NSRIT

AUTONOMOUS

ANSWER KEY & SCHEME OF EVALUATION

Second Semester 2021 Admitted Batch

ACADEMIC REGULATION 2020

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Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	Common to All			Academic Year	2021- 2022
Course Code	20BSX12	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	PARTIAL DIFFERENTIAL EQUATIONS AND VECTOR CALCULAS						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Find the differential equation of all spheres of fixed radius having their centers in the xy – plane.	20BSX12.1	L1
2	Solve $(D - D')(D + D' - 3)z = 0$.	20BSX12.2	L2
3	Compute $\beta(\frac{3}{2}, \frac{1}{2})$.	20BSX12.3	L2
4	Define Solenoidal and Irrotational vectors.	20BSX12.4	L1
5	Write the Statement of Gauss Divergence Theorem.	20BSX12.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Form PDE by eliminating the arbitrary function f from $z = f(x^2 + y^2) + x + y$.	6M	20BSX12.1	L2
6 (b)	Solve $x(y-z)p + y(z-x)q = z(x-y)$.	6M	20BSX12.1	L2
	OR			
7 (a)	Solve $(\frac{p}{2} + x)^2 + (\frac{q}{2} + y)^2 = 1$.	8M	20BSX12.1	L3
7 (b)	Solve $x^2p^2 + y^2q^2 = z^2$.	4M	20BSX12.1	L2
8 (a)	Solve $(D^2 - 2DD')z = e^x + x^2y$.	6M	20BSX12.2	L3
8 (b)	Solve $(4D^2 - 4DD' + D'^2)z = 16\log(x + 2y)$.	6M	20BSX12.2	L2
	OR			
9 (a)	Solve $(D - D' - 1)(D - D' - 2)z = e^{2x-y}$.	6M	20BSX12.2	L2
9 (b)	Solve $\frac{\partial u}{\partial x} = 2\frac{\partial u}{\partial t} + u$, u(x,0) =6 e^{-3x} by the method of separation of variables.	6M	20BSX12.2	L3
10 (a)	Prove that $\int_{-1}^{1}(1+x)^{p-1}(1-x)^{q-1}dx = 2^{p+q-1}\beta(p,q)$.	6M	20BSX12.3	L3
10 (b)	Evaluate $\int_1^e \int_1^{\log y} \int_1^{e^x} \log z\,dz\,dy\,dx$.	6M	20BSX12.3	L2
	OR			
11 (a)	Prove that $\int_0^1 \frac{x}{\sqrt{1-x^5}}dx = \frac{1}{5}\beta(\frac{2}{5}, \frac{1}{2})$.	6M	20BSX12.3	L3
11 (b)	Show that the area between the parabolas y^2=4ax and x^2=4ay is $\frac{16}{3}a^2$.	6M	20BSX12.3	L2

12 (a)	The derivative of f(x, y, z) at a point P is greatest in the direction of $v = i - j - k$. In this direction, the value of the derivative is $3\sqrt{3}$. Find the gradient vector at P.	6M	20BSX12.4	L3
12 (b)	Determine the constants a, b, c so that $A = (x + 2y + az)i + (bx - 3y - z)j + (4x + cy + 2z)k$ is irrotational.	6M	20BSX12.4	L3
	OR			
13 (a)	If $\bar{F} = grad(x^3 + y^3 + z^3 - 3xyz)$ Find div $\bar{F}$ and curl $\bar{F}$.	6M	20BSX12.4	L3
13 (b)	Prove that $div(gradr^m) = m(m+1)r^{m-2}$.	6M	20BSX12.4	L2
14	Verify Green's theorem for $\int_c [(xy + y^2)dx + x^2\,dy]$, where C is bounded by $y = x$ and $y = x^2$.	12M	20BSX12.5	L3
	OR			
15	Verify Stoke's theorem for $\bar{F} = (x^2 + y^2)\bar{i} - 2xy\bar{j}$ taken around the rectangle bounded by the lines $x = \pm a$, $y = 0$, $y = b$.	12M	20BSX12.5	L3

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ANSWER KEY AND SCHEME OF EVALUATION

PARTIAL DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS

No.	Questions (1 through 5)	Marks
1	The equation of all spheres having centers on z-axis and fixed radius is $(x-a)^2+(y-b)^2+z^2=r^2$ By differentiating w.r.to x partially, we get,2(x-a) +2z p =0 By differentiating w.r.to y partially, we get ,2(y-b) + 2z q =0	1
2	By substituting in the given relation, we get $z^2p^2+z^2q^2+z^2=r^2$ or $z^2(p^2+q^2+1)=r^2$ By comparing (D-D^1) (D+D^1-3) with (D-m_1D^1-α_1) (D-m_2D^1-α_2), we have $m_1=1,\ \ m_2=-1,\ \alpha_1=0,\ \ \alpha_2=3$.	1 1
3	The solution is given by z= $f_1(y+x)+e^{3x}f_2(y+3x)$.β(m,n)= $\frac{\Gamma(m)\Gamma(n)}{\Gamma(m+n)}$ .In this put m=$\frac{3}{2}$, n=$\frac{1}{2}$. Then we get $\beta(\frac{3}{2},\frac{1}{2})=\frac{\Gamma(\frac{3}{2})\Gamma(\frac{1}{2})}{\Gamma(2)}$ =π/2	1 1 1
4	A Vector $\bar{F}$is said to be Solenoidal if Div $\bar{F}$ =0 and Irrotational if curl $\bar{F}=\bar{0}$	1 1
5	Gauss's DivergenceTheorem: If$\bar{F}$is a continuously differentiable vector point function in the region E bounded by a closed surface S, then $\iint_S \bar{F}.\bar{n}\ dS=\iiint_E div\ \bar{F}\ dv$ where $\bar{n}$ is the unit outward drawn normal vector to the surface	1 1

No.	Questions (6 through 11)	
6(a)	Thegiven relation is $z=f(x^2+y^2)+x+y$ By differentiating w.r.to x partially, we get p = $f'(x^2+y^2)(2x)+1$ By differentiating w.r.to y partially, q = $f'(x^2+y^2)(2y)+1$ So, $\frac{p-1}{x}=\frac{q-1}{y}$ By cross multiplication, p y -q x = y - x is the required PDE.	2 2 2
6 (b)	The subsidiary equations are $\frac{dx}{x(y-z)}=\frac{dy}{y(z-x)}=\frac{dz}{z(x-y)}=\frac{ldx+mdy+ndz}{lx(y-z)+my(z-x)+nz(x-y)}$	1

For the multipliers l=1, m=1, n=1, Denominator of the fourth fraction =0.
So, we have Nr=o means $dx + dy + dz$ =0 2
On integration, we get $x + y + z$ = a.

Again, for the multipliers l=$\frac{1}{x}$, m=$\frac{1}{y}$, n=$\frac{1}{z}$, Denominator o the fourth fraction =0.
So, we have Nr=o means $ldx + mdy + ndz$ =0
which gives us$\frac{1}{x}dx + \frac{1}{y}dy + \frac{1}{z}dz$ =0 2
On integration, we get, x y z=b

Hence the general solution of the given PDE is given by f($x + y + z$, x y z) = 0. 1

$(\frac{p}{2} + x)^2 + (\frac{q}{2} + y)^2$ =1 is a non-linear PDE of first order of the form f (x,p) = g (y, q) 1

$\left(\frac{p}{2} + x\right)^2$ =1 - $\left(\frac{q}{2} + y\right)^2$. 2
Let both the sides be equal to k, some constant.
Then we have $(\frac{p}{2} + x)^2$ =k and 1 - $(\frac{q}{2} + y)^2 = k$.

7 (a) Which gives, p = 2 ($\sqrt{k} - x$), q = 2($\sqrt{(1-k)}$ – y)
We have dz = p dx + q dy. 2
By substituting above values of p and q, we get
d z = 2 ($\sqrt{k} - x$) dx + 2($\sqrt{(1-k)}$ – y) dy

On integration, we get, z = 2 ($\sqrt{k}\,x$) - x^2 + 2($\sqrt{(1-k)}$ y) - y^2 + c. 1

The given PDE is $x^2p^2 + y^2q^2 = z^2$. .....(i)
It is of the form f(x^mp, y^nq, z) = 0 for m=1, n=1. 2
Put X=logx, Y=logy. Then xp=P, yq=Q where P=$\frac{\partial z}{\partial X}$ and Q=$\frac{\partial z}{\partial Y}$
So given equation changes to P^2+Q^2= z^2.....(ii)
Let the solution be z=f(u) where u= X + aY. Then P=$\frac{dz}{du}$ $Q = a\frac{dz}{du}$

7 (b) So, equation (ii) now changes to (1+ a^2)$(\frac{dz}{du})^2$ = z^2 2
which is same as $\sqrt{1 + a^2}\frac{dz}{du}$=z (or)$\sqrt{1 + a^2}\frac{dz}{z}$= du

On integrating, we get $\sqrt{1 + a^2}\,logz$ =u +c
$\sqrt{1 + a^2}\,logz$ = X + aY +c 2
$\sqrt{1 + a^2}\,logz$ = logx + a logy +c.
$(D^2 - 2DD')z = e^x + x^2y$.
8 (a) The A.E. is m^2-2m =0, which gives m = 0 ,2 2
The C.F. is given by f(y) + g(y+2x)

The Particular integral is given by P.I. $=\frac{1}{D^2-2DD'}(e^x + x^2y)$

$=\frac{1}{D^2-2DD'}(e^x)+\frac{1}{D^2-2DD'}(x^2y)$= P. I_1+P. I_2(say)

P. I_1 $=\frac{1}{D^2-2DD'}(e^x)$

Put D=I, D'=0

$=e^x$

P. I_2 $=\frac{1}{D^2-2DD'}(x^2y)=\frac{1}{D^2(1-2\frac{D'}{D})}(x^2y)=\frac{1}{D^2}(1-2\frac{D'}{D})^{-1}(x^2y)=$ 3

$=\frac{1}{D^2}(1-2\frac{D'}{D}+4\frac{D'^2}{D^2})(x^2y)=\frac{1}{D^2}(x^2y-2\frac{1}{D}(x^2)+4(0))=\frac{1}{D^2}(x^2y-4x)=$

$=\frac{1}{D}\int(x^2y-4x)\,dx=\frac{1}{D}(\frac{x^3y}{3}-2x^2)=\int(\frac{x^3y}{3}-2x^2)\,dx=\frac{x^4y}{12}-\frac{2x^3}{3}$

So, P.I. $= e^x+\frac{x^4y}{12}-\frac{2x^3}{3}$

The complete solution is given by z= C.F. + P.I.

i.e., z= f(y) +g(y+2x) + $e^x+\frac{x^4y}{12}-\frac{2x^3}{3}$ 1

$$\left(4D^2-4DD'+D'^2\right)z = 16\log(x+2y)$$

The A.E. is $(2m-1)^2$ =0, which gives m = $\frac{1}{2},\frac{1}{2}$ 2

The C.F. is given by f(y+$\frac{x}{2}$) + x g(y+$\frac{x}{2}$)

The Particular integral is given by P.I. $=\frac{1}{4D^2-24D'+D'^2}16\log(x+2y)$

8 (b) $=4\ \frac{1}{D-\frac{D'}{2}}$

$=4\ \frac{1}{D-\frac{D'}{2}}\int\log(2c)dx$ where c= y + $\frac{x}{2}$ 3

$=4\ \frac{1}{D-\frac{D'}{2}}$ x log $(2c)$ = 4 $\frac{1}{D-\frac{D'}{2}}$ x $\log(x+2y)$

$=4\int x\log(2c)dx = 2x^2\log(2c) = 2x^2\log(x+2y)$

The complete solution is given by z= C.F. + P.I. = f(y+$\frac{x}{2}$) + x g(y+$\frac{x}{2}$) + $2x^2\log(x+2y)$ 1

Given PDE is $(D-D'-1)(D-D'-2)z = e^{2x-y}$.

By comparing $(D-D'-1)(D-D'-2)$ with $(D-m_1D^1-\alpha_1)(D-m_2D^1-\alpha_2)$,

We have $m_1=1,\ m_2=1,\ \alpha_1=1,\ \alpha_2=2$. 3

The C. F. is given by z= $e^xf_1(y+x)+e^{2x}f_2(y+x)$

P.I. $=\frac{1}{D-D^1-1}\frac{1}{D-D^1-2}(e^{2x-y})$ 1

9 (a) $=\frac{1}{2-(-1)-1}\frac{1}{2-(-1)-2}(e^{2x-y})$ 1

$=\frac{1}{2}e^{2x-y}$.

The complete solution is given by z= C.F. + P. I.

z= $e^xf_1(y+x)+e^{2x}f_2(y+x)+\frac{1}{2}e^{2x-y}$. 1

Solve $\frac{\partial u}{\partial x}=2\frac{\partial u}{\partial t}+u$, u(x,0) =6 $e^{-3x}$by the method of separation variables.

Let us assume the complete solution as u =X(x).T(t) 1

Then given PDE becomes $X^1T = 2XT^1+XT$

9 (b) On dividing with XT, we get

$\frac{X^1}{X}=-2\frac{T^1}{T}+1$ =k (say) 2

Which gives X^1 =kX, $T^1=(\frac{1-k}{2})T$

$\frac{dX}{dx}$ = kX, $\frac{dT}{dt}=(\frac{1-k}{2})T$

$\frac{dX}{X} = k\,dx \& \frac{dT}{T} = (\frac{1-k}{2})\,dt$

By integrating, we get log X = kx+ logA & log T=$(\frac{1-k}{2})$ t +logB
Which implies X = Ae^{kx}&T = $Be^{(\frac{1-k}{2})t}$ — 2

So, the complete solution is u= $Ae^{kx}Be^{(\frac{1-k}{2})t} = Ce^{kx}e^{(\frac{1-k}{2})t}$, $where\ C = AB$
Given that u(x,0) =6 e^{-3x}
which gives Ce^{kx} =6 e^{-3x} . So, C=6, k=-3 — 1
Hence the solution of the given problem is
u= $6e^{-3x}e^{(\frac{1+3}{2})t}$ (or) u= $6e^{-3x+2t}$

10 (a)
Consider $\int_{-1}^{1}(1+x)^{p-1}(1-x)^{q-1}dx$
Put y = $\frac{1+x}{2}$ (or) x= 2y-1. Then dx= 2dy — 3
x=-1 gives y=0 and x=1 gives y=1
So, the above integral changes to the form $\int_0^1(2y)^{p-1}(2-2y)^{q-1}(2dy)$ — 3
$2^{p+q-1}\int_0^1(y)^{p-1}(1-y)^{q-1}dy = 2^{p+q-1}\,\beta(p,q)$

10 (b)
$$\int_1^e\int_1^{logy}\int_1^{e^x} logz\,dz\,dx\,dy$$ — 1
Here z : 1→ e^x ,x : 1→ $logy$, y :1→ e

=
$\int_1^e\int_1^{logy}[z(logz-1)]dxdy where z: 1\to e^x$
=
$\int_1^e\int_1^{logy}[e^x(x-1)-0]dxdy$
$=\int_1^e\int_1^{logy}[e^x(x-1)]dxdy$
$=\int_1^e[e^x(x-2)]dy,\ where\ x: 1\to logy$
$=\int_1^e[y(logy-2)+e]dy,$
= — 3

$=\int_1^e[y(logy)]dy+\int_1^e -2ydy+\int_1^e[e]dy$

$=\frac{e^2}{4}+\frac{5}{4}$ -e. *(On Simplification)* — 2

11 (a)
$\int_0^1\frac{x}{\sqrt{1-x^5}}$ dx. In this integral put $x^5 = y$. Then x = $y^{\frac{1}{5}}$ and dx = $\frac{1}{5}y^{\frac{-4}{5}}$ dy — 1
x=0 gives y=0, x =1 gives y=1. — 1
So, given integral changes to $\int_0^1\frac{y^{\frac{1}{5}}}{\sqrt{1-y}}\frac{1}{5}y^{\frac{-4}{5}}dy = \frac{1}{5}\int_0^1 y^{\frac{-3}{5}}(1-y)^{\frac{-1}{2}}dy$ — 1
By comparing this with $\frac{1}{5}\int_0^1 y^{m-1}(1-y)^{n-1}$ dy, we have m = $\frac{2}{5}$ and n = $\frac{1}{2}$. — 1

But we know that $\int_0^1 y^{m-1}(1-y)^{n-1}\,dy, = \beta(m,n)$ 2

And hence,given integral $=\frac{1}{5}\beta(\frac{2}{5},\frac{1}{2})$.

11 (b)

By solving $y^2=4ax$ and $x^2=4ay$, we get $y^4=16a^2(4ay) = 64\,a^3y$ 2

which gives $y(y^3 - 64\,a^3)=0$

which gives y=0 or y=4a.

When y=0, we get x=0 and when y=4a, x=4a.

So, the two parabolas will intersect at

(0,0) and (4a,4a).

In the region bounded by the two parabolas, x varies from 0 to 4a and y varies from $\frac{x^2}{4a}$ to $2\sqrt{ax}$. Now 2

the area between the parabolas $= \int_0^{4a}\int_{\frac{x^2}{4a}}^{2\sqrt{ax}}(1)dx\,dy$

$= \int_0^{4a}(2\sqrt{ax} - \frac{x^2}{4a})\,dx = \{\,2\sqrt{a}\frac{x^{3/2}}{3/2} - \frac{x^3}{12a}\}$ where x varies from 0 to 4a. 2

$=\frac{4}{3}\sqrt{a}(4a)^{3/2}\frac{(4a)^3}{12a} = \frac{16a^2}{3}$.

Let the Gradient vector at P be $\nabla\varphi$ where φ =0 is the equat5ion of the surface. 2

The directional derivative of φ at P in the direction of $\bar{v}$ is $\frac{\nabla\varphi.\bar{v}}{|\bar{v}|}$.....(i)

12(a)

The directional derivative is maximum if $\nabla\varphi$ is along the direction of $\bar{v}$. So, $\nabla\varphi$must be either $\bar{v}$. Or a multiple of $\bar{v}$. So let $\nabla\varphi = k\bar{v}$. 2

By substituting in equation (i), we get,the directional derivative of φ at P in the direction of $\bar{v}$ is

$\frac{k\bar{v}.\bar{v}}{|\bar{v}|} = k|\bar{v}| = k\,|\bar{\imath} - \bar{\jmath} - \bar{\bar{k}}| = k\sqrt{1+1+1} = k\sqrt{3}$

Butit is given that, the value of $k\sqrt{3} = 3\sqrt{3}$, which gives k = 3. 2

Hence, the gradient vector is $\nabla\varphi = k\bar{v} = 3\,\bar{v} = 3(\bar{\imath} - \bar{\jmath} - \bar{\bar{k}}) = 3\bar{\imath} - 3\bar{\jmath} - 3\bar{\bar{k}}$.

For $\bar{F}$ to be irrotational, we should have Curl $\bar{F} = 0$. 1

Curl $(\bar{F}) = \begin{vmatrix} \bar{\imath} & \bar{\jmath} & \bar{\bar{k}} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ x + 2y + az & bx - 3y - z) & 4x + cy + 2z \end{vmatrix}$ 2

12(b)

$= \bar{\imath}\,[\frac{\partial}{\partial y}(4x + cy + 2z) - \frac{\partial}{\partial z}(bx - 3y - z)] + \bar{\jmath}\,[\frac{\partial}{\partial z}(x + 2y + az) - \frac{\partial}{\partial x}(4x + cy + 2z)]$

$+\bar{\bar{k}}\,[\frac{\partial}{\partial x}(bx - 3y - z) - \frac{\partial}{\partial y}(x + 2y + az)]$ 2

$= \bar{\imath}(c - 1) + \bar{\jmath}(a - 4) + \bar{\bar{k}}(b - 2)$

By equating this to zero, we get

$\bar{\imath}(c - 1) + \bar{\jmath}(a - 4) + \bar{\bar{k}}(b - 2) = \bar{\imath}(0) + \bar{\jmath}(-0) + \bar{\bar{k}}(0) = \bar{0}$

Which gives, a =4, b =2, c =1 1

Hence, $\bar{F}$ is irrotational if

a =4, b =2, c =1.

$\bar{F} = grad(x^3 + y^3 + z^3 - 3xyz)$ =grad$\emptyset$

.=$\bar{\imath}\frac{\partial\emptyset}{\partial x} + \bar{\jmath}\frac{\partial\emptyset}{\partial y} + \bar{k}\frac{\partial\emptyset}{\partial z}$ = . $\bar{\imath}(3x^2 - yz) + \bar{\jmath}(3y^2 - zx) + \bar{k}(3z^2 - xy)$ 3

div($\bar{F}$) = $\frac{\partial}{\partial x}(3x^2 - yz) + \frac{\partial}{\partial y}(3y^2 - zx) + \frac{\partial}{\partial z}(3z^2 - xy)$ =6x + 6y + 6z

13(a)

Curl ($\bar{F}$)= $\begin{vmatrix} \bar{\imath} & \bar{\jmath} & \bar{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ 3x^2 - yz & 3y^2 - zx & 3z^2 - xy \end{vmatrix}$ 3

= $\bar{\imath}$ [$\frac{\partial}{\partial y}(3z^2 - xy) - \frac{\partial}{\partial z}(3y^2 - zx)$] + $\bar{\jmath}$ [$\frac{\partial}{\partial z}(3x^2 - yz) - \frac{\partial}{\partial x}(3z^2 - xy)$] +$\bar{k}$ [$\frac{\partial}{\partial x}(3y^2 - zx) - \frac{\partial}{\partial y}(3x^2 - yz)$]

= $\bar{\imath}(-x + x) + \bar{\jmath}(-y + y) + \bar{k}(-z + z) = \bar{0}$

$\bar{r}$ = x$\bar{\imath}$ + y$\bar{\jmath}$ + z$\bar{k}$ gives us r = $\sqrt{x^2 + y^2 + z^2}$

$\frac{\partial r}{\partial x} = \frac{x}{r}$, $\frac{\partial r}{\partial y} = \frac{y}{r}$, $\frac{\partial r}{\partial z} = \frac{z}{r}$ 1

Grad (r^m) = m$r^{m-1}\frac{\bar{r}}{r}$ =m $r^{m-1}\frac{x\bar{\imath} + y\bar{\jmath} + z\bar{k}}{r}$ = m r^{m-2}(x$\bar{\imath}$ + y$\bar{\jmath}$ + z$\bar{k}$) 2

13(b)

div(grad r^m) = $\sum\frac{\partial}{\partial x}$(m $r^{m-2}x$) = m r^{m-2} + m (m-2) $r^{m-3}(\frac{x}{r})x$ 1

= $\sum$[m r^{m-2} + m (m − 2) $r^{m-4}x^2$] = 3m r^{m-2} + m (m − 2) r^{m-2}

= m (m+1) r^{m-2} 2

LHS : Evaluating the line integral $\oint(xy + y^2)\,dx + x^2\,dy$:

The line integral is the sum of the line integrals along y = x^2 and along y= x.

14 Along y = x^2, dy = 2x dx and x: 0 → 1. So, the line integral along y = x^2 becomes 6

$\int_0^1(x^3+x^4)\,dx + 2x^3\,dx = \int_0^1(3x^3+x^4)\,dx = (\frac{3x^4}{4} + \frac{x^5}{5})$ where x: 0 → 1

Which gives us $\frac{3}{4} + \frac{1}{5} = \frac{19}{20}$.

Along y = x, from A to O, dy =dx and x :1→ 0 .

So, the line integral along y = x becomes $\int_0^1 3x^2\,dx$

Which is same as $x^3$where x: 1→ 0 which gives us -1

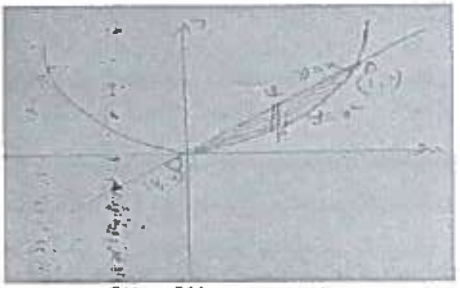
So, LHS = $\frac{19}{20}1 = \frac{-1}{20}$.

Evaluating RHS:

M= xy + x^2 and N = x^2. So, $\frac{\partial N}{\partial x} = 2x$, $\frac{\partial M}{\partial y}$ = x + 2y which gives

$\frac{\partial N}{\partial x} = 2x$, $\frac{\partial M}{\partial y}$ = x – 2y

BY Green's Theorem, $\int_C Mdx + N\,dy = \iint_R (\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y})dy\,dx$



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So, $\iint_R (\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y})dy\,dx = \int_0^1 \int_{x^2}^{x} (x - 2y)dy\,dx = \int_0^1 (x^4 - x^3)\,dx$

Which on simplification gives $\frac{-1}{20}$.

Hence LHS = RHS, which means that Greens theorem is verified.

Verify Stoke's theorem for

$\bar{F} = (x^2 + y^2)\bar{\imath}$ - 2xy$\bar{\jmath}$ taken around the rectangle bounded by the lines $x = \pm a$, $y = 0$, $y = b$.

15

Let $ABCD$ be the given rectangle as shown in Fig. 7·14.

$$\int_{ABCD} \mathbf{F}\cdot d\mathbf{R} = \int_{AB} \mathbf{F}\cdot d\mathbf{R} + \int_{BC} \mathbf{F}\cdot d\mathbf{R} + \int_{CD} \mathbf{F}\cdot d\mathbf{R} + \int_{DA} \mathbf{F}\cdot d\mathbf{R}$$

and $\mathbf{F}\cdot d\mathbf{R} = [(x^2 + y^2)\mathbf{I} - 2xy\mathbf{J}]\cdot(\mathbf{I}dx + \mathbf{J}dy) = (x^2 + y^2)dx - 2xy\,dy$

Along AB, $x = a$ (*i.e.* $dx = 0$) and y varies from 0 to b.

$$\therefore \quad \int_{AB} \mathbf{F}\cdot d\mathbf{R} = -2a\int_0^b y\,dy = -2a\,\frac{b^2}{2} = -ab^2.$$

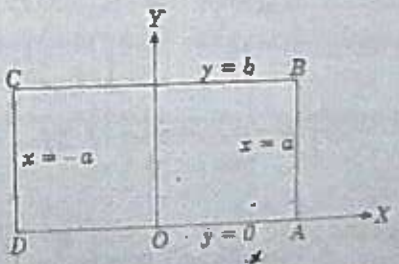


Fig. 7·14

Similarly $\int_{BC} \mathbf{F}\cdot d\mathbf{R} = \int_a^{-a} (x^2 + b^2)\,dx = -\frac{2a^3}{3} - 2ab^2$ ...(i)

$$\int_{CD} \mathbf{F}\cdot d\mathbf{R} = 2a\int_b^0 y\,dy = -ab^2$$

and $$\int_{DA} \mathbf{F}\cdot d\mathbf{R} = \int_{-a}^{a} x^2 dx = \frac{2a^3}{3}$$

Thus $\int_{ABCD} \mathbf{F}\cdot d\mathbf{R} = -4ab^2$ ...(ii)

Also since curl $\mathbf{F} = -4\mathbf{K}y$

$$\therefore \int_S \text{curl}\,\mathbf{F}\cdot\mathbf{N}\,ds = \int_0^b \int_{-a}^{a} -4\mathbf{K}y\cdot\mathbf{K}\,dx\,dy = -4\int_0^b \int_{-a}^{a} y\,dx\,dy$$

$$= -4\int_0^b |x|_{-a}^{a} y\,dy = -8a\left|\frac{y^2}{2}\right|_0^b = -4ab^2$$

Hence Stoke's theorem is verified from the equality of (i) and (ii)

02/08/22

NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	CE/ME/CSE/CSM/CSD			Academic Year	2021 - 2022
Course Code	20ESX05	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	Basic Electrical and Electronics Engineering						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Explain Kirchoff's laws.	20ESX05.1	L2
2	Write the EMF equation of a DC Generator.	20ESX05.2	L1
3	What is the difference between DC generator and alternator?	20ESX05.3	L1
4	Write the relation between primary and secondary voltages and currents of a single-phase transformer.	20ESX05.4	L1
5	Mention any two applications of a diode.	20ESX05.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6	Derive star-delta and delta-star transformations.	12M	20ESX05.1	L2
	OR			
7 (a)	In an A.C. circuit, v = 200 Sin(ωt+300) V, i = 15 Sin(ωt-300) A. Find the active and reactive power.	6M	20ESX05.1	L2
7 (b)	Find the current through and the voltage across all the elements in the circuit by applying Kirchoff's laws as shown in the Fig. 7(b).  Fig.7(b)	6M	20ESX05.1	L2
8 (a)	Derive the emf equation of simplex wave wound DC generator.	4M	20ESX05.2	L2
8 (b)	Explain the construction of a DC generator.	8M	20ESX05.2	L2
	OR			
9 (a)	Derive the torque equation of a DC Motor.	8M	20ESX05.2	L2
9 (b)	A DC shunt machine develops an A.C. emf. of 250V, at 1500 rpm. Find it's torque and mechanical power developed for an armature current of 50A.	4M	20ESX05.2	L2
10 (a)	What are the merits and demerits of induction motor?	6M	20ESX05.3	L1
10 (b)	A 3-phase, 60 Hz induction motor has 2 poles. If the slip is 2% at a certain load, determine: i) The synchronous speed ii) The speed of the rotor and iii) The frequency of the induced e.m.f.'s in the rotor.	6M	20ESX05.3	L2
	OR			
11 (a)	Explain the working principle of 3- Φ induction motor.	6M	20ESX05.3	L2
11 (b)	Explain Speed-Torque Characteristics of 3- Φ induction Motor with neat sketches.	6M	20ESX05.3	L2

12 (a)	Derive an expression for emf induced in a transformer secondary winding if V_1 volts applied across its primary winding.	4M	20ESX05.4	L2
12 (b)	Explain open circuit and short circuit test on a transformer.	8M	20ESX05.4	L2
	OR			
13	Explain the construction of 1-Φ transformer.	12M	20ESX05.4	L2
14	Explain the working of p-n junction diode both in forward and reverse biases conditions.	12M	20ESX05.5	L2
	OR			
15 (a)	Draw the circuit diagram of half wave rectifier and explain its operation.	8M	20ESX05.5	L2
15 (b)	Draw the circuit diagram of non-inverting amplifier and derive the expression for its output voltage.	4M	20ESX05.5	L2

BEEE KEY AND SCHEME

A.Y.:21-22

PART-A

Sl.No	Answer	Marks
1	**Explain Kirchoff's laws.** Kirchhoff's current law: Kirchhoff's current law states that the total current flowing into a node or junction in an electric circuit must be equal to the total current flowing out. Kirchhoff's voltage law: Kirchhoff's Voltage Law states that the algebraic sum of all the voltages in a given circuit will be equal to zero	2M
2	**Write the EMF equation of a DC Generator.** $$E_g = \frac{\phi Z N}{60} X \frac{P}{A} volt$$ Where, Z = total numbers of conductor A = number of parallel paths Then, Z/A = number of conductors connected in series E = emf of one conductor × number of conductor connected in series. N = speed of the armature conductor in rpm. Φ = Flux produced by each pole in weber (Wb) and P = number of poles in the DC generator.	2M
3	**What is the difference between DC generator and alternator?**	2M

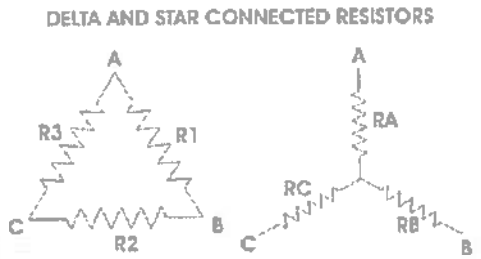
DC Generator	Alternator
Output is electrical energy which is DC in nature	Output is electrical energy which is AC in nature
Armature must be rotating in nature, otherwise commutation action will fail	Armature may be stationary or rotation
Commutation required	Commutation is not required

4	**Write the relation between primary and secondary voltages and currents of a single-phase transformer.** Transformation Ratio, $K = V_2/V_1 = E_2/E_1 = N_2/N_1 = I_1/I_2$	2M
5	**Mention any two applications of a diode.** a. It is used as a switch b. It can be used as a solar cell	2M

PART-B

Sl.No	Answer	Ma
6	Derive star-delta and delta-star transformations.	12

Delta to Star Conversion



Consider a delta system that's three corner points are A, B and C as shown in the figure. Electrical resistance of the branch between points A and B, B and C and C and A are R1, R2 and R3 respectively.

The resistance between the points A and B will be,

$$R_{AB} = R_1 || (R_2 + R_3) = \frac{R_1.(R_2 + R_3)}{R_1 + R_2 + R_3}$$

Now, one star system is connected to these points A, B, and C as shown in the figure. Three arms R_A, R_B and R_C of the star system are connected with A, B and C respectively. Now if we measure the resistance value between points A and B, we will get,

$$R_{AB} = R_A + R_B$$

Since the two systems are identical, resistance measured between terminals A and B in both systems must be equal.

$$R_A + R_B = \frac{R_1.(R_2 + R_3)}{R_1 + R_2 + R_3} \cdots\cdots\cdots\cdots (i)$$

Similarly, resistance between points B and C being equal in the two systems,

$$R_B + R_C = \frac{R_2.(R_3 + R_1)}{R_1 + R_2 + R_3} \cdots\cdots\cdots\cdots (ii)$$

And resistance between points C and A being equal in the two systems,

$$R_C + R_A = \frac{R_3.(R_1 + R_2)}{R_1 + R_2 + R_3} \cdots\cdots\cdots\cdots (iii)$$

Adding equations (I), (II) and (III) we get,

$$2(R_A + R_B + R_C) = \frac{2(R_1.R_2 + R_2.R_3 + R_3.R_1)}{R_1 + R_2 + R_3}$$

$$R_A + R_B + R_C = \frac{R_1.R_2 + R_2.R_3 + R_3.R_1}{R_1 + R_2 + R_3} \ldots\ldots\ldots (iv)$$

Subtracting equations (I), (II) and (III) from equation (IV) we get,

$$R_A = \frac{R_3.R_1}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots\ldots (v)$$

$$R_B = \frac{R_1.R_2}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots\ldots (vi)$$

$$R_C = \frac{R_2.R_3}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots\ldots (vii)$$

The relation of delta – star transformation can be expressed as follows. The equivalent star resistance connected to a given terminal, is equal to the product of the two delta resistances connected to the same terminal divided by the sum of the delta connected resistances. If the delta connected system has same resistance R at its three sides then equivalent star resistance r will be,

$$r = \frac{R.R}{R + R + R} = \frac{R}{3}$$

Star To Delta Conversion

For **star – delta transformation** we just multiply equations (v), (VI) and (VI), (VII) and (VII), (V) that is by doing (v) × (VI) + (VI) × (VII) + (VII) × (V) we get,

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_1.{R_2}^2.R_3 + R_1.R_2.{R_3}^2 + {R_1}^2.R_2.R_3}{(R_1 + R_2 + R_3)^2}$$

$$= \frac{R_1.R_2.R_3(R_1 + R_2 + R_3)}{(R_1 + R_2 + R_3)^2}$$

$$= \frac{R_1.R_2.R_3}{R_1 + R_2 + R_3} \ldots\ldots\ldots\ldots\ldots (viii)$$

Now dividing equation (VIII) by equations (V), (VI) and equations (VII) separately we get,

$$R_3 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

$$R_1 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_B}$$

$$R_2 = \frac{R_A R_B + R_B R_C + R_C R_A}{R_C}$$

OR

7(a) In an A.C. circuit, v = 200 Sin(ωt+300) V, i = 15 Sin(ωt-300) A. Find the active and reactive power. 6

Soln

$v = 200 \sin(\omega t + 300)$

$i = 15 \sin(\omega t - 300)$

Active power $= V_{eff} \cdot I_{eff} \cos\theta$

$= \frac{200}{\sqrt{2}} \frac{15}{\sqrt{2}} \cos(600)$

$= +75$ kW

Reactive power $= V_{eff} \cdot I_{eff} \sin\theta$

$= \frac{200}{\sqrt{2}} \cdot \frac{15}{\sqrt{2}} \sin(600)$

$= -129.9$ kVAR

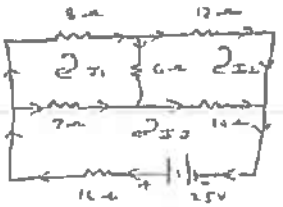
7(b) Find the current through and the voltage across all the elements in the circuit by applying Kirchoff's laws as shown in the Fig. 7(b). 6

Soln

Loop - 1

$8I_1 + 6(I_1 - I_2) + 7(I_1 - I_3) = 0$

$21I_1 - 6I_2 - 7I_3 = 0 \rightarrow 1$



Loop - 2

$6(I_2 - I_1) + 12I_2 + 10(I_2 - I_3)$

$14I_2 - 3I_1 - 5I_3 = 0 \rightarrow 2$

Loop - 3

$25 = 7(I_3 - I_1) + 10(I_3 - I_2) + 16I_3$

$25 = 33I_3 - 7I_1 - 10I_2 \rightarrow 3$

By solving 3 equations

$I_1 = 0.45A \quad I_2 = 0.45A \quad I_3 = 0.99A$

	8Ω	6Ω	12Ω	7Ω	10Ω	16Ω
Voltage across element	3.7	0.05	5.4	3.7	5.2	15.9
Current across element	0.46	0.1	0.45	0.53	0.53	0.994

8(a) Derive the emf equation of simplex wave wound DC generator. 4M

As the armature rotates, a voltage is generated in its coils. In the case of a generator, the emf of rotation is called the Generated emf or Armature emf and is denoted as Er = Eg. In the case of a motor, the emf of rotation is known as Back emf or Counter emf and represented as Er = Eb. The expression for emf is same for both the operations, i.e., for Generator as well as for Motor.
Derivation of EMF Equation of a DC Machine – Generator and Motor
Let,

- P – number of poles of the machine
- ϕ – Flux per pole in Weber.
- Z – Total number of armature conductors.
- N – Speed of armature in revolution per minute (r.p.m).
- A – number of parallel paths in the armature winding.

In one revolution of the armature, the flux cut by one conductor is given as:

$$\text{Flux cut by one conductor} = P\varphi \quad \text{wb} \ldots\ldots (1)$$

Time taken to complete one revolution is given as:

$$t = \frac{60}{N} \quad \text{seconds} \quad \ldots\ldots (2)$$

Therefore, the average induced e.m.f in one conductor will be:

$$e = \frac{P\varphi}{t} \quad \ldots\ldots (3)$$

Putting the value of (t) from Equation (2) in the equation (3) we will get

$$e = \frac{P\varphi}{60/N} = \frac{P\varphi N}{60} \quad \text{volts} \quad \ldots\ldots (4)$$

The number of conductors connected in series in each parallel path = Z/A.

Therefore, the average induced e.m.f across each parallel path or the armature terminals is given by the equation shown below:

$$E = \frac{P\varphi N}{60} \times \frac{Z}{A} = \frac{PZ\varphi N}{60\,A} \text{ volts} \quad \text{or}$$

$$E = \frac{PZ\varphi n}{A} \ldots\ldots(5)$$

Where n is the speed in revolution per second (r.p.s) and given as:

$$n = \frac{N}{60}$$

For a given machine, the number of poles and the number of conductors per parallel path (Z/A) are constant. Hence, equation (5) can be written as:

$$E = K\varphi n$$

Where K is a constant and given as:

$$K = \frac{PZ}{A}$$

Therefore, the average induced emf equation can also be written as:

$$E \propto \varphi n \quad \text{or}$$

$$E = K_1 \varphi N$$

Where K1 is another constant and hence induced emf equation can be written as:

$$E \propto \varphi N \quad \text{or}$$

$$E \propto \varphi\omega$$

Where ω is the angular velocity in radians/second is represented as:

$$\omega = \frac{2\pi N}{60}$$

Thus, it is clear that the induced emf is directly proportional to the speed and flux per pole. The polarity of induced emf depends upon the direction of the magnetic field and the direction of rotation. If either of the two is reversed the polarity changes, but if two are reversed the polarity remains unchanged.

This induced emf is a fundamental phenomenon for all the DC Machines whether they are working as a generator or motor.

If the DC Machine is working as a Generator, the induced emf is given by the equation shown below:

$$E_g = \frac{PZ\,\varphi\,N}{60\,A} \quad \text{volts}$$

Where Eg is the **Generated Emf**

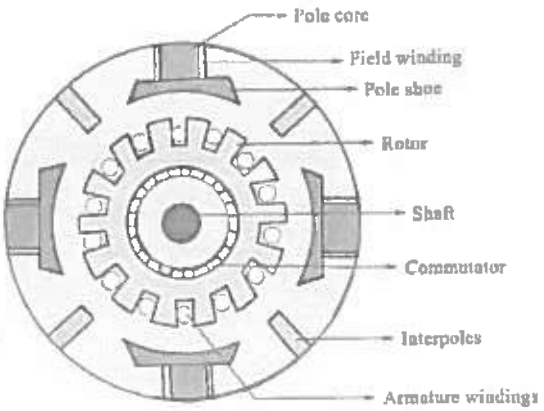
If the DC Machine is working as a Motor, the induced emf is given by the equation shown below:

$$E_b = \frac{PZ\,\varphi\,N}{60\,A} \quad \text{volts}$$

8(b) Explain the construction of a DC generator. 8M

Working Principle of DC Generator:
A DC generator operates on the principle of Faraday's laws of electromagnetic induction. According to Faraday's law, whenever a conductor is placed in a fluctuating magnetic field (or when a conductor is moved in a magnetic field) an EMF is induced in the conductor.
If the conductor is guided with a closed path, the current will get induced in the conductor. The direction of the induced current (given by Fleming's right-hand rule) changes as the direction of movement of the conductor changes.

Construction of DC Generator
A DC generator is also used as a DC motor without changing its construction. Therefore, a DC motor otherwise a DC generator can be generally called a DC machine. The construction of a 4-pole DC generator is discussed here
This generator comprises of several parts like yoke, poles & pole shoes, field winding, an armature core, armature winding, commutator & brushes. But the two essential parts of this device are the stator as well as the rotor.
The DC machine consists of two parts: One part is rotating, called rotor and the other part is stationary, called stator.



