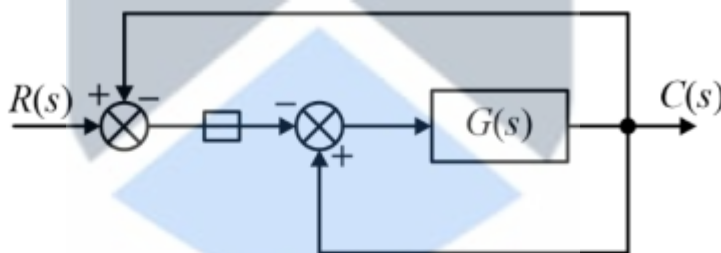


GATE 2024 Electrical Engineering (EE) Question Paper(Memory-Based)

Ques 1. Z-transform of finite duration discrete signal $x(n)$ is $X(z)$ then Z.T of $y(n) = x(2n)$ is?

- (a) $Y(z) = \frac{1}{2} \left(X(z^{1/2}) + X(-z^{1/2}) \right)$
- (b) $Y(z) = \frac{1}{2} \left(X(z^2) + X(-z^2) \right)$
- (c) $Y(z) = \frac{1}{2} \left(X(z^{-1/2}) + X(-z^{-1/2}) \right)$
- (d) $Y(z) = X(z^2)$

Ques 2. For the block dig-shown in the figure the T.F $c(s)/R(s)$ is _____

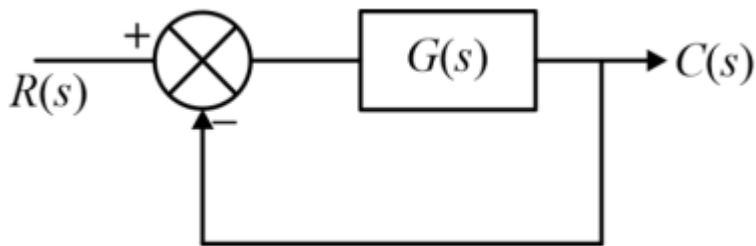


- (a) $\frac{G(s)}{1-2G(s)}$
- (b) $-\frac{G(s)}{1-2G(s)}$
- (c) $\frac{G(s)}{1+2G(s)}$
- (d) $-\frac{G(s)}{1+2G(s)}$

Ques 3. Consider the closed low system shown in the figure with

$$G(s) > \frac{k(S^2 - 2S + 2)}{S^2 + 2S + 5}.$$

The root locus for the closed loop system to be drawn for $0 < k < \infty$. The angle of departure (0° to 360°) of the root locus branch drawn from the pole $(-1 + j2)$ in degrees is _____



Ques 4. Consider the cascade system as shown in the figure. Neglecting the faster component of the transient response, which one of the following option is a first order pole. Only approximation of such that the steady value of the unit step responses of the original and the approximated system as.



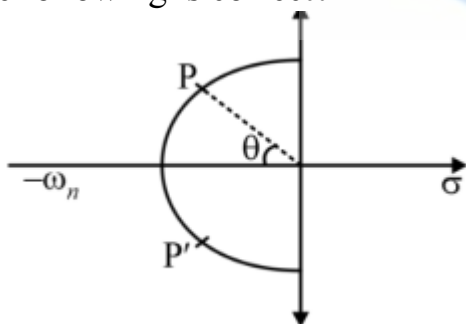
(a) $\frac{2}{s+1}$

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

(c) $\frac{1}{s+20}$

(d) $\frac{2}{s+20}$

Ques 5. Consider the standard 2nd order system with the poles P & P_n having negative real part the pole locations are also shown in the figure number consider two such second order system defined each System (1) $\omega_n = 3 \text{ rad/sec}$ & $\zeta = 60^\circ$ System (2) $\omega_n = 1 \text{ rad/sec}$ & $\zeta = 70^\circ$ Which of the following is correct?



- (a) Settling time of system (1) is more than system (2)
- (b) Settling time can't be computed from the given information
- (c) Settling time of both systems are same
- (d) Settling time of system (2) is more than system (1)

Ques 6. Consider the stable closed loop system shown in the figure. The asymptotic bode magnitude plot $G(s)$ has a constant slope of -20 dB/dec at least till 100 rad/sec with the gain crossover frequency being 10 rad/sec . The

asymptotic bode phase plot remains constant at -90° at least. $\omega = 10$ rad/sec. The steady state error of the closed system for a unit ramp input is _____. (Rounded off to 2 decimal phase).

