GATE WALLAH

ELECTRONICS AND COMMUNICATION ENGINEERING

EXAM HELD ON

11th FEBRUARY 2024

MORNING SESSION

DETAILED SOLUTION BY TEAM

[MCQ]

Q.1. P, Q, R, S and T have launched a new startup. Two of them are sibling. The office of the startup has just three rooms All of them agree that the sibling should not share the same room. If S and Q are single children and the room allocations shown below are acceptable.

PR	TS	Q

PQ	RT	S

Then which one of the given options is the sibling

(a) T and Q (b) T and S

(c) T and R (d) P and T

Sol. **(d)**

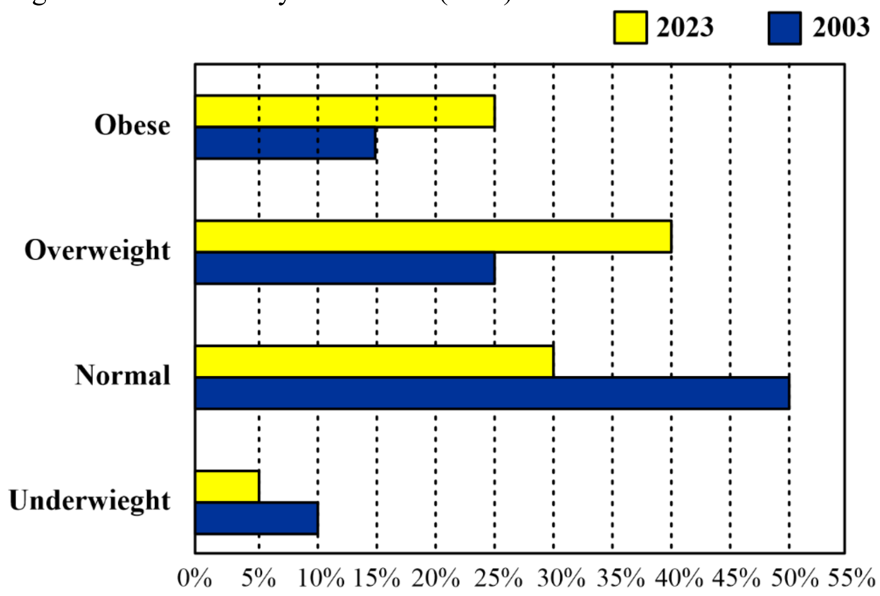
Since S and Q are single children

RT is grouped together so there are not sibling.

Hence P and T are sibling.

[MCQ]

Q.2. The bar chart shows the data for the percentage of population falling into different categories based on. Body mass index (BMI) in 2003 and 2023.



Based on the data provided which one of the following options in CORRECT?

(a) The ratio of the percentage of population falling into overweight category to the percentage of population falling into normal category has increased in 20 years

(b) The ratio of the percentage of population falling into obese category to the percentage of population falling into normal category has decreased in 20 years

(c) The [percentage of population falling into normal category has decreased in 20 years

(d) The ratio of the percentage of population falling into underweight category to the percentage of population falling into normal category has decreased in20 year

Sol. **(b)**

The percentage of population falling into obese category in 2003 is 15%

The percentage of population falling into obese category in 2023 is 25%

Percentage of population falling into normal category in 2003 is 50%

Percentage of population falling into normal category in 2023 is 30%

The ratio of the percentage of population falling into obese category to the percentage of population falling into normal category has decreased in 20 years

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[MCQ]

Q.3. Five years ago the ratio of Aman age to his father's age was 1:4 and five years from now, the ratio will be 2:5 what was his father's wage when Aman was born?

(a) 35 years (b) 32 years

(c) 30 years (d) 28 years

Sol. **(c)**

$A = x + 5$

After $A = x + 10$

$F = 4x + 5$

$F = 4x + 10$

$$\frac{x+10}{4x+10} = \frac{2}{5}$$

$5x + 50 = 8x + 20$

$5x = 30$

$x = 10$

$45 - 15 = 30$

[MCQ]

Q.4. For a real number $x > 1$

$$\frac{1}{\log_2 x} + \frac{1}{\log_3 x} + \frac{1}{\log_4 x} = 1$$

The value of x is

(a) 4 (b) 12

(c) 36 (d) 24

Sol. **(d)**

$\log_x 2 + \log_x 3 + \log_x 4 = 1$

$= \log_x 24 = 1$

$x = 24$

[MCQ]

Q.5. Sequence the following sentences (P, Q, R, S) in a coherent passage

P: Shifu's student exclaimed, "Why do you run since the bull is an illusion"

Q: Shifu said, "Surely my running away from the bull is also an illusion"

R: Shifu once proclaimed that all life is illusion

S: One day when a bull gave him chase, Shifu began running for his life

(a) SPRQ (b) SRPQ

(c) RSPQ (d) RPQS

Sol. **(c)**

Shifu once proclaimed that all life is illusion

One day when a bull gave him chase, Shifu began running for his life

Shifu's student exclaimed, "Why do you run since the bull is an illusion"

Shifu said, "Surely my running away from the bull is also an illusion"

[MCQ]

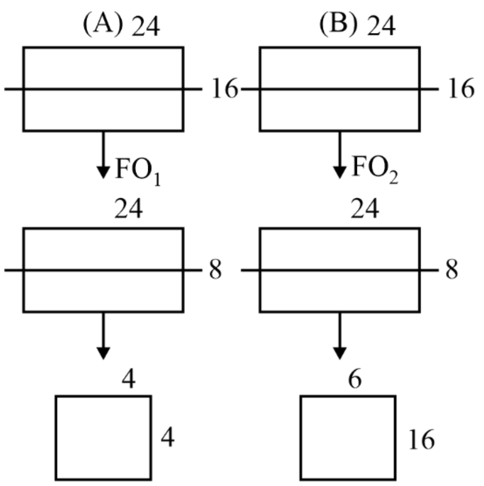
Q.6. Two identical sheets A and B of dimensions 24 cm × 16 cm, can be folded into half using two distinct operations FO_1 or FO_2. In FO_1, the axis of folding remains parallel to the initial long edge and in FO_2 the axis of folding remains parallel to the initial short edge If sheet A is folded twice using FO_1 and sheet B is flooded twice using FO_2 the ratio of the perimeters of the final shapes of A and B

