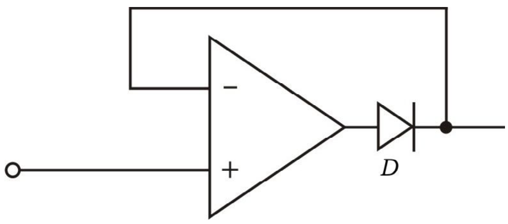
Q.1 To Q.25 carry one mark each.

Q.1 Which among the given statement is/are CORRECT
(I) Avalanche breakdown voltage increases with temperature
(II) Zener breakdown voltage decreases with temperature
(a) Only I (b) Only II (c) both (d) None
Ans. (c)

Q.2 If the 0PAMP has an open loop gain, A=100 and V_r of the diode is 0.7V; what is the cutin voltage for the superdiode circuit shown below.



(a) 7 mV (b) 70 mV (c) 700 mV (d) 0.7 mV
Ans. (a)

Q.3 A BJT is operating is saturation region with $V_{CE} = V_{CE,sat}$ at 20°C. If the temperature is increased to 40°C, V_{CE} will
(a) increase by –5 mV (b) decrease by –5 mV
(c) decrease by –50 mV (d) not change
Ans. (b)

Q.4 If h_{FE} is DC current gain $\left(ie\ \ h_{FE} = \frac{I_C}{I_B}\right)$ and h_{fe} is small signal curent gain

$\left(ie\ \ h_{fe} = \left.\frac{\partial i_C}{\partial i_B}\right|_{V_{CE}}\right)$, then

(a) $h_{fe} = h_{FE}$
(b) h_{fe} is always less than h_{FE}
(c) h_{fe} is less than h_{FE} for smaller currents and h_{fe} is greater than h_{FE} for larger currents
(d) h_{fe} is greater than h_{FE} for smaller currents and h_{fe} is less than h_{fE} for larger currents
Ans. (d)

Q.5 If $X = 0$ in the logic equation

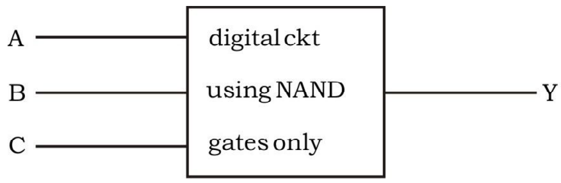
$\left[X + Z\left\{Y + \left(Z + \bar{X}Y\right)\right\}\right]\left[\bar{Y} + \bar{X}\left(Z + Y\right)\right] = 0$ then

(a) $Z = 0$ (b) $Z = Y$ (c) $Z = 1$ (d) $Z = \bar{Y}$
Ans. (a)

Q.6 Minimum no of 2:1 MUX required to implement 2-input OR and 2-input EX-NOR gates are
(a) 1 and 2 (b) 1 and 3 (c) 2 and 2 (d) 1 and 1
Ans. (d)

Q.7 Total number of 2-i/P NAND gate required for the implementation of 3 variables Boolean function

$Y = f(A,B,C) = \sum m(1,5,6,7)$ is



(a) 2 (b) 3 (c) 4 (d) 5

Ans. **(c)**

Q.8 In a μP, the service routine for a certain interrupt starts from a fixed location of memory
which cannot be used for implementing software break points. The interrupt can be delayed or rejected and it is level triggered.The interrupt can be

(a) RST 7.5, 6.5 or 5.5
(b) RST 7.5, 6.5, 5.5 or INTR
(c) RST 6.5, 5.5 or INTR
(d) RST 6.5 or 5.5

Ans. **(d)**

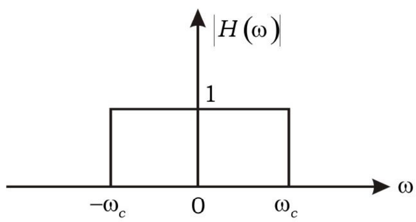
Q.9 The ROC of z-transform of the discrete time sequence is

$$x[n] = \left(\frac{1}{4}\right)^n u(n-1) + 5^n u(-n-1)$$

(a) $\frac{1}{4} < |Z| < 5$ (b) $\frac{1}{5} < |Z| < 4$ (c) $\frac{1}{5} < |Z| < \frac{1}{4}$ (d) $|Z| > 5$

Ans. **(a)**

Q.10 Given below is the frequency response of an ideal LPF. The LPF is (TI : Time Invariant)



(a) Linear, TI, Causal
(b) Linear, TI & Non-Causal
(c) Linear, Not TI & Causal
(d) Linear, Not TI & Non-Causal

Ans. **(b)**

Q.11 A Fast Fourier Transform (FFT) requires 'M' complex multiplications and 'A' complex additions for computing N-point DFT. Then M & A are

(a) $M = \frac{N}{2}\log_2 N$; $A = N\log_2 N$
(b) $M = N^2$; $A = N^2 - N$
(c) $M = N\log_2 N$; $A = N^2$
(d) $M = \frac{N}{2}\log_2 N$; $A = N(N-1)$

Ans. **(a)**

Q.12 Consider the statements regarding a stable and causal minimum phase systems
(I) All of its poles and zeros lie inside the unit circle.
(II) Poles must lie inside the unit circle. zeros can lie anywhere.
(III) The inverse of such system is also stable and causal

(IV) $H(Z)=\left(1-\frac{1}{2}Z^{-1}\right)$ is a minimum phase system

Which of the above statements is/are CORRECT

(a) I,III & IV (b) I & III (c) II,III & IV (d) I & IV

Ans. (a)

Q.13 Consider two independent Random Variables 'X' and 'Y' with identical distributions. The 'X' and 'Y' take values 0,1,2 and 3 with probabilities 1/2, 1/4, 1/8 and 1/8. What is the conditional probability $P\left((X+Y=4)/|X-Y|=2\right)$ is

(a) 1/32 (b) 1/16 (c) 1/8 (d) 0

Ans. (b)

Q.14 If the Power Spectral density (PSD) for a stationary process is double exponential function $S_Y(f)=e^{-\pi|f|}$ Autocorrelation function (ACF) is

(a) $\frac{1}{1+4\pi f^2}$ (b) $\frac{\pi}{1+f^2}$ (c) $\frac{1/\pi}{1+f^2}$ (d) $\frac{(2/\pi)}{1+4f^2}$

Ans. (d)

Q.15 The Nyquist sampling rate for the signal

$g(t)=\left[\frac{\sin(200\pi t)}{t}\right]\left[\frac{\sin 300\pi t}{\pi t}\right]$ is

(a) 200 Hz (b) 100 Hz (c) 500 Hz (d) 300 Hz

Ans. (c)

Q.16 given $\mu_0=4\pi\times10^{-7}\ H/m$ and $\in_0=8.85\times10^{-12}\ F/m$ An air filled rectangular waveguide has inner dimensions of $3cm\times1cm$. The wave impendance of TE_{10} mode of propagation in the waveguide at a frequency of 30 GHz is

(a) 377Ω (b) 391Ω (c) 382Ω (d) 400Ω

Ans. (c)

Q.17 The $\vec{E}$ field (in V/m) of a plane wave propagating in free space is given by

