ACE
Engineering Academy
Leading Institute for ESE/GATE/PSUs

Hyderabad | Delhi | Ahmedabad | Pune | Bhubaneswar | Bengaluru | Lucknow | Chennai | Vijayawada | Vizag | Tirupathi | Kukatpally | Kolkata

GATE-2020

Questions with Detailed Solutions

ELECTRONICS & COMMUNICATION ENGINEERING

All Queries related to **GATE-2020 Solutions** are to be sent to the following email address

hyderabad@aceenggacademy.com | Contact Us : **040 - 23234418, 19, 20**

SUBJECTWISE WEIGHTAGE

S. No.	NAME OF THE SUBJECT	1 MARK QUESTIONS	2 MARKS QUESTIONS	Total Marks
1	Verbal Ability	2	3	8
2	Numerical Ability	3	2	7
3	Engineering Mathematics	5	3	11
4	Network Theory	3	2	7
5	Control Systems	2	3	8
6	Digital Circuits & Microprocessors	3	3	9
7	Signals & System	2	3	8
8	EDC & VLSI	2	4	10
9	Analog Circuits	3	5	13
10	EMT	3	4	11
11	Communication Systems	2	3	8
Total No. of Marks		**30**	**35**	**100**

Section : General Aptitude

01. A superadditive function f(.) satisfies the following property

$f(x_1 + x_2) \geq f(x_1) + f(x_2)$

Which of the following functions is a superadditive function for x > 1 ?

(a) $\frac{1}{x}$ (b) e^x

(c) e^{-x} (d) $\sqrt{x}$

01. Ans: (b)

Sol: a^m is super additive function, if a > 1.

example $2^5 > 2^2 + 2^3$

$f(x_1 + x_2) > f(x_1) + f(x_2)$

So, e^x is super additive fucntion. ($\because$ e > 1)

02. The Canadian constitution requires equal importance be given to English and French. Last year, Air Canada lost a lawsuit, and had to pay a six- figure fine to French-speaking couple after they filed a complaints about formal in-flight announcements in English lasting 15 seconds, as compared to informal 5 seconds messages in French.

The French-speaking couple were upset at ____.

(a) the in-flight announcement being made in English.

(b) the English announcements being clearer than French ones

(c) equal importance being given to English and French.

(d) the English announcements being longer than French ones.

02. Ans: (d)

03. The global financial crisis in 2008 as considered to be the most serious world-wide financial crisis, which started with the sub-prime landing crisis in USA in 2007. The sub-prime lending crisis led to the banking crisis in 2008 with the collapse of Lehman Brothers in 2008. The sub-prime lending refers to the provision of loans to those borrowers who may have difficulties in repaying loans, and its arises because of excess liquidity following the East Asian crisis.

Which one of the following sequences show the correct precedence as per the given passage?

(a) Banking crisis — Sub-prime lending crisis — Global financial crisis — East Asian crisis

(b) East Asian crisis — Sub-prime landing crisis — Banking crisis — Global financial crisis

(c) Sub-prime lending crisis — Global financial crisis — Banking crisis — East Asian crisis

(d) Global financial crisis — East Asian crisis — Banking crisis — Sub-prime landing crisis

03. Ans: (b)

04. a,b,c are real numbers. The quadratic equation $ax^2 - bx + c = 0$ has equal roots, which is β, then

(a) $\beta^2 = ac$ (b) $\beta = b/a$

(c) $b^2 \neq 4ac$ (d) $\beta^3 = bc / (2a^2)$

04. Ans: (d)

Sol: $ax^2 - bx + c = 0$

Sum of roots $= \beta + \beta = \frac{b}{a} \Rightarrow 2\beta = \frac{b}{a}$ - - - - - (1)

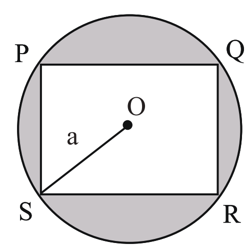
Product of roots $= \beta * \beta = \frac{c}{a} \Rightarrow \beta^2 = \frac{c}{a}$ - - - - - (2)

Now (1) × (2) $\Rightarrow (2\beta)(\beta^2) = (b/a)(c/a)$

$(2\beta^3) = bc/a^2$

$\beta^3 = bc/(2a^2)$

05. A circle with centre O is shown in the figure. A rectangle PQRS of maximum possible area is inscribed in the circle. If the radius of the circle is a, then the area of the shaded portion is _____.



Find shaded area

(a) $\pi a^2 - 3a^2$ (b) $\pi a^2 - 2a^2$

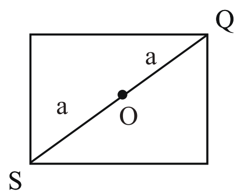
(c) $\pi a^2 - a^2$ (d) $\pi a^2 - \sqrt{2}\,a^2$

05. Ans: (b)

Sol: Area of shaded portion

= Area of circle – Area of rectangle

Area of rectangle is maximum, when it becomes square.



Diagonal = 2a

Area of square = $\frac{1}{2}(\text{diagonal})^2 = 2a^2$

$\therefore$ Area of shaded portion

= Area of circle – Area of square

$= \pi a^2 - 2a^2$

06. Select the word that fits the analogy:

Explicit: Implicit:: Express: ______

(a) Repress (b) Impress

(c) Suppress (d) compress

06. Ans: (c)

07. The untimely loss of life is a cause of serious global concern as thousands of people get killed ____ accidents every year while many other die ____ diseases like cardio vascular disease, cancer, etc.

(a) from, of

(b) from, from

(c) during, from

(d) in, of

07. Ans: (d)

08. He was not only accused of theft ___ of conspiracy.

(a) rather than

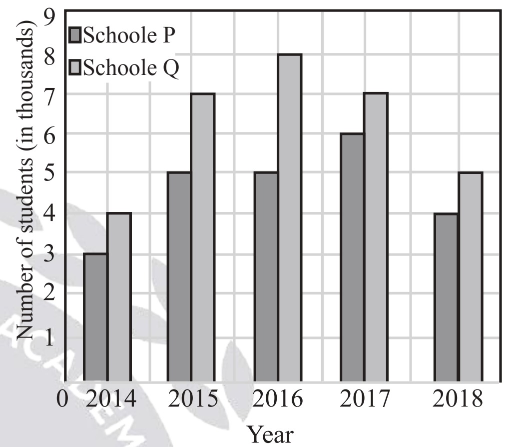
(b) rather

(c) but also

(d) but even

08. Ans: (c)

09. The following figure shows the data of students enrolled in 5 years (2014 t0 2018) for two schools P and Q. During this period, the ratio of the average number of the students enrolled in school P to the average of the difference of the number of students enrolled in schools P and Q is ____



(a) 8 : 23 (b) 31 : 23

(c) 23 : 8 (d) 23 : 31

09. Ans: (c)

Sol: Average number of students enrolled in school P in 5 years = $\frac{3000+5000+5000+6000+4000}{5}$

= 4600

Average number of students enrolled in school Q in 5 years = $\frac{4000+7000+8000+7000+5000}{5}$

= 6200

Average of the difference of the number of students in school P and Q = 6200 – 4600 = 1600

Desired ratio = $\frac{4600}{1600} = \frac{23}{8}$

23 : 8

10. It is quarter past three in your watch. The angle between the hour hand and the minute hand is ___

(a) 0° (b) 7.5°

(c) 22.5° (d) 15°

10. Ans: (b)

Sol: Time: 03 : 15

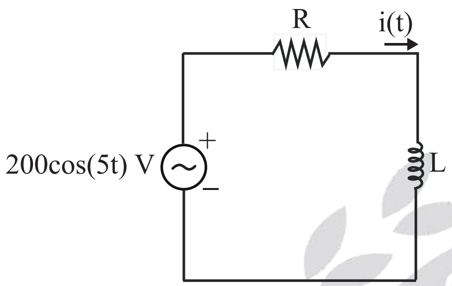
Angle between hands $\theta = \left|30h - \frac{11m}{2}\right|$

Here, h = 3 and m = 15

So, $\theta = \left|30 \times 3 - \frac{165}{2}\right| = 7.5^\circ$

Section : Electronics & Communication Engineering

01. The current in the RL-circuit shown below is $i(t) = 10 \cos(5t - \pi/4)$A.
The value of the inductor **(rounded off to two decimal places)** is ____ H.



01. Ans: 2.828

Sol: $\overline{V} = 200\angle 0^\circ$

$\overline{I} = 10\angle -45^\circ$

$Z = \dfrac{V}{I} = 20\angle +45^\circ$

$Z = 14.14 + j14.14$

$\downarrow$

X_L

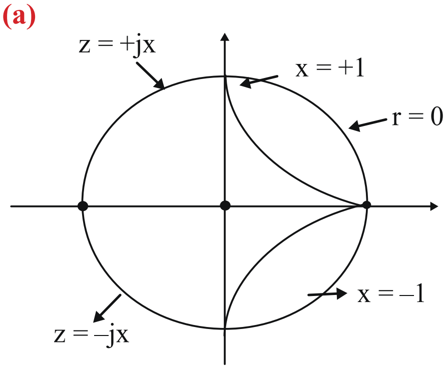
$X_L = \omega L = 14.14 \Rightarrow L = \dfrac{14.14}{\omega} = \dfrac{14.14}{5}$

$L = 2.828$H

02. The impedances Z = jX, for all X in the range $(-\infty, \infty)$, map to the Smith chart as
(a) a circle of radius 1 with centre at (0, 0)
(b) a point at the centre of the chart.
(c) a circle of radius 0.5 with centre at (0.5, 0)
(d) a line passing through the centre of the chart.

02. Ans: (a)

Sol:



Circle of radius 1 with centre at (0, 0) indicates pure induction and capacitive load.

03. For a vector field $\vec{A}$, which one of the following is FALSE ?
(a) $\vec{A}$ is irrotational if $\nabla^2\vec{A} = 0$
(b) $\nabla \times (\nabla \times \vec{A}) = \nabla(\nabla.\vec{A}) - \nabla^2\vec{A}$
(c) $\nabla \times \vec{A}$ is also another vector field
(d) $\vec{A}$ is solenoidal if $\nabla.\vec{A} = 0$

03. Ans: (a)

Sol: For a vector field $\vec{A}$
(a) $\vec{A}$ is irrotational (or) conservative only if $\nabla \times \vec{A} = 0$
(b) $\nabla \times (\nabla \times \vec{A}) = \nabla(\nabla.\vec{A}) - \nabla^2\vec{A}$ is used to obtain EM wave equation.
(c) curl of a vector, $\vec{A}$ is an another vector field i.e. $\nabla \times \vec{A}$ is another vector field.
(d) $\vec{A}$ is said to be solenoidal if $\nabla.\vec{A} = 0$
Therefore option (a) is FALSE

04. A 10-bit D/A converter is calibrated over the full range from 0 to 10V. If the input to the D/A converter is 13A (in hex), the output **(rounded off to three decimal places)** is ____ V.

04. Ans: 3.066

Sol: DAC output = Number of steps for given digital input × step size
Where Number of steps for digital input $13A_H$ is
$\Rightarrow 1 \times 16^2 + 3 \times 16^1 + 10 \times 16^0 = 314$

step size $= \dfrac{10}{2^{10}} = \dfrac{10}{1024}$

Thus, DAC output

$= 314 \times \dfrac{10}{1024} = \dfrac{3140}{1024} = 3.066$ volts.

05. The general solution of $\dfrac{d^2y}{dx^2} - 6\dfrac{dy}{dx} + 9y = 0$ is
(a) $y = C_1e^{3x} + C_2e^{-3x}$
(b) $y = (C_1 + C_2x)e^{-3x}$
(c) $y = C_1e^{3x}$
(d) $y = (C_1 + C_2x)e^{3x}$

05 Ans: (d)

Sol: Given $f(D)y = 0$, wher $f(D) = D^2 - 6D + 9$

$\Rightarrow$ Auxiliary equation is $f(m) = 0$

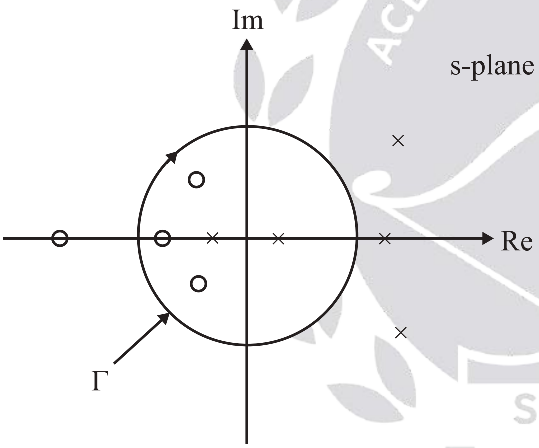
$\Rightarrow m^2 - 6m + 9 = 0$

$\Rightarrow m = 3,3$ are real and equal roots

$\therefore$ The general solution of given v differential equation is $y = (C_1 + C_2x)e^{3x}$.

$\therefore$ option (d) is correct.

06. The pole-zero map of a rational function G(s) is shown below. When the closed contour Γ is mapped into the G(s)-plane, then the mapping encircles.



(a) the origin of the G(s)-plane once in the counter-clockwise direction.