(a) 11:18 (b) 11:14

(c) 14:11 (d) 18:11

Sol. **(c)**

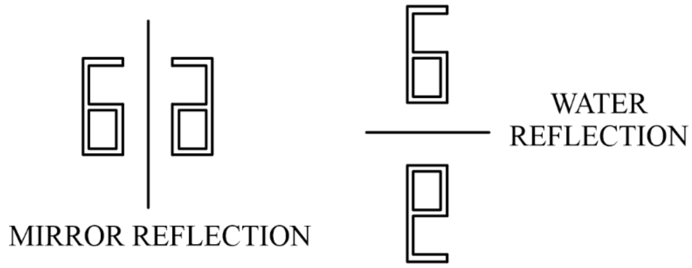
P(A) = 2 × 28 = 56



[MCQ]

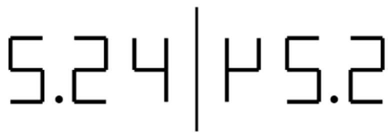
Q.7. Examples of mirror and water reflections are shown in the figures below

An object appears as the following image after first reflecting in a mirror and then reflecting on water 5.24

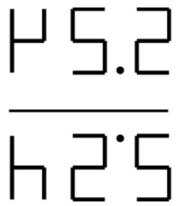


Sol. ()

Reflecting on mirror image



Reflecting on water



[MSQ]

Q.8. For a causal discrete – time LTI system with transfer function $H(z)=\dfrac{2z^2+3}{\left(z+\frac{1}{3}\right)\left(z-\frac{1}{3}\right)}$

Which of the following statements is/are true?

(a) The system is a minimum phase system

(b) The system is stable

(c) The initial value of the impulse response is 2

(d) The final value of the impulse response is 0.

Sol. **(b,c,d)**

Since the system has a pole at + 1/3, the system is not a minimum phase system

Since both the poles lies inside unit circle the system stable

$$h(0) = \lim_{z \to \infty} H(z)$$

$$= \lim_{z \to \infty} \frac{2 + 3z^{-2}}{\left(1 + \frac{z^{-1}}{3}\right)\left(1 - \frac{z^{-1}}{3}\right)} = 2$$

$$h(\infty) = \lim_{z \to 1} \left(1 - z^{-1}\right) H(z)$$

$$\lim_{z \to 1} \left(1 - z^{-1}\right) \frac{2z^2 + 3}{\left(1 + \frac{1}{3}\right)\left(1 - \frac{1}{3}\right)} = 0$$

[NAT]

Q.9. A machine has a 32 – bit architecture with 1 – word long instruction and supports an instruction set of size 40. Each instruction has namely opcode, two source register identifiers one destination and an immediate Value, as summing thar the immediate open integer. Its maximum value is___________.

Sol. **(2047)**

32-bit $\rightarrow$ size = 32

24 Registers $\rightarrow$ 2m > 24 $\rightarrow$ m = 5

No. of instruction = 40 $\rightarrow$ No. of opcodes = 40 $\rightarrow 2^n > 40$

← 32 →

Opcode 6	Reg 3 6	Reg 2 6	Reg 1 5	Immediate 11

32 – (6 + 5 + 5 + 5) = 11

The maximum value?

$2^{11} = 2048$

Un signed integer

0 $\rightarrow$ + 2047

[MCQ]

Q.10. In the context of Bode magnitude plots, 40dB/decade is the same as____

(a) 12 dB/octave
(b) 6 dB/octave
(c) 10 dB/octave
(d) 20 dB/ octave

Sol. **(a)**

Bode plot $\Rightarrow$ 40 dB/decad
$\Rightarrow$ in dB/octave
20 n dB/dec = 6n dB/oct
40 dB/dec = 12 dB/oct

[MCQ]

Q.11. The general from of the complementary function of a differential equation is given by $y(t) = (At + B)^{e^{-2t}}$, where A and B are real constants determined by the initial condition. The corresponding differential equation is __________.

(a) $\frac{d^2y}{dt^2} + 4\frac{dy}{dt} + 4y = f(t)$
(b) $\frac{d^2y}{dt^2} + 3\frac{dy}{dt} + 2y = f(t)$
(c) $\frac{d^2y}{dt^2} + 4y = f(t)$
(d) $\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 6y = f(t)$

Sol. **(a)**

$y(t) = (At + B)e^{-2t}$ complementary function

Taking Laplace transform of equation $\Rightarrow Y(s) = \frac{A}{(s+2)^2} + \frac{B}{(s+2)}$

Form option (a)
$y'' + 4y' + 4y = f(t)$
Taking Laplace transform
$\Rightarrow s^2Y(s) + 4sY(s) + 4Y(s) = F(s)$

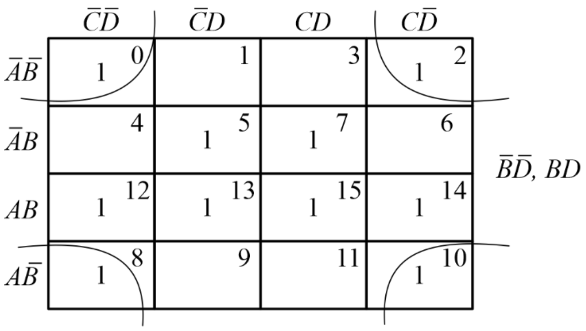
$$Y(s) = \frac{F(s)}{(s+2)^2}$$

[MCQ]

Q.12. For the Boolean function $\text{F}(\text{A},\text{B},\text{C},\text{D}) = \sum \text{M}(0,2,5,7,8,10,12,13,14,15)$ The essential prime implicants are ___________

(a) BD, AB
(b) $AB, \overline{B}\overline{D}$
(c) $BD, \overline{B}\overline{D}$
(d) $BD, \overline{B}\overline{D}, AB$

Sol. **(c)**



Essential prime implicants are $BD, \overline{B}\overline{D}$

[NAT]

Q.13. A source transmits symbols from an alphabet of size 16. The achievable entropy (in bits) is ___________.

Sol. **(4)**

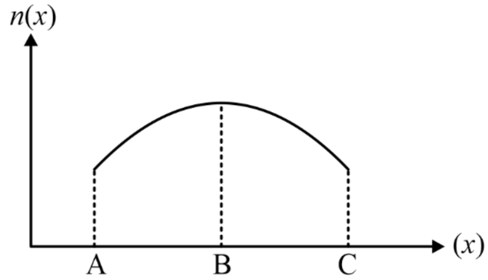
There are 16 symbols, and for maximum entropy the symbols should be equiprobable

$$P = \frac{1}{16}$$

There for maximum entropy in bits is 4

[MSQ]

Q.14. The free electron concentration profile $n(x)$ in a dope semiconductor at equilibrium is shown in the figure, where the points A, B and C mark three different position. Which of the following statements is/ are true?