The major components of a DC machine are:

- Magnetic frame or yoke
- Pole core and pole shoe
- Field coil or winding
- Armature core and winding
- Commutator
- Brushes
- Bearings and shaft

1. Magnetic Frame or yoke

It is the stationary part of the machine in the shape of hollow cylinder. Poles are fixed at the inner periphery of the yoke.

It acts as the outer cover or frame for the entire machine and serves two main purposes: It is used to carry the magnetic flux produced by the poles. It acts as mechanical support for the machine.

Yoke is usually made of cast iron for small machine, because of its cheapness. But for large machines, it is made of cast steel or rolled steel, due to its high permeability.

The lifting eye, feet and the terminal box are welded to the frame afterwards.

2. Pole core and pole shoe

The field pole consists of pole cores, pole shoes and field winding. The poles are made of thin laminated sheets, to avoid heating and eddy current loss.

Pole cores are the projecting rectangular parts, which produce magnetic flux needed for the generator, when it is excited by the field winding. It is fitted to the yoke or frame by means of bolts and nuts or rivets.

The pole shoes are located at the end of pole core. The purpose of providing pole shoe in the poles is to make the magnetic field uniform on the surface of the armature.

Since the poles project inwards they are called as salient poles. Each pole as a pole shoe having a curved surface.

Following are the main function of the poles

it acts as a mechanical support to the field coil.

they reduce the reluctance of the magnetic path.

they guide and spread out the flux in the air gap

3. Field coil or winding

Field coil is made up of copper. They are mounted on the pole core and carry the dc current. The field coils are connected in such a way that adjacent poles have opposite polarity.

When the coils carry dc current, the pole core become an electromagnet and produces the magnetic flux. The magnetic flux passes through the pole core, the air gap, the armature and the yoke.

The number of poles in a DC Generator depends on the speed of the machine and the output for which the machine is designed.

There are several field constructions are adopted according to the type of excitation. In shunt field, more number of turns with small cross sectional are used, in series field only a few turns of large cross sectional area are used and in compound field, both shunt and series field winding are used.

4. Armature core and winding

In the construction of DC generator, armature core is designed as the rotating part and is built in cylindrical or drum shape with slots on its outer periphery. The purpose of armature is to house the winding and to rotate the conductors in the uniform magnetic field. It is mounted on the shaft.

It is build up of steel lamination which are insulated by each other by thin paper or thin coating of varnish as insulation. The thickness of each lamination is about 0.5 mm. These lamination will reduce the eddy current loss. If silicon sheet is used for armature core, the hysteresis loss will also reduce.

Due to losses, heat will be developed in the armature. To dissipate this heat, a fan is provided at one end of armature. Ventilating ducts (air holes) are also provided in the armature for the purpose of cooling. The width of the ventilating ducts varies from 5 to 10 mm.

The armature winding or coil is placed on slots available on the armature's outer periphery. The ends of the coils are joined with commutator segments. Insulated higher conductivity copper wire is used for making the coils. There are two types of winding.

lap winding – Lap winding is used for high current, low voltage generators.

Wave winding – Wave winding is used for high voltage, low current generators.

5. Commutator

The commutator provides the electrical connection between the rotating armature coil and the stationary external circuit. It is essentially a cylindrical structure and is built up of wedge shaped copper segments insulated from each other by mica sheets and mounted on the shaft of the machine.

The commutator is a mechanical rectifier which converts the alternating emf generator in the armature winding into direct voltage across the brushes. The ends of the armature coil or winding are connected to commutator segments.

Great care is to be taken while building the commutator because even slight eccentricity will cause the brushes to bounce, which can cause high sparking.

6. Brushes

The function of brush is to collect the current from the commutator and supply it to the external load circuit. The brushes are manufactured in a variety of compositions to suit the commutation requirements. It is made of carbon, graphite metal graphite or copper and is rectangular in shape.

The brushes are placed in the brush holders which is mounted on rocker arm. The brushes are arranged in rocker arm in such a way that, it touches the commutator.

Brush pressure is adjusted by means of adjustable springs. If the bush pressure is high, the friction produces heating of the commutator and the brushes. If the pressure is too weak, the imperfect contact with the commutator may produce spark.

7. Bearings and Shaft

For construction of smaller DC generator, ball bearings are used at both the ends of the shaft but for larger machines, roller bearings are used at the driving end and ball bearings are used at the non driving end of the machine.

The shaft is made up of mild steel having maximum breaking strength. It is used to transfer the mechanical power from or to the machine. All the rotating parts including the armature core, commutator, cooling parts and mounted and keyed to the shaft.

OR

9(a) Derive the torque equation of a DC Motor. 8M

TORQUE ON DC MOTOR:

When a DC machine is loaded, either as m or G, rotor conductors carry current. These lie in MF of air gap. Thus each conductor experiences a force. As these lie near the surface of the rotor, a torque is produced around circumference & rotor starts rotating.

$$V = E + I_a R_a$$

$\times^{ly}$ by I_a

$$V I_a = E I_a + I_a^2 R_a \longrightarrow \text{copper loss}$$

electrical power i/p — electrical equivalent of gross mechanical power

input = output + losses

mechanical power developed

$$\Rightarrow P_m = \omega T_{av} = 2\pi n T_{av}$$

T_{av} = avg. electromagnetic torque developed by armature

So, $E I_a = P_m = 2\pi n T_{av}$

but $E = \frac{\phi Z N}{60} \cdot \frac{P}{A}$ $\quad n = \frac{N}{60}$

$$= \phi Z n \cdot \frac{P}{A}$$

$$\Rightarrow \frac{n\phi Z}{A} i_a = 2\pi n T_{av}$$

$$T_{av} = \frac{PZ\phi}{2\pi A} \cdot i_a$$

$$\because \frac{PZ}{2\pi A} \text{ are constant}$$

$$= \frac{PZ\phi}{2\pi A} = k$$

$$T_{av} = k\phi I_a$$

$$\boxed{T_{av} \propto \phi I_a}$$

9(b) A DC shunt machine develops an A.C. emf. of 250V, at 1500 rpm. Find it's torque and mechanical power developed for an armature current of 50A. 4M

$$\omega = \frac{2 \times \pi \times 1500}{60}$$

= 157.08 radians/sec.

Power = generated emf × armature current

= 250 × 50

= 12500 watts.

Torque = power/speed.

$$= \frac{12500}{157.08}$$

= **79.577 Nm.**

10(a) What are the merits and demerits of induction motor? 6

A. The most important advantage of an induction motor is that its construction is quite simple in nature. The construction of the Stator is similar in both Synchronous motors as well as induction motors. However, a slip ring is required to feed DC Supply to the Rotor in the case of a Synchronous Generator. These Slip rings are not required in a Squirrel cage induction motor because the windings are permanently short circuited. When compared with a DC Motor, the induction motor does not have Brushes and hence, maintenance required is quite low. This leads to a simple construction.
B. The working of the motor is independent of the environmental condition. This is because the induction motor is Robust and mechanically strong.
C. A Squirrel cage induction motor does not contain Brushes, Slip rings and Commutators. Due to this reason, the cost of the motor is quite low. However, Slip Rings are used in Wound type induction motor to add external resistance to the rotor winding.
D. Due to the absence of Brushes, there are no sparks in the motor. It can also be operated in hazardous conditions.
E. Unlike synchronous motors, a 3 phase induction motor has a high starting torque, good speed regulation and reasonable overload capacity.

10(b) A 3-phase, 60 Hz induction motor has 2 poles. If the slip is 2% at a certain load, determine: 6
i) The synchronous speed ii) The speed of the rotor and iii) The frequency of the induced e.m.f.'s in the rotor.

(a) $f = 60\ Hz$ and $p = (2/2) = 1$ Hence **synchronous speed**, $n_s = (f/p) = (60/1) = 60$ rev/s or $60 \times 60 = 3600$ rev/min.

(b) Since slip,

$$s = \left(\frac{n_s - n_r}{n_s}\right) \times 100\%$$

$$2 = \left(\frac{60 - n_r}{60}\right) \times 100$$

Hence

$$\frac{2 \times 60}{100} = 60 - n_r$$

i.e.

$$n_r = 60 - \frac{2 \times 60}{100} = 58.8 \text{ rev/s}$$

i.e. the rotor runs at $58.8 \times 60 = 3528$ rev/min

(c) Since the synchronous speed is 60 rev/s and that of the rotor is 58.8 rev/s, the rotating magnetic field cuts the rotor bars at $(60 - 58.8) = 1.2$ rev/s.

Thus the frequency of the e.m.f.'s induced in the rotor bars is 1.2 Hz.

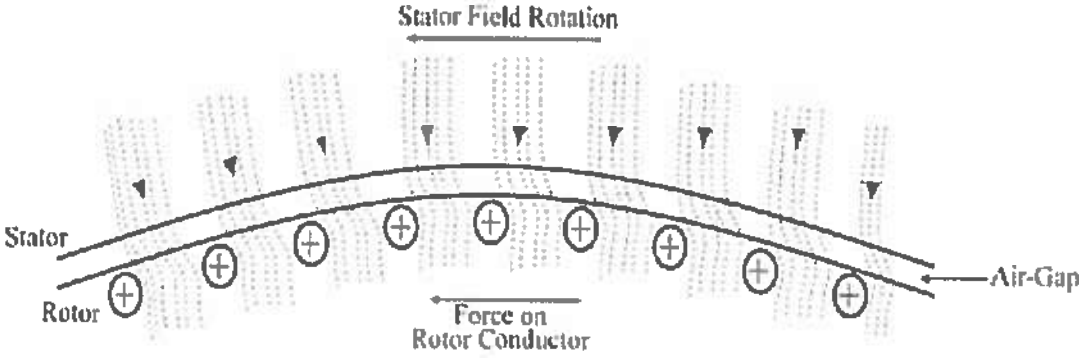
OR

11(a) Explain the working principle of 3- Φ induction motor.

- A three phase induction motor has a stator and a rotor. The stator carries a 3-phase winding called as stator winding while the rotor carries a short circuited winding called as rotor

winding. The stator winding is fed from 3-phase supply and the rotor winding derives its voltage and power from the stator winding through electromagnetic induction. Therefore, the working principle of a 3-phase induction motor is fundamentally based on electromagnetic induction.

- Consider a portion of a three phase induction motor (see the figure). Therefore, the working of a three phase induction motor can be explained as follows



- When the stator winding is connected to a balanced three phase supply, a rotating magnetic field (RMF) is setup which rotates around the stator at synchronous speed (N_s). Where,

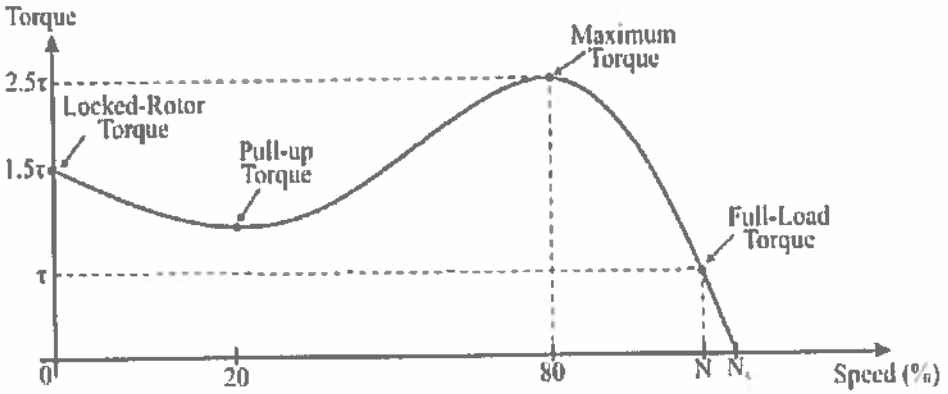
$Ns = 120f/P$

- The RMF passes through air gap and cuts the rotor conductors, which are stationary at start. Due to relative motion between RMF and the stationary rotor, an EMF is induced in the rotor conductors. Since the rotor circuit is short-circuited, a current starts flowing in the rotor conductors.
- Now, the current carrying rotor conductors are in a magnetic field created by the stator. As a result of this, mechanical force acts on the rotor conductors. The sum of mechanical forces on all the rotor conductors produces a torque which tries to move the rotor in the same direction as the RMF.
- Hence, the induction motor starts to rotate. From, the above discussion, it can be seen that the three phase induction motor is self-starting motor.
- The three induction motor accelerates till the speed reached to a speed just below the synchronous speed.

11(b) Explain Speed-Torque Characteristics of 3- Φ induction Motor with neat sketches. 6M

The torque-speed characteristics of a 3-phase induction motor is defined as the curve plotted between torque developed and rotational speed of the motor. It gives the information about variation in the motor torque with the change in its speed.

As the torque of three-phase induction depends upon its speed but the relationship between them cannot be expressed by a simple equation. Therefore, we use the torque-speed curve to express the relationship between them.



- If the full-load torque is τ, then the starting torque or locked rotor torque is 1.5 times of τ and the maximum torque (also known as breakdown torque) is 2.5 times of τ.
- The full load speed of the motor is N. If the mechanical load on the shaft is increased, the motor speed will decrease until the electromagnetic torque (or motor torque) is again equal to the load torque. As soon as the two torques are equal, the motor will run at a constant speed but lower than the previous speed. Although, if the torque exceeds the breakdown torque (2.5τ), the will suddenly stop.
- The torque-speed characteristics of a three-phase induction motor is a straight line between the no-load and full-load operating points. The slope of the curve line depends upon the resistance of the rotor circuit i.e. the higher the rotor circuit resistance, the sharper the slope of the curve.
- The small three-phase induction motors (below 10 kW rating) develop their maximum torque at a speed about 80% of synchronous speed whereas large motors (more than 1000 kW rating) develop their maximum torque at a speed about 98% of synchronous speed.

12(a) Derive an expression for emf induced in a transformer secondary winding if V_1 volts applied across its primary winding. 4

Let,
N_1 = Number of turns in primary winding
N_2 = Number of turns in secondary winding
Φ_m = Maximum flux in the core (in Wb) = (B_m x A)
f = frequency of the AC supply (in Hz)

As, shown in the fig., the flux rises sinusoidally to its maximum value Φ_m from 0. It reaches to the maximum value in one quarter of the cycle i.e in T/4 sec (where, T is time period of the sin wave of the supply = 1/f).
Therefore,
average rate of change of flux = $\Phi_m / (T/4)$ = $\Phi_m / (1/4f)$
Therefore,
average rate of change of flux = $4f\ \Phi_m$ ..... (Wb/s).
Now,
Induced emf per turn = rate of change of flux per turn

Therefore, average emf per turn = $4f\ \Phi_m$ .....(Volts).
Now, we know, Form factor = RMS value / average value
Therefore, RMS value of emf per turn = Form factor X average emf per turn.

As, the flux Φ varies sinusoidally, form factor of a sine wave is 1.11

Therefore, RMS value of emf per turn = 1.11 x $4f\ \Phi_m$ = $4.44f\ \Phi_m$.

RMS value of induced emf in whole primary winding (E_1) = RMS value of emf per turn X Number of turns in primary winding

$$E_1 = 4.44f N_1 \Phi_m \quad \text{..... eq 1}$$

Similarly, RMS induced emf in secondary winding (E_2) can be given as

$$E_2 = 4.44f N_2 \Phi_m. \quad \text{..... eq 2}$$

from the above equations 1 and 2,

$$\frac{E_1}{N_1} = \frac{E_2}{N_2} = 4.44f\,\Phi m$$

This is called the **emf equation of transformer**, which shows, emf / number of turns is same for both primary and secondary winding.

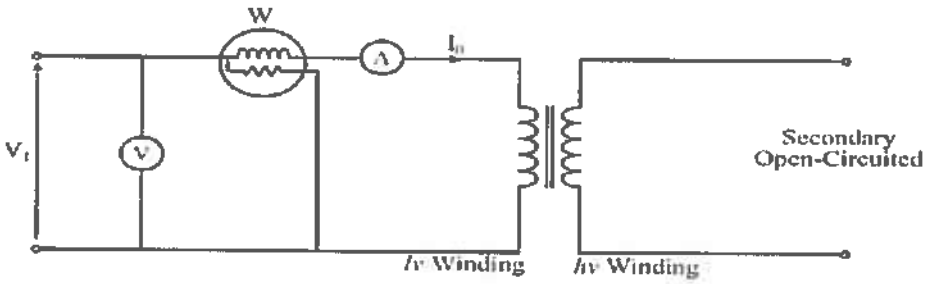
For an ideal transformer on no load, $E_1 = V_1$ and $E_2 = V_2$.
where, V_1 = supply voltage of primary winding
V_2 = terminal voltage of secondary winding

12(b) Explain open circuit and short circuit test on a transformer. 8M

The open circuit and short circuit test are performed for determining the parameter of the transformer like their efficiency, voltage regulation, circuit constant etc. These tests are performed without the actual loading and because of this reason the very less power is required for the test. The open circuit and the short circuit test gives a very **accurate result** as compared to the full load test.

Open Circuit Test

The purpose of the open-circuit test is to determine the no-load current and losses of the transformer because of which their no-load parameters are determined. This test is performed on the primary winding of the transformer. The wattmeter, ammeter and the voltage are connected to their primary winding. The nominal rated voltage is supplied to their primary winding with the help of the ac source.



Circuit Diagram of Open Circuit Test on Transformer

The secondary winding of the transformer is kept open, and the voltmeter is connected to their terminal. This voltmeter measures the **secondary induced voltage**. As the secondary of the transformer is open, thus no-load current flows through the primary winding.

The value of no-load current is very small as compared to the full rated current. The copper loss occurs only on the primary winding of the transformer because the secondary winding is open. The reading of the wattmeter only represents the core and iron losses. The core loss of the transformer is the same for all types of loads.

Calculation of open-circuit test

Let,

- W_0 – wattmeter reading
- V_1 – voltmeter reading

- I_0 – ammeter reading

Then the iron loss of the transformer $P_i = W_0$ and

$$W_0 = V_1 I_0 \cos\varphi_0 \quad \ldots\ldots\ldots\ldots(1)$$

The no-load power factor is

$$\cos\varphi_0 = \frac{W_0}{V_1 I_0}$$

Working component I_w is

$$I_w = \frac{W_0}{V_1} \ldots\ldots\ldots\ldots(2)$$

Putting the value of W_0 from the equation (1) in equation (2) you will get the value of the working component as

$$I_w = I_0 \cos\varphi_0$$

Magnetizing component is

$$I_m = \sqrt{I_0^2 - I_w^2}$$

No-load parameters are given below:

Equivalent exciting resistance is

$$R_0 = \frac{V_1}{I_w}$$

Equivalent exciting reactance is

$$X_0 = \frac{V_1}{I_m}$$

Short Circuit Test

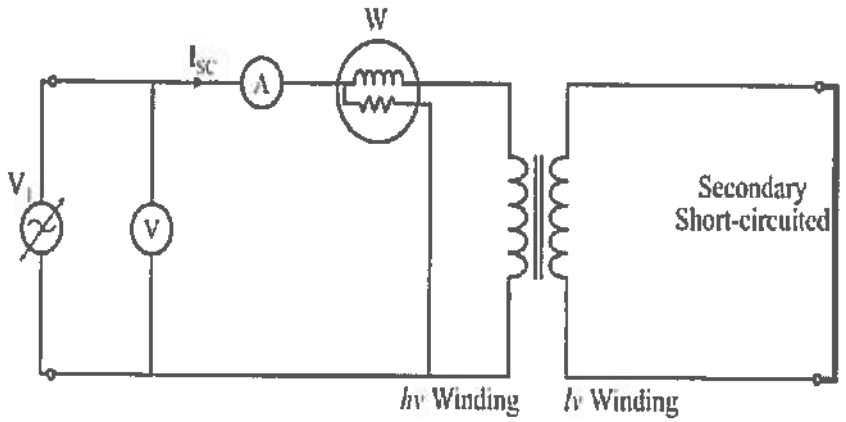
The short circuit test is performed for determining the below mention parameter of the transformer.

- It determines the copper loss occur on the full load. The copper loss is used for finding the efficiency of the transformer.
- The equivalent resistance, impedance, and leakage reactance are known by the short circuit test.

The short circuit test is performed on the secondary or high voltage winding of the transformer. The measuring instrument like wattmeter, voltmeter and ammeter are connected to the high voltage winding of the transformer. Their primary winding is short-circuited by the help of thick strip or ammeter which is connected to its terminal.

The low voltage source is connected across the secondary winding because of which the full load current flows from both the secondary and the primary winding of the transformer. The full load current is measured by the ammeter connected across their secondary winding.

The circuit diagram of the short circuit test is shown below:



The low voltage source is applied across the secondary winding, which is approximately 5 to 10% of the normal rated voltage. The flux is set up in the core of the transformer. The magnitude of the flux is small as compared to the normal flux.

The iron loss of the transformer depends on the flux. It is less occur in the short circuit test because of the low value of flux. The reading of the wattmeter only determines the copper loss occurred, in their windings. The voltmeter measures the voltage applied to their high voltage winding. The secondary current induces in the transformer because of the applied voltage.

Calculation of Short Circuit Test

Let,

- W_c – Wattmeter reading
- V_{2sc} – voltmeter reading
- I_{2sc} – ammeter reading

Then the full load copper loss of the transformer is given by

$$P_c = \left(\frac{I_{2fl}}{I_{2sc}}\right)^2 W_c \qquad \text{And} \qquad I_{2sc}^2 R_{es} = W_c$$

Equivalent resistance referred to the secondary side is

$$R_{es} = \frac{W_c}{I_{2sc}^2}$$

Equivalent impedance referred to the secondary side is given by

$$Z_{es} = \frac{V_{2sc}}{I_{2sc}}$$

The equivalent reactance referred to the secondary side is given by

$$X_{es} = \sqrt{(Z_{es})^2 - (R_{es})^2}$$

The voltage regulation of the transformer can be determined at any load and power factor after knowing the values of Z_{es} and R_{es}.

In the short circuit test the wattmeter record, the total losses, including core loss but the value of core loss are very small as compared to copper loss so the core loss can be neglected.

OR

13 Explain the construction of 1-Φ transformer. 12

Construction of Single Phase Transformer

A single phase transformer consists of two windings viz. primary winding and secondary winding put on a magnetic core. The magnetic core is made from thin sheets (called laminations) of high graded silicon steel and provides a definite path to the magnetic flux. These laminations reduce the eddy-current losses while the silicon steel reduces the hysteresis losses.

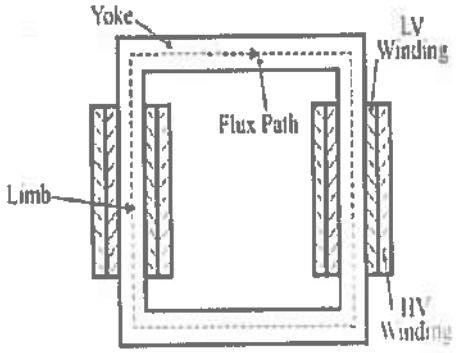
The laminations are insulated from each other by enamel insulation coating. The thin laminations are stacked together to form the core of the transformer. The air-gap between the laminations should be minimum so that the excitation current being minimum.

For a single phase transformer, there are two types of transformer constructions viz. the core type and the shell type.

Core Type Transformer Construction

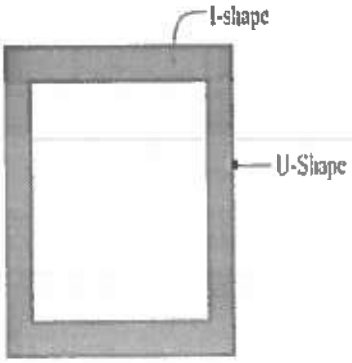
In core type construction of the transformer, the magnetic circuit consists of two vertical lags (called limbs) and two horizontal sections called yokes. To minimise the effect of leakage flux, half of each winding is placed on each limb (see the figure).

The low-voltage winding is placed next to the core while the high-voltage winding over the low-voltage winding to reduce the insulation requirements. Therefore the two windings are arranged as concentric coils and known as cylindrical winding.



Core Type Construction

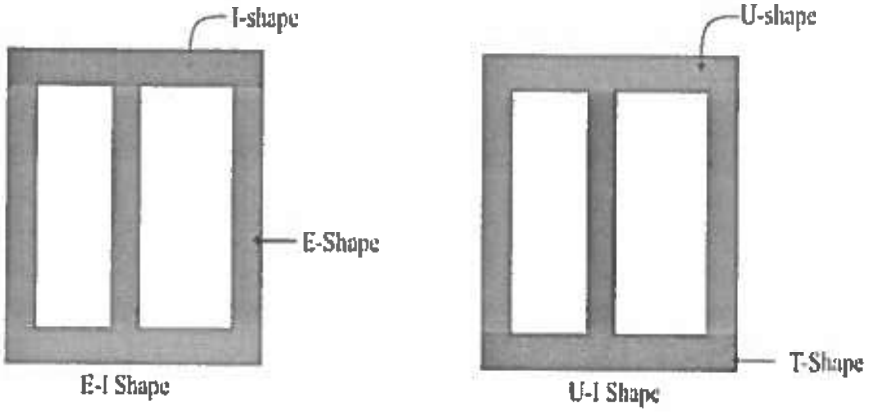
The laminations of the core type transformer are of U-I shape as shown in the figure.



Shell Type Transformer Construction

In the shell type construction of transformer, the magnetic circuit consists of three limbs, both the primary and secondary windings are placed on the central limb and the two outer limbs complete the low reluctance flux path. The each winding is sub-divided into sections viz. the low voltage (LV) section and the high-voltage (HV) section, which are alternatively put one over the other in the form of sandwich (see the figure). Therefore, such windings are called sandwich winding or disc winding

The core of the shell type transformer is made up either U-T shape or E-I shape (see the figure).



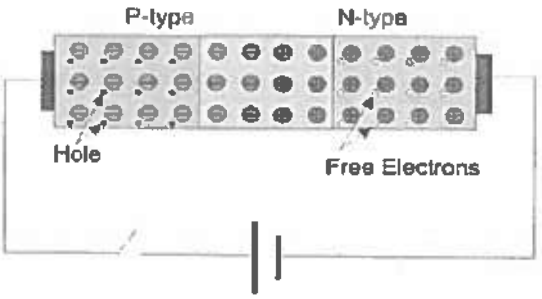
14 Explain the working of p-n junction diode both in forward and reverse biases conditions. 12

P-N JUNCTION DIODE:

A simple PN junction diode can be created by doping donor impurity in one portion and acceptor impurity in other portion of a silicon or germanium crystal block. These make a p n junction at the middle portion of the block beside which one portion is p type (which is doped by trivalent or acceptor impurity) and other portion is n type (which is doped by pentavalent or donor impurity). It can also be formed by joining a p-type (intrinsic semiconductor doped with a trivalent impurity) and n-type semiconductor (intrinsic semiconductor doped with a pentavalent impurity) together with a special fabrication technique such that a p-n junction is formed.

A. Working Principle of Diode:

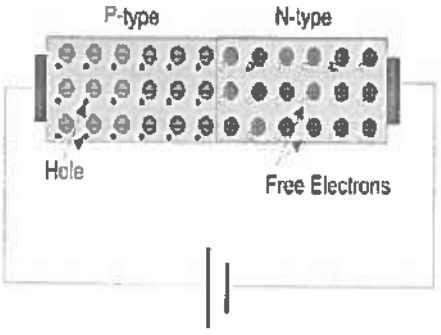
The n side will have a large number of electrons and very few holes (due to thermal excitation) whereas the p side will have a high concentration of holes and very few electrons. Due to this, a process called diffusion takes place. In this process free electrons from the n side will diffuse (spread) into the p side and combine with holes present there, leaving a positive immobile (not moveable) ion in the n side. Hence, few atoms on the p side are converted into negative ions. Similarly, few atoms on the n-side will get converted to positive ions. Due to this large number of positive ions and negative ions will accumulate on the n-side and p-side respectively. This region so formed is called as depletion region. Due to the presence of these positive and negative ions a static electric field called as "barrier potential" is created across the p-n junction of the diode.



B. Forward Bias Condition:

In a PN junction diode when the forward voltage is applied i.e. positive terminal of a source is connected to the p-type side, and the negative terminal of the source is connected to the n-type side, the diode is said to be in forward biased condition.

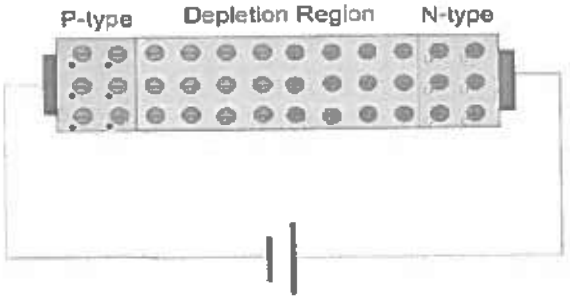
We know that there is a barrier potential across the junction. This barrier potential is directed in the opposite of the forward applied voltage. So a diode can only allow current to flow in the forward direction when forward applied voltage is more than barrier potential of the junction. This voltage is called forward biased voltage. (For silicon diode, it is 0.7 volts. For germanium diode, it is 0.3 volts). When forward applied voltage is more than this forward biased voltage, there will be forward current in the diode, and the diode will become short circuited. Hence, there will be no more voltage drop across the diode beyond this forward



biased voltage, and forward current is only limited by the external resistance">resistance connected in series with the diode. Thus, if forward applied voltage increases from zero, the diode will start conducting only after this voltage reaches just above the barrier potential or forward biased voltage of the junction. The time taken by this input voltage to reach that value or in other words the time taken by this input voltage to overcome the forward biased voltage is called recovery time.

C. Reverse Bias Characteristics:

Now if the diode is reverse biased i.e. positive terminal of the source is connected to the n-type end, and the negative terminal of the source is connected to the p-type end of the diode, there will be no current through the diode except reverse saturation current. This is because at the reverse biased condition the depilation layer of the junction becomes wider with increasing reverse biased voltage. Although there is a tiny current flowing from n-type end to p-type end in the diode due to minority carriers. This tiny current is called reverse saturation current. Minority carriers are mainly thermally generated electrons and holes in p-type semiconductor and n-type semiconductor respectively. Now if reverse applied voltage across the diode is continually increased, then after certain applied voltage the depletion layer will destroy which will cause a huge reverse current to flow through the diode. If this current is not externally limited and it reaches beyond the safe value, the diode may be permanently destroyed. This is because, as the magnitude of the reverse voltage increases, the kinetic energy of the minority charge carriers also increase. These fast moving electrons collide with the other atoms in the device to knock-off some more electrons from them. The electrons so released further release much more electrons from the atoms by breaking the covalent bonds. This process is termed as carrier multiplication and leads to a considerable increase in the flow of current through the p-n junction. The associated phenomenon is called Avalanche Breakdown.



D. Characteristics Of P-N Junction:

The volt-ampere characteristics of a diode explained by the following equations:

$$I = I_S(e^{V_D/(\eta V_T)} - 1)$$

Where

I = current flowing in the diode, I0 = reverse saturation current

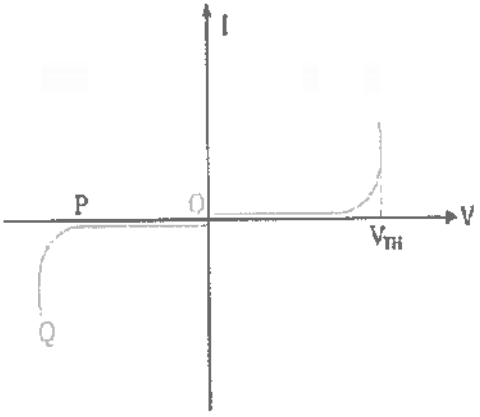
V_D = Voltage applied to the diode

V_T = volt- equivalent of temperature = k T/q = T/ 11,600 = 26mV (@ room temp)

η = 1(for Ge) and 2 (for Si)

It is observed that Ge diodes has smaller cut-in-voltage when compared to Si diode. The reverse saturation current in Ge diode is larger in magnitude when compared to silicon diode.

When, V is positive the junction is forward biased and when V is negative, the junction is reversing biased. When V is negative and less than VTH, the current is very small. But when V exceeds VTH, the current suddenly becomes very high. The voltage VTH is known as threshold or cut in voltage. For Silicon diode VTH = 0.6 V. At a reverse voltage corresponding to the point P, there is abrupt increment in reverse current. The PQ portion of the characteristics is known as breakdown region.

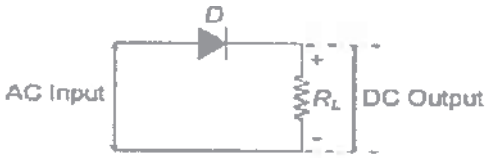


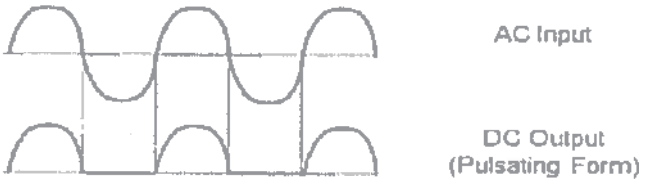
OR

15(a) Draw the circuit diagram of half wave rectifier and explain its operation. 8M

HALF WAVE RECTIFIERS:

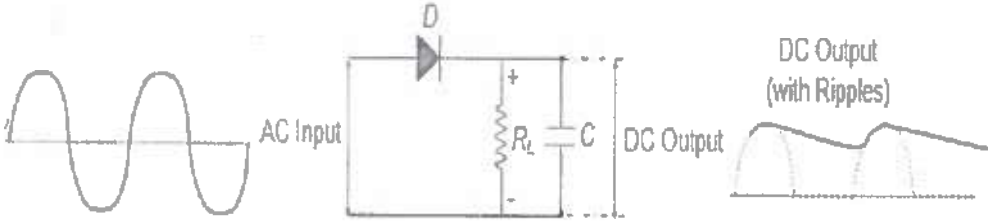
Rectifiers are the circuits used to convert alternating current (AC) into direct current (DC). Half-Wave Rectifiers are designed using a diode (D) and a load resistor (RL) as shown in Figure. In these rectifiers, only one-half of the input waveform is obtained at the output i.e. the output will comprise of either positive pulses or the negative pulses only. The polarity of the output voltage so obtained (across R_L) depends on the direction of the diode used in the circuit of half-wave rectifier.



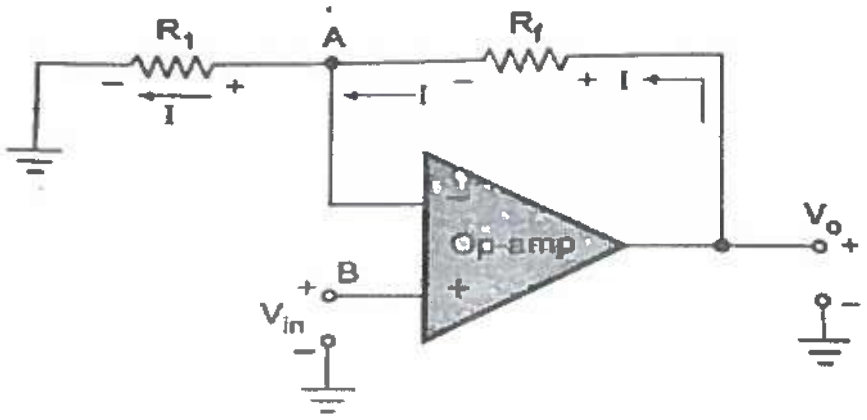


Further for the same case, if the input pulse becomes negative, then the diode will be reverse biased and hence there will be no current flow and no output voltage.

Next, one can connect a capacitor across the resistor in the circuit of half wave rectifier to obtain a smoother DC output. Here the capacitor charges through the diode D during the positive pulse of the input while it discharges through the load resistor RL when the input pulse will be negative. Thus the output waveform of such a rectifier



15(b) Draw the circuit diagram of non-inverting amplifier and derive the expression for its output voltage 4M



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Expression for output voltage

$V_A = V_B = V_{in}$

from o/p side

$$I = \frac{V_o - V_A}{R_f}$$

$$I = \frac{V_o - V_{in}}{R_f}$$

from i/p side

$$I = \frac{V_A - 0}{R_1}$$

$$I = \frac{V_{in}}{R_1}$$

$$\frac{V_o - V_{in}}{R_f} = \frac{V_{in}}{R_1}$$

$$\frac{V_o}{R_f} = \frac{V_{in}}{R_1} + \frac{V_{in}}{R_f}$$

$$\frac{V_o}{R_f} = V_{in}\left[\frac{(R_1 + R_f)}{R_1 R_f}\right]$$

$$A_f = \frac{V_o}{V_{in}} = 1 + \frac{R_f}{R_1}$$

NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	EEE			Academic Year	2021- 2022
Course Code	20CS403	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	PYTHON PROGRAMMING						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	How variables are used in Python?	20CS403.1	L1
2	What is the use of Pass statement?	20CS403.2	L1
3	How the functions declared in the Python?	20CS403.3	L1
4	Define constructors in python	20CS403.4	L1
5	What is Graphical user Interface?	20CS403.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	How the Program Development Cycle used in Python?	4M	20CS403.1	L1
6 (b)	Explain the arithmetic and Relational operators used in the Python Programming.	8M	20CS403.1	L2
	OR			
7 (a)	Discuss about Type Conversions and Expressions.	8M	20CS403.1	L2
7 (b)	Write a Python program to convert centigrade to Fahrenheit.	4M	20CS403.1	L3
8 (a)	Describe Python Break and Continue statements with examples.	6M	20CS403.2	L2
8 (b)	Write a Python program to find the given number is Armstrong Number.	6M	20CS403.2	L3
	OR			
9 (a)	Explain about Strings and Number Systems in python.	4M	20CS403.2	L2
9 (b)	Discuss about List and Tuples in Python	8M	20CS403.2	L2
10 (a)	Explain about Functions as Abstraction Mechanisms.	6M	20CS403.3	L2
10 (b)	Define Function? Explain the Problem Solving with Top - Down Design	6M	20CS403.3	L2
	OR			
11 (a)	Discuss in detail about the modules and explain any 4 modules and their functions.	8M	20CS403.3	L2
11 (b)	Explain installing packages via PIP.	4M	20CS403.3	L2
12 (a)	Write a Python Program on Multi-Level Inheritance.	8M	20CS403.4	L2
12 (b)	Write a Python Program on Composition. Compare Composition with Inheritance.	4M	20CS403.4	L3
	OR			
13	Define file. Explain the file operations with an example program.	12M	20CS403.4	L3
14 (a)	Compare the Behavior of Terminal Based Programs and GUI - Based Programs.	4M	20CS403.5	L2
14 (b)	Explain the different methods of creating GUI with Python.	8M	20CS403.5	L2
	OR			
15	Explain the following Mathematical Libraries: NumPy, matplotlib , Sympy, Pandas.	12M	20CS403.5	L2

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SCHEME OF VALUATION
&
ANSWER KEY
PYTHON PROGRAMMING

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	How variables are used in Python? **2M**	20CS403.1	L1

Python Variable is containers which store values. Python is not "statically typed". We do not need to declare variables before using them or declare their type. A variable is created the moment we first assign a value to it. A Python variable is a name given to a memory location. It is the basic unit of storage in a program.
EXAMPLE:

```
Var = "NSRIT"
print(Var)
```

2 What is the use of Pass statement? **2M** — 20CS403.2 — **L1**

pass is used when the user doesn't want any code to execute. So user can simply place pass where empty code is not allowed, like in loops, function definitions, class definitions, or in if statements. So using pass statement user avoids this error..
Example
Using the pass keyword in a function definition:

```
def myfunction():
  pass
```

3 How the functions declared in the Python? **2m** — 20CS403.3 — **L1**

A function is a block of code which only runs when it is called.
In Python a function is defined using the def keyword:
Example

```
def my_function():
  print("Hello from a function")
```

4 Define constructors in python? **2m** — 20CS403.4 — **L1**

Constructors are generally used for instantiating an object. The task of constructors is to initialize(assign values) to the data members of the class when an object of the class is created. In Python the __init__() method is called the constructor and is always called when an object is created.
Syntax of constructor declaration :

```
def __init__(self):

    # body of the constructor
```

20CS403.5 — **L1**

5 What is Graphical user Interface? 2m

A graphical user interface is an application that has buttons, windows, and lots of other widgets that the user can use to interact with your application. A good example would be a web browser. It has buttons, tabs, and a main window where all the content loads.

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Learning Outcome (s)	DoK
6 (a)	How the Program Development Cycle used in Python? 4m	20CS403.1	L3

Generally, the program development life cycle contains 6 phases, they are as follows....

- Problem Definition
- Problem Analysis
- Algorithm Development
- Coding & Documentation
- Testing & Debugging
- Maintenance

6 (b) Explain the arithmetic and Relational operators used in the Python Programming **8M Arithmetic operator =4M Relational operator =4m** 20CS403.1 L2

Arithmetic operators

Arithmetic operators are used to perform mathematical operations like addition, subtraction, multiplication, etc.

Operator	Meaning	Example
+	Add two operands or unary plus	x + y+ 2
-	Subtract right operand from the left or unary minus	x - y- 2
*	Multiply two operands	x * y
/	Divide left operand by the right one (always results into float)	x / y
%	Modulus - remainder of the division of left operand by the right	x % y (remainder of x/y)
//	Floor division - division that results into whole number adjusted to the left in the number line	x // y
**	Exponent - left operand raised to the power of right	x**y (x to the power y)

```
// Arithmetic operators in Python
x = 15
y = 4
# Output: x + y = 19
print('x + y =',x+y)

# Output: x - y = 11
```

```
print('x - y =',x-y)

# Output: x * y = 60
print('x * y =',x*y)

# Output: x / y = 3.75
print('x / y =',x/y)

# Output: x // y = 3
print('x // y =',x//y)

# Output: x ** y = 50625
print('x ** y =',x**y)
```

Run Code

Output

```
x + y = 19
x - y = 11
x * y = 60
x / y = 3.75
x // y = 3
x ** y = 50625
```

Comparison operators

Comparison operators are used to compare values. It returns either True or False according to the condition.