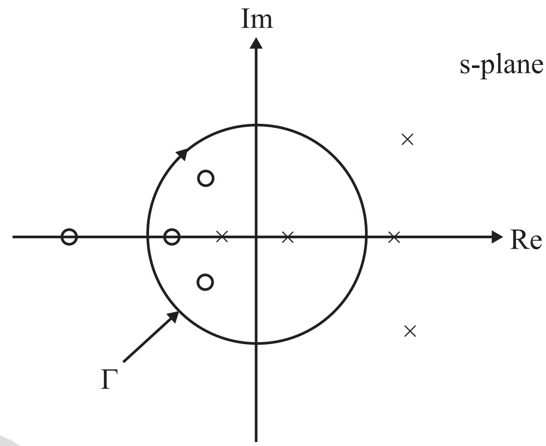
(b) the point $-1+j0$ of the G(s)-plane once in the counter-clockwise direction.

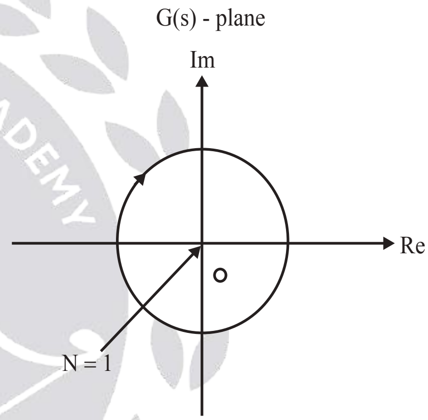
(c) the origin of the G(s)-plane once in the clockwise direction.

(d) the point $-1+j0$ of the G(s)-plane once in the clockwise direction.

06. Ans: (c)

Sol: Once encircles the origin in the clock wise direction.





07. The output y[n] of a discrete-time system for an input x[n] is

$$y[n] = \max_{-\infty \le k \le n} |x[k]|$$

The unit impulse response of the system is

(a) unit step signal u[n]

(b) 1 for all n

(c) 0 for all n

(d) unit impulse signal δ[n]

07. Ans: (a)

Sol: $y(n) = \max|x(k)| \quad -\infty \le k \le n$

The unit impulse response is

If we apply $x(n) = \delta(n)$

$y(n) = \max|\delta(k)| = 1 \quad n \ge 0$

$= u(n)$

08. Consider the recombination process via bulk traps in a forward biased pn homojunction diode. The maximum recombination rate is U_{max}. If the electron and the hole capture cross-sections are equal, which one of the following is FALSE ?

(a) U_{max} depends exponentially on the applied bias

(b) U_{max} occurs at the edges of the depletion region in the device

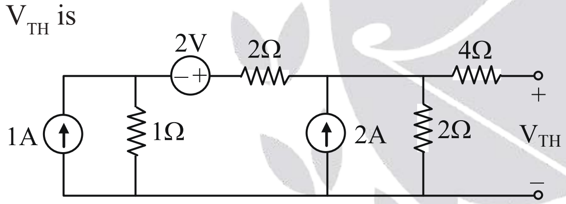
(c) With all other parameters unchanged, U_{max} decreases if the intrinsic carrier density is reduced.

(d) With all other parameters unchanged, U_{max} increases if the thermal velocity of the carrier increases.

08. Ans: (c)

Sol: Intrinsic carrier density will not affect generation and recombination rate. so, statement (c) is false.

09. In the circuit shown below, the Thevenin voltage V_{TH} is

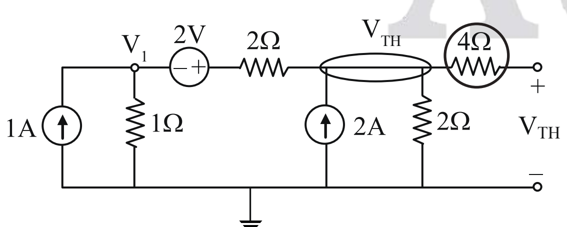


(a) 2.8 V (b) 4.5 V

(c) 3.6 V (d) 2.4 V

09. Ans: (c)

Sol: Nodal Analysis:



$$-1+\frac{V_1}{1}+\frac{(V_1-V_{TH}+2)}{2}=0$$

$3V_1 - V_{TH} = 0$ ________(1)

$$\frac{V_{TH}}{2}-2+\frac{(V_{TH}-V_1-2)}{2}=0$$

$-V_1 + 2V_{TH} = 6$ ________(2)

By multiply equation (2) with 3, then we get

$-3V + 6\,V_{TH} = 18$________(2A)

By adding equation (1) with (2A), then we get

$5\,V_{TH} = 18$

$$V_{TH}=\frac{18}{5}=3.6V$$

10. The two sides of a fair coin are labelled as 0 and 1. The coin is tossed two times independently. Let M and N denote the labels corresponding to the outcomes of those tosses. For a random variable X, defined as X = min(M,N), the expected value E(X) (rounded off to two decimal places) is _____

10. Ans: 0.25

Sol: Coin tossed two times:

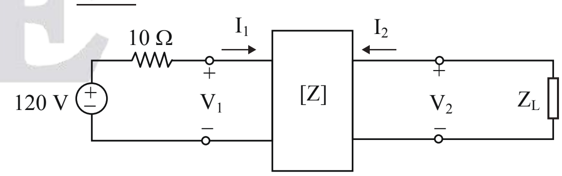
Outcomes		X = min (m, N)
0	0	0
0	1	0
1	0	0
1	1	1

$P(X = 0) = 3/4,\ P(X = 1) = 1/4$

$$E(X)=\sum_i x_i\,P(X=x_i)$$

$$E(X)=0\times\frac{3}{4}+1\times\frac{1}{4}=0.25$$

11. In the given circuit, the two-port network has the impedance matrix $[Z]=\begin{bmatrix}40 & 60\\ 60 & 120\end{bmatrix}$. The value of Z_L for which maximum power is transferred to the load is ____ Ω.

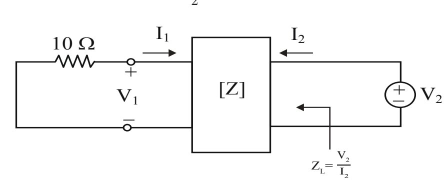


11. Ans: 48

Sol: $V_1 = 40I_1 + 60I_2$_______(1)

$V_2 = 60I_1 + 120I_2$_______(2)

S-I $\qquad Z_L=\frac{V_2}{I_2}$



also,

$10\,I_1 + V_1 = 0$ _____(3)

(3) in (1)

$-10I_1 = 40\,I_1 + 60I_2$

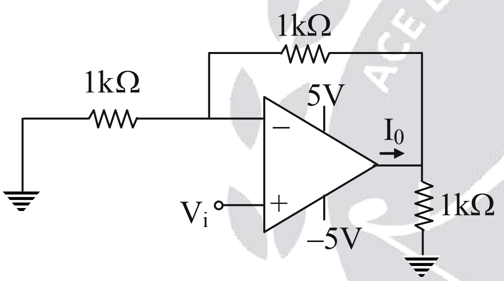
$-50I_1 = 60\,I_2 \rightarrow I_1 = -\frac{6}{5}I_2$ ________(4)

(4) in (2) $V_2 = 60\left[\frac{-6}{5}\right]I_2 + 120I_2$

$V_2 = -72\,I_2 + 120I_2$

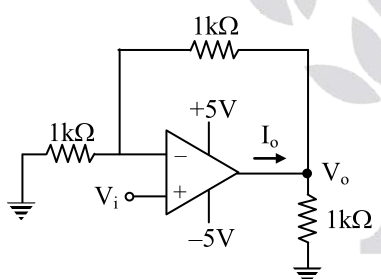
$V_2 = 48I_2 \Rightarrow Z_L = \frac{V_2}{I_2} = 48\Omega$

12. In the circuit shown below, all the components are ideal. If V_i is +2V, the current I_0 sourced by the op-amp is _____ mA.



12. Ans: 6

Sol:



Given op-amp is in non-inverting mode, then output

$$V_o = \left(1 + \frac{R_f}{R_i}\right)V_{in} = \left(1 + \frac{1k}{1k}\right) + 2V = 4V$$

KCL at node V_o

$$\frac{V_o - V_i}{1k} + \frac{V_o}{1k} - I_o = 0$$

$$I_o = \frac{4-2}{1k} + \frac{4}{1k}$$

$I_o = 6\text{mA}$

13. A transmission line of length $3\lambda/4$ and having a characteristic impedance of 50Ω is terminated with a load of 400Ω. The impedance (rounded off to two decimal places) seen at the input end of the transmission line is ____ Ω

13. Ans: 6.25

Sol: Given: Length of transmission line: $\ell = \frac{3\lambda}{4}$

$Z_o = 50\Omega$

$Z_R = 400\Omega$

As length of the transmission line is $\frac{3\lambda}{4}$, (odd multiples of quarter wavelengths like $\frac{\lambda}{4}, \frac{3\lambda}{4}, \frac{5\lambda}{4}$....) and hence this line must be a quarter wave transmission line.

Assume this quarter wave transmission line is lossless then $Z_{in} = \frac{Z_o^2}{Z_R}$

$= \frac{50^2}{400}$

$= 6.25\Omega$

14. The random variable

$$Y = \int_{-\infty}^{\infty} W(t)\phi(t)dt,$$

where $\phi(t) = \begin{cases} 1; 5 \le t \le 7 \\ 0; \text{otherwise} \end{cases}$

and W(t) is a real white Gaussian noise process with two-sided power spectral density $S_W(f) = 3$ W/Hz, for all f. The variance of Y is ____

14. Ans: 6

Sol: $Y = \int_{-\infty}^{\infty} W(t)\phi(t)dt$

Let $\phi(t) = h(-(t-\tau)) \Rightarrow$ where τ is the symbol duration

$$Y = \int_{-\infty}^{\infty} W(t)h(-(t-\tau))dt \text{ Let } t = \tau \Rightarrow dt = d\tau$$

$$Y = \int_{-\infty}^{\infty} W(\tau)h(\tau - t)d\tau$$

$Y(t) = W(t) * h(t)$

$\Rightarrow S_Y(f) = |H(f)|^2 s_W(f)$

$\sigma_Y^2 = E[Y^2] - E[Y]^2$

$$E[Y^2] = \int_{-\infty}^{\infty} S_Y(f)df = \int_{-\infty}^{\infty} |H(f)|^2 s_W(f)df$$

$$E[Y] = E\left[\int_{-\infty}^{\infty} W(t)\phi(t)\right]dt$$

$$= E\left[\int_{-\infty}^{\infty} E[W(t)]\phi(t)dt\right]$$

$$= 0$$

$$S_W(f) = \frac{N_0}{2}$$

$$= \frac{N_0}{2}\int_{-\infty}^{\infty} |H(f)|^2 df$$

$$= \frac{N_0}{2}\int_{-\infty}^{\infty} |\phi(f)|^2 df \left(\because \phi(t) = h(-(t-\tau))\right)$$

$$|\phi(f)|^2 = |H(f)|^2$$

$$= \frac{N_0}{2}\int_{-\infty}^{\infty} |\phi(t)|^2 dt \left(\text{from the rayleigh's energy theorem}\right)$$

$$= \left(\frac{N_0}{2}\right)E_\phi$$

$$= 3 \times 2 \left(\because E_\phi = 2\right)$$

$$= 6$$

15. If $v_1, v_2, \ldots, v_6$ are six vectors in R^4, which one of the following statements is FALSE ?

(a) These vectors are not linearly independent

(b) Any four of these vectors form a basis for R^4

(c) It is not necessary that these vectors span R^4

(d) If $\{v_1, v_3, v_5, v_6\}$ spans R^4, then it forms a basis for R^4

15. Ans: (d)

Sol: option (d) is a wrong statement.

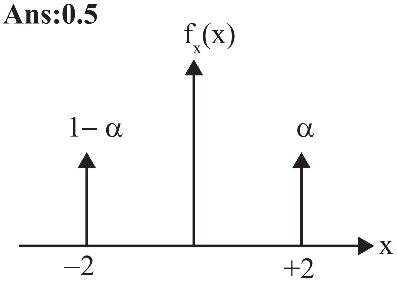
if $\{v_1, v_3, v_5, v_6\}$ spans R^4 then it may (or) may not be a basis for R^4.

i.e. To form a basis, the set $\{v_1, v_3, v_5, v_6\}$ should be linearly independent set.