(a) For x between B and C the electric field is directed from B to C.

(b) For x between B and A, the electric field is directed form A and B.

(c) For x between B and C, the electron diffusion current is directed form C to B

(d) For between B and A, the electron drift current is directed from B to A.

Sol. **(a,c,d)**

[MCQ]

Q.15. A white Gaussian $w(t)$ with zero mean and power spectral density $\frac{N_0}{2}$, when applied to a first- order RC low pass filter produces an output $n(t)$. At a particular time, t = tk, the variance of the random variable $n(t_k)$ is _________.

(a) $\frac{N_0}{RC}$

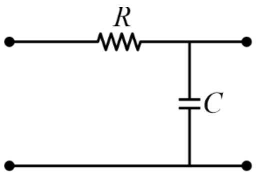
(b) $\frac{N_0}{4RC}$

(c) $\frac{N_0}{2RC}$

(d) $\frac{2N_0}{RC}$

Sol. **(b)**

$$PSD = \frac{N_0}{2} \Rightarrow \text{applied to RC filter}$$



$PSD_o = PSD_i \times |H(\omega)|^2$

$$H(\omega) = \frac{1}{j\omega RC + 1}$$

$$|H(\omega)|^2 = \frac{1}{1+\omega^2 R^2 C^2}$$

$$PSD_o = \frac{N_0}{2} \cdot \left(\frac{1}{1+4\pi^2 R^2 C^2 f^2}\right)$$

Power of output $\int_{-\infty}^{\infty} \frac{N_0}{2} \frac{1}{1+4\pi^2 f^2 R^2 C^2} df$

$$\Rightarrow \frac{N_0}{2} \cdot \frac{1}{4\pi^2 R^2 C^2} \cdot \int_{-\infty}^{\infty} \frac{1}{\frac{1}{4\pi^2 R^2 C^2} + f^2} df$$

$$\Rightarrow \frac{N_0}{2} \cdot \frac{1}{4\pi^2 R^2 C^2} \cdot 2\pi RC \cdot \pi \Rightarrow \frac{N_0}{4RC}$$

[NAT]

Q.16. An amplitude modulator has output (in Volts)) $S(t) = A\cos(400\pi t) + B\cos(360\pi t) + B\cos(440\pi t)$ The carrier power normalized to 1Ω resistance is 50 Watts. The sideband power to the total power is 1/9. The value of B in Volts (upto two decimal places) is_________.

Sol. **(2.5)**

$$S(t) = A\cos(400\pi t) + B\cos(360\pi t) + B\cos(440\pi t)$$

Carrier power $P_C = A^2/2$

Side band power $P_{SB} = \frac{B^2}{2} + \frac{B^2}{2} = B^2$

$P_C = 50$

$A = 10$

$$\frac{\text{Side band power}}{\text{Total power}} = \frac{1}{9}$$

$$\frac{B^2}{\frac{A^2}{2} + B^2} = \frac{1}{9}$$

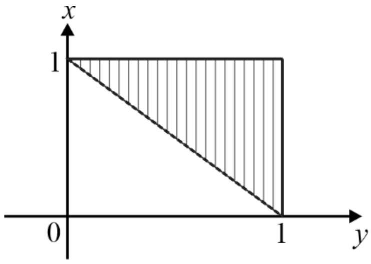
$$B^2 = \frac{50}{8}$$

$B = 2.5$

[NAT]

Q.17. Suppose X and Y are in dependent and identically distributed rank are distributed uniformly in the interval [0, 1]. The probable is _____________.

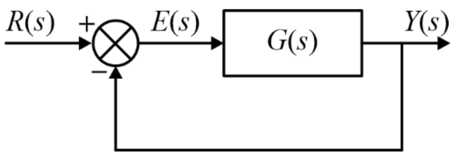
Sol. **(0.5)**



$$\text{Probability } = \iint_R \text{joint PDF}\,dxdy = \frac{1}{2}$$

[MCQ]

Q.18. In the feedback control system shown in the figure below $\frac{6}{s(s+1)(s+2)}$



R(s), Y(s) and E(s) are the Laplace transforms of r(t), y(t) and e(t) respectively. If the imput r(t) is a unit step function then _____________.

(a) $\lim_{t\to\infty} e(t) = \frac{1}{4}$

(b) $\lim_{t\to\infty} e(t) = 0$

(c) $\lim_{t\to\infty} e(t)$ does not exist, $r(t)$ is oscillatory

(d) $\lim_{t\to\infty} e(t) = \frac{1}{3}$

Sol. **(b)**

$$\frac{E(S)}{R(S)} = \frac{1}{1+G(S)}$$

$$e(\infty) = \lim_{t\to\infty} \frac{S.R(S)}{1+G(S)}$$

$$e(\infty) = \lim_{s\to 0} \frac{S\cdot\frac{1}{S}}{1+\frac{6}{S(S+1)(S+2)}} = 0$$

[NAT]

Q.19. In a number system of base r, the equation $x^2 - 12x + 37$ has $x = 8$ one of its solutions. The value of r is ___________.

Sol. **(11)**

At $x = 8$,

$82 - (12)_r\,(8)_r + (37)_r = 0$

$64 - (r + 2)8 + 3r + 7 = 0$

$64 - 8r - 16 + 3r + 7 = 0$

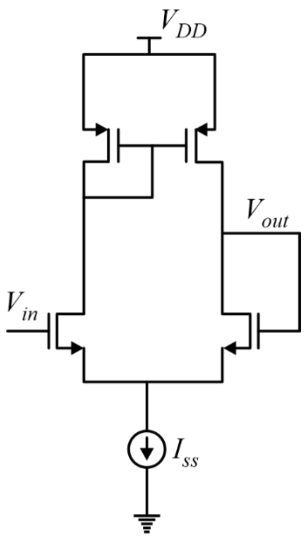
$5r = 64 - 16 + 7$

$5r = 55$

$r = 11$

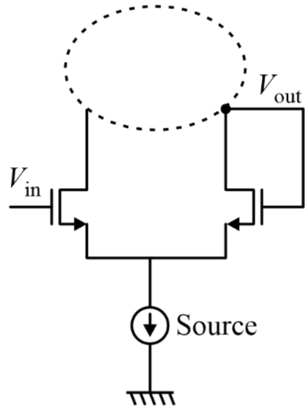
[NAT]

Q.20. For the closed loop amplifier circuit shown below. The magnitude of open loop low frequency small signal Voltage gain is 40. All the transistors are biased in saturation. The correct source I_{ss} is ideal. Neglect body effect. Channel length modulation and intrinsic device capacitances. The closed loop low frequency small signal voltage gain (rounded off to three decimal places) is ___________.

