Q.35 Let A be an $m \times n$ matrix and B an $n \times m$ matrix. It is given that determinant $(I_m + AB)$ = determinant $(I_n + BA)$, where I_k is the $k \times k$ identity matrix. Using the above property, the determinant of the matrix given below is

$$\begin{bmatrix} 2 & 1 & 1 & 1 \\ 1 & 2 & 1 & 1 \\ 1 & 1 & 2 & 1 \\ 1 & 1 & 1 & 2 \end{bmatrix}$$

(A) 2 (B) 5 (C) 8 (D) 16

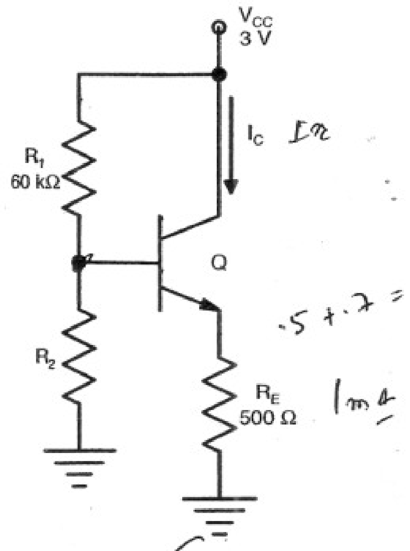
Q.36 Let U and V be two independent zero mean Gaussian random variables of variances $\frac{1}{4}$ and $\frac{1}{9}$ respectively. The probability $P(3V \geq 2U)$ is

(A) 4/9 (B) 1/2 (C) 2/3 (D) 5/9

Q.37 Let U and V be two independent and identically distributed random variables such that $P(U = +1) = P(U = -1) = \frac{1}{2}$. The entropy $H(U + V)$ in bits is

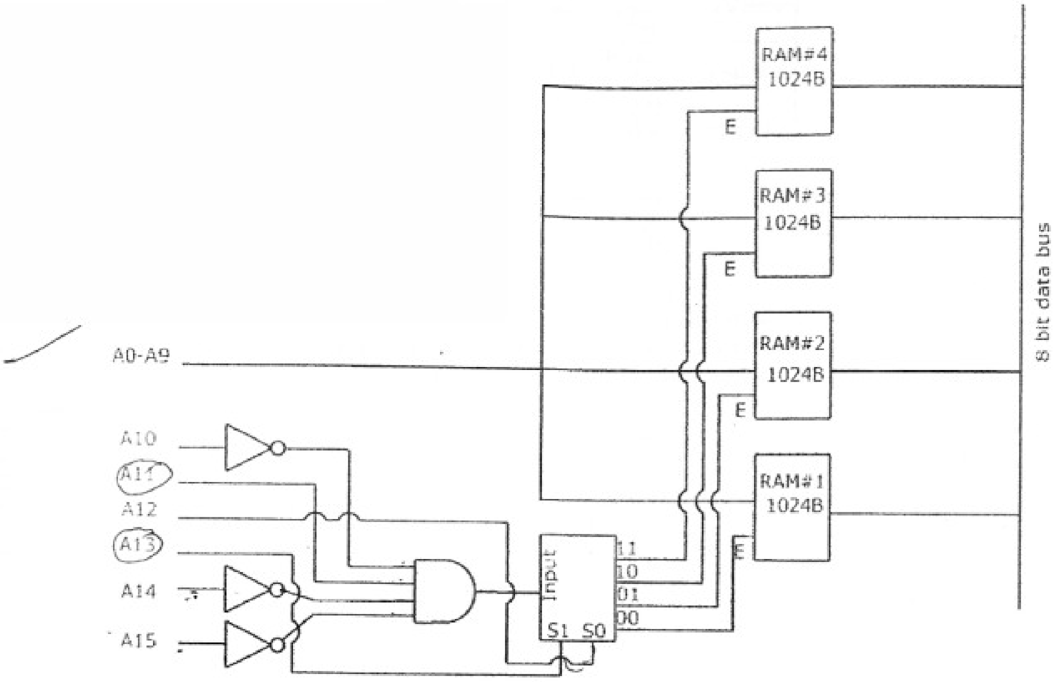
(A) 3/4 (B) 1 (C) 3/2 (D) $\log_2 3$

Q.38 In the circuit shown below, the silicon npn transistor Q has a very high value of β. The required value of R_2 in kΩ to produce $I_C = 1$ mA is