16. A binary random variable X takes the value +2 or –2. The probability $P(X = +2) = \alpha$. The value of α (rounded off to one decimal place), for which the entropy of X is maximum, is ____

16. Ans:0.5

Sol:



Entropy will be maximum when the probabilities are equal i.e $P(X = +2) = 1/2 = 0.5$

17. A single crystal intrinsic semiconductor is at a temperature of 300K with effective density of states for holes twice that of electrons. The thermal voltage is 26mV. The intrinsic Fermi level is shifted from mid-bandgap energy level by

(a) 13.45 meV (b) 18.02 meV

(c) 26.90 meV (d) 9.01 meV

17. Ans: (d)

Sol: $T = 300K$, $N_V = 2N_C$ $V_T = 26mV$

$$E_F = \frac{E_C + E_V}{2} - \frac{KT}{2}\ell n\left(\frac{N_C}{N_V}\right)$$

if $N_C = N_V$ then $E_{Fi} = \frac{E_C + E_V}{2}$ $\Rightarrow$ Midband gap energy

Given $N_V = 2N_C$

$$E_F = E_{Fi} - \frac{KT}{2}\ell n\left(\frac{N_C}{2N_C}\right)$$

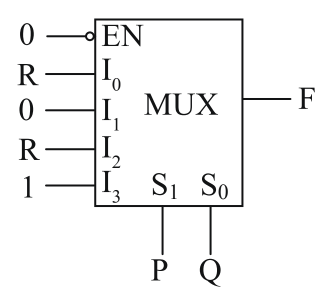
$$= E_{Fi} - \frac{KT}{2}\ell n\left(\frac{1}{2}\right)$$

$$= E_{Fi} - \frac{0.026}{2}\ell n\left(\frac{1}{2}\right)$$

$$= E_{Fi} + 9.01 \times 10^{-3}$$

$$= 9.01 meV$$

18. The figure below shows a multiplexer where S_1 and S_0 are the select lines, I_0 to I_3 are the input data lines, EN is the enable line, and F(P, Q, R) is the output F is



(a) $PQ + \overline{Q}R$ (b) $P\overline{Q}R + \overline{P}Q$

(c) $P + Q\overline{R}$ (d) $\overline{Q} + PR$

18. Ans: (a)

Sol: As EN = 0 → The multiplexer is Enabled.

The output $F = \overline{S}_1\overline{S}_0 I_0 + \overline{S}_1 S_0 I_1 + S_1\overline{S}_0 I_2 + S_1 S_0 I_3$

$F = \overline{P}\,\overline{Q}.R + \overline{P}.Q.0 + P.\overline{Q}.R + P.Q.1$

$= \overline{Q}R + PQ$.

19. The loop transfer function of a negative feedback system is

$$G(s)H(s) = \frac{K(s+11)}{s(s+2)(s+8)}.$$

The value of K, for which the system is marginally stable, is ______.

19. Ans:160

Sol: $G(s)H(s) = \dfrac{K(s+11)}{s(s+2)(s+8)}$

Characteristic equation: 1 + G(s)H(s) = 0

: s(s+2) (s+8) + K(s+11) = 0

: $s^3 + 10s^2 + 16s + Ks + 11K = 0$

: $s^3 + 10s^2 + (16+K)s + 11K = 0$

s^3	1	16+K
s^2	10	11K
s^1	$\dfrac{10(16+K)-11K}{10}$	
s^0	11K	

For marginal stability,

$\left(\dfrac{10(K+16)-11K}{10}\right) = 0$

10K + 160 – 11K = 0

K = 160

20. The partial derivative of the function

$f(x,y,z) = e^{1-x\cos y} + xze^{-\frac{1}{(1+y^2)}}$

with respect to x at the point (1, 0, e) is

Options

(a) 1 (b) 0 (c) $\frac{1}{e}$ (d) –1

20. Ans: (b)

Sol: Given $f(x,y,z) = e^{1-x\cos y} + xze^{\frac{-1}{1+y^2}}$

and (x, y, z) = (1, 0, e)

$f_x = \dfrac{\partial f}{\partial x} = e^{1-x\cos y}(-\cos y) + z.e^{\frac{-1}{1+y^2}}$

$\therefore (f_x)_{(1,0,e)} = e^{1-1}(-\cos 0) + (e).e^{\frac{-1}{1+0}} = -1 + 1 = 0$

Hence, option (b) is correct

21. A digital communication system transmits a block of N bits. The probability of error in decoding a bit is α. The error event of each bit is independent of the error events of the other bits. The received block is declared erroneous if at least one of its bits is decoded wrongly. The probability that the received block is erroneous is

(a) $1 - \alpha^N$ (b) $1 - (1-\alpha)^N$

(c) α^N (d) $N(1-\alpha)$

21. Ans: (b)

Sol:

1	2	3	----------	N

P(1 bit error) = α, P(1 bit correct) = 1 – α

P(N bit error) = α^N, P(N bit correct) = $(1-\alpha)^N$

(N bits are independent)

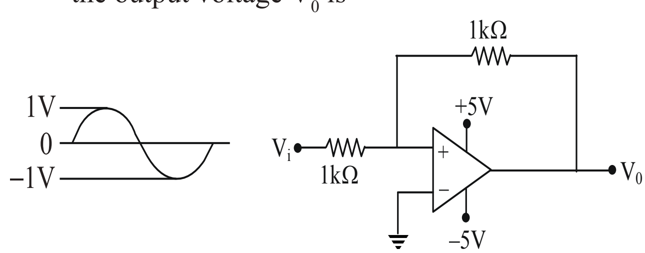
The received block declared erroneous if atleast one of bits decoding wrongly (i.e correct probability means all bits should be correct)

P(received block is erroneous) = $1 - (1-\alpha)^N$

= 1 – P (all bits correct)

= P (any one bit or more error)

22. The components in the circuit shown below are ideal. If the op-amp is in positive feedback and the input voltage V_i is a sine wave of amplitude 1 V, the output voltage V_0 is



(a) a square wave of 5V amplitude.

(b) an inverted sine wave of 1V amplitude.

(c) a constant of either +5 V or –5V.

(d) a non-inverted sine wave of 2V amplitude.

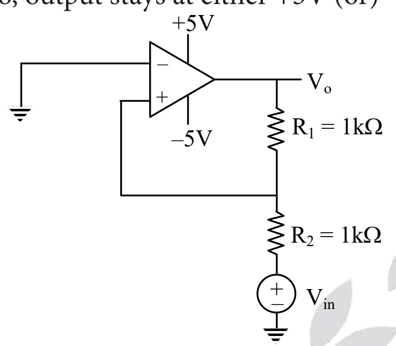
22. Ans: (c)

Sol: If $V_{in} > +5V$ then V_o changes from –5V to +5V

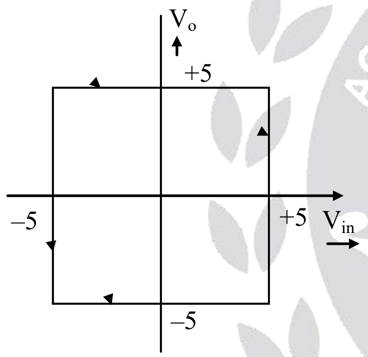
If $V_{in} < -5V$ then V_o changes from +5V to –5V

As $V_{in_{max}} = \pm 1V$ therefore the input cannot flip the output.

So, output stays at either +5V (or) –5V



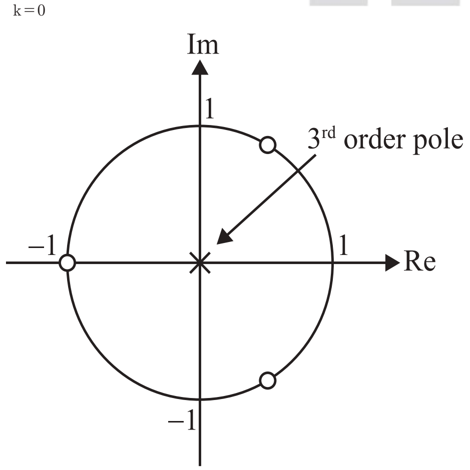
Transfer characteristics



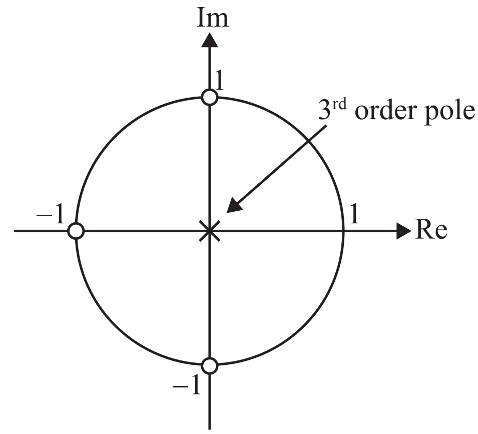
23. Which one of the following pole-zero plots corresponds to the transfer function of an LTI system characterized by the input-output difference equation given below?

$$y[n] = \sum_{k=0}^{3} (-1)^k x[n-k]$$

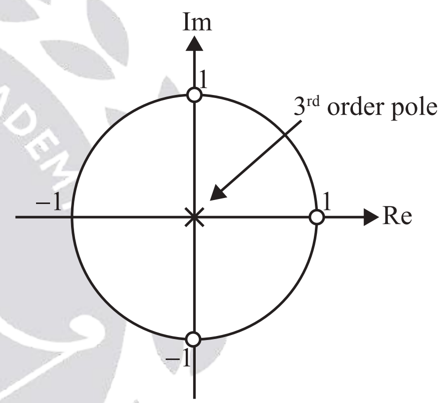
(a)



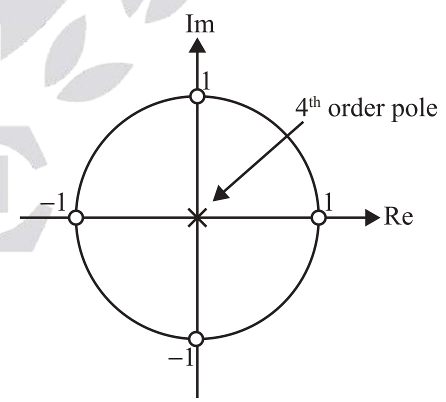
(b)



(c)



(d)



23. Ans: (c)

Sol: $$y(n) = \sum_{k=0}^{3} (-1)^k x(n-k)$$

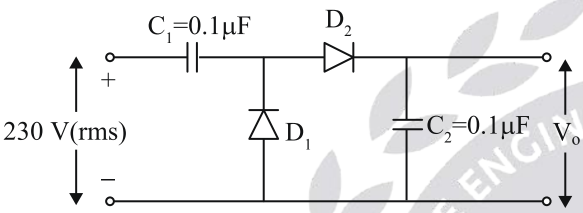
$$y(n) = x(n) - x(n-1) + x(n-2) - x(n-3)$$

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

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

one zero at z = 1 & 2 zeros at z = ±j
3poles at z = 0
From the given pole-zero plot answer will be option (c)

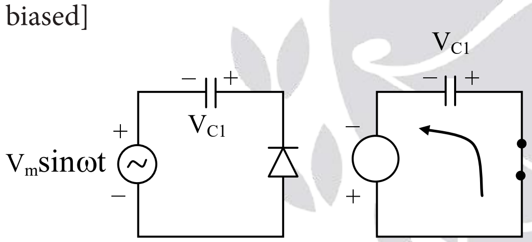
24. In the circuit shown below, all the components are ideal and the input voltage is sinusoidal. The magnitude of the steady-state output V_0 **(rounded off to two decimal places)** is _______ V.



24. Ans: 650.54

Sol: $V_{in_{max}} = 230 \times \sqrt{2} = V_m$

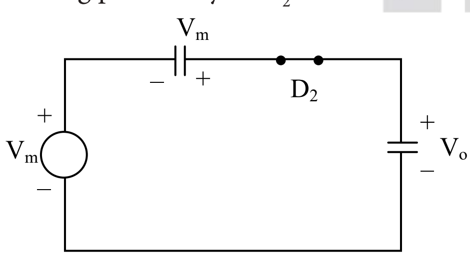
During negative cycle C_1 charges [D_1 forward biased]



KVL, $-V_m + V_{C1} = 0$

$V_{C1} = V_m$

During positive cycle D_2 forward biased



KVL, $-V_m - V_m + V_o = 0$

$V_o = 2V_m$

$= 2 \times 230 \times \sqrt{2} = 650.530V$

$= 650.54V.$

25. In an 8085 microprocessor, the number of address lines required to access a 16K byte memory bank is ______.

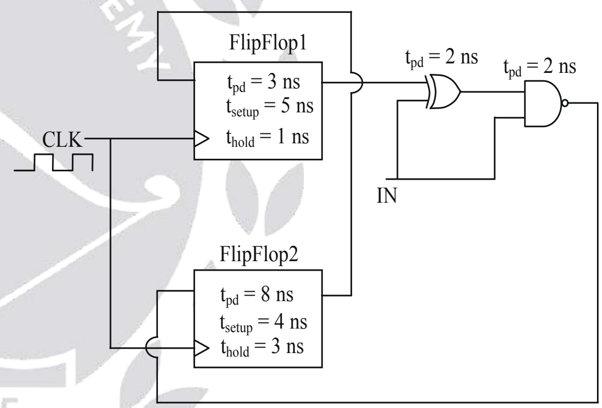
25. Ans: 14

Sol: In 8085 microprocessor, the number of address lines required to a access a 16KB memory bank is

$2^n \geq 16KB \Rightarrow 2^n \geq 2^{14} \times 8$

The number of adder lines required are n = 14.

26. For the components in sequential circuit shown below, t_{pd} is the propagation delay, t_{setup} is the setup time, and t_{hold} is the hold time. The maximum clock frequency **(rounded off to the nearest integer),** at which given circuit can operate reliably is _____ MHz.