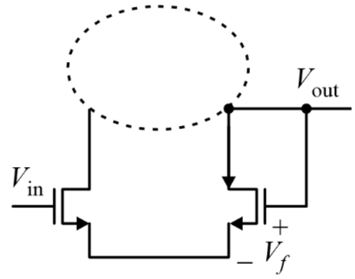


Sol. **(0.975)**

Open look gain $A = 40$



AC analysis of circuit



$\Rightarrow V_f = V_0$

$$\beta = \frac{V_f}{V_0} = 1$$

Negative feedback

$$\text{Closed loop gain } = \frac{A}{1+A\beta} = \frac{40}{41}$$

[MSQ]

Q.21. Let $\rho(x,y,z,t)$ and $u(x,y,z,t)$ represent density and velocity respectively at a point (x, y, z) and time t, Assume $\frac{\partial \rho}{\partial t}$ is continuous Let V be an arbitrary volume in space enclosed by the closed surface S and n be the outward unit normal of S Which of the following equations is/are equivalent to $\frac{\partial \rho}{\partial t} + \nabla.(pu) = 0$?

(a) $\int_v \frac{\partial \rho}{\partial t} dv = -\int_v \nabla.(pu) dv$ (b) $\int_s \frac{\partial \rho}{\partial t} dv = -\int_s (pu)\,\dot{n}\,ds$

(c) $\int_v \frac{\partial \rho}{\partial t} dv = -\int_s pu.\dot{n}\,ds$ (d) $\int_v \frac{\partial \rho}{\partial t} dv = -\int_s \nabla(pu) dv$

Sol. **(a, c)**

$$\frac{\partial \rho}{\partial t} + \nabla(\rho \vec{u}) = 0$$

$$\int_v \frac{\partial \rho}{\partial t} dv = -\int_v \nabla.(pu) dv$$

$$\int_v \frac{\partial \rho}{\partial t} dv = -\int_s pu.\dot{n}\,ds$$

[MSQ]

Q.22. Let i and j be the unit vectors along x and y axes, respectively ant let A be a positive constant. Which one of the following statements is true for the fields $\overline{F_1} = A(iy + jx)$ and $\overline{F_2} = A(iy - jx)$?

(a) Only $\overline{F_2}$ is an electrostatic field

(b) Neither $\overline{F_1}$ nor $\overline{F_2}$ is an electromatic field

(c) only $\overline{F_1}$ is an electrostatic field

(d) Both $\overline{F_1}$ and $\overline{F_2}$ are electrostatic fields

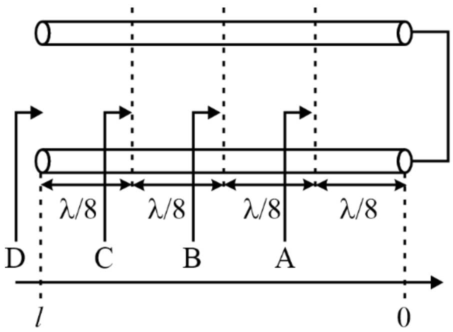
Sol. **(c)**

$$\vec{\nabla} \times \vec{F_1} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ Ay & Ax & 0 \end{vmatrix} = 0$$

$$\vec{\nabla} \times \vec{F_2} = \begin{vmatrix} \hat{a}_x & \hat{a}_y & \hat{a}_z \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y & -x & 0 \end{vmatrix} = -2A\hat{a}_z + 0$$

[NAT]

Q.23. Consider a lossless transmission line terminated with a short as shown in the figure below, as one moves towards the generator form the load the normalized impedances Z_{inA}, Z_{inB}, Z_{inC}, Z_{inD} is



(a) $Z_{inA} = j1\Omega$, $Z_{inB} = \infty$, $Z_{inC} = -j1\Omega$, $Z_{inD} = 0$

(b) $Z_{inA} = j0.4\Omega$, $Z_{inB} = \infty$, $Z_{inC} = -j0.4\Omega$, $Z_{inD} = 0$

(c) $Z_{inA} = \infty$, $Z_{inB} = j1\Omega$, $Z_{inC} = 0$, $Z_{inD} = -j1\Omega$

(d) $Z_{inA} = \infty$, $Z_{inB} = j0.4\Omega$, $Z_{inC} = 0$, $Z_{inD} = -j0.4\Omega$

Sol. **(a)**

$ZL = 0$

$Z_{in} = jZ_0 \tan\beta l$

At A, $l = \frac{\lambda}{8}$, $\beta l = \frac{2\pi}{\lambda} \cdot \frac{\lambda}{8} = \frac{\pi}{4}$

$Z_{in} = jZ_0$

$Z_{inA} = j1\Omega$

At B, $l = \frac{2\lambda}{8}$, $\beta l = \frac{2\pi}{\lambda} \cdot \frac{2\lambda}{8} = \frac{\pi}{2}$

$Z_{in} = jZ_0 \tan\frac{\pi}{2}$

$Z_{inB} = \infty$

At C, $l = \frac{3\lambda}{8}$, $\beta l = \frac{2\pi}{\lambda} \cdot \frac{3\lambda}{8} = \frac{3\pi}{4}$

$Z_{in} = -jZ_0$

$Z_{inC} = -j1\Omega$

At D, $l = \frac{4\lambda}{8}$, $\beta l = \frac{2\pi}{\lambda} \cdot \frac{4\lambda}{8} = \pi$

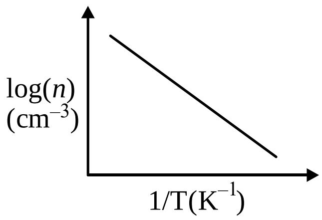
$Z_{in} = jZ_0 \tan \pi$

$Z_{inD} = 0\Omega$

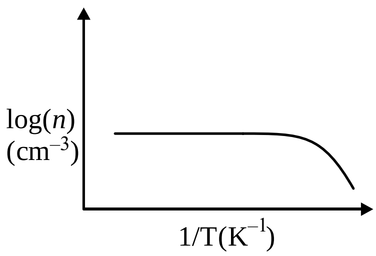
[MSQ]

Q.24. For non-degenerately doped n -type silicon when one of the following plots represents the temperature (T) dependence of free election concentration (n)?

