Graduate Aptitude Test in Engineering 2017

Question Paper Name:	Electronics and Communication Engineering 5th Feb 2017 session1
Subject Name:	Electronics and Communication Engineering
Duration:	180
Total Marks:	100

Organizing Institute:

Indian Institute of Technology Roorkee

Question Number : 1 Correct : 1 Wrong : -0.33

Consider the 5×5 matrix

$$A = \begin{bmatrix} 1 & 2 & 3 & 4 & 5 \\ 5 & 1 & 2 & 3 & 4 \\ 4 & 5 & 1 & 2 & 3 \\ 3 & 4 & 5 & 1 & 2 \\ 2 & 3 & 4 & 5 & 1 \end{bmatrix}.$$

It is given that A has only one real eigenvalue. Then the real eigenvalue of A is

(A) -2.5 (B) 0 (C) 15 (D) 25

Question Number : 2 Correct : 1 Wrong : -0.33

The rank of the matrix $\mathbf{M} = \begin{bmatrix} 5 & 10 & 10 \\ 1 & 0 & 2 \\ 3 & 6 & 6 \end{bmatrix}$ is

(A) 0 (B) 1 (C) 2 (D) 3

Question Number : 3 Correct : 1 Wrong : -0.33

Consider the following statements about the linear dependence of the real valued functions $y_1 = 1$, $y_2 = x$ and $y_3 = x^2$, over the field of real numbers.

I. y_1, y_2 and y_3 are linearly independent on $-1 \leq x \leq 0$
II. y_1, y_2 and y_3 are linearly dependent on $0 \leq x \leq 1$
III. y_1, y_2 and y_3 are linearly independent on $0 \leq x \leq 1$
IV. y_1, y_2 and y_3 are linearly dependent on $-1 \leq x \leq 0$

Which one among the following is correct?

(A) Both I and II are true
(B) Both I and III are true
(C) Both II and IV are true
(D) Both III and IV are true

Question Number : 4 **Correct : 1 Wrong : 0**

Three fair cubical dice are thrown simultaneously. The probability that all three dice have the same number of dots on the faces showing up is (up to third decimal place) _______.

Question Number : 5 **Correct : 1 Wrong : -0.33**

Consider the following statements for continuous-time linear time invariant (LTI) systems.

I. There is no bounded input bounded output (BIBO) stable system with a pole in the right half of the complex plane.
II. There is no causal and BIBO stable system with a pole in the right half of the complex plane.

Which one among the following is correct?

(A) Both I and II are true
(B) Both I and II are not true
(C) Only I is true
(D) Only II is true

Question Number : 6 **Correct : 1 Wrong : -0.33**

Consider a single input single output discrete-time system with $x[n]$ as input and $y[n]$ as output, where the two are related as

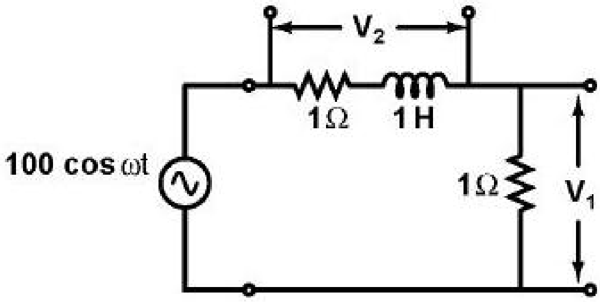
$$y[n] = \begin{cases} n|x[n]|, & \text{for } 0 \leq n \leq 10 \\ x[n] - x[n-1], & \text{otherwise.} \end{cases}$$

Which one of the following statements is true about the system?

(A) It is causal and stable
(B) It is causal but not stable
(C) It is not causal but stable
(D) It is neither causal nor stable

Question Number : 7 **Correct : 1 Wrong : 0**

In the circuit shown, the positive angular frequency ω (in radians per second) at which the magnitude of the phase difference between the voltages V_1 and V_2 equals $\frac{\pi}{4}$ radians, is ________.



Question Number : 8 Correct : 1 Wrong : -0.33

A periodic signal $x(t)$ has a trigonometric Fourier series expansion

$$x(t) = a_0 + \sum_{n=1}^{\infty} (a_n \cos n\omega_0 t + b_n \sin n\omega_0 t)$$

If $x(t) = -x(-t) = -x(t - \pi/\omega_0)$, we can conclude that

(A) a_n are zero for all n and b_n are zero for n even
(B) a_n are zero for all n and b_n are zero for n odd
(C) a_n are zero for n even and b_n are zero for n odd
(D) a_n are zero for n odd and b_n are zero for n even

Question Number : 9 Correct : 1 Wrong : -0.33

A bar of Gallium Arsenide (GaAs) is doped with Silicon such that the Silicon atoms occupy Gallium and Arsenic sites in the GaAs crystal. Which one of the following statements is true?

(A) Silicon atoms act as p-type dopants in Arsenic sites and n-type dopants in Gallium sites
(B) Silicon atoms act as n-type dopants in Arsenic sites and p-type dopants in Gallium sites
(C) Silicon atoms act as p-type dopants in Arsenic as well as Gallium sites
(D) Silicon atoms act as n-type dopants in Arsenic as well as Gallium sites

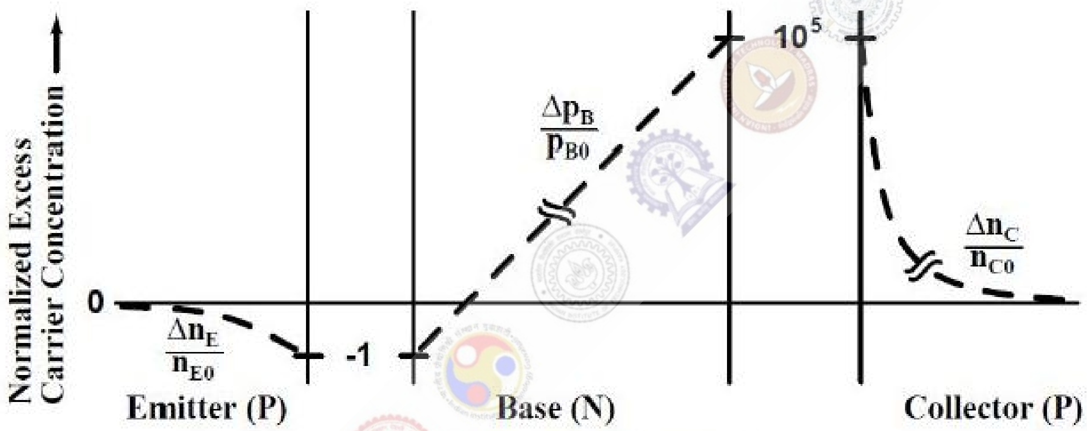
Question Number : 10 Correct : 1 Wrong : -0.33

An n^+-n Silicon device is fabricated with uniform and non-degenerate donor doping concentrations of $N_{D1} = 1 \times 10^{18}\ \text{cm}^{-3}$ and $N_{D2} = 1 \times 10^{15}\ \text{cm}^{-3}$ corresponding to the n^+ and n regions respectively. At the operational temperature T, assume complete impurity ionization, $kT/q = 25\ \text{mV}$, and intrinsic carrier concentration to be $n_i = 1 \times 10^{10}\ \text{cm}^{-3}$. What is the magnitude of the built-in potential of this device?