Ques 7. Consider a vector:

$\vec{u} = 2\hat{x} + \hat{y} + 2\hat{z}$, where $\hat{x}, \hat{y}, \hat{z}$ represents the unit vector along the coordinate axes x, y, z respectively. The directional derivative of function $t(x, y, z) = 2 \ln(xy) + \ln(yz) + 3 \ln(xz)$ at the points $(x, y, z) = (1, 1, 1)$ in the direction u of is

- (a) 21
- (b) 7
- (c) 7 2 5
- (d) 0

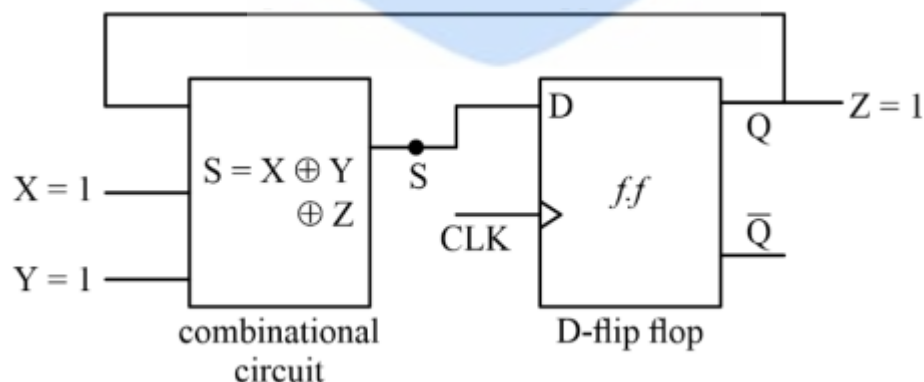
Ques 8. Input $x(t)$ & output $y(t)$ of the system related as

$$y(t) = e^{-t} \int_{-\infty}^t e^{\tau} x(\tau) d\tau, -\infty < t < \infty$$

The system is:

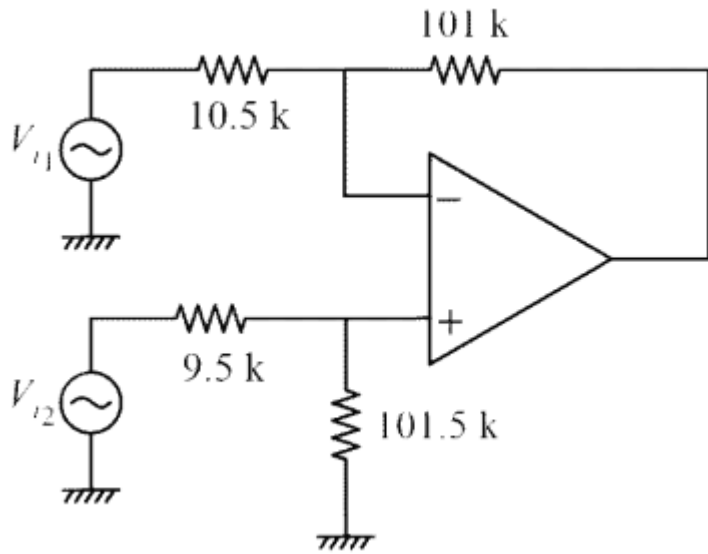
- (a) non-linear
- (b) linear & time invariant
- (c) linear but not time invariant
- (d) non-causal

Ques 9. In the circuit, the present value of Z is 1 neglecting delay in the combinational circuit. The values of s and Z respectively, after the application of clock will be

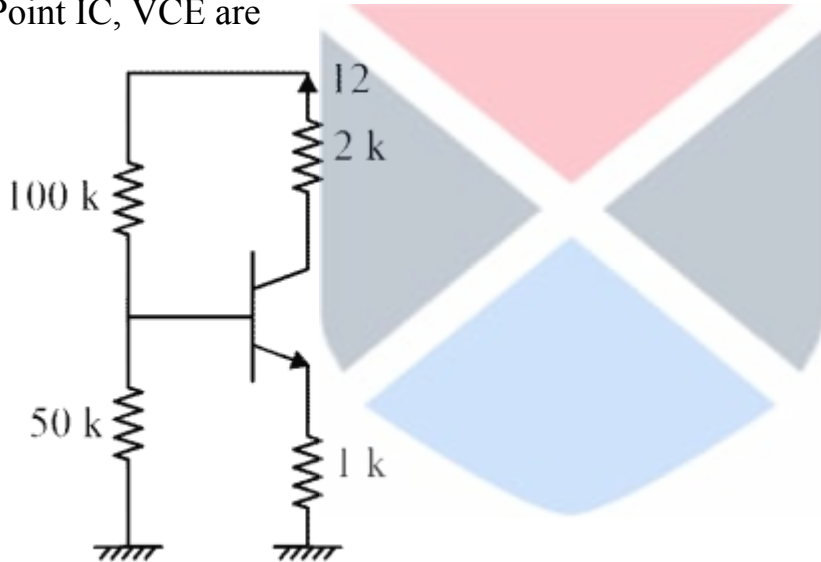


- (a) $S = 0$ $Z = 0$
- (b) $S = 1$ $Z = 0$
- (c) $S = 1$ $Z = 1$
- (d) $S = 0$ $Z = 1$