26. Ans: 76.92

Sol: In any sequential circuit, the condition for proper operation is

Clock period (T) $\geq t_{pd} + t_{comb\ logic} + t_{setup}$

Thus,

For Flipflop 1 $\Rightarrow T \geq 8 + 5 \Rightarrow T \geq 13ns$

For Flipflop 2 $\Rightarrow T \geq 3 + 2 + 2 + 4 \Rightarrow T \geq 11ns$

Thus $T \geq 13ns$

$\Rightarrow$ frequency of operation $f \leq \frac{1}{13 \times 10^{-9}}$

$f_{max} = 0.07692 \times 10^9$

$f_{max} = 76.92MHz.$

27. Which one of the following options contains two solutions of the differential equation $\frac{dy}{dx} = (y-1)x$?

(a) $\ln|y-1| = 0.5x^2 + C$ and $y = -1$

(b) $\ln|y-1| = 2x^2 + C$ and $y = 1$

(c) $\ln|y-1| = 0.5x^2 + C$ and $y = 1$

(d) $\ln|y-1| = 2x^2 + C$ and $y = -1$

27. Ans: (c)

Sol: Given $\frac{dy}{dx} = (y-1)x$

$$\Rightarrow \int \frac{1}{y-1}dy = \int x dx + c$$

$$\Rightarrow \log|(y-1)| = \frac{x^2}{2} + C$$

$$\left(\because \int \frac{f'(x)}{f(x)}dx = \log|f(x)| + C\right)$$

$\therefore \log|y-1| = (0.5)x^2 + C$

The second solution is $y = 1$

Hence, option (c) is correct.

28. The magnetic field of a uniform plane wave in vacuum is given by $\vec{H}(x,y,z,t) = (\hat{a}_x + 2\hat{a}_y + b\hat{a}_z)\cos(\omega t + 3x - y - z)$. The value of b is ______.

28. Ans: 1

Sol: $\overline{H} = (\hat{x} + 2\hat{y} + b\hat{z})\cos(\omega t + 3x - y - z)$

$\overline{H} = \overline{H}_o \cos(\omega t - \overline{k}.\overline{r})$

$= \overline{H}_o \cos[\omega t - (-3\hat{x} + \hat{y} + \hat{z}).(x\hat{x} + y\hat{y} + z\hat{z})]$

So $\overline{H}_o = \hat{x} + 2\hat{y} + b\hat{z}$

$\overline{k} = -3\hat{x} + \hat{y} + \hat{z}$

For plane wave $\overline{H}_o.\hat{k} = 0$

$$(\hat{x} + 2\hat{y} + b\hat{z}).\frac{(-3\hat{x} + \hat{y} + \hat{z})}{\sqrt{9+1+1}} = 0$$

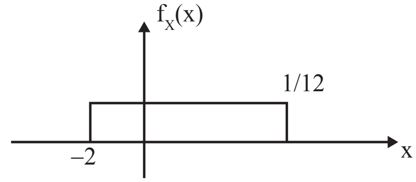
$-3 + 2 + b = 0$

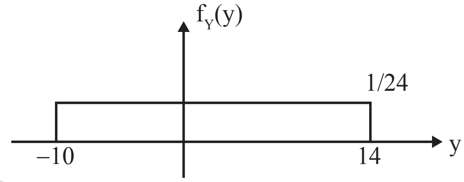
$b = 1$

29. If X is a random variable with uniform probability density function in the interval [– 2, 10]. For Y = 2X – 6, the conditional probability $P(y \le 7 \mid x \ge 5)$ **(rounded off to three decimal places)** is ______.

29. Ans: 0.3

Sol:



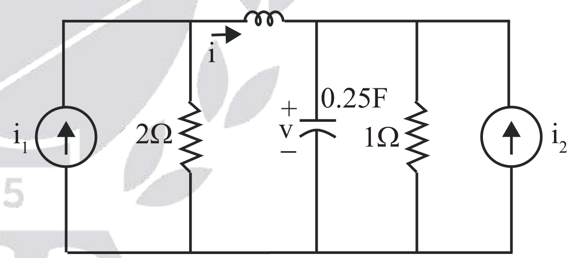


$$P(Y \le 7 / X \ge 5) = P(Y \le 7 / Y \ge 4)$$

$$= \frac{P(Y \le 7, Y \ge 4)}{P(Y \ge 4)}$$

$$= \frac{P(4 \le Y \ge 7)}{P(Y \ge 4)} = \frac{\int_4^7 1/24\, dy}{\int_4^{14} 1/24\, dy} = \frac{3/24}{10/24} = 0.3$$

30. For the given circuit, which one of the following is the correct state equation?



(a) $\frac{d}{dt}\begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} -4 & -4 \\ -2 & -4 \end{bmatrix}\begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 4 & 0 \\ 0 & 4 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$

(b) $\frac{d}{dt}\begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} -4 & -4 \\ -2 & 4 \end{bmatrix}\begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 4 & 4 \\ 4 & 0 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$

(c) $\frac{d}{dt}\begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} -4 & 4 \\ -2 & -4 \end{bmatrix}\begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 0 & 4 \\ 4 & 0 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$

(d) $\frac{d}{dt}\begin{bmatrix} v \\ i \end{bmatrix} = \begin{bmatrix} 4 & -4 \\ -2 & -4 \end{bmatrix}\begin{bmatrix} v \\ i \end{bmatrix} + \begin{bmatrix} 0 & 4 \\ 4 & 4 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$

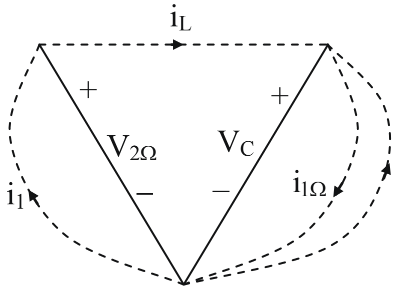
30. Ans: (c)

Sol: **Using Topology:**

Inductor → Link

Capacitor → Twigs

Current sources → Links



By KCL,

$$i_L + i_Z = C\frac{dV_C}{dt} + i_{1\Omega} \_\_\_\_\_\_(1)$$

By KVL,

$$-V_{2\Omega} + L\frac{di_L}{dt} + V_C = 0 \_\_\_\_\_\_(2)$$

Now, voltage across 2Ω, current theory 1Ω

$$i_1 = \frac{V_{2\Omega}}{2} + i_L \qquad \Rightarrow V_{2\Omega} = 2[i_1 - i_L] \_\_\_\_\_\_(3)$$

$$1.\ i_{1\Omega} - V_C = 0 \Rightarrow i_{1\Omega} = V_C \_\_\_\_\_\_(4)$$

$$i_L + i_2 = \frac{1}{4}\left[\frac{dV_C}{dt}\right] + V_C$$

$$-\left[2\left(i_1 - i_L\right)\right] + \frac{1}{2}\frac{di_L}{dt} + V_C = 0$$

$$\frac{1}{4}\frac{dV_C}{dt} = -V_C + i_L + i_2$$

$$\frac{1}{2}\frac{di_L}{dt} = -V_C - 2i_L + 2i_1$$

$$\frac{dV_C}{dt} = -4V_C + 4i_L + 4i_2$$

$$\frac{di_L}{dt} = -2V_C - 4i_L + 4i_1$$

$$\begin{bmatrix} \frac{dV_C}{dt} \\ \frac{di_L}{dt} \end{bmatrix} = \begin{bmatrix} -4 & 4 \\ -2 & -4 \end{bmatrix}\begin{bmatrix} V_C \\ i_L \end{bmatrix} + \begin{bmatrix} 0 & 4 \\ 4 & 0 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix}$$

31. The characteristic equation of a system is $s^3 + 3s^2 + (K + 2)s + 3K = 0$.
In the root locus plot for the given system, as K varies from 0 to ∞, the break-away or break-in point(s) lie within
(a) (–2, –1)
(b) (– ∞, –3)
(c) (–3, –2)
(d) (–1, 0)

31. Ans: (d)

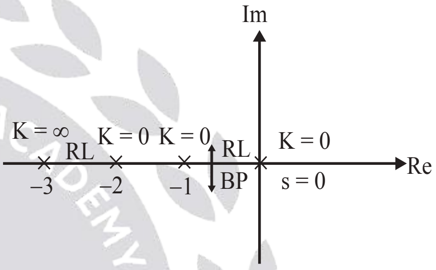
Sol: Characteristic Equation:

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

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

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

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



Break point exist between (–1, 0)

32. In a digital communication system, a symbol S randomly chosen from the set $\{s_1, s_2, s_3, s_4\}$ is transmitted. It is given that $s_1 = –3$, $s_2 = –1$, $s_3 = +1$ and $s_4 = +2$. The received symbol is Y = S + W. W is a zero-mean unit-variance Gaussian random variable and is independent of S. P_i is the conditional probability of symbol error for the maximum likelihood (ML) decoding when the transmitted symbol $S = s_i$. The index i for which the condional symbol error probability P_i is the highest is _____.

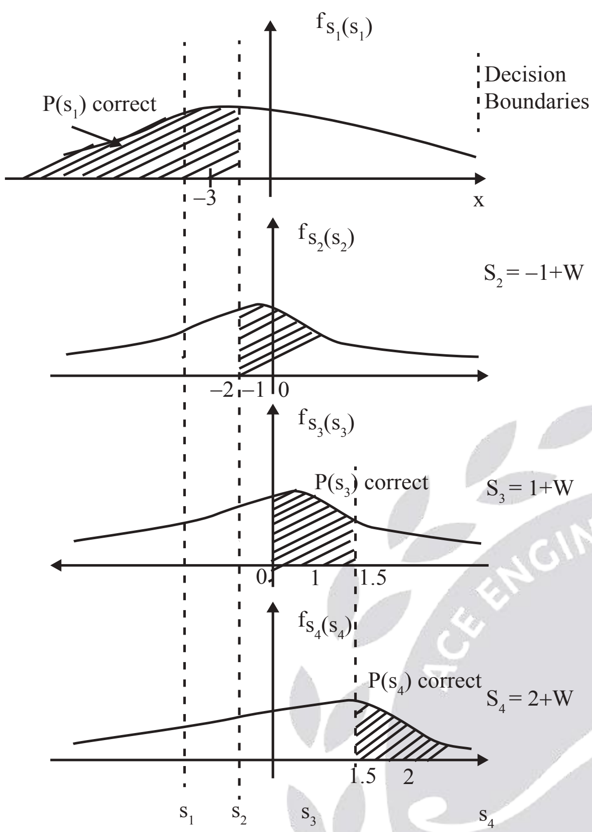
32. Ans: 3

Sol: $S_1 = –3,\ S_2 = –1,\ S_3 = +1,\ S_4 = +2$

Y = S + W

$$W = N(0, 1) = \frac{1}{\sqrt{2\pi}}e^{-\omega^2/2}$$

$$f_{s_1}(s_1) \Rightarrow -3 + W = S_1$$



Since all symmbols are equally likely, decision boundaries are mid points.

i.e., for S_1, decision boundary –2 V i.e., anything below –2 V considered as S_1.

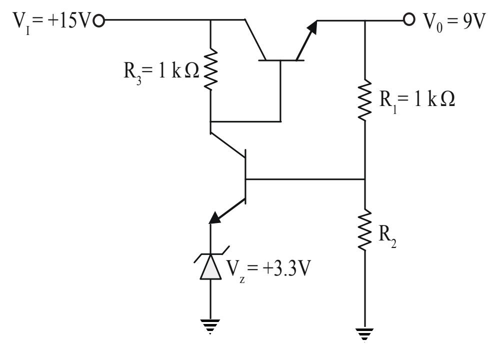
For S_2 decision boundaries are –2 & 0V, i.e., any thing –2V to 0V considered as S_2.

For S_3 decision boundaries are 0V & 1.5V.

For S_4 decision boundaries is 1.5V i.e., 1.5V to ∞ considered as S_4.

P(Correct symbol receiveing is less for S_3 only therefore S_3 has highest conditional symbol error probability).

33. In the voltage regulator shown below, V_I is the unregulated input at 15V. Assume V_{BE} = 0.7V and the base current is negligible for both the BJTs. If the regulated output V_0 is 9V, the value of R_2 is ________ Ω.