(A) 0.748 V (B) 0.460 V (C) 0.288 V (D) 0.173 V

Question Number : 11 Correct : 1 Wrong : -0.33

For a narrow base PNP BJT, the excess minority carrier concentrations (Δn_E for emitter, Δp_B for base, Δn_C for collector) normalized to equilibrium minority carrier concentrations (n_{E0} for emitter, p_{B0} for base, n_{C0} for collector) in the quasi-neutral emitter, base and collector regions are shown below. Which one of the following biasing modes is the transistor operating in?

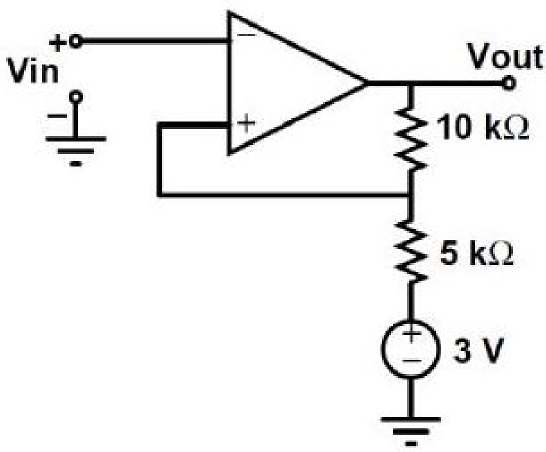


X and Y axes are not to scale

(A) Forward active (B) Saturation (C) Inverse active (D) Cutoff

Question Number : 12 Correct : 1 Wrong : -0.33

For the operational amplifier circuit shown, the output saturation voltages are ± 15 V. The upper and lower threshold voltages for the circuit are, respectively,



(A) +5 V and -5 V (B) +7 V and -3 V (C) +3 V and -7 V (D) +3 V and -3 V

Question Number : 13 **Correct : 1 Wrong : -0.33**

A good transconductance amplifier should have

(A) high input resistance and low output resistance
(B) low input resistance and high output resistance
(C) high input and output resistances
(D) low input and output resistances

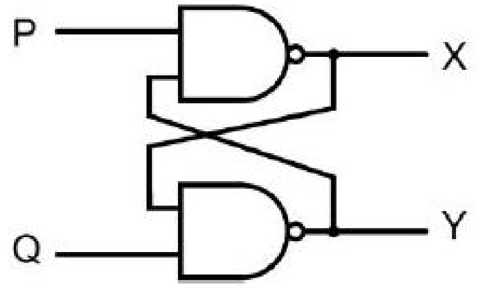
Question Number : 14 **Correct : 1 Wrong : -0.33**

The Miller effect in the context of a Common Emitter amplifier explains

(A) an increase in the low-frequency cutoff frequency
(B) an increase in the high-frequency cutoff frequency
(C) a decrease in the low-frequency cutoff frequency
(D) a decrease in the high-frequency cutoff frequency

Question Number : 15 **Correct : 1 Wrong : -0.33**

In the latch circuit shown, the NAND gates have non-zero, but unequal propagation delays. The present input condition is: P = Q = '0'. If the input condition is changed simultaneously to P = Q = '1', the outputs X and Y are



(A) X = '1', Y = '1'

(B) either X = '1', Y = '0' or X = '0', Y = '1'

(C) either X = '1', Y = '1' or X = '0', Y = '0'

(D) X = '0', Y = '0'

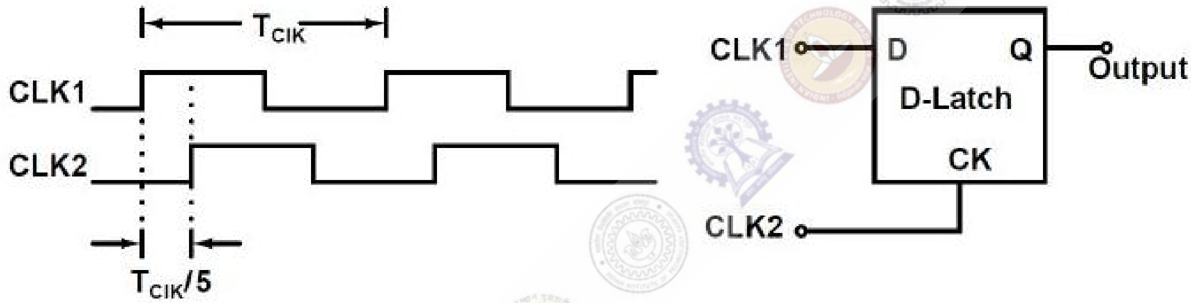
Question Number : 16 Correct : 1 Wrong : -0.33

The clock frequency of an 8085 microprocessor is 5 MHz. If the time required to execute an instruction is 1.4 μs, then the number of T-states needed for executing the instruction is

(A) 1 (B) 6 (C) 7 (D) 8

Question Number : 17 Correct : 1 Wrong : 0

Consider the D-Latch shown in the figure, which is transparent when its clock input CK is high and has zero propagation delay. In the figure, the clock signal CLK1 has a 50% duty cycle and CLK2 is a one-fifth period delayed version of CLK1. The duty cycle at the output of the latch in percentage is ___________.

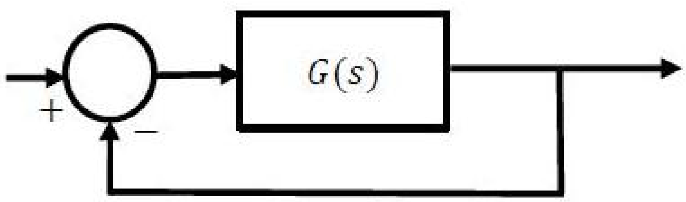


Question Number : 18 Correct : 1 Wrong : 0

The open loop transfer function

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

where p is an integer, is connected in unity feedback configuration as shown in the figure.