$\vec{E}=\hat{x}5\sin(\omega t-\beta z)+\hat{y}5\sqrt{3}\cos(\omega t-\beta z+\pi/3)$

The time average power flow density in watts is (η_0 is characteristic impedance of free space)

(a) $\frac{50}{\eta_0}$ (b) $\frac{100}{\eta_0}$ (c) $\eta_0 50$ (d) $\eta_0 100$

Ans. (a)

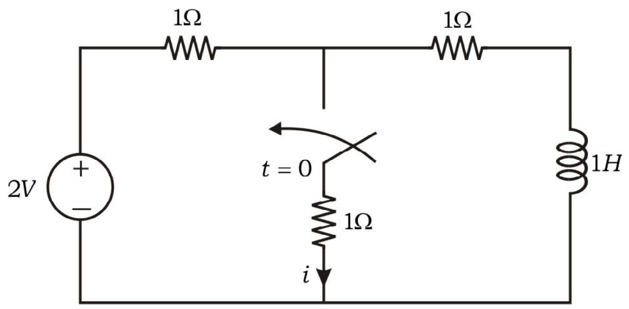
Q.18 One end of a loss-less transmission line having the characteristic impedance of 50Ω and length of 2cm is short-circuited. At a frequency of 6 GHz, the input impedance at the other end of the transmission line is

(a) 0 (b) ∞ (c) Capacitive (d) Inductive

Ans. **(c)**

NETWORK

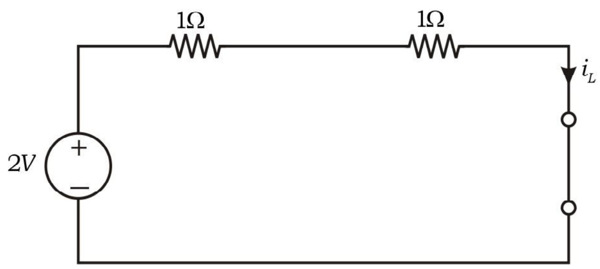
Q.19 In the circuit shown, the switch S is closed at t=0 after long time. $i\left(0^{+}\right)$ is



(a) 0.5A (b) 1A (c) 2A (d) 1.5A

Ans. **(a)**

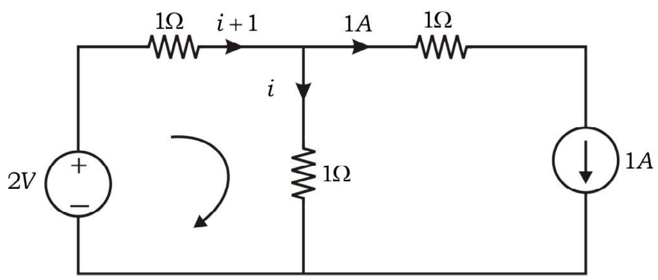
Exp. $t<0$ $S \rightarrow$ opened for long time i.e. Steady state $L \rightarrow S/C$



So $i_L = \frac{2}{1+1} = 1A$

Hence $i_L\left(0^{+}\right) = i_L\left(0^{-}\right) = 1A$

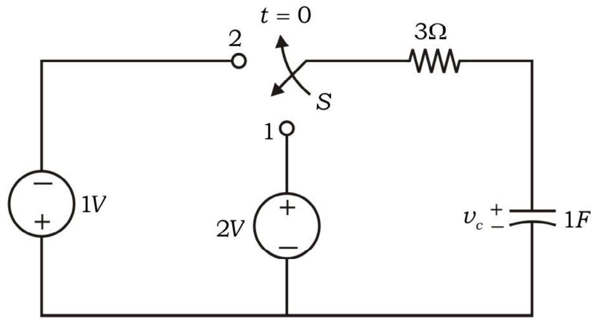
$t=0^{+}$ S is closed, L as a current source



$-2+1.(i+1)+i.1=0$

$2i=1 \quad \Rightarrow \quad i=0.5A$

Q.20

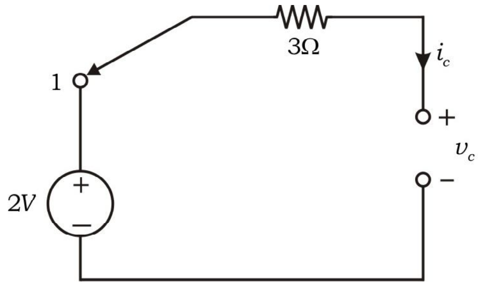


In the above circuit shown S is changed from position 1 to 2, $\frac{dv_c}{dt}(0+)$ is

(a) 3V/sec (b) –1V/sec (c) –2V/sec (d) –3V/sec

Ans. **(b)**

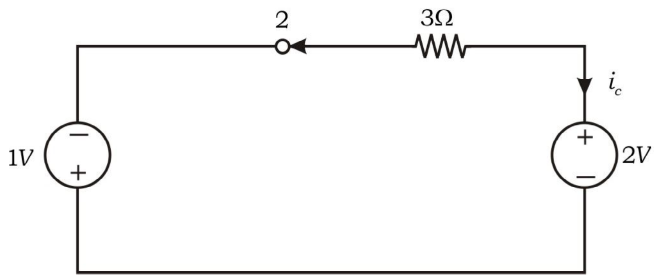
Exp. $S \to 1$ for long time t<0 C behaves as open circuit in steady state



$v_c = 2V$

hence $v_c(0^+) = v_c(0^-) = 2V$

At $t = 0^+$ $S \to 2$ C acts a voltage source of 2V



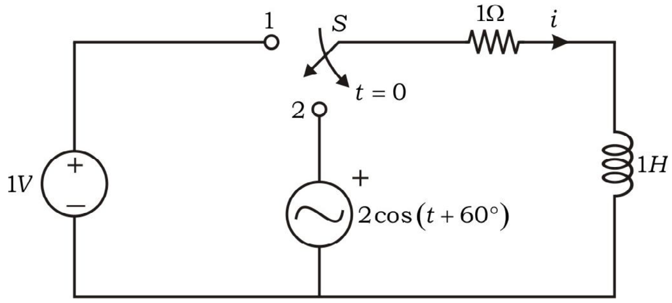
$i_c = -\frac{3}{3} = -1A$

$i_c(0^+) = -1A$

$i_c = C\frac{dv_c}{dt}$ $\Rightarrow$ $i_c(0^+) = 1 \times \frac{dv_c}{dt}(0^+)$

$\Rightarrow$ $\frac{dv_c}{dt}(0^+) = -1V$ / sec

Q.21



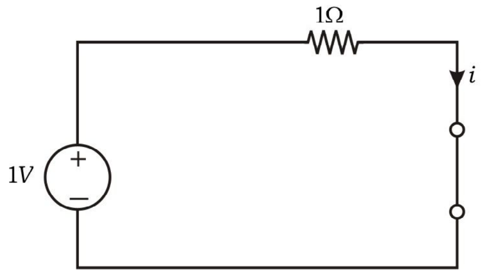
The switch S is changed from 1 to 2 positioin after long time, $\frac{di}{dt}(0+)$ is