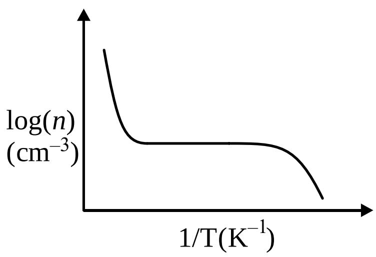
(a)



(b)

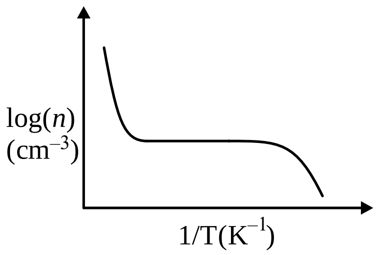


(c)



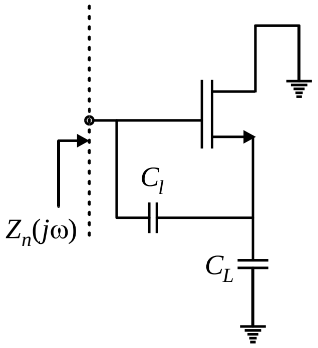
(d) None of these

Sol. **(c)**



[MSQ]

Q.25. In the circuit below assume that the long channel NMOS transistor is biased in saturation. The small signal trans conductance of the transistor is g, Neglect body effect channel length modulation and intrinsic device capacitances. The small signal input impedance Z $(j\omega)$ is _____.



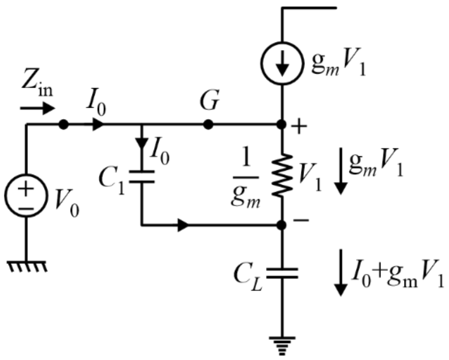
(a) $\frac{1}{j\omega C_1} + \frac{1}{j\omega C_L}$

(b) $\frac{-g_n}{C_I C_L \omega^2} + \frac{1}{j\omega C_I + j\omega C_L}$

(c) $\frac{-g_n}{C_I C_L \omega^2} + \frac{1}{j\omega C_I} + \frac{1}{j\omega C_L}$

(d) $\frac{g_n}{C_I C_L \omega^2} + \frac{1}{j\omega C_I} + \frac{1}{j\omega C_L}$

Sol. **(c)**



$$V_1 = Z_{C_i} \cdot I_0$$

$$-V_0 + I_0 Z_{C_i} + (I_0 + g_m V_1) Z_{C_L} = 0$$

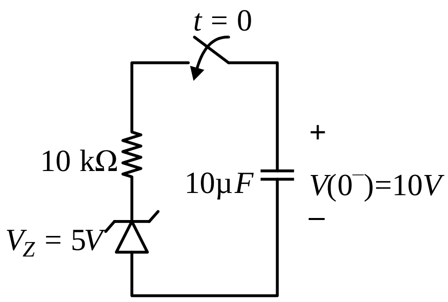
$$-V_0 + I_0 Z_{C_i} + I_0 Z_{C_L} + g_m Z_{C_i} I_0 Z_{C_L} = 0$$

$$\frac{V_0}{I_0} = \left(Z_{C_i} + Z_{C_L} + g_m Z_{C_i} Z_{C_L}\right)$$

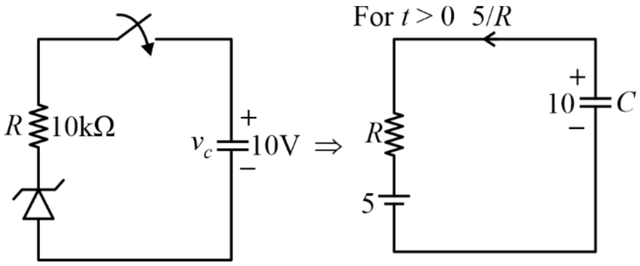
$$\frac{V_0}{I_0} = \frac{1}{j\omega C_i} + \frac{1}{j\omega C_L} + \frac{g_m}{-\omega^2 C_i C_L}$$

[NAT]

Q.26. As shown in the circuit the initial voltage across the capacitor is 10 V. with the switch being open. The switch is then closed at t = 0. The total energy dissipated in the ideal Zener diode (V_2 = 5V) after the switch is closed (in mJ, rounded off to three decimal places) is _____.



Sol. **(0.25)**



$$\Rightarrow i(t) = \frac{5}{R} e^{-t/RC}$$

$$P(t) = v \times i$$

$$P(t) = 5 \times \frac{5}{R} e^{-t/RC}$$

Energy dissipated in Zener $\Rightarrow \int_0^{\infty} \frac{25}{R} e^{-t/RC} dt$

$$\Rightarrow -\frac{25RC}{R} e^{-t/RC}\Big|_0^{\infty}$$

$\Rightarrow 25\ C$

Energy dissipated $\Rightarrow 25C$

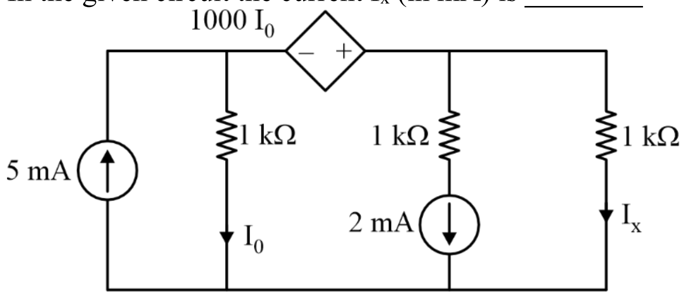
$\Rightarrow 25 \times 10 \times 10^{-6}$

$\Rightarrow 250\mu J$

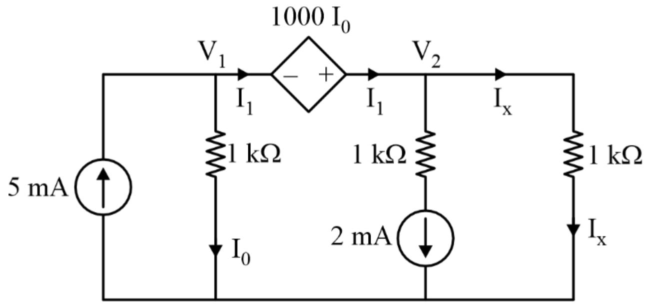
$\Rightarrow 0.250$ Milli Joule

[NAT]