Given that the steady state error is zero for unit step input and is 6 for unit ramp input, the value of the parameter p is __________.

Question Number : 19

Correct : 1 Wrong : -0.33

Consider a stable system with transfer function

$$G(s) = \frac{s^p + b_1 s^{p-1} + \cdots + b_p}{s^q + a_1 s^{q-1} + \cdots + a_q}$$

where $b_1, \ldots, b_p$ and $a_1, \ldots, a_q$ are real valued constants. The slope of the Bode log magnitude curve of $G(s)$ converges to -60 dB/decade as $\omega \to \infty$. A possible pair of values for p and q is

(A) $p = 0$ and $q = 3$

(B) $p = 1$ and $q = 7$

(C) $p = 2$ and $q = 3$

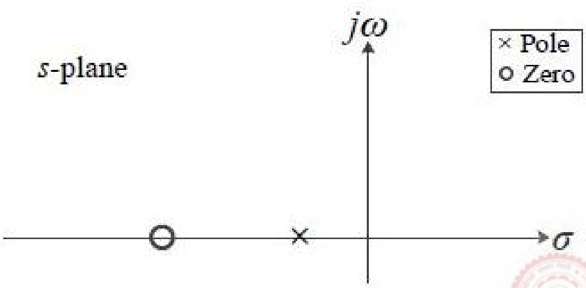
(D) $p = 3$ and $q = 5$

Question Number : 20

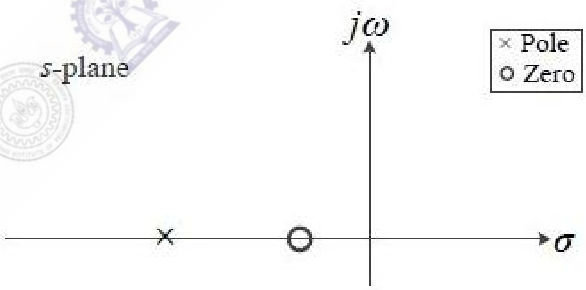
Correct : 1 Wrong : -0.33

Which of the following can be the pole-zero configuration of a phase-lag controller (lag compensator)?

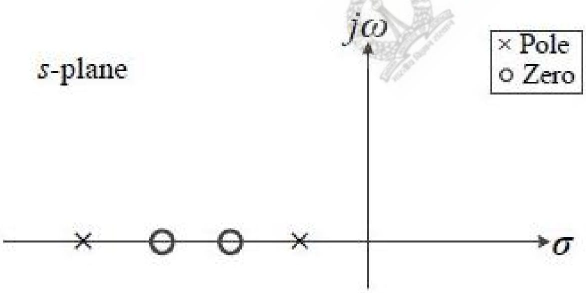
(A)



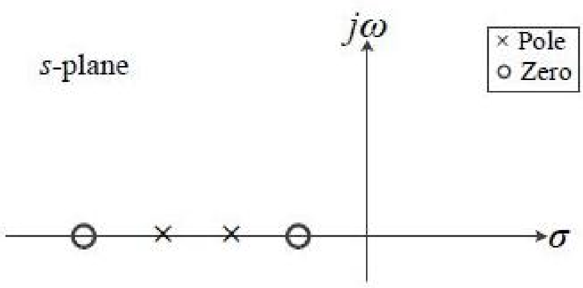
(B)



(C)



(D)



Question Number : 21

Correct : 1 Wrong : 0

Let (X_1, X_2) be independent random variables. X_1 has mean 0 and variance 1, while X_2 has mean 1 and variance 4. The mutual information $I(X_1; X_2)$ between X_1 and X_2 in bits is ________.

Question Number : 22 Correct : 1 Wrong : -0.33

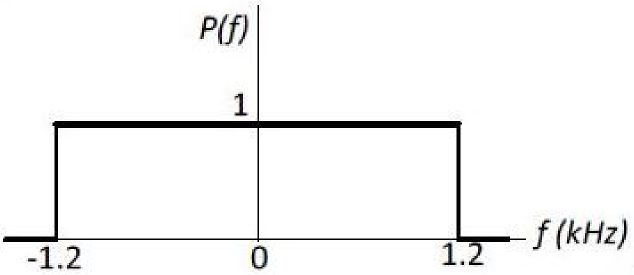
Which one of the following statements about differential pulse code modulation (DPCM) is true?

(A) The sum of message signal sample with its prediction is quantized
(B) The message signal sample is directly quantized, and its prediction is not used
(C) The difference of message signal sample and a random signal is quantized
(D) The difference of message signal sample with its prediction is quantized

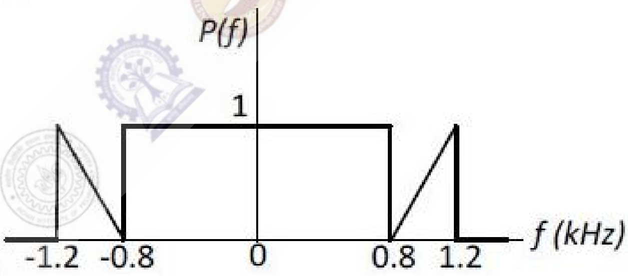
Question Number : 23 Correct : 1 Wrong : -0.33

In a digital communication system, the overall pulse shape $p(t)$ at the receiver before the sampler has the Fourier transform $P(f)$. If the symbols are transmitted at the rate of 2000 symbols per second, for which of the following cases is the inter symbol interference zero?

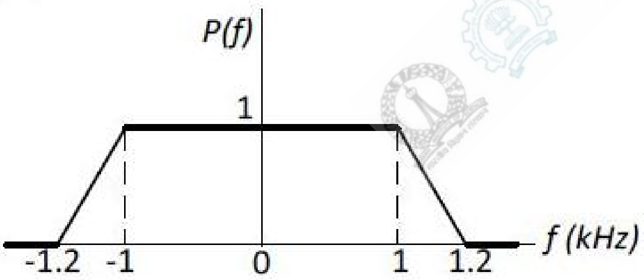
(A)



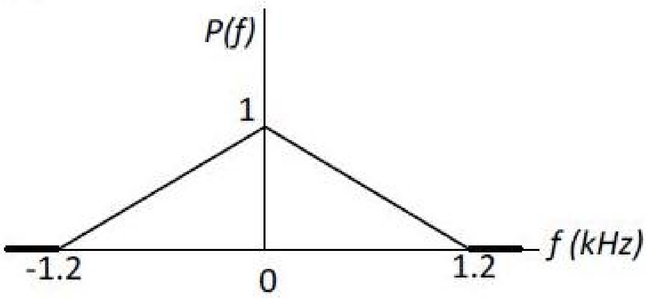
(B)



(C)



(D)



uestion Number : 24 Correct : 1 Wrong : 0

The voltage of an electromagnetic wave propagating in a coaxial cable with uniform characteristic impedance is $V(l) = e^{-\gamma l + j\omega t}$ Volts, where l is the distance along the length of the cable in metres, $\gamma = (0.1 + j40)\ \mathrm{m}^{-1}$ is the complex propagation constant, and $\omega = 2\pi \times 10^9$ rad/s is the angular frequency. The absolute value of the attenuation in the cable in dB/metre is ___________.