(a) $1A/s$ (b) $0.5A/sec$ (c) 0 (d) $\frac{\sqrt{3}}{2}A$ / sec

Ans. **(c)**

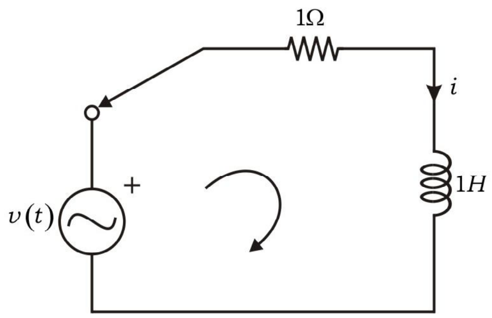
Exp. $t<0$ $S \to 1$ for long time i.e. Steady state L acts as S/C

$$i = \frac{1}{1} = 1A$$



So $i(0^+) = i(0^-) = 1A$

At $t \geq 0$ $S \to 2$



$$i.\frac{di}{dt} + 1.i = v(t)$$

$$\Rightarrow \quad \frac{di}{dt} = 2\cos(t+60°) - i(t)$$

$$\Rightarrow \quad \frac{di}{dt}(0^+) = 2\cos 60° - i(0^+) = 1 - 1 = 0$$

CONTROL SYSTEM

Q.22 The state transition matrices of a systim at instant t= 2 & t=3 are given as

$$\phi(2)=\begin{bmatrix}2 & 0\\ 0 & -3\end{bmatrix} \quad \& \quad \phi(3)=\begin{bmatrix}-4 & 0\\ 0 & 5\end{bmatrix}$$

(a) $\begin{bmatrix}-2 & 0\\ 0 & 2\end{bmatrix}$ (b) $\begin{bmatrix}-2 & -3\\ -3 & 2\end{bmatrix}$ (c) $\begin{bmatrix}-8 & 0\\ 0 & -15\end{bmatrix}$ (d) $\begin{bmatrix}0 & 8\\ 15 & 20\end{bmatrix}$

Ans. **(c)**

Exp. As $\phi(t)=e^{At}$

$$\phi(t_1+t_2)=e^{A(t_1+t_2)}=e^{At_1}e^{At_2}=\phi(t_1)\phi(t_2)$$

$$\phi(5)=\phi(2+3)=\phi(2).\phi(3)$$

$$=\begin{bmatrix}2 & 0\\ 0 & -3\end{bmatrix}\begin{bmatrix}-4 & 0\\ 0 & 5\end{bmatrix}=\begin{bmatrix}-8 & 0\\ 0 & -15\end{bmatrix}$$

Q.23 A system having T.F. $\frac{1}{s+1}$ is excited by a step function of magnitude '3'. The time required by output to reach upto 96% of its steady state value is

(a) 0.54 sec (b) 1.23 sec (c) 2.08 sec (d) 3.22 sec

Ans. **(d)**

Exp. Input $=3u(t)$

$$R(s)=3/s$$

$$G(s)=\frac{C(s)}{R(s)}=\frac{1}{s+1}$$

$$C(s)=\frac{3}{s(s+1)}=\frac{3}{s}-\frac{3}{s+1}$$

$\Rightarrow$ $c(t)=3\left(1-e^{-t}\right)$

$t\to\infty \quad c_{SS}=3$

At $t=T_1$, $c=0.96c_{SS}$

$=0.96\times 3$

so $0.96\times 3=3\left(1-e^{-T_1}\right)$

$\Rightarrow$ $T_1=3.22s$

MATHEMATICS

Q.24 If eigen values of $A_{3\times 3}$ matrix are –1,1/2,3. The eigen values of A^2+2A+I are

(a) 0, 16, 9/4 (b) 1, 1/4, 9 (c) 2, 9/2, 4 (d) 2, 3/2, –2

Ans. **(a)**

Exp. $A^2+2A+I=A^2+2AI+I^2$

$=(A+I)^2$

$A\to -1,\frac{1}{2}, 3$

$A+I\to -1+1,\frac{1}{2}+1,3+1$

$= 0, 3/2, 4$

$(A + I)^2 \rightarrow 0, 9/4, 16$

Q.25 The Cauchy's mean value of the functions e^x & e^{-x} between (0,1) is

(a) $\ln(e-1)$ (b) 0.5 (c) $\ln\left(\frac{e}{e+1}\right)$ (d) 0.334

Ans. **(b)**

Exp. $f(x) = e^x, \; g(x) = e^{-x}$

$a = 0, \; b = 1$

Cauchy's mean value a<c<b

$$\frac{f'(c)}{g'(c)} = \frac{f(b) - f(a)}{g(b) - g(a)}$$

$f'(x) = e^x$ & $g(x) = -e^{-x}$

$$\frac{e^c}{-e^{-c}} = \frac{e - e^0}{e^{-1} - e^0} = \frac{e-1}{1/e - 1}$$

$\Rightarrow \quad -e^{2c} = \frac{e-1}{(1-e)/e}$

$\Rightarrow \quad -e^{2c} = -e$

$\Rightarrow \quad 2c = 1 \quad \Rightarrow \quad c = 0.5$

Q.26 To Q.55 carry two marks each.

Q.26 Consider a silicon PN function with equal level of doping on both sides at room temperature with the given parameters

Doping level $= 1 \text{ in } 10^8$

Depletion width (total) $= 2\mu m$

Density of $Si = 2.33 g/cm^3$

At. wt. of $Si = 28.1$

Intrinsic Carrier conc $= 1.5 \times 10^{10} cm^{-3}$

Permittvity of free space $= 8.85 \times 10^{-12} F/m$

Dielectric Constant of Si = 12

The peak electric field in the device is

(a) 75.3 kV/cm from N to P (b) 75.3 kV/cm from P to N

(c) 150 kV/cm from N to P (d) 150 kV/cm form P to N

Ans. **(a)**

Q.27 $x[n]$ is a real-valued causal sequence with

$x[0] > 0 \text{ and } \left|X(e^{j\omega})\right|^2 = (1 + a^2) - 2a\cos\omega$

Then $x[n]$ is

(a) $\delta[n] - a\delta[n-1]$ (b) $a\delta[n] + \delta[n-1]$

(c) $a\delta[n] - \delta[n-1]$ (d) $\delta[n] + a\delta[n-1]$

Ans. **(a)**

Q.28 DTFT of the two-sided sequence

$$x[n] = \left(\frac{1}{4}\right)^{|n|} \text{ is}$$

(a) $\dfrac{\left(\frac{15}{16}\right)}{\left(\frac{17}{16}\right) - 2\cos\omega}$

(b) $\dfrac{\left(\frac{17}{16}\right)}{\left(\frac{15}{16}\right) + 2\cos\omega}$