Operator	Meaning	Example
>	Greater than - True if left operand is greater than the right	x > y
<	Less than - True if left operand is less than the right	x < y
==	Equal to - True if both operands are equal	x == y
!=	Not equal to - True if operands are not equal	x != y
>=	Greater than or equal to - True if left operand is greater than or equal to the right	x >= y
<=	Less than or equal to - True if left operand is less than or equal to the right	x <= y

Comparison operators in Python

```
x = 10
y = 12
# Output: x > y is False
print('x > y is',x>y)
# Output: x < y is True
print('x < y is',x<y)
# Output: x == y is False
print('x == y is',x==y)
# Output: x != y is True
print('x != y is',x!=y)
# Output: x >= y is False
print('x >= y is',x>=y)
# Output: x <= y is True
print('x <= y is',x<=y)
```

Run Code

Output

```
x > y is False
```

x < y is True
x == y is False
x != y is True
x >= y is False
x <= y is True

OR

7 (a)	Discuss about Type Conversions and Expressions? **type conversion-4m Expressions-4m**	20CS403.1	L3

Python defines type conversion functions to directly convert one data type to another.
There are two types of Type Conversion in Python:

1. Implicit Type Conversion
2. Explicit Type Conversion

IMPLICIT TYPE CONVERSION
In Implicit type conversion of data types in Python, the Python interpreter automatically converts one data type to another without any user involvement
Example:

```
x = 10

print("x is of type:",type(x))

y = 10.6
print("y is of type:",type(y))

z = x + y

print(z)
print("z is of type:",type(z))
```

Output:

```
x is of type: <class 'int'>
y is of type: <class 'float'>
20.6
z is of type: <class 'float'>
```

EXPLICIT TYPE CONVERSION
In Explicit Type Conversion in Python, the data type is manually changed by the user as per their requirement. With explicit type conversion, there is a risk of data loss since we are forcing an expression to be changed in some specific data type.

1. **int(a, base)**: This function converts **any data type to integer**. 'Base' specifies the **base in which string is** if the data type is a string.
2. **float()**: This function is used to convert **any data type to** a floating-point **number.**

```
# Python code to demonstrate Type conversion
# using int(), float()

# initializing string
s = "10010"

# printing string converting to int base 2
c = int(s,2)
print ("After converting to integer base 2 : ", end="")
print (c)

# printing string converting to float
e = float(s)
print ("After converting to float : ", end="")
```

```
print (e)
```
Output:

After converting to integer base 2 : 18
After converting to float : 10010.0

An **expression** is a combination of operators and operands that is interpreted to produce some other value. In any programming language, an expression is evaluated as per the precedence of its operators. So that if there is more than one operator in an expression, their precedence decides which operation will be performed first. We have many different types of expressions in Python.

1. Constant Expressions: These are the expressions that have constant values only.

Example:

```
# Constant Expressions
x = 15 + 1.3
  print(x)
# Arithmetic Expressions
x = 40
y = 12

add = x + y
sub = x - y
pro = x * y
div = x / y

print(add)
print(sub)
print(pro)
print(div)
```

Output

52
28
480
3.3333333333333335

3. Integral Expressions: These are the kind of expressions that produce only integer results after all computations and type conversions.

Example:

```
  # Integral Expressions
  a = 13
  b = 12.0
    c = a + int(b)
  print(c)
```

7 (b) Write a Python program to convert centigrade to Fahrenheit **4m** 20CS403.1 **L3**

```
# Python Program to convert temperature in celsius to fahrenheit
        # change this value for a different result
        celsius = 37.5
        # calculate fahrenheit
        fahrenheit = (celsius * 1.8) + 32
print('%0.1f degree Celsius is equal to %0.1f degree Fahrenheit' %(celsius,fahrenheit))
```

output:

37.5 degree Celsius is equal to 99.5 degree Fahrenheit

8 (a)	Describe Python Break and Continue statements with examples. Break-3m continue-3m	20CS403.2	L2

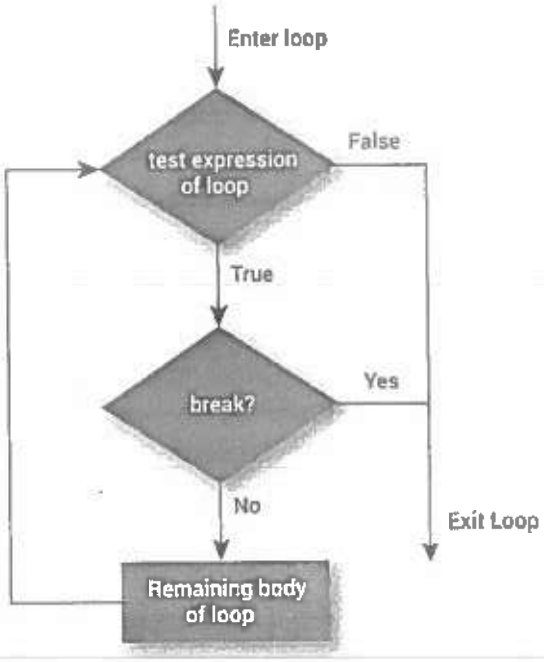
PYTHON BREAK STATEMENT

The break statement terminates the loop containing it. Control of the program flows to the statement immediately after the body of the loop.

If the break statement is inside a nested loop (loop inside another loop), the break statement will terminate the innermost loop

Syntax:

Break



Flowchart of break statement in Python

Example

Python break

```
# Use of break statement inside the loop
for val in "string":
    if val == "i":
        break
    print(val)
print("The end")
```

Output

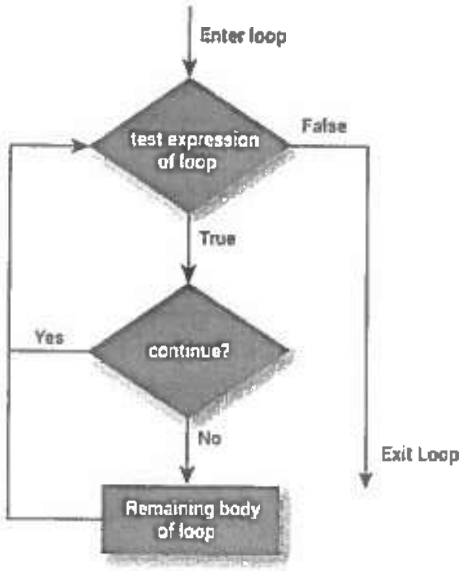
```
s
t
r
The end
```

PYTHON CONTINUE STATEMENT

The continue statement is used to skip the rest of the code inside a loop for the current iteration only. Loop does not terminate but continues on with the next iteration.

Syntax of Continue

Continue



lowchart of continue statement in Python

example

Example: Python continue

```
# Program to show the use of continue statement inside loops
for val in "string":
   if val == "i":
      continue
   print(val)

print("The end")
```

Output

```
s
t
r
n
g
The end
```

8 (b) Write a Python program to find the given number is Armstrong Number. 20CS403.2 L3

Program-6m

```
# Python program to check if the number is an Armstrong number or not

# take input from the user
num = int(input("Enter a number: "))
```

```
# initialize sum
sum = 0

# find the sum of the cube of each digit
temp = num
while temp > 0:
   digit = temp % 10
   sum += digit ** 3
   temp //= 10

# display the result
if num == sum:
   print(num,"is an Armstrong number")
else:
   print(num,"is not an Armstrong number")
```

Output 1

```
Enter a number: 663
663 is not an Armstrong number
```

Output 2

```
Enter a number: 407
407 is an Armstrong number
```

OR

9 (a) Explain about Strings and Number Systems in python **4m** 20CS403.2 **L3**

String is **a collection of alphabets, words or other characters**. It is one of the primitive data structures and are the building blocks for data manipulation. Python has a built-in string class named str . Python strings are "immutable" which means they cannot be changed after they are created.

```
# defining strings in Python
# all of the following are equivalent
my_string = 'Hello'
print(my_string)

my_string = "Hello"
print(my_string)

my_string = '''Hello'''
print(my_string)

# triple quotes string can extend multiple lines
my_string = """Hello, welcome to
        the world of Python"""
print(my_string)
```

output:

- Hello
- Hello
- Hello
- Hello, welcome to
  the world of Python

NUMBER SYSTEM IN PYTHON

types of Number System

The number system in python is represented using the following four systems:

- Binary Number System (base or radix =2)
- Octal Number System (base or radix = 8)
- Decimal Number System (base or radix = 10)
- Hexadecimal Number System (base or radix = 16)

BINARY NUMBER SYSTEM

A number system with base or radix 2 is known as a binary number system. Only 0 and 1 are used to represent numbers in this system.

1) Binary to Decimal

For Binary to Decimal conversion, the binary number uses weights assigned to each bit position. like

a = 1 0 0 1

$a = 1*2^3 + 0*2^2 + 0*2^1 + 1*2^0$

a= (8+0+0+1) = 9

2) Binary to Octal

First convert binary number to decimal number by assigning weight to each binary bit.

a = 1 0 0 1

$a = 1*2^3 + 0*2^2 + 0*2^1 + 1*2^0$

a= (8+0+0+1) = 9

Now, 9 can be converted into octal by dividing it by 8 until we get the remainder between (0-7).

$(1001)_2 = (9)_{10} = (11)_8$

9 (b) Discuss about List and Tuples in Python? **8m List -4m tuples-4m** 20CS403.2 **L2**

LIST

Lists are used to store multiple items in a single variable.

Lists are one of 4 built-in data types in Python used to store collections of data, the other 3 are Tuple, Set, and Dictionary, all with different qualities and usage.

Lists are created using square brackets:

Example

Create a List:

```
thislist = ["apple", "banana", "cherry"]
print(thislist)
```

LIST ITEMS

List items are ordered, changeable, and allow duplicate values.

List items are indexed, the first item has index [0], the second item has index [1] etc

ORDERED

When we say that lists are ordered, it means that the items have a defined order, and that order will not change.

If you add new items to a list, the new items will be placed at the end of the list.

CHANGEABLE

The list is changeable, meaning that we can change, add, and remove items in a list after it has been created.

ALLOW DUPLICATES

Since lists are indexed, lists can have items with the same value:

Example

Lists allow duplicate values:

```
thislist = ["apple", "banana", "cherry", "apple", "cherry"]
print(thislist)
```

LIST LENGTH

To determine how many items a list has, use the len() function:

Example

Print the number of items in the list:

```
thislist = ["apple", "banana", "cherry"]
print(len(thislist))
```

TUPLE

Tuples are used to store multiple items in a single variable.

Tuple is one of 4 built-in data types in Python used to store collections of data, the other 3 are List, Set, and Dictionary, all with different qualities and usage.

A tuple is a collection which is ordered and **unchangeable**.

Tuples are written with round brackets.

Example

Create a Tuple:

```
thistuple = ("apple", "banana", "cherry")
print(thistuple)
```

TUPLE ITEMS

Tuple items are ordered, unchangeable, and allow duplicate values.

Tuple items are indexed, the first item has index [0], the second item has index [1] etc.

ORDERED

When we say that tuples are ordered, it means that the items have a defined order, and that order will not change.

UNCHANGEABLE

Tuples are unchangeable, meaning that we cannot change, add or remove items after the tuple has been created.

ALLOW DUPLICATES

Since tuples are indexed, they can have items with the same value:

Example

Tuples allow duplicate values:

```
thistuple = ("apple", "banana", "cherry", "apple", "cherry")
print(thistuple)
```

TUPLE LENGTH

To determine how many items a tuple has, use the len() function:

Example

Print the number of items in the tuple:

```
thistuple = ("apple", "banana", "cherry")
print(len(thistuple))
```

10 (a) Explain about Functions as Abstraction Mechanisms ?**6m** 20CS403.3 **L3**

Abstraction in python Abstraction is used to hide the internal functionality of the function from the users. The users only interact with the basic implementation of the function, but inner working is hidden. User is familiar with that **"what function does"** but they don't know **"how it does."**

In simple words, we all use the smartphone and very much familiar with its functions such as camera, voice-recorder, call-dialing, etc., but we don't know how these operations are happening in the background. Let's take another example - When we use the TV remote to increase the volume. We don't know how pressing a key increases the volume of the TV. We only know to press the "+" button to increase the volume.

ABSTRACTION CLASSES IN PYTHON

In Python, abstraction can be achieved by using abstract classes and interfaces.

A class that consists of one or more abstract method is called the abstract class. Abstract methods do not

contain their implementation. Abstract class can be inherited by the subclass and abstract method gets its definition in the subclass. Abstraction classes are meant to be the blueprint of the other class. An abstract class can be useful when we are designing large functions. An abstract class is also helpful to provide the standard interface for different implementations of components. Python provides the **abc** module to use the abstraction in the Python program. Let's see the following syntax.

Syntax

```
from abc import ABC
class ClassName(ABC):
```

10 (b)	Define Function? Explain the Problem Solving with Top - Down Design ? Function definition -**1m** problem solving with top down design -**5m**	20CS403.3	L3

Function: function is a self contained block of statements to perform some task

PYTHON PROGRAMMING – TOP-DOWN APPROACH OF PROBLEM SOLVING

Top-down design is the technique of breaking down a problem into various major tasks needed to be performed. Each of these tasks is further broken down into separate subtasks, and so on till each sub-task is sufficiently simple to be written as a self-contained or procedure module. The entire solution to the problem will then consist of a series of simple modules.

In top-down design, you initially describe the problem you are working on at the highest or most general level. The description of the problem at this level will usually be concerned with what must be done – not how it must be done. The description will be in terms of complex, higher-level operations. You must take all of the operations at this level and individually break them down into simpler steps that begin to describe how to accomplish the tasks. If these simple steps can be represented as acceptable algorithmic steps, you need not split them any further. If that is not the case, then you split each of these second-level operations individually into still simpler steps. This stepwise refinement continues until each of the original top-level operations has been described in terms of acceptable shortest (primitive) statements.

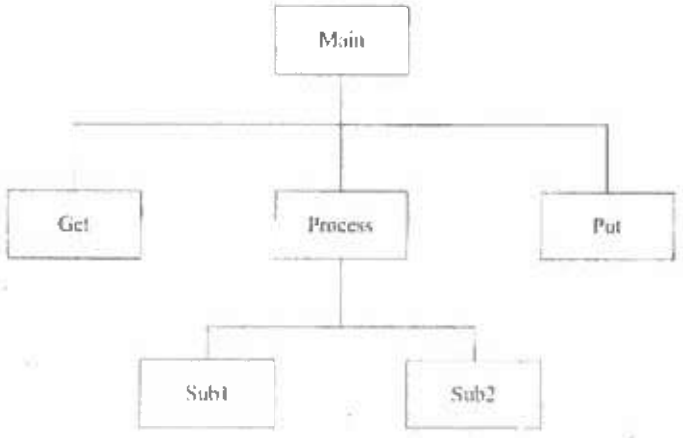
- The top-down approach is used in the system analysis and design process.

The top-down approach, starting at the general levels to gain an understanding of the system and gradually moving down to levels of greater detail is done in the analysis stage. In the process of moving from top to bottom, each component is exploded into more and more details.

Thus, the problem at hand is analyzed or broken down into major components, each of which is again broken down if necessary.

- The top-down process involves working from the most general down to the most specific.

The design of modules is reflected in hierarchy charts such as the one shown in Figure 10.1. The purpose of procedure Main is to coordinate the three branch operations e.g. Get, Process, and Put routines. These three routines communicate only through Main. Similarly, Sub1 and Sub2 can communicate only through the Process routine.



Advantages of Top-down Approach

The advantages of the top-down approach are as follows:

a. This approach allows a programmer to remain "on top of" a problem and view the developing solution in context.

The solution always proceeds from the highest level downwards. With other techniques, you may find yourselves bogged down with very low-level decisions at a very early stage. It will be difficult to make these decisions if it is not clear as to how they may affect the overall solution of the problem.
b. This would be a very good way to delay decisions on problems whose solution may not be readily available. At each stage in the development, the individual operation will be split up into a number of more elementary steps. If you are not sure how to proceed with Step 1 you can still work on Step 2.
c. By dividing the problem into a number of sub-problems, it is easier to share problem development. For example, one person may solve one part of the problem and the other person may solve another part of the problem.
.

OR

11 (a)	Discuss in detail about the modules and explain **any 4 modules** and their **functions. Each module- 4*2 =8m**	20CS403.3	L3

Modules:Math,os,platform,json,Regex,random,Cmath,....etc
A Python module is a file containing Python definitions and statements. A module can define functions, classes, and variables. A module can also include runnable code. Grouping related code into a module makes the code easier to understand and use. It also makes the code logically organized.

```
# A simple module, calc.py

def add(x, y):
    return (x+y)

def subtract(x, y):
    return (x-y)
```

IMPORT MODULE IN PYTHON – IMPORT STATEMENT
We can import the functions, classes defined in a module to another module using the **import statement** in some other Python source file.
Syntax:
import module
When the interpreter encounters an import statement, it imports the module if the module is present in the search path. A search path is a list of directories that the interpreter searches for importing a module. For example, to import the module calc.py, we need to put the following command at the top of the script.
Note: This does not import the functions or classes directly instead imports the module only. To access the functions inside the module the dot(.) operator is used.

```
# importing  module calc.py
import calc
  print(calc.add(10, 2))
```

Output:
12
PYTHON MATH MODULE
Python has a built-in module that you can use for mathematical tasks.
The math module has a set of methods and constants.
MATH METHODS

Method	Description
math.acos()	Returns the arc cosine of a number
math.acosh()	Returns the inverse hyperbolic cosine of a number
math.asin()	Returns the arc sine of a number

math.asinh()	Returns the inverse hyperbolic sine of a number
math.atan()	Returns the arc tangent of a number in radians
math.atan2()	Returns the arc tangent of y/x in radians
math.atanh()	Returns the inverse hyperbolic tangent of a numb

Random Module:
Python has a built-in module that you can use to make random numbers.
The random module has a set of methods:

Method	Description
seed()	Initialize the random number generator
getstate()	Returns the current internal state of the random number generator
setstate()	Restores the internal state of the random number generator
getrandbits()	Returns a number representing the random bits
randrange()	Returns a random number between the given range

A RegEx, or Regular Expression, is a sequence of characters that forms a search pattern.
RegEx can be used to check if a string contains the specified search pattern.

REGEX MODULE

Python has a built-in package called re, which can be used to work with Regular Expressions.
Import the re module:

```
import re
```

REGEX IN PYTHON

When you have imported the re module, you can start using regular expressions:
Example
Search the string to see if it starts with "The" and ends with "Spain":

```
import re

txt = "The rain in Spain"
x = re.search("^The.*Spain$", txt)
```

REGEX FUNCTIONS

The re module offers a set of functions that allows us to search a string for a match:

Function	Description
findall	Returns a list containing all matches
search	Returns a Match object if there is a match anywhere in the string
split	Returns a list where the string has been split at each match
sub	Replaces one or many matches with a string

JSON is a syntax for storing and exchanging data.
JSON is text, written with JavaScript object notation.

JSON IN PYTHON

Python has a built-in package called json, which can be used to work with JSON data.

Example

Import the json module:

```
import json
```

PARSE JSON - CONVERT FROM JSON TO PYTHON

If you have a JSON string, you can parse it by using the json.loads() method.

Example

Convert from JSON to Python:

```
import json

# some JSON:
x =  '{ "name":"John", "age":30, "city":"New York"}'

# parse x:
y = json.loads(x)

# the result is a Python dictionary:
print(y["age"])
```

CONVERT FROM PYTHON TO JSON

If you have a Python object, you can convert it into a JSON string by using the json.dumps() method.

Example

Convert from Python to JSON:

```
import json

# a Python object (dict):
x = {
  "name": "John",
  "age": 30,
  "city": "New York"
}

# convert into JSON:
y = json.dumps(x)

# the result is a JSON string:
print(y)
```

11 (b) Explain installing packages via PIP **? installing-4m** 20CS403.3 **L2**

Python pip is the package manager for Python packages. We can use pip to install packages that do not come with Python. The basic syntax of pip commands in command prompt is:

pip 'arguments'

HOW TO INSTALL PIP?

Python pip comes pre-installed on 3.4 or older versions of Python. To check whether pip is installed or not type the below command in the terminal.

pip --version

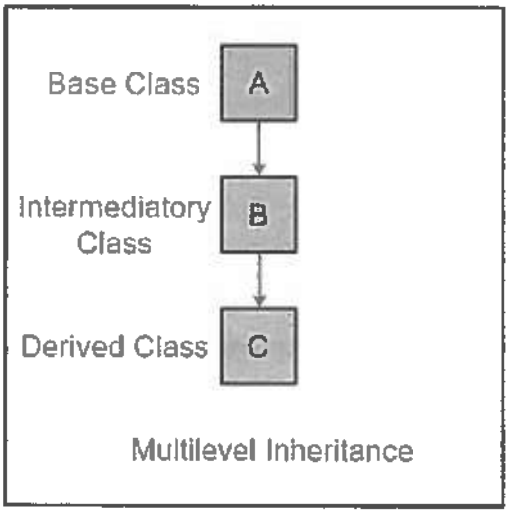
HOW TO INSTALL PACKAGE WITH PIP

We can install additional packages by using the Python **pip install** command. Let's suppose we want to

install the Numpy using pip. We can do it using the below command.
Syntax:
pip install numpy

12 a) Write a Python Program on Multi-Level Inheritance ? **program -8m** **20CS403.4**

Multilevel Inheritance :
In multilevel inheritance, features of the base class and the derived class are further inherited into the new derived class. This is similar to a relationship representing a child and a grandfather.




```
# Python program to demonstrate
# multilevel inheritance

# Base class


class Grandfather:

    def __init__(self, grandfathername):
        self.grandfathername = grandfathername

# Intermediate class


class Father(Grandfather):
    def __init__(self, fathername, grandfathername):
        self.fathername = fathername

        # invoking constructor of Grandfather class
        Grandfather.__init__(self, grandfathername)

# Derived class
class Son(Father):
    def __init__(self, sonname, fathername, grandfathername):
        self.sonname = sonname

        # invoking constructor of Father class
        Father.__init__(self, fathername, grandfathername)

    def print_name(self):
```

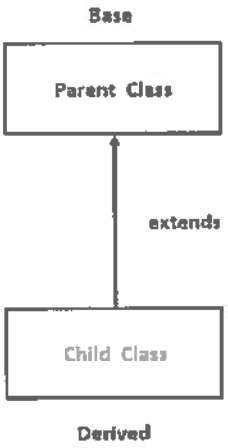
```
        print('Grandfather name :', self.grandfathername)
        print("Father name :", self.fathername)
        print("Son name :", self.sonname)


# Driver code
s1 = Son('Prince', 'Rampal', 'Lal mani')

  print(s1.grandfathername)
  s1.print_name()
```

Output:
Lal mani
Grandfather name : Lal mani
Father name : Rampal
Son name : Prince

12(b) Write a Python Program on Composition. Compare Composition with Inheritance ? **4m** **20CS403.4**

WHAT IS INHERITANCE (IS-A RELATION)?

It is a concept of Object-Oriented Programming. Inheritance is a mechanism that allows us to inherit all the properties from another class. The class from which the properties and functionalities are utilized is called the **parent class** (also called as **Base Class**). The class which uses the properties from another class is called as **Child Class** (also known as **Derived class**). Inheritance is also called an **Is-A Relation**.



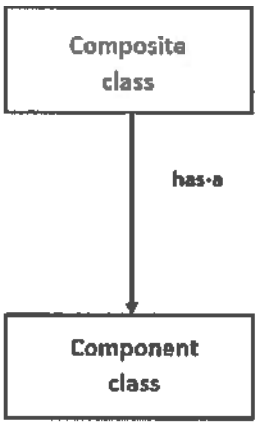
In the figure above, classes are represented as boxes. The inheritance relationship is represented by an arrow pointing from **Derived Class(Child Class)** to **Base Class(Parent Class)**. The extends keyword denotes that the **Child Class** is inherited or derived from **Parent Class**.

Syntax :

```
# Parent class
class Parent :
        # Constructor
        # Variables of Parent class

        # Methods
        ...
```

WHAT IS COMPOSITION (HAS-A RELATION)?

It is one of the fundamental concepts of Object-Oriented Programming. In this concept, we will describe a class that references to one or more objects of other classes as an Instance variable. Here, by using the class name or by creating the object we can access the members of one class inside another class. It enables creating complex types by combining objects of different classes. It means that a class Composite can contain an object of another class Component. This type of relationship is known as **Has-A Relation**.



13 Define file. Explain the file operations with an example program **file def -1m file operations- 6m program -5m 20CS403.4**

FILES

Files are named locations on disk to store related information. They are used to permanently store data in a non-volatile memory (e.g. hard disk).

Since Random Access Memory (RAM) is volatile (which loses its data when the computer is turned off), we use files for future use of the data by permanently storing them.

When we want to read from or write to a file, we need to open it first. When we are done, it needs to be closed so that the resources that are tied with the file are freed.

Hence, in Python, a file operation takes place in the following order:

Open a file
Read or write (perform operation)
Close the file

OPENING FILES IN PYTHON

Python has a built-in open() function to open a file. This function returns a file object, also called a handle, as it is used to read or modify the file accordingly.

```
>>> f = open("test.txt")    # open file in current directory
>>> f = open("C:/Python38/README.txt")  # specifying full path
```

We can specify the mode while opening a file. In mode, we specify whether we want to read r, write w or append a to the file. We can also specify if we want to open the file in text mode or binary mode.

The default is reading in text mode. In this mode, we get strings when reading from the file.

On the other hand, binary mode returns bytes and this is the mode to be used when dealing with non-text files like images or executable files.

Mode	Description
r	Opens a file for reading. (default)
w	Opens a file for writing. Creates a new file if it does not exist or truncates th exists.
x	Opens a file for exclusive creation. If the file already exists, the operation fa
a	Opens a file for appending at the end of the file without truncating it. Creates

	it does not exist.
t	Opens in text mode. (default)
b	Opens in binary mode.
+	Opens a file for updating (reading and writing)

```
f = open("test.txt")      # equivalent to 'r' or 'rt'
f = open("test.txt",'w')  # write in text mode
f = open("img.bmp",'r+b') # read and write in binary mode
```

CLOSING FILES IN PYTHON

When we are done with performing operations on the file, we need to properly close the file.

Closing a file will free up the resources that were tied with the file. It is done using the close() method available in Python.

Python has a garbage collector to clean up unreferenced objects but we must not rely on it to close the file.

```
f = open("test.txt", encoding = 'utf-8')
# perform file operations
f.close()
```

example:

```
# a file named "geek", will be opened with the reading mode.
file = open('geek.txt', 'r')
# This will print every line one by one in the file
for each in file:
    print (each)
```

example:

```
# Python code to illustrate read() mode
file = open("file.txt", "r")
print (file.read())
```

example:

```
# Python code to illustrate read() mode character wise
file = open("file.txt", "r")
print (file.read(5))
```

example

```
# Python code to create a file
file = open('geek.txt','w')
file.write("This is the write command")
file.write("It allows us to write in a particular file")
file.close()
```

example:

```
# Python code to illustrate append() mode
file = open('geek.txt','a')
file.write("This will add this line")
file.close()
```

14 a) Compare the Behavior of Terminal Based Programs and GUI -Based Programs **4m 20CS403.5**

CLI	GUI
CLI is difficult to use.	Whereas it is easy to use.
It consumes low memory.	While consumes more memory.
In CLI we can obtain high precision.	While in it, low precision is obtained.
CLI is faster than GUI.	The speed of GUI is slower than CLI.

14 b) EXPLAIN THE DIFFERENT METHODS OF CREATING GUI WITH PYTHON **8M 20CS403.5**

Python provides various options for developing graphical user interfaces (GUIs). Most important are listed below.

- **Tkinter** – Tkinter is the Python interface to the Tk GUI toolkit shipped with Python. We would look this option in this chapter.
- **wxPython** – This is an open-source Python interface for wxWindows http://wxpython.org.
- **JPython** – JPython is a Python port for Java which gives Python scripts seamless access to Java class libraries on the local machine

TKINTER PROGRAMMING

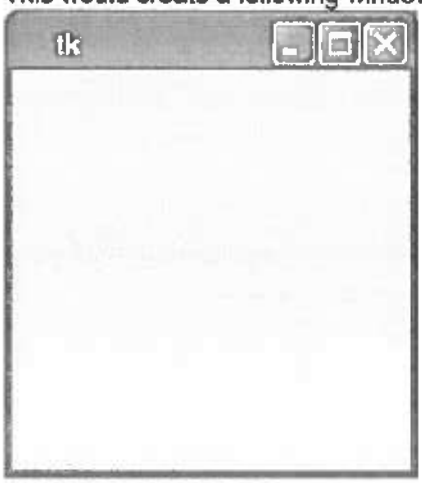
Tkinter is the standard GUI library for Python. Python when combined with Tkinter provides a fast and easy way to create GUI applications. Tkinter provides a powerful object-oriented interface to the Tk GUI toolkit. Creating a GUI application using Tkinter is an easy task. All you need to do is perform the following steps –

- Import the *Tkinter* module.
- Create the GUI application main window.
- Add one or more of the above-mentioned widgets to the GUI application.
- Enter the main event loop to take action against each event triggered by the user.

EXAMPLE

```
#!/usr/bin/python

import Tkinter
top = Tkinter.Tk()
# Code to add widgets will go here...
top.mainloop()
```

This would create a following window –



TKINTER WIDGETS

Tkinter provides various controls, such as buttons, labels and text boxes used in a GUI application. These controls are commonly called widgets.

There are currently 15 types of widgets in Tkinter. We present these widgets as well as a brief description in the following table –

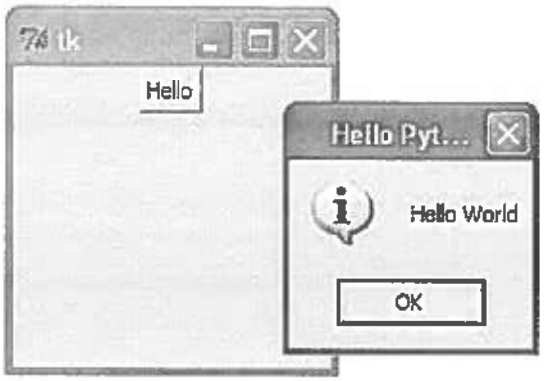
Sr.No.	Operator & Description
1	Button The Button widget is used to display buttons in your application.
2	Canvas The Canvas widget is used to draw shapes, such as lines, ovals, polygons and rectangles, in your application.
3	Checkbutton The Checkbutton widget is used to display a number of options as checkboxes. The user can select multiple options at a time.
4	Entry The Entry widget is used to display a single-line text field for accepting values from a user.
5	Frame The Frame widget is used as a container widget to organize other widgets.
6	Label The Label widget is used to provide a single-line caption for other widgets. It can also contain images.
7	Listbox The Listbox widget is used to provide a list of options to a user.
8	Menubutton The Menubutton widget is used to display menus in your application.

EXAMPLE

Try the following example yourself −

```
import Tkinter
import tkMessageBox

top = Tkinter.Tk()

def helloCallBack():
   tkMessageBox.showinfo( "Hello Python", "Hello World")

B = Tkinter.Button(top, text ="Hello", command = helloCallBack)

B.pack()
top.mainloop()
```

When the above code is executed, it produces the following result −



(OR)

15 Explain the following Mathematical Libraries: NumPy, matplotlib , Sympy, Pandas ? 12 M 20CS403.5

WHAT IS NUMPY?

NumPy is a Python library used for working with arrays.
It also has functions for working in domain of linear algebra, fourier transform, and matrices.
NumPy was created in 2005 by Travis Oliphant. It is an open source project and you can use it freely.
NumPy stands for Numerical Python.

WHY USE NUMPY?

In Python we have lists that serve the purpose of arrays, but they are slow to process.
NumPy aims to provide an array object that is up to 50x faster than traditional Python lists.
The array object in NumPy is called ndarray, it provides a lot of supporting functions that make working with ndarray very easy.
Arrays are very frequently used in data science, where speed and resources are very important.

FINDING LCM (LOWEST COMMON MULTIPLE)

The Lowest Common Multiple is the least number that is common multiple of both of the numbers.

Example

Find the LCM of the following two numbers:

```
import numpy as np
num1 = 4
num2 = 6
x = np.lcm(num1, num2)
print(x)
```

Example

Find the LCM of the values of the following array:

```
import numpy as np
arr = np.array([3, 6, 9])
x = np.lcm.reduce(arr)
print(x)
```

Example

Find the LCM of the values of the following array:

```
import numpy as np
arr = np.array([3, 6, 9])
x = np.lcm.reduce(arr)
print(x)
```

MATPLOTLIB PYPLOT

PYPLOT

Most of the Matplotlib utilities lies under the pyplot submodule, and are usually imported under the plt alias:

```
import matplotlib.pyplot as plt
```

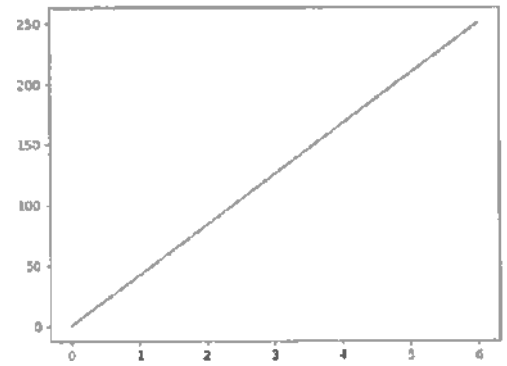
Now the Pyplot package can be referred to as plt.

Example

Draw a line in a diagram from position (0,0) to position (6,250):

```
import matplotlib.pyplot as plt
import numpy as np
xpoints = np.array([0, 6])
ypoints = np.array([0, 250])
plt.plot(xpoints, ypoints)
plt.show()
```

Result:



SymPy is a Python library for symbolic mathematics. It aims to become a full-featured computer algebra system (CAS) while keeping the code as simple as possible in order to be comprehensible and easily extensible. SymPy is written entirely in Python.
SymPy only depends on mpmath, a pure Python library for arbitrary floating point arithmetic, making it easy to use.

Installing sympy module:

SymPy as a calculator:
SymPy defines following numerical types: *Rational* and *Integer*. The Rational class represents a rational number as a pair of two Integers, numerator and denominator, so Rational(1, 2) represents 1/2, Rational(5, 2) 5/2 and so on. The Integer class represents Integer number.

Example #1 :

Python3

```
# import everything from sympy module
from sympy import *
 a = Rational(5, 8)
print("value of a is :" + str(a))

b = Integer(3.579)
print("value of b is :" + str(b))
```

Output:

value of a is :5/8
value of b is :3
SymPy uses mpmath in the background, which makes it possible to perform computations using arbitrary-precision arithmetic. That way, some special constants, like exp, pi, oo (Infinity), are treated as symbols and can be evaluated with arbitrary precision.

```
# import everything from sympy module
from sympy import *
 # you can't get any numerical value
p = pi**3
print("value of p is :" + str(p))
 # evalf method evaluates the expression to a floating-point number
```

```
q = pi.evalf()
print("value of q is :" + str(q))
 # equivalent to e ^ 1 or e ** 1
r = exp(1).evalf()
print("value of r is :" + str(r))
 s = (pi + exp(1)).evalf()
print("value of s is :" + str(s))
rslt = oo + 10000
print("value of rslt is :" + str(rslt))
 if oo > 9999999 :
   print("True")
else:
   print("False")
```

Output:

```
 value of p is :pi^3
value of q is :3.14159265358979
value of r is :2.71828182845905
value of s is :5.85987448204884
value of rslt is :oo
True
```

Pandas is an open-source library that is made mainly for working with relational or labeled data both easily and intuitively. It provides various data structures and operations for manipulating numerical data and time series. This library is built on top of the NumPy library. Pandas is fast and it has high performance & productivity for users.

Advantages

- Fast and efficient for manipulating and analyzing data.
- Data from different file objects can be loaded.
- Easy handling of missing data (represented as NaN) in floating point as well as non-floating point data
- Size mutability: columns can be inserted and deleted from DataFrame and higher dimensional objects
- Data set merging and joining.
- Flexible reshaping and pivoting of data sets
- Provides time-series functionality.
- Powerful group by functionality for performing split-apply-combine operations on data sets.

Getting Started

The first step of working in pandas is to ensure whether it is installed in the Python folder or not. If not then we need to install it in our system using **pip command**. Type cmd command in the search box and locate the folder using cd command where **python-pip file** has been installed. After locating it, type the command:

pip install pandas

Creating a Series

In the real world, a Pandas Series will be created by loading the datasets from existing storage, storage can be SQL Database, CSV file, an Excel file. Pandas Series can be created from the lists, dictionary, and from a scalar value etc.

Example:

Python3

```
import pandas as pd
import numpy as np
 # Creating empty series
```

```
ser = pd.Series()
  print(ser)
# simple array
data = np.array(['g', 'e', 'e', 'k', 's'])
  ser = pd.Series(data)
print(ser)
```

Output:

```
Series([], dtype: float64)
0  g
1  e
2  e
3  k
4  s
dtype: object
```

Creating a DataFrame:

In the real world, a Pandas DataFrame will be created by loading the datasets from existing storage, storage can be SQL Database, CSV file, an Excel file. Pandas DataFrame can be created from the lists, dictionary, and from a list of dictionaries, etc.