Question Number : 25 Correct : 1 Wrong : -0.33

Consider a wireless communication link between a transmitter and a receiver located in free space, with finite and strictly positive capacity. If the effective areas of the transmitter and the receiver antennas, and the distance between them are all doubled, and everything else remains unchanged, the maximum capacity of the wireless link

(A) increases by a factor of 2
(B) decreases by a factor of 2
(C) remains unchanged
(D) decreases by a factor of $\sqrt{2}$

Question Number : 26 Correct : 2 Wrong : -0.66

Let $f(x) = e^{x+x^2}$ for real x. From among the following, choose the Taylor series approximation of $f(x)$ around $x = 0$, which includes all powers of x less than or equal to 3.

(A) $1 + x + x^2 + x^3$
(B) $1 + x + \frac{3}{2}x^2 + x^3$
(C) $1 + x + \frac{3}{2}x^2 + \frac{7}{6}x^3$
(D) $1 + x + 3x^2 + 7x^3$

Question Number : 27 Correct : 2 Wrong : 0

A three dimensional region R of finite volume is described by

$$x^2 + y^2 \leq z^3;\ 0 \leq z \leq 1,$$

where x, y, z are real. The volume of R (up to two decimal places) is __________.

Question Number : 28 Correct : 2 Wrong : 0

Let $I = \int_C (2z\,dx + 2y\,dy + 2x\,dz)$ where x, y, z are real, and let C be the straight line segment from point A: $(0, 2, 1)$ to point B: $(4, 1, -1)$. The value of I is ____________.

Question Number : 29 **Correct : 2 Wrong : -0.66**

Which one of the following is the general solution of the first order differential equation

$$\frac{dy}{dx} = (x + y - 1)^2 ,$$

where x, y are real?

(A) $y = 1 + x + \tan^{-1}(x + c)$, where c is a constant.
(B) $y = 1 + x + \tan(x + c)$, where c is a constant.
(C) $y = 1 - x + \tan^{-1}(x + c)$, where c is a constant.
(D) $y = 1 - x + \tan(x + c)$, where c is a constant.

Question Number : 30 **Correct : 2 Wrong : 0**

Starting with $x = 1$, the solution of the equation $x^3 + x = 1$, after two iterations of Newton-Raphson's method (up to two decimal places) is ___________

Question Number : 31 **Correct : 2 Wrong : -0.66**

Let $x(t)$ be a continuous time periodic signal with fundamental period $T = 1$ seconds. Let $\{a_k\}$ be the complex Fourier series coefficients of $x(t)$, where k is integer valued. Consider the following statements about $x(3t)$:

I. The complex Fourier series coefficients of $x(3t)$ are $\{a_k\}$ where k is integer valued
II. The complex Fourier series coefficients of $x(3t)$ are $\{3a_k\}$ where k is integer valued
III. The fundamental angular frequency of $x(3t)$ is 6π rad/s

For the three statements above, which one of the following is correct?

(A) only II and III are true
(B) only I and III are true
(C) only III is true
(D) only I is true

Question Number : 32 **Correct : 2 Wrong : 0**

Two discrete-time signals $x[n]$ and $h[n]$ are both non-zero only for $n = 0, 1, 2$, and are zero otherwise. It is given that

$$x[0] = 1, \qquad x[1] = 2, \qquad x[2] = 1, \qquad h[0] = 1.$$

Let $y[n]$ be the linear convolution of $x[n]$ and $h[n]$. Given that $y[1] = 3$ and $y[2] = 4$, the value of the expression $(10y[3] + y[4])$ is ___________.

Question Number : 33 Correct : 2 Wrong : 0

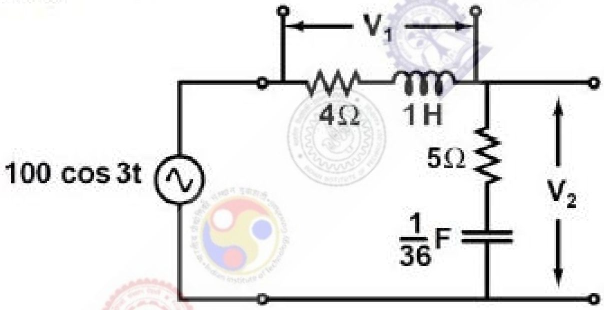
Let $h[n]$ be the impulse response of a discrete-time linear time invariant (LTI) filter. The impulse response is given by

$$h[0] = \frac{1}{3};\ h[1] = \frac{1}{3};\ h[2] = \frac{1}{3};\ \text{and}\ \ h[n] = 0 \text{ for } n < 0 \text{ and } n > 2.$$

Let $H(\omega)$ be the discrete-time Fourier transform (DTFT) of $h[n]$, where ω is the normalized angular frequency in radians. Given that $H(\omega_0) = 0$ and $0 < \omega_0 < \pi$, the value of ω_0 (in radians) is equal to ________.

Question Number : 34 Correct : 2 Wrong : 0

The figure shows an RLC circuit excited by the sinusoidal voltage $100\cos(3t)$ Volts, where t is in seconds. The ratio $\frac{\text{amplitude of } V_2}{\text{amplitude of } V_1}$ is ________.