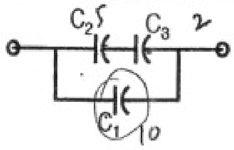
(A) 20 (B) 30 (C) 40 (D) 50

Q.39 There are four chips each of 1024 bytes connected to a 16 bit address bus as shown in the figure below. RAMs 1, 2, 3 and 4 respectively are mapped to addresses



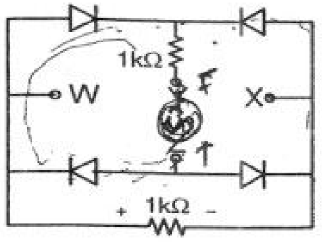
(A) 0C00H-0FFFH, 1C00H-1FFFH, 2C00H-2FFFH, 3C00H-3FFFH
(B) 1800H-1FFFH, 2800H-2FFFH, 3800H-3FFFH, 4800H-4FFFH
(C) 0500H-08FFH, 1500H-18FFH, 3500H-38FFH, 5500H-58FFH
(D) 0800H-0BFFH, 1800H-1BFFH, 2800H-2BFFH, 3800H-3BFFH

Q.40 Three capacitors C_1, C_2 and C_3 whose values are 10μF, 5μF, and 2μF respectively, have breakdown voltages of 10V, 5V, and 2V respectively. For the interconnection shown below, the maximum safe voltage in Volts that can be applied across the combination, and the corresponding total charge in μC stored in the effective capacitance across the terminals are respectively,



(A) 2.8 and 36
(B) 7 and 119
(C) 2.8 and 32
(D) 7 and 80

Q.41 A voltage $1000\sin\omega t$ Volts is applied across YZ. Assuming ideal diodes, the voltage measured across WX in Volts, is



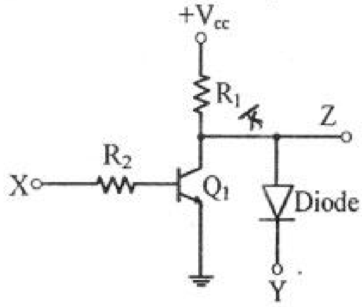
(A) $\sin\omega t$

(B) $(\sin\omega t + |\sin\omega t|)/2$

(C) $(\sin\omega t - |\sin\omega t|)/2$

(D) 0 for all t

Q.42 In the circuit shown below, Q_1 has negligible collector-to-emitter saturation voltage and the diode drops negligible voltage across it under forward bias. If V_{cc} is +5 V, X and Y are digital signals with 0 V as logic 0 and V_{cc} as logic 1, then the Boolean expression for Z is



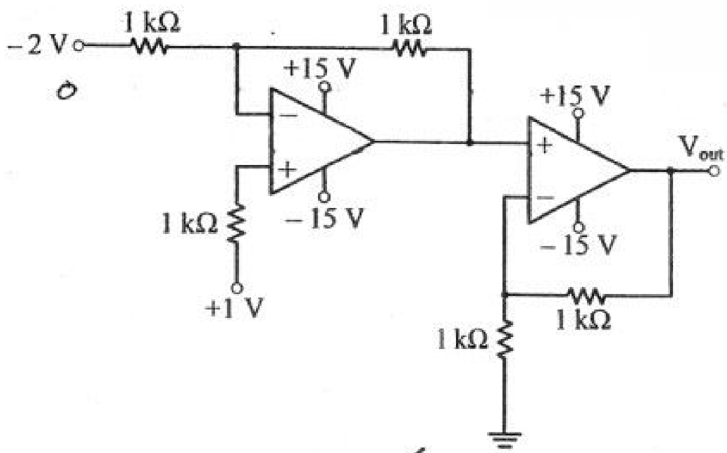
(A) XY

(B) $\overline{X}Y$

(C) $X\overline{Y}$

(D) $\overline{XY}$

Q.43 In the circuit shown below the op-amps are ideal. Then V_{out} in Volts is



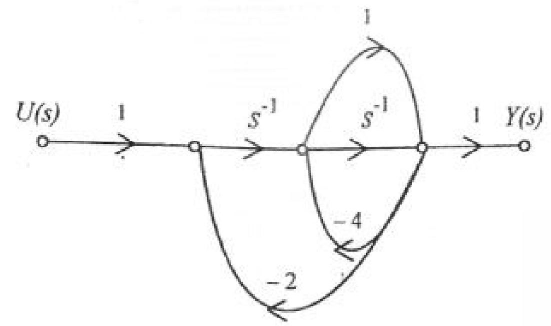
(A) 4

(B) 6

(C) 8

(D) 10

Q.44 The signal flow graph for a system is given below. The transfer function $\frac{Y(s)}{U(s)}$ for this system is



