

Technical Section

Q1.

Consider a matrix $A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 4 & -2 \\ 0 & 1 & 1 \end{bmatrix}$

The A satisfies the equation $6A^{-1} = A^2 + cA + dI$, where C and d scalar and I is the Identity matrix. Then (c + d) is equal to

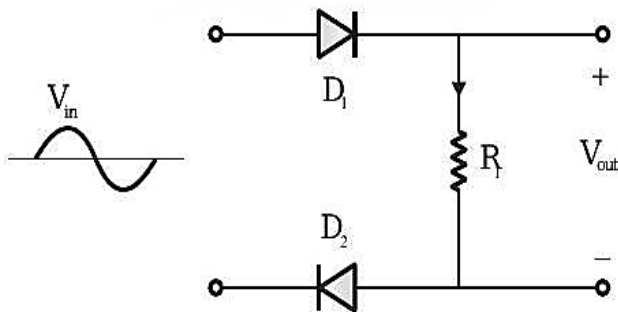
- (a) 5
- (b) 17
- (c) 11
- (d) - 6

S1. Ans. (a)

Sol.

Q2.

For the circuit shown below with ideal diode, the output will be

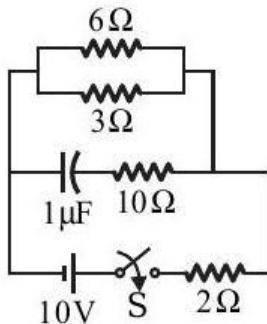


- (a) $V_{out} = V_{in}$ for $V_{in} > 0$
- (b) $V_{out} = V_{in}$ for $V_{in} < 0$
- (c) $V_{out} = -V_{in}$ for $V_{in} > 0$
- (d) $V_{out} = -V_{in}$ for $V_{in} < 0$

S2. Ans. (a)

Sol.

Q3. In the circuit shown below, the switch S is closed at $t = 0$. The magnitude of the steady state voltage, in volts, across the 6Ω resistor is _____. (round off to two decimal places).

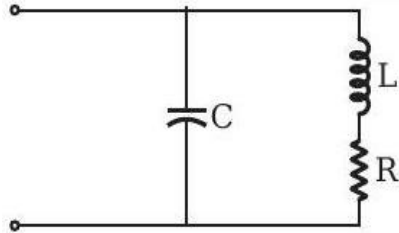


S3. Ans. 0

Sol.

5

Q4. The network shown below has a resonant frequency of 150kHz and a bandwidth of 600 Hz. The Q - factor of the network is _____. (round off to nearest integer)



S4. Ans. 0

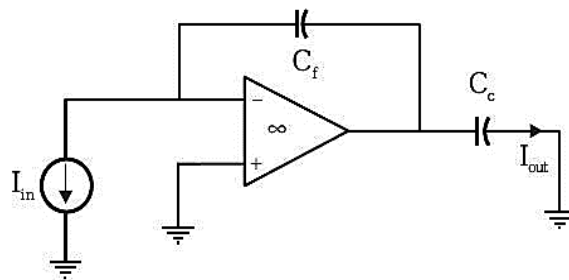
Sol. 250

Q5. A inductor having a Q factor of 60 is connected in series with a capacitor having a Q factor of 240. The overall Q - factor of the circuit is (round off to nearest integer)

S5. Ans. 0

Sol. 48

Q6. The current gain (I_{out}/I_{in}) in the circuit with an ideal current amplifier given below



(a) $-\frac{C_c}{C_f}$

(b) $-\frac{C_f}{C_c}$

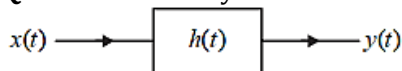
(c) $\frac{C_c}{C_f}$

(d) $\frac{C_f}{C_c}$

S6. Ans. (c)

Sol.

Q7. Consider the system as shown below



Where $y(t) = x(e^t)$.

The system is

(a) Non - linear and causal

(b) Linear and non - causal

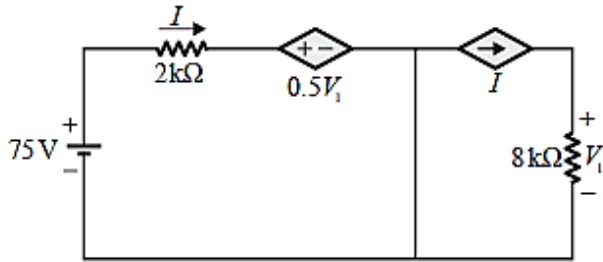
(c) Non - linear and non - causal

(d) Linear and causal

S7. Ans. (b)

Sol.

Q8. In the circuit shown below, the magnitude of the voltage V_1 in volts, across the $8k\Omega$ resistor is _____ (rounded off to nearest integer).