Example:

Python3

```
import pandas as pd
  # Calling DataFrame constructor
df = pd.DataFrame()
print(df)
 # list of strings
lst = ['Geeks', 'For', 'Geeks', 'is',
          'portal', 'for', 'Geeks']
  # Calling DataFrame constructor on list
df = pd.DataFrame(lst)
print(df)
```

Output:

```
Empty DataFrame
Columns: []
Index: []
       0
0  Geeks
1    For
2  Geeks
3     is
4 portal
5    for
6  Geeks
```

N. Viswanadha Reddy 4/8/22

Semester End Regular/Supplementary Examination, August, 2022

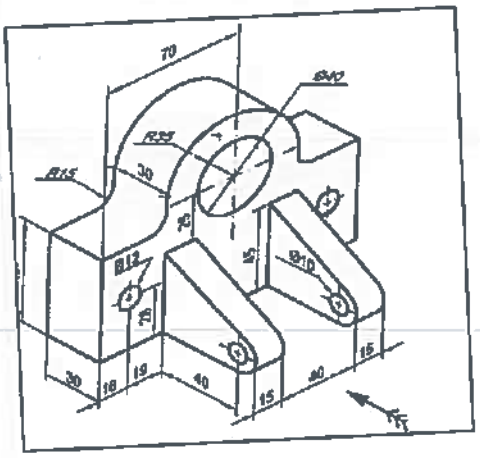
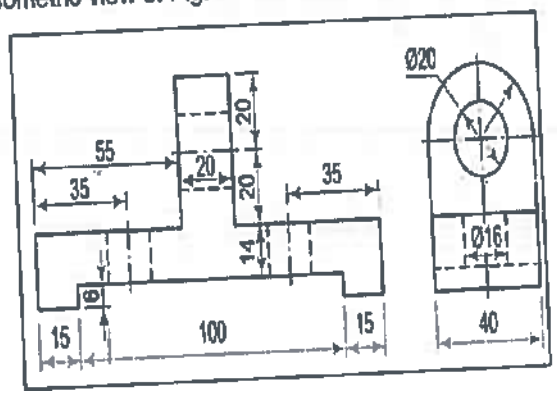
Degree	B. Tech. (U. G.)	**Program**	ECE			**Academic Year**	2021 - 2022
Course Code	20ESX01	**Test Duration**	3 Hrs.	**Max. Marks**	70	**Semester**	II
Course	**ENGINEERING DRAWING**						

Part A (Short Answer Questions 2 x 5 = 10 Marks)

No.	Questions (1 through 2)	Learning Outcome (s)	DoK	
1	A hexagonal plate side of base 30mm and it is resting on HP and perpendicular to VP.	20ESX01.3	L1	[5]
2	A straight line of AB 50 mm long is 60mm above HP and 50mm in front of the VP. The line inclined with an angle of 30⁰ to HP and parallel to VP. Draw its projections.	20ESX01.2	L1	[5]

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 10)	Learning Outcome (s)	DoK	
3 (a)	Construct a pentagon of side 40mm when one side is Horizontal.	20ESX01.1	L2	[6]
3 (b)	The foci of an ellipse are 108 mm apart and the major axis is 120 mm long. Construct an ellipse using oblong method. Draw a tangent and normal to the ellipse at a point on it 50 mm from its centre	20ESX01.1	L3	[6]
	OR			
4 (a)	Draw a full size diagonal scale of RF=2 and long enough to measure up to 5 centimeters. Show on this scale the following distances 2.35 centimeters	20ESX01.1	L3	[6]
4 (b)	Draw a vernier scale of R.F=5 to read 1/5 cm and 1/25 cm and to measure up to 5 cm. Mark on the scale distances of 2.12 cm	20ESX01.1	L2	[6]
5 (a)	Draw the projections of a straight line AB of 60mm long, in the following positions: (i) Perpendicular to the HP and parallel to VP (ii) Parallel to and 30 mm in front of the VP and on the HP (iii) Inclined at 30⁰ to the VP and parallel to HP .	20ESX01.2	L2	[6]
5 (b)	A line PQ, 100 mm long, is inclined at 45⁰ to the H.P and at 30⁰ to the VP. A point P is 40mm from both the planes. Draw the projections of PQ.	20ESX01.2	L3	[6]
	OR			
6	A line CD, 80mm long, it is inclined at 25⁰ to HP and 30⁰ to VP. End C in the first quadrant and 25 mm and 15 mm from HP and VP respectively. Draw the projections; find true length and true inclination. Locate the traces	20ESX01.2	L2	[12]
7 (a)	Draw a rhombus of diagonals 100 mm and 60 mm long, with the longer diagonal horizontal. The figure is the top view of a square of 100 mm long diagonals, with a corner on the ground. Draw its front view and determine the angle which its surface makes with the ground.	20ESX01.3	L2	[6]
7 (b)	Hexagonal plate of negligible thickness is of 25 mm side, lying in such a way that one of its corners touches on the HP and the plane makes an angle of 60⁰ with the HP and 30⁰ with the VP. Draw the projections.	20ESX01.3	L3	[6]

	OR			
8 (a)	The circular plate of negligible thickness and 50mm diameter is on the HP and 30⁰ inclined to HP and 45⁰ inclined to VP. Draw its projections.	20ESX01.3	L2	[6]
8 (b)	A mirror of size 560mm × 320mm is fixed on a wall on one of its shorter edges. The mirror is so fixed that it appears as a square in the front view. Draw the projections of the mirror Find its inclinations with the wall and the ground?	20ESX01.3	L3	[6]
9	A pentagonal prism, side of base 25mm and axis 50mm long rests with one of its edges on the HP such that the base containing that edge makes an angle of 30⁰ to the HP and its axis is parallel to the VP. Draw its projections.	20ESX01.4	L2	[12]
	OR			
10	Draw the projections of a pentagonal prism of base side 30mm and axis length 60mm rests on the HP. The axis is inclined at 45⁰ to the HP and parallel to the VP?	20ESX01.4	L3	[12]
11	Draw the front view, top view and side view from the isometric view. All dimensions are in mm. 	20ESX01.5	L4	[12]
	OR			
12	Draw the isometric view of Fig. 	20ESX01.5	L4	[12]

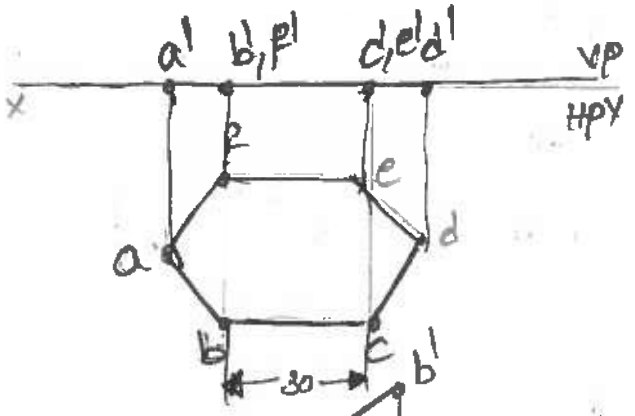
Semester End Regular / Supply Examination, August, 2022

Course – Engineering Drawing (20ES0101)

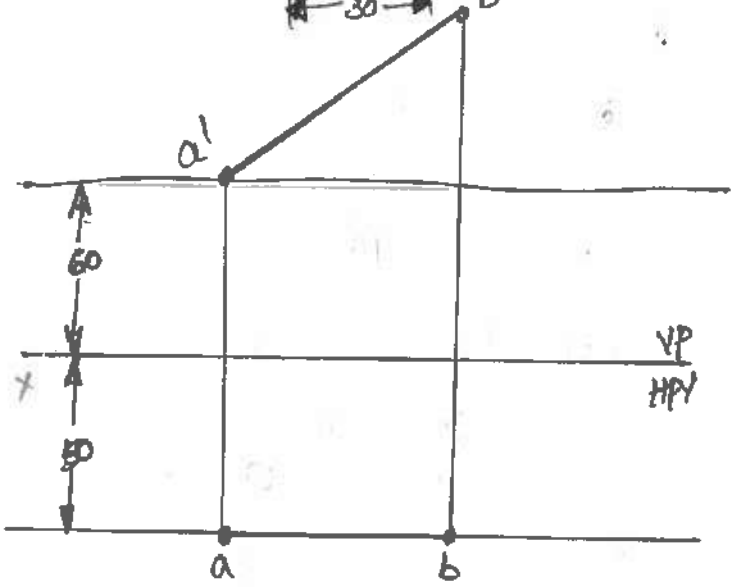
Program – ECE Degree – B.Tech

PART-A

(1)

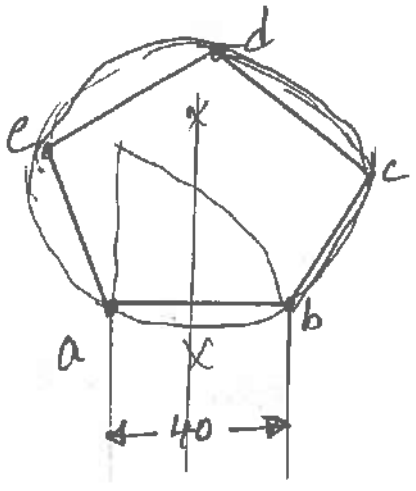


(2)

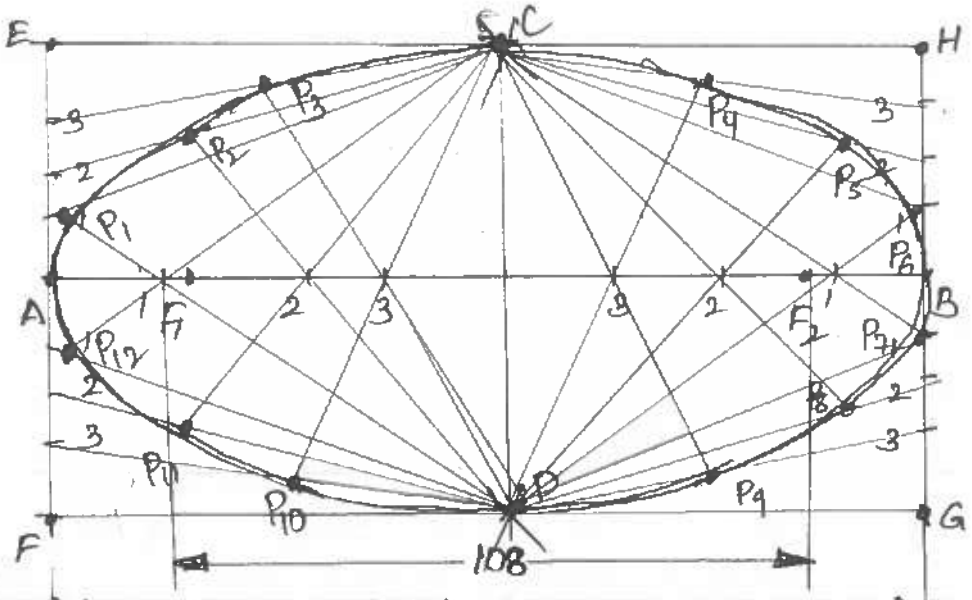


PART – B

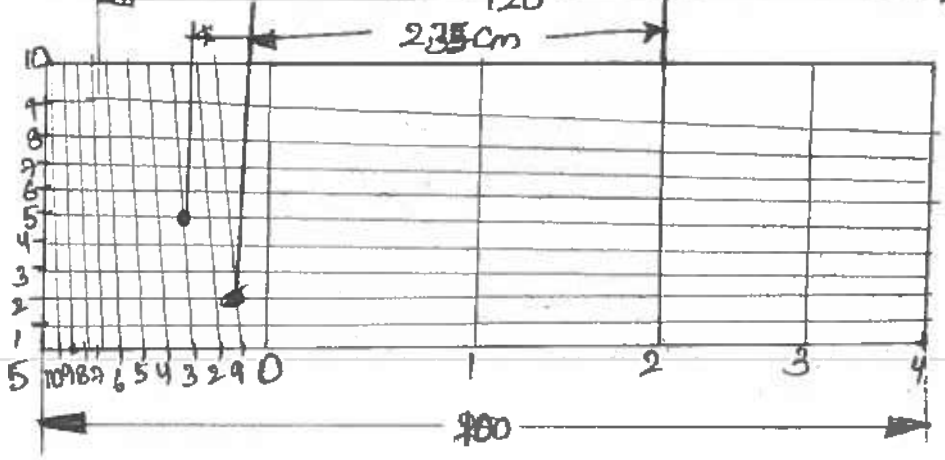
(3)(a)



(3)(b)



(4)(a)

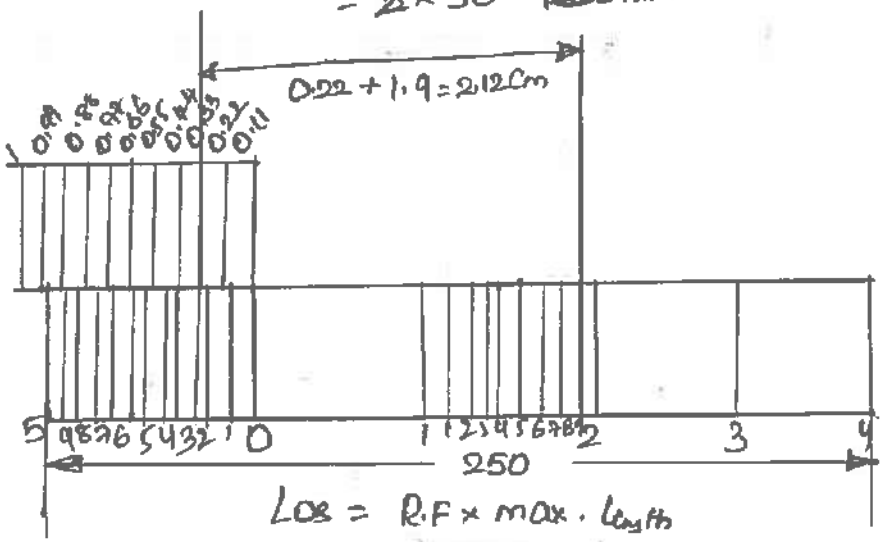


LOS = R.F × max length

= 2 × 5Cm

= 2 × 50 = 100 mm

(4)(b)



2.12
0.22
1.90

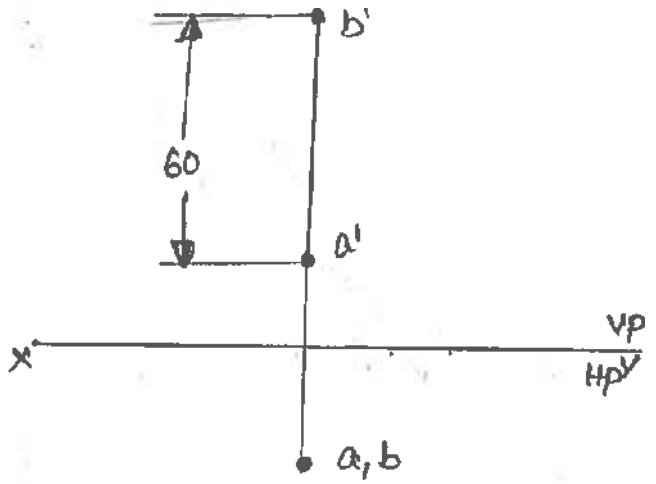
LOS = R.F × max. length

= 5 × 5

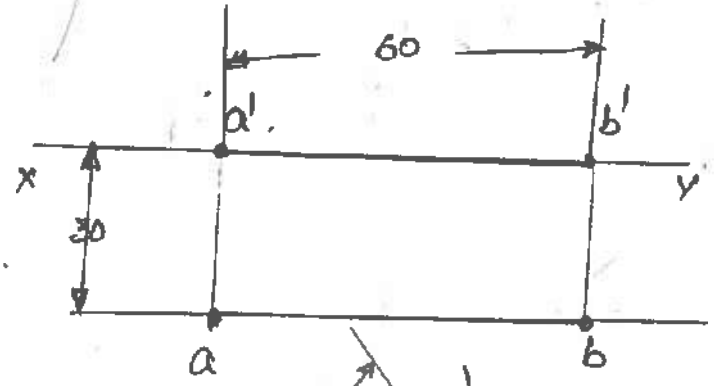
= 250 mm

5(a)

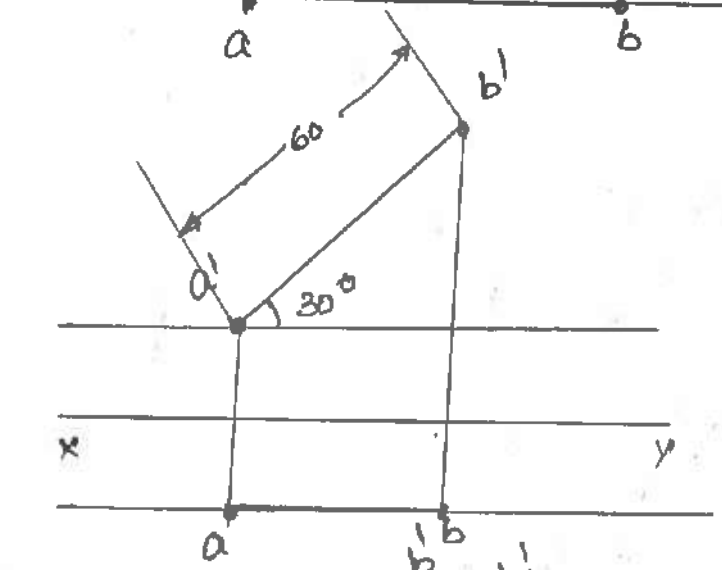
(i)


b'
60
a'
VP
x
HP
a, b

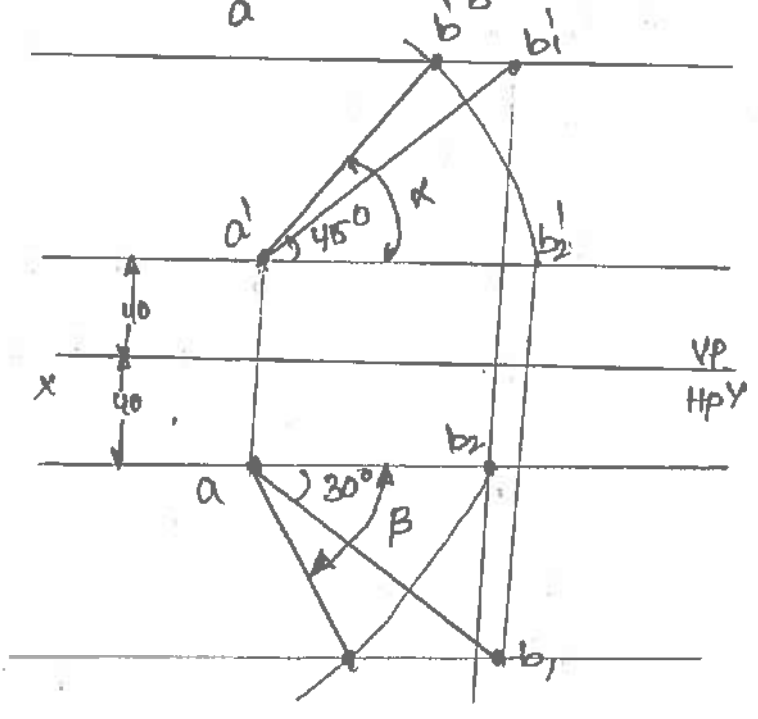
(ii)


60
a'
b'
x
y
30
a
b

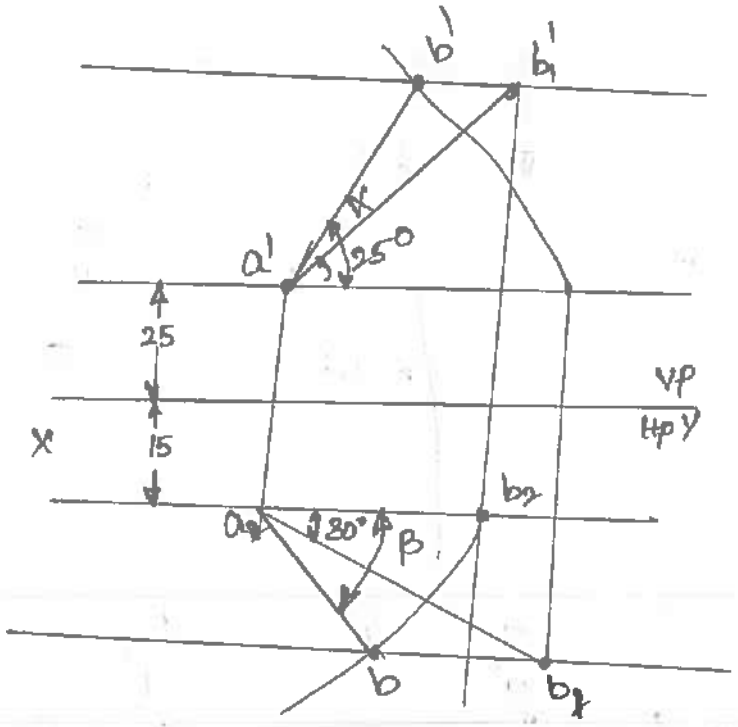
(iii)


b'
60
a'
30°
x
y
a
b

5(b)

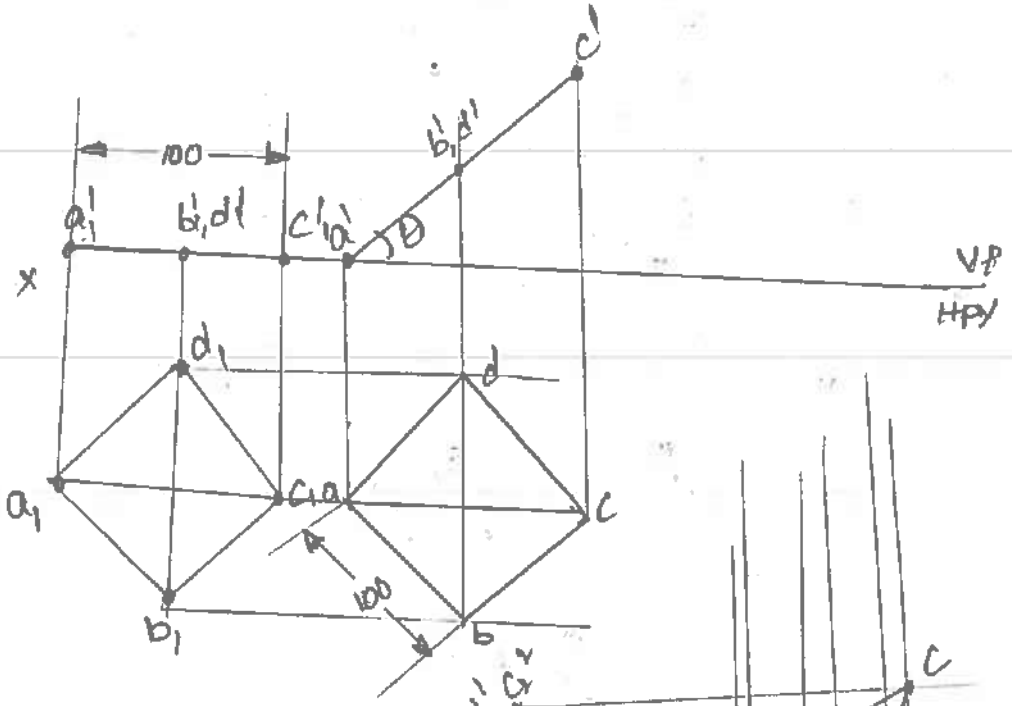

b'
b1
a'
45°
α
b2
40
VP
x
40
HP
b2
a
30°
β
b1

(6)

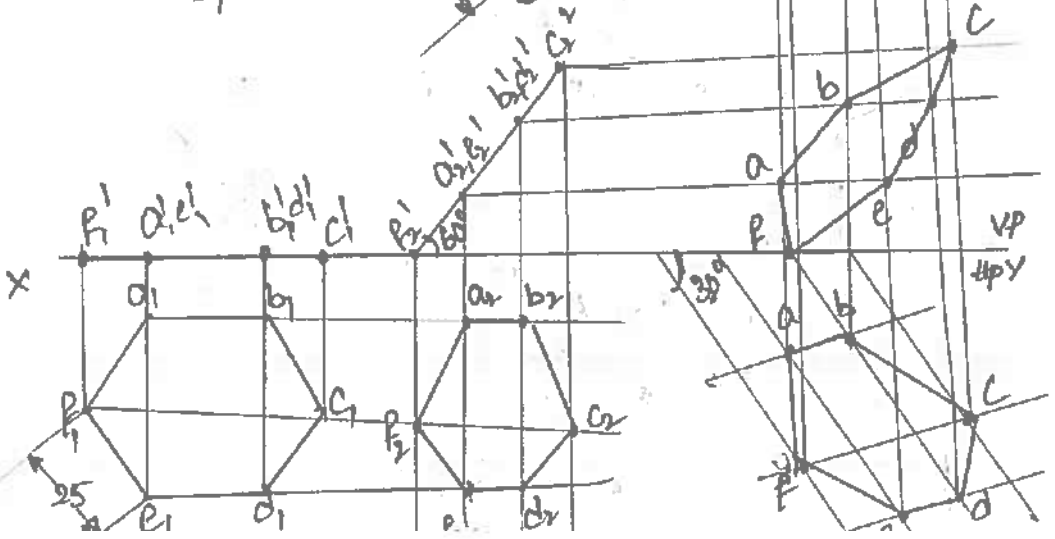

b'
b'1
a'
25°
25
15
VP
HPY
X
b2
a2
30°
β
b
b1

(7)

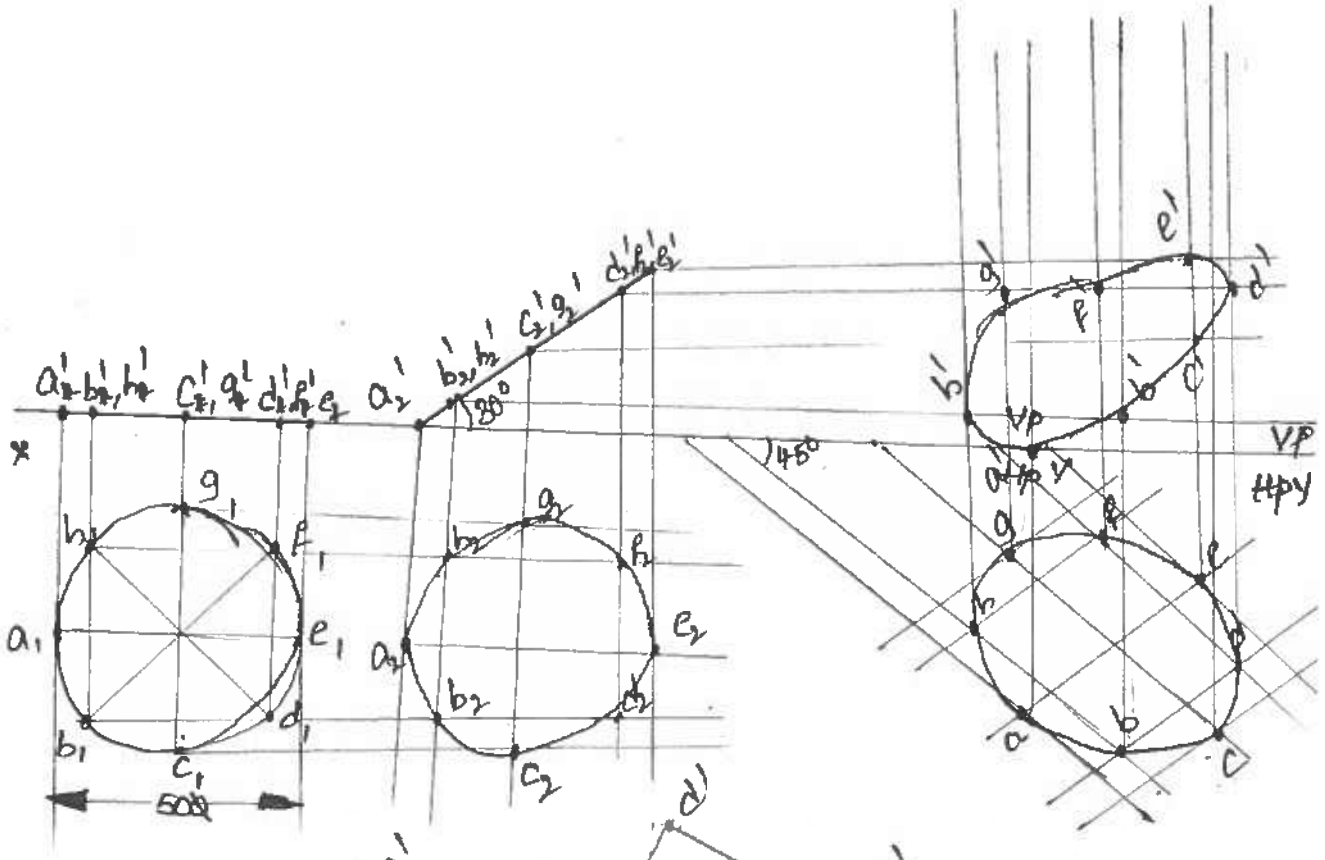
(a)


c'
100
b'1,d'1
a'1
b'1,d'1
c'1,a'
θ
VP
X
HPY
d1
d
a1
c1,a
c
100
b1
b

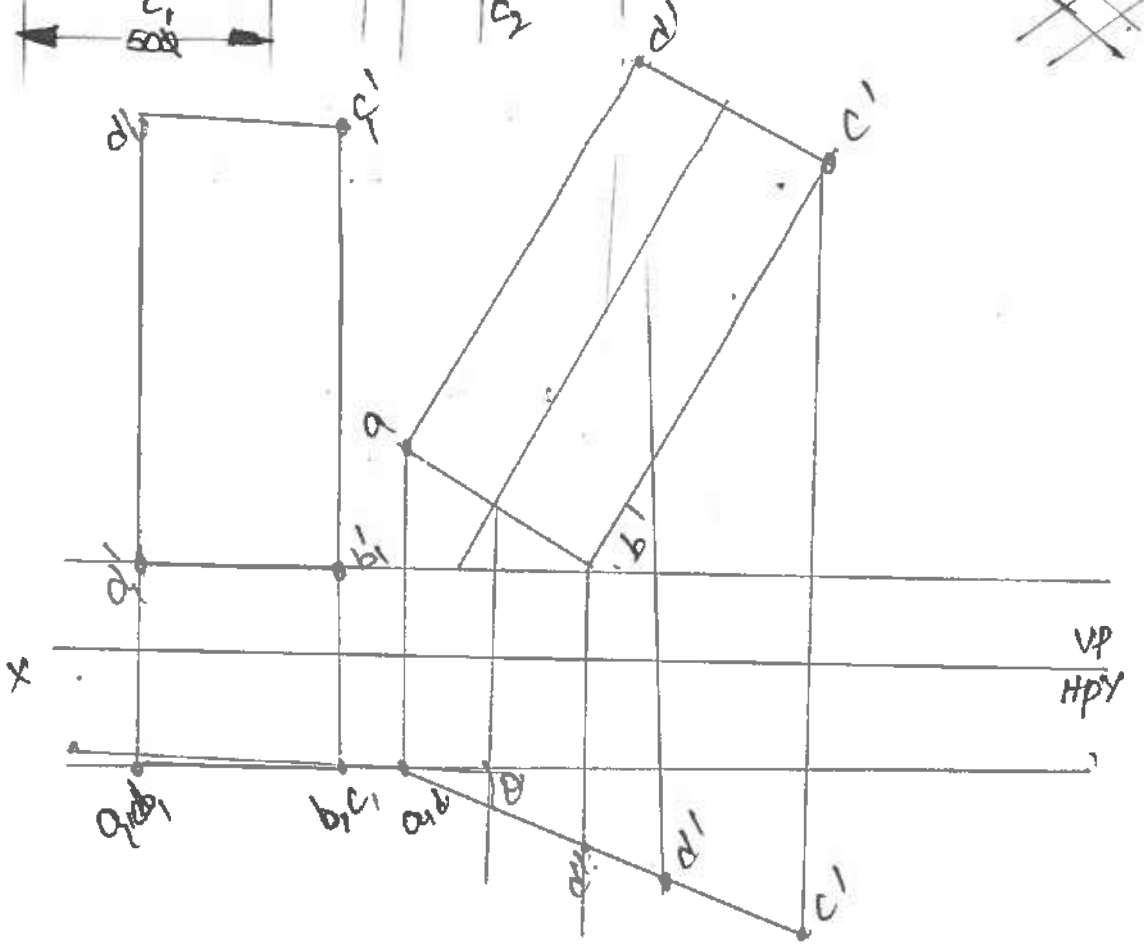
(7)(b)


c'2
b'2,d'2
a'2,c'2
b'1,d'1
c'1
60°
X
VP
HPY
30°
25
a
b
c
d
e

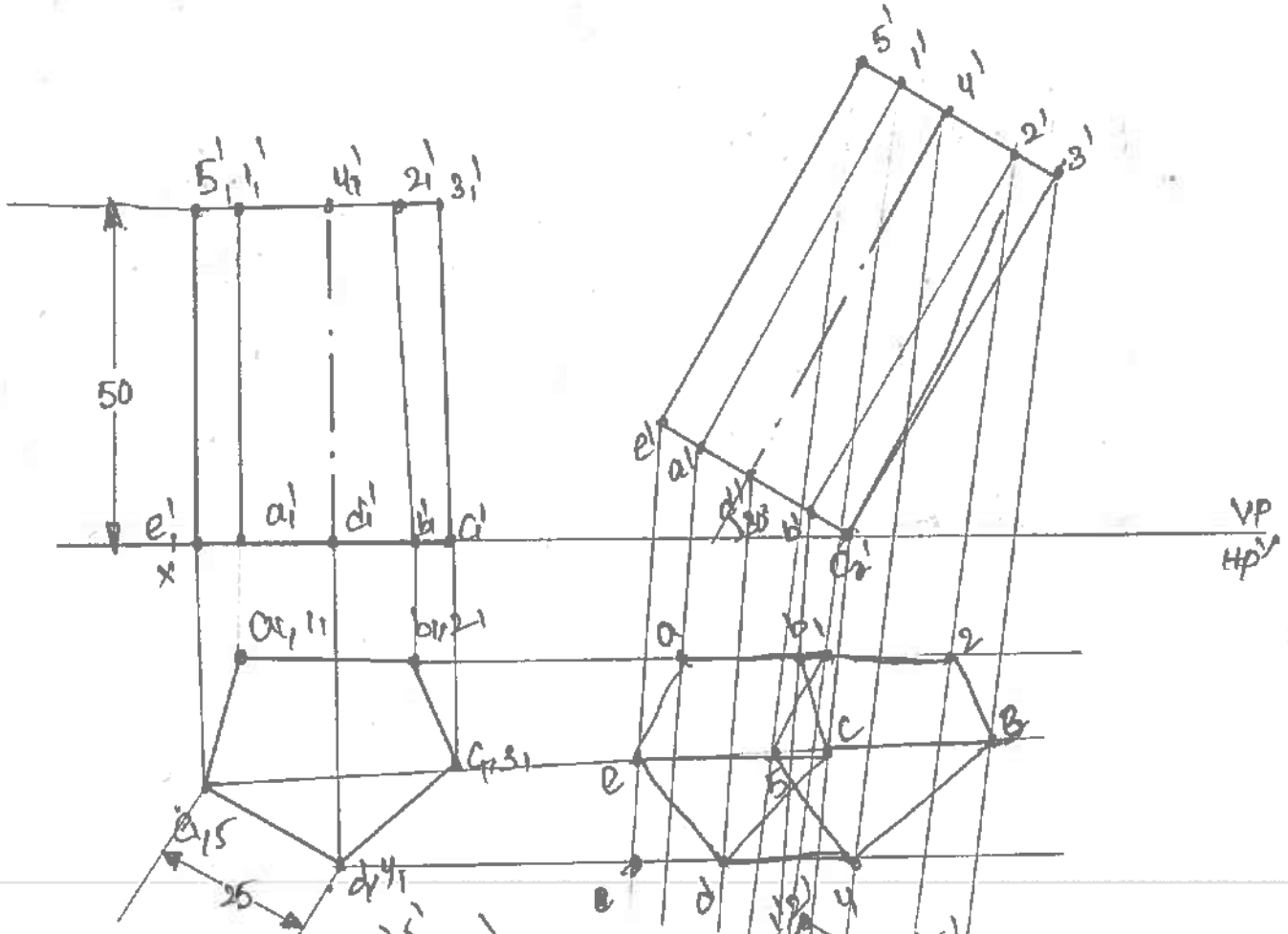
(8)(a)



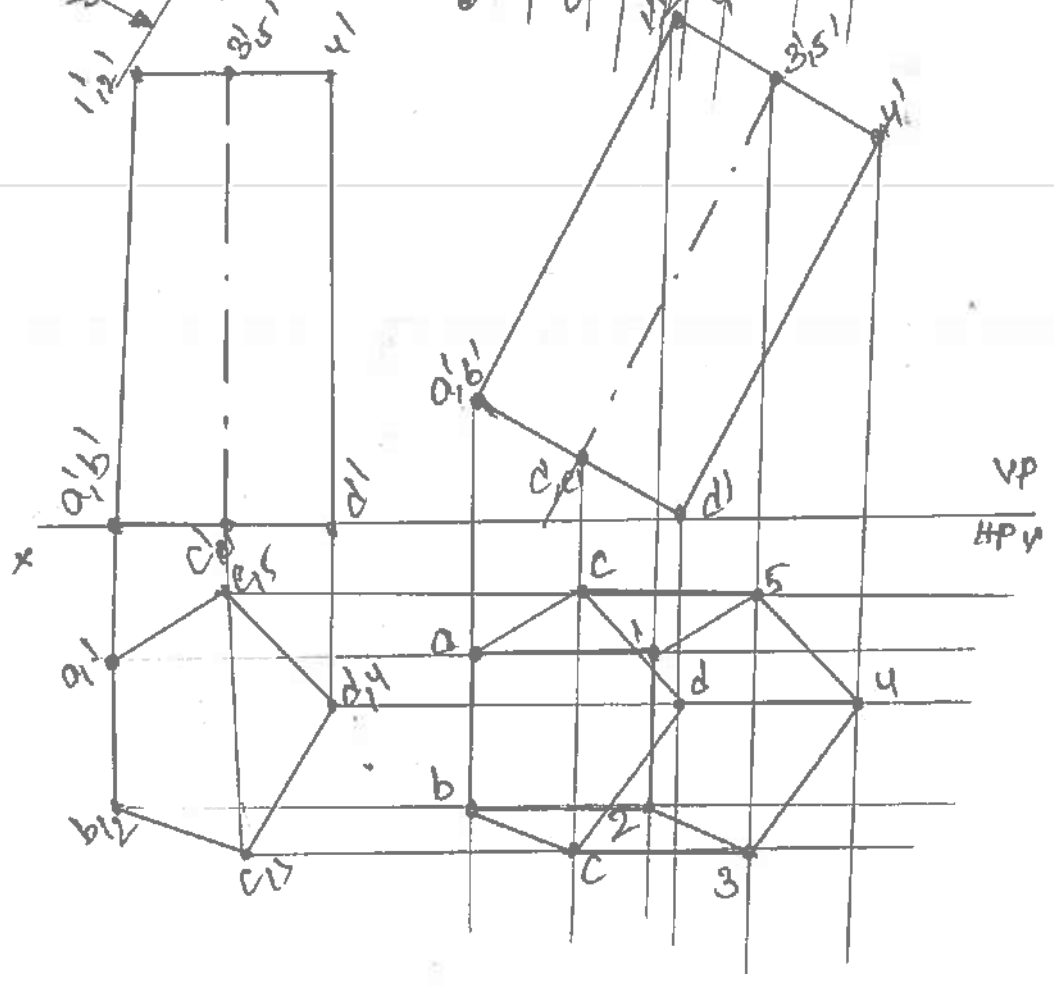
(8)(b)



(9)


5' 1' 4' 2' 3'
50
e' a' d' b' c'
x
VP
HP
a'1 b'2
c'3
e'5
d'4
25
5' 1' 4' 2' 3'
e' a' d' b' c'
a b 2
c B
e 5
d 4
1 2 3

(10)


3'5' 4'
1'2'
a'b' d'
c'e'
x
VP
HP
a'b'
c'd'
d'
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b'2'
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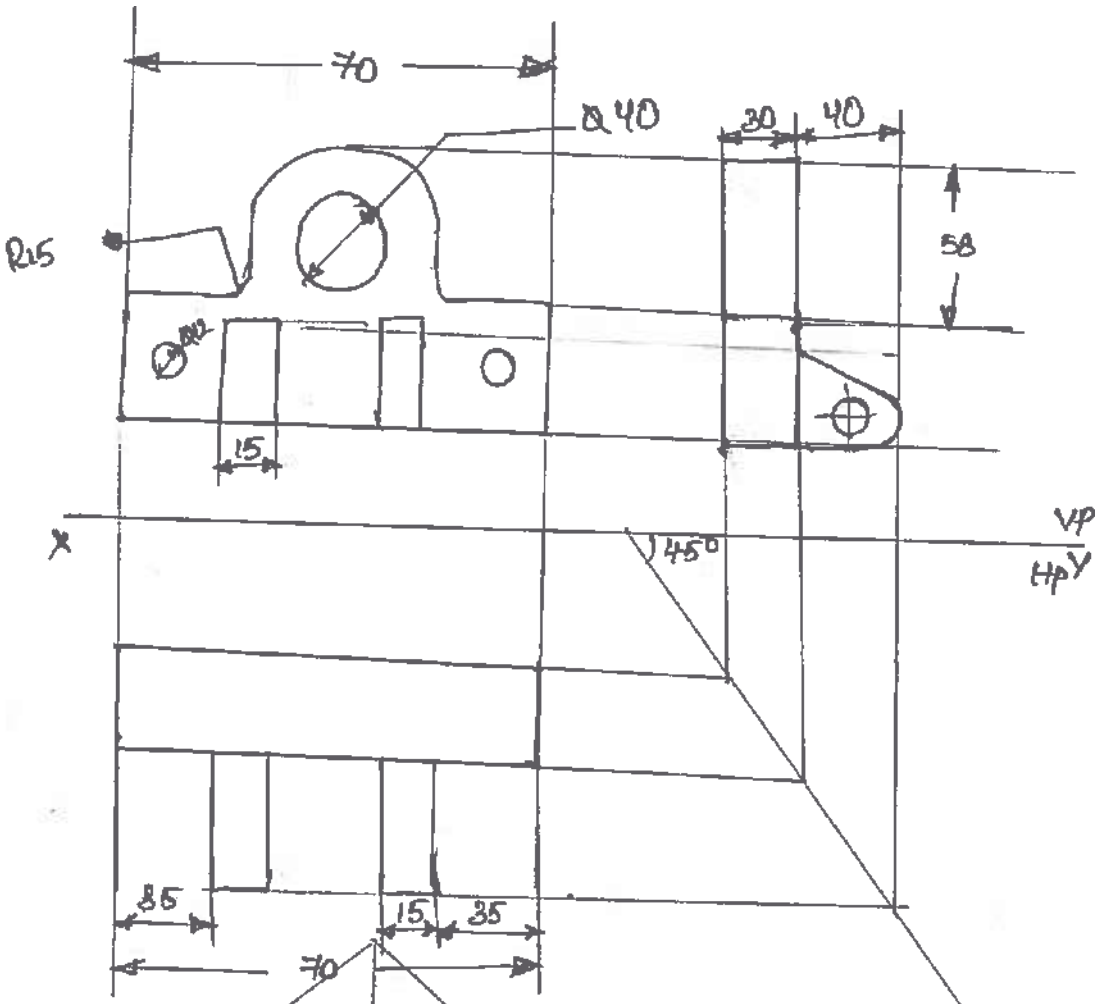
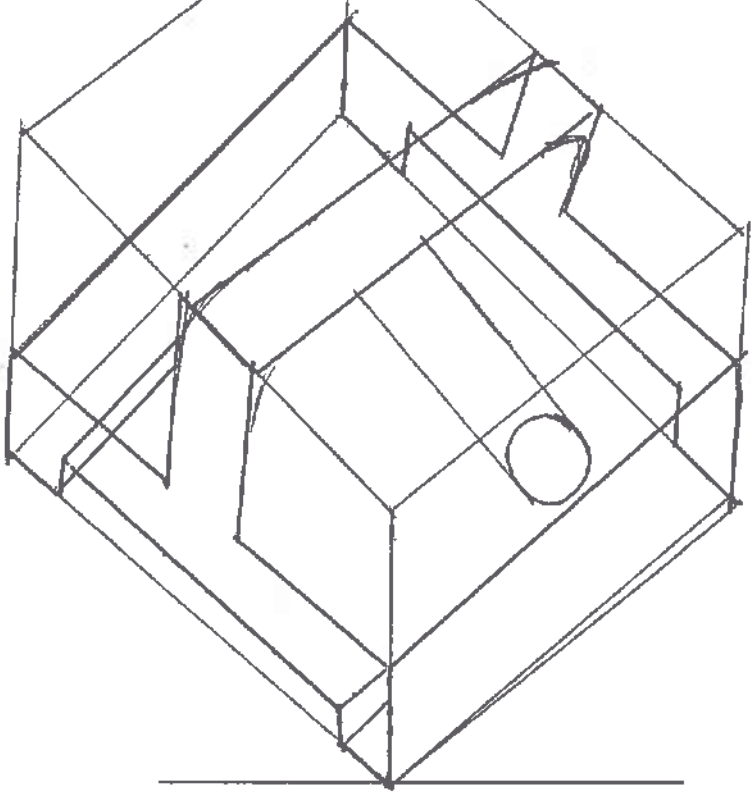
(11.)



(12.)