Ques 10. The difference amp is shown in the figure. Assume the op-amp is ideal the CNRR is dB is _____

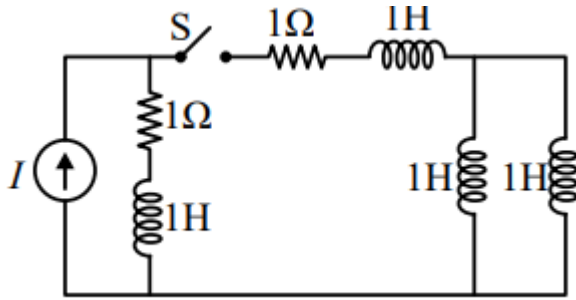


Ques 11. The BJT biasing circuit in the figure $V_{BE} = 0.7 \text{ V}$, $\beta = 1000$. The Q Point I_C , V_{CE} are



- (a) 3.5 V, 2.46 mA
- (b) 4.6 V, 2.46 mA
- (c) 2.61 V, 3.13 mA
- (d) 4.6 V, 3.17 mA

Ques 12. The circuit shown in the figure with switch open in steady state. After switch S is closed, the time constant of circuit in seconds



- (a) 1
- (b) 1.25
- (c) 1.5
- (d) 0

Ques 13. Let $X(\omega)$ be the fourier transform of the figral

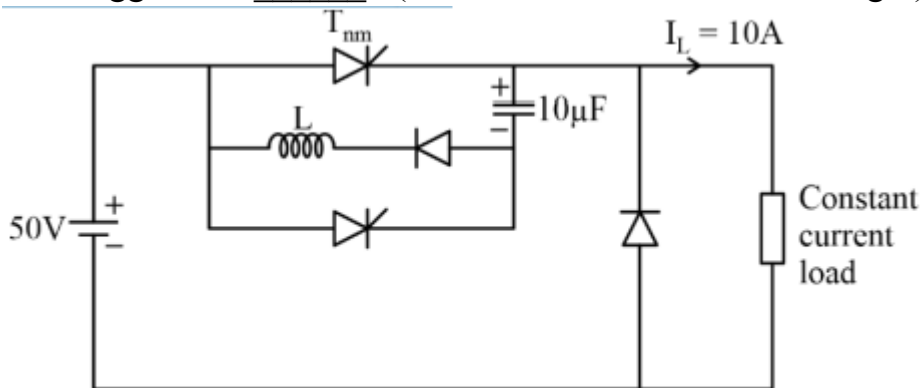
$$x(t) = e^{-t^4} \cdot \cos t \quad -\infty < t < \infty$$

The derivative of $X(\omega)$ at $\omega = 0$ is _____ (rounded off to 1 decimal place).

Ques 14. A three phase 50 Hz 6 pole induction motor runs at 960 rpm the stator copper loss. Core loss and rotate or less of the motor can be neglect the % efficiency of motor (a) 98 (b) 94 (c) 96 (d) 92

Ans. (c)

Ques 15. A forced commutated thyristorized step down chopper is shown below. Neglect the ON-state drop across the power device. Assume that the capacitor is initially charged to 50V with the polarity shown in the figure, the load current (I_L) can be assumed to be consumed at 10A. Initially, T_{main} is ON and T_A is off. The turn-off time available to T_{nm} in microseconds when T_A triggered is _____. (Rounded off to the nearest integer).



Ques 16. A single-phase time based, A.C voltage controller feeds RL load. The input a.c supply is 230 volts, 50Hz. The values of R and L are 10 and 18.37 mH respectively. The minimum triggering angle of the triac to obtain