Q.27. In the given circuit the current I_x (in mA) is ________



Sol. **(2)**



$$\frac{V_1 - 0}{1\text{k}} + I_1 = 5\text{ mA} \Rightarrow V_1 + 1000 I_1 = 5$$

$$V_2 - V_1 = 1000 I_0 = 1000\left(\frac{V_1}{1\text{k}}\right)$$

$$\Rightarrow V_1 = \frac{V_2}{2}$$

$$V_2 + 2 = 1000\, I_1$$

$$V_1 + V_2 + 2 = 5$$

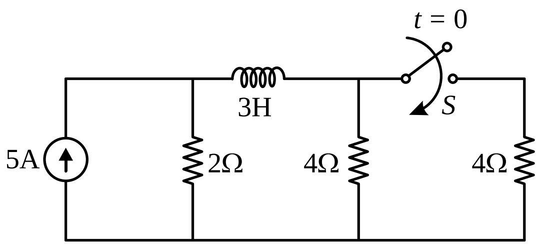
$$\frac{V_2}{2} + V_2 = 3 \Rightarrow V_2 = 2\text{V}$$

$$\frac{V_2 - 0}{1\text{k}} + 2\text{ mA} = I_1$$

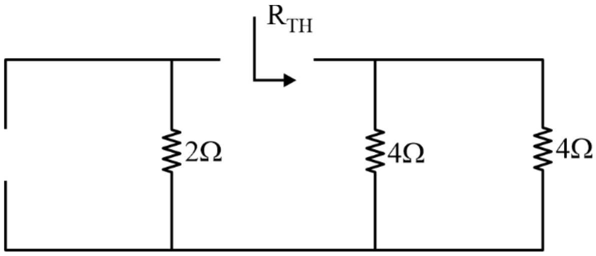
$$I_x = \frac{V_2}{1\text{k}} = 2\text{mA}$$

[NAT]

Q.27. In the circuit given below the switch S was kept open for sufficiency long time and is closed at time t = 0, The time constant (in seconds) of the circuit for t > 0 is ___________.



Sol. **(0.75)**



$$\tau = \frac{L}{R} = \frac{3}{4} = 0.75$$

[NAT]

Q.29. Let R and R^2 denote the set of real number and the three-dimensional vector space over respectively. The value of a for which the set of vectors

{[2 – 3 a]. [3 – 1 3], [1 – 5 7}]

Does not form a basis of R^3 is _________

Sol. **(5)**

{[2 – 3 a]. [3 – 1 3], [1 – 5 7}]

To form basis, all vectors should be independent

$$\begin{vmatrix} 2 & -3 & a \\ 3 & -1 & 3 \\ 1 & -5 & 7 \end{vmatrix} = 0$$

$\Rightarrow 2\{8\} + 3\{18\} + a\{-14\} = 0$

$a = 5$

[MSQ]

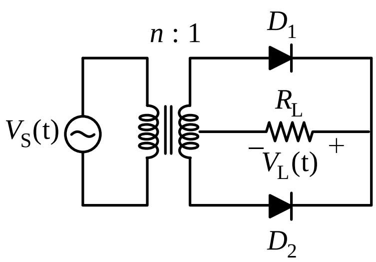
Q.30. A causal and stable LTI system with impulse response h(t) produces an output y(t) for an input signal x(t) A signal x(0.5t) is applied to another causal and stable LTI system with impulse response h(0.5t) the resulting output is____.

(a) 0.25 y(2t)
(b) 0.25y(0.25t)
(c) 2y(0.5y)
(d) 4y(0.5t)

Sol. **(c)**

[MSQ]

Q.31. In the circuit shown the n : 1 step down transfer and the diodes are ideal The diodes have no voltage drop forward condition If the input Voltage (in Volts) is $V_s(t) = 10 \sin \omega t$ and the average value of load voltage V_L (t_0 (in Volts) is $2.5/\pi$. the value of n is _________



Sol. **(4)**

$V_s = 10 \sin\omega t$

$V_{\text{induced}} = \frac{10}{n}\sin\omega t$

$V_0 = \left|\frac{V_s}{2n}\right|$

$V_0 = \left|\frac{5\sin g\omega t}{n}\right|$

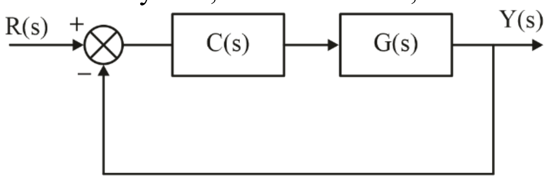
$V_{0avg} = \frac{2V_m}{\pi}$

$= 2\times\frac{5}{n}\cdot\frac{1}{\pi} = \frac{10}{n\pi} \Rightarrow \frac{2.5}{\pi}$

$n = 4$

[NAT]

Q.32. A satellite altitude control system, as shown below,



has a plant with transfer function $G(s) = \frac{1}{s^2}$ cascaded with a compensator $C(s) = \frac{K(s+\alpha)}{(s+4)}$ where K and α are positive real constant.

In order for closed-loop system to have poles at $-1 + j\sqrt{3}$, the value of α must be ________.

Sol. **(1)**

$OLTF = \frac{k(s+\alpha)}{s^2(s+4)}$

$|G(s)|_{s=-1+j\sqrt{3}} = \frac{k(-1+j\sqrt{3}+\alpha)}{(-1+j\sqrt{3})^2(-1+j\sqrt{3}+4)}$

$= \frac{k(\alpha-1+j\sqrt{3})}{(-1+j\sqrt{3})^2(3+j\sqrt{3})}$

If s_1 lie on Root Locus

$\angle G(s) = (2q+1)180$

$\angle G(s) = \tan^{-1}\frac{\sqrt{3}}{\alpha-1} - \left[2\tan^{-1}\frac{\sqrt{3}}{-1} - \tan^{-1}\frac{\sqrt{3}}{3}\right] = 180$

$= \tan^{-1}\frac{\sqrt{3}}{\alpha-1} - \left[2\left(180\tan^{-1}\sqrt{3}\right) - \tan^{-1}\frac{1}{\sqrt{3}}\right] = 180$

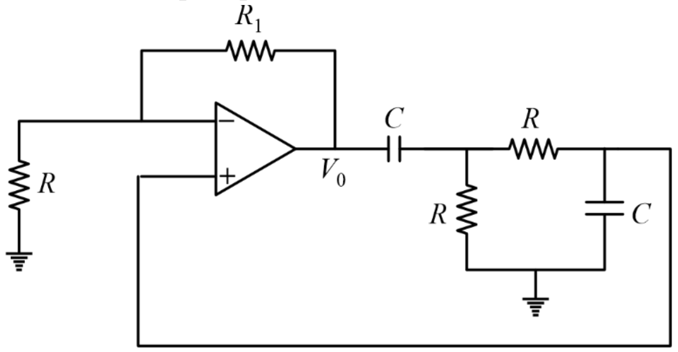
$$= \tan^{-1}\frac{\sqrt{3}}{\alpha-1} - [360-120-30] = 180$$

$$\tan^{-1}\frac{\sqrt{3}}{(\alpha-1)} - [210] = 180$$

$\alpha = 1$

[MCQ]

Q.33. In circuit shown below, op-amp is ideal.