(A) $\frac{s+1}{5s^2+6s+2}$

(B) $\frac{s+1}{s^2+6s+2}$

(C) $\frac{s+1}{s^2+4s+2}$

(D) $\frac{1}{5s^2+6s+2}$

Q.45 The DFT of a vector $[a \quad b \quad c \quad d]$ is the vector $[\alpha \quad \beta \quad \gamma \quad \delta]$. Consider the product

$$[p \quad q \quad r \quad s] = [a \quad b \quad c \quad d]\begin{bmatrix} a & b & c & d \\ d & a & b & c \\ c & d & a & b \\ b & c & d & a \end{bmatrix}.$$

The DFT of the vector $[p \quad q \quad r \quad s]$ is a scaled version of

(A) $[\alpha^2 \quad \beta^2 \quad \gamma^2 \quad \delta^2]$

(B) $[\sqrt{\alpha} \quad \sqrt{\beta} \quad \sqrt{\gamma} \quad \sqrt{\delta}]$

(C) $[\alpha+\beta \quad \beta+\delta \quad \delta+\gamma \quad \gamma+\alpha]$

(D) $[\alpha \quad \beta \quad \gamma \quad \delta]$

Q.46 Consider two identically distributed zero-mean random variables U and V. Let the cumulative distribution functions of U and $2V$ be $F(x)$ and $G(x)$ respectively. Then, for all values of x

(A) $F(x)-G(x)\le 0$

(B) $F(x)-G(x)\ge 0$

(C) $(F(x)-G(x))\cdot x\le 0$

(D) $(F(x)-G(x))\cdot x\ge 0$

Q.47 A system described by a linear, constant coefficient, ordinary, first order differential equation has an exact solution given by $y(t)$ for $t>0$, when the forcing function is $x(t)$ and the initial condition is $y(0)$. If one wishes to modify the system so that the solution becomes $-2y(t)$ for $t>0$, we need to

(A) change the initial condition to $-y(0)$ and the forcing function to $2x(t)$

(B) change the initial condition to $2y(0)$ and the forcing function to $-x(t)$

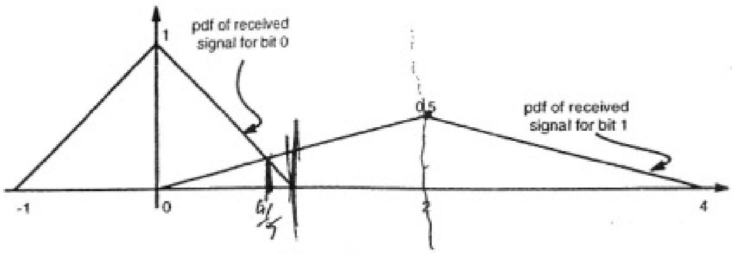
(C) change the initial condition to $j\sqrt{2}y(0)$ and the forcing function to $j\sqrt{2}x(t)$

(D) change the initial condition to $-2y(0)$ and the forcing function to $-2x(t)$

Common Data Questions

Common Data for Questions 48 and 49:

Bits 1 and 0 are transmitted with equal probability. At the receiver, the pdf of the respective received signals for both bits are as shown below.