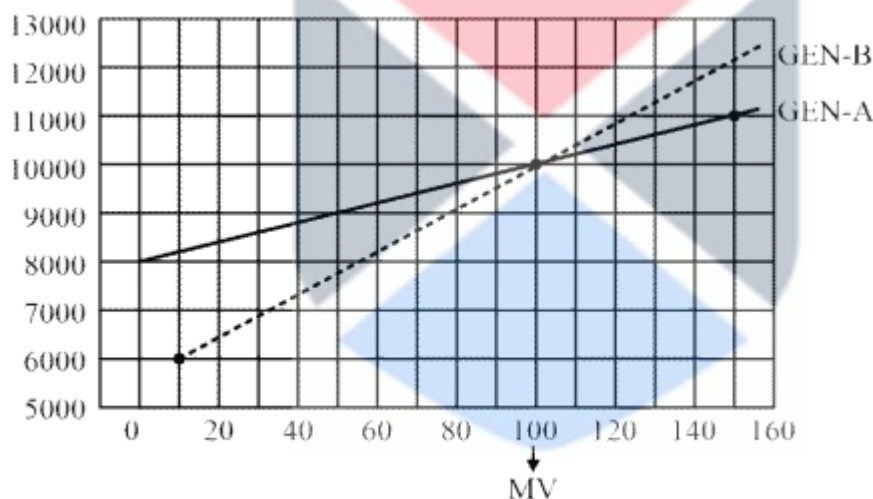
controller output voltage is

- (a) 30°
- (b) 60°
- (c) 45°
- (d) 15°

Ques 17. If the following switching devices have similar power ratings, which one of them is the fastest

- (a) G.T.O
- (b) Power mosfet
- (c) IGBT
- (d) SCR

Ques 18. The increments cost curves of the two generators (Gen A & Gen B) in a plant supplying a common load are shown in figure. If the increments cost of supplying the common load is Rs 7400 per Mwhr then common load in M.W is _____ (Round off upto two decimal digit).

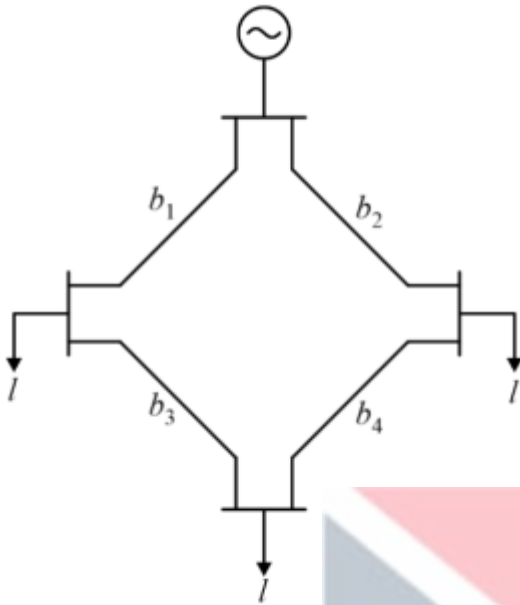


Ques 19. A 3-phase 11 kV, 10 mVA synchronous generator is connected to an inductive load of power factor $\left(\frac{\sqrt{3}}{2}\right)$ via a loss less line with 3-phase inductive reactance of 5Ω . The per phase synchronous reactance of the generator is 30 with negligible armature resistance. If the generator produces the rated current at the rated voltage. Then the power factor at the terminal of the generator.

- (a) 0.63 lagging
- (b) 0.63 leading
- (c) 0.87 leading
- (d) 0.87 lagging

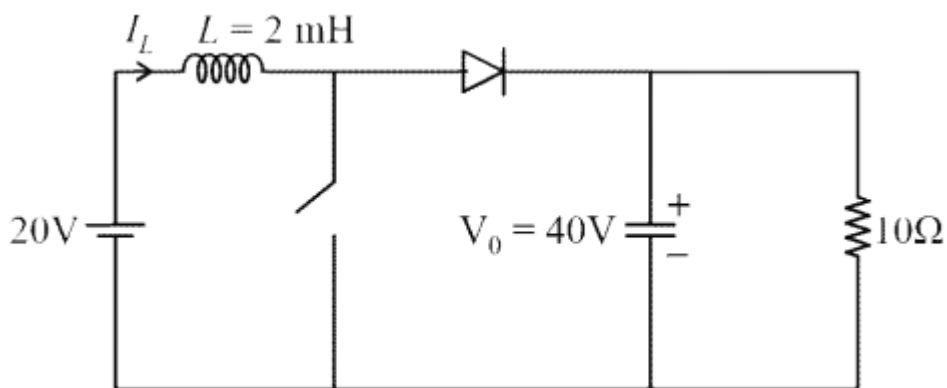
Ques 20. The figure shows a single line diagram of a 4-bar power N/. Branch b1, b2, b3 and b4 have impedances $4z$, z , $2z$ and $4z$ per unit (p.u.) respectively

where $z = r + jx$ with $r > 0$ and $x > 0$. The current drawn from a load bus (marked as an arrow) is equal to '1' p.u. where $l = 0$. Its network is to operate with minimum loss, the branch that should be opened is.