S8. Ans. 0

Sol. 100

Q9. Let an input $x(t) = 2 \sin(10\pi t) + 5 \cos(15\pi t) + 7 \sin(42\pi t) + 4 \cos(45\pi t)$ is passed through an LTI system having an impulse response

$$h(t) = 2 \left(\frac{\sin(10\pi t)}{\pi t} \right) \cdot \cos(40\pi t)$$

The output of the system is

- (a) $2 \sin(10\pi t) + 5 \cos(15\pi t)$
- (b) $2 \sin(10\pi t) + 4 \cos(45\pi t)$
- (c) $7 \sin(42\pi t) + 4 \cos(45\pi t)$
- (d) $5 \cos(15\pi t) + 7 \sin(42\pi t)$

S9. Ans. (c)

Sol.

Q10. The transfer function a real system, $H(s)$ is given as

$$H(s) = \frac{As + B}{s^2 + Cs + D}$$

where A, B, C & D are positive constant. This system cannot operate as:

- (a) Band pass filter
- (b) Low pass filter
- (c) An Integrator
- (d) High pass filter

S10. Ans. (d)

Sol.

Q11. The voltage at the output of an AC - DC rectifier is given by $v(t) = 230\sqrt{2} \sin \omega t$, where $\omega = 2\pi \times 50 \text{ rad/sec}$. The input current drawn by the rectifier is given by

$$i(t) = 10 \sin \left(\omega t - \frac{\pi}{3} \right) + 4 \sin \left(3\omega t - \frac{\pi}{6} \right) + 3 \sin \left(5\omega t - \frac{\pi}{3} \right)$$

The input power factor, (rounded off to two decimal places) is, _____ lag.

S11. Ans. 0

Sol. 0.4476

Q12. A discrete time Fourier series representation of a signal $x[n]$ with period N is written as $x[n] = \sum_{k=0}^{N-1} a_k e^{j(2k\pi n/N)}$. A discrete time period signal with period $N = 3$, has the non - zero Fourier coefficients: $a_{-3} = 2$ and $a_4 = 1$. The signal is

- (a) $2 + 2e^{-j\frac{2\pi}{6}n} \cdot \cos\left(\frac{2\pi}{6}n\right)$
- (b) $2 + 2e^{j\frac{2\pi}{6}n} \cdot \cos\left(\frac{2\pi}{6}n\right)$
- (c) $1 + 2e^{j\frac{2\pi}{6}n} \cdot \cos\left(\frac{2\pi}{6}n\right)$

(d) $1 + 2e^{(j\frac{2\pi}{3}n)} \cdot \cos\left(\frac{2\pi}{6}n\right)$

S12. Ans. (c)

Sol.

Q13. A MOD2 and a MOD5 up counter when cascaded together results in a MOD

S13. Ans. ()

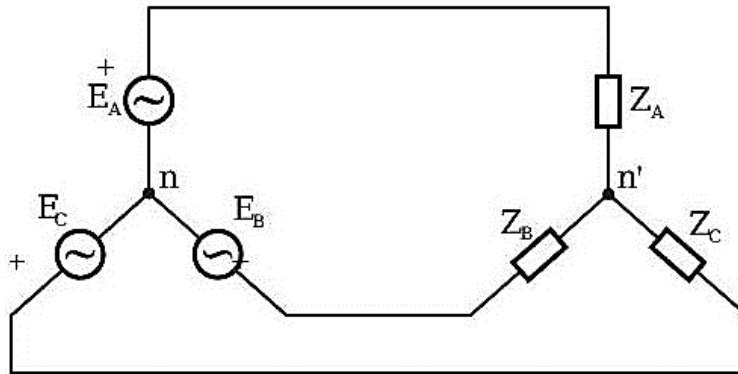
Sol. 10

Q14. The maximum clock frequency in MHz of a 4 - bit ripple counter with each flip - flop having propagation delay of 20 ns, is _____ (round off to one decimal places)

S14. Ans. ()

Sol. 12.5

Q15. Three phase star - connection unbalanced load is connected to a balanced three phase supply of $100\sqrt{3}$ V load has $Z_A = 10\Omega$ and $Z_B = 20\angle 60^\circ\Omega$. The value of Z_C in Ω for which the voltage difference across the nodes n and n' is zeros is



(a) $20\angle -30^\circ\Omega$

(b) $20\angle 30^\circ\Omega$

(c) $20\angle 60^\circ\Omega$

(d) $20\angle -60^\circ\Omega$

S15. Ans. (d)

Sol.

Q16. e^A is defined as the exponential of square matrix A and its eigen values are λ and V are the eigen vectors of the square matrix A. Consider the following statements

S: e^λ is eigen value of e^A .