(c) $\dfrac{15}{17 - 6\cos\omega}$

(d) $\dfrac{15}{15 - 10\cos\omega}$

Ans. **(a)**

Q.29 The Z-transform of a sequence is

$$X(z) = \frac{z + 2z^{-2} + z^{-3}}{1 - 3z^{-4} + z^{-5}}$$

If R.O.C includes the unity circle, then DTFT of $x(n)$ *at* $\omega = \pi$ is

(a) 1 (b) –1 (c) 0 (d) 2

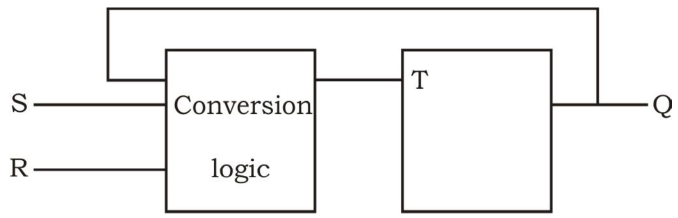
Ans. **(c)**

Q.30 If $x[n] = \{1, 2, 3, 3\}$ and $h[n] = \{1, -1, 1\}$ then the circular convolution of $x[n]$ & $h[n]$ is

(a) $\{2, 0, 4, 1\}$ (b) $\{1, 0, 2, 4\}$ (c) $\{3, 1, 0, 2\}$ (d) $\{1, 4, 2, 2\}$

Ans. **(d)**

Q.31 An SR flip-flop is to be implemented using T-flip flop. The conversion logic should be



(a) $T = S\bar{Q}_n + RQ_n$

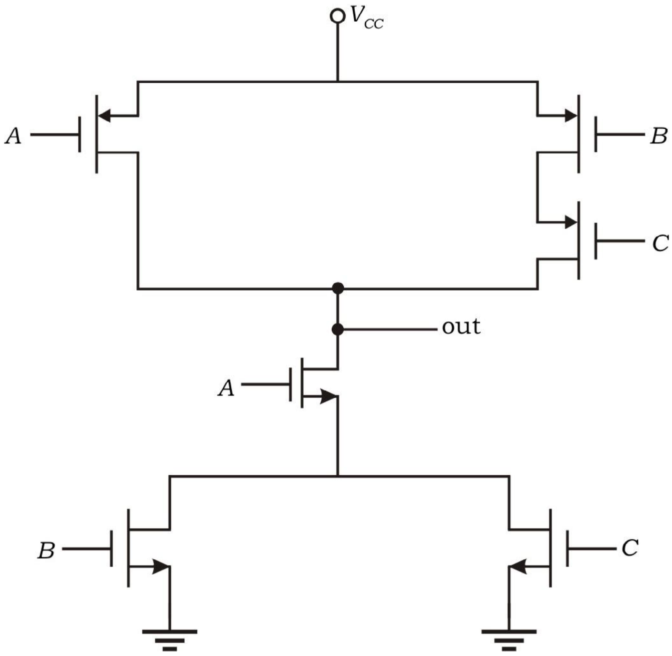
(b) $T = \bar{S}\bar{Q}_n + RQ_n$

(c) $T = S + \bar{R}Q_n$

(d) $T = SQ_n + R\bar{Q}_n$

Ans. **(a)**

Q.32 The logic function implemented by the given circuit at terminal out is



(a) $\overline{A+BC}$ (b) $A+BC$ (c) $\overline{A.(B+C)}$ (d) $A.(B+C)$

Ans. (a)

Q.33 Following is the segment of 8085 Assembly language program

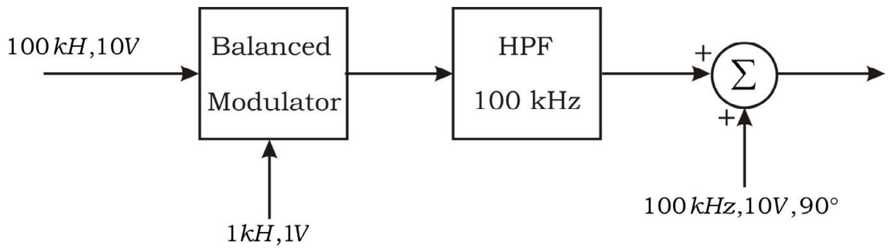
```
         LXI SP, 3FFFH
         CALL 2700H
2700H :  LXI H,2050H
         XRA A
         PUSH PSW
         POP H
         SPHL
         POP PSW
         RET
```

On completion of RET instruction, the contents of SP is

(a) 0046_H (b) 0048_H (c) 2054_H (d) $3FFF_H$

Ans. (b)

Q.34 A 100 kHz carrier of 10V amplitude and a 1 kHz modulating signal of 1V amplitude are fed to a balanced modulator. The output of the modulator is passed through an ideal HPF with cut off freq. of 100 kHz. The o/p of the filter is added with 100 kHz signal of 10V amplitude and 90° phase shift as shown in fig. The envelope of the resultant signal is



(a) Constant

(b) $5\sqrt{1/4 - \sin\left(2\pi \times 10^3 t\right)}$

(c) $10\sqrt{\left(\frac{5}{4}\right) - \sin\left(2\pi \times 10^3 t\right)}$

(d) $10\sqrt{\left(\frac{5}{4}\right) + \sin\left(2\pi \times 10^3 t\right)}$

Ans. (c)

Q.35 Let X and Y be two statistically independent Random Variables uniformly distributed in the ranges (0,1) and (2,6) respectively

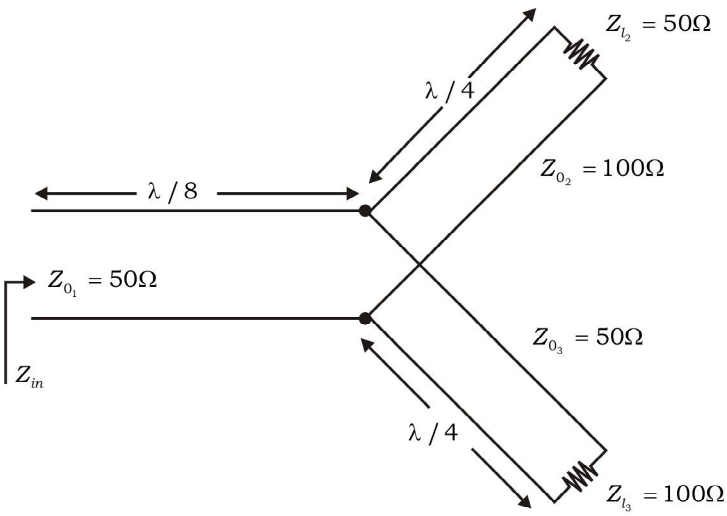
Let $Z = X + Y$. Then the probability that $(Z \le 5)$ is

(a) 1 (b) 5/8 (c) 3/8 (d) 1/2

Ans. (b)

Q.36 A transmission line terminates in two branches each of length $\lambda/4$, as shown. Input impedance Zin, as seen by the source is

(All the transmission lines are lossless)



(a) Inductive (b) Capacitive (c) Zero (d) Infinite

Ans. (a)

Q.37 A plane wave having the electric field component $\vec{E_i} = 10\cos\left(2\pi \times 10^9 t - y\right)\hat{a}_z$ V/m and travelling in free space in incident normally on a loss less medium with $\mu = \mu_0$ *and* $\in = 4\in_0$ which occupies the region $y \ge 0$. The reflected magnetic field component is given by : $(\eta_0 = 120\pi\ \Omega)$