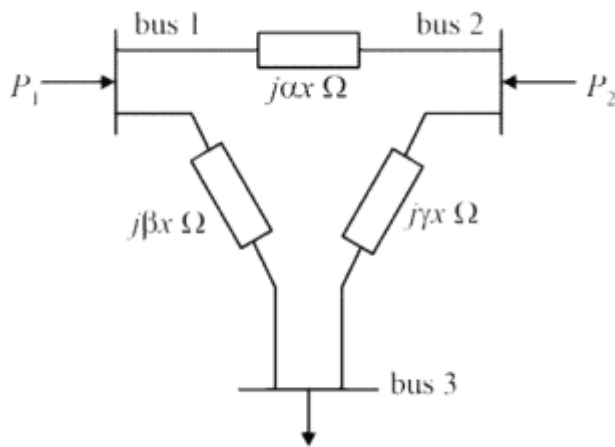
- (a) b4
- (b) b3
- (c) b1
- (d) b2

Ques 21. In the DC to DC converter is shown in figure, the current through the inductor is continuous. The switching frequency is 500 Hz. The voltage V_0 across the load is assumed to be constant and ripple free. The peak value of inductor current in ampere is _____.



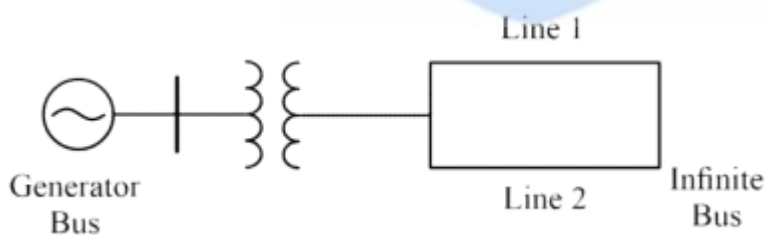
Ques 22. For the 3 bus lossless power network shown in the figure the voltage magnitude at all the buses are equal to 1 per unit (PU) and the difference of the voltage phase angles are very small the reactance's are marked in the figure where, x_1 , x_2 , and x_3 are strictly positive the bus injection P1 and P2 are in P.U. If

$P_1 = mP_2$ where $m > 0$ and the real power flow from bus 1 to bus 2 is 0 p.u. then which one of the following options is correct?



- (a) $\alpha = m\beta$
- (b) $\beta = m\gamma$
- (c) $\alpha = m\gamma$
- (d) $\gamma = m\beta$

Ques 23. The single line diagram of a loss-less system is shown in the figure. The system is operating in steady state at a stable equilibrium point with the power output of the generator being $P_{max} \sin \delta$, where δ is the load angle and the mechanical power input is $0.5 P_{max}$. A fault occurs on line 2 such that the power output of the generator is less than $0.5 P_{max}$. during the fault. After fault is cleared by opening line 2, the power output of the generation is $(P_{max} / \sqrt{2} \sin \delta)$ If the critical fault clearing angle is $\pi/2$ radians, the accelerating area on the power angle curve is _____ times P_{max} .



Ques 24. A 3-phase star connected slip ring induction motor has the following parameter referred to the stator. $R_S = 3$, $X_S = 2$, $X_r' = 2$, $R_r' = 2.5$. The per phase stator to rotor effective turn ratio 3 : 1, the rotor winding is also star connected the magnetizers reactance and core loss of the motor can be neglected to have maximum torque at starting the value of the extra resistance in ohms (referred to rotor side) to be connected in series with each phase of the rotor winding is _____ (2 decimals).

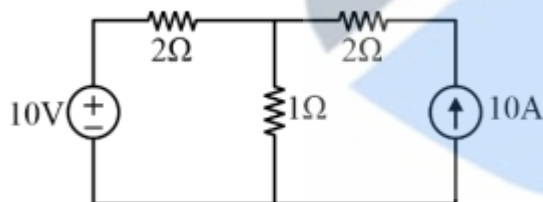
Ques 25. The table lists 2. Instrument transformers & their features.

Instrument-transformers	Features
	(P) Primary is connected in parallel to grid
(X) Current Transformer (CT)	(Q) Open circuited secondary is not desirable
(Y) Potential transformer (PT)	(R) Primary current is line current
	(S) Secondary burden effects the primary current

The correct matching of 2 columns is

- (a) X matches with P and R; Y matches with Q & S.
- (b) X matches with Q and R; Y matches with P & S.
- (c) X matches with Q and S; Y matches with P & R.
- (d) X matches with P and Q; Y matches with R and S.

Ques 26. All the elements in the circuit are ideal, the power delivered by the 10V source in _____ watt.