06/08

NSRIT

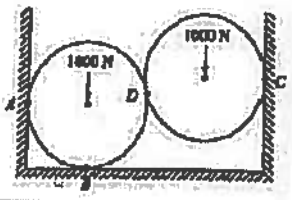
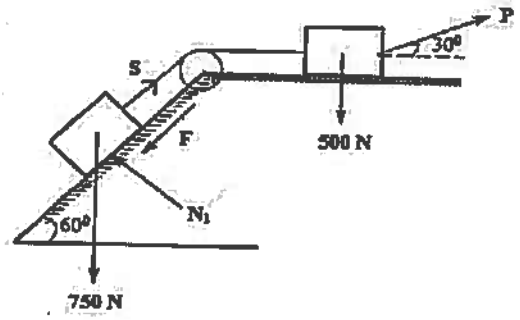
Semester End Regular/Supplementary Examination, August, 2022

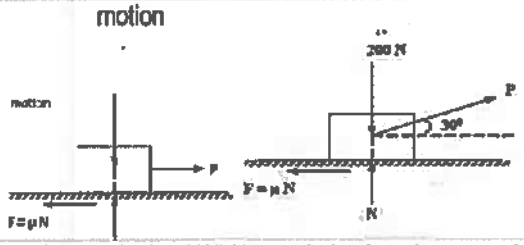
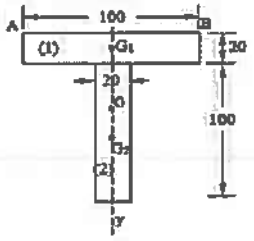
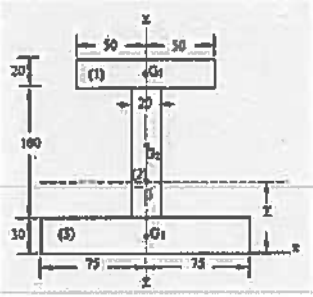
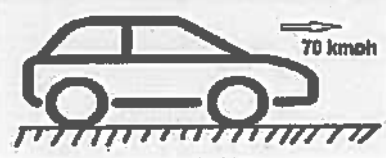
Degree	B. Tech. (U. G.)	**Program**	CE, EEE & ME			**Academic Year**	2021 - 2022
Course Code	20ESX04	**Test Duration**	3 Hrs.	**Max. Marks**	70	**Semester**	II
Course	**ENGINEERING MECHANICS**						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define Triangle Law of Forces	20ESX04.1	L1
2	State the laws of Friction	20ESX04.2	L1
3	State the location of Centroid of Semi Circle whose Radius is R with a sketch	20ESX04.3	L1
4	Differentiate between Rectilinear and Curvilinear Motions	20ESX04.4	L2
5	State the Work Energy Theorem	20ESX04.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Define Force, components of the Force, and the Resultant of the Force with examples	6M	20ESX04.1	L2
6 (b)	State and prove Lami's theorem	6M	20ESX04.1	L2
	OR			
7 (a)	Define the Free body Diagram, illustrate with two examples	6M	20ESX04.1	L2
7 (b)	Two spheres each of 1000N and of radius 25cm rest in a horizontal channel of width 90cm as Shown in figure. Find the reaction at the point of Contact A, B and C 	6M	20ESX04.1	L3
8 (a)	What is the value of P in the system shown in the figure to cause the motion to impend? Assume the pulley is smooth and coefficient of friction between the other two contact surfaces is 0.20 	8M	20ESX04.2	L3
8 (b)	What are the different conditions of Equilibrium, also write the equilibrium equations in Spatial force System	4M	20ESX04.2	L1
	OR			
9 (a)	A body of weight 200 N is placed on a rough horizontal plane. If the coefficient of friction between the body and horizontal plane is 0.3, determine a) Horizontal force required to impend motion b) Pull at an angle 30° to horizontal required to impend	8M	20ESX04.2	L2

	motion 			
9 (b)	A Block weighing ' W' Newton's is placed upon a plane inclined at an angle 'θ ' with Horizontal. What happens if the angle of friction ' Φ' is(a)greater than ' θ' (b)equal to ' θ' Φ(c)less than 'θ	4M	20ESX04.2	L3
10 (a)	Locate the centroid of T – section shown in figure 	6M	20ESX04.3	L3
10 (b)	Differentiate between Centroid and Centre of Gravity	6M	20ESX04.3	L2
	OR			
11 (a)	Locate the centroid of a Frustum of a cone of height 8cm and having a Diameter of 5cm and 8cm at top and bottom of the frustum of the cone respectively.	4M	20ESX04.3	L2
11 (b)	Locate the centroid of the following figure 	8M	20ESX04.3	L3
12 (a)	A lift can operate under a maximum of 8 persons; mass of the lift is 800Kg.Determine the limits of tension if the lift accelerates at constant rate of 1 m/s² either upwards or downwards. Take average weight of a person as 750N	6M	20ESX04.4	L3
12 (b)	A motorist travelling at a speed of 70 kmph, suddenly applies brakes and halts after 50m. Determine a) The time required to stop the car b) The coefficient of friction between the tyres and the road 	6M	20ESX04.4	L3
	OR			
13 (a)	A Particle is projected vertically upwards from the ground with an initial velocity of u m/sec. find a) The time taken to reach the maximum height b) The maximum height reached c) Time required for descending d) Velocity when it strikes the ground. Consider	6M	20ESX04.4	L3

	the upward motion of the particle			
13 (b)	A bullet fired from a height of 120m at a velocity of 360km/hr. at an angle of 300^0 upwards, neglecting the Air Resistance, find a)total time of flight b)Horizontal Range of bullet, c) Max .height reached by the bullet d)final velocity of the bullet just before touching the ground	6M	20ESX04.4	L3
14	Find the Power of a locomotive, drawing a train whose weight including that of engine is 420 kN up an incline 1 in 120 at a steady speed of 56 kmph, the frictional resistance being 5 N/kN. While the train is ascending the incline, the steam is shut off. Find how far it will move before coming to rest, assuming that the resistance to motion remains the same	12M	20ESX04.5	L3
	OR			
15	Derive the Work Energy equation for translation.	12M	20ESX04.5	L3

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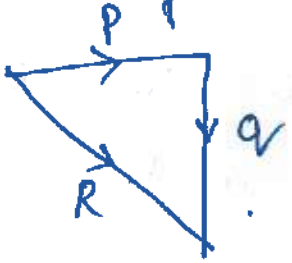
ANSWER KEY AND SCHEME OF EVALUATION

Part (A) (2 short Answer Questions)

1. **Triangle law of force:** (2M)

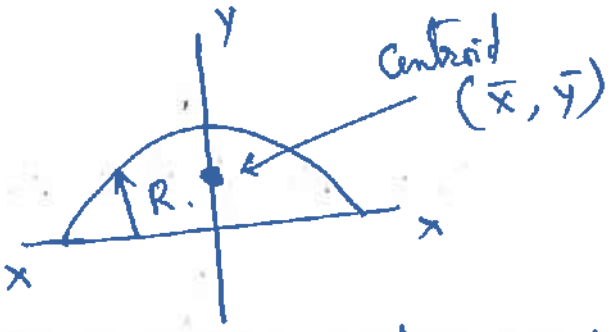
if P, Q are the two forces represented by the two sides of a triangle both in magnitude and the direction which are same directs order then the closing side of the triangle gives the resultant of these two in opposite order.



2. **Laws of friction:** (2M) ⇒ (Write any two)

1. friction acts in a direction opposite to the direction of motion
2. friction force depends on the nature of the surface in contact.
3. friction is independent of the sliding velocity
4. frictional force is directly proportional to the normal force.

3. location of Centroid of Semi Circle whose Radius is 'R' with a sketch. (2m)



4. Differentiate between Rectilinear and Curvilinear motions (2m)

* In rectilinear motion of the body travel same distance along parallel straight lines.
* In Curvilinear motion the trajectories of the body are Curved.

5. Work Energy Theorem (2m)

$$W = K_2 - K_1$$

$$K_1 = \frac{1}{2} m v_1^2$$

$$K_2 = \frac{1}{2} m v_2^2.$$

States that net work done Equals the change in its kinetic energy.

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ANSWER KEY AND SCHEME OF EVALUATION

Part (B) [Long Answer Questions].

6 (a) force; Component of force and Resultant of force: (6M)

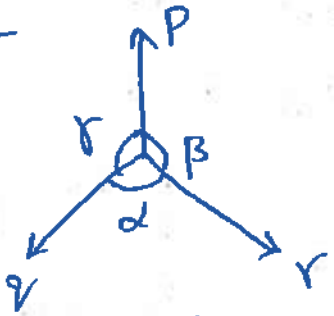
It is an external number which is acted on the body to change its state.

$F_H = F\cos\theta$; $F_V = F\sin\theta$

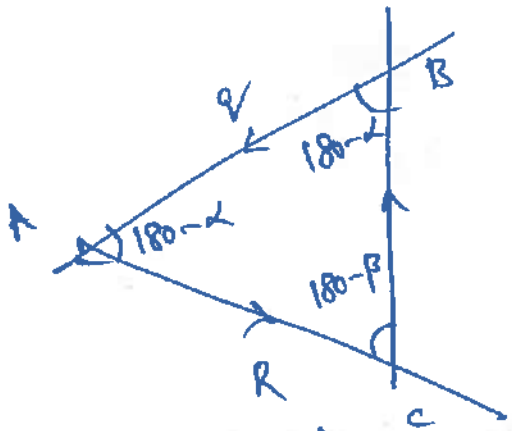
Resultant $(R) = \sqrt{(\Sigma H)^2 + (\Sigma V)^2}$

$R = F_1 + F_2 + F_3$.

(b) Lami's theorem: (6M)



The two forces acting at a point are in Equilibrium and hence they can be represented by the three sides of the Δle taken in the same order.



by the sine rule, we get.

$$\frac{Ac}{\sin(180-r)} = \frac{Bc}{\sin(180-\alpha)} = \frac{AB}{\sin(180-\beta)}$$

$$\frac{R}{\sin r} = \frac{P}{\sin\alpha} = \frac{Q}{\sin\beta}$$

7 (a) Free body diagram (6 m)

When the analysis of actual structure is done then it is simplified by considering the equilibrium of a portion of structure only. The portion is drawn separately showing all the forces acting on it.

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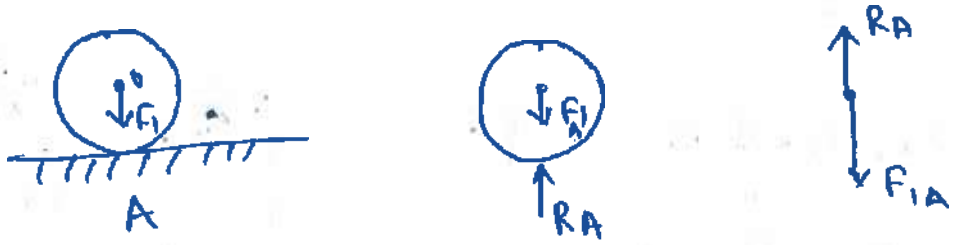
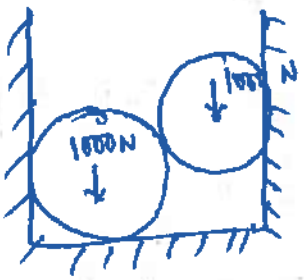
7(a)



7(b)

O_1, O_2 be the



$$\cos\alpha = \frac{O_1P}{O_1O_2} = \frac{90 - AO_1 - O_1C}{O_1D + O_2B}$$

$$\cos\alpha = \frac{90 - 25 - 25}{50} = 0.8$$

$$\sin\alpha = 0.6.$$

Sphere-2

$\Sigma V = 0$; $R_D \times 0.6 = 1000$

$R_D = 1666.66$

$\Sigma H = 0$; $R_C = R_D \times 0.3 = 1000$

$R_C = 1333.33$

Sphere-1

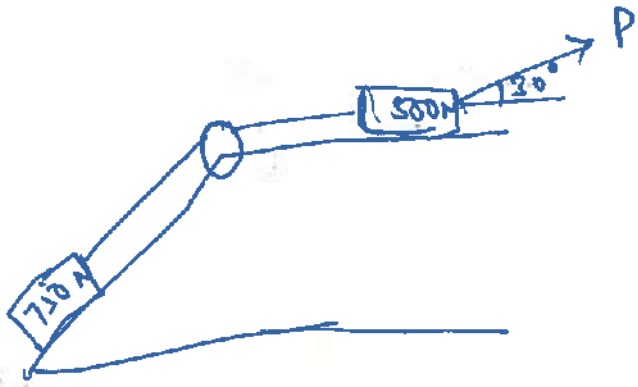
$\Sigma V = 0$; $R_B = 1000 + (R_D \times 0.6)$

$R_B = 1999.996$

$\Sigma H = 0$.

$R_A = 1333.32 - 8$

8 (a) (8M)



Σ = forces normal to the plane = 0.

$$N_1 - 750 \cos 60^\circ = 0$$

$$N_1 = 375\,N$$

motion is impending law of friction

$$F_1 = \mu N_1$$

$$= 0.3 \times 375 = 112.50\,N$$

Σ forces parallel to plane = 0

$$T - F_1 - 750 \sin 60^\circ = 0$$

$$T - 112.5 + 750 \sin 60$$

$$\boxed{T = 762.0\,N}$$

Consider the Equilibrium of 500N block

$$\Sigma F_V = 0$$

$$N_2 - 500 + P \sin 30^\circ N_2 + 0.5P = 500$$

$$N_2 = (500 - 0.5P)$$

from law of friction

$$F_2 = \mu N_2$$

$$= 0.3 \times (500 - 0.5P)$$

$$= 150 - 0.15P$$

ΣF_H.

$$P \cos 30 - T - F_2 = 0$$

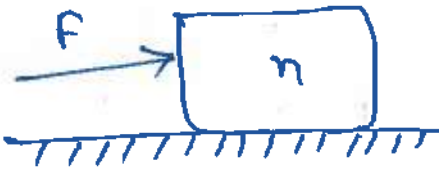
$$P \cos 30^\circ - 762.0 - 150 + 0.15P$$

$$P(0.866 - 0.15) = 612.01$$

$$\boxed{P = 854.76}$$

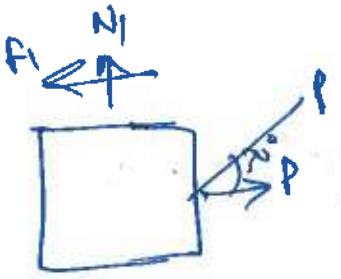
ANSWER KEY AND SCHEME OF EVALUATION

8(b) Equilibrium : (4m)



$\Sigma H = 0$
$\Sigma V = 0$ } Collinear forces.
$\Sigma M_A = 0$ } parallel forces.

9(a)



$\Sigma H = 0$

$F_1 - T = 0 \qquad T = F_1$

$\Sigma V = 0$

$N_2 - N_1 - 200 = 0$

$N_2 = 200 + N_1$

$P = F_1 + F_2$

if P is inclined ($\theta = 30^\circ$) then.,

$\Sigma V = 0$.

$\Sigma F_H = 0 \Rightarrow T = F_1$

$N_2 - 200 - N_1 + P \sin 30^\circ$

$f_2 = \mu N_2$

$P \cos 30 - f_1 - f_2 = 0$

$P \left(\cos 30 + \frac{0.5}{3} \right) = 0$

$P =$ ____ Newton

9 (b) (4m)

$F/N = \tan\theta$

$\tan\phi = F/N$.

$\tan\phi = \tan\theta$

$\boxed{\phi = \alpha}$

$\tan\phi = \mu = \tan\alpha$

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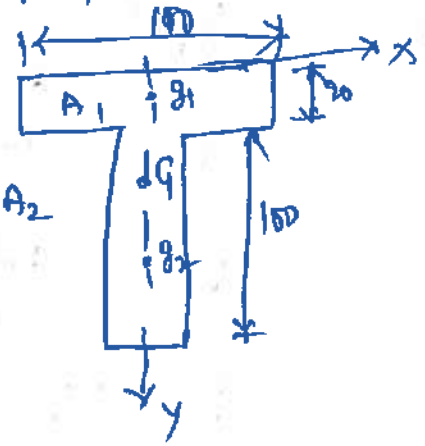
ANSWER KEY AND SCHEME OF EVALUATION

(6M)

10(a) Locate the Centroid of T-section.



Two rectangles areas A_1 & A_2 each of size 100×20 and 20×100

The Centroid of A_1 and A_2 are $g_1(0,10)$ & $g_2(0,70)$

$$\bar{y} = \frac{100 \times 20 \times 10 + 20 \times 100 \times 70}{100 \times 20 + 20 \times 100} = 40 \text{ mm}$$

10(b) Difference between Centroid & Centre of Gravity (6M)

(1) The term Centre of gravity applies to bodies with mass and weight, and Centroid applies to plane areas.

(2) Centre of gravity of a body is a point through which the resultant gravitational force (weight)

acts for any orientation of the body whereas centroid is a point in a plane area such that the moment of area about any axis through that point is zero.

11 (a) Centroid of a Cone. (4m)

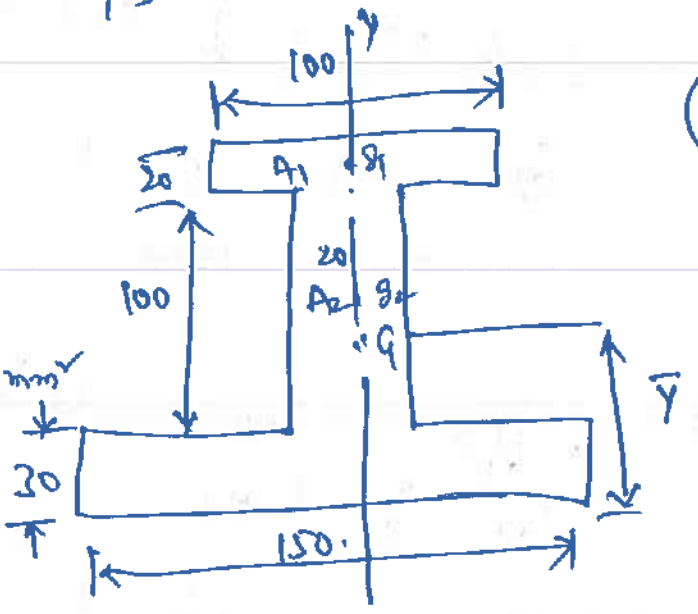
$b_1/b = (h-y)/h$

$b_1 = \left(\frac{h-y}{h}\right) b$

$\bar{y} = h/2.$

$h/3$ or $2h/3$

11 (b) (8m)



$A_1 = 100 \times 20 = 2000\ mm^2$

$y_1 = 30 + 100 + \frac{20}{2}$

$= 140mm$

$A_2 = 100 \times 20 = 2000\ mm^2$

$y_2 = 30 + \frac{100}{2} = 80mm$

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ANSWER KEY AND SCHEME OF EVALUATION

11(b) $A_3 = 150 \times 30 = 4500\ mm^2$ ✓

$Y_2 = 30/2 = 15\ mm$

$$\bar{Y} = \frac{A_1Y_1 + A_2Y_2 + A_3Y_3}{A} = 59.71\ mm$$

(6m)

12(a) $\Sigma V = 0$

$R - W + F = 0$

$R - W + \frac{W}{g}(a) = 0$

$$R = \frac{-W}{g}(a) + W$$

$\Sigma V = 0$

$R - W - F = 0.$

$R - W - W/g\,(a) = 0.$

$$R = W + \frac{W}{g}(a)$$

(6m)

12(b) $v^2 - u^2 = 2as$

$v = u + at$

$v = 0 \; ; \; u = \frac{70 \times 1000}{60 \times 60} = 19.4\ m/s$

$v^2 - u^2 = 2as$

$0 - (19.4)^2 = 2a \times 50$

$\boxed{a = -3.78 \text{ m/s}^2}$

$v = u + at$

$0 = 19.4 + (-3.76)t$

$\boxed{t = 5.13 \text{ s}}$

(ii) $\Sigma H = 0.$

$W/g\,(a) - \mu N = 0.$

$\Sigma V = 0.$

$\boxed{N = W}$

$W/g\,(a) - \mu W = 0.$

$\boxed{\mu = a/g.}$

$\mu = -3.78 / 9.81$

$\boxed{\mu = 0.38}$

(6m)

13 (a) (i) Time taken:

$v = u + at$

$0 = u + (-g)t.$

$\boxed{t = u/g}$

$u = -g = -9.81$

(ii) $v^2 - u^2 = 2as$

$0 - u^2 = 2(-g) \times h$

$u^2 = 2gh$

$\boxed{h = u^2/2g}$

(iii) $v = u + at$

$0 = u + gt.$

$\boxed{t = -u/g}$

(iv) $v^2 = 2g\,(u^2/2g)$

$\boxed{v = u}$

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ANSWER KEY AND SCHEME OF EVALUATION

(6m)

13(b) $h = 120m$

$\theta = 30^\circ$

$u = 360 \text{ km/hr}$

(i) $v = u + at$

$t = u/g$

(ii) $v^2 - u^2 = 2as$

$h = u^2/2g$

(iii) $v^2 = 2g(u^2/g)$

$v = u$

(iv) $u = -g = -9.81$

$u = g$

(6m)

14(a) $N = W = 420$

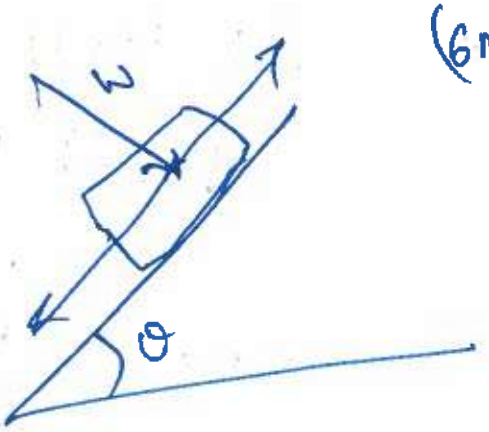
Speed $= 56 \text{ km/hr}$

$\mu = 5 \text{ N/kN}$

$\text{velocity} = \frac{56 \times 1000}{60 \times 60} = 15.5 \text{ m/sec.}$

$F = \mu N$

$F = 5 \times 420 = 2.1 N$



$\Sigma H = 0$

$P - W\sin\theta - F = 0$

$P - 420/120 - 2.1 = 0.$

$\boxed{P = 5.6\ kN}$

Power of the locomotive = work done of P/sec

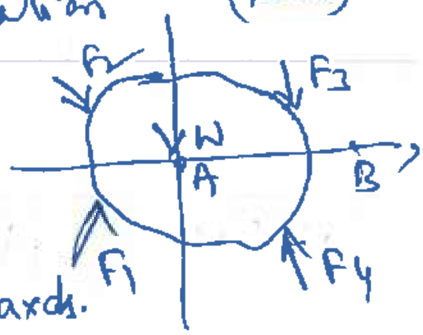
$= P \times V = 5.6 \times 15.5$

$\boxed{P = 86.80\ kN}$

Energy = k.E $\Rightarrow$ $P \times s = \frac{1}{2} mv^2$

$\boxed{S = 918.31\ m}$

15. Work Energy Equation for translation (12M)



Resultant $R = \Sigma F_x$.

$R = W/g \times a.$

elementary distance $R\,ds = W/g \times a \times ds.$

$W/g \times v\, dv/ds \times ds$

$= W/g\ v\,dv.$

Work done = Final kinetic Energy − Initial kinetic Energy

$= Wu^2/2g - Wv^2/2g.$

N 6/8/2021 Mech (Dr.P.N.E.Naveen)

NSRIT

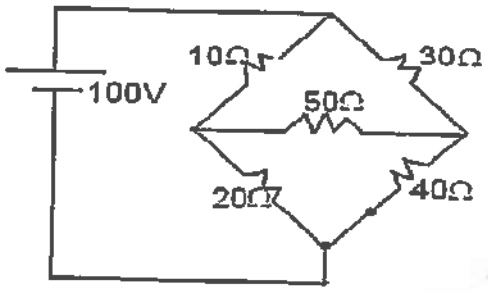
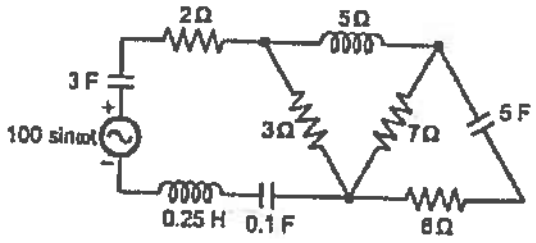
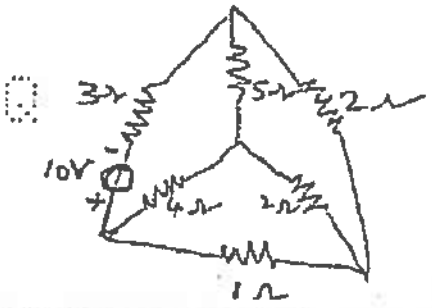
Semester End Regular/Supplementary Examination, August, 2022

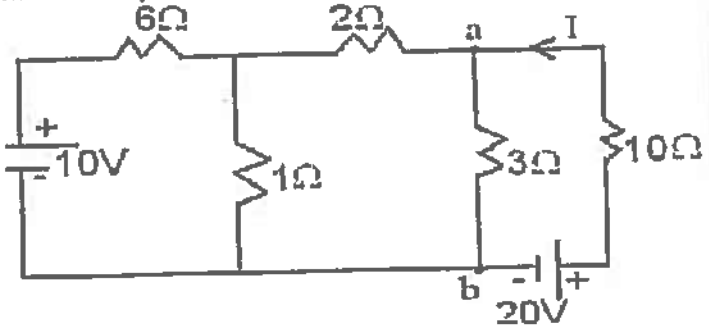
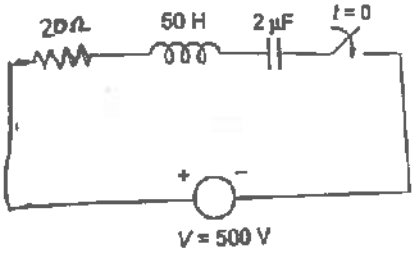
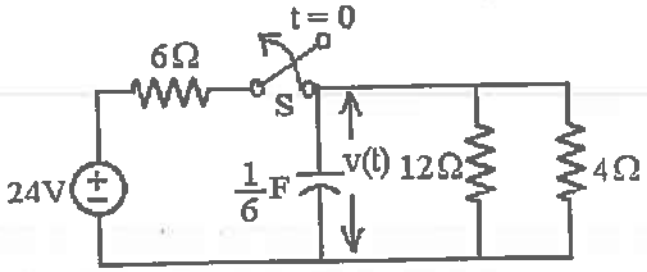
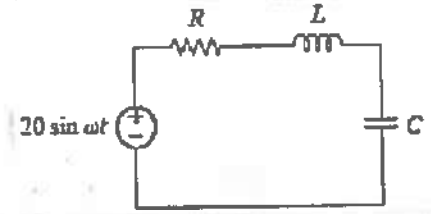
Degree	B. Tech. (U. G.)	Program	ECE			Academic Year	2021- 2022
Course Code	20EE201	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	Network Analysis and Synthesis						

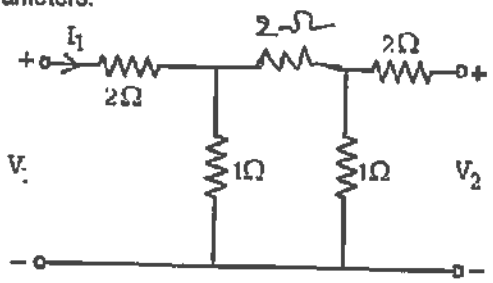
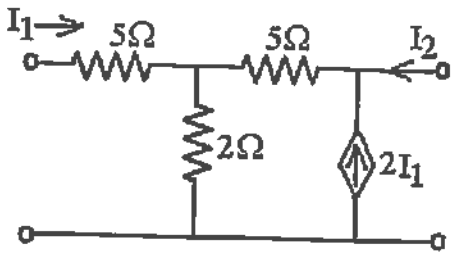
Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Write about source transformation.	20EE201.1	L1
2	State Norton's Theorem.	20EE201.2	L1
3	Define time constant and write its significance.	20EE201.3	L1
4	Give the conditions of Series and Parallel resonance.	20EE201.4	L1
5	Write the relation between Z and Y parameters.	20EE201.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Determine the current through 50 ohm resistor  Figure 5:	6M	20ESX05.1	L3
6 (b)	Explain Mesh Analysis with an example.	6M	20ESX05.1	L2
	OR			
	For the network shown in Figure, draw the following a) Graph b) Tree c) Dual network.			
7 (a)		6M	20ESX05.1	L2
	For the fallowing network writedown number of branches,nodes and links. Write incidence matrix also			
7 (b)		6M	20ESX05.1	L3

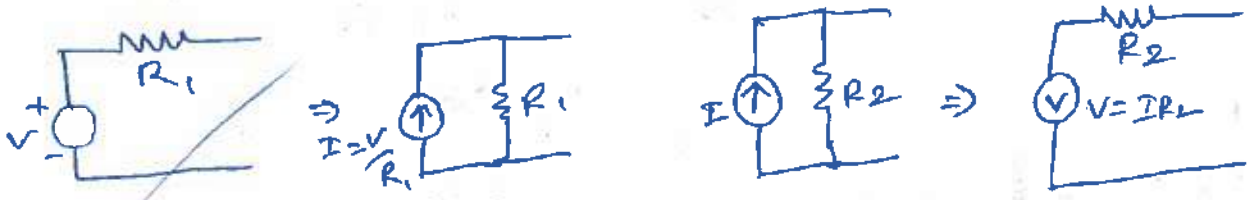
8 (a)	State and Explain Compensation theorem with an Example. Replace the network to the left of the terminals 'ab' by its Thevenin's equivalent circuit. Hence determine 'I'.	8M	20ESX05.2	L2
8(b)		4M	20ESX05.2	L3
	OR			
9 (a)	Realize Z(s) = (S^3 +4S)/(S^4 +10S^2+9)in Cauer I forms	6M	20ESX05.2	L3
9 (b)	State and explain the properties of positive real function	6M	20ESX05.2	L2
10	From the RLC circuit given find i(0+), di/dt and d^2i/dt^2 at $t=0^+$, if the switch is closed at t=0 	12M	20ESX05.3	L3
	OR			
11 (a)	Describe the procedure for evaluation of initial conditions of R, L and C. Find v(t) for t ≥ 0 and initial energy stored across a capacitor for the circuit shown in Fig.1. When the switch is opened at t = 0.	6M	20ESX05.3	L2
11(b)		6M	20ESX05.3	L3
12 (a)	Explain dot conversion for coupled circuits.	4M	20ESX05.4	L2
12 (b)	Derive expression for self and mutual inductance.	8M	20ESX05.4	L3
	OR			
13	In the circuit shown in below Figure.6 R = 2 ohms, L = 1 mH, and C = 0.4 μF. a) Find the resonant frequency and the half-power frequencies. b) Calculate the quality factor and bandwidth. 	12M	20ESX05.4	L3

14	Determine Y – parameters of the below Figure. Hence determine the h-parameters. 	12M	20ESX05.5	L3
	OR			
15(a)	Derive the relation between h-parameters and Z-parameters of a two port networks.	6M	20ESX05.5	L2
15(b)	Determine the Z – Parameters and transmission parameters of the current shown in 	6M	20ESX05.5	L2

I-II ECE - NAAS scheme and key.

1) write about source transformation? (2M)

A) The convertion of voltage source to current source (or) current source to voltage source is called source transformation.



2) State Norton's theorem (2M)

A) Norton's theorem states that any two-terminal linear network with current sources, voltage sources and resistances can be replaced by an equivalent circuit consisting of a current source in parallel with a resistance.

3) Define time constant and write its significance. (2M)

A) Time constant of R-L circuit tells how fast or how slow is the growth/decay of current in the R-L circuit.

→ Low value of time constant indicates that growth and decay are fast.

→ Large value indicates growth and decay of current are slow.

) Conditions of series & parallel resonance? (2M)

1)→ In a series RLC circuit, whenever the inductive reactance is equivalent to the capacitive reactance, then the circuit is said to be in resonance

when $X_L = X_C$

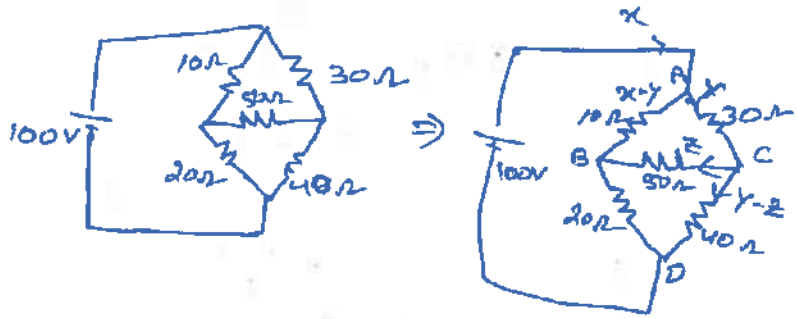
→ In parallel circuit the condition of resonance is when current is in phase with voltage or net susceptance is zero and equating the imaginary part to zero.

5) Relation between z and y parameters (2m)

4) $z_{11} = \frac{Y_{22}}{\Delta Y}$ $z_{12} = \frac{-Y_{12}}{\Delta Y}$ $Y_{11} = \frac{z_{22}}{\Delta z}$ $Y_{12} = \frac{-z_{12}}{\Delta z}$

$z_{21} = \frac{-Y_{21}}{\Delta Y}$ $z_{22} = \frac{Y_{11}}{\Delta Y}$ $Y_{21} = \frac{-z_{21}}{\Delta z}$ $Y_{22} = \frac{z_{11}}{\Delta z}$

6a) Current through 50Ω resistor. (6M)



Loop 1 :- ABCA

$-30y - 50z + 10(x-y) = 0$

$-30y + 10x - 10y - 50z = 0$

$10x - 40y - 50z = 0$ — (1)

Loop 2 :- BCDB

$-40(y-z) + 20(x-y+z) + 50z = 0$

$-40y + 40z + 20x - 20y + 20z + 50z = 0$

$20x - 60y + 110z = 0$ — (2)

Loop 3 :- ABDA

$10(x-y) + 20(x-y+z) - 100 = 0$

$10x - 10y + 20x - 20y + 20z - 100 = 0$

$30x - 30y + 20z = 100$ — (3)

Solve (1) & (2)

$10x - 40y - 50z = 0 \times 20$

$20x - 60y + 110z = 0 \times 10$

$200x - 800y - 1000z = 0$

$200x - 600y + 1100z = 0$

$-200y - 1000z = 0$ — (4)

$-2y - z = 0$

$z = -2y$

Solve (2) & (3)

$20x - 60y + 110z = 0 \times 30$

$30x - 30y + 20z = 100 \times 20$

$600x - 1800y + 3300z = 0$

$600x - 600y + 400z = 2000$

$-1200y + 2900z = -2000$ — (5)

$-1200y + 2900(-2y) = -2000$

$-1200y - 5800y = -2000$

$-7000y = -2000$

$y = \frac{2000}{7000} = 0.285A$

$z = -2y = -2(0.285)$

$z = -0.57A$

Solve (4) & (5)

$200y + 100z = 0 \Rightarrow 2y + z = 0 \times 12$

$-1200y + 2900z = 0$ 2) $-12y + 29z = 20 \times 2$

$24y + 12z = 0$

$-24y + 58z = 40$

$70z = 40$

$z = \frac{40}{70} = 0.57$

$z = 0.57A$

Current flowing through 50Ω is 0.57A

6b) Mesh analysis with example. (6m)

A) Mesh analysis

Procedure - 4m
example - 2m

step 1:- Identify meshes and label mesh currents in either clockwise or anti clockwise direction.

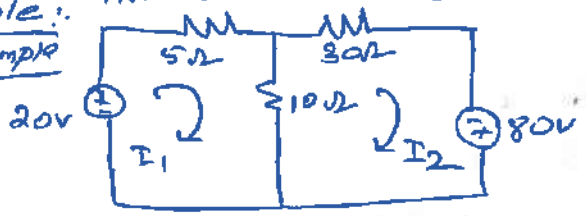
step 2:- Observe amount of current that flows through each element in terms of mesh currents.

step 3:- write mesh equations by applying KVL and ohm's law.

step 4:- solve mesh equations and obtain mesh currents.

example:- any example

find I through 30Ω



mesh equation (1):-

$20 - 5I_1 - 10(I_1 - I_2) = 0$

$-15I_1 + 10I_2 + 20 = 0$ — (1)

mesh equation (2):-

$-10(I_2 - I_1) - 30I_2 + 80 = 0$

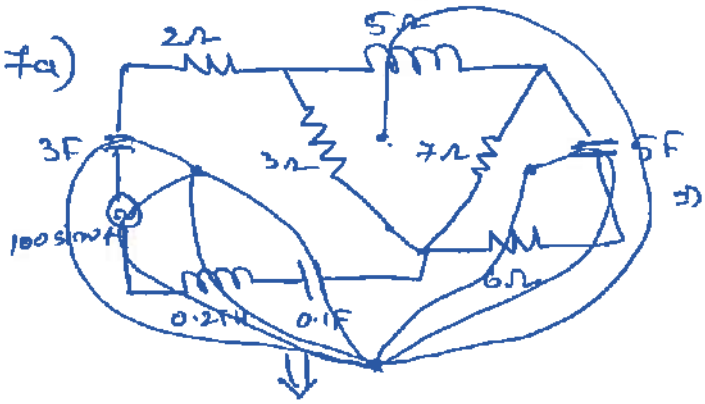
$-4I_2 + I_1 + 8 = 0$ — (2)

solving equation (1) and (2)

we get $I_1 = \frac{16}{5}$ A $I_2 = \frac{14}{5}$ A

Current flowing through 30Ω is $I_2 = \frac{14}{5}$ A →

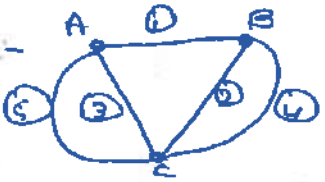
7a)



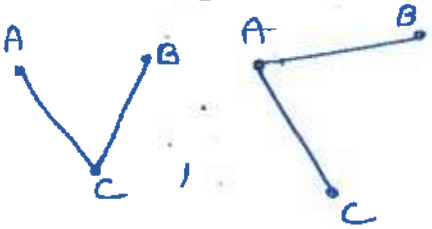
⇒

6m

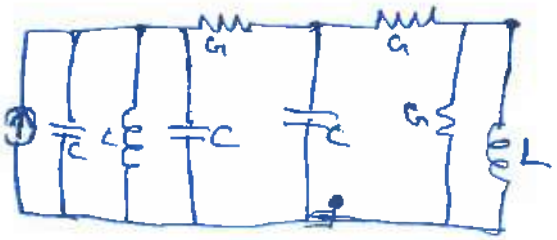
a) Graph:-



b) Tree:



c) Dual network:-

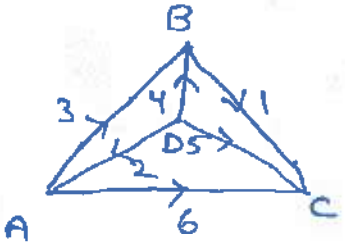


*6) 

write branches, nodes, links and incidence matrix

(6m)

The oriented graph of above network is



No. of branches = 6

No. of nodes = 4

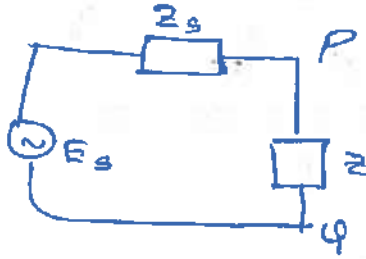
The incidence matrix is

Nodes	Branches 1	2	3	4	5	6
A	0	-1	1	0	0	1
B	1	0	-1	-1	0	0
C	-1	0	0	0	-1	-1
D	0	1	0	+1	1	0

8)a) **Compensation theorem:-**

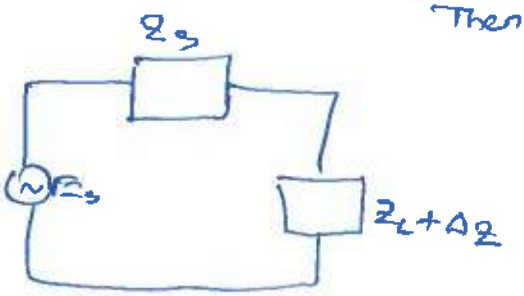
(8m) => statement - 2M
explanation - 3M
example - 3M

Compensation theorem states that the resistance of any network can be replaced by a voltage source, having the same voltage as the voltage drop across the resistance which is replaced. $V_c = I\Delta R_L$



$$i = \frac{E_s}{Z_s + Z_L}$$

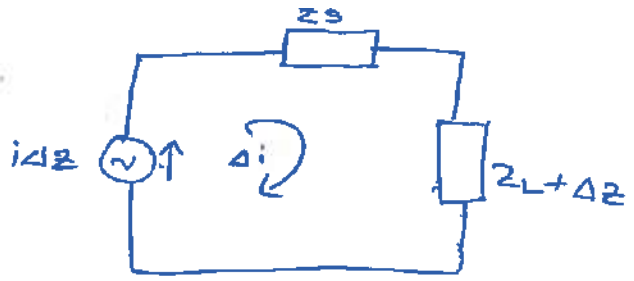
impedance change from Z_L to $(Z_L + \Delta Z)$



Then $i = \dfrac{E_s}{Z_s + Z_L + \Delta Z}$

$$\Delta i = \frac{E_s}{Z_s + Z_L} - \frac{E_s}{Z_s + Z_L + \Delta Z}$$

$$= \frac{E_s \Delta Z}{(Z_s + Z_L)(Z_s + Z_L + \Delta Z)} = \frac{i \Delta Z}{Z_s + Z_L + \Delta Z}$$

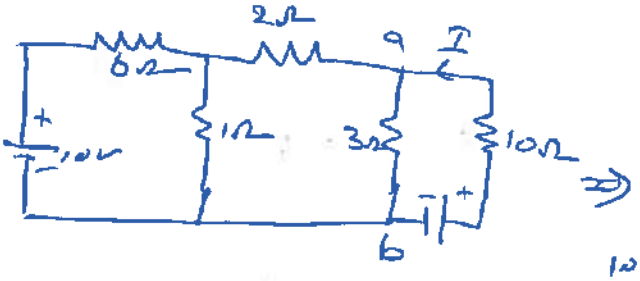


By compensation theorem, small change in current due to small change in impedance,

$$\Delta i = \frac{i\Delta Z}{Z_{total}}$$

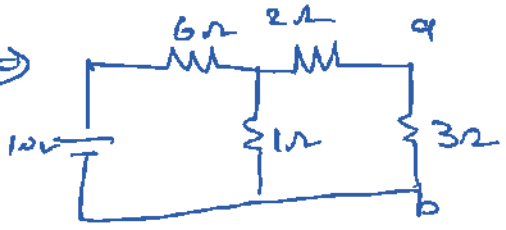
Any example.