(a) $\frac{1}{18\pi}\cos\left(2\pi \times 10^9 t + y\right)\hat{a}_x$

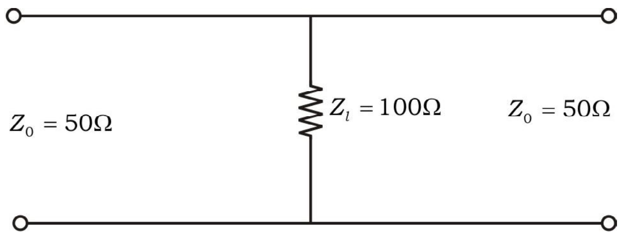
(b) $\frac{1}{36\pi}\cos\left(2\pi \times 10^9 t + y\right)\hat{a}_x$

(c) $-\frac{1}{18\pi}\cos\left(2\pi \times 10^9 t - y\right)\hat{a}_x$

(d) $-\frac{1}{36\pi}\cos\left(2\pi \times 10^9 t - y\right)\hat{a}_x$

Ans. **(b)**

Q.38 The S-matrix for the n/w shown below is



(a) $\begin{bmatrix} -\frac{1}{3} & \frac{2}{3} \\ \frac{2}{2} & -\frac{1}{3} \end{bmatrix}$ (b) $\begin{bmatrix} -\frac{1}{5} & \frac{4}{5} \\ \frac{4}{5} & -\frac{1}{5} \end{bmatrix}$ (c) $\begin{bmatrix} -\frac{1}{2} & \frac{1}{3} \\ \frac{1}{3} & -\frac{1}{2} \end{bmatrix}$ (d) $\begin{bmatrix} 0 & \frac{1}{3} \\ \frac{1}{3} & 0 \end{bmatrix}$

Ans. **(b)**

Q.39 Consider the given statements regarding smith chart. which among them is/are CORRECT

(I) An anticlock wise movement on constant 'r' circle adds inductor

(II) A circle with origin at centre is constant VSWR circle

(III) A clockwise movement of an angle $\pi / 2$ means movement on a lossless transmission line towards the generator for a length, $l = \lambda / 8$

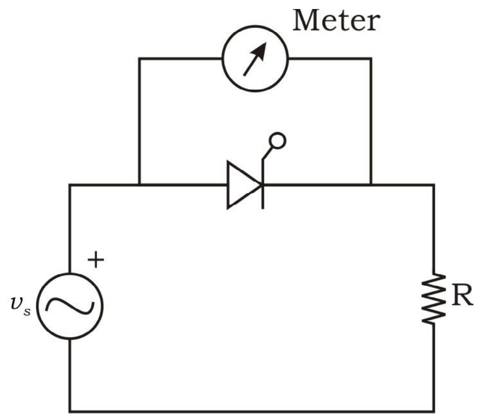
(IV) The smith chart can be used for designing impedance matching network

(a) I & IV only (b) II,III & IV (c) I,II & III (d) All

Ans. **(b)**

POWER ELECTRONICS

Q.40



In the above circuit shown, SCR is supplying a pure resestive load from 30 V, 50 Hz supply, if SCR is fired at 45°, the reading of dc voltmeter connected is

(a) 6.5 V (b) 11.5 V (c) 8.1 V (d) 3.2 V

Ans. **(b)**

Q.41 The ideal SCR's in the full converter are supplying highly inductive load from 5 kHz supply. If the turn off time of each Thyristor is 25 μs. The maximum allowed firing angle is

(a) 45° (b) 90° (c) 135° (d) 180°

Ans. **(c)**

NETWORK

Q.42 An input voltage $v(t) = 5\sqrt{2}\sin(t + 20°) + 5\sqrt{2}\sin(2t + 20°)$ is applied to a series combination of resistance of 1Ω and capacitance of 1F.The steady-state current i(t) in Amp is

(a) $5\cos(t + 65°) + 10\sqrt{2}\cos(2t + 65°)$

(b) $5\sin(t + 65°) + 10\sqrt{2/5}\sin(2t - 25°)$

(c) $5\sin(t - 25°) + 10\sqrt{2}\sin(2t - 25°)$

(d) $5\sin(t + 65°) + 10\sqrt{2/5}\sin\{2t + 20° + \tan^{-1}(1/2)\}$

Ans. **(d)**

Exp. Applied voltage

$$v = v_1 + v_2$$

$$v_1(t) = 5\sqrt{2}\sin(t + 20°)$$

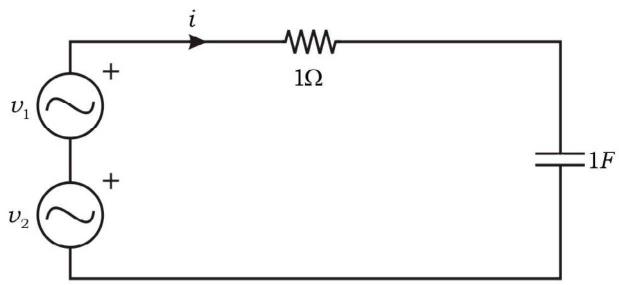
frequency $\omega = 1$ rad / sec. , rms $V_1 = 5V$

phase $\bar{V}_1 = 5\underline{|20°}$

$$v_2(t) = 5\sqrt{2}\sin(2t + 20°)$$

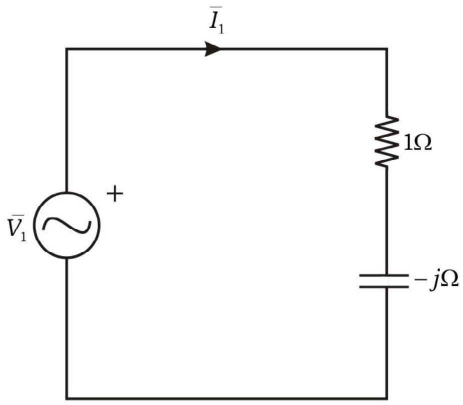
$\omega = 2$ rad / sec , rms$V_2 = 5V$

$$\bar{V} = 5\underline{|20°}V$$



Using super position

If only V_1 is taken



$$Z_{c_1} = \frac{1}{j\omega C_1} = \frac{1}{j \times 1} = -j$$

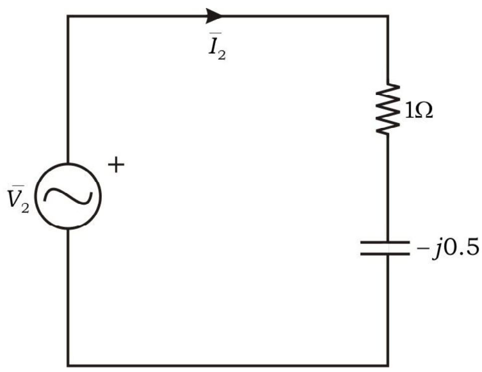
$$\bar{I} = \frac{\bar{V}_1}{1-j} = \frac{5\angle 20^\circ}{1-j} = \frac{5}{\sqrt{2}}\angle 65^\circ$$

peak $I_{1m} = \frac{5}{\sqrt{2}} \times \sqrt{2} = 5A$

$$i_1(t) = 5\sin(t + 65^\circ)$$

If only $\bar{V}_2$ is taken

$$Z_{i_2} = \frac{1}{j2 \times 1} = -j0.5$$



$$\bar{I}_2 = \frac{\bar{V}_2}{1-j0.5} = \frac{5\angle 20^\circ}{1-j1/2}$$

$$= \frac{10\angle 20^\circ}{2-j} = \frac{10}{\sqrt{5}}\angle 20^\circ + \tan^{-1}(1/2)$$

$$rms\ I_2 = \frac{10}{\sqrt{5}}$$

peak $I_{2m} = \sqrt{2} \times \frac{10}{\sqrt{5}} = 10\sqrt{\frac{2}{5}}$

$$i_2(t) = 10\sqrt{\frac{2}{5}}\sin\left[2t + 20^\circ + \tan^{-1}(1/2)\right]$$

so $i(t) = i_1(t) + i_2(t)$

$\Rightarrow$ $i(t) = 5\sin(t + 65^\circ) + 10\sqrt{\frac{2}{5}}\sin\left\{2t + 20^\circ + \tan^{-t}(1/2)\right\}$