S_2 : Vis the eigen vector of e^A .

(a) S_1 is correct and S_2 is incorrect

(b) S_1 is incorrect and S_2 is correct

(c) Both S and S_2 are correct

(d) Both S and S_2 are incorrect

S16. Ans. (c)

Sol.

Q17. Let a causal LTI system be governed by the following differential equation $y(t) + \frac{1}{4} \frac{dy}{dt} = 2x(t)$, where $x(t)$ and $y(t)$ are the input and output respectively. Its impulse response is

(a) $8e^{-4t}u(t)$

(b) $8e^{-\frac{1}{4}t}u(t)$

(c) $2e^{-4t}u(t)$

(d) $2e^{-\frac{1}{4}t}u(t)$

S17. Ans. (a)

Sol.

Q18. Let the probability density function of a random variable x be given as $f(x) = ae^{-2|x|}$. The value of a is

S18. Ans. (0)

Sol. 1

Q19. An LTI system is shown in the figure above $G(s) = \frac{100}{s^2 + 0.1s + 100}$. The steady state output of the system to the input $x(t)$ is given as $y(t) = a + b \sin(10t + \theta)$. The value of a and b will be

$x(t) = 1 + 0.1 \sin(10t) \longrightarrow \boxed{G(s)} \longrightarrow y(t)$

(a) $a = 100, b = 1$

(b) $a = 10, b = 1$

(c) $a = 1, b = 10$

(d) $a = 1, b = 100$

S19. Ans. (c)

Sol.

Q20. Consider a 3×3 matrix A whose $(i - j)$ th element, $a_{i,j} = (i - j)^3$. Then the matrix A will be

(a) null

(b) symmetric

(c) skew - symmetric

(d) unitary

S20. Ans. (c)

Sol.

Q21. A single-phase full bridge diode rectifier feeds a resistive load of 50Ω from a $200\text{ V}, 50\text{ Hz}$, single phase AC supply. If the diodes are ideal, then the active power in watts, drawn by the load is _ . (rounded off to nearest integer)

S21. Ans. (0)

Sol. 800

Q22. Let $f(x) = \int_0^x e^t (t - 1)(t - 2) dt$. Then $f(x)$ decreasing in the interval

(a) $x \in (2, 3)$

(b) $x \in (1, 2)$

(c) $x \in (0, 1)$

(d) $x \in (0.5, 1)$

S22. Ans. (b)

Sol.

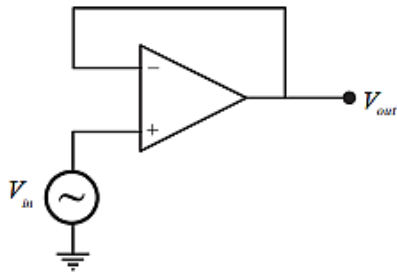
Q23. A balanced wheat stone bridge ABCD has the following arm resistances: $R_{AQ} = 1\text{k}\Omega \pm 2.1\%$; $R_{BC} = 100\Omega \pm 0.5\%$; R_{CD} is an unknown resistance; $R_{DA} = 300\Omega \pm 0.4\%$; the value of R_{CD} and its accuracy is

- (a) $3000\Omega \pm 90\Omega$
- (b) $3000\Omega \pm 3\Omega$
- (c) $30\Omega \pm 0.9\Omega$
- (d) $30\Omega \pm 3\Omega$

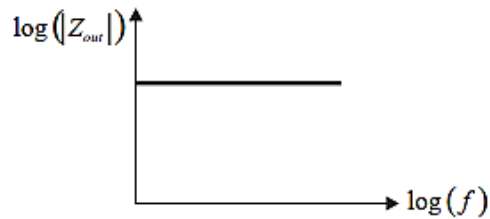
S23. Ans. (c)

Sol.

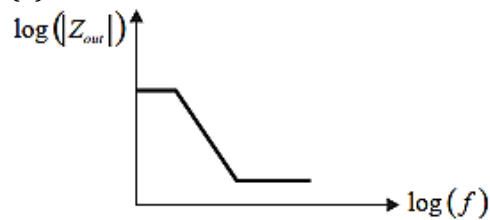
Q24. The output impedance of a non - ideal operational amplifier is denoted by Z_{out} . The variation in the magnitude of Z_{out} with increasing frequency, f in the circuit shown below, is best represented by



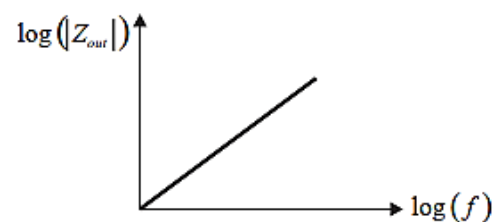
(a)