Q.48 The optimum threshold to achieve minimum bit error rate (BER) is

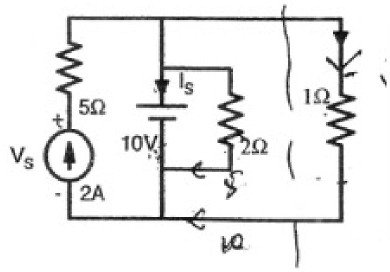
(A) $\frac{1}{2}$ (B) $\frac{4}{5}$ (C) 1 (D) $\frac{3}{2}$

Q.49 If the detection threshold is 1, the BER will be

(A) $\frac{1}{2}$ (B) $\frac{1}{4}$ (C) $\frac{1}{8}$ (D) $\frac{1}{16}$

Common Data for Questions 50 and 51:

Consider the following figure



Q.50 The current in the 1Ω resistor in Amps is

(A) 2 (B) 3.33 (C) 10 (D) 12

Q.51 The current I_S in Amps in the voltage source, and voltage V_S in Volts across the current source respectively, are

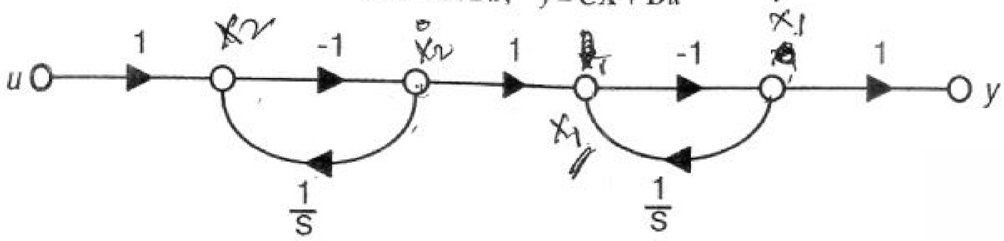
(A) 13, −20 (B) 8, −10 (C) −8, 20 (D) −13, 20

Linked Answer Questions

Statement for Linked Answer Questions 52 and 53:

The state diagram of a system is shown below. A system is described by the state-variable equations

$$\dot{X} = AX + Bu; \quad y = CX + Du$$



Q.52 The state-variable equations of the system shown in the figure above are

(A) $\dot{X} = \begin{bmatrix} -1 & 0 \\ 1 & -1 \end{bmatrix} X + \begin{bmatrix} -1 \\ 1 \end{bmatrix} u$, $y = \begin{bmatrix} 1 & -1 \end{bmatrix} X + u$

(B) $\dot{X} = \begin{bmatrix} -1 & 0 \\ -1 & -1 \end{bmatrix} X + \begin{bmatrix} -1 \\ 1 \end{bmatrix} u$, $y = \begin{bmatrix} -1 & -1 \end{bmatrix} X + u$

(C) $\dot{X} = \begin{bmatrix} -1 & 0 \\ -1 & -1 \end{bmatrix} X + \begin{bmatrix} -1 \\ 1 \end{bmatrix} u$, $y = \begin{bmatrix} -1 & -1 \end{bmatrix} X - u$

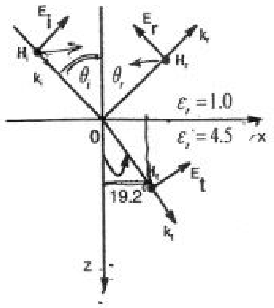
(D) $\dot{X} = \begin{bmatrix} -1 & -1 \\ 0 & -1 \end{bmatrix} X + \begin{bmatrix} -1 \\ 1 \end{bmatrix} u$, $y = \begin{bmatrix} 1 & -1 \end{bmatrix} X - u$

Q.53 The state transition matrix e^{At} of the system shown in the figure above is

(A) $\begin{bmatrix} e^{-t} & 0 \\ te^{-t} & e^{-t} \end{bmatrix}$ (B) $\begin{bmatrix} e^{-t} & 0 \\ -te^{-t} & e^{-t} \end{bmatrix}$ (C) $\begin{bmatrix} e^{-t} & 0 \\ e^{-t} & e^{-t} \end{bmatrix}$ (D) $\begin{bmatrix} e^{-t} & -te^{-t} \\ 0 & e^{-t} \end{bmatrix}$

Statement for Linked Answer Questions 54 and 55:

A monochromatic plane wave of wavelength $\lambda = 600\mu$m is propagating in the direction as shown in the figure below. $\vec{E}_i$, $\vec{E}_r$, and $\vec{E}_t$ denote incident, reflected, and transmitted electric field vectors associated with the wave.