- (a) 100 (b) Depend on ∞ (c) 0 (d) -50

Ques 27. Simplified form of the Boolean function

$$F(P, Q, R, S) = \bar{P}\bar{Q} + \bar{P}QS + P\bar{Q}\bar{R}\bar{S} + P\bar{Q}R\bar{S}$$

- (a) $\bar{P}Q + R\bar{S}$ (b) $P\bar{S} + Q\bar{R}$
- (c) $\bar{P}S + \bar{Q}\bar{S}$ (d) $\bar{P}\bar{Q} + \bar{Q}\bar{S}$

Ques 28. Let X be a discrete random variable that is uniformly distributed over the set $(-10, -9, \dots, 0, \dots, 9, 10)$. Which of the following random variables is/are uniformly distributed.

- (a) x^3 (b) $(x - 5)^2$
- (c) $(x + 10)^2$ (d) x^2

Ques 29. Suppose signal $y(t)$ is obtained by the time reversal of signal $x(t)$, i.e. $y(t) = x(-t)$ which one of the following options is always taken about when $y(t)$ is convolved with $x(t)$.

- (a) Odd signal
- (b) Causal signal
- (c) Even signal
- (d) Anticausal signal

Ques 30. $u(t)$ is unit step signal then ROC of Laplace transform of signal is

$$x(t) = e^{t^2} (u(t-2) - u(t-10))$$

- (a) $-\infty$ to ∞
- (b) 1 to 10
- (c) $\text{Re}(s) \leq 1$
- (d) $\text{Re} \geq 10$

Ques 31. Consider the complex function $f(z) = \cos z + e^{z^2}$. The coefficient of z^5 in the Taylor series expansion of $f(z)$ about the origin is _____ (rounded off to 1 decimal place).

Ques 32. Which of the following complex function is/are analytic on the complex plane?

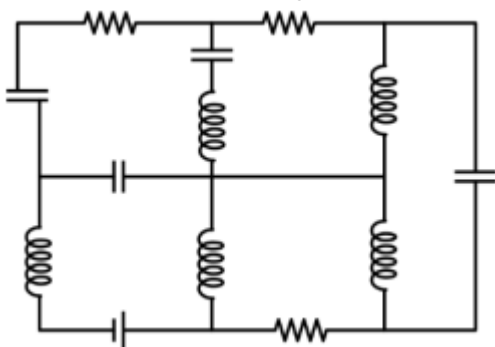
- (a) $f(z) = z^2 - z$
- (b) $f(z) = e^{|z|}$
- (c) $f(z) = I_m(z)$
- (d) $f(z) = j \text{Re}(z)$

Ques 33. The sum of eigen values of matrix

$$A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}^2$$

(rounded off to the nearest integer) is _____

Ques 34. The number of junction in the circuit is



- (a) 9
- (b) 6

- (c) 7
- (d) 8

Ques 35. Let $f(t)$ be a real valued function whose second derivative is positive for $-\infty < t < \infty$. Which of the following statements is always true?

- (a) The minimum value of $f(t)$ cannot be negative
- (b) Has at least one local maximum
- (c) $f(t)$ cannot have two distinct local minimum
- (d) $f(t)$ has at least one local minimum

Ques 36. The given equation represents a magnetic field strength $\vec{H}(r, \theta, \phi)$ in the spherical coordinate system, in the space. Here, \hat{r} and $\hat{\theta}$ represent the unit vector along r and θ , respectively. The value of P in the equation should be _____. (round off to the nearest integer)

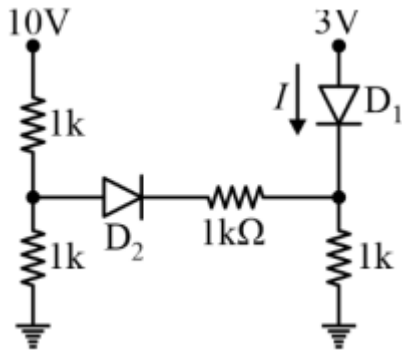
$$\vec{H}(r, \theta, \phi) = \frac{1}{r^3} (P \cos \theta \hat{a}_r + \sin \theta \hat{a}_\theta)$$

Ques 37. In the (X, Y, Z) coordinate system, three point charge Q , Q and Q are located in free space $(-1, 0, 0)$, $(1, 0, 0)$ and $(0, -1, 0)$ respectively. The value of “ r ” for the electric field to be zero at $(0, 0.5, 0)$ is _____. (Rounded off to 1 decimal places.)

Ques 38. Consider the stable closed loop system shown in the figure. The magnitude and phase value of frequency response of $G(s)$ are given in the table. The value of the gain $kI (> 0)$ for a 50° phase margin is _____.