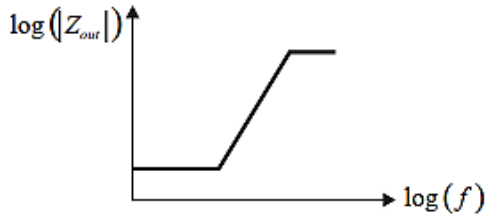
(b)



(c)



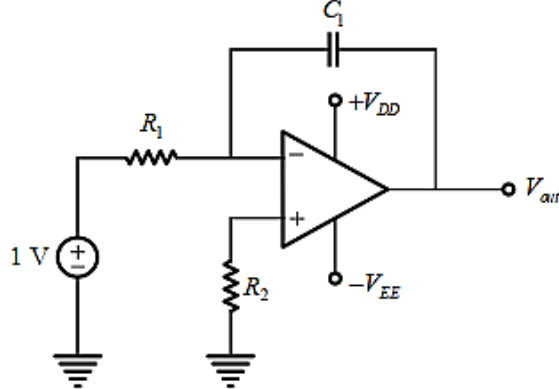
(d)



S24. Ans. (d)

Sol.

Q25. The steady state output (V_{out}) of the circuit shown below will



- (a) Saturate to $-V_{EE}$
- (b) Saturate to $+V_{DD}$
- (c) Become equal to -0.1 V
- (d) Become equal to 0.1 V

S25. Ans. (a)

Sol.

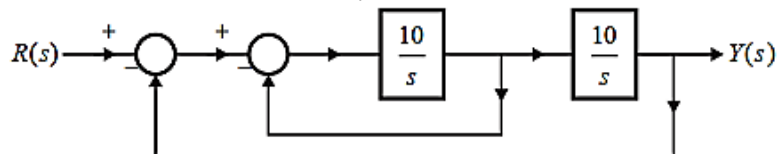
Q26. A vector is defined as $\vec{E} = 2x\hat{i} + 5y\hat{j} + 3z\hat{k}$, then find the value of $\iiint_V (\vec{\nabla} \cdot \vec{E}) dV$ is, where V is volume enclosed by unit cube ($0 < x < 1, 0 < y < 1, 0 < z < 1$)

- (a) 3
- (b) 8
- (c) 10
- (d) 5

S26. Ans. (c)

Sol.

Q27. The damping ratio in damped network frequency of a closed loop system as shown in figure are denoted as ξ and ω_n respectively. The value of ξ and ω_n are



- (a) $\xi = 0.1$ and $\omega_n = 10\text{rad/s}$
- (b) $\xi = 0.5$ and $\omega_n = 10\text{rad/s}$
- (c) $\xi = 0.707$ and $\omega_n = 10\text{rad/s}$
- (d) $\xi = 0.707$ and $\omega_n = 100\text{rad/s}$

S27. Ans. (b)

Sol.

Q28. Two generating units rated for 250 MW and 400 MW have governor speed regulations of 6% and 6.4%, respectively, from no load to full load. Both the generating units are operated in parallel to share a load of 500 MW. Assuming free governor action, the shared in MW, by the 250 MW generating unit is _____. (Round off to nearest integer)

S28. Ans. ()

Sol. 200

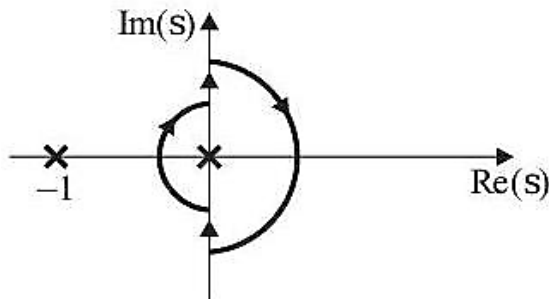
Q29. For an ideal MOSFET biased in saturation, the magnitude of the small signal current gain for a common drain amplifier is

- (a) ∞
- (b) 1
- (c) 100
- (d) 0

S29. Ans. (a)

Sol.

