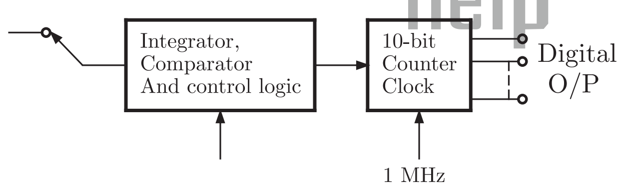

(A) $R_A = 3.62\,\text{k}\Omega, R_B = 3.62\,\text{k}\Omega$

(B) $R_A = 3.62\,\text{k}\Omega, R_B = 7.25\,\text{k}\Omega$

(C) $R_A = 7.25\,\text{k}\Omega, R_B = 3.62\,\text{k}\Omega$

(D) $R_A = 7.25\,\text{k}\Omega, R_B = 7.25\,\text{k}\Omega$

**Q.65** The simplified block diagram of a 10-bit A/D converter of dual slope integrator type is shown in figure. The 10-bit counter at the output is clocked by a 1 MHz clock. Assuming negligible timing overhead for the control logic, the maximum frequency of the analog signal that can be converted using this A/D converter is approximately




(A) 2 kHz

(B) 1 kHz

(C) 500 Hz

(D) 250 Hz

**Q.66** The boolean expression $\overline{X}\,Y\,\overline{Z} + \overline{X}\,\overline{Y}Z + XY\overline{Z} + X\overline{Y}Z + XYZ$ can be simplified to

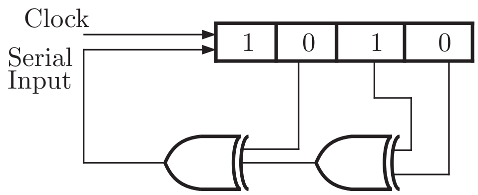
(A) $X\overline{Z} + \overline{X}Z + YZ$

(B) $XY + \overline{Y}Z + Y\overline{Z}$

(C) $\overline{X}Y + YZ + XZ$

(D) $\overline{XY} + Y\overline{Z} + \overline{X}Z$

**Q.67** The shift register shown in figure is initially loaded with the bit pattern 1010. Subsequently the shift register is clocked, and with each clock pulse the pattern gets shifted by one bit position to the right. With each shift, the bit at the serial input is pushed to the left most position (msb). After how many clock pulses will the content of the shift register become 1010 again ?




(A) 3
(B) 7
(C) 11
(D) 15

**Q.68** 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 |

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

**Q.69** A memory system has a total of 8 memory chips each with 12 address lines and 4 data lines, The total size of the memory system is

(A) 16 kbytes
(B) 32 kbytes
(C) 48 kbytes
(D) 64 kbytes

**Q.70** The following program is written for an 8085 microprocessor to add two bytes located at memory addresses 1FFE and 1FFF

```
LXI     H, 1FFE
MOV     B, M
INR     L
MOV     A, M
ADD     B
INR     L
```

MOV M, A
XOR A

On completion of the execution of the program, the result of addition is found

(A) in the register A

(B) at the memory address 1000

(C) at the memory address 1F00

(D) at the memory address 2000

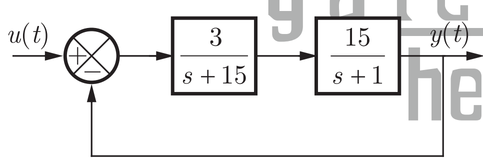
**Q.71** A control system with certain excitation is governed by the following mathematical equation

$$\frac{d^2x}{dt^2} + \frac{1}{2}\frac{dx}{dt} + \frac{1}{18}x = 10 + 5e^{-4t} + 2e^{-5t}$$

The natural time constant of the response of the system are

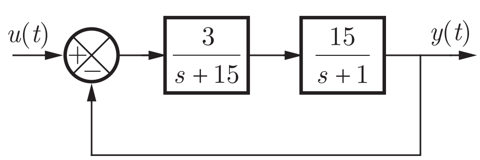
(A) 2 sec and 5 sec
(B) 3 sec and 6 sec
(C) 4 sec and 5 sec
(D) 1/3 sec and 1/6 sec

**Q.72** The block diagram shown in figure gives a unity feedback closed loop control system. The steady state error in the response of the above system to unit step input is




(A) 25%
(B) 0.75 %
(C) 6%
(D) 33%

**Q.73** The roots of the closed loop characteristic equation of the system shown above (Q-5.55)




(A) $-1$ and $-15$
(B) 6 and 10
(C) $-4$ and $-15$
(D) $-6$ and $-10$

**Q.74** The following equation defines a separately excited dc motor in the form of a differential equation

$$\frac{d^2\omega}{dt} + \frac{B}{J}\frac{d\omega}{dt} + \frac{K^2}{LJ}\omega = \frac{K}{LJ}V_a$$