33. Ans: 800

Sol: $V_{R2} = 0.7 + 3.3 = 4V$

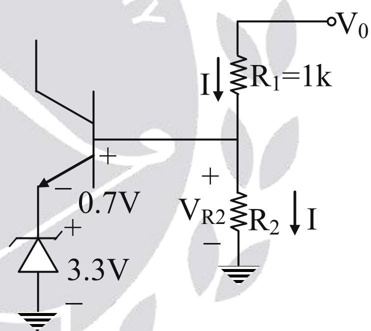
$V_o = IR_1 + IR_2$

$9 = I(R_1 + R_2)$ [Given $V_o = 9V$]

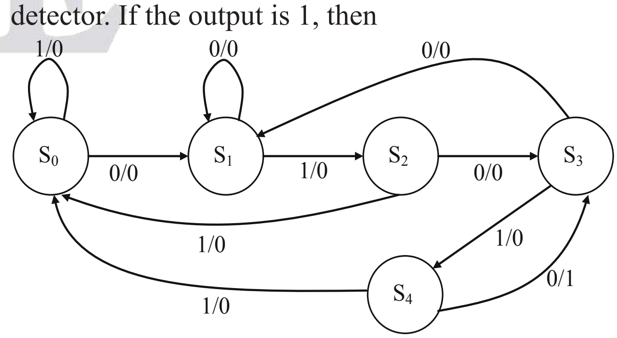
Neglect base current

$$9 = \frac{4}{R_2}(1k + R_2)$$

$R_2 = 800\Omega$



34. The state diagram of a sequence detector is shown below. State S_0 is the initial state of sequence detector. If the output is 1, then

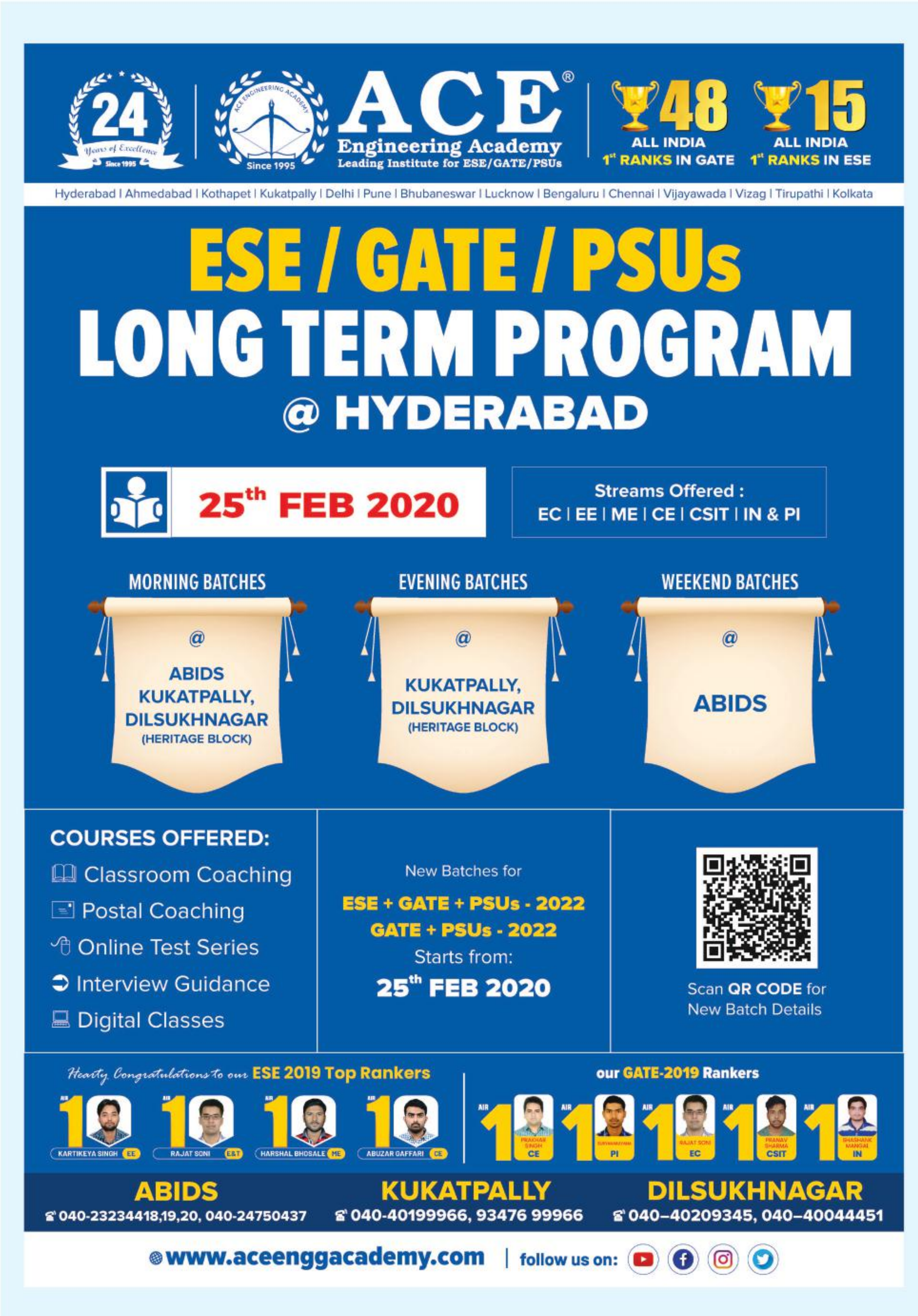


(a) the sequence 01011 is detected.

(b) the sequence 01001 is detected.

(c) the sequence 01010 is detected.

(d) the sequence 01110 is detected.



24 Years of Excellence Since 1995
ACE® Engineering Academy
Leading Institute for ESE/GATE/PSUs
Since 1995
48 ALL INDIA 1st RANKS IN GATE
15 ALL INDIA 1st RANKS IN ESE
Hyderabad | Ahmedabad | Kothapet | Kukatpally | Delhi | Pune | Bhubaneswar | Lucknow | Bengaluru | Chennai | Vijayawada | Vizag | Tirupathi | Kolkata
ESE / GATE / PSUs
LONG TERM PROGRAM
@ HYDERABAD
25th FEB 2020
Streams Offered :
EC | EE | ME | CE | CSIT | IN & PI
MORNING BATCHES
@ ABIDS KUKATPALLY, DILSUKHNAGAR (HERITAGE BLOCK)
EVENING BATCHES
@ KUKATPALLY, DILSUKHNAGAR (HERITAGE BLOCK)
WEEKEND BATCHES
@ ABIDS
COURSES OFFERED:
Classroom Coaching
Postal Coaching
Online Test Series
Interview Guidance
Digital Classes
New Batches for
ESE + GATE + PSUs - 2022
GATE + PSUs - 2022
Starts from:
25th FEB 2020
Scan QR CODE for New Batch Details
Hearty Congratulations to our ESE 2019 Top Rankers
AIR 1 KARTIKEYA SINGH EE
AIR 1 RAJAT SONI E&T
AIR 1 HARSHAL BHOSALE ME
AIR 1 ABUZAR GAFFARI CE
our GATE-2019 Rankers
AIR 1 CE
AIR 1 PI
AIR 1 EC
AIR 1 CSIT
AIR 1 IN
ABIDS
040-23234418,19,20, 040-24750437
KUKATPALLY
040-40199966, 93476 99966
DILSUKHNAGAR
040–40209345, 040–40044451
www.aceenggacademy.com | follow us on:

34. Ans: (c)

Sol: Given S_0 is initial state

For output to be 1, the sequence of states traversed are

$$S_0, S_1, S_2, S_3, S_4, S_3$$

i.e., input is $\rightarrow$ 0 1 0 1 0

35. A system with transfer function $G(s) = \frac{1}{(s+1)(s+a)}$, $a > 0$ is subjected to an input 5cos3t. The steady state output of the system is $\frac{1}{\sqrt{10}}\cos(3t - 1.892)$. The value of a is _____.

35. Ans: 4

Sol: $G(s) = \frac{1}{(s+1)(s+a)} a \quad 0$

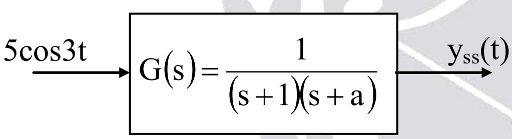
$x(t) = 5\cos 3t$

$y_{ss}(t) = \frac{1}{\sqrt{10}}\cos(3t - 1.892)$

$x(t) = A\cos(\omega_0 t + \theta)$

$H(s)|_{S=j\omega_0} = |H(\omega_0)|\angle H(\omega_0)$

$y_{ss}(t) = A|H(\omega_0)|\cos(\omega_0 t + \theta + \angle H(\omega_0))$



$A = 5 \quad \omega_0 = 3$

$G(s)|_{S=j3} = \frac{1}{(j3+1)(j3+a)}$

$|G(j3)| = \frac{1}{\sqrt{a^2+9}\sqrt{1+9}}$

From the above expression

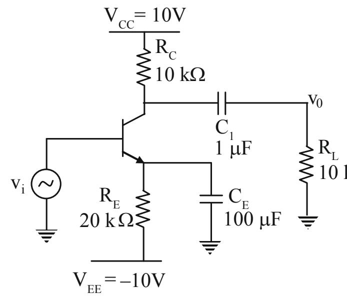
$A|G(\omega_0)| = \frac{1}{\sqrt{10}}$

$\frac{5}{\sqrt{10}\sqrt{a^2+9}} = \frac{1}{\sqrt{10}} \Rightarrow 5\sqrt{a^2+9}$

$25 - a^2 + 9$

$a = 4$

36. For the BJT in the amplifier shown below, $V_{BE} = 0.7V$, $kT/q = 26$ mV. Assume that BJT output resistance (r_o) is very high and the base current is negligible. The capacitors are also assumed to be short circuited at signal frequencies. The input v_i is direct coupled. The low frequency voltage gain v_o/v_i of the amplifier is



(a) – 89.42 (b) – 256.42

(c) – 178.85 (d) – 128.21

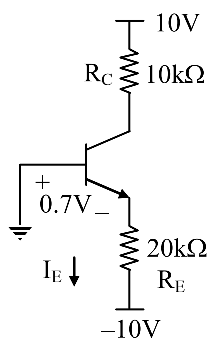
36. Ans: (a)

Sol: DC Analysis:

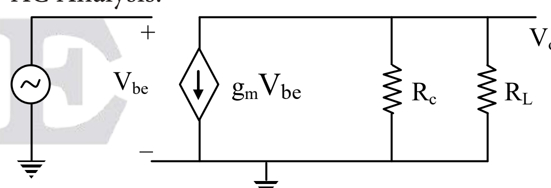
$I_E = \frac{-0.7-(-10V)}{20k}$

$= \frac{9.3V}{20V} = 0.465mA = I_{C_{DC}}$

$g_m = \frac{I_{C_{DC}}}{V_t} = 0.0178$



AC Analysis:



$V_o = -g_m (R_C||R_L)V_{be}$

$V_i = V_{be}$

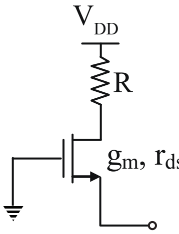
$\frac{V_o}{V_i} = \frac{-g_m(R_C||R_L)V_{be}}{V_{be}} = -g_m(R_C||R_L)$

$= -0.0178(10k||10k)$

$= -0.0178(5k)$

$= -89.423$

37. Using the incremental low frequency small-signal model of the MOS device, the Norton equivalent resistance of the folowing circuit is

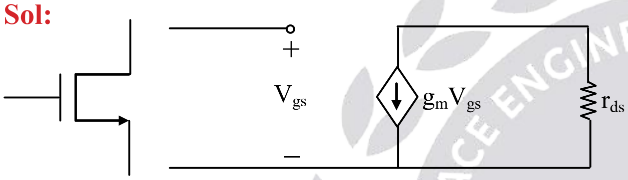


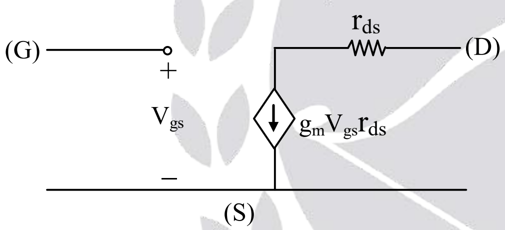
(a) $\frac{r_{ds}+R}{1+g_m r_{ds}}$ (b) $r_{ds}+R$

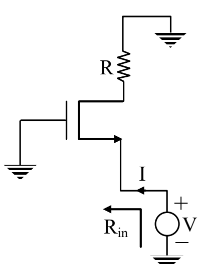
(c) $r_{ds}+R+g_m r_{ds} R$ (d) $r_{ds}+\frac{1}{g_m}+R$

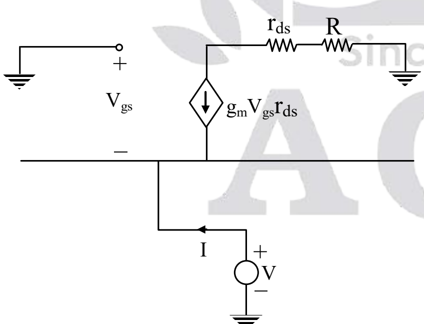
37. Ans: (a)

Sol:









KVL

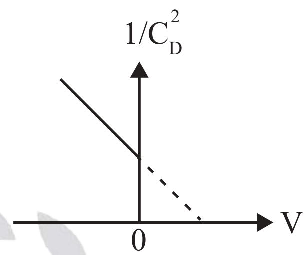
$V_{gs}+V=0 \Rightarrow V=-V_{gs}$

$I=\frac{V_x}{r_{ds}+R}=\frac{-g_m r_{ds} V_{gs}+V}{r_{ds}+R}$

$I=\frac{g_m r_{ds} V+V}{r_{ds}+R}$

$\frac{V}{I}=\frac{r_{ds}+R}{1+g_m r_{ds}}$

38. A one-sided abrupt pn junction diode has a depletion capacitance C_D of 50 pF at a reverse bias of 0.2V. The plot of $1/C_D^2$ versus the applied voltage V for this diode is a straight line as shown in the figure below. The slope of the plot is _____ $\times 10^{20}\,F^{-2}V^{-1}$.