Q30. The open loop transfer function of unity gain negative feedback system is given as $G(s) = \frac{1}{s(s+1)}$. The Nyquist contour in the s - plane encloses the entire right half plane and a small neighborhood around the origin in the left half plane as shown in figure. The Nyquist plot of $G(s)$ corresponding to the Nyquist contour is denoted as N . Then N equals to



- (a) 3
- (b) 2
- (c) 0
- (d) 1

S30. Ans. ()

Sol. Data insufficient

Q31. The fuel cost functions in rupees 600MW thermal power plants are given by

$$\text{Plant 1: } C_1 = 350 + 6P_1 + 0.004P_1^2$$

$$\text{Plant 2: } C_2 = 450 + aP_1 + 0.003P_2^2$$

where P_1 and P_2 are power generated by plant 1 and plant 2, respectively, in MW and a is constant. The incremental cost of power (λ) is 8 rupees per MWh. The two thermal power plants together meet a total power demand of 550MW. The optimal generation of plant 1 plant 2 in MW, respectively are

- (a) 200, 350
- (b) 350, 200
- (c) 325, 225

(d) 250, 300

S31. Ans. (d)

Sol.

Q32. A 20MVA, 11.2kV, 4 - pole, 50 Hz alternator has an inertia constant of 15MJ/MVA. If the input and output power of the alternator are 15MW and 10MW, respectively, the angular acceleration in mechanical degree /s² is _____. (Round off to nearest integer)

S32. Ans. 0

Sol. 75

Q33. The valid positive, negative and zero sequence impedance (in p.u.) , respectively for a 220kV, fully transposed three - phase transmission line, from the given choices are

(a) 0.15, 0.15 and 0.35

(b) 0.2, 0.2 and 0.2

(c) 1.1, 0.15 and 0.08

(d) 0.1, 0.3 and 0.1

S33. Ans. (a)

Sol.

Q34. A 3 - phase, 415 V, 4 - pole, 50 Hz induction motor draws 5 times the rated current at rated voltage at starting. It is required to bring down the starting current from the supply of 2 times of the rated current using a 3phase autotransformer. If the magnetizing impedance of the induction motor and no transformation ratio of the transformer is given by _____. (Round off to two decimal places)

S34. Ans. 0

Sol. 0.632

Q35. A 280 V, separately excited DC motor with armature resistance of 1Ω and consistent field excitation drives a load. The load torque is proportional to speed. The motor draws a current of 30 A when running at a speed of 1000rpm neglecting frictional losses in the motor. The speed in rpm, at which the motor will run if an additional resistance value 10Ω is connected in series with the armature is _____. (Round off to nearest integer)

S35. Ans. 0

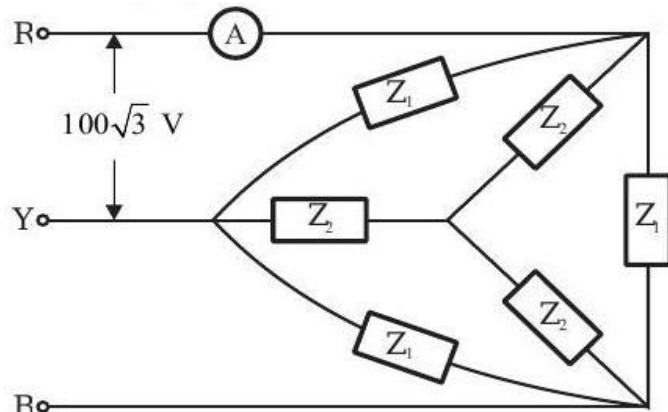
Sol. 483

Q36. If only 5% of the supplied power to a cable reaches the output terminal, the power loss in the cable in decibels, is. (Round off to nearest integers)

S36. Ans. 0

Sol. 0.22

Q37. Two balanced three phase loads, as shown in the figure, are connected to a $100\sqrt{3}$ V, three phase 50 Hz main supply. Given : $Z_1 = (18 + j24) \Omega$ and $Z_2 = (6 + j8) \Omega$. The ammeter reading, in amperes, is _____. (rounded off to nearest integer)



S37. Ans. ()

Sol. 20

Q38. The most commonly used relay, for protection of an alternative against the loss of excitation is

- (a) Buch hole relay
- (b) Differential relay
- (c) Over current relay
- (d) Off - set Mho relay

S38. Ans. (d)

Sol.

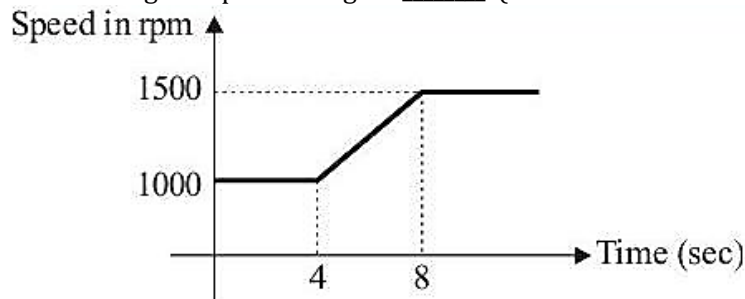
Q39. A function $f(x, y, z) = 4x^2 + 7xy + 3xz^2$. The direction of f increases most rapidly at point P (1, 0, 2) is

- (a) $20\hat{i} + 12\hat{k}$
- (b) $20\hat{i} + 7\hat{j} + 12\hat{k}$
- (c) $20\hat{i} + 7\hat{j}$
- (d) $20\hat{i}$

S39. Ans. (b)

Sol.