8b)

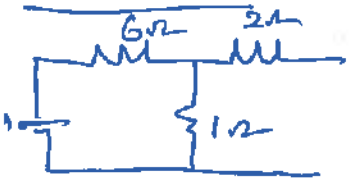


(Um)

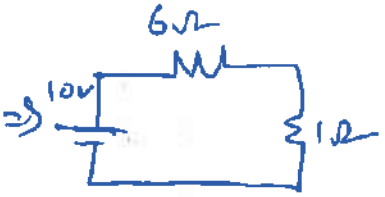
Thevenin's equivalent circuit



Remove 3Ω



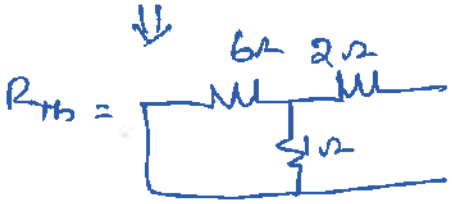
⇒ as it is open circuited 2Ω can be neglected then



$$\Rightarrow I = \frac{10}{6+1} = \frac{10}{7} = 1.42A$$

$V_{OC} = IR = 1.42 \times 1$

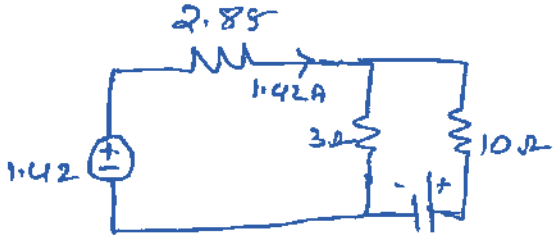
$V_{OC} = 1.42V$



$6\Omega // 1\Omega + 2\Omega \Rightarrow \frac{6\times1}{6+1} + 2 = \frac{6}{7} + 2$

$= 0.85 + 2$

$R_{Th} = 2.85\Omega$



$$\Rightarrow I = \frac{1.42 \times 3}{10+3}$$

$I = 1.65A$

9a) Realize $Z(s) = \frac{s^3+4s}{s^4+10s^2+9}$ Cauer form I. (6m)

step 1: identify the network

By observing given function is LC N/w

odd polynomial

even polynomial

step 2: perform division

$s^3+4s \;)\; s^4+10s^2+9 \;(\; s$

s^4+4s^2

$6s^2+9 \;)\; s^3+4s \;(\; s/6$

$s^3+9s/6$

$\frac{6s}{2} \;)\; 6s^2+9 \;(\; 12s/5$

$6s^2$

$9 \;)\; \frac{5s}{2} \;(\; 5s/18$

$\frac{9s}{2}$

0

step 3: first element of N/w

$Z = \frac{s^3}{s^4} = \frac{1}{s} = \frac{1}{Cs}$

first element capacitor.

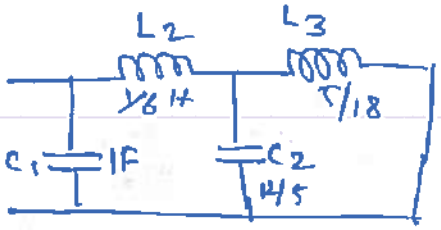
The circuit elements can be obtained by taking coefficients

$s \rightarrow$ coefficient is '1' $\Rightarrow C_1 = 1F$

$s/6 \rightarrow 1/6 \Rightarrow L_2 = 1/6\ H$

$\frac{12s}{5} \rightarrow \frac{12}{5} \Rightarrow C_2 = \frac{12}{5}\ F$

$\frac{5s}{18} \rightarrow \frac{5}{18} \Rightarrow L_3 = \frac{5}{18}\ H$



9b) Properties of positive real function. (6m)

A) Function F(s) is positive real if following conditions are satisfied.

a) F(s) is real for real s

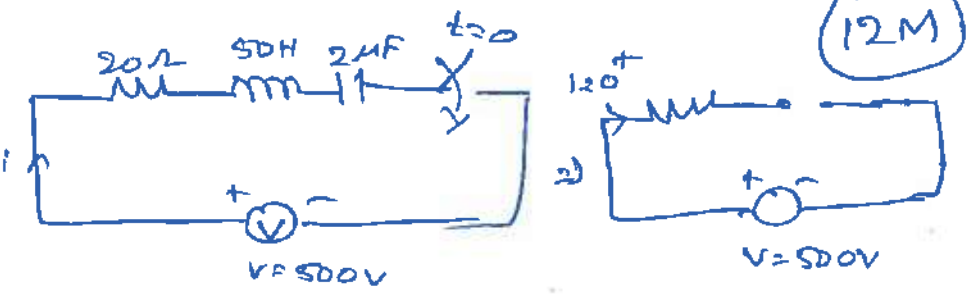
b) Real part of F(s) is greater than or equal to zero when real parts of 's' is greater than or equal to zero.

Properties

1) $F(s)$ is real then $\frac{1}{F(s)}$ is also positive real.
2) sum of 2 positive real functions is positive real function
3) Poles and zeros of positive real function cannot have positive real parts. i.e. should not present on right side of s-plane.
4) only simple poles with real positive residues can exist on $j\omega$-axis.
5) poles and zeros of positive real function are real or occur in conjugate pairs.
6) highest power of numerator and denominator differ by 1.
7) Lowest power of denominator and Numerator differ by 1.

12M

10) given $R = 20\Omega$
$L = 50H$
$C = 2\mu F$



before closing switch, $i(0^-) = 0$

applying KVL, $V = 20i + 50\frac{di}{dt} + \frac{1}{2\times10^{-6}}\int i\,dt$

i at $t = 0^+ = 0$,

$\frac{1}{C}\int v\,dt = V_c$, V_c at $t = 0^+ = 0$

so equation becomes

$$V = 20\,i(0^+) + 50\frac{di(0^+)}{dt} + v_c(0^+)$$

$$500 = 20\times0 + 50\frac{di(0^+)}{dt} + 0$$

$$\frac{di(0^+)}{dt} = \frac{500}{50} = 10\ A/sec$$

differentiating equ-① w.r.t 't',
we get

$$0 = 20\frac{di}{dt} + 50\frac{d^2i}{dt^2} + \frac{1}{2\times10^{-6}}i$$

Substituting conditions $t=0^+$

$$0 = 20\frac{di(0^+)}{dt} + 50\frac{d^2i(0^+)}{dt^2} + \frac{1}{2\times10^{-6}}i(0^+)$$

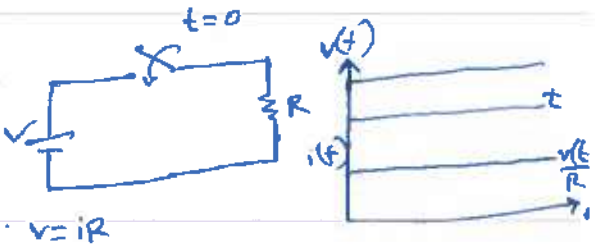
$$0 = 20\times10 + 50\frac{d^2i(0^+)}{dt^2}$$

$$\Rightarrow \boxed{\frac{d^2i(0^+)}{dt^2} = -\frac{200}{50} = -4\ A/sec^2}$$

11)a) Initial conditions of R, L, C :-

Resistor:

if step voltage is applied to resistor the current will have same waveform as input but will be altered in magnitude. $v=iR$

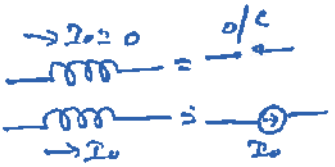


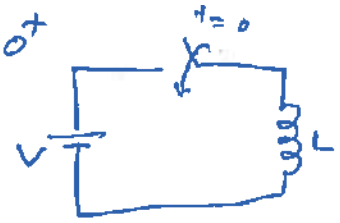
Hence if voltage changes, the current also changes. No transient period.

Inductor: we know current through inductor cannot change instantaneously. Accordingly if a voltage source is connected suddenly to inductor it will not cause current to flow initially and so inductor will act as open circuit. If it were carrying a current I_0, before switching, the same current will flow even after after switching.

Current at $t=0^-$ = Current at $t=0^+$

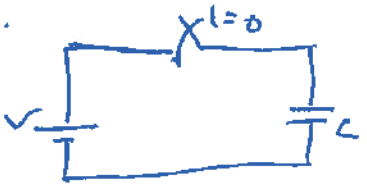
$V = L\frac{di}{dt}$

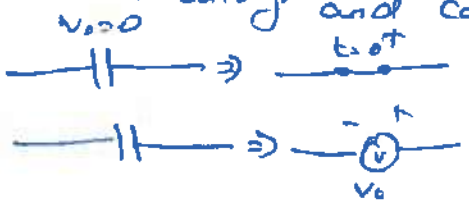




Capacitors: volt ampere relation $i = C\frac{dv}{dt}$

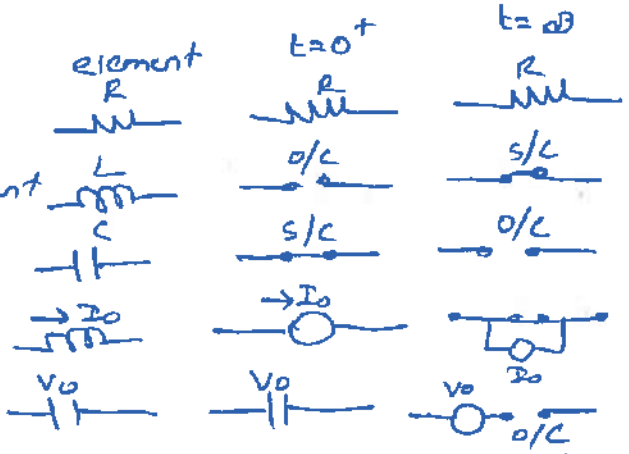
Voltage across a capacitor cannot change instantaneously. if it does current becomes infinite. If an uncharged capacitor is switched on to a DC source the current will flow instantaneously and capacitor acts as short circuit.





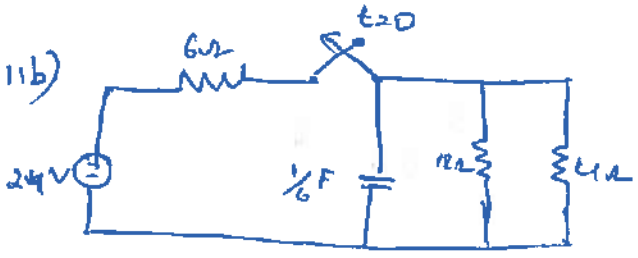
Procedure to find initial conditions:

Step 1: Draw equivalent circuit at $t = 0^+$, by replacing inductors with DC or constant current source and capacitor with sc or with constant voltage source. Resistors are left unchanged. Evaluate the initial values.



Step 2: find $\frac{di}{dt}$ and $\frac{dv}{dt}$ at $t=0^+$ write KCL or KVL for all values of 't'

11b)



sol: the equivalent circuit of the given circuit is.

Thevenin's equivalent circuit at aa' is

$$V_{th} = \frac{\left(\frac{24}{s}\right) \times \frac{1}{6s}}{6 + \frac{1}{6s}} = \frac{\frac{24}{6s}}{\frac{36s+1}{6s}} = \frac{24}{s} \cdot \frac{1}{36s+1}$$

$$= \frac{24}{36s^2 + s}$$

$$Z_{Th} = 6 \,//\, \frac{1}{6s} \,//\, 12$$

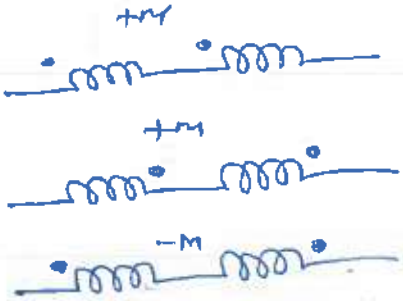
$$Z_{Th} = \frac{6 \times \frac{1}{6s}}{6 + \frac{1}{6s}} \,//\, 12$$

$$Z_{Th} = \frac{\frac{1}{s}}{\frac{36s+1}{6s}} = \frac{6}{36s+1}$$

$$I_L = \frac{V_{Th}}{Z_{Th}} = \frac{\frac{24}{s}}{\frac{36s+1}{6}} = \frac{24}{(36s+1)s}$$

$$I_L = 4/s$$

12a) Dot Convention: (4M)

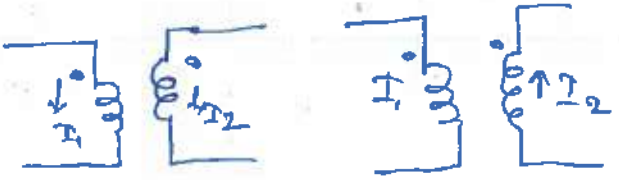


The relative polarity of induced voltage in coupled coils is determined by marking coils with dots(•).

On each coil a dot is placed at terminals which are of same polarity on the basis of mutual inductance.

The currents through each of the mutually coupled coils are either going away or towards the dot. The mutual inductance is considered positive when current through coil is leaving the dot, while it is considered negative when current is entering the dot.

Posibilities of Dot Convention



Electrically joined coupled coils

Series aiding

Series opposing

Parallel aiding

Parallel opposing

12) b) Expression for self and mutual inductance :- (8m)

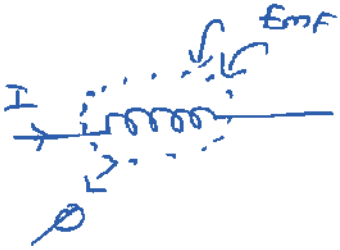
self (4m)

mutual (4m)

Self inductance :-

when current changes in circuit, the magnetic flux linking the same circuit changes and emf is induced in the circuit. emf is directly proportional to rate change of current.

$$V = L \frac{di}{dt} \quad -(1)$$



we know $L = \frac{N\phi}{I}$ -(2)

substituting above

$$V = L\left(\frac{d(N\phi/I)}{dt}\right)$$

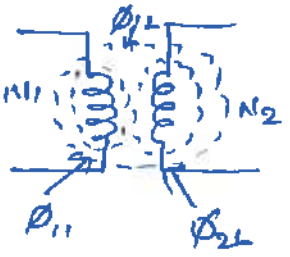
$$V = L \times \frac{1}{I} \times N \times \frac{d\phi}{dt}$$

$$V = N \frac{d\phi}{dt} \quad -(3)$$

Comparing (2) & (3) $L \frac{di}{dt} = N \frac{d\phi}{dt}$

$$\boxed{L = N \frac{d\phi}{dt}}$$

Mutual inductance :-



Mutual inductance is a constant proportionality b/w rate of change of current in one circuit and resulting emf in another circuit

$$V_{L2} = N_2 \frac{d\phi_{12}}{dt} \quad -(1)$$

$$V_{L2} = M \frac{di_1}{dt} \quad -(2)$$

Comparing both.

$$M \frac{di_1}{dt} = N_2 \frac{d\phi_{12}}{dt}$$

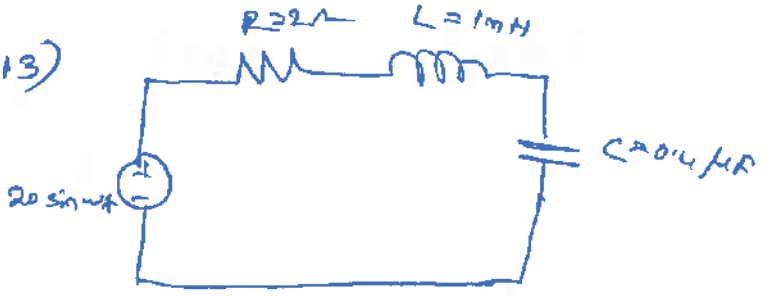
$$M = N_2 \frac{d\phi_{12}}{dI_1}$$

$$M = N_1 \frac{d\phi_{21}}{dI_2}$$

when coils are linked with air as medium the flux and current are linearly proportional to each other and

$$M = \frac{N_2 \phi_{12}}{I_1} \qquad M = N_1 \frac{\phi_{21}}{I_2}$$

13)



a) resonant frequency

given $R = 2\Omega$

$L = 1mH = 1 \times 10^{-3} H$

$C = 0.4 \times 10^{-6} F$

Resonant frequency $= f_0 = \frac{1}{2\pi\sqrt{LC}}$

$$f_0 = \frac{1}{2\pi\sqrt{10^{-3} \times 0.4 \times 10^{-6}}}$$

$$f_0 = \frac{1}{2\pi\sqrt{0.4 \times 10^{-9}}} =$$

Quality factor $= \frac{1}{R} \times \sqrt{\frac{L}{C}}$

$$= \frac{1}{2} \times \sqrt{\frac{10^{-3}}{0.4 \times 10^{-6}}}$$

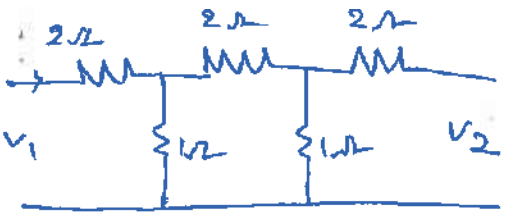
$=$

half power frequency $= f_0 = \sqrt{f_1 f_2}$

2) $f_1 f_2 = f_0^2$

we know $Q = \frac{f_0}{f_2 - f_1}$ 2) $f_2 - f_1 = \frac{f_0}{Q}$

14)



Y-parameters

$I_1 = Y_{11}V_1 + Y_{12}V_2$

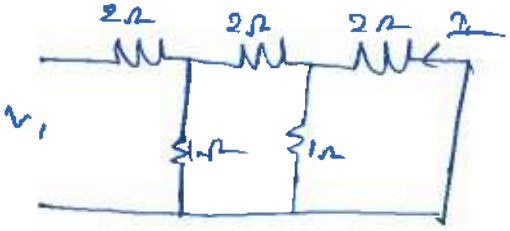
$I_2 = Y_{21}V_1 + Y_{22}V_2$

Step① By short circuiting output port.

$V_2 = 0$

Here $I_1 = Y_{11}V_1 \Rightarrow Y_{11} = I_1/V_1$

$I_2 = Y_{21}V_1 \Rightarrow Y_{21} = I_2/V_1$



$2//1 \Rightarrow \frac{2\times1}{2+1} = \frac{2}{3} = 0.66$

$\Rightarrow 0.66 + 2 = 2.66$

$2.66//1 \Rightarrow \frac{2.66\times1}{2.66+1} = \frac{2.66}{3.66} = 0.72$

$0.72 + 2 = 2.72\ \Omega$

$R_{eq} = 2.72\ \Omega$

$V_1 = I_1\, 2.72$

$\frac{I_1}{V_1} = \frac{1}{2.72} = 0.36\,\mho$

$Y_{11} = 0.36\,\mho$

$\frac{V_1}{2.72}\times\frac{1}{3}$

$Y_{11} = Y_{22}$

$I_2 = (I_1 - I_1')\times\frac{1}{3}$

$I_2 = \left(\frac{V_1}{2.72} - I_1'\right)\frac{1}{3}$

$I_2 = (0.122V_1)\frac{1}{3}$

$I_2 = 0.04\,V_1$

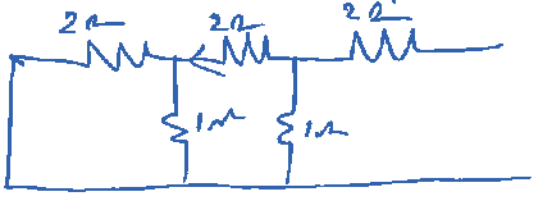
$\frac{I_2}{V_1} = -0.04\,\mho = Y_{21}$

Step② By short circuiting the input port

$V_1 = 0$

$I_1 = Y_{12}V_2 \Rightarrow Y_{12} = I_1/V_2$

$I_2 = Y_{22}V_2 \Rightarrow Y_{22} = I_2/V_2$



$2//1 \Rightarrow \frac{2\times1}{2+1} = \frac{2}{3} = 0.66$

$0.66 + 2 = 2.66$

$2.66//1 \Rightarrow \frac{2.66\times1}{2.66+1} = \frac{2.66}{3.66} = 0.72$

$0.72 + 2 = 2.72\ \Omega$

$R_{eq} = 2.72\ \Omega$

$V_2 = I_2\, 2.72$

$\frac{I_2}{V_2} = \frac{1}{2.72} = 0.36\,\mho$

$Y_{22} = 0.36\,\mho$

$I_2 = \frac{V_2}{2.72}$ $\quad I_2' = \frac{V_2}{2.72}\times\frac{1}{3}$

$I_2' = 0.122\,V_2$

$I_1 = -I_2'\times\frac{1}{2+1}$

$= -0.122\times\frac{1}{3}V_2$

$I_1 = -0.04\,V_2$

$\frac{I_1}{V_2} = Y_{12} = -0.04$

$$\begin{bmatrix} Y_{11} & Y_{12} \\ Y_{21} & Y_{22} \end{bmatrix} = \begin{bmatrix} 0.36 & -0.04 \\ -0.04 & 0.36 \end{bmatrix}$$

$\Delta y = 0.36\times0.36 - (-0.04\times-0.04)$

$= 0.1296 - 0.0016 = 0.128$

Relation between Y and h-parameter.

$$h_{11} = \frac{1}{Y_{11}} = \frac{1}{0.36} = 2.7 \qquad h_{21} = \frac{Y_{21}}{Y_{11}} = \frac{-0.04}{0.36} = -0.11$$

$$h_{12} = \frac{-Y_{12}}{Y_{11}} = \frac{-(-0.04)}{0.36} = 0.11 \qquad h_{22} = \frac{\Delta Y}{Y_{11}} = \frac{0.128}{0.36} = 0.35$$

15) a) relation between h-parameters and z parameters

we know z parameters

$$V_1 = z_{11} I_1 + z_{12} I_2$$
$$V_2 = z_{21} I_1 + z_{22} I_2$$

h-parameters

$$V_1 = h_{11} I_1 + h_{12} V_2$$
$$I_2 = h_{21} I_1 + h_{22} V_2$$

we get $V_2 = \frac{I_2 - h_{21} I_1}{h_{22}}$

Substituting above $V_1 = h_{11} I_1 + h_{12}\left(\frac{I_2 - h_{21} I_1}{h_{22}}\right)$

$$= \left(h_{11} - \frac{h_{12} h_{21}}{h_{22}}\right) I_1 + \frac{h_{12}}{h_{22}} I_2$$

$$= \left(\frac{h_{11} h_{22} - h_{12} h_{21}}{h_{22}}\right) I_1 + \frac{h_{12}}{h_{22}} I_2$$

$$\therefore V_1 = \frac{\Delta h}{h_{22}} I_1 + \frac{h_{12}}{h_{22}} I_2$$

Comparing both we get

$$z_{11} = \frac{\Delta h}{h_{22}} \qquad z_{12} = \frac{h_{12}}{h_{22}}$$

$$V_2 = \frac{1}{h_{22}} I_2 - \frac{h_{21}}{h_{22}} I_1$$

$$= -\frac{h_{21}}{h_{22}} I_1 + \frac{1}{h_{22}} I_2$$

$$z_{21} = \frac{-h_{21}}{h_{22}} \qquad z_{22} = \frac{1}{h_{22}}$$

Similarly 'h' interms of 'z'

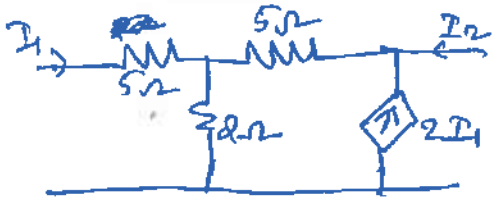
$$h_{11} = \frac{\Delta z}{z_{22}} \qquad h_{12} = \frac{z_{12}}{z_{22}}$$

$$h_{21} = \frac{-z_{21}}{z_{22}} \qquad h_{22} = \frac{1}{z_{22}}$$

15b) Z-parameters and ABCD parameters

$V_1 = Z_{11} I_1 + Z_{12} I_2$

$V_2 = Z_{21} I_1 + Z_{22} I_2$



Step 1: Consider $I_2 = 0$, o/p port O.C

Circuit is reduced to

$V_2 = 2I_1$

$I_1 = V_2/2$

Loop ②

$V_2 = 5(I_1 - I_1') + 2I'$

$V_2 = 5\left(\frac{V_2}{7}\right) + 2(I_2 - I_1)$

$V_2 = \frac{5V_2}{7} + 2I_2 - 2I_1$

$V_2 = \frac{5V_2}{7} + 2I_2 - V_2$

$V_2 = \frac{5V_2}{7} - V_2 + 2I_2$

$V_2 = \frac{5V_2 - 7V_2}{7} + 2I_2$

$V_2 = -\frac{2V_2}{7} + 2I_2$

$V_2 + \frac{2V_2}{7} = 2I_2$

$\frac{9V_2}{7} = I_2$

$\frac{9V_2}{14} = I_2 \Rightarrow \frac{V_2}{I_2} = \frac{14}{9} = 1.56 = Z_{22}$

~~$0.64 = I_2/V_2$~~

Loop ①

$V_1 = 5I_1 + 2(I_1 - I_2)$

$V_1 = 5I_1 + 2\left(I_1 - \frac{V_2}{2}\right)$

$V_1 = 5I_1 + 2\left(\frac{2I_1 - V_2}{2}\right)$

$V_1 = 7I_1 - V_2$

$7I_1 = V_1 + V_2$

$7I_1 = V_1 + 2I_1$

$7I_1 - 2I_1 = V_1$

$5I_1 = V_1$

$\frac{V_1}{I_1} = 5 = Z_{11}$

$I_2 = -I_1\left(\frac{2}{7}\right)$

$= \frac{V_2}{2}\left(\frac{2}{7}\right)$

$I_2 = V_2/7$

$7I_1 = V_1 + V_2$

$7I_1 = 5I_1 + V_2$

$2I_1 = V_2$

$\frac{V_2}{I_1} = Z_{21} = 2$

~~$7I_1 + 1 + 1$~~

$7I_1 = V_1 + V_2$

$I_1 = V_2/2$

$7(V_2/2) = V_1 + I_2(1.56)$

$7\left(\frac{I_2(1.56)}{2}\right) = V_1 + 1.56 I_2$

$5.46 I_2 = V_1 + 1.56 I_2$

$(5.64 - 1.56) I_2 = V_1$

$3.9 I_2 = V_1$

$\frac{V_1}{I_2} = 3.9 = Z_{12}$

$\begin{bmatrix} Z_{11} & Z_{12} \\ Z_{21} & Z_{22} \end{bmatrix} = \begin{bmatrix} 5 & 3.9 \\ 2 & 1.56 \end{bmatrix}$

ABCD parameters

$A = \frac{Z_{11}}{Z_{21}} = \frac{5}{2} = 2.5$

$B = \frac{\Delta Z}{Z_{21}} = \frac{7.8 - 7.8}{2} = 0$

$C = \frac{1}{Z_{21}} = \frac{1}{2} = 0.5$

$D = \frac{Z_{22}}{Z_{21}}$

$= \frac{1.56}{2}$

$= 0.78$

NSRIT

Semester End Regular/Supplementary Examination, August, 2022

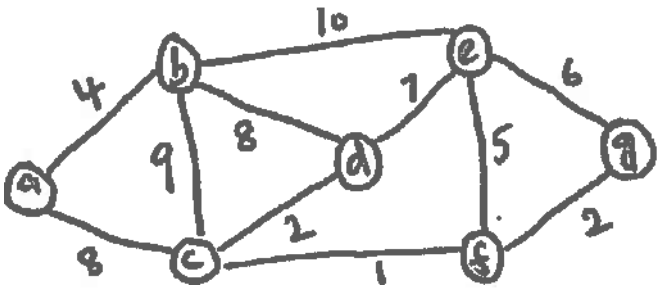
Degree	B. Tech. (U. G.)	Program	CSE/CSM/CSD			Academic Year	2021 - 2022
Course Code	20CS201	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	Data Structures Using 'C'						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define time complexity and space complexity.	20CS201.1	L1
2	Compare Linked list with Arrays.	20CS201.2	L1
3	Define a stack with an example.	20CS201.3	L1
4	Define a Binary tree with an example.	20CS201.4	L1
5	List any 4 applications of spanning trees.	20CS201.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Explain the Binary search with an example.	6M	20CS201.1	L2
6 (b)	Explain the Bubble sort with time complexity.	6M	20CS201.1	L2
	OR			
7 (a)	Explain algorithm for Linear Search with an example.	6M	20CS201.1	L2
7 (b)	Write the insertionsort algorithm and apply it to sort the following elements 11, 25, 13, 32, 17	6M	20CS201.1	L2
8 (a)	Explain the Single linked list representation and traverse the List.	6M	20CS201.2	L2
8 (b)	Explain with an algorithm to insert and delete elements using Single Linked List.	6M	20CS201.2	L2
	OR			
9 (a)	Explain the Double linked list with examples.	6M	20CS201.2	L2
9 (b)	ExplainSparse Matrix Representation using Linked List.	6M	20CS201.2	L2
10 (a)	Explain the conversion of infix to postfix with expression: a+b*c+(d*e+f)*g	6M	20CS201.3	L2
10 (b)	Explain the applications of Stack.	6M	20CS201.3	L2
	OR			
11 (a)	Write an algorithm to perform Circular Queue with an example.	6M	20CS201.3	L2
11 (b)	What are the differences between priority queues and Dqueue?	6M	20CS201.3	L2
12 (a)	Explain the In order, pre order, post order tree traversal with an example.	6M	20CS201.4	L2
12 (b)	Explain the Binary Tree and Binary Search Tree.	6M	20CS201.4	L2
	OR			
13	Construct a Binary Tree from the following list In order : 4 10 12 15 18 22 24 Pre order: 24 15 10 4 12 22 18	12M	20CS201.4	L3
14 (a)	Compare Breadth First Search with Depth First Search.	6M	20CS201.5	L2
14 (b)	Explain Breadth First Search with examples.	6M	20CS201.5	L2
	OR			
15	Find the minimum cost spanning tree by using Prim's Algorithm.	12M	20CS201.5	L3


a
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SCHEME OF EVALUATION

Degree	B. Tech. (U. G.)	**Program**	CSE/CSM/CSD	**Academic Year**	2021 - 2022
Course Code	20CS201	**Test Duration**	3 Hrs. Max. Marks 70	**Semester**	II
Course	**Data Structures Using 'C'**				

No.	Questions (1 through 5)	Marks
1	Definition of time complexity (1 M) Definition of space complexity. (1 M)	2 M
2	Any 4 difference of Linked list and Arrays. (2M)	2 M
3	Definition of stack (1 M) Example of Stack. (1 M)	2 M
4	Definition of a Binary tree (1 M) Binary Tree representation (1 M)	2 M
5	List any 4 applications of spanning trees. (2M)	2 M

No.	Questions (6 through 15)	Marks
6 (a)	Explanation of the Binary search (2M) Performing binary search on integers (4M)	6M
6 (b)	Explanation of the Bubble sort with an example (5 M) Binary search time complexity. (1M)	6M
7 (a)	Linear Search Algorithm (3M) Linear Search example (3M)	6M
7 (b)	Insertion sort algorithm (3 M) Apply it to sort the following elements 11, 25, 13, 32, 17 (3 M)	6M
8 (a)	Single linked list representation in memory (3 M) Traversal Algorithm. (3 M)	6M
8 (b)	Single linked list Insertion algorithm (3 M) (Insert beginning (or) ending (or) before and after the given node) Single linked list deletion algorithm (3 M) (Delete beginning (or) delete ending (or) delete a node specific)	6M

9 (a)	Explanation of Double linked list with examples. (6M)	6M
9 (b)	Definition of Sparse Matrix (2 M) Representation using Linked List. (4 M)	6M
10 (a)	Conversion of infix to postfix with expression: (6M) a+b*c+(d*e+f)*g	6M
10 (b)	Any 6 applications of Stack. (6 M)	6M
11 (a)	Algorithm of Circular Queue (Insertion and deletion) (3 M) Example of circular queue (3 M)	6M
11 (b)	Any 6 differences between priority queues and Dequeue. (6 M)	6M
12 (a)	Definition of In order, pre order, post order tree traversal (3 M) Traversal result of all 3 with binary tree (3 M)	6M
12 (b)	Explanation of Binary Tree. (3 M) Explanation of Binary Search Tree. (3 M)	6M
13	Construct a Binary Tree from the following list (6 M) In order : 4 10 12 15 18 22 24 Pre order: 24 15 10 4 12 22 18	12M
14 (a)	List any 4 comparisons of BFS with DFS. (6M)	6M
14 (b)	Explanation of Breadth First Search (3 M) Example of BFS for any graph (3M)	6M
15	Prim's Algorithm (4 M) Constructing MST for the graph (6 M) Cost of MST (2 M)	12M

Answer key (DSUC)
I-BTech-II Sem (CSE, CSM, CSD)

1) Time Complexity: The time complexity of an algorithm is basically the running time of a program as a function of the input size. It is represented as T(N) where N is no of inputs.
Space Complexity: The space complexity of an algorithm is the amount of computer memory that is required during the program execution as a function of the input size. . It is represented as S(N) where N is no of inputs.

2)

ARRAY	LINKED LISTS
1. Arrays are stored in contiguous location.	1. Linked lists are not stored in contiguous location.
2. Fixed in size.	2. Dynamic in size.
3. Memory is allocated at compile time.	3. Memory is allocated at run time.
4. Uses less memory than linked lists.	4. Uses more memory because it stores both data and the address of next node.
5. Elements can be accessed easily.	5. Element accessing requires the traversal of whole linked list.
6. Insertion and deletion operation takes time.	6. Insertion and deletion operation is faster.

3) STACK: A stack is a linear data structure which uses the same principle, i.e., the elements in a stack are added and removed only from one end, which is called the *top*. Hence, a stack is called a LIFO(Last-In,First-Out) data structure as the element that is inserted last is the first one to be taken out.

Eg : stack of plates, Rack of books, Undo operation in MS-word.

4) BINARY TREE: In a normal tree, every node can have any number of children. A binary tree is a special type of tree data structure in which every node can have a maximum of 2 children. One is known as a left child and the other is known as right child. In a binary tree, every node can have either 0 children or 1 child or 2 children but not more than 2 children.

5) Applications of Spanning trees:

1. used in airline routing
2. used to design routing algorithm
3. used in travelling to find shortest path
4. used to design networks .

6a) BINARYSEARCH

Binary Search is one of the fastest searching algorithms. It is used for finding the location of an element in a linear array. It works on the principle of divide and conquers technique. Binary search is a searching algorithm that works efficiently with a sorted list.

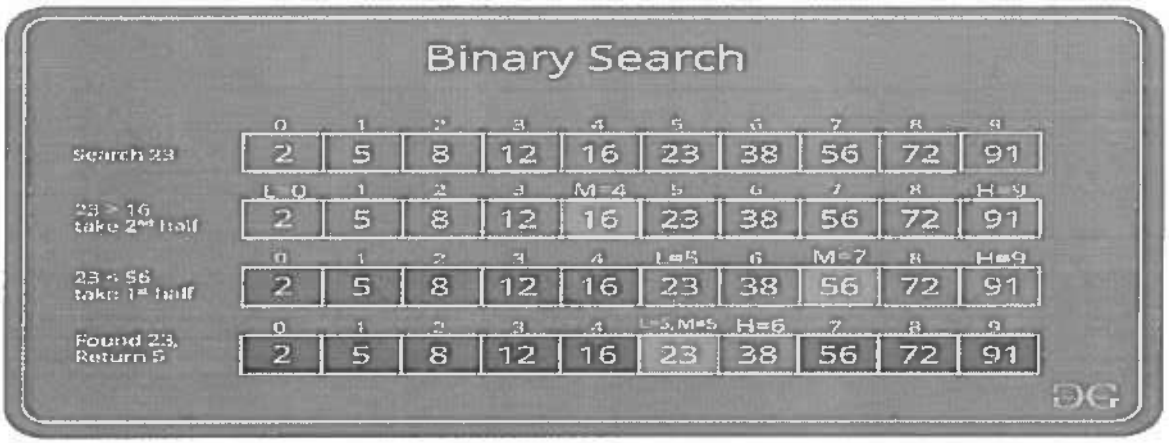
Algorithm:

Step 5: IF POS=-1

PRINT "VALUE IS NOT PRESENT INTHEARRAY"

[ENDOFIF]

Step 6:EXIT



Complexity of Binary Search Algorithm : ***O(logn)***

6b) BUBBLE SORT: Bubble sort is a very simple method that sorts the array elements by repeatedly moving the largest element to the highest index position of the arrays.

ALGORITHM:

Step 1: RepeatStep2For1=toN-1

Step 2: RepeatForJ=0toN-I

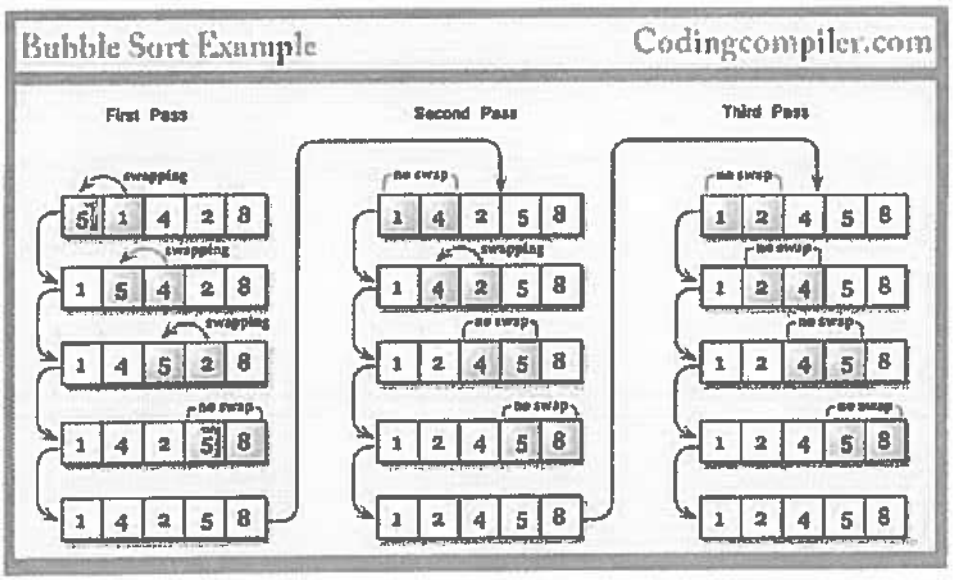
Step 3: IFA[J]>A[J+1]

SWAPA[J]andA[J+1]

[END OF INNER LOOP]

[ENDOFOUTERLOOP]

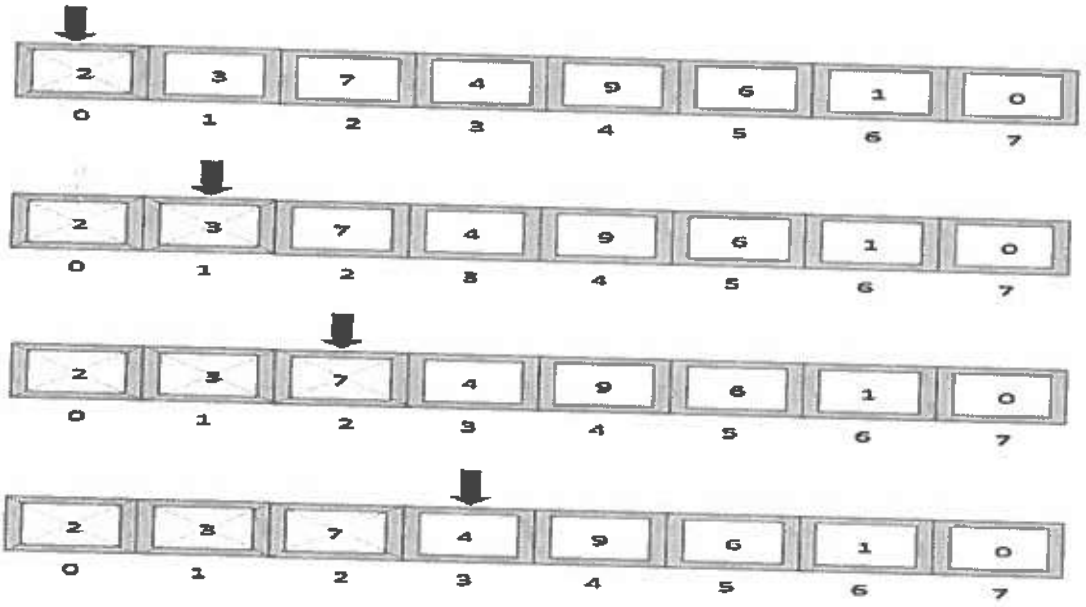
Step4:End



7(a) Linear Search algorithm

LINEAR_SEARCH (A,N,VAL)
Step 1: [INITIALIZE]SETPOS=-1
Step 2 : [INITIALIZE]SETI=1
Step 3:RepeatStep4whileI<=N
Step 4:IF A[I]=VAL
SET POS=I
PRINT POS
Go to Step 6
[END OF IF]
[ENDOFLOOP]
SETI=I+1
Step 5: IF POS = -1
"PRINTVALUEISNOTPRESENTINTHEARRAY"[ENDOFIF]
Step 6: EXIT

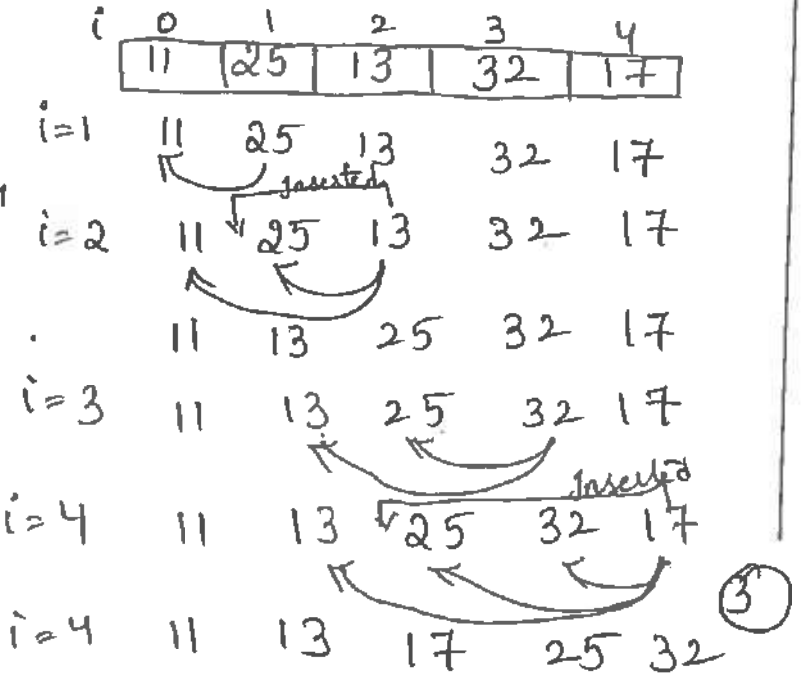
Search Number:4 in the List:



7b) INSERTION SORT:

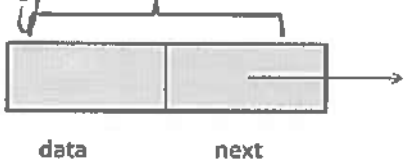
ALGORITHM

Insertionsort (ARR, N)
Step 1 : Repeat Steps 2 to 5 for K=1toN-1
Step 2 : SET TEMP=ARR [K]
Step 3 : SETJ=K-1
Step 4 : Repeat while
TEMP<=ARR[J]
SET ARR[J+1]=ARR[J]
SETJ=J-1



8(a) Linked list representation.