The above equation may be organized in the state-space form as follows

$$\begin{bmatrix} \frac{d^2\omega}{dt^2} \\ \frac{d\omega}{dt} \end{bmatrix} = P\begin{bmatrix} \frac{d\omega}{dt} \\ \omega \end{bmatrix} + QV_a$$

Where the $P$ matrix is given by

(A) $\begin{bmatrix} -\frac{B}{J} & -\frac{K^2}{LJ} \\ 1 & 0 \end{bmatrix}$ (B) $\begin{bmatrix} -\frac{K^2}{LJ} & -\frac{B}{J} \\ 0 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} 0 & 1 \\ -\frac{K^2}{LJ} & -\frac{B}{J} \end{bmatrix}$ (D) $\begin{bmatrix} 1 & 0 \\ -\frac{B}{J} & -\frac{K^2}{LJ} \end{bmatrix}$

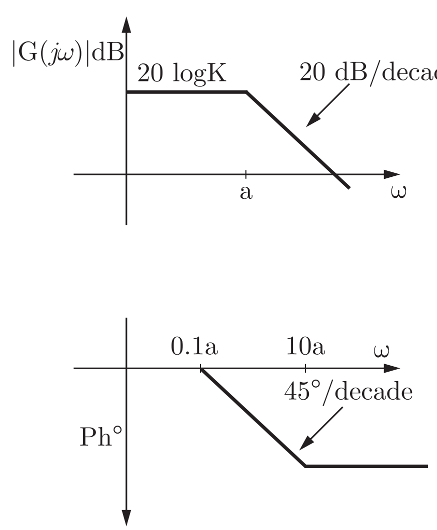
**Q.75** The loop gain $GH$ of a closed loop system is given by the following expression $\frac{K}{s(s+2)(s+4)}$

The value of K for which the system just becomes unstable is

(A) $K = 6$ (B) $K = 8$

(C) $K = 48$ (D) $K = 96$

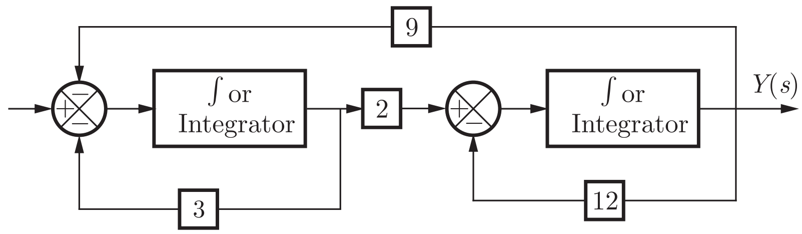
**Q.76** The asymptotic Bode plot of the transfer function $K/[1+(s/a)]$ is given in figure. The error in phase angle and dB gain at a frequency of $\omega = 0.5a$ are respectively




(A) 4.9°, 0.97 dB (B) 5.7°, 3 dB

(C) 4.9°, 3 dB (D) 5.7°, 0.97 dB

**Q.77** The block diagram of a control system is shown in figure. The transfer function $G(s) = Y(s)/U(s)$ of the system is




(A) $\frac{1}{18\left(1+\frac{s}{12}\right)\left(1+\frac{s}{3}\right)}$ (B) $\frac{1}{27\left(1+\frac{s}{6}\right)\left(1+\frac{s}{9}\right)}$

(C) $\frac{1}{27\left(1+\frac{s}{12}\right)\left(1+\frac{s}{9}\right)}$ (D) $\frac{1}{27\left(1+\frac{s}{9}\right)\left(1+\frac{s}{3}\right)}$

**Q.78** The items in Group-I represent the various types of measurements to be made with a reasonable accuracy using a suitable bridge. The items in Group-II represent the various bridges available for this purpose. Select the correct choice of the item in Group-II for the corresponding item in Group-I from the following

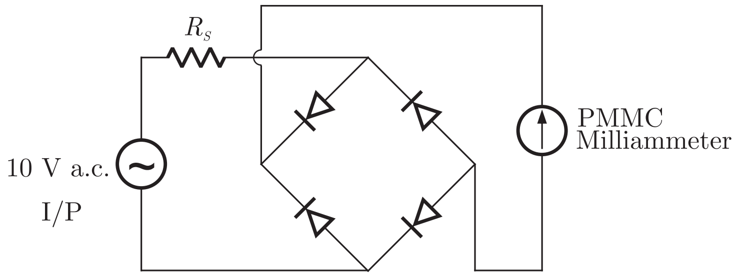
| | **List-I** | List-II |
|---|---|---|
| P. | Resistance in the milli-ohm range | 1. Wheatstone Bridge |
| Q. | Low values of Capacitance | 2. Kelvin Double Bridge |
| R. | Comparison of resistance which are nearly equal | 3. Schering Bridge |
| S. | Inductance of a coil with a large time-constant | 4. Wien's Bridge |
| | | 5. Hay's Bridge |
| | | 6. Carey-Foster Bridge |