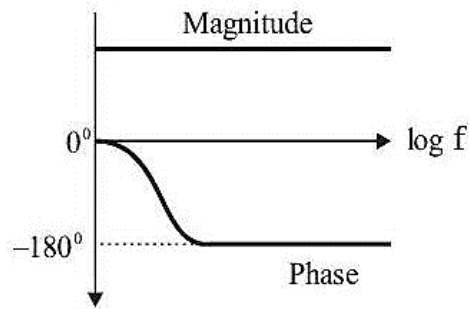
Q40. A 4 - pole induction motor with inertia of $0.1 \text{ kg} - \text{m}^2$ drives a constant load torque of 2Nm. The speed of the motor is increased linearly from 1000rpm to 1500rpm in 4 second as shown in the figure below, neglect losses in the motor. The energy in joules, consumed by the motor during the speed change is _____. (Round off to nearest integer)



S40. Ans. ()

Sol. 1047

Q41. For a first order stable system bode magnitude plot is shown below,



- (a) one left hand side pole and one right hand side zero at same frequency
- (b) one left hand side pole and two right hand side zero at same frequency
- (c) two left hand side pole and one left hand side zero at same frequency
- (d) one left hand side pole and one left hand side zero at same frequency

S41. Ans. (a)

Sol.

Q42. The frequencies of the stator and rotor currents flowing in three - phase, 8 - pole induction motor are 40 Hz and 1 Hz respectively. The motor speed in rpm is _____. (Round off to nearest integer)

S42. Ans. ()

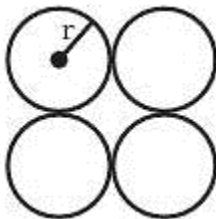
Sol. 585

Q43. The most commonly used relay for the protection of an alternator against loss of excitation is

- (a) differential relay
- (b) offset mho relay
- (c) Buchholz relay
- (d) over current relay

S43. Ans. (b)

Q44. The geometric mean radius of a conductor having four equal strands with each strand of radius 'r' as shown in the figure below is



- (a) 1.723r
- (b) 2r
- (c) 4r
- (d) 1.414r

S44. Ans. (a)

Sol.

Q45. Consider the magnetic field intensity $\mathbf{H} = x^2\hat{i} + x^2y^2\hat{j} + x^2y^2z^2\hat{k}$ A/m. The value of $|\mathbf{J}|$ at $x = 1$ m, $y = 1$ m, $z = 1$ m is _____. (round off to one decimal places)

S45. Ans. () 3.464

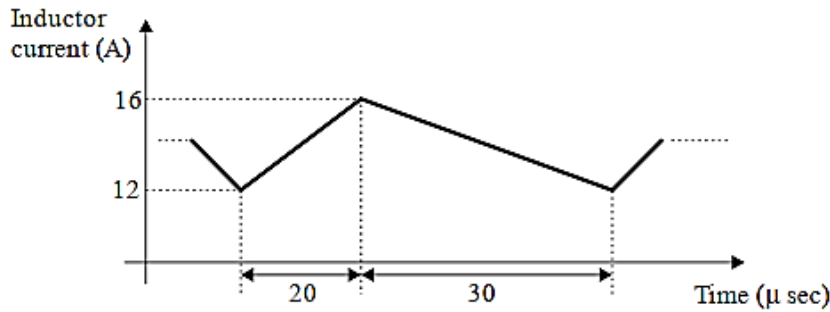
Q46. A long conducting cylindrical body having radius b is placed on z axis and $\mathbf{J} = J_a r^3 \hat{z}$ for $r < b$. r is the radial distance. The value of H for $r < b$.

- (a) $\frac{J_a}{3} r^3$
- (b) $\frac{J_a}{4} r^4$
- (c) $J_a r^3$
- (d) $\frac{J_a}{5} r^4$

S46. Ans. (d)

Sol.