(a) –5.7 (b) –0.4

(c) –1.2 (d) –3.8

38. Ans: (*) insufficient data

Sol: [If we assume $V_0 = 0.5V$]

$$C_D=\sqrt{\frac{q\varepsilon}{2(V_0+V_R)}\left(\frac{N_AN_D}{N_A+N_D}\right)}$$

$$C_D^2 \,\alpha\, \frac{1}{(V_0+V_R)}$$

$$\frac{1}{C_D^2}\,\alpha\,(V_0+V_R)$$

$$\frac{1}{C_D^2}=k(V_0+V_R)$$

$$k=\frac{\frac{1}{C_D^2}}{V_0+V_R}=\text{slope}$$

$$=\frac{\left(\frac{1}{50pF}\right)^2}{0.5+0.2}$$

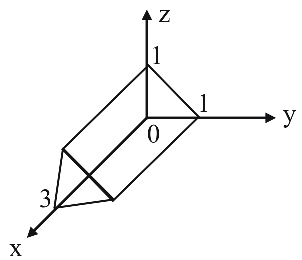
$$=\frac{1}{(50pF)^2\times 0.7}$$

$= 5.71 \times 10^{20}\ F^{-2}\ V^{-1}$

Then option (a) is correct

39. For the solid S shown below, the value of $\iiint_s xdxdydz$

(rounded off to two decimal places) is



39. Ans: (2.25)

Sol: From the figures, the limits of te integral are given by

$$\text{lim its:}\begin{cases} x = 0 \text{ to } x = 3 \\ y = 0 \text{ to } y = 1 \\ z = 0 \text{ to } z = 1 - y \end{cases}$$

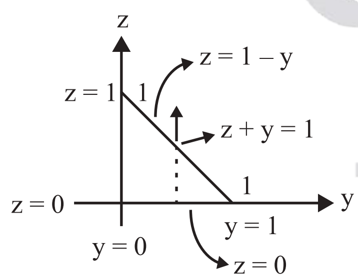
$$I = \int_{x=0}^{3}\left[\int_{y=0}^{1}\left\{\int_{z=0}^{1-y} x\,dz\right\}dy\right]dx$$

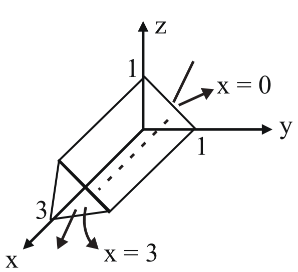
$$= \int_{x=0}^{3}\left[\int_{y=0}^{1} x(z)_0^{1-y}\,dy\right]dx$$

$$= \int_{x=0}^{3}\left[\int_{y=0}^{1} x.(1-y)\,dy\right]dx$$

$$= \left(\frac{x^2}{2}\right)_0^3 .\left(y - \frac{y^2}{2}\right)_0^1$$

$$= \frac{9}{4} = 2.25$$



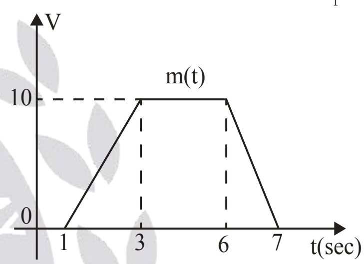


40. $S_{PM}(t)$ and $S_{FM}(t)$ as defined below, are the phase modulated and the frequency modulated waveforms, respectively, corresponding to the message signal m(t) shown in the figure.

$S_{PM}(t) = \cos(1000\pi t + K_p m(t))$

and $S_{FM}(t) = \cos\left(1000\pi t + K_f \int_{-\infty}^{t} m(\tau)d\tau\right)$

where K_p is the phase deviation constant in radians/volt and K_f is the frequency deviation constant in radians/second/volt. If the highest instantaneous frequencies of $S_{PM}(t)$ and $S_{FM}(t)$ are same, then the value of the ratio $\frac{K_p}{K_f}$ is _____ seconds.



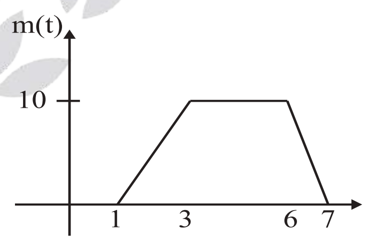
40. Ans:2

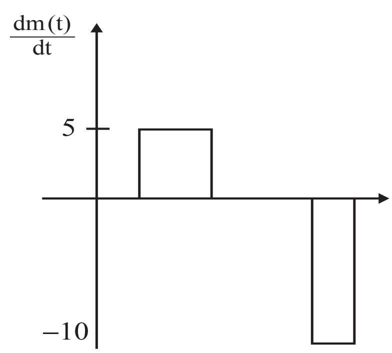
Sol: highest instantaneous frequencies are same.

i.e., $f_{i,\,max,\,PM} = f_{i,\,max,\,FM}$

$$f_c + \frac{K_p}{2\pi}\frac{dm(t)}{dt}\bigg|_{max} = f_c + \frac{K_f}{2\pi}m(t)\bigg|_{max}$$

$$K_p \frac{dm(t)}{dt}\bigg|_{max} = K_f\, m(t)\big|_{max}$$





$K_p . 5 = K_f . 10$

$$\frac{K_p}{K_f} = \frac{10}{5} = 2 \text{ sec}$$

41. A pn junction solar cell of area 1.0 cm^2, illuminated uniformly with 100 mW cm^{-2}, has the following parameters: Efficiency = 15%, open circuit voltage = 0.7V, fill factor = 0.8, and thickness = 200 μm. The charge of an electron is 1.6×10^{-19} C. The average optical generation rate (in cm^{-3} s^{-1}) is

(a) 83.60×10^{19} (b) 1.04×10^{19}
(c) 5.57×10^{19} (d) 0.84×10^{19}

41. Ans: (d)

Sol: $A = 1cm^2$

P_{in} (/cm^2) = 100 mW/cm^2

$\eta = 0.15$, $V_{oc} = 0.7$, Fill factor = 0.8

Thickness = 200μm

$$\text{Power } (/cm^2) = \frac{100mW/cm^2}{200 \times 10^{-4}} = 5W/cm^3$$

$$\eta = \frac{V_m I_m}{P_{in}} \quad \text{Fill factor} = \frac{V_m I_m}{V_{oc} I_{SC}}$$

$$V_m I_m = \eta P_{in}$$

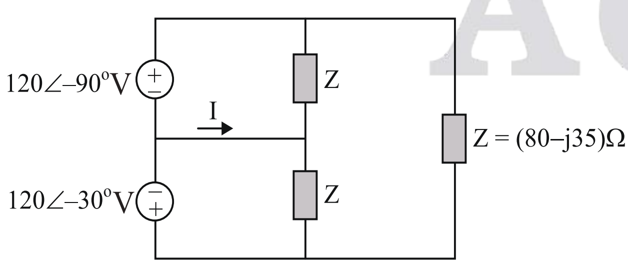
$$I_{SC} = \frac{V_m I_m}{V_{oc}(\text{Fill Factor})} = \frac{0.75}{0.7 \times 0.8} = 1.339 \text{ A/cm}^3$$

$$I = \frac{Q}{t} \Rightarrow Q = It = 1.339A - s/cm^3$$

$$Q = nq \Rightarrow n = \frac{Q}{q} = \frac{1.339C/cm^2}{1.6 \times 10^{-19}C} = 0.84 \times 10^{19}/cm^3$$

Optical generation rate = 0.84×10^{19}/Cm^3-s

42. The current I in the given network is

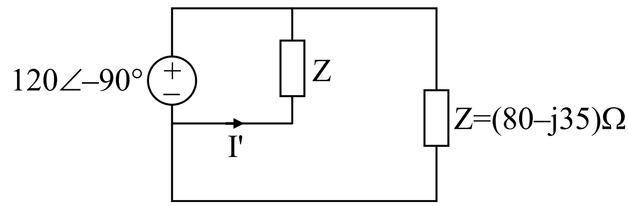


(a) 2.38 ∠–23.63° A
(b) 2.38 ∠–96.37° A
(c) 2.38 ∠143.63° A
(d) 0A

42. Ans: (c)

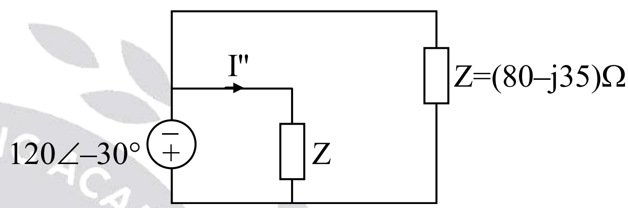
Sol: By applying super-position theorem

Step-I



$$I' = -\frac{[120\angle -90^\circ]}{Z} = -\frac{[-j120]}{80 - j35} = \frac{j120}{80 - j35}$$

Step-II



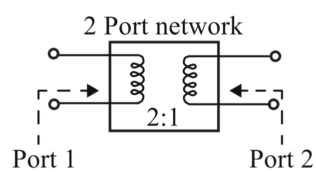
$$I'' = -\frac{[120\angle -30^\circ]}{Z} = \frac{-[120\angle -30^\circ]}{80 - j35}$$

$$I = I' + I'' = \frac{1}{(80 - j35)}[j120 - 103.92 + j60]$$

$$I = \frac{(-103.92 + j180)}{(80 - j35)} = \frac{207.34\angle 120^\circ}{87.32\angle 23.63^\circ}$$

$I = 2.380\angle 143.63°$A

43. For a 2-port network consisting of an ideal lossless transformer, the parameter S_{21} **(rounded off to two decimal places)** for a reference impedance of 10Ω, is ________.



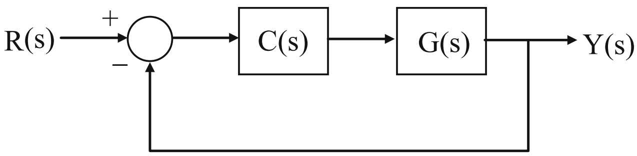
43. Ans: 0.8

Sol: For ideal Transformer,

$$\begin{bmatrix} S_{11} & S_{12} \\ S_{21} & S_{22} \end{bmatrix} = \begin{bmatrix} \frac{n^2 - 1}{n^2 + 1} & \frac{2n}{n^2 + 1} \\ \frac{2n}{n^2 + 1} & \frac{1 - n^2}{n^2 + 1} \end{bmatrix}$$

$$\because n = 2 \Rightarrow S_{12} = S_{21} = \frac{2n}{n^2 + 1} = \frac{2 \times 2}{2^2 + 1} = 0.8$$

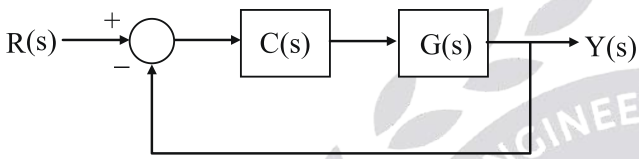
44. Consider the following closed loop control system



where $G(s) = \dfrac{1}{s(s+1)}$ and $C(s) = K\dfrac{s+1}{s(s+3)}$.
If the steady state error for a unit ramp input is 0.1, then the value of K is _____.

44. Ans: 30

Sol:



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

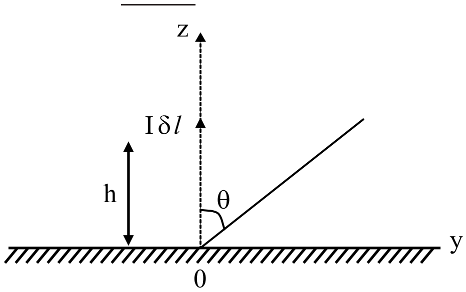
$$e_{ss}\,(\text{ramp}) = \frac{1}{k_v} = 0.1$$

$$k_v = \underset{s\to 0}{\text{lt}}\, s\,C(s)G(s) = \underset{s\to 0}{\text{lt}}\, s.\frac{k}{s(s+3)} = \frac{k}{3}$$

$$e_{ss} = \frac{1}{k_v} = \frac{3}{k} = 0.1$$

$k = 30$

45. For an infinitesimally small dipole in free space, the electric field E_θ in the far field is proportional to $\left(\dfrac{e^{-jkr}}{r}\right)\sin\theta$, where $k = \dfrac{2\pi}{\lambda}$. A vertical infinitesimally small electric dipole $(\delta I << \lambda)$ is placed at a distance $h(h > 0)$ above an infinite ideal conducting plane, as shown in figure. The minimum value of 'h', for which one of the maxima in the far field radiation pattern occurs at $\theta = 60°$ is _____.



Infinite conduction plate

(a) λ (b) 0.25λ

(c) 0.75λ (d) 0.5λ

45. Ans: (a)

Sol: Consider an infinitesimal electric dipole $(d\ell \quad \lambda)$, which is vertically placed at height 'h' above an infinite grounded conductor.