If the circuit is to show sustained oscillation, the respective value of R_1 and the corresponding frequency of oscillation are __________.

(a) 2R and $\frac{1}{(2\pi\sqrt{6}RC)}$

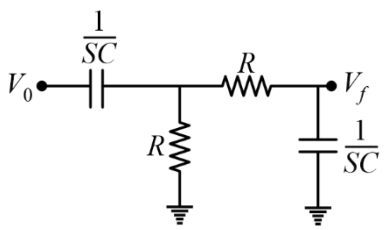
(b) 2R and $\frac{1}{(2\pi RC)}$

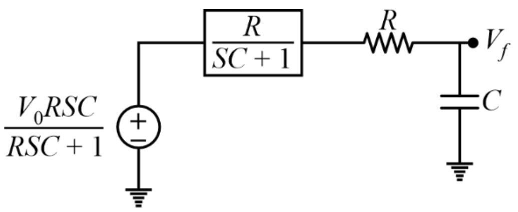
(c) 29R and $\frac{1}{(2\pi RC)}$

(d) 29R and $\frac{1}{(2\pi\sqrt{6}RC)}$

Sol. **(b)**

Gain $A = \left(1 + \frac{R_1}{R}\right)$





$$V_f \Rightarrow \frac{V_0 RSC}{RSC+1} \cdot \frac{1/SC}{\frac{1}{SC}+R+\frac{R}{RSC+1}}$$

$$\beta = \frac{V_f}{V_0} = \frac{RSC}{(RSC+1)\left(RSC+1+\frac{RSC}{RSC+1}\right)}$$

$$= \frac{RSC}{(RSC+1)^2 + RSC}$$

$$\beta \Rightarrow \frac{RSC}{(RSC)^2 + 3RSC + 1}$$

$$\beta = \frac{j\omega RC}{-\omega^2 R^2 C^2 + 1 + 3j\omega RC}$$

$$1 - \omega^2 R^2 C^2 = 0$$

$$\omega = \frac{1}{RC}$$

$$f = \frac{1}{2\pi RC}$$

$$\beta = \frac{1}{3}$$

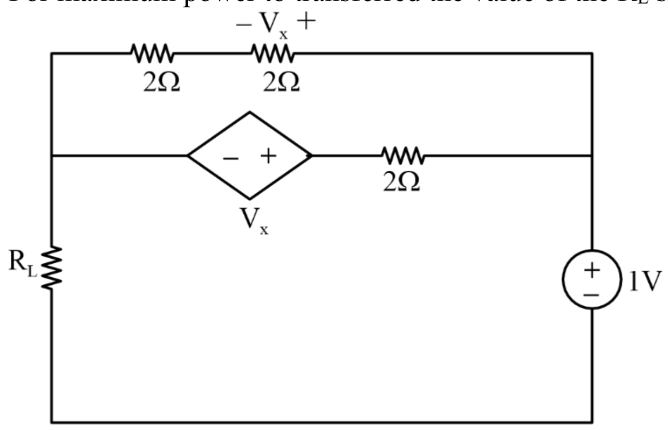
So for oscillation $A = 3$

$$3 = 1 + \frac{R_i}{R}$$

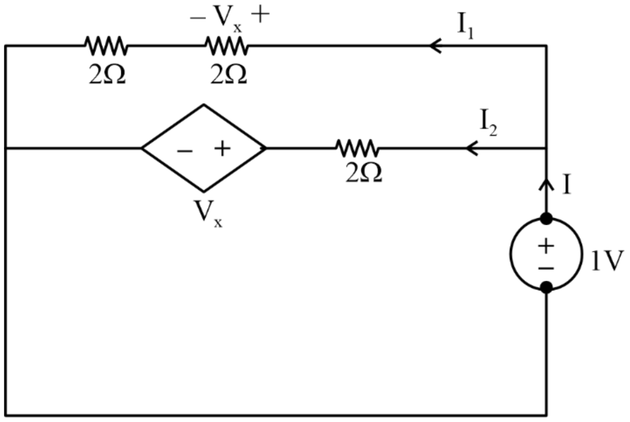
$R_i = 2R$

[NAT]

Q.34. For maximum power to transferred the value of the R_L should be



Sol. **(2.5)**



$$\frac{I}{2}=\frac{1-V_x}{2}$$

$$=\frac{1-3/5}{2}=\frac{1}{5}$$

$$V_x=\frac{1}{5}\times 3=\frac{3}{5}$$

R_L = ?

R_2

$$R_{th}=\frac{1}{I}$$

$I = I_1 + I_2 = 2/5$

$$R_{th}=\frac{5}{2}=2.5\Omega$$

[NAT]

Q.35. A transmission line with $Z_0 = 50\ \Omega$, $|\Gamma| = 0.6$, is terminated with an unknow load. When seen from generator end to load the magnitude of maximum input impedance is.

Sol. **(200)**

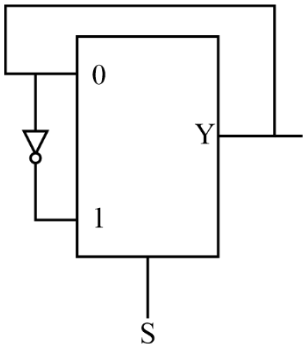
$Z_0 = 50\ \Omega$, $|\Gamma| = 0.6$, Z_{max} = ?

$$VSWR=\frac{1+|\Gamma|}{1-|\Gamma|}=\frac{1.6}{0.4}=4$$

$$VSWR=\frac{Z_{max}}{Z_o}=4\Rightarrow Z_{max}=4Z_o=200\Omega$$

[MCQ]

Q.36. The propagation delay of the 2 × 1 MUX shown in the circuit is 10 ns. Consider the propagation delay of the inverter as 0 ns.