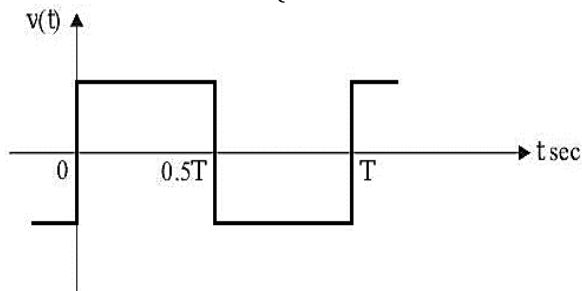
Q47. The steady state current flowing through the inductor of a DC - DC buck - boost converter is given in the figure below. If the peak - to - peak ripple in the output voltage of the converter is 1 V, then the value of the output capacitor, in μF , is _____. (rounded off to nearest integer)



S47. Ans. 0

Sol. 168

Q48. Consider an ideal full - bridge single phase DC - AC inverter with a DC bus voltage magnitude of 1000 V. The inverter output voltage $v(t)$ shown below, is obtained when diagonal switches of the inverter are switched with 50% duty cycle. The inverter feeds a load with a sinusoidal current given by, $i(t) = 10\sin\left(\omega t - \frac{\pi}{3}\right)\text{A}$, where $\omega = \frac{2\pi}{T}$. The active power in watts, delivered to the load is (rounded off to nearest integer)



S48. Ans. 0

Sol. 3183

Q49. A charger supplies 100 W at 20 V for charging the battery of a laptop. The power devices, used in the converter inside the charger, operate at a switching frequency of 200kHz. Which power device is best suited for this purpose?

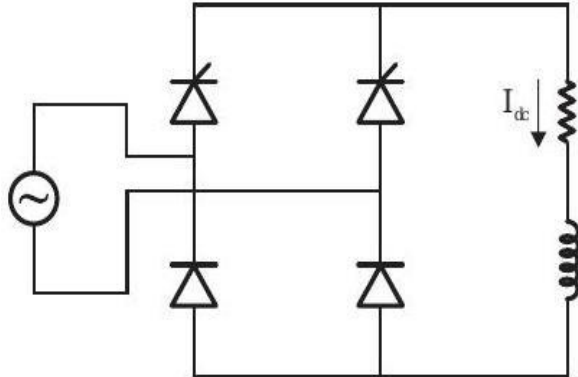
- (a) Thyristor
- (b) MOSFET
- (c) BJT

(d) IGBT

S49. Ans. (b)

Sol.

Q50. For the ideal AC - DC rectifier circuit shown in the figure below, the load current magnitude is $I_{dc} = 15$ A and is ripple free. The thyristors are fired with a delay angle of 45° . The amplitude of the fundamental component of the source current, in amperes, is _____. (rounded off to two decimal places)



S50. Ans. ()

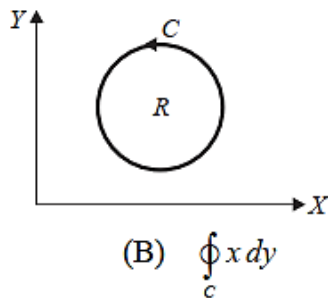
Sol. 17.65

Q51. A 3 - phase grid - connected voltage source converter with DC link voltage of 1000 V is switched using sinusoidal pulse width modulation (PWM) technique. If the grid phase current is 10 A and the 3 - phase complex power supplied by the converter is given by $(-4000 - j3000)$ VA, then the modulation index used in sinusoidal PWM is _____. (rounded off to two decimal places)

S51. Ans. ()

Sol. 0.471

Q52. Which of the not AREA of region R



(a) $\oint_C y dx$

(b) $\oint_C x dy$

(c) $\frac{1}{2} \oint_C (x dy - y dx)$

(d) $\iint dxdy$

Q53. The type of 1 - phase induction motor expected to have a maximum power factor during steady state running is

(a) Capacitor start

(b) Split phase

- (c) Capacitor start capacitor run
- (d) Shaded pole

S54. Ans. (c)

Sol.

Q54. A star connected 3 - phase synchronous motor of 400 V, 50kVA, 50 Hz has a synchronous reactance of 1Ω / phase with negligible armature resistance. The shaft load on the motor is 10 kW while the power factor is 0.8 leading. The loss is 2 kW. The magnitude of per phase excitation emf of motor in volts is _____.

S54. Ans. (0)

Sol. 244.5

General Aptitude

Q56. The letters P, Q, R, S, T and U are to be placed one per vertex on regular convex hexagon, but not necessarily in the same order. Consider the following statements.

The line segment joining R and S is longer than the line segment joining P and Q.

The line segment joining R and S is perpendicular to the line segment joining P and Q.

The line segment joining R and U is parallel to the line segment joining T and Q.

Based on the above statements which one of the following option is correct?

(a) The line segment joining T and Q is parallel to the line joining P and Q.

(b) The line segment joining Q and S is perpendicular to the line segment joining R and P.

(c) The line segment joining R and T is parallel to the line segment joining Q and S.

(d) The line segment joining R and P is perpendicular to the line segment joining U and Q.

S56. Ans. (c)

Sol.

Q57.