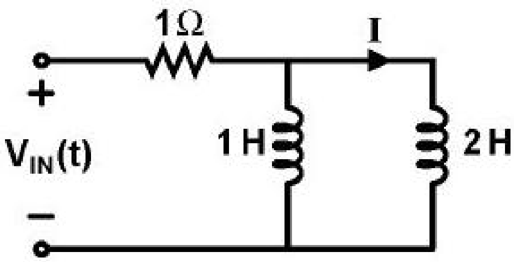


Question Number : 35 Correct : 2 Wrong : 0

In the circuit shown, the voltage $V_{IN}(t)$ is described by:

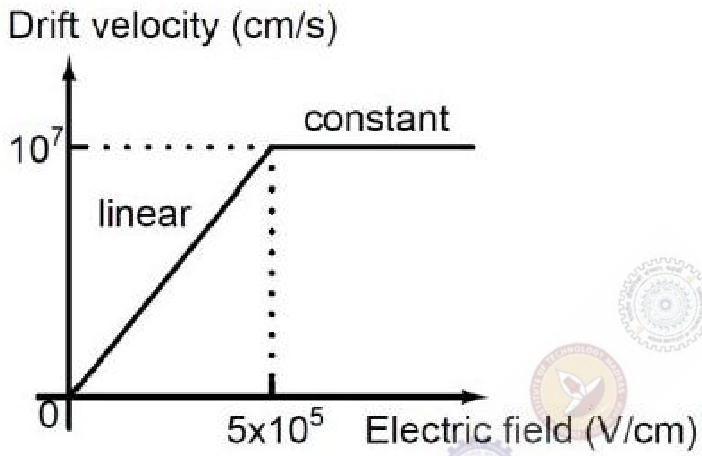
$$V_{IN}(t) = \begin{cases} 0, & \text{for } t < 0 \\ 15 \text{ Volts}, & \text{for } t \geq 0 \end{cases}$$

where t is in seconds. The time (in seconds) at which the current **I** in the circuit will reach the value 2 Amperes is ________.



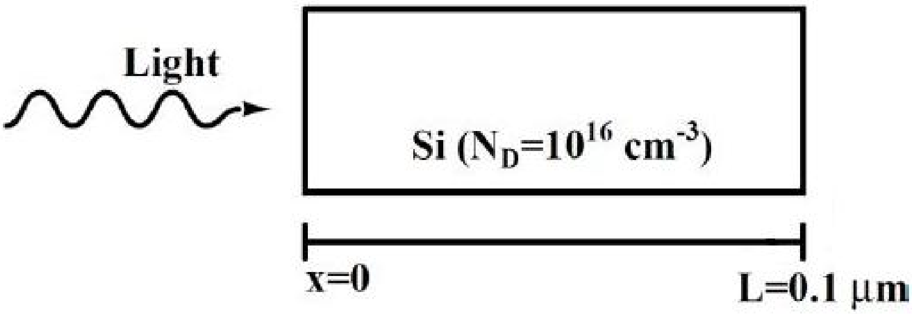
Question Number : 36 Correct : 2 Wrong : 0

The dependence of drift velocity of electrons on electric field in a semiconductor is shown below. The semiconductor has a uniform electron concentration of $n = 1 \times 10^{16}\ \text{cm}^{-3}$ and electronic charge $q = 1.6 \times 10^{-19}$ C. If a bias of 5 V is applied across a 1 μm region of this semiconductor, the resulting current density in this region, in kA/cm^2, is ________.



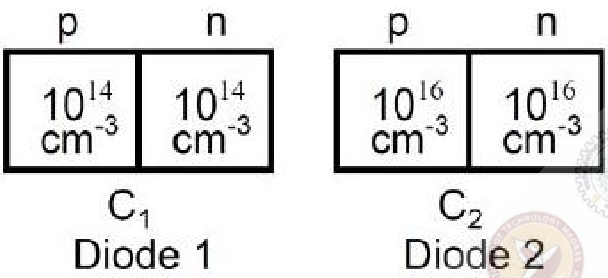
Question Number : 37 Correct : 2 Wrong : 0

As shown, a uniformly doped Silicon (Si) bar of length $L = 0.1$ μm with a donor concentration $N_D = 10^{16}\ \text{cm}^{-3}$ is illuminated at $x = 0$ such that electron and hole pairs are generated at the rate of $G_L = G_{L0}\left(1 - \frac{x}{L}\right), 0 \le x \le L$, where $G_{L0} = 10^{17}\ \text{cm}^{-3}\text{s}^{-1}$. Hole lifetime is 10^{-4} s, electronic charge $q = 1.6 \times 10^{-19}$ C, hole diffusion coefficient $D_p = 100\ \text{cm}^2/\text{s}$ and low level injection condition prevails. Assuming a linearly decaying steady state excess hole concentration that goes to 0 at $x = L$, the magnitude of the diffusion current density at $x = L/2$, in A/cm^2, is ________.



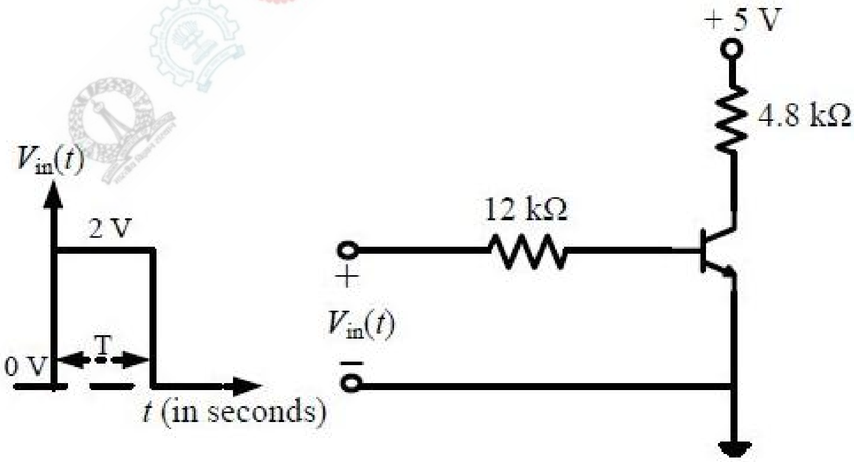
Question Number : 38 Correct : 2 Wrong : 0

As shown, two Silicon (Si) abrupt *p-n* junction diodes are fabricated with uniform donor doping concentrations of $N_{D1} = 10^{14}$ cm^{-3} and $N_{D2} = 10^{16}$ cm^{-3} in the *n*-regions of the diodes, and uniform acceptor doping concentrations of $N_{A1} = 10^{14}$ cm^{-3} and $N_{A2} = 10^{16}$ cm^{-3} in the *p*-regions of the diodes, respectively. Assuming that the reverse bias voltage is $\gg$ built-in potentials of the diodes, the ratio C_2/C_1 of their reverse bias capacitances for the same applied reverse bias, is ________.