CONTROL

Q.43 The state space representation of a control system are:

$$\dot{x} = -2x_1 - x_2 + 2u$$

$$\dot{x} = 3x_1$$

$$y = 2x_1 + u$$

(a) Controllable & Observable
(b) Controllable but not observable
(c) Observable but not Controllable
(d) Neither controllable nor Observable

Ans. (a)

Exp. $$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}-2 & -1\\ 3 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}2\\ 0\end{bmatrix}u$$

$$y=[2 \quad 0]\begin{bmatrix}x_1\\ x_2\end{bmatrix}+[1]u$$

$$A=\begin{bmatrix}-2 & -1\\ 3 & 0\end{bmatrix}, B=\begin{bmatrix}2\\ 0\end{bmatrix},\ C=[2 \quad 0]$$

number of state variables n=2
Contsollability Test Matrix

$$Q_c=[B \ \vdots \ AB]$$

$$AB=\begin{bmatrix}-4\\ 6\end{bmatrix}$$

$$Q_c=\begin{bmatrix}2 & -4\\ 0 & 6\end{bmatrix}$$

rank of $Q_c=2=n$ so it is contsallable

Observability Test Matrix $Q_0=\begin{bmatrix}C\\ \hline CA\end{bmatrix}$

$$CA=[-4 \quad -2]$$

$\Rightarrow$ $Q_0=\begin{bmatrix}2 & 0\\ -4 & -2\end{bmatrix}$ rank of $Q_0=2=n$ it is Observable

Q.44 The characteristic equation of a control system is given as

$$s^5+s^4+3s^3+3s^2+5s+4=0$$

The number of roots lying in right half of s-plane and the number of roots an $j\omega$ axis are

(a) 4 & 2 (b) 2 & 0 (c) 0 & 4 (d) 0 & 2

Ans. **(b)**

Exp.

s^5	1	3	5
s^4	1	3	4
s^3	$0(\varepsilon)$	1	0
s^2	$\dfrac{3\varepsilon-1}{\varepsilon}$	4	0
s^1	$\dfrac{-1+3\varepsilon-4\varepsilon^2}{-1+3\varepsilon}$	0	0
s^0	4	0	0

As $\varepsilon \to 0$ but +ve
1^{st} column

1	$+ve$
1	$+ve$
ε	$+ve$
$3-\frac{1}{\varepsilon}=-\infty$	$-ve$
$\frac{-1+3\varepsilon-4\varepsilon^2}{-1+3\varepsilon}$	$+ve$
4	$+ve$

There are 2-sign changes
so number of roots in RH of s-plane =2

As complete row is not zero. So no root is lging on $j\omega-axis$

Q.45 The zero input response of the system,

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}2 & 0\\ -1 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}1\\ 0\end{bmatrix}u$$

Where $\begin{bmatrix}x_1(0)\\ x_2(0)\end{bmatrix}=\begin{bmatrix}5\\ 0\end{bmatrix}$, is

(a) $\begin{bmatrix}e^{-t}\\ e^{2t}\end{bmatrix}$

(b) $\begin{bmatrix}e^{2t}-e^{-3t}\\ e^{2t}+e^{-3t}\end{bmatrix}$

(c) $\begin{bmatrix}e^{-t}-e^{-2t}\\ e^{3t}\end{bmatrix}$

(d) $\begin{bmatrix}5e^{2t}\\ -e^{2t}+e^{-3t}\end{bmatrix}$

Ans. (d)

Exp. $A=\begin{bmatrix}2 & 0\\ -1 & -3\end{bmatrix}$, $[sI-A]=\begin{bmatrix}s-2 & 0\\ 1 & s+3\end{bmatrix}$

$$\phi(s)=[sI\quad -A]^{-1}=\begin{bmatrix}s-2 & 0\\ 1 & s+3\end{bmatrix}^{-1}$$

$$=\frac{1}{(s-2)(s+3)}\begin{bmatrix}s+3 & 0\\ -1 & s-2\end{bmatrix}$$

$$\Rightarrow \quad \phi(s)=\begin{bmatrix}\frac{1}{s-2} & 0\\ -\frac{1}{(s-2)(s+3)} & \frac{1}{s+3}\end{bmatrix}$$

$$=\begin{bmatrix}\frac{1}{s-2} & 0\\ -\frac{1}{5(s-2)}+\frac{1}{5(s+3)} & \frac{1}{s+3}\end{bmatrix}$$

Z.I.R $X(s)=\phi(s)x(0)$

$$= \begin{bmatrix} \frac{1}{s-2} & 0 \\ -\frac{1}{(s-2)(s+3)} & \frac{1}{s+3} \end{bmatrix} \begin{bmatrix} 5 \\ 0 \end{bmatrix}$$

$$= \begin{bmatrix} \frac{5}{s-2} \\ -\frac{5}{(s-2)(s+3)} \end{bmatrix} = \begin{bmatrix} \frac{5}{s-2} \\ -\frac{1}{s-2} + \frac{1}{s+3} \end{bmatrix}$$

$$\Rightarrow \quad x(t) = \begin{bmatrix} 5e^{2t} \\ -e^{2t} + e^{-3t} \end{bmatrix}$$

Q.46 The break away point (s) on the root locus of the sytem with OLTF $\frac{K}{s(s+1)(s+3)}$ is (are)