Codes :

(A) P=2, Q=3, R=6, S=5 (B) P=2, Q=6, R=4, S=5

(C) P=2, Q=3, R=5, S=4 (D) P=1, Q=3, R=2, S=6

**Q.79** A rectifier type ac voltmeter of a series resistance $R_s$, an ideal full-wave rectifier bridge and a PMMC instrument as shown in figure. The internal. resistance of the instrument is 100 Ω and a full scale deflection is produced by a dc current of 1 mA. The value of $R_s$ required to obtain full scale deflection with an ac voltage of 100 V (rms) applied to the input terminals is




(A) 63.56 Ω (B) 69.93 Ω

(C) 89.93 Ω (D) 141.3 kΩ

**Q.80** A wattmeter reads 400 W when its current coil is connected in the R-phase and its pressure coil is connected between this phase and the neutral of a symmetrical 3-phase system supplying a balanced star connected 0.8 p.f. inductive load. This phase sequence is RYB. What will be the reading of this wattmeter if its pressure coil alone is reconnected between the B and Y phases, all other connections remaining as before ?

(A) 400.0 (B) 519.6

(C) 300.0 (D) 692.8

**Q.81** The inductance of a certain moving-iron ammeter is expressed as

$L = 10 + 3\theta - (\theta^2/4)\,\mu H$, where $\theta$ is the deflection in radians from the zero position. The control spring torque is $25 \times 10^{-6}$ Nm/radian. The deflection of the pointer in radian when the meter carries a current of 5 A, is

(A) 2.4 (B) 2.0

(C) 1.2 (D) 1.0

**Q.82** A 500A/5A, 50 Hz transformer has a bar primary. The secondary burden is a pure resistance of 1 Ω and it draws a current of 5 A. If the magnetic core requires 250 AT for magnetization, the percentage ratio error is

(A) 10.56 (B) $-10.56$

(C) 11.80 (D) $-11.80$

**Q.83** The voltage-flux adjustment of a certain 1-phase 220 V induction watt-hour meter is altered so that the phase angle between the applied voltage and the flux due to it is 85° (instead of 90°). The errors introduced in the reading of this meter when the current is 5 A at power factor of unity and 0.5 lagging are respectively

(A) 3.8 mW, 77.4 mW (B) $-3.8$ mW, $-77.4$ mW

(C) $-4.2$ W, $-85.1$ W (D) 4.2 W, 85.1 W

**Q.84** Group-II represents the figures obtained on a CRO screen when the voltage signals $V_x = V_{xm}\sin\omega t$ and $V_y = V_{ym}\sin(\omega t + \Phi)$ are given to its X and Y plates respectively and $\Phi$ is changed. Choose the correct value of $\Phi$ from Group-I to match with the corresponding figure of Group-II.

Group-I

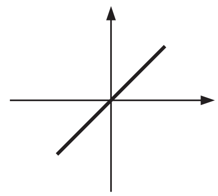
P. $\Phi = 0$

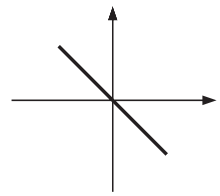
Q. $\Phi = \pi/2$

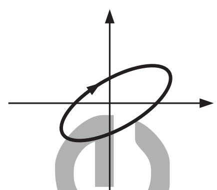
R. $\pi < \Phi < 3\pi/2$

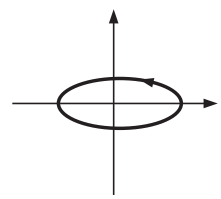
S. $\Phi = 3\pi/2$

Group-II

1.


2.


3.


4.


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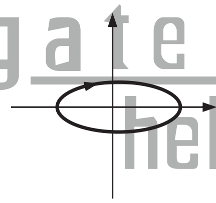

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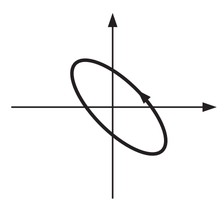
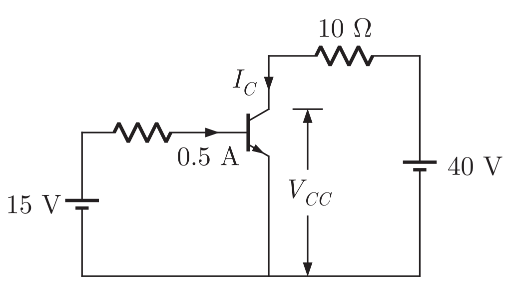


Codes :