→Single linked list:




```
structnode
{
    intdata;
    structnode*next;
};
```

START

	Data	Next
1	H	4
2		
3		
4	E	7
5		
6		
7	L	8
8	L	10
9		
10	O	-1

Figure START pointing to the first element of the linked list in the memory

8b) OPERATIONS ON LINKED LIST

I. InsertingaNodeattheBeginningofaLinkedList

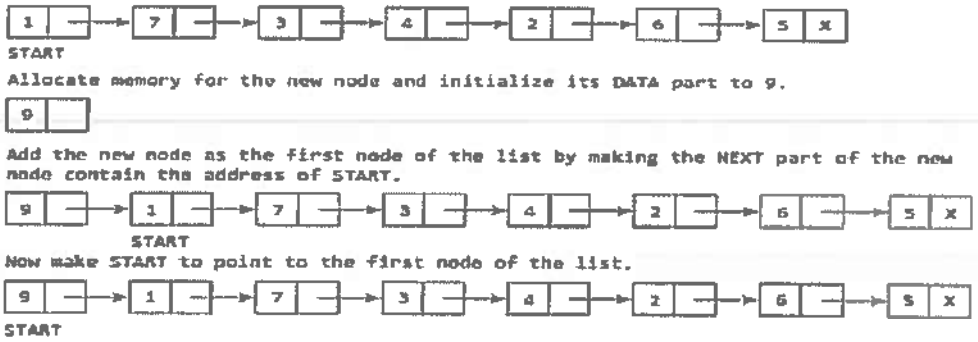


Figure Inserting an element at the beginning of a linked list

AlgorithmtoInsertnewnodeatthebeginningoftheSLL

```
Step 1: IF AVAIL = NULL
            Write OVERFLOW
            Go to Step 7
        [END OF IF]
Step 2: SET NEW_NODE = AVAIL
Step 3: SET AVAIL = AVAIL->NEXT
Step 4: SET NEW_NODE->DATA = VAL
Step 5: SET NEW_NODE->NEXT = START
Step 6: SET START = NEW_NODE
Step 7: EXIT
```

Figure Algorithm to insert a new node at the beginning

Allocate memory for the new node and initialize its DATA part to 9 and NEXT part to NULL.

Take a pointer variable PTR which points to START.

Move PTR so that it points to the last node of the list.

Add the new node after the node pointed by PTR. This is done by storing the address of the new node in the NEXT part of PTR.

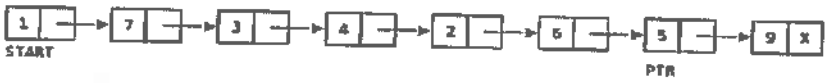
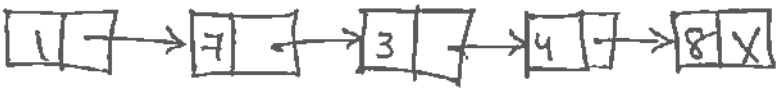


Figure Inserting an element at the end of a linked list

II. Inserting an element at the end of a linked list.

we can insert an element at the end of the linked list

III. Inserting an element before a specific node



10 Insert before node with value 4.

IV Insert an element after a specific node.

we will insert a node after a specif node.

Algorithmtoinsertnewnodeattheend oftheSLL

```
Step 1: IF AVAIL = NULL
            Write OVERFLOW
            Go to Step 10
        [END OF IF]
Step 2: SET NEW_NODE = AVAIL
Step 3: SET AVAIL = AVAIL -> NEXT
Step 4: SET NEW_NODE -> DATA = VAL
Step 5: SET NEW_NODE -> NEXT = NULL
Step 6: SET PTR = START
Step 7: Repeat Step 8 while PTR -> NEXT != NULL
Step 8:     SET PTR = PTR -> NEXT
        [END OF LOOP]
Step 9: SET PTR -> NEXT = NEW_NODE
Step 10: EXIT
```

Figure Algorithm to insert a new node at the end

Deleting A Node From A Single Linked List

To delete a node from an already existing linked list. We consider three cases and then see how deletion is done in each case.

Case1: The first node is deleted.
Case2: The last node is deleted.
Case3: The node after a given node is deleted.

a. Deleting the First Node from a Linked List

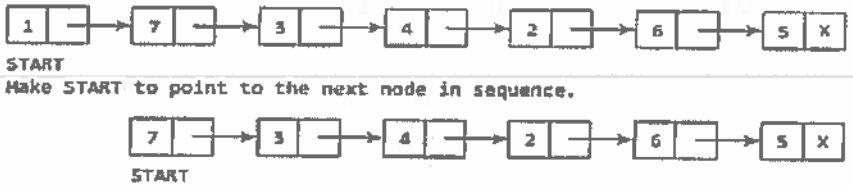


Figure Deleting the first node of a linked list

Algorithm for Deleting the First Node from a Linked List

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 5
        [END OF IF]
Step 2: SET PTR = START
Step 3: SET START = START -> NEXT
Step 4: FREE PTR
Step 5: EXIT
```

Figure Algorithm to delete the first node

b. DeletingtheLastNodefromaLinkedList

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 8
        [END OF IF]
Step 2: SET PTR = START
Step 3: Repeat Steps 4 and 5 while PTR->NEXT != NULL
Step 4:     SET PREPTR = PTR
Step 5:     SET PTR = PTR->NEXT
        [END OF LOOP]
Step 6: SET PREPTR->NEXT = NULL
Step 7: FREE PTR
Step 8: EXIT
```

Figure Algorithm to delete the last node

9a) **DOUBLY LOINKED LIST**

a. A doubly linked list or a two-way linked list is a more complex type of linked list which contains apointer to the next as well as the previous node in the sequence.

b. It consists of three parts—data, a pointer to the next node, and a pointer to the previous node

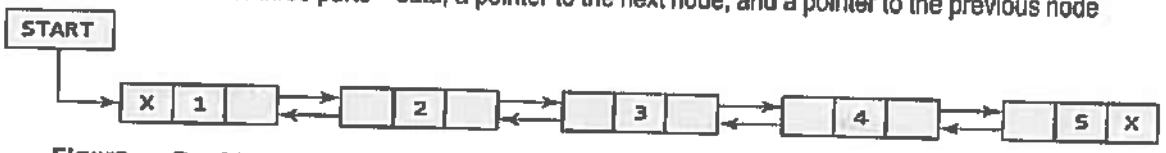


Figure Doubly linked list

In C, the structure of a doubly linked list can be given as,struct node

```
{
  struct node *prev;int data;
  struct node *next;
};
```

START

1

	DATA	PREV	NEXT
1	H	-1	3
2			
3	E	1	6
4			
5			
6	L	3	7
7	L	6	9
8			
9	O	7	-1

Figure Memory representation of a doubly linked list

the linked list.

```
Step 1: IF AVAIL = NULL
                Write OVERFLOW
                Go to Step 9
        [END OF IF]
Step 2: SET NEW_NODE = AVAIL
Step 3: SET AVAIL = AVAIL -> NEXT
Step 4: SET NEW_NODE -> DATA = VAL
Step 5: SET NEW_NODE -> PREV = NULL
Step 6: SET NEW_NODE -> NEXT = START
Step 7: SET START -> PREV = NEW_NODE
Step 8: SET START = NEW_NODE
Step 9: EXIT
```

Figure Algorithm to insert a new node at the beginning

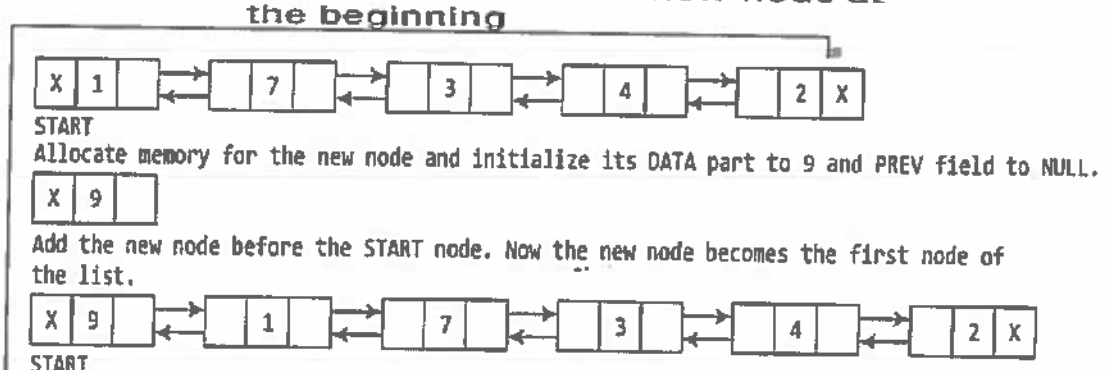


Figure Inserting a new node at the beginning of a doubly linked list

```
Step 9: SET PTR -> NEXT = NEW_NODE
Step 10: SET NEW_NODE -> PREV = PTR
Step 11: EXIT
```

Figure Algorithm to insert a new node at the end

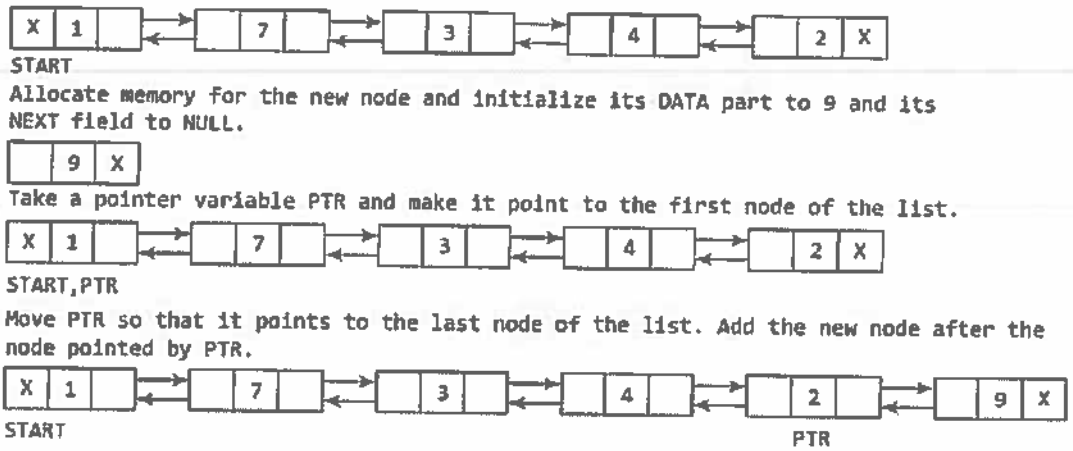


Figure Inserting a new node at the end of a doubly linked list

Deleting A Node From A Doubly Linked List

We consider four cases and then see how deletion is done in each case.
Case 1: The first node is deleted.
Case 2: The last node is deleted.
Case 3: The node after a given node is deleted.
Case 4: The node before a given node is deleted.

Deleting the First Node from a Doubly Linked List

Consider the doubly linked list shown in Fig. 6.47. When we want to delete a node from the beginningof the list, then the following changes will be done in the linked list.

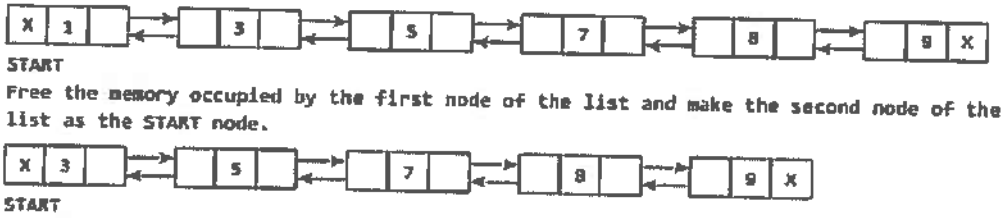


Figure 6.47 Deleting the first node from a doubly linked list

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 6
        [END OF IF]
Step 2: SET PTR = START
Step 3: SET START = START -> NEXT
Step 4: SET START -> PREV = NULL
Step 5: FREE PTR
Step 6: EXIT
```

Figure 6.48 Algorithm to delete the first node

Deleting the Last Node from a Doubly Linked List

Consider the doubly linked list shown in Fig. 6.49. Suppose we want to delete the last node from the linked list, then the following changes will be done in the linked list.

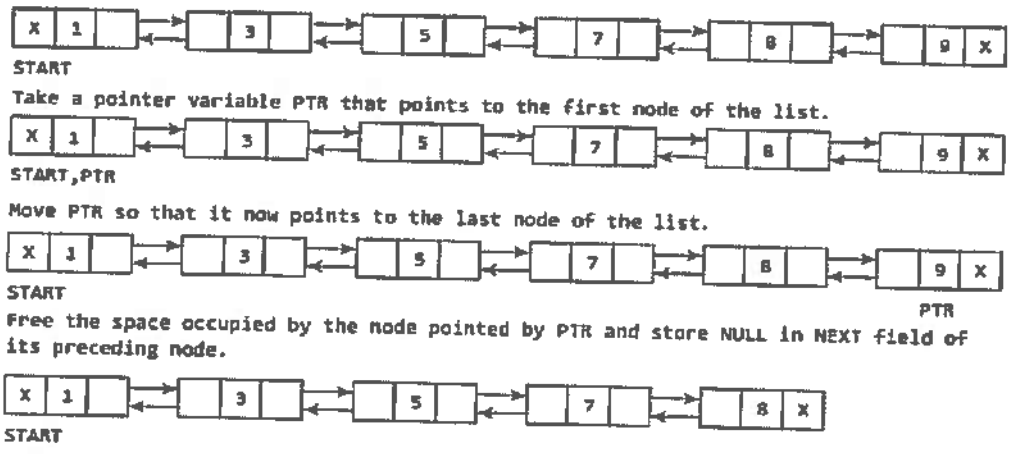


Figure 6.49 Deleting the last node from a doubly linked list

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 5
        [END OF IF]
Step 2: SET PTR = START
Step 3: Repeat Step 4 while PTR -> NEXT != NULL
Step 4:     SET PTR = PTR -> NEXT
```

Deleting the Node After a Given Node in a Doubly Linked List

Consider the doubly linked list shown in Fig. 6.51. Suppose we want to delete the node that succeedsthe node which contains data value 4. Then the following changes will be done in the linked list.

Delete the node after a given node

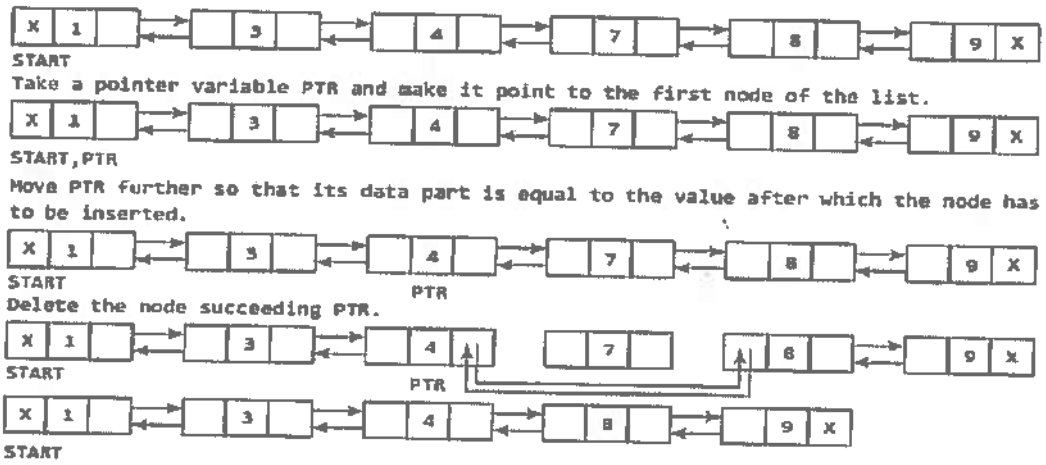


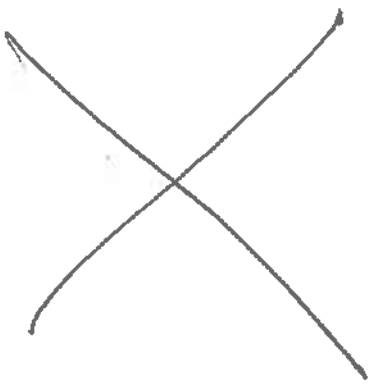
Figure 6.51 Deleting the node after a given node in a doubly linked list

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 9
        [END OF IF]
Step 2: SET PTR = START
Step 3: Repeat Step 4 while PTR -> DATA != NUM
Step 4:       SET PTR = PTR -> NEXT
        [END OF LOOP]
Step 5: SET TEMP = PTR -> NEXT
Step 6: SET PTR -> NEXT = TEMP -> NEXT
Step 7: SET TEMP -> NEXT -> PREV = PTR
Step 8: FREE TEMP
Step 9: EXIT
```

Figure 6.52 Algorithm to delete a node after a given node

Deleting the Node Before a Given Node in a Doubly Linked List

Consider the doubly linked list shown in Fig. 6.53. Suppose we want to delete the node preceding the node with value 4. Before discussing the changes that will be done in the linked list, let us first look at the algorithm.



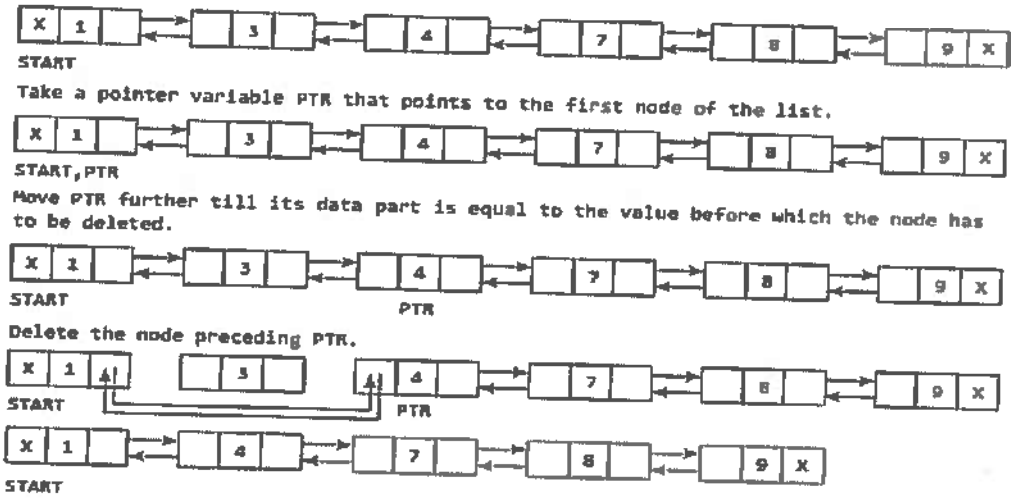


Figure 6.53 Deleting a node before a given node in a doubly linked list