(a) K=0.6 (b) K=2.5 (c) K=3.4 (d) K=11

Ans. **(a)**

Exp. Ch. equation $1 + G(s)H(s) = 0$

$$1 + \frac{K}{s(s+1)(s+3)} = 0$$

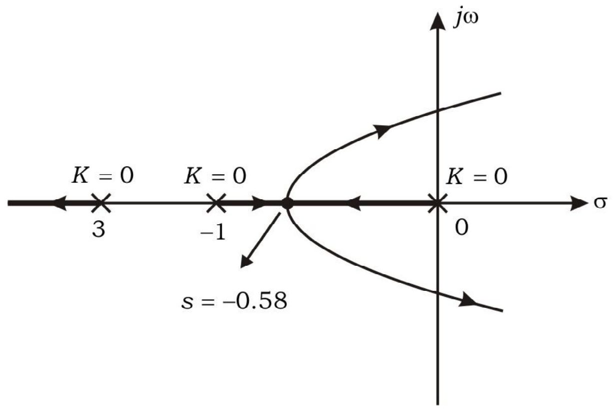
$$\Rightarrow \quad s^3 + 4s^2 + 3s + K = 0$$

$$K = -\left[s^3 + 4s^2 + 3s\right]$$

For break away point $\frac{dK}{ds} = 0$

$$\frac{dk}{ds} = -\left[3s^2 + 8s + 3\right] = 0$$

$$\Rightarrow \quad s = -0.58 \,,\ -15.42$$



It can be observed from root locu that tywo branches start from $s = 0$ & $s = -1$, so break away point must be in between 0 & 1 i.e. at $s = -0.58$

$$K = -\left[s^3 + 4s^2 + 3s\right]$$

$$= -\left[(-0.58)^3 + 4(-0.58)^2 + 3(-0.58)\right]$$

$$= 0.59$$

Q.47 The system with OLTF $G(s)H(s) = \frac{1}{s(s^2+s+2)}$ has a gain margin of

(a) –3 dB (b) 6 dB (c) –6 dB (d) 2 dB

Ans. **(b)**

Exp. For frequency response $s = j\omega$

$$GH(j\omega) = \frac{1}{j\omega\left[(2-\omega^2) + j\omega\right]}$$

Gain $M = |GH| = \frac{1}{\omega\sqrt{(2-\omega^2)^2 + \omega^2}}$

phase $\phi = \underline{|GH} = -90° - \tan^{-1}\left(\frac{\omega}{2-\omega^2}\right)$

At phase cross-over frequency ω_P , $\phi = -180°$

$$-180° = -90° - \tan^{-1}\left(\frac{\omega_P}{2-\omega_P^2}\right)$$

$\Rightarrow$ $\tan^{-1}\left(\frac{\omega_P}{2-\omega_P^2}\right) = 90°$

$\Rightarrow$ $2 - \omega_P^2 = 0$ $\Rightarrow$ $\omega_P = \sqrt{2}$

Gain at $\omega_P = \sqrt{2}$

$$M = \frac{1}{\sqrt{2}\sqrt{0 + (\sqrt{2})^2}}$$

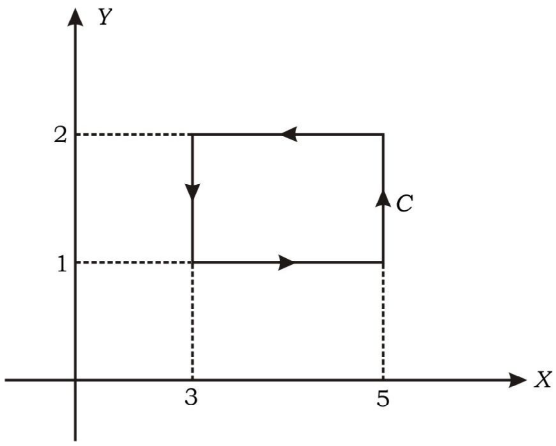
$$= \frac{1}{2}$$

G.M. $= \frac{1}{M} = 2$

GM (in dB) = 20 log 2 = 6 dB

MATHEMATICS

Q.48 The Line integral of the vector function $\bar{F} = (x^2 + y^2)\hat{i} + 3xy\,\hat{j}$ over the path as shown in figure is



(a) 3 (b) 0 (c) 2 (d) 6

Ans. **(a)**

Exp.
$$\oint_C \overline{F}.\overline{dr} = \oint_C \left(x^2 + y^2\right)dx + 3xy\,dy$$

Where $\overline{dr} = dx\,\hat{i} + dy\,\hat{i}$

Using Green's Therem

$$\oint_C \left(x^2 + y^2\right)dx + 3xy\,dy = \iint_R \left[\frac{\partial}{\partial x}(3xy) - \frac{\partial}{\partial y}\left(x^2 + y^2\right)\right]dy dx$$

$$= \iint_R (3y - 2y)\,dy\,dx$$

$$= \iint_R y\,dy\,dx$$

Where R is the region bounded by C

$$I = \int_{x=3}^{5}\int_{y=1}^{2} y\,dy\,dx = \frac{1}{2}\int_{x=3}^{5} \left|y^2\right|_1^2 dx$$

$$= \frac{3}{2}\int_3^5 dx = 3$$

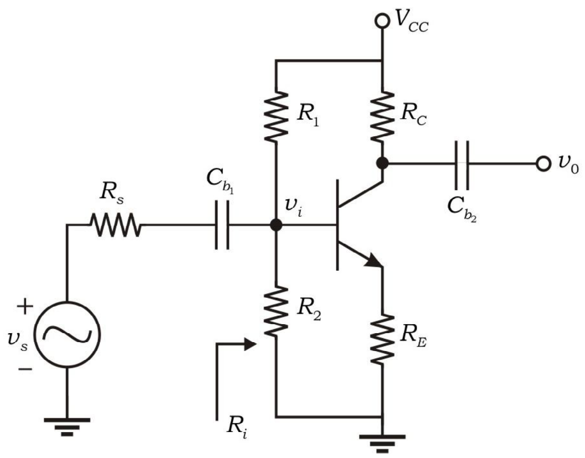
Statement for linked Question 49, 50 and 51

Consider the CE amplifier shown below,

$V_{CC} = 10V$; $R_C = 2k$; $R_E = 2k$; $C_{b_1} = 4\mu F$; $C_{b_2} = 8\mu F$

$\beta = 100$; $I_{co} = 10nA$; $h_{re} = h_{oe} = 0$; $Rs = 3k$,

$R_1 = R_2 = 400k$; $V_T = 25mV$; $V_{BE} = 0.7V$



Q.49 The current in the emitter resistance R_E is

(a) 0.6 mA (b) 1 mA (c) 1.5 mA (d) 2 mA

Ans. **(b)**

Q.50 The input resistance R_i is

(a) 3.97 k (b) 200 k (c) 101k (d) 2k

Ans. **(c)**

Q.51 The small signal voltage gain $\left(\frac{V_0}{V_i}\right)$ is

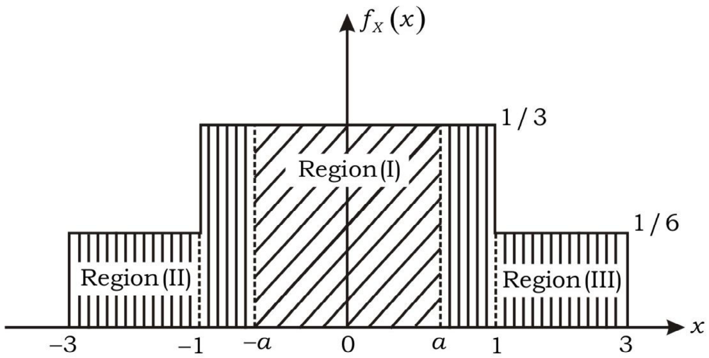
(a) –1 (b) –5 (c) –42 (d) –0.5

Ans. **(a)**

Statement for linked questions 52 & 53

Asymmetric three-level midtread quantizer is to be designed assuming equiprobable occurence of all quantization levels.