(A) P=1, Q=3, R=6, S=5 (B) P=2, Q=6, R=4, S=5

(C) P=2, Q=3, R=5, S=4 (D) P=1, Q=5, R=6, S=4

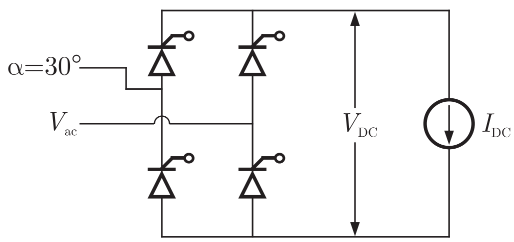
**Q.85** In the circuit shown in Fig. Q85, the current gain ($\beta$) of the ideal transistor is 10. The operating point of the transistor ($V_{CC}, I_C$) is



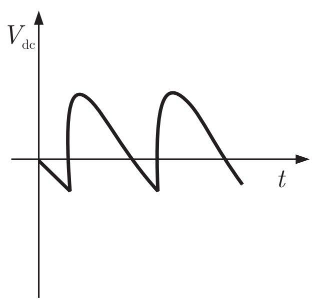
(A) (40 V, 4 A) (B) (40 V, 5 A)

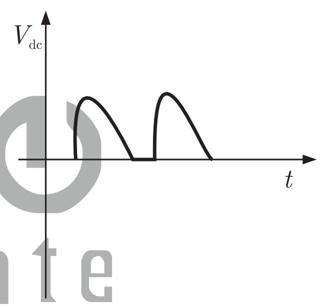
(C) (0 V, 4 A) (D) (15 V, 4 A)

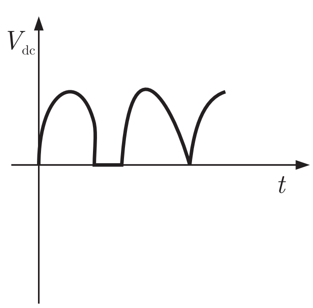
**Q.86** A phase-controlled half-controlled single-phase converter is shown in figure. The control angle $\alpha = 30^\circ$

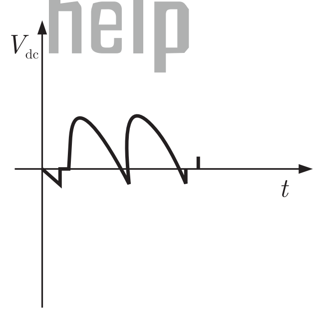



The output dc voltage wave shape will be as shown in

(A)


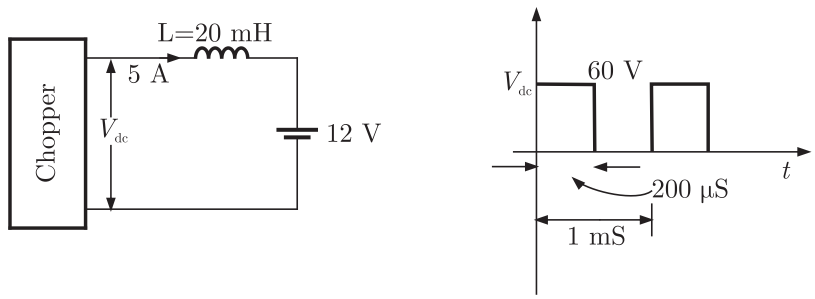

(B)



(C)



(D)





**Q.87** A chopper is employed to charge a battery as shown in figure. The charging current is 5 A. The duty ratio is 0.2. The chopper output voltage is also shown in the figure. The peak to peak ripple current in the charging current is



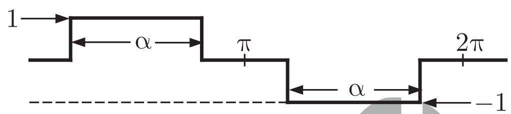

(A) 0.48 A

(B) 1.2 A

(C) 2.4 A

(D) 1 A

**Q.88** An inverter has a periodic output voltage with the output wave form as shown in figure




When the conduction angle $\alpha = 120^\circ$, the rms fundamental component of the output voltage is

(A) 0.78 V

(B) 1.10 V

(C) 0.90 V

(D) 1.27 V

**Q.89** With reference to the output wave form given in above figure , the output of the converter will be free from $5^{th}$ harmonic when

(A) $\alpha = 72^\circ$

(B) $\alpha = 36^\circ$

(C) $\alpha = 150^\circ$

(D) $\alpha = 120^\circ$

**Q.90** An ac induction motor is used for a speed control application. It is driven from an inverter with a constant $V/f$ control. The motor name-plate details are as follows (no. of poles = 2)

$V$: 415 V  $V_{Ph}$: 3 V  $f$: 50 Hz  $N$: 2850 rpm

The motor runs with the inverter output frequency set at 40 Hz, and with half the rated slip. The running speed of the motor is

(A) 2400 rpm

(B) 2280 rpm

(C) 2340 rpm

(D) 2790 rpm