Q.54 The angle of incidence θ_i and the expression for $\vec{E}_i$ are

(A) 60^0 and $\frac{E_0}{\sqrt{2}}(\hat{a}_x - \hat{a}_z)e^{-j\frac{\pi\times10^4(x+z)}{3\sqrt{2}}}$ V/m

(B) 45^0 and $\frac{E_0}{\sqrt{2}}(\hat{a}_x + \hat{a}_z)e^{-j\frac{\pi\times10^4 z}{3}}$ V/m

(C) 45^0 and $\frac{E_0}{\sqrt{2}}(\hat{a}_x - \hat{a}_z)e^{-j\frac{\pi\times10^4(x+z)}{3\sqrt{2}}}$ V/m

(D) 60^0 and $\frac{E_0}{\sqrt{2}}(\hat{a}_x - \hat{a}_z)e^{-j\frac{\pi\times10^4 z}{3}}$ V/m

Q.55 The expression for $\vec{E}_r$ is

(A) $0.23\frac{E_0}{\sqrt{2}}(\hat{a}_x + \hat{a}_z)e^{-j\frac{\pi\times10^4(x-z)}{3\sqrt{2}}}$ V/m

(B) $-\frac{E_0}{\sqrt{2}}(\hat{a}_x + \hat{a}_z)e^{j\frac{\pi\times10^4 z}{3}}$ V/m

(C) $0.44\frac{E_0}{\sqrt{2}}(\hat{a}_x + \hat{a}_z)e^{-j\frac{\pi\times10^4(x-z)}{3\sqrt{2}}}$ V/m

(D) $\frac{E_0}{\sqrt{2}}(\hat{a}_x + \hat{a}_z)e^{-j\frac{\pi\times10^4(x+z)}{3}}$ V/m

General Aptitude (GA) Questions

Q.56 to Q.60 carry one mark each.

Q.56 Complete the sentence:
Dare ______________ mistakes.

(A) commit (B) to commit (C) committed (D) committing

Q.57 They were requested not to **quarrel** with others.
Which one of the following options is the closest in meaning to the word **quarrel**?

(A) make out (B) call out (C) dig out (D) fall out

Q.58 **Statement:** You can always give me a ring whenever you need.
Which one of the following is the best inference from the above statement?

(A) Because I have a nice caller tune.
(B) Because I have a better telephone facility.
(C) Because a friend in need is a friend indeed.
(D) Because you need not pay towards the telephone bills when you give me a ring.

Q.59 In the summer of 2012, in New Delhi, the mean temperature of Monday to Wednesday was 41°C and of Tuesday to Thursday was 43°C. If the temperature on Thursday was 15% higher than that of Monday, then the temperature in °C on Thursday was

(A) 40 (B) 43 (C) 46 (D) 49

Q.60 Choose the grammatically **CORRECT** sentence:

(A) Two and two add four.
(B) Two and two become four.
(C) Two and two are four.
(D) Two and two make four.

Q.61 to Q.65 carry two marks each.

Q.61 The set of values of p for which the roots of the equation $3x^2+2x+p(p-1)=0$ are of opposite sign is

(A) $(-\infty, 0)$ (B) $(0, 1)$ (C) $(1, \infty)$ (D) $(0, \infty)$

Q.62 What is the chance that a leap year, selected at random, will contain 53 Saturdays?

(A) 2/7 (B) 3/7 (C) 1/7 (D) 5/7

Q.63 Find the sum to *n* terms of the series 10+84+ 734 + ...

(A) $\frac{9(9^n+1)}{10}+1$

(B) $\frac{9(9^n-1)}{8}+1$

(C) $\frac{9(9^n-1)}{8}+n$

(D) $\frac{9(9^n-1)}{8}+n^2$

Q.64 **Statement:** There were different streams of freedom movements in colonial India carried out by the moderates, liberals, radicals, socialists, and so on.

Which one of the following is the best inference from the above statement?

(A) The emergence of nationalism in colonial India led to our Independence.
(B) Nationalism in India emerged in the context of colonialism.
(C) Nationalism in India is homogeneous.
(D) Nationalism in India is heterogeneous.

Q.65 A car travels 8 km in the first quarter of an hour, 6 km in the second quarter and 16 km in the third quarter. The average speed of the car in km per hour over the entire journey is

(A) 30 (B) 36 (C) 40 (D) 24

END OF THE QUESTION PAPER