The resultant electric field intensity is given by

$$E_\theta = \frac{j\eta I_o \beta d\ell \sin\theta}{4\pi r} e^{-j\beta r}\, 2\cos(\beta h\cos\theta); z \geq 0$$

$$= 0 \qquad ; z < 0$$

(or)

$$E_\theta = \frac{j\eta I_o k d\ell \sin\theta}{4\pi r} e^{-jkr}\, 2\cos(kh\cos\theta); z \geq 0$$

$$= 0 \qquad ; z < 0$$

where k (or) β is phase shift constant (or) wave number.

$$\beta(\text{or})k = \frac{2\pi}{\lambda}$$

Given $\theta_{max} = 60°$

Field will have maxima,

when $|\cos(kh\cos\theta_{max})| = 1$

$\Rightarrow kh\cos\theta_{max} = \pi$

$$\frac{2\pi}{\lambda} h\cos 60° = \pi$$

$$\frac{2\pi}{\lambda}.h.\frac{1}{2} = \pi$$

$\therefore h = \lambda$

(or)

$$\frac{\partial E_\theta}{\partial h} = 0$$

$$\text{let}\ \frac{j\eta k I_o d\ell e^{-jkr}\sin\theta}{4\pi r} = P$$

$$\frac{\partial}{\partial h}\left\{2P\cos(kh\cos\theta_{max})\right\} = 0$$

$-2pk\cos\theta_{max}\sin(kh\cos\theta_{max}) = 0$

$\sin(kh\cos\theta_{max}) = 0$

$kh\cos\theta_{max} = n\pi$

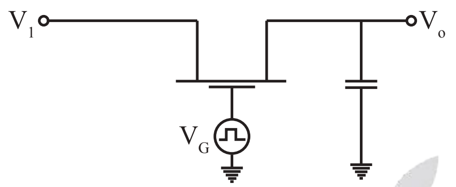
assume $n = 1$

$kh\cos 60 = \pi$

$$\frac{2\pi}{\lambda}\times h.\frac{1}{2} = \pi$$

$\therefore h = \lambda$

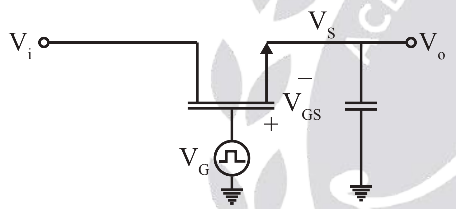
46. An ehhancement MOSFET of threshold voltage 3 V is being used in the sample and hold circuit given below. Assume that the substrate of the MOS device is connected to –10 V. If the input voltage V_1 lies between ±10 V, the minimum and the maximum values of V_G required for proper sampling and holding respectively, are



(a) 13 V and −7V. (b) 10 V and −13 V.
(c) 10 V and −10 V. (d) 3 V and −3 V.

46. Ans: (a)

Sol:



$V_T = 3V$

$V_i = \pm 10V$

During sampling (i.e when input ±10V) MOSFET must be ON:

$V_{GS} > V_T$

$V_G - V_S > V_T$ [$\because V_{GS} = V_G - V_S$]

$V_G > V_s + V_T$

$V_G > V_i + V_T$

when $V_i = 10V \Rightarrow V_G > 10V + 3V$
[when $V_{imax} = 10V$]

$V_G > 13V$

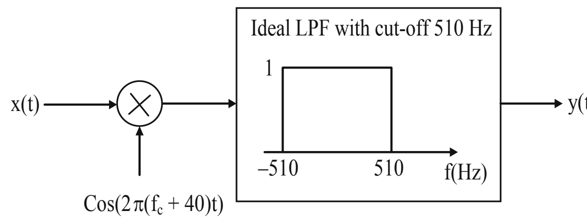
when $V_i = -10V$

$\Rightarrow V_G > V_i + V_T$ [when $V_{imin} = -10V$]

$V_G > -10 + 3V$

$V_G > -7V$

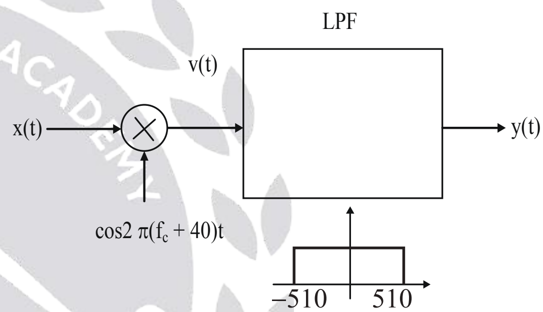
47. For the modulated signal $x(t) = m(t)\cos(2\pi f_c t)$, the message signal $m(t) = 4\cos(1000\pi t)$ and the carrier frequency f_c is 1 MHz. The signal x(t) is passed through a demodulator, as shown in the figure below. The output y(t) of the demodulator is



(a) $\cos(540\pi t)$ (b) $\cos(920\pi t)$
(c) $\cos(460\pi t)$ (d) $\cos(1000\pi t)$

47. Ans:(b)

Sol:



$$v(t) = m(t)\cos(2\pi f_c t)\cos(2\pi(f_c + 40)t)$$

$$v(t) = 4\cos(2\pi 500t)\cos(2\pi.10^6 t)\cos(2\pi(10^6 + 40)t)$$

$$v(t) = 4\cos(2\pi 500t)\frac{1}{2}[\cos(4\pi 10^6 + 2\pi 40)t + \cos(2\pi 40t)]$$

$$v(t) = 2\cos(2\pi.500t)[\cos(2\pi.40t) + \cos(2\pi(2.10^6 + 40)t]$$

$$v(t) = \cos(2\pi.540t) + \cos(2\pi.460t) + \cos(2\pi(2.10^6 + 540)t) + \cos(2\pi(2.10^6 + 460t))$$

$$y(t) = \cos(2\pi 460t)$$

$$y(t) = \cos(920\pi t)$$

48. A finite duration discrete time signals x[n] is obtained by sampling the continuous time signal $x(t) = \cos(200\pi t)$ of sample instant $t = \frac{n}{400}$, n = 0, 1, 2, ... 7. The 8-point discrete fourier transform (DFT) of x(n) is defined as

$$X[k] = \sum_{n=0}^{7} x(n).e^{-i\frac{\pi k}{4}n}, k = 0, 1, ...7$$

Which one of the following statements is TRUE?

(a) Only X(2) and X(6) are non-zero

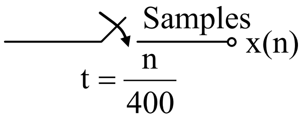
(b) Only X(3) and X(5) are non-zero

(c) Only X(4) is non-zero

(d) All X(k) are non-zero

48. Ans: (a)

Sol: $x(t) = \cos(200\pi t)$



$$x(nT_s) = \cos\left(\frac{200\pi n}{400}\right) \Rightarrow x(n) = \cos\left(\frac{\pi n}{2}\right)$$

$x(n) = \{1, 0, –1, 0, 1, 0, –1, 0\}$

$$X(k) = \sum_{n=0}^{N-1} x(n) W_N^{kn}$$

$$= \sum_{n=0}^{7} x(n) e^{-j\frac{\pi kn}{4}}$$

$$X(4) = \sum_{n=0}^{7} x(n) e^{-j\pi n} = \sum_{n=0}^{7} x(n)(-1)^n$$

$X(4) = 1 – 1 + 1 – 1 = 0$

$$X(2) = \sum_{n=0}^{7} x(n) e^{-j\frac{\pi n}{2}} = 1 + 1 + 1 + 1 = 4$$

As $X(k) = X^*(N – K)$

$X(2) = X^*(8–2) = X^*(6)$

Only X(2) & (6) are non zero.

(or)

when we look at x(n), it contains only even samples. If we assume z(n) = {1–1 1–1}

$$Z(k) = \begin{bmatrix} Z(0) \\ Z(1) \\ Z(2) \\ Z(3) \end{bmatrix} = \begin{bmatrix} 1 & 1 & 1 & 1 \\ 1 & -j & -1 & j \\ 1 & -1 & 1 & -1 \\ 1 & j & -1 & -j \end{bmatrix} \begin{bmatrix} 1 \\ -1 \\ 1 \\ -1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 4 \\ 0 \end{bmatrix}$$

We know zero interpolation in time domain corresponds to replication of DFT spectrum

$$x(n) = z\left(\frac{n}{2}\right) \xleftrightarrow{DFT} X(k) = \{Z(k), Z(k)\}$$

$$= \{0,0,4,0,0,0,4,0\}$$

(or)

$$\cos\left(\frac{2\pi}{N}k_0 n\right) \leftrightarrow \frac{N}{2}\left[\delta(k-k_0) + \delta(k+k_0)\right]$$

$$\cos\left(\frac{n\pi}{2}\right) = \cos\left(\frac{2\pi}{8}2n\right) \leftrightarrow \frac{8}{2}\left[\delta(k-2) + \delta(k+2)\right]$$

So, non zero samples are –2, 2. From periodicity property non zero samples are –2+8, 2 = 6,2.

49. The transfer function of a stable discrete time LTI system is $H(z) = \frac{K(z-\alpha)}{(z+0.5)}$, where K and α are real numbers. The value of α (rounded off to one decimal place) with $|\alpha| > 1$, for which the magnitude response of the system is constant over all frequencies, is ____.

49. Ans: –2

Sol: $H(z) = \frac{K(z-\alpha)}{z+0.5}, |\alpha| \quad 1$

$|H(e^{j\omega})| = 1 \ \forall \ \omega$

For an all pass filter poles & zeros are reciprocal to each other.

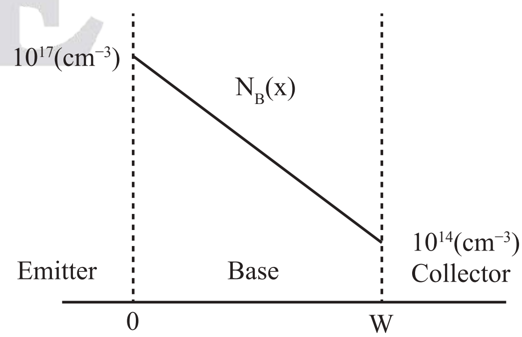
To get constant magnitude for all frequency pole located at z = –0.5

$\therefore$ zero is located at $= \frac{1}{-0.5} = -2$

$$H(z) = \frac{k(z+2)}{z+0.5}$$

$\therefore \alpha = –2$

50. The base of an npn BJT T1 has a linear doping profile $N_B(x)$ as shown below. The base of another non BJT T2 has a uniform doping N_B of 10^{17} cm^{-3}. All other parameters are identical for both the devices. Assuming that the hole density profile is the same as that of doping, the common-emitter current gain of T2 is



(a) approximately 0.3 times that of T1.

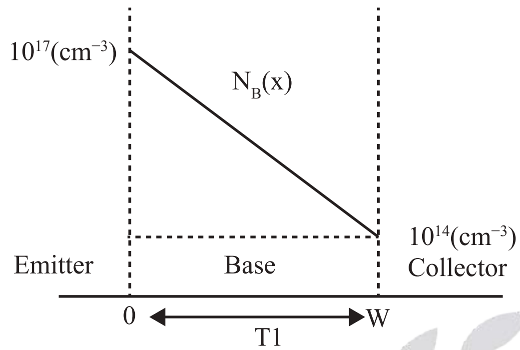
(b) approximately 2.0 times that of T1.

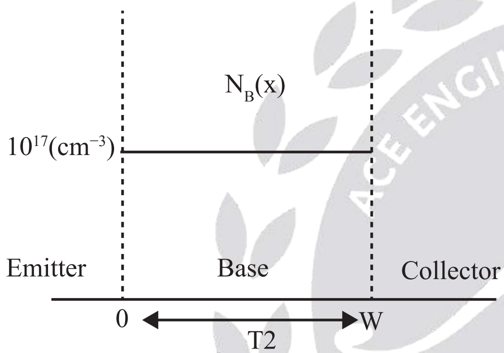
(c) approximately 0.7 times that of T1.

(d) approximately 2.5 times that of T1.