Q.52 If the probability density function is divided into three regions as shown in the figure, the value of 'a' in the figure is



(a) 1 (b) 1/2 (c) 1/3 (d) 2/3

Ans. **(b)**

Q.53 The Quantization Noise power for the quantization region between '–a' and '+a' in the figure is

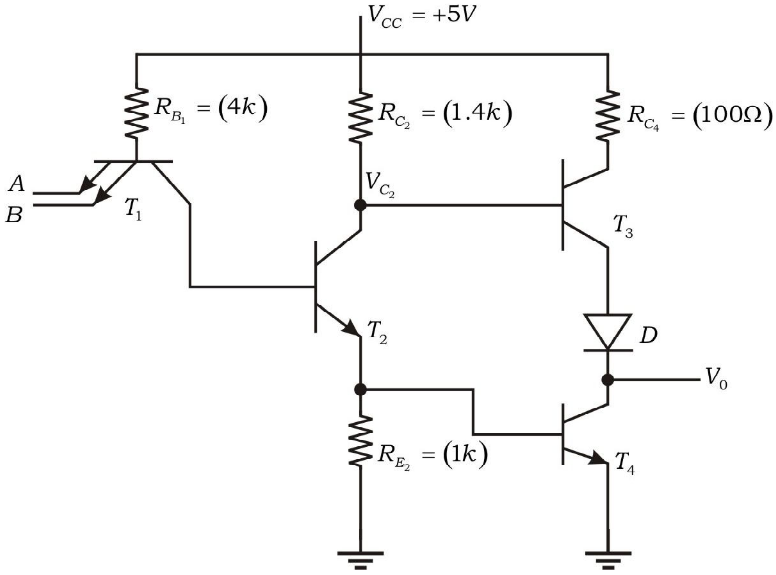
(a) 4/81 (b) 1/36 (c) 1/18 (d) 2/81

Ans. **(b)**

Statement for the linked questions 54 & 55

Consider TTL 2-i/P NAND gate given

$V_{BE,active} = 0.7V$ $V_{BE,sat} = 0.8V$ $V_{CE,sat} = 0.2V$ for each tramistor



Q.54 When A=B=1 (ie + 5V) ; the states of the different transistors are

(a) T_1: Inverse Active; T_2: Saturation; T_3: Saturation T_4: Saturation
(b) T1: Inverse Active; T2: Saturation; T3: Cut off; T4: Saturation
(c) T1; Active; T2: Cut off; T3: Saturation T4: Saturation
(d) T1: Active; T2: Saturation; T3: Cut off; T4: Saturation

Ans. **(b)**

Q.55 The voltage V_{c2} is equal to

(a) 0.2V (b) 5V (c) 1.4V (d) 1.0V

Ans. **(d)**

GENERAL APTITUDE (GA) QUESTIONS
Q. 56 to Q.60 carry one mark each

Q.56 Four bells ring at the interval of 6,8,12 and 18 seconds. They start ringing togather at 12 'O clock. After how many seconds will they ring togather again

(a) 72 (b) 84 (c) 60 (d) 48

Ans. **(a)**

Exp. It is a question in which you are required to find out the L.C.M. and LCM of 6,8,12 and 18 is 72. Thus the four bells will ring together after 72 seconds.

Q.57 Choose the most appropriate word from the following options given below to complete the following sentence.

From time to time, those vaccine strains revert to________, becoming potentially as dangerous as their wild counterparts.

(a) strategy (b) impermissible
(c) virulence (d) resolutely

Ans. **(c)**

Q.58 Which of the following options given below that is most **opposite**to the given word: **Discrepancy**

(a) contradiction, (b) inconsistency,

(c) disparity, (d) consensus

Ans. **(d)**

Q59. The question below consists of a pair of related words followed by four pair of words. Select the pair that best expresses the relation in the original pair.

COLOR: SPECTRUM:

(a) tone : scale (b) sound : waves
(c) verse : poem (d) dimension : space

Ans. **(c)**

Q60. Choose the most appropriate word from the options given below to complete the following sentence:

In parts of the Arctic, the land grades into thelandfast ice so ______ that you can walk offthe coast and not know you are over the hiddensea.

(a) permanently (b) imperceptibly
(c) irregularly (d) precariously

Ans. **(b)**

Q.61 to Q.65 carry Two marks each

Q.61 The model of development we are pursuing is heavily dependent on the increasing use of energy. Most of the energy currently generated in the world is from non-renewable sources like coal or petroleum. Large tract of the Amazon rain forests are being deforested in order to provide for the increased consumer needs. Are there enough of these non-renewable resources which can allow not only the advanced countries but all people in the world to enjoy an affluent life style? Given the finite nature of these resources, the answer would be no. What about the future generations? Are we going to hand over a depleted earth and multiple problems to them?

According to the author, "what about the future generation"? Means that what would be the solution to this problem:

(a) Centralized planning (b) Decentralized planning
(c) Sustainable development (d) Economic and environmental development

Ans. **(c)**

Q.62 With an average speed of 40 km/h train reaches its distination in time. If it goes with an average speed of 35 km/h, it is late by 15 minutes. The length of the entire journey is.

(a) 40 km (b) 70 km (c) 30 km (d) 80 km

Ans. **(b)**

Exp. The train needs to travel 15 minutes extra at 35 km/h. Hence it is behind by 8.75 km. The rate of losing distance is 5 km/h. Hence, the train must have travelled for 8.75/5(1 hour 45 minutes) @ 40 km/h. Alternatively you can check with the options.

Q.63 Mohan's expenditure and savings are in the ratio of 3:2. His income increases by 10%. His expenditure increases by 12%. By what percentage does his savings increase.

(a) 12% (b) 5% (c) 7% (d) 10%

Ans. **(c)**

Exp. Let his expenditure and savings are Rs. 300 and Rs 200 respectively, so the income is

Rs. 500, which increases to Rs. 550 similarly, the expenditure increases to Rs 336. So the new savings is equal to 214, which is 7% more than Rs 200

Q.64 An engineer undertakes to build a wall in 50 days. He employs 50 people for the same. However, after 25 days he finds that the work is only 40% complete. How many more men need to be employed to complete the work in time.

(a)50 (b) 75 (c) 25 (d) 80

Ans. (d)

Exp. In order to finish the work in time engineer needs to finish 60% of work in 25 days.

In print 25 days work does $= 20 \times 25 = 1250$ man days (40% of the work)

Hence work left = 60% of the work = 1865 man days since 25 days are left the number of men required is 1875/25 = 75 men.

50 men are already working so 25 more need to be employed.

Q.65 There are 20,000 people living in a town out of them 9000 subscribe to times of india and 12,000 to hindustan times. If 4000 subscribe to both how many also not subscribe to any of the two?

(a) 3000 (b) 2000 (c) 1000 (d) 4000

Ans. (a)

Exp. The number of people subscribe both the newspaper have been counted with each so substrates 4000 from each we get the number who read only one of the newspaper.

That means.

5000 read only T 01

8000 read only HT.

Where 4000 read both.

This gives us a total of 17000. Which means 3000 remaining do not read any of the two newspaper