ω	magnitude in dB	Phase in degree
0.5	-7	-40
1.0	-10	-80
1.0	-18	+30
10.0	-40	-20

Ques 39. The diode are ideal, find the current I from D1 diode _____ mA



Ques 40. Single phase half-controlled bridge converter supplies inductive load with constant load current. Triggering angle is 60° . The ratio of rms value of fundamental component of input current to the rms value of the total input current of bridge _____ (3 decimal places).

Single phase full bridge voltage source inverter feeds a purely inductive load. The inverter output voltage is a square wave in 180° conduction mode. The fundamental frequency of the output voltage is 50Hz. If the DC input voltage of the inverter is 100 V and the value of the load inductance is 20 mH, the peak to peak load current in ampere in _____. (Nearest integer).



Ques 41. A 5 kW, 220 V DC shunt motor has 0.5Ω armature resistance including brushes. The motor draws a no-load current of 3A. The field current is constant 1 A. Assuming that the core and rotational losses are constant and independent of the load, the current in (A) drawn by the motor while delivering the rated load for the best possible efficiency is _____.

Ques 42. Let 'x' discrete uniformly distributed over $\{-10, -9, \dots, 0, \dots, 9, 10\}$. Which of the following are uniformly distributed.

- (a) x^3
- (b) $(x - 5)^2$
- (c) $(x + 10)^2$
- (d) x^2

Ques 43. $f(z) = \cos z + e^{z^2}$ coefficient of z^5 in Taylor series of $f(z)$ about

origin _____.

Ques 44. Which of the following matrices has an inverse?

(a) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 1 & 2 & 4 \end{bmatrix}$

(b) $\begin{bmatrix} 1 & 2 & 3 \\ 2 & 4 & 6 \\ 3 & 2 & 9 \end{bmatrix}$

(c) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 3 & 12 & 24 \end{bmatrix}$

(d) $\begin{bmatrix} 1 & 4 & 8 \\ 0 & 4 & 2 \\ 0.5 & 2 & 4 \end{bmatrix}$

Ques 45. Which of the following is/are analytic on complex plane?

(a) $z^2 - z$

(b) $e^{|z|}$

(c) $\text{Im}(z)$

(d) $j \text{Re}(z)$

Ques 46. Sum of the eigen value of $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}^2$ is _____.

Ques 47. $f(t) = [\max(0, t)]^2$; for $-\infty < t < \infty$; which of the following statements is true?

Ques 48.

$\vec{u} = 2\hat{x} + \hat{y} + 2\hat{z}$ where $\hat{x}, \hat{y}, \hat{z}$ are unit vectors along x, y, z respective. The directional derivative of the function $f(x, y, z) = 2 \ln(xy) + \ln(yz) + 3 \ln(xz)$ at $(1, 1, 1)$ in direction of \vec{u} is

(a) 21

(b) 7

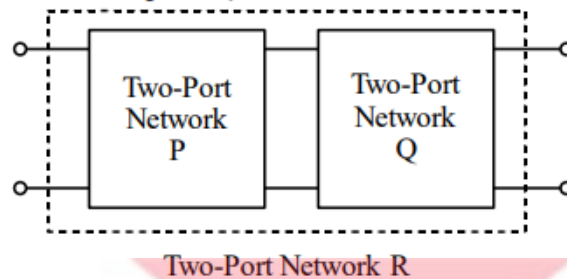
(c) $\frac{7}{5\sqrt{2}}$

(d) 0

Ques 49.

Two passive two-port networks P and Q are connected as shown in the figure. The impedance matrix of network P is $Z_P = \begin{bmatrix} 40\Omega & 60\Omega \\ 80\Omega & 100\Omega \end{bmatrix}$. The admittance matrix of network Q is $Y_Q = \begin{bmatrix} 5\text{ S} & -2.5\text{ S} \\ -2.5\text{ S} & 1\text{ S} \end{bmatrix}$. Let the ABCD matrix of the two-port network R in the figure be $\begin{bmatrix} \alpha & \beta \\ \gamma & \delta \end{bmatrix}$. The value of β in Ω is _____.

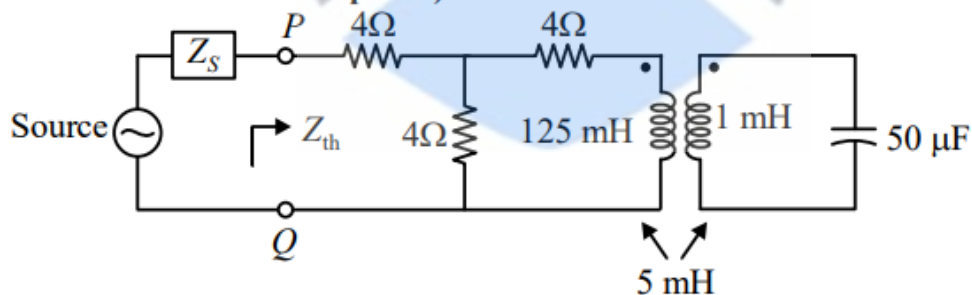
(rounded off to 2 decimal places)



Ques 50.