50. Ans: (b)

Sol: $\frac{\beta_{T2}}{\beta_{T1}} = \frac{\text{Area under the carrier profile of base of T1}}{\text{Area under the carrier profile of base of T2}}$



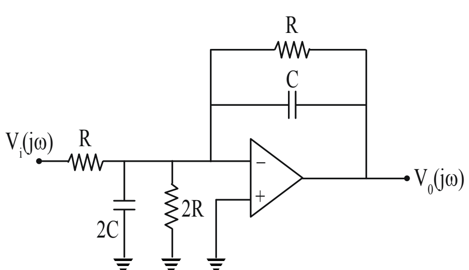


$$\frac{\beta_{T2}}{\beta_{T1}} = \frac{10^{17}\times W}{\frac{1}{2}(10^{17}-10^{14})W + 10^{14}W}$$

$$= \frac{10^{17}}{\frac{1}{2}(10^{17}-10^{14}) + 10^{14}} \simeq 2$$

$$\Rightarrow \beta_{T2} = 2\beta_{T1}$$

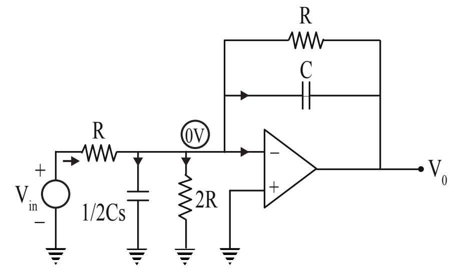
51. The components in the circuit given below are ideal. If R = 2 kΩ and C = 1 μF, the –3 dB cut-off frequency of the circuit in Hz is



(a) 14.92 (b) 59.68
(c) 34.46 (d) 79.58

51. Ans: (d)

Sol:



No current flows through 2C and 2R

KCL

$$\frac{V_{in}-0}{R} = \frac{0-0}{1/2sC} + \frac{0-0}{2R} + 0 + \frac{0-V_o}{1/sC} + \frac{0-V_o}{R}$$

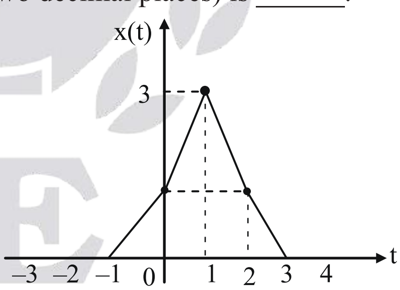
$$\frac{V_{in}}{R} = -V_o\left[\frac{1}{R} + sC\right]$$

$$\left|\frac{V_o}{V_{in}}\right| = \frac{1}{1+sCR} = \frac{1}{1+s\tau}$$

$$\omega_{3dB} = \frac{1}{\tau} = \frac{1}{RC}$$

$$f_{3dB} = \frac{1}{2\pi RC} = \frac{1}{2\pi(2k)(1\mu)} = 79.58\text{Hz}$$

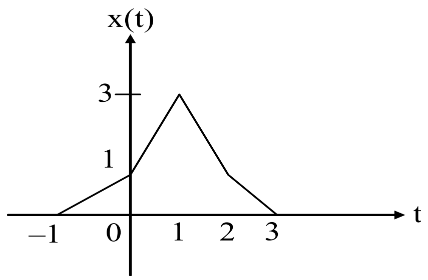
52. X(ω) is Fourier transform of x(t) shown below. The value of $\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega$ (rounded off to two decimal places) is ______.



52. Ans: 58.64

Sol: From parseval's theorem

$$\int_{-\infty}^{\infty} |X(\omega)|^2 d\omega = 2\pi \int_{-\infty}^{\infty} |x(t)|^2 dt$$



Because of symmetry of the signal w.r.t to t = 1

$$\int_{-\infty}^{+\infty} |X(\omega)|^2 d\omega = 2\pi\left[\int_{-1}^{3} |x(t)|^2 dt\right]$$

$$= 2(2\pi)\left[\int_{-1}^{0} (t+1)^2 dt + \int_{0}^{1} (2t+1)^2 dt\right]$$

$$2(2\pi)\left[\int_{-1}^{0} (t+1)^2 dt + \int_{0}^{1} (4t^2+4t+1) dt\right]$$

$$= 4\pi\left[\left[\frac{(t+1)^3}{3}\right]_{-1}^{0} + \left[\frac{4t^3}{3} + \frac{4t^2}{2} + t\right]_{0}^{1}\right]$$

$$= 4\pi\left[\frac{1}{3} + \frac{4}{3} + 2 + 1\right] = 4\pi\left[\frac{5}{3} + 3\right]$$

$$= \frac{56\pi}{3}$$

$$= 58.64$$

53. P, Q, and R are the decimal integers corresponding to the 4-bit binary number 1100 considered in signed magnitude, 1's complement and 2's complement representations, respectively. The 6-bit 2's complement representation of (P + Q + R) is

(a) 111101
(b) 110101
(c) 110010
(d) 111001

53. Ans: (b)

Sol: P = The decimal value of sign magnitude no 1100

= –4

Q = The decimal value of 1's complement no 1100

= –3

R = The decimal value of 1's complement no 1100

= –4

Thus P+Q+R = (–4) + (–3) + (–4)

P+Q+R = –11

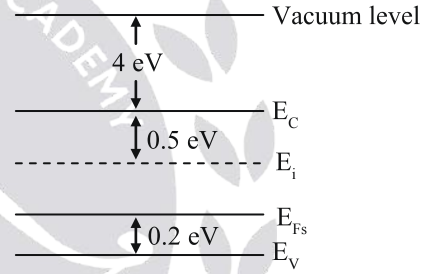
= 2's complement of +11

= 2's complement of 001011

= 110101

Thus P+Q+R in 6-bit 2's complement representation is 110101.

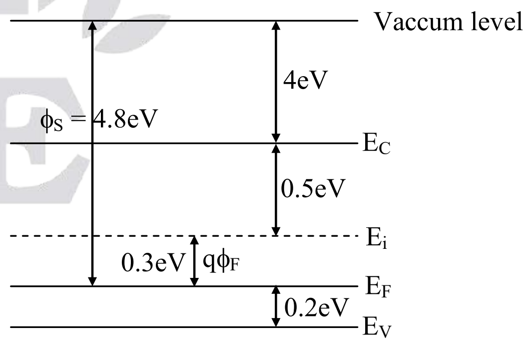
54. The band diagram of a p-type semiconductor with a band-gap of 1 eV is shown, using this semiconductor, a MOS capacitor having V_{TH} of –0.16 V, C'_{ox} of 100 nF/cm^2 and a metal work function of 3.87 eV is fabricated. There is no charge within the oxide. If the voltage across the capacitor is V_{TH}, the magnitude of depletion charge per unit area (in C/cm^2) is



(a) 1.41×10^{-8}
(b) 1.70×10^{-8}
(c) 0.52×10^{-8}
(d) 0.93×10^{-8}

54. Ans: (b)

Sol:



ϕ_S = 4eV+0.5eV+0.3eV=4.8eV

V_{TH} = –0.16V, C_{ox} =100nF/cm^2

ϕ_m = 3.87 eV

$$V_T - V_{FB} = \frac{|Q_{dinv}|}{C_{ox}} + \phi_t$$

$V_{FB} = \phi_{ms}$ (∵ No oxide charge)

$V_{FB} = \phi_{ms} = \phi_m - \phi_s = 3.87 - 4.8 = -0.93$

$\phi_t = 2\,\phi_F$, $\phi_F = 0.3V$

$\phi_t = 2 \times 0.3 = 0.6V$

$$-0.16-(-0.93)=\frac{|Q_{dinv}|}{100n}+0.6$$

$|Q_{dinv}| = 0.17 \times 100 \times 10^{-9} = 17 \times 10^{-9}$

$= 1.7 \times 10^{-8} C/cm^2$

55. Consider the following system of linear equation.

$x_1 + 2x_2 = b_1$; $2x_1 + 4x_2 = b_2$; $3x_1 + 7x_2 = b_3$; $3x_1 + 9x_2 = b_4$

Which one of the following conditions ensures that a solution exists for the above system?

(a) $b_2 = 2b_1$ and $3b_1 - 6b_3 + b_4 = 0$

(b) $b_3 = 2b_1$ and $3b_1 - 6b_3 + b_4 = 0$

(c) $b_3 = 2b_1$ and $6b_1 - 3b_3 + b_4 = 0$

(d) $b_2 = 2b_1$ and $6b_1 - 3b_3 + b_4 = 0$

55. Ans: (d)

Sol: Consider augmented matrix

$$(A|B)=\left[\begin{array}{cc|c}1&2&b_1\\2&4&b_2\\3&7&b_3\\3&9&b_4\end{array}\right]$$

$R_2 \to R_2 - 2R_1$; $R_3 \to R_3 - 3R_1$; $R_4 \to R_4 - 3R_1$

$$(A|B)\sim\left[\begin{array}{cc|c}1&2&b_1\\0&0&b_2-2b_1\\0&1&b_3-3b_1\\0&3&b_4-3b_1\end{array}\right]$$

$R_2 \leftrightarrow R_3$

$$(A|B)\sim\left[\begin{array}{cc|c}1&2&b_1\\0&1&b_3-3b_1\\0&0&b_2-2b_1\\0&3&b_4-3b_1\end{array}\right]$$

$R_4 \to R_4 - 3R_2$

$$(A|B)\sim\left[\begin{array}{cc|c}1&2&b_1\\0&1&b_3-3b_1\\0&0&b_2-2b_1\\0&0&6b_1-3b_3+b_4\end{array}\right]$$

Here, $\rho(A) = 2$

To have a solution, $\rho(A) = 2 = \rho(A|B)$

if $b_2 - 2b_1 = 0$ and $6b_1 - 3b_3 + b_4 = 0$ then $\rho(A|B) = 2$

$\therefore$ solution exists if $b_2 = 2b_1$

and $6b_1 - 3b_3 + b_4 = 0$

Hence, option (d) is correct.


Hearty Congratulations
to our GATE-2019 Top Rankers
AIR 1 PRAKHAR SINGH CE
AIR 1 SURYANARYANA PI
AIR 1 RAJAT SONI EC
AIR 1 PRANAV SHARMA CSIT
AIR 1 SHASHANK MANGAL IN
AIR 2 KUNAL G EE
AIR 2 MUKESH POONIA EE
AIR 2 ANAND JERRY GEORGE EC
AIR 2 PRIYANKA GUPTA IN
AIR 2 VINAY SEELAM PI
AIR 3 ANKIT KULHARI ME
AIR 3 IDRIS MANAQIBWALA CE
AIR 3 SHUBHAM MAURYA EC
AIR 3 PRATEEK AGARWAL CSIT
AIR 3 VINEET GOSWAMI IN
AIR 3 ROHIT KHANNA PI
AIR 4 CHETAN HANAKANAHALLI EC
AIR 4 CHAITANYA KUMAR EC
AIR 4 ARJUNDAS K IN
AIR 4 RAJ BHAWANI SINGH IN
AIR 4 SIDDARTH WADHWA ME
AIR 5 SAYANTAN BHATTACHARYA EE
AIR 5 PRADEEP KUMAR VERMA EE
AIR 5 CHARMIN PATEL ME
AIR 5 AYUSH JHAM PI
AIR 5 RUTVIK LATHIA XE
AIR 6 PRIYANSHU SHARMA EC
AIR 6 HARI SHRAWGI CSIT
AIR 6 RAMESH KAMULLA IN
AIR 6 RAJ ZUNKE PI
AIR 7 CHIRAG RATHI CE
AIR 7 SHREYANS MEHTA CE
AIR 7 ANKIT KUMAR EC
AIR 7 SAIKIRAN CHOLLETI EC
AIR 7 DEEPITA ROY EE
AIR 7 SHUBHAM MITTAL EE
AIR 7 SAISH KALASKAR IN
AIR 7 SHWETA YADAV IN
AIR 7 AMIT LAL SHAH PI
AIR 7 ANUJ MEENA PI
AIR 9 RAVI SHANKAR MISHRA CSIT
AIR 9 ARKA RAY CSIT
AIR 9 RANJIT KUMAR SINGH EC
AIR 9 DEEP ADHVARYU IN
AIR 9 B. SREEKAR IN
AIR 9 ATULYA JYOTI PI
AIR 10 GEETH GEORGE EE
AIR 10 ASIF KHAN CE
AIR 10 MAHESH SINGH YADAV ME
AIR 10 GARVIT GUPTA XE
AIR 10 MANMOHAN ARORA PI
AIR 10 SHUBHAM PANDE PI
and many more...
CE TOP 10 5 TOP 100 44
ME TOP 10 6 TOP 100 60
EE TOP 10 7 TOP 100 71
EC TOP 10 9 TOP 100 74
CS TOP 10 5 TOP 100 28
IN TOP 10 10 TOP 100 74
PI TOP 10 10 TOP 100 49


Hearty Congratulations
to our ESE-2019 Top Rankers
AIR 1 KARTIKEYA SINGH EE
AIR 1 RAJAT SONI E&T
AIR 1 HARSHAL BHOSALE ME
AIR 1 ABUZAR GAFFARI CE
AIR 2 SHAMBHAVI T EE
AIR 2 ANKUSH MANGLA E&T
AIR 2 SAHIL GOYAL ME
AIR 3 ABHISHEK ANAND EE
AIR 3 ROHIT KUMAR E&T
AIR 3 KUMAR CHANDAN ME
AIR 3 AMARJEET CE
AIR 4 ANKIT TAYAL EE
AIR 4 AMIR KHAN E&T
AIR 4 SAURAV ME
AIR 4 AMAN GULIA CE
AIR 5 KUMAR MAYANK EE
AIR 5 AYUSH CHANDRA CE
AIR 6 RITESH LALWANI EE
AIR 6 PUSHPAK ME
AIR 6 KABIL BHARGAVA CE
AIR 7 KARTIKEY SINGH EE
AIR 7 RAHUL JAIN E&T
AIR 7 MANISH RAJPUT ME
AIR 8 KULDEEP KUMAR E&T
AIR 8 HEMANT KUMAR SINGH ME
AIR 8 YOGESH KUMAR CE
AIR 9 DEEPITA ROY EE
AIR 9 SHUBHAM KARNANI E&T
AIR 9 DWEEP SABAPARA ME
AIR 9 ANKIT KUMAR CE
AIR 10 ANKITA SHARMA EE
AIR 10 GAURAV SRIVASTAVA E&T
AIR 10 SUMIT BHAMBOO ME
and many more...
Total Selections in Top 10: 33 | EE : 9 | E&T : 8 | ME : 9 | CE : 7