Question Number : 39 Correct : 2 Wrong : 0

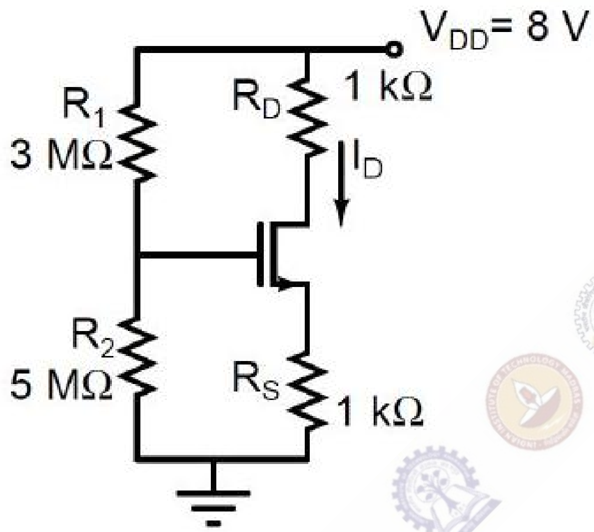
In the figure shown, the *npn* transistor acts as a switch.



For the input $V_{in}(t)$ as shown in the figure, the transistor switches between the cut-off and saturation regions of operation, when T is large. Assume collector-to-emitter voltage at saturation $V_{CE(sat)} = 0.2$V and base-to-emitter voltage $V_{BE} = 0.7$V. The minimum value of the common-base current gain (α) of the transistor for the switching should be ___________.

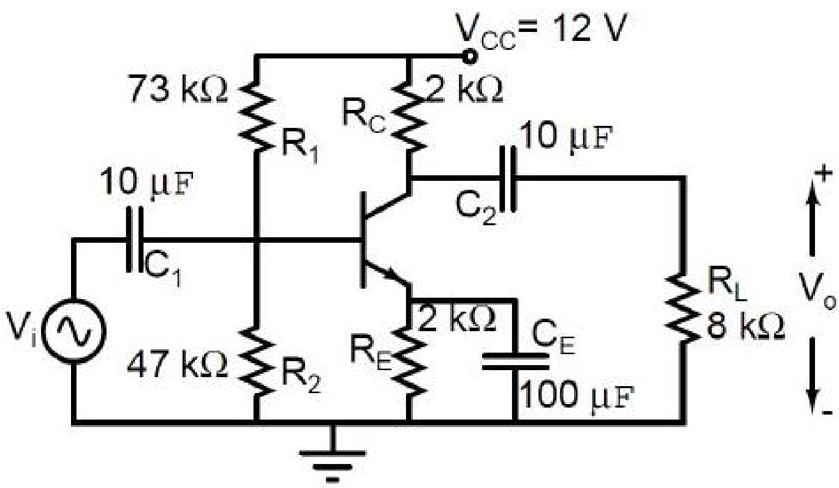
Question Number : 40 Correct : 2 Wrong : 0

For the circuit shown, assume that the NMOS transistor is in saturation. Its threshold voltage $V_{tn} = 1\ V$ and its transconductance parameter $\mu_n C_{ox}\left(\frac{W}{L}\right) = 1\ mA/V^2$. Neglect channel length modulation and body bias effects. Under these conditions, the drain current I_D in mA is ___________.



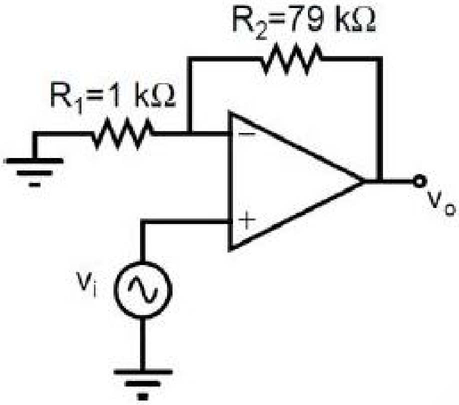
Question Number : 41 Correct : 2 Wrong : 0

For the DC analysis of the Common-Emitter amplifier shown, neglect the base current and assume that the emitter and collector currents are equal. Given that $V_T = 25$ mV, $V_{BE} = 0.7$ V, and the BJT output resistance r_o is practically infinite. Under these conditions, the midband voltage gain magnitude, $A_v = |v_o/v_i|$ V/V, is ____________.



Question Number : 42 **Correct : 2 Wrong : 0**

The amplifier circuit shown in the figure is implemented using a compensated operational amplifier (op-amp), and has an open-loop voltage gain, $A_0 = 10^5$ V/V and an open-loop cut-off frequency, $f_c = $ 8 Hz. The voltage gain of the amplifier at 15 kHz, in V/V, is____________.



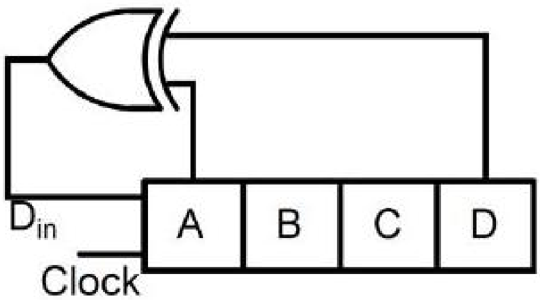
Question Number : 43 **Correct : 2 Wrong : -0.66**

Which one of the following gives the simplified sum of products expression for the Boolean function $F = m_0 + m_2 + m_3 + m_5$, where m_0, m_2, m_3 and m_5 are minterms corresponding to the inputs A, B and C with A as the MSB and C as the LSB?

(A) $\bar{A}B + \bar{A}\bar{B}\bar{C} + A\bar{B}C$
(B) $\bar{A}\bar{C} + \bar{A}B + A\bar{B}C$
(C) $\bar{A}\bar{C} + A\bar{B} + A\bar{B}C$
(D) $\bar{A}BC + \bar{A}\bar{C} + A\bar{B}C$

Question Number : 44 **Correct : 2 Wrong : 0**

A 4-bit shift register circuit configured for right-shift operation, i.e. $D_{in} \rightarrow A,\ A \rightarrow B,\ B \rightarrow C,\ C \rightarrow D$, is shown. If the present state of the shift register is $ABCD = 1101$, the number of clock cycles required to reach the state $ABCD = 1111$ is __________.



Question Number : 45 **Correct : 2 Wrong : -0.66**

The following FIVE instructions were executed on an 8085 microprocessor.