Statement I : some bottles are cups

Statement II : All cups are knives

Conclusion I : Some bottles are knives.

Conclusion II : Some knives are cups.

Conclusion III : All Cups are bottles

Conclusion IV : All knives are cups

Which one of the following options can be logically inferred?

(a) Only Conclusion II and III are correct

(b) only Conclusion II and IV are correct (C) Only Conclusion III and IV are correct

(d) Only Conclusion I and II correct

S57. Ans. (d)

Sol.

Q58. Altruism is the human concern for the wellbeing of others. Altruism has been shown to be motivated more by social bonding, familiarity and identification of belongingness to a group. The notion that, altruism may be attributed to empathy or guilt has now been rejected.

Which one of the following is the corrected logical inference based on the information in the above passage?

(a) Humans engage in altruism due to guilt but not empathy.

(b) Humans engage in altruism due to group identification but not empathy.

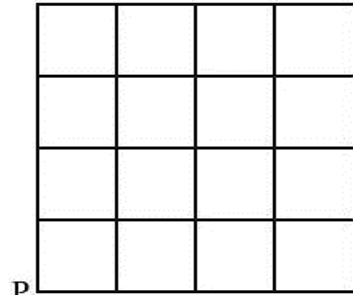
(c) Human engage in altruism due to empathy but not guilt.

(d) Human engage in altruism due to empathy but not familiarity.

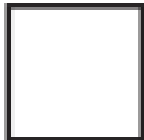
S59. Ans. (b)

Sol.

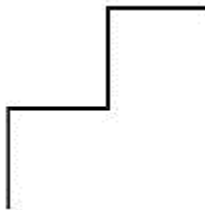
Q59. An ant is at the bottom left corner of a grid (point p) as shown below. It aims to move to the top right corner of the grid. The ant moves only along the lines marked in the grid such that the current distance to the top right corner strictly decreases. Which one of the following is a part of a passive trajectory of the ant during the movement?



(a)



(b)



(c)



(d)



S59. Ans. (b)

Sol.

Q60. Three bells P, Q and R rings periodically in a school. P rings in every 20 minutes, Q rings in every 30 minutes and R rings in every 50 minutes. If all the three bells rang at 12:00 PM, when will the three bells ring together, again the next time?

(a) 6:30 PM

(b) 5:00 PM

(c) 6:00 PM

(d) 5:30PM

S60. Ans. (b)

Sol.

Q61. The price of an item is 10% cheaper in an online store S compared to the price at another online store M, Store S charges ₹ 150 for delivery, there are no Delivery charges for orders from the store M. A person bought the item from the store S and saved ₹ 100. What is the price of the item at the online store S (in ₹) if there are no other charges than what is described above?

(a) 1500

(b) 2500

(c) 1750

(d) 2250

S61. Ans. (d)

Sol.

Q62. In a 500 m race, P and Q have speed in the ratio of 3:4. Q starts the race when P has already covered 140 m. What is the distance between P and Q (in m) when P wins the race?

(a) 20

(b) 140

(c) 40

(d) 60

S62. Ans. (a)

Sol.

Q63. There are two identical dice with a single letter on each of the faces. The following six letters: Q, R, S, T, U and V one on each of the faces. Any of the six outcomes are equally likely. The two dice are thrown once independently at random. What is the probability that the outcomes on the dice were composed only of any combination of the following possible outcomes : Q, U and V?

(a) $\frac{1}{6}$

(b) $\frac{3}{4}$

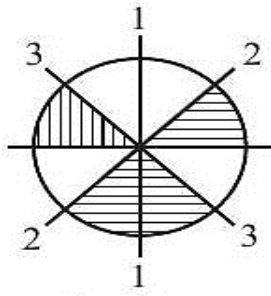
(c) $\frac{5}{36}$

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

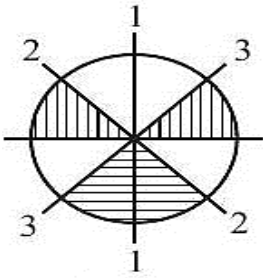
S63. Ans. (d)

Sol.

Q64. The figure below shows the front and rear view of a disc, which is shaded with identical patterns. The disc is flipped once with the respect to any one of the fixed axes 1 - 1, 2 - 2 or 3 - 3 chosen uniformly at random. What is the probability that the disc does not retain the same front and rear views after the flipping operation?



Front view



Rear view

(a) 1

(b) 0

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

(d) $\frac{1}{3}$

S64. Ans. (c)

Sol.

Q65. As you grow older, an injury to your _____ may take longer to _____.

(a) heal/heal

(b) heel/heel

(c) heel/heal

(d) heal/heel

S65. Ans. (c)

Sol.