If S is set to 1 then output of Y is ________

(a) Constant at '0'

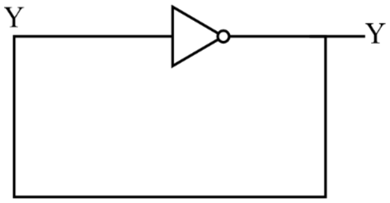
(b) Constant at '1'

(c) A square wave of frequency 100 MHz

(d) A square wave of frequency 50 MHz

Sol. **(d)**

At S = 1



Output Y will be square waveform

$T = 2\,n\,t_{pd}$

$= 2(1)\,(10\text{ns})$

$= 20$ ns

$$f = \frac{1}{T} = 50 \text{ MHz}$$

[MCQ]

Q.37. A digital communication system transmits through a Noiseless band limited channel [–W, W]. The received signal z(t) at output of receiving filter is given by $z(t) = \sum_a b(n)x(t-nT)$ where b(n) are the symbols and x(t) is the overall system response to single symbol. The received signal is sampled at t = mT the fourier transform x(t) is x(f), the Nyquist condition that x(f) must satisfy for zero inter symbol interference at the receiver is______

(a) $\sum_{m=-\infty}^{\infty} X\left(f+\frac{m}{T}\right)=\frac{1}{T}$

(b) $\sum_{m=-\infty}^{\infty} X\left(f+mT\right)=\frac{1}{T}$

(c) $\sum_{m=-\infty}^{\infty} X\left(f+\frac{m}{T}\right)=T$

(d) $\sum_{m=-\infty}^{\infty} X\left(f+mT\right)=T$

Sol. **(c)**

Zero ISI

$x(t)$ is pulse

$\Rightarrow x(t) \cdot \delta(t - nT) = \delta(t)$

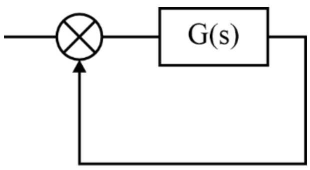
$$\frac{1}{2\pi}\left(X(\omega) * \sum \frac{2\pi}{T}\delta(\omega - n\omega_s)\right) = 1$$

$$\Rightarrow \sum_{n=\infty}^{\infty} X(\omega - n\omega_s) = T$$

$$\sum_{m=-\infty}^{\infty} X\left(f + \frac{m}{T}\right) = T$$

[MCQ]

Q.38.



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

The impulse response of close loop system de faster than e^{-t} if.

(a) $-24 \le K \le -6$

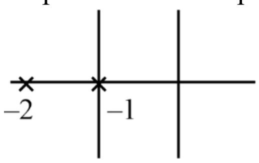
(b) $-4 \le K \le -1$

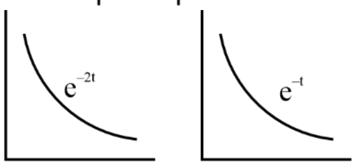
(c) $7 \le K \le 21$

(d) $1 \le K \le 5$

Sol. **(d)**

So pole of close loop system should be lie L.H.S of s = – 1 plane





s = (s – 1)

CE = 1+ (s) = 0

$$= 1 + \frac{K}{(s+1)(s+2)(s+3)}$$

(s + 1)(s + 2)(s + 3) + K = 0

Put s = s – 1

$s(s + 1)(s + 2) + K = 0$

$s(s^2 + 3s + 2) + K = 0$

$s^3 + 3s2 + 2s + K = 0$

Apply R.H.S

s^3	1	2
s^2	3	K
s	$\frac{6-K}{3}$	0
s^0	K	

$\frac{6-K}{3} > 0$

$K < 6$

$K > 0$

$0 < K < 6$

$1 \le K \le 5$

[MCQ]

Q.39. Which of the following is/are eigen vectors for matrix $\begin{bmatrix} 1 & k \\ 2 & 1 \end{bmatrix}$; $k \in R^+$

(a) $\begin{bmatrix} -1 \\ \sqrt{\frac{2}{k}} \end{bmatrix}$

(b) $\begin{bmatrix} \sqrt{2k} \\ -1 \end{bmatrix}$

(c) $\begin{bmatrix} \sqrt{2k} \\ 1 \end{bmatrix}$

(d) $\begin{bmatrix} 1 \\ \sqrt{\frac{2}{k}} \end{bmatrix}$

Sol. **(a, d)**

$\begin{vmatrix} 1-\lambda & k \\ 2 & 1-\lambda \end{vmatrix} = 0 \Rightarrow (\lambda - 1)^2 = 2k$

$\Rightarrow \lambda = 1 \pm \sqrt{2k}$

$\begin{bmatrix} -1 \\ \sqrt{\frac{2}{k}} \end{bmatrix}, \begin{bmatrix} 1 \\ \sqrt{\frac{2}{k}} \end{bmatrix}$

[MCQ]

Q.40. The radian frequency value (s) for which the discrete thin sinusoidal signal $x(n) = A\cos\left(\Omega n + \frac{\pi}{3}\right)$ has a period of 40 is/are __________.

(a) 0.15π

(b) 0.3π

(c) 0.45π

(d) 0.225π

Sol. **(a,b,c)**

N = 40

$$\frac{\Omega}{2\pi} = \frac{K}{N}$$

$$\Omega = 2\pi \frac{K}{N}$$

$$\Omega = 2\pi \times \frac{K}{40}$$

$$\Omega = \frac{\pi}{20} \cdot K$$

$$K = 1 \Rightarrow \Omega = \frac{\pi}{20}$$

$$K = 2 \Rightarrow \Omega = \frac{\pi}{10}$$

$K = 3 \Rightarrow \Omega = 0.15\pi$

$K = 4 \Rightarrow \Omega = 0.2\pi$

$K = 5 \Rightarrow \Omega = 0.25\pi$

$K = 6 \Rightarrow \Omega = 0.3\pi$

$K = 9 \Rightarrow \Omega = 0.45\pi$

[NAT]

Q.41. 12. The relationship between any N-length sequence $x[n]$ and its corresponding point discrete Fourier transform X[K] is defined as $X[K] = f\{x[n]\}$

If $y[n] = F\{F\{F\{F\{x(n)\}\}\}\}$

For the sequence $x[n] = \{1,2,1,3\}$ the value of $Y[0]$ is _________.

Sol. **(112)**

$\text{DFT}(\text{DFT}(x(n)) = Nx(-n))$

$\text{DFT}(\text{DFT}(Nx(n)) = N^2 x(n))$

$y(n) = 16x(n)$

$Y(0) = \Sigma y(n) = 16\times(1 + 3 + 1 + 2) = 112$

GATE WALLAH
SOLDIERS

THANK YOU