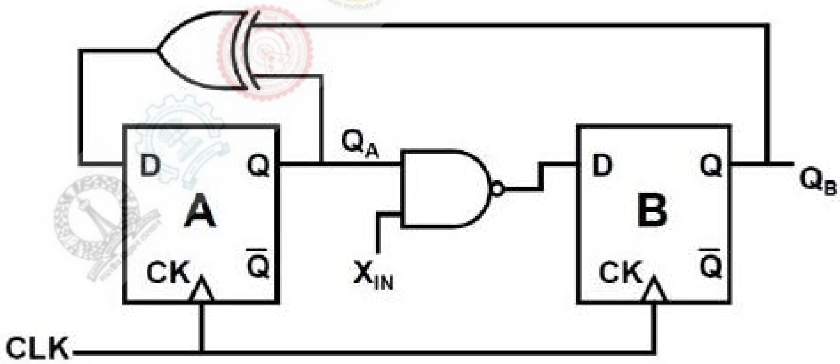
```
MVI A, 33H
MVI B, 78H
ADD B
CMA
ANI 32H
```

The Accumulator value immediately after the execution of the fifth instruction is

(A) 00H (B) 10H (C) 11H (D) 32H

Question Number : 46 **Correct : 2 Wrong : -0.66**

A finite state machine (FSM) is implemented using the D flip-flops A and B, and logic gates, as shown in the figure below. The four possible states of the FSM are $Q_AQ_B = 00, 01, 10, \text{and } 11$.



Assume that X_{IN} is held at a constant logic level throughout the operation of the FSM. When the FSM is initialized to the state $Q_AQ_B = 00$ and clocked, after a few clock cycles, it starts cycling through

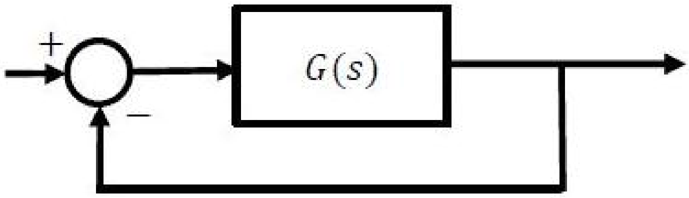
(A) all of the four possible states if $X_{IN} = 1$
(B) three of the four possible states if $X_{IN} = 0$
(C) only two of the four possible states if $X_{IN} = 1$
(D) only two of the four possible states if $X_{IN} = 0$

Question Number : 47 Correct : 2 Wrong : -0.66

A linear time invariant (LTI) system with the transfer function

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

is connected in unity feedback configuration as shown in the figure.



For the closed loop system shown, the root locus for $0 < K < \infty$ intersects the imaginary axis for $K = 1.5$. The closed loop system is stable for

(A) $K > 1.5$
(B) $1 < K < 1.5$
(C) $0 < K < 1$
(D) no positive value of K

Question Number : 48 Correct : 2 Wrong : -0.66

Which one of the following options correctly describes the locations of the roots of the equation $s^4 + s^2 + 1 = 0$ on the complex plane?

(A) Four left half plane (LHP) roots
(B) One right half plane (RHP) root, one LHP root and two roots on the imaginary axis
(C) Two RHP roots and two LHP roots
(D) All four roots are on the imaginary axis

Question Number : 49 Correct : 2 Wrong : -0.66

The Nyquist plot of the transfer function

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

does not encircle the point $(-1 + j0)$ for $K = 10$ but does encircle the point $(-1 + j0)$ for $K = 100$. Then the closed loop system (having unity gain feedback) is

(A) stable for $K = 10$ and stable for $K = 100$
(B) stable for $K = 10$ and unstable for $K = 100$
(C) unstable for $K = 10$ and stable for $K = 100$
(D) unstable for $K = 10$ and unstable for $K = 100$

Question Number : 50

Correct : 2 Wrong : -0.66

In binary frequency shift keying (FSK), the given signal waveforms are

$$u_0(t) = 5\cos(20000\pi t)\,; 0 \le t \le T, \text{and}$$
$$u_1(t) = 5\cos(22000\pi t)\,; 0 \le t \le T,$$

where T is the bit-duration interval and t is in seconds. Both $u_0(t)$ and $u_1(t)$ are zero outside the interval $0 \le t \le T$. With a matched filter (correlator) based receiver, the smallest positive value of T (in milliseconds) required to have $u_0(t)$ and $u_1(t)$ uncorrelated is

(A) 0.25 ms (B) 0.5 ms (C) 0.75 ms (D) 1.0 ms

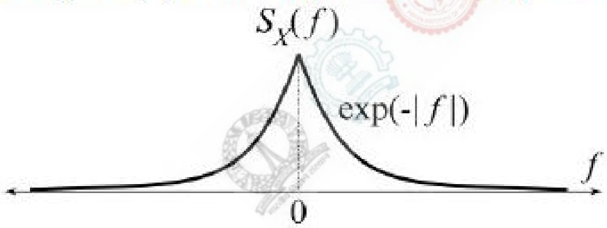
Question Number : 51

Correct : 2 Wrong : -0.66

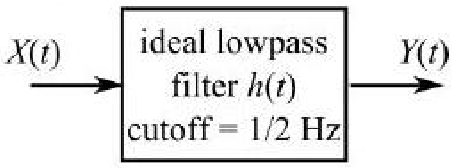
Let $X(t)$ be a wide sense stationary random process with the power spectral density $S_X(f)$ as shown in Figure (a), where f is in Hertz (Hz). The random process $X(t)$ is input to an ideal lowpass filter with the frequency response

$$H(f) = \begin{cases} 1, & |f| \le \frac{1}{2}\,\text{Hz} \\ 0, & |f| > \frac{1}{2}\,\text{Hz} \end{cases}$$

as shown in Figure (b). The output of the lowpass filter is $Y(t)$.



(a)



(b)

Let E be the expectation operator and consider the following statements:

I. $E(X(t)) = E(Y(t))$
II. $E(X^2(t)) = E(Y^2(t))$
III. $E(Y^2(t)) = 2$

Select the correct option:

(A) only I is true
(B) only II and III are true
(C) only I and II are true
(D) only I and III are true

Question Number : 52 Correct : 2 Wrong : 0

A continuous time signal $x(t) = 4\cos(200\pi t) + 8\cos(400\pi t)$, where t is in seconds, is the input to a linear time invariant (LTI) filter with the impulse response

$$h(t) = \begin{cases} \dfrac{2\sin(300\pi t)}{\pi t}, & t \neq 0 \\ 600, & t = 0. \end{cases}$$

Let $y(t)$ be the output of this filter. The maximum value of $|y(t)|$ is ________.