For the circuit shown in the figure, the source frequency is 5000 rad/sec. The mutual inductance between the magnetically coupled inductors is 5 mH with their self inductances being 125 mH and 1 mH. The Thevenin's impedance, Z_{th} between the terminals P and Q in Ω is _____.

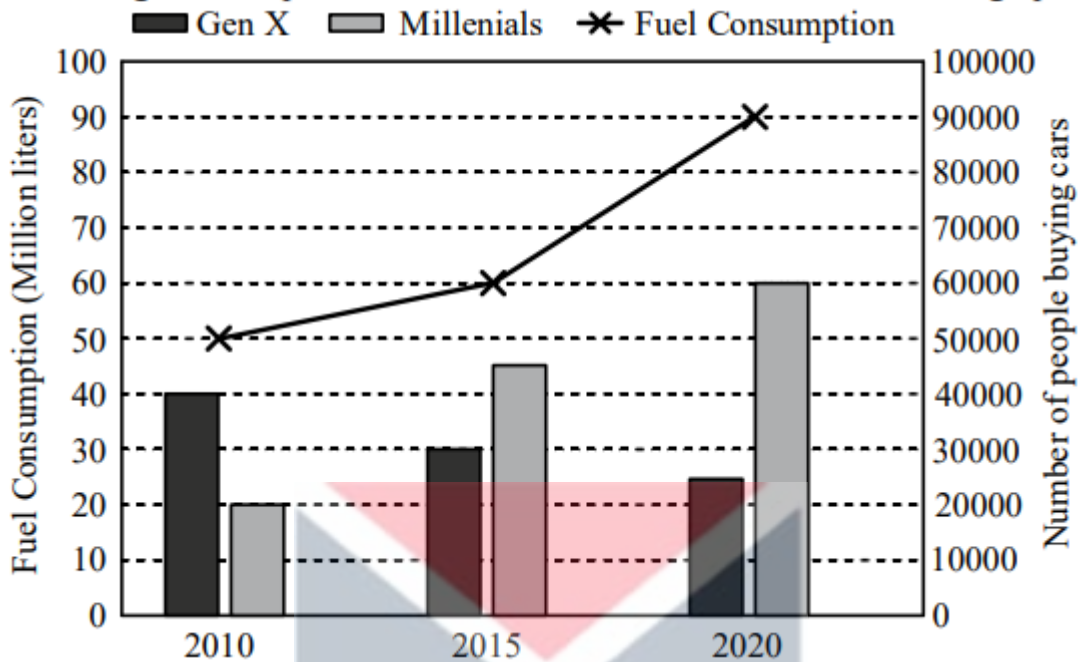
(Rounded off to 2 decimal places).



Ques 51. The decimal number system uses the characters 0, 1, 2, 8, 9, and the octal number system uses the character 0, 1, 2, 6, 7. For example, the decimal number 12 ($= 1 \times 10^1 + 2 \times 10^0$) is expressed as 14 ($= 1 \times 8^1 + 4 \times 8^0$) in the octal number system. The decimal number 108 in the octal number system is

- (a) 154
- (b) 168
- (c) 108
- (d) 150

Q.53. The chart below shows the data of the number of cars bought by Millennials and Gen X people in a country from the year 2010 to 2020 as well as the yearly fuel consumption of the country (in Million litres). Considering the data presented in the chart, which one of the following options is true?



- (a) The decrease in the number of Gen X car buyers from 2015 to 2020 is more than the increase in the number of Millennial car buyers from 2010 to 2015.
- (b) The increase in the number of Millennial car buyers from 2010 to 2015 is more than the decrease in the number of Gen X car buyers from 2010 to 2015.
- (c) The increase in the number of Millennial car buyers from 2015 to 2020 is less than the decrease in the number of Gen X car buyers from 2010 to 2015.
- (d) The percentage increase in fuel consumption from 2010 to 2015 is more than the percentage increase in fuel consumption from 2015 to 2020.

Ans. b

Ques 54. If, for non-zero real variable x , y and real parameter $a > 1$, $x : y = (a + 1) : (a - 1)$,

Then the ratio $(x^2 - y^2) : (x^2 + y^2)$ is

- (a) $2a : (a^2 + 1)$
- (b) $a : (a^2 + 1)$
- (c) $a : (a^2 - 1)$
- (d) $2a : (a^2 - 1)$

Ans. a