Question Number : 53 Correct : 2 Wrong : 0

An optical fiber is kept along the $\hat{z}$ direction. The refractive indices for the electric fields along $\hat{x}$ and $\hat{y}$ directions in the fiber are $n_x = 1.5000$ and $n_y = 1.5001$, respectively ($n_x \neq n_y$ due to the imperfection in the fiber cross-section). The free space wavelength of a light wave propagating in the fiber is 1.5 μm. If the lightwave is circularly polarized at the input of the fiber, the minimum propagation distance after which it becomes linearly polarized, in centimetres, is ____________.

Question Number : 54 Correct : 2 Wrong : -0.66

The expression for an electric field in free space is $\mathbf{E} = E_0\,(\hat{x} + \hat{y} + j2\hat{z})\,e^{-j(\omega t - kx + ky)}$, where x, y, z represent the spatial coordinates, t represents time, and ω, k are constants. This electric field

(A) does not represent a plane wave.
(B) represents a circularly polarized plane wave propagating normal to the z-axis.
(C) represents an elliptically polarized plane wave propagating along the x-y plane.
(D) represents a linearly polarized plane wave.

Question Number : 55 Correct : 2 Wrong : -0.66

A half wavelength dipole is kept in the x-y plane and oriented along 45° from the x-axis. Determine the direction of null in the radiation pattern for $0 \leq \phi \leq \pi$. Here the angle θ $(0 \leq \theta \leq \pi)$ is measured from the z-axis, and the angle ϕ $(0 \leq \phi \leq 2\pi)$ is measured from the x-axis in the x-y plane.

(A) $\theta = 90°, \phi = 45°$
(B) $\theta = 45°, \phi = 90°$
(C) $\theta = 90°, \phi = 135°$
(D) $\theta = 45°, \phi = 135°$

Question Number : 56 **Correct : 1 Wrong : -0.33**

She has a sharp tongue and it can occasionally turn____________

(A) hurtful (B) left (C) methodical (D) vital

Question Number : 57 **Correct : 1 Wrong : -0.33**

I ___________ made arrangements had I ___________ informed earlier.

(A) could have, been
(B) would have, being
(C) had, have
(D) had been, been

Question Number : 58 **Correct : 1 Wrong : -0.33**

In the summer, water consumption is known to decrease overall by 25%. A Water Board official states that in the summer household consumption decreases by 20%, while other consumption increases by 70%.

Which of the following statements is correct?

(A) The ratio of household to other consumption is 8/17
(B) The ratio of household to other consumption is 1/17
(C) The ratio of household to other consumption is 17/8
(D) There are errors in the official's statement.

Question Number : 59 **Correct : 1 Wrong : -0.33**

40% of deaths on city roads may be attributed to drunken driving. The number of degrees needed to represent this as a slice of a pie chart is

(A) 120 (B) 144 (C) 160 (D) 212

Question Number : 60

Correct : 1 Wrong : -0.33

Some tables are shelves. Some shelves are chairs. All chairs are benches. Which of the following conclusions can be deduced from the preceding sentences?

i. At least one bench is a table
ii. At least one shelf is a bench
iii. At least one chair is a table
iv. All benches are chairs

(A) Only i (B) Only ii (C) Only ii and iii (D) Only iv

Question Number : 61

Correct : 2 Wrong : -0.66

"If you are looking for a history of India, or for an account of the rise and fall of the British Raj, or for the reason of the cleaving of the subcontinent into two mutually antagonistic parts and the effects this mutilation will have in the respective sections, and ultimately on Asia, you will not find it in these pages; for though I have spent a lifetime in the country, I lived too near the seat of events, and was too intimately associated with the actors, to get the perspective needed for the impartial recording of these matters".

Here, the word 'antagonistic' is closest in meaning to

(A) impartial (B) argumentative (C) separated (D) hostile

Question Number : 62

Correct : 2 Wrong : -0.66

S, T, U, V, W, X, Y, and Z are seated around a circular table. T's neighbours are Y and V. Z is seated third to the left of T and second to the right of S. U's neighbours are S and Y; and T and W are not seated opposite each other. Who is third to the left of V?

(A) X (B) W (C) U (D) T

Question Number : 63

Correct : 2 Wrong : -0.66

Trucks (10 m long) and cars (5 m long) go on a single lane bridge. There must be a gap of at least 20 m after each truck and a gap of at least 15 m after each car. Trucks and cars travel at a speed of 36 km/h. If cars and trucks go alternately, what is the maximum number of vehicles that can use the bridge in one hour?

(A) 1440 (B) 1200 (C) 720 (D) 600

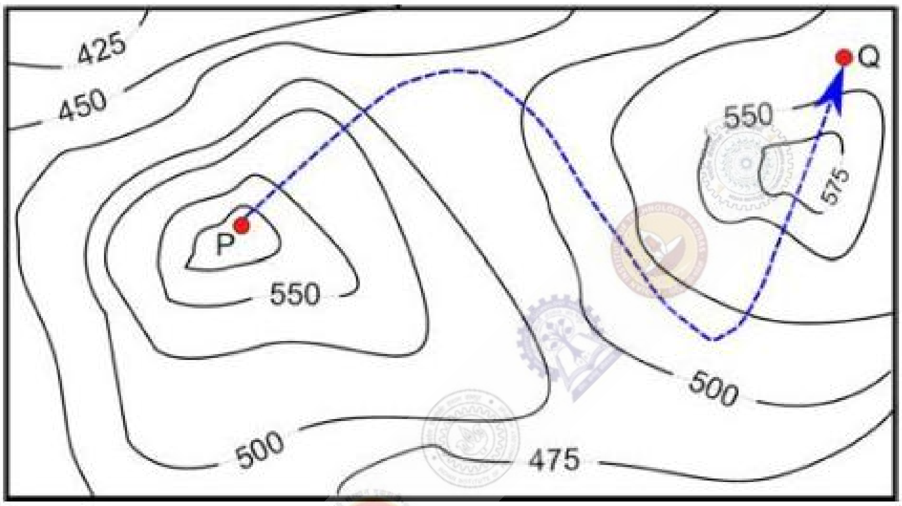
Question Number : 64 Correct : 2 Wrong : -0.66

There are 3 Indians and 3 Chinese in a group of 6 people. How many subgroups of this group can we choose so that every subgroup has at least one Indian?

(A) 56 (B) 52 (C) 48 (D) 44

Question Number : 65 Correct : 2 Wrong : -0.66

A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region. Contour lines are shown at 25 m intervals in this plot.



The path from P to Q is best described by

(A) Up-Down-Up-Down

(B) Down-Up-Down-Up

(C) Down-Up-Down

(D) Up-Down-Up