```
Step 1: IF START = NULL
            Write UNDERFLOW
            Go to Step 9
        [END OF IF]
Step 2: SET PTR = START
Step 3: Repeat Step 4 while PTR->DATA != NUM
Step 4:     SET PTR = PTR->NEXT
        [END OF LOOP]
Step 5: SET TEMP = PTR->PREV
Step 6: SET TEMP->PREV->NEXT = PTR
Step 7: SET PTR->PREV = TEMP->PREV
Step 8: FREE TEMP
Step 9: EXIT
```

Figure 6.54 Algorithm to delete a node before a given node

9 b) SPARSE MATRIX:

Sparse matrix is a matrix that has large number of elements with a zero value.

- Such matrices have very few non-zero values stored and most of the entries are zero. Sparsematrices are very common in engineering applications.
- If we use a normal array to store such matrices, we will end up wasting a lot of space.
- Therefore, a better solution is to represent these matrices using multi-linked lists.
- The sparse matrix shown in Fig. 6.72 can be represented using a linked list for every row andcolumn.
- Since a value is in exactly one row and one column, it will appear in both lists exactly once.
- A node in the multi-linked will have four parts.
- First stores the data, second stores a pointer to the next node in the row, third stores a pointer to the next node in the column, and the fourth stores the coordinates or the row and column number in which the data appears in linked

y \ x	0	1	2
0	0	25	0
1	0	0	0
2	17	0	5
3	19	0	10

list.

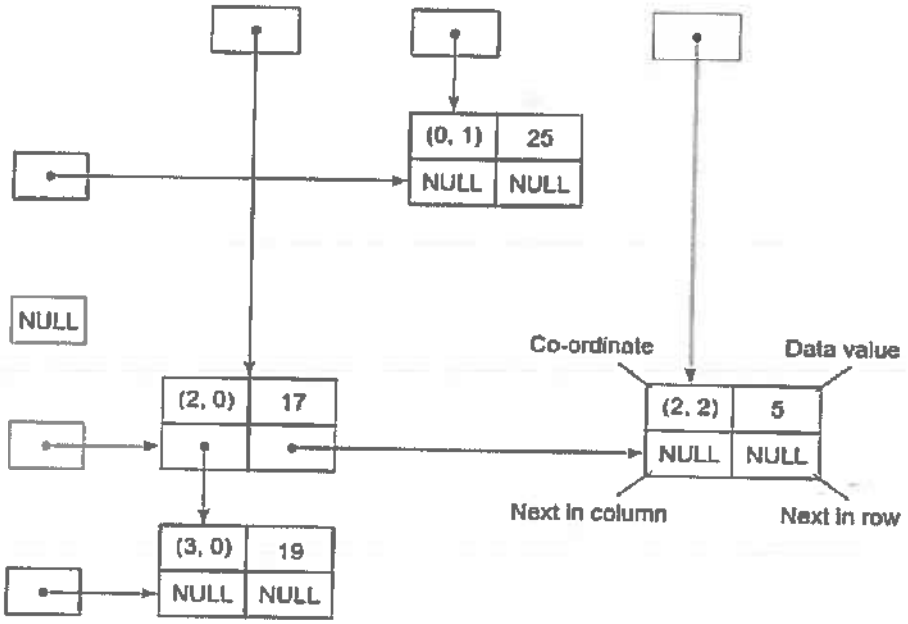


Figure 6.73 Multi-linked representation of sparse matrix shown in Fig. 6.72

10 a) conversion of infix to postfix with expression: a+b*c+(d*e+f)*g →

Input (Infix Expression	Stack	Output (postfix exp)
a	Nil	a
+	+	a
b	+	a b
*	+ *	a b
c	+ *	a b c
+	+ * +	a b c a b c * +
(	* + (	a b c * +

(12)

d	+ (	a b c * + d
	+ (*	a b c * + d
*		
e	+ (*	a b c * + d e
+	+ (* +	a b c * + d e
f	+ (* +	a b c * + d e
)	+	a b c * + d e + *
*	+ *	a b c * + d e + *
g	+ *	a b c * + d e + * g * +

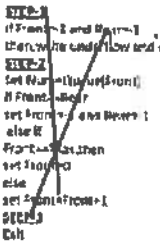
∴ postfix a b c * + d e + * g * +

10(b) Applications of stacks:

1. Reversing a list
2. Parentheses checker
3. Conversion of an infix expression into a postfix expression
4. Evaluation of a postfix expression
5. Conversion of an infix expression into a prefix expression
6. Evaluation of a postfix expression
7. Recursion
8. Tower of Hanoi
9. Factorial Calculation

Explanation of above points.

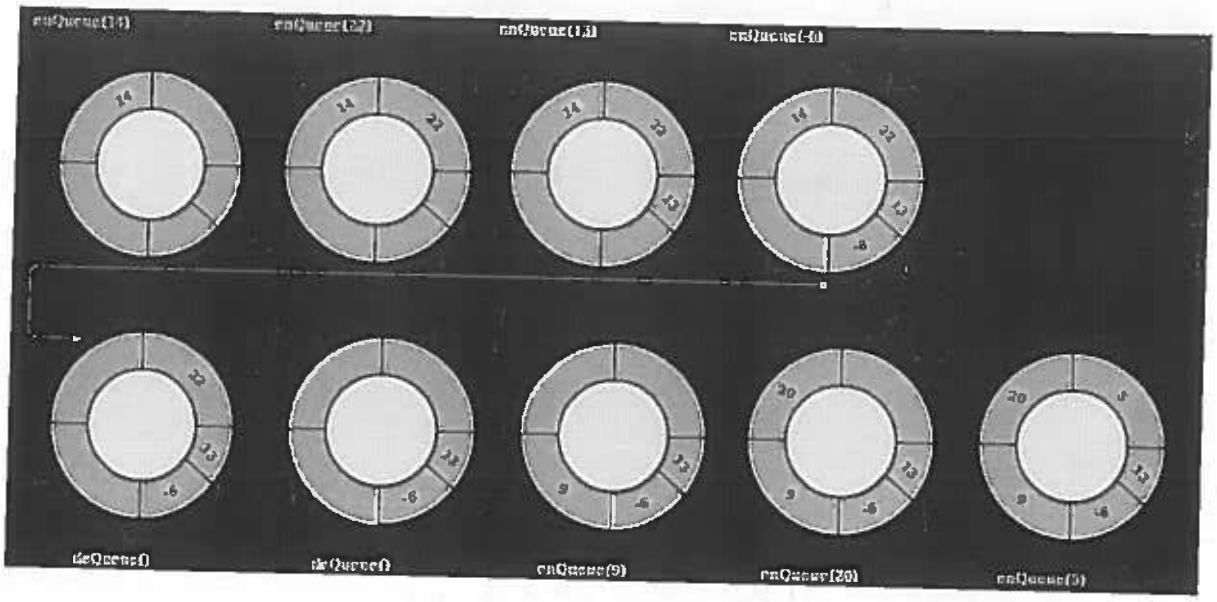
11(a)



ALGORITHM for Circular Queue Insertion

step 1: if front = -1 & Rear = -1
then "under flow"

step 2: slet num = Q[front]
if front == rear.
set front = -1 & rear = -1
else if
front == Max then
set front = 0
else
set front = front++;

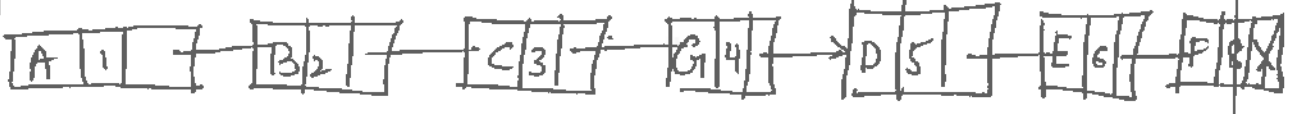


11(b) Difference b/w proiority Que and Dequeue.

priority Queue:

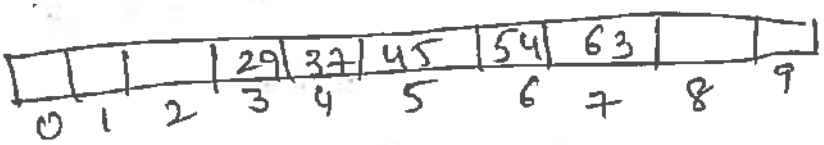
A priority Queue is a data structure in which each element is assigned a priority. The priority of the element will be used to determine the order in which the elements will be processed.

when a new element with the priority G → priority 4 enters the Queue then the above representation will be

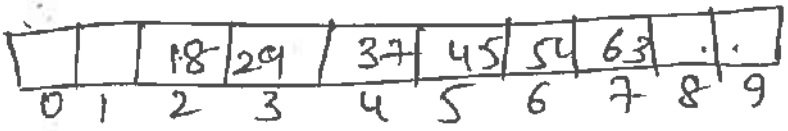


Thus the G node will be Inserted by the priority.

Dequeue : Doubly ended Queue is a list in which the elements can be inserted or deleted at either ends.



we can insert from both the ends.

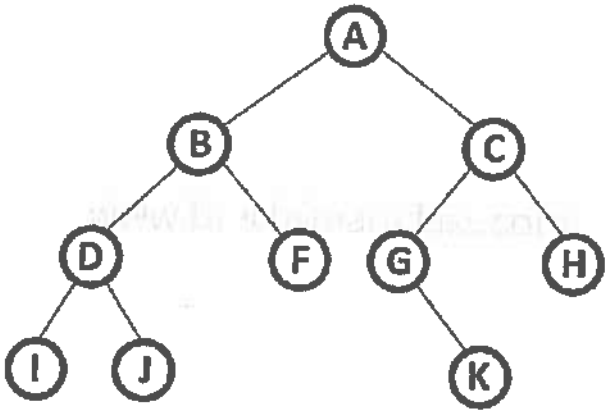


And we can delete from both the ends.

12(a) There are three types of binary tree traversals.

1. **In - Order Traversal**
2. **Pre - Order Traversal**
3. **Post - Order Traversal**

Consider the following binary tree...



1. In - Order Traversal (leftChild - root - rightChild)

In In-Order traversal, the root node is visited between the left child and right child. In this traversal, the left child node is visited first, then the root node is visited and later we go for visiting the right child node. This in-order traversal isapplicable for every root node of all sub trees in the tree. This is performed recursively for all nodes in the tree.

In the above example of a binary tree, first we try to visit left child of root node'A', but A's left child 'B' is a root node for left sub tree. so we try to visit its (B's) left child 'D' and again D is a root for sub tree with nodes D, I and J. So we try to visit its left child 'I' and it is the leftmost child. So first we visit 'I' then go for its root node 'D' and later we visit D's right child 'J'. With this we have completed the left part of node B. Then visit 'B' and next B's right child 'F' is visited. With this we have completed left part of node A. Then visit root node 'A'. With this we have completed left and root parts of node A. Then we go for the right part of the node A. In right of A again there is a sub tree with root C. So go for left child of C and again it is a sub tree with root G. But G does not have left part so we visit 'G' and then visit G's right child K. With this we have completed the left partof node C. Then visit root node 'C' and next visit C's right child 'H' which is the rightmost child in the tree. So we stop the process.

That means here we have visited in the order of **I - D - J - B - F - A - G - K - C -H** using In-Order Traversal.

In-Order Traversal for above example of binary tree is

I - D - J - B - F - A - G - K - C – H

Algorithm for in-order traversal:

Step 1: Repeat Steps 2 to 4 while TREE != NULL
Step 2: INORDER(TREE -> LEFT)
Step 3: Write TREE -> DATA
Step 4: INORDER(TREE -> RIGHT)[END OF LOOP]
Step 5: END

2. Pre - Order Traversal (root - leftChild - rightChild)

In Pre-Order traversal, the root node is visited before the left child and right child nodes. In this traversal, the root node is visited first, then its left child and laterits right child. This pre-order traversal is applicable for every root node of all subtrees in the tree.In the above example of binary tree, first we visit root node 'A' then visit its leftchild 'B' which is a root for D and F. So we visit B's left child 'D' and again D is a root for I and J. So we visit D's left child 'I' which is the leftmost child. So next we go for visiting D's right child 'J'. With this we have completed root, left and right parts of node D and root, left parts of node B. Next visit B's right child 'F'. Withthis we have completed root and left parts of node A. So we go for A's right child 'C' which is a root node for G and H. After visiting C, we go for its left child 'G' which is a root for node K. So next we visit left of G, but it does nothave left child so we go for G's right child 'K'. With this, we have completed node C's root and left parts. Next visit C's right child 'H' which is the rightmost child in the tree. So we stop the process.

That means here we have visited in the order of **A-B-D-I-J-F-C-G-K-H** using Pre-Order Traversal.

Pre-Order Traversal for above example binary tree is

A - B - D - I - J - F - C - G - K – H

Algorithm for pre-order traversal

Step 1: Repeat Steps 2 to 4 while TREE != NULL
Step 2: Write TREE -> DATA
Step 3: PREORDER(TREE -> LEFT)
Step 4: PREORDER(TREE -> RIGHT)[END OF LOOP]
Step 5: END

3. Post - Order Traversal (leftChild - rightChild - root)

In Post-Order traversal, the root node is visited after left child and right child. Inthis traversal, left child node is visited first, then its right child and then its rootnode. This is recursively performed until the right most node is visited.

Here we have visited in the order of **I - J - D - F - B - K - G - H - C - A** using Post-Order Traversal.

Post-Order Traversal for above example binary tree is

I - J - D - F - B - K - G - H - C – A

Algorithm for post-order traversal

Step 1: Repeat Steps 2 to 4 while TREE != NULL
Step 2: POSTORDER(TREE -> LEFT)
Step 3: POSTORDER(TREE -> RIGHT)
Step 4: Write TREE -> DATA[END OF LOOP]
Step 5: END

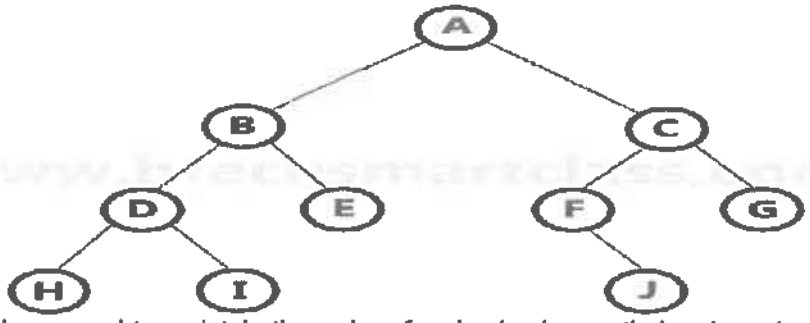
12(b) **Binary Tree Data structure:** In a normal tree, every node can have any number of children. A binary tree is a special type of tree data structure in which every node can have a maximum of2 children. One is known as a left child and the other is known as right child.

A tree in which every node can have a maximum of two children is calledBinary

In a binary tree, every node can have either 0 children or 1 child or 2 childrenbut not more than 2 children.

Example

Binary search Tree: In a binary tree, every node can have a maximum of two children but there



is no need to maintain the order of nodes basing on their values. In a binary tree, the elements are arranged in the order they arrive at the tree from top to bottom and left to right.

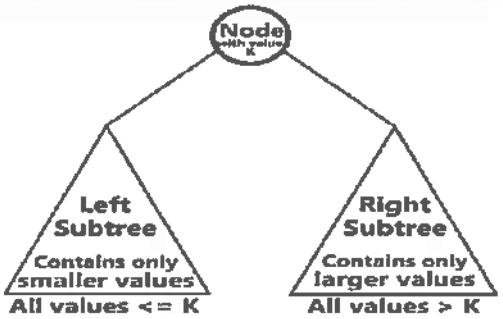
A binary tree has the following time complexities...

1. **Search Operation - O(n)**
2. **Insertion Operation - O(1)**
3. **Deletion Operation - O(n)**

To enhance the performance of binary tree, we use a special type of binary tree known as **Binary Search Tree**. Binary search tree mainly focuses on the search operation in a binary tree. Binary search tree can be defined as follows...

Binary Search Tree is a binary tree in which every node contains only smaller values in its left subtree and only larger values in its right subtree.

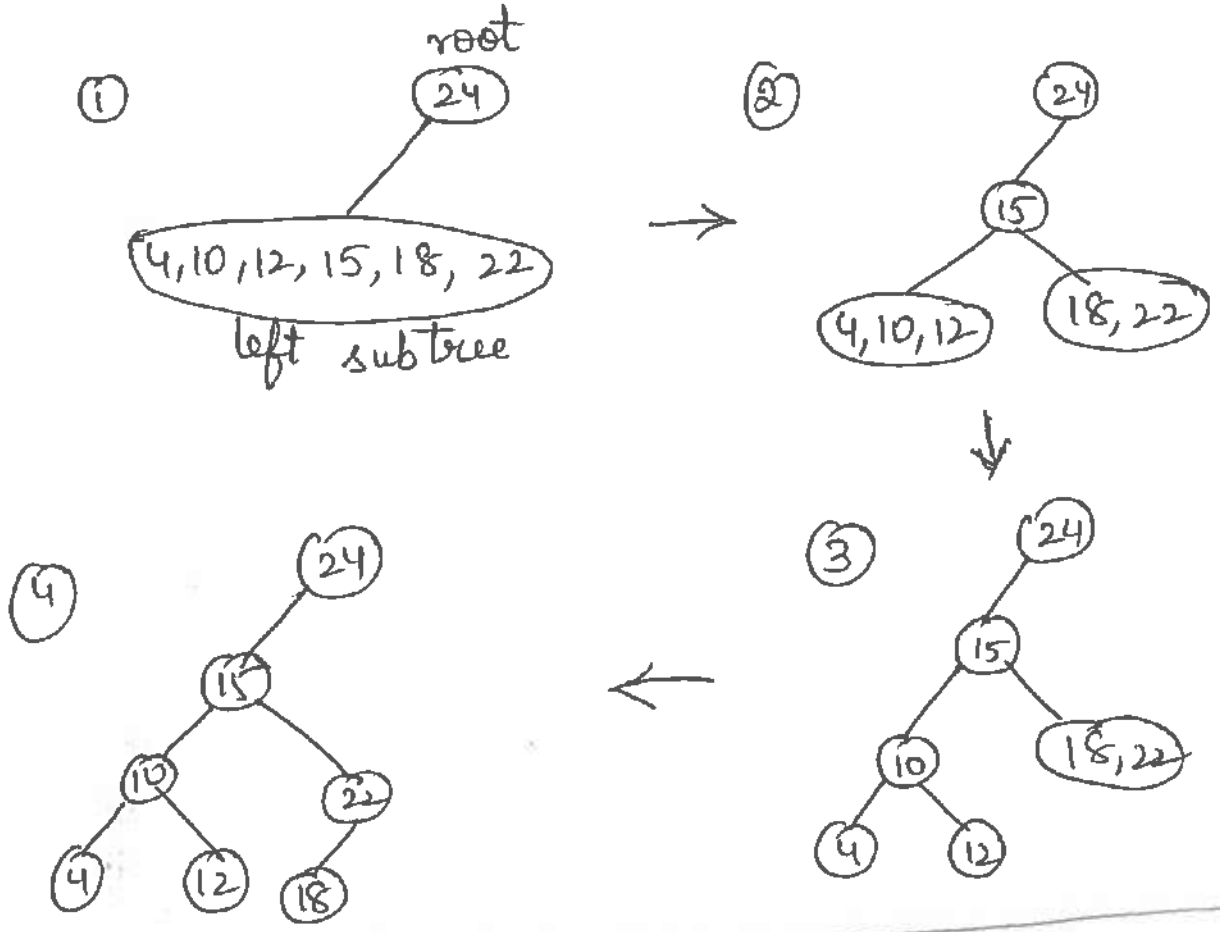
In a binary search tree, all the nodes in the left subtree of any node contains smaller values and all the nodes in the right subtree of any node contains larger values as shown in the following figure...



13 Construct Binary tree,

Inorder : 4 10 12 15 18 22 24

preorder : 24 15 10 4 12 22 18



14(a) Difference between BFS and DFS

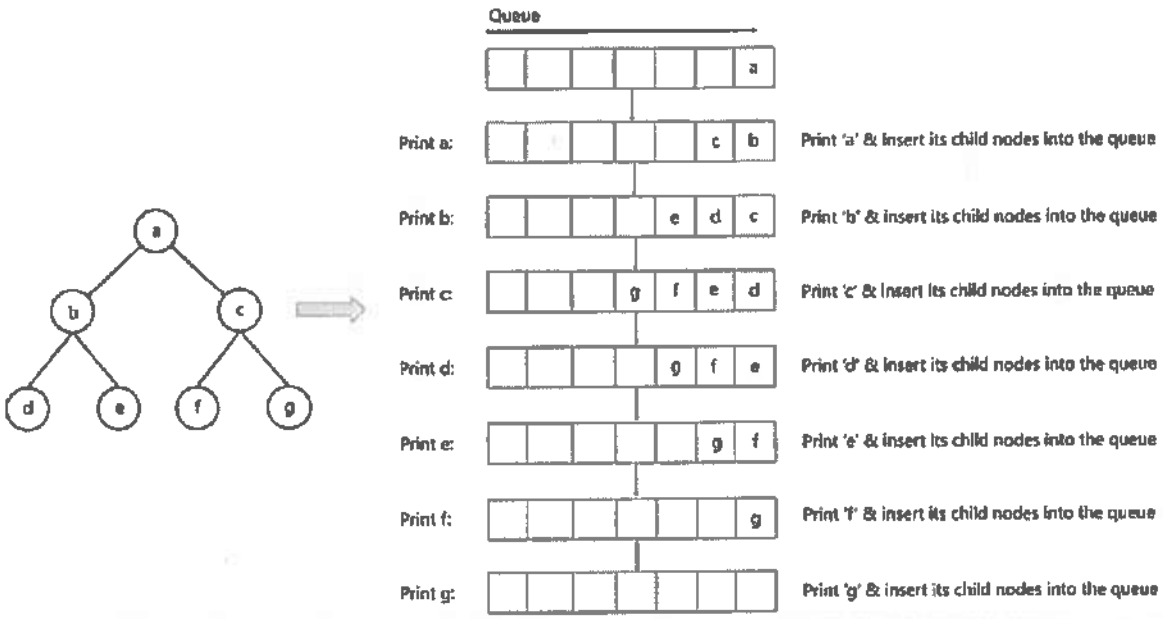
Differences are listed based on few terms.

P.T.O

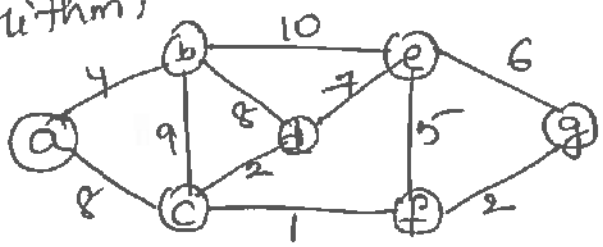
BASIS FOR COMPARISON	BFS	DFS
Basic	Vertex-based algorithm	Edge-based algorithm
Data structure used to store the nodes	Queue	Stack
Memory consumption	Inefficient	Efficient
Structure of the constructed tree	Wide and short	Narrow and long
Traversing fashion	Oldest unvisited vertices are explored at first.	Vertices along the edge are explored in the beginning.
Optimality	Optimal for finding the shortest distance, not in cost.	Not optimal
Application	Examines bipartite graph, connected component and shortest path present in a graph.	Examines two-edge connected graph, strongly connected graph, acyclic graph and topological order.

14(b) Breath first search will follow Queue technique (Fifo) to traverse the given graph.

step 1: Select a node of your choice
step 2: Insert the node in the Queue.
step 3: Delete the node from the Queue and Insert the adjecent nodes from the graph to Queue.
step 4: Repeat the same process step2 and step3 untill all node are traversed. (20)



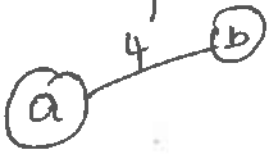
15 Prim's algorithm;



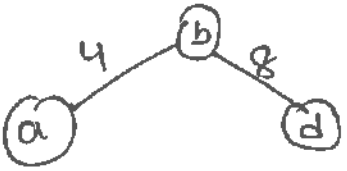
Step 1: Select a node and find the minimum path to reach next node

(a)

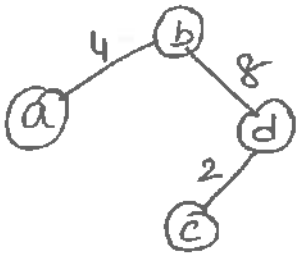
Step 2: {a, b} the weight is 4 which is less compared to other vertex.



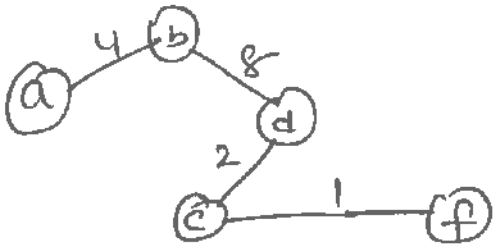
Step 3: {b, d} the vertex weigh is less i.e., & only



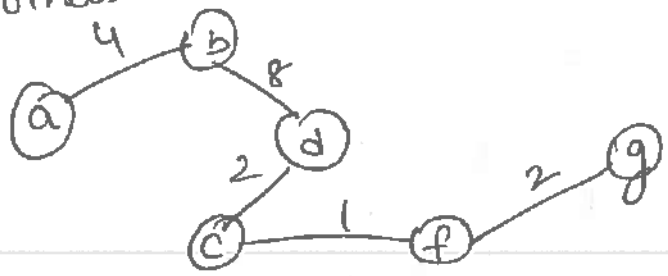
Step 4: {d, c} = 2 which least among other



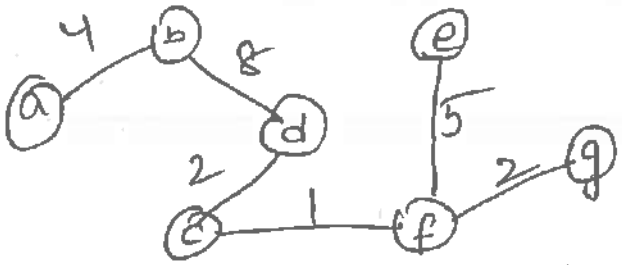
Step 5: Consider the vertex $\{c, f\} = 1$



Step 6: $\{\{a,b\}, \{b,d\}\{d,c\}, \{c,f\}\}$. Now consider. $\{f, g\} = 2$ which least weight compared to others.



Step 7: from $\{f, e\}$ the weight is less to reach node e so we select it



∴ Resultant MST from given graph

Minimum cost is = $4+8+2+1+2+5$

= 22 units.

6/8/22

←end→

NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	CE/ME			Academic Year	2021- 2022
Course Code	20BSX31	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	Engineering Physics						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define interference.	20BSX31.1	L1
2	What do you mean by Stimulated emission	20BSX31.2	L1
3	Define Orientation polarization and write the expression for orientation polarizability.	20BSX31.3	L1
4	Define Non-Destructive Testing.	20BSX31.4	L1
5	Define packing fraction and write the formula for packing fraction.	20BSX31.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Explain how Newton's Rings are formed in the reflected light and show that the diameter of dark ring is proportional to $\sqrt{n}$.	10M	20BSX31.1	L2
6 (b)	Calculate the fringe width, if the two slits separated by 0.2 mm are illuminated by sodium light of wavelength 5893 Angstrom unit and the screen is 10 cm away from the slits.	2M	20BSX31.1	L2
	OR			
7 (a)	Describe Fraunhofer's diffraction due to a single slit and deduce the condition for primary maxima, secondary maxima and minima.	8M	20BSX31.1	L2
7(b)	A monochromatic light of wavelength 6.56×10^{-7} m incident normally on a grating of 2 cm wide. The first order spectrum is produced at an angle of 18^{o} from the normal. Calculate the total number of lines in the grating.	4M	20BSX31.1	L2
8 (a)	List out few applications of laser.	4M	20BSX31.2	L1
8 (b)	Explain the construction and working of Ruby Laser.	8M	20BSX31.2	L2
	OR			
9 (a)	List out few applications of optical fibers and derive the expression for numerical aperture and acceptance angle.	10M	20BSX31.2	L2
9 (b)	The refractive indices of core and cladding of an optical fiber are 1.45 and 1.15 respectively. Determine the numerical aperture and acceptance angle of this optical fiber.	2M	20BSX31.2	L2
10	Explain how various magnetic materials like Dia, Para and Ferromagnetic materials are distinguished based on different properties like susceptibility, permeability etc.	12M	20BSX31.3	L2
	OR			
11	Describe various types of polarizations in dielectrics.	12M	20BSX31.3	L2
12 (a)	Explain how the absorption coefficient of an acoustic material can be determined.	8M	20BSX31.4	L2
12(b)	The total absorption coefficient of all the materials in a hall is 733.33 Open Window Units. If the volume of this hall is 8000 m^3 then determine the Reverberation time using Sabine's formula.	4M	20BSX31.4	L2

	OR			
13 (a)	Explain Magnetostriction effect and discuss generation of ultrasonics using this method.	10M	20BSX31.4	L2
13 (b)	List any four applications of ultrasonics.	2M	20BSX31.4	L1
14	Determine the packing fraction of SC, BCC and FCC.	12M	20BSX31.5	L2
	OR			
15 (a)	A plane of atoms makes 2a, 3b and 4c intercepts on the crystallographic axes. Similarly, another plane of atoms makes 4a, 6b and 8c intercepts on the crystallographic axes. Determine the Miller indices for these two different planes and comment on the result.	4M	20BSX31.5	L3
15 (b)	Explain the Powder method of X – ray diffraction with relevant sketches.	8M	20BSX31.5	L2

N S Raju Institute of Technology

(Autonomous)

Semester End Regular / Supplementary Examinations, August, 2022 – Scheme of Valuation

Course : Engineering Physics

Course code : 20BSX31

part A

1. Definition of Interference – 2M
2. Definition of Stimulated Emission – 2M
3. Definition of orientation polarization – 1M
   Orientation polarizability equation – 1M } 2M
4. Definition of Non-Destructive Testing – 2M
5. Definition of APF – 1M
   Formula of APF – 1M } 2M

part B

6(a). Formation of Newton's rings – 3M
Ray diagrams – – – – – 2M
Diameter of the dark ring is proportional to $\sqrt{n}$ – – – 5M } 10M

6(b) Write up given data with formula – 1M
Calculation & answer with units – 1M } 2M

7(a) Description of Fraunhofer diffraction due to a single slit ---------- 2M

Ray diagrams of Single slit ---------- 2M

conditions of primary maxima, Secondary maxima and Minima ---------- 4M

} 8M

7(b). Write up given data with formula --- 2M

calculations --- 1M

Answer with unit --- 1M

} 4M

8(a) Any four applications of Laser – 4M

8(b) Diagrams of Ruby Laser – 2M

Construction of Ruby Laser – 3M

Working of Ruby Laser – 3M

} 8M

9(a) Any four applications of optical fibers – 4M

Expression for NA ---------- 3M

Expression for Acceptance angle – 3M

} 10M

9(b). Determination of NA ---------- 1M

Determination of Acceptance angle – 1M

} 2M

10. properties of Dia magnetic materials – 4M

properties of para magnetic materials – 4M

properties of Ferro magnetic materials – 4M

} 12M

10/8/22

11. Explanation of Electronic polarization — 3M
Explanation of Ionic polarization — 3M
Explanation of Orientational polarization — 3M
Explanation of Space charge polarization — 3M
} 12 M

12(a) Determination of absorption Coefficient — 2M
Measurement of Acoustic materials — 6M
} 8 M

12(b) Write up given data — 1M
Formula — 1M
Calculation & answer with units — 2M
} 4M

13(a) Definition & Explanation of Magnetostriction effect — 4M
Diagrams — 2M
production of ultrasonics — 4M
} 10 M

13(b) Any four applications of ultrasonics — 2M

14. Atomic packing factor (fraction) of SC — 2M
Atomic packing factor of BCC — 5M
Atomic packing factor of FCC — 5M
} 12 M

15(a) Miller indices for the plane 2a, 3b and 4c — 2M
Miller indices for the plane 4a, 6b and 8c — 2M
} 4M

15(b) powder method diagrams — 3M
Explanation of powder method — 5M
} 8 M

HOD

(Mr. S.V. Prabhu)

N S Raju Institute of of Technology (Autonomous) (C)

Semester End Regular / Supplementary Examination, August, 2022

course : Engineering physics - Key

course code : 20BSX31

PART-A

1. Define Interference.

→ When two or more waves having same frequency and constant phase difference superimpose to each other, the intensity / amplitude of light should be modified. The modification of intensity or amplitude of light due to superposition of waves is called Interference

2. What do you mean by Stimulated Emission.

→ An atom can pass from an excited state to lower energy state emitting a photon not only spontaneously but also when forced to it under the influence of another external photon, i.e a photon energy $E_2 - E_1 = h\nu$, can induce the excited atom to make a downward transition releasing the energy in the form of photon. Thus the interaction of a photon with an excited atom triggers excited atom drop to the lower energy state giving up a photon. The phenomenon of forced emission of photons is called induced emission or Stimulated Emission.

3. Define orientation polarization and write the expression for orientation polarizability.

→ The contribution of the polarization due to the orientation of the molecular dipoles is called orientational polarization. It is also called dipolar or molecular polarization.

orientational polarizability $\alpha_o = \frac{\mu_o^2}{3K_BT}$

where K_B is the Boltzmann Constant and T is absolute temp.

4. Define Non-Destructive Testing.

→ It is a method of finding defects in an object without harming the object.

5. Define packing fraction and write the formula for packing fraction.

→ Atomic packing fraction is the ratio of Volume occupied by

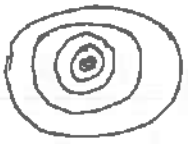
the atoms in a unit cell (v) to the total volume of the unit cell (V). It is also called packing density.

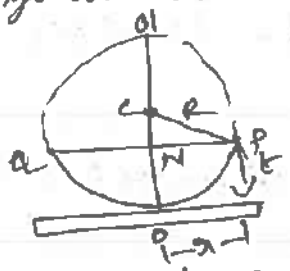
Atomic packing fraction = $\frac{v}{V}$.

Part B

(6a) Explain how Newton's rings are formed in the reflected light and show that diameter of the dark ring is proportional to $\sqrt{n}$.

→ If a monochromatic light is allowed to fall normally and the film is viewed in reflected light, alternate dark and bright concentric circular rings are observed around the point of contact.





Let R be the radius of curvature of lens and r be the radius of Newton's ring corresponding to the constant film thickness 't'

The effective path difference b/w the rays

$$\delta = 2\mu t\cos r + \frac{\lambda}{2} \longrightarrow (1)$$

For air film $\mu = 1$, $r = 0$

$$\delta = 2t + \frac{\lambda}{2} \longrightarrow (2)$$

At the point of contact $t = 0$, $\delta = \frac{\lambda}{2}$, this is the condition for minimum intensity.

Hence the central spot is dark

The condition for dark rings is

$$\delta = 2t + \frac{\lambda}{2} = (2n+1)\frac{\lambda}{2} \Rightarrow 2t = n\lambda$$ where n → (3)

Let us consider the curved surface of the lens and arc of the circle is at 'c'

$$NP \times NQ = NO \times NO'$$
$$r \times r = t(2R - t)$$
$$r^2 = 2Rt - t^2$$
$$r^2 = 2Rt \quad (\because t \text{ is small, } t^2 \text{ is very small})$$
$$t = \frac{r^2}{2R} \longrightarrow (4)$$

For dark rings, $2 \times \frac{r^2}{2R} = n\lambda \Rightarrow \frac{r^2}{2R} = n\lambda$

$$\Rightarrow r^2 = n\lambda R$$

If D is the diameter of the ring, $r = \frac{D}{2}$

$$\frac{D^2}{4} = nR\lambda \Rightarrow D^2 = 4n\lambda R$$

$$D = \sqrt{4n\lambda R}$$

$$D_n \propto \sqrt{n}$$

∴ The diameter of the dark ring is proportional to the square root of natural numbers.

6(b) Calculate the fringe width, if the two slits separated by 0.2mm are illuminated by sodium light of wavelength 5893 A° unit and the screen is 10 cm away from the slits.

→ Given that $d = 0.2\text{mm} = 0.2 \times 10^{-3}\text{m}$

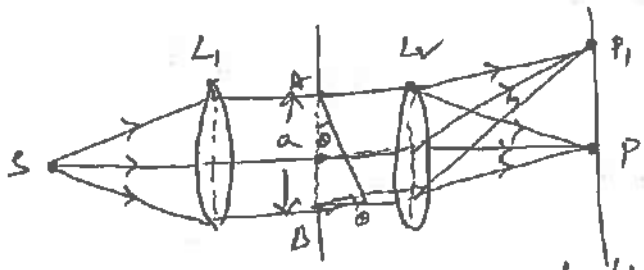
$\lambda = 5893\text{A}^\circ = 5893 \times 10^{-10}\text{m}$

$D = 10\text{cm} = 10 \times 10^{-2}\text{m}$

Fringe width $\beta = \frac{\lambda D}{d} = \frac{5893 \times 10^{-10} \times 10 \times 10^{-2}}{0.2 \times 10^{-3}} = 29,465 \times 10^{-8}\text{m}$.

7(a) Describe fraunhofer's diffraction due to a single slit and deduce the condition for primary maxima, secondary maxima and minima

→ According to fraunhofer diffraction, the incident wavefront must be plane. So to get plane wavefront converging lens is used.



Let 'S' is a monochromatic source of light, it emits the light rays in all direction.

A lens L_1 is used to convert incident light rays into a beam of parallel rays and is incident normally on a narrow slit AB of width is 'a'.

The diffracted light is focused on a screen xy at a point P after passing through the lens L_2

Resultant intensity at point P_1: The intensity at point P_1 is maximum or minimum depending on the path difference b/w the rays coming from AEB.

The path difference b/w the secondary wavelets from A and B in the direction of θ is

$BC = \delta = AB \sin\theta = a\sin\theta$

the corresponding phase difference is

$$\phi = \frac{2\pi}{\lambda} \cdot \delta = \frac{2\pi}{\lambda} a\sin\theta$$

Let us assume, the phase difference b/w any two consecutive slits is $\frac{\phi}{n}$

i.e $\frac{\phi}{n} = \frac{1}{n}\frac{2\pi}{\lambda} a\sin\theta = \alpha$ (say)

By using the vector addition of amplitudes, the resultant intensity or amplitude P_1 is given by

$$R = \frac{a'\sin\left(n\frac{\alpha}{2}\right)}{\sin\left(\frac{\alpha}{2}\right)} = \frac{a'\sin\left[\frac{n}{2}\cdot\frac{1}{n}\cdot\frac{2\pi a\sin\theta}{\lambda}\right]}{\sin\left[\frac{1}{2}\cdot\frac{1}{n}\cdot\frac{2\pi a\sin\theta}{\lambda}\right]} = \frac{a'\sin\alpha}{\sin\left(\frac{\alpha}{n}\right)}$$

where $\alpha = \frac{\pi a\sin\theta}{\lambda}$

when n is very large (i.e $n \to \infty$) then $\frac{\alpha}{n}$ is very small.

since $\sin\left(\frac{\alpha}{n}\right) = \frac{\alpha}{n}$

Hence $R = \frac{a'\sin\alpha}{\frac{\alpha}{n}} = \frac{na'\sin\alpha}{\alpha}$

Let $na' = A$

$$\therefore R = \frac{A\sin\alpha}{\alpha} \longrightarrow (1)$$

The resultant Intensity at point P_1 is given by

$$I \propto R^2$$

$$I = R^2 = \frac{A^2\sin^2\alpha}{\alpha^2} = I_0\frac{\sin^2\alpha}{\alpha^2} \longrightarrow (2) \quad \text{where } I_0 = A^2$$

Case (i) Condition for primary maxima:-

If $\theta \to 0$ then $\alpha \to 0$

$\therefore \frac{\sin\alpha}{\alpha} = 1$ ($\because \sin\alpha \approx \alpha$)

Apply this condition in eqn (2), we get

$$I = \frac{I_0\sin^2\alpha}{\alpha^2} = I_0\left(\frac{\sin\alpha}{\alpha}\right)^2 = I_0(1)^2 = I_0$$

case (ii) Condition for minima:-

The intensity will be minimum, when $\sin\alpha = 0$ but not $\alpha = 0$

If $\alpha = \pm m\pi \quad m = 1, 2, 3, \cdots \ (m \neq 0)$

$\frac{\pi a\sin\theta}{\lambda} = \pm m\pi \Rightarrow \boxed{a\sin\theta = \pm m\lambda}$ where $m = 1, 2, 3 \cdots$

Case (iii) :- Condition for secondary maxima :- (3)

It is obtained by differentiating eqn (2) w.r.to α and equating to zero.

$$\frac{dI}{d\alpha} = 0$$

$$\frac{d}{d\alpha}\left[\frac{I_0 \sin^2\alpha}{\alpha^2}\right] = 0 \Rightarrow \alpha = \tan\alpha \longrightarrow (3)$$

This equation is called transcendental equation.

7(b) → G.T $\lambda = 6.56 \times 10^{-7}$ mm, $n = 1$

$\theta = 18^\circ$

$N = ?$

$$d = \frac{\sin\theta}{Nn} \Rightarrow N = \frac{\sin\theta}{\lambda n} = \frac{\sin 18^\circ}{6.56 \times 10^{-7} \times 1 \times 10^{-2}} = 4710.36 \text{ lines / 2cm}$$

$\therefore$ Total no. of lines on the grating per cm $= \frac{4710.36}{2} = 2355.18.$

8(a). Few applications of laser

→1. Scientific studies : Isotope Separation, plasma generation

2. Defense : Laser guided missiles, RADARS

3. Industries : Drilling high quality holes, welding, cutting

4. communications : fiber systems, CD/DVD/USB/HDD

5. Medicine : Blood less Surgery, endoscopic Studies

6. Holography : Generation & reconstruction of holograms

7. commertial : Bar code readers, printing.

8b Construction and working of Ruby Laser:

It was first laser device, fabricated by T.H Maiman in 1960.

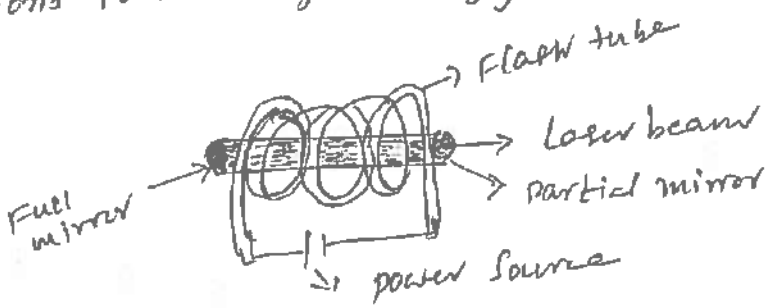
It produces high output power in form of pulses, so that it is called as pulsed laser

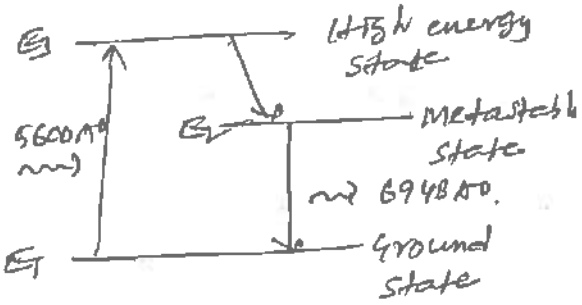
Ruby is basically Aluminum oxide (Al_2O_3) Crystal doped with chromium oxide (Cr_2O_3) atoms.

The percentage of Al_2O_3 is 99.95% and Cr_2O_3 is 0.05%. Due to the presence of chromium atoms the ruby rod is appear as pink in color.

construction : Ruby laser consist a long narrow cylinder rod. The end faces of the rod made parallel and coated with silver

such that one end face becomes fully reflected and other end face is partially reflecting.
The ruby rod is surrounded by helical xenon flash tube which provides the suitable light energy to raise the chromium ions to the high energy level.





Working :- The chromium atoms are active atoms and have three active energy levels named as ground state, Meta stable state and higher energy state.
Initially, the Cr^{3+} ions are in the ground state. When the ruby rod is irradiated, the Cr^{3+} atoms are excited to higher energy state where the light absorption band 5600 Å.
The excited Cr atoms in the high energy state stay only 10^{-8} sec and decays into metastable state. Here the metastable state becomes more populated than that of ground state within a short interval of time and hence desired population inversion is achieved.
The end of the ruby rod acts as reflecting mirrors. Therefore photons that are not moving parallel to the uniform rod escape from the side but those moving parallel to the rod are reflected back. The chain reaction quickly develops a beam of photons moving parallel to the rod, which is monochromatic and coherent. The wavelength of the laser beam is 6943 Å corresponding to the red color.

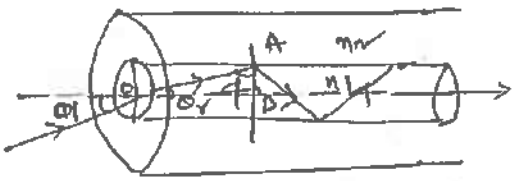
9(a) Applications of optical fibers:

1. optical fibers are used in sensors
2. optical fibers are used in medicine industry like Laparoscopic surgery and key hole surgery
3. optical fibers are used in communication

4. optical fibers are used to carry greater amount of information. (4)

Expression for NA and Acceptance angle:

The maximum angle of incidence at the end face of an optical fiber for which the light ray can be propagated along core–cladding interface is known as maximum acceptance angle



If ϕ is the greater than the critical angle θ_c, the ray undergoes total internal reflection at the interface, since $n_1 > n_2$. According to Snell's law $n_0 \sin\theta_i = n_1 \sin\theta_r$

$$\sin\theta_i = \frac{n_1}{n_0}\sin\theta_r \longrightarrow (1)$$

If θ_i is increased beyond a limit, ϕ will decrease below the critical angle θ_c, and ray escapes from the side walls of the fiber.

From Δ^{le} OAB, $\phi + \theta_r = 90^\circ$

$$\theta_r = 90^\circ - \phi$$

$$\sin\theta_r = \sin(90-\phi)$$

$$\sin\theta_r = \cos\phi \longrightarrow (2)$$

Substituting eqn (2) in eqn (1), we get

$$\sin\theta_i = \frac{n_1}{n_0}\cos\phi = \frac{n_1}{n_0}\cos\theta_c \quad (\because \phi = \theta_c) \longrightarrow (3)$$

condition for total internal reflection is $\sin\theta_c = \frac{n_2}{n_1}$

$$\cos\theta_c = \sqrt{1-\sin^2\theta} = \sqrt{1-\left(\frac{n_2}{n_1}\right)^2} = \sqrt{\frac{n_1^2 - n_2^2}{n_1^2}}$$

Substituting $\cos\theta_c$ in eqn (3), we get

$$\sin\theta_i = \frac{n_1}{n_0}\sqrt{\frac{n_1^2-n_2^2}{n_1^2}} = \sqrt{n_1^2-n_2^2}$$

$$\sin\theta_a = \sqrt{n_1^2-n_2^2} \qquad (\because \sin\theta_i = \sin\theta_a)$$

$$\therefore \theta_a = \sin^{-1}\left[\sqrt{n_1^2-n_2^2}\right]$$

$\Rightarrow$

This is the equation of acceptance angle.

NA:- The light gathering capacity of an optical fiber is known as Numerical Aperture. It is proportional to the acceptance angle. i.e $NA = \sin\theta_a$

$$= \sqrt{n_1^2 - n_2^2}$$

$$= \sqrt{(n_1 + n_2)(n_1 - n_2)}$$

$$= \sqrt{2n_1(n_1 - n_2)} \quad (\because n_1 \approx n_2)$$

$$= \sqrt{2n_1 \cdot \Delta n_1} \quad \left(\because \Delta = \frac{n_1 - n_2}{n_1}\right)$$

$$= \sqrt{2\Delta n_1^2}$$

$$\boxed{NA = n_1\sqrt{2\Delta}}$$

where Δ is a fractional difference b/w refractive indices of core and cladding.

9(b) G.T $n_1 = 1.45$, $n_2 = 1.15$, $NA = ?$ $\theta_a = ?$

$$NA = \sqrt{n_1^2 - n_2^2} = \sqrt{(1.45)^2 - (1.15)^2} = 0.883.$$

$$\theta_a = \sin^{-1}[NA] = \sin^{-1}[0.883] = 62.006^\circ$$

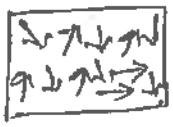
10. **Properties of Diamagnetic materials.**

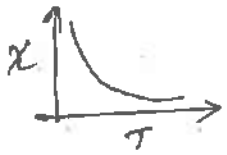
1. The materials which are weakly magnetized in a direction opposite to that of the applied magnetic field are called diamagnetic materials.
2. The lines of force denote prefer to pass through the specimen since the ability of a material to permit the passage of magnetic lines of force through it is less.
3. There is no permanent dipole moment, so the magnetic effects are very small.
4. The magnetic susceptibility is negative. It is independent of temperature and magnetic field strength
5. The relative permeability μ_r for diamagnetic substances is less than one.
6. Ex:- Cu, Au, Bi, Sb, Hg, Semiconductors (Si, Ge), NaCl, air, water H_2 etc.

properties of paramagnetic materials:-

1. The paramagnetic materials are freely magnetized in the direction of the magnetizing field
2. The magnetic Susceptibility is small and positive.
3. As soon as the magnetizing field is removed, the paramagnetic materials lose their magnetization.
4. The paramagnetic Susceptibility varies inversely with temp.

$$\chi_p = \frac{C}{T}$$ C is curie constant





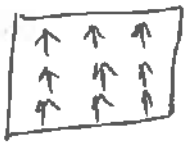
5. Ex: Al, Ca, Ti, Pt, Cr, Mn etc.

properties of Ferromagnetic materials:-

1. These materials gets strongly magnetized in the direction of the field.
2. The magnetic Susceptibility and relative permeability are positive and exhibit very high values.
3. These materials having permanent magnetic dipoles are orderly oriented
4. Above a certain temperature, ferromagnetic materials behaves paramagnetic and the Susceptibility varies with temp

$$\chi_F = \frac{C}{T - T_c} \quad T > T_c$$

C is curie Constant
T_c is Curie temp.



5. Fe, Ni, Co, $ZnFe_2O_3$ etc

11. Describe various types of polarizations in dielectrics.

→ 1. Electronic polarization
2. Ionic polarization
3. orientational polarization
4. space charge polarization

Electronic polarization :-

→ The production of polarization due to the displacement of electrons is called as electronic polarization.

→ The dipole moment is proportional to the magnitude of field strength and is given by

$$\mu_e \propto E \Rightarrow \mu_e = \alpha_e E$$

Where 'α_e' is called electronic polarizability constant.

→ It increases with increase of volume of the atom

→ It is mostly exhibited in monatomic gases

→ It occurs only at optical frequencies (10^{15} Hz)

→ It is independent of temp.

→ $\alpha_e = 4\pi\varepsilon_0 R^3$, electronic polarizability is directly proportional to cube of the radius of the atom

Ionic polarization :-

→ When an electric field is applied to the molecule, the polarization that arises due to the displacement of positive ions away from the field and displacement of negative ions towards the field is known as ionic or atomic polarization

→ This type of polarization occurs in ionic molecules like NaCl, KBr, KCl etc.

→ The induced dipole moment is proportional to the magnitude of field strength and is given by

$$\mu_i \propto E \Rightarrow \mu_i = \alpha_i E$$

Where 'α_i' is called Ionic polarizability constant

→ This polarization occurs at frequency 10^{13} Hz.

→ It is a slower process compared to electronic polarization

→ It is independent of temperature

→ $\alpha_i = \frac{e^2}{\omega_0^2}\left[\frac{1}{M}+\frac{1}{m}\right]$

Orientational polarization :-

→ The contribution of the polarization due to the orientation of the molecular dipoles is called orientational polarization

→ The orientational polarization strongly depends on temperature. (6)

→ It occurs at a frequency 10^6 Hz to 10^{10} Hz

→ It is slow process compare to Ionic polarization

→ It greatly depends on temp.

→ $\alpha_0 = \frac{\mu_0^2}{3K_B T}$, the orientational polarization is inversely proportional to the absolute temp.

Space charge polarization:-

→ space charge polarization occurs in multiphase dielectric materials in which there is a change of resistivity b/w different phases.

12(a) Explain how the absorption coefficient of an acoustic material can be determined.

→ There are two methods for measuring the absorption coefficients.

→ If T_1 be the reverberation time measured in absence of absorbing material and T_2 be the reverberation time when the absorbing material present in the room then, by using the sabine's formula we have

$$\frac{1}{T_1} = \frac{A}{0.165V} = \frac{\Sigma aS}{0.165V}$$

$$\frac{1}{T_2} = \frac{\Sigma aS + a_1 S_1}{0.165V}$$

where 'a' is the absorption coefficient of the material of area of the surface S_1 and V is the total volume of the hall.

subtracting these equations, we get

$$\frac{a_1 S_1}{0.165V} = \frac{1}{T_2} - \frac{1}{T_1}$$

$$a_1 = \frac{0.165V}{S_1}\left[\frac{1}{T_2} - \frac{1}{T_1}\right]$$

The value of the absorption coefficient can be measured by knowing the values of V and S_1.

12(b) G.T $A = 733.33$ OWU
$V = 8000 m^3$
$T = ?$

$$T = \frac{0.165V}{A}$$

$$= \frac{0.165 \times 8000}{733.33} = 1.800 \text{ sec.}$$

13(a) Explain magnetostriction effects and discuss generation of ultrasonics using this method.

→ When a rod of ferromagnetic material such as iron or nickel is kept in a magnetic field parallel to its length, the rod suffers a change in its length and is independent of the direction of the magnetic field. It depends on the magnitude of magnetic field and nature of the material. This phenomenon is known as magnetostriction.

If alternating magnetic field is applied, the rod undergoes alternate extensions and contractions at a frequency twice the frequency of the applied magnetic field.

The rod is subjected to longitudinal vibrations thereby producing ultrasonic waves in the surrounding medium.

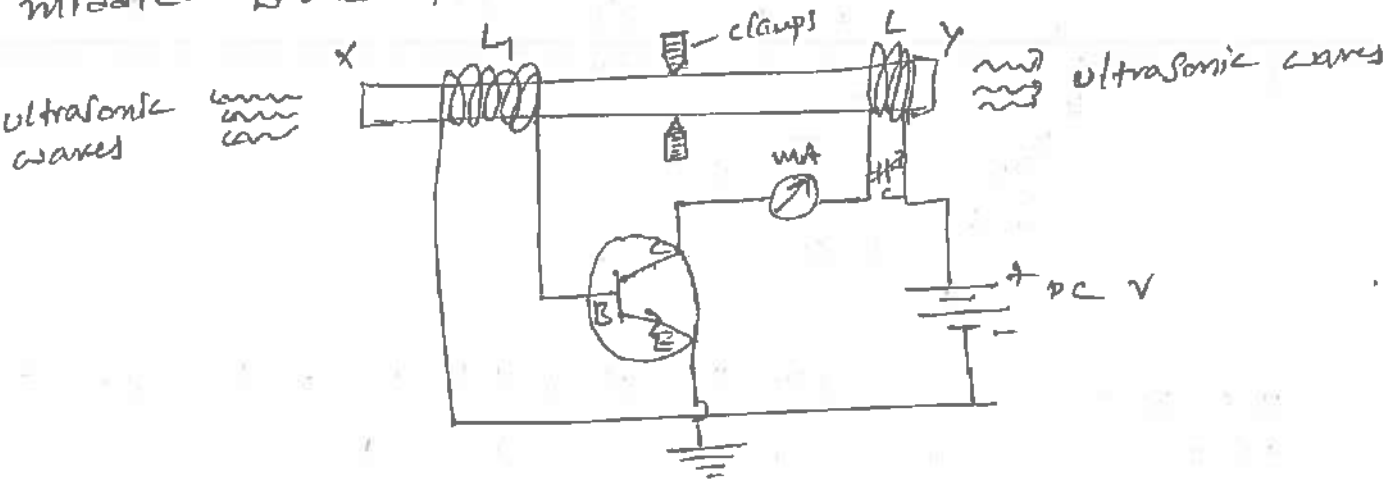
The range of frequency depends upon the dimensions of the material and extends upto 300kHz.

The frequency of vibrations of such a rod is

$$f = \frac{1}{2l}\sqrt{\frac{Y}{\rho}}$$

where Y is the youngs modulus of the rod, l is the length of the rod and ρ is the density of the material of rod.

Construction:- It consists of a rod XY, of ferromagnetic material made up of iron or nickel and is clamped at the middle. L and L_1 are two coils surrounded by the rod XY.



The capacitor C is connected with the coil L in parallel and the combination is connected to a collector terminal of the NPN transistor. The coil L_1 is connected b/w the base and

the emitter of the transistor. The mA connected in the collector circuit, measured the collector current.
The frequency of the oscillator circuit can be determined by using the values of 'L' and 'C'.

Working :- Initially the rod is magnetised by passing the DC. The capacitance C is adjusted so that the frequency of the oscillator current is same as the natural frequency of longitudinal vibrations of the rod.
Any change in the collector current causes a change in magnetisation so that the length of the rod changes.
The oscillations are maintained and the amplitude of oscillations becomes large.
The frequency of oscillation of the L-C circuit is given by the expression

$$f = \frac{1}{2\pi}\sqrt{LC}$$

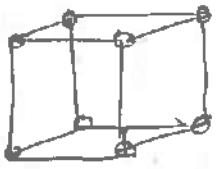
In this case the max. collector current is recorded by the mA and the rod vibrates with maximum amplitude.
By adjusting the length of the rod and capacitance of the capacitor, high frequency oscillation of different frequencies are obtained.

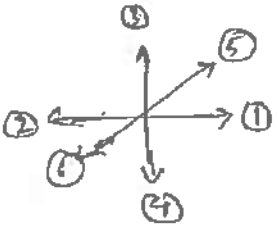
13(b) Four applications of ultrasonics

1. These waves can be used for signaling in a particular direction
2. These waves can be used for drilling and cutting process in metals.
3. These waves can be used in the formation of alloys
4. These waves are used to detect flaws in metals.
5. These waves are used to find the depth of the sea by using fathometer.
6. These waves are used for detecting tumors and other defects in human body.

14. Determine the packing fraction of SC, BCC and FCC.

→ SC: In this structure the atoms are present only at corners of the unit cell, hence unit cell of simple cubic structure is primitive cell.





No. of atoms in SC is 1

Co-ordination number is 6

Atomic radius $r = \frac{a}{2} \Rightarrow a = 2r$

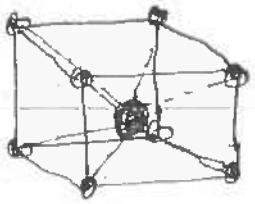
Volume of the atom $(V) = \frac{4}{3}\pi r^3$

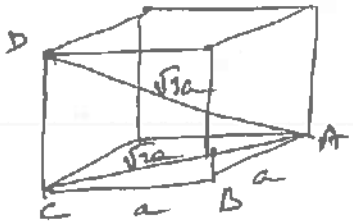
$$APF = \frac{v}{V} = \frac{\frac{4}{3}\pi r^3 \times 1}{(2r)^3} = \frac{\pi}{6} = 0.52 = 52\%.$$

→ BCC: BCC structure has eight atoms at eight corners of the cube and one atom at centre of the cube. This structure is more tightly packed than the SC structure.

No. of atoms in BCC is $\left[\frac{1}{8} \times 8\right] + 1 = 2$ atoms

Co-ordination number is ~~12~~ 8.





From fig, ΔABC, $AC^2 = AB^2 + BC^2 = a^2 + a^2 = 2a^2 \rightarrow (1)$

$$AC = \sqrt{2}a \rightarrow (2)$$

From ΔADC, $AD^2 = AC^2 + CD^2 = 2a^2 + a^2 = 3a^2 \rightarrow (3)$

$$AD = \sqrt{3}a \rightarrow (4)$$

If 'r' is the radius of the atom, $AD = 4r$

Substituting the value of AD in eqn (4), we get

$$4r = \sqrt{3}a \Rightarrow r = \frac{\sqrt{3}a}{4} \rightarrow (5)$$

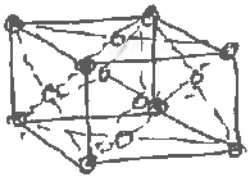
$$a = \frac{4r}{\sqrt{3}} \rightarrow (6)$$

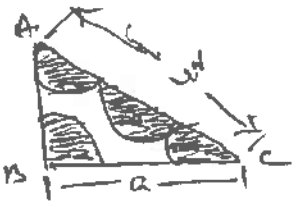
$$APF = \frac{2v}{V} = \frac{\frac{4}{3}\pi r^3 \times 2}{\left(\frac{4r}{\sqrt{3}}\right)^3} = \frac{\sqrt{3}\pi}{8} = 0.68 = 68\%.$$

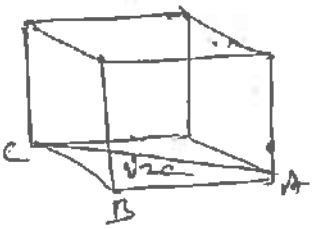
FCC:- The Fcc has 8 atoms at eight corners of the unit cell and 6 atoms at centre of 6 faces of the cube. (8)

The total no. of atoms per unit cell is $[\frac{1}{8}\times 8]+[6\times\frac{1}{2}] = 4$ atoms

co-ordination number is 12







From fig, ΔABC, $AC^2 = AB^2 + BC^2$

$= a^2 + a^2 = 2a^2 \rightarrow (1)$

$AC = \sqrt{2}a \rightarrow (2)$

If two diagonal atoms on the bottom faces are joined, then

$AC = 4r$

$AC^2 = 16r^2 \rightarrow (3)$

From eqns (1) & (3), we get

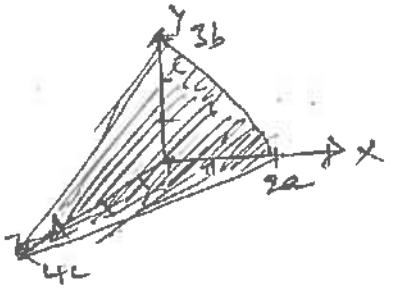
$2a^2 = 16r^2 \Rightarrow a = 2\sqrt{2}r \rightarrow (4)$

$$APF = \frac{v}{V} = \frac{\frac{4}{3}\pi r^3 \times 4}{(2\sqrt{2}a)^3} = \frac{\pi}{3\sqrt{2}} = 0.74 = 74\%$$

∴ The Fcc crystal system is highly packed than Sc and BCC.

15(a). A plane of atoms makes 2a, 3b & 4c intercepts on the crystallographic axes. Similarly, another plane of atoms makes 1a, 6b & 8c intercepts on the crystallographic axis. Determine miller indices for these two different planes and comment on the result.

(1)



From the given plane, the intercepts are 2a, 3b & 4c.

$\frac{2a}{a}, \frac{3b}{b}, \frac{4c}{c}$

2, 3, 4

$\frac{1}{2}, \frac{1}{3}, \frac{1}{4}$

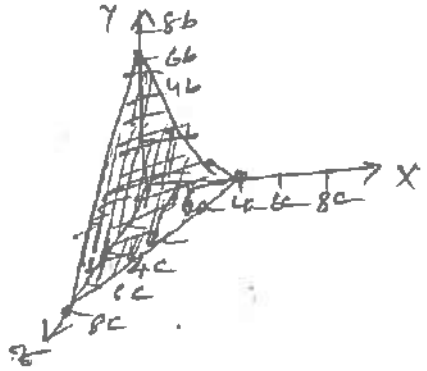
LCM is 12

$\frac{1}{2}\times 12, \frac{1}{3}\times 12, \frac{1}{4}\times 12$

6, 4, 3

∴ The Miller indices are (6 4 3).

(b)



From the given plane, the intercepts are 4a, 6b and 8c.

$$\frac{4a}{a}, \frac{6b}{b}, \frac{8c}{c}$$

$$4, 6, 8$$

$$\frac{1}{4} : \frac{1}{6} : \frac{1}{8}$$

LCM is 24

$$\frac{1}{4} \times 24, \frac{1}{6} \times 24, \frac{1}{8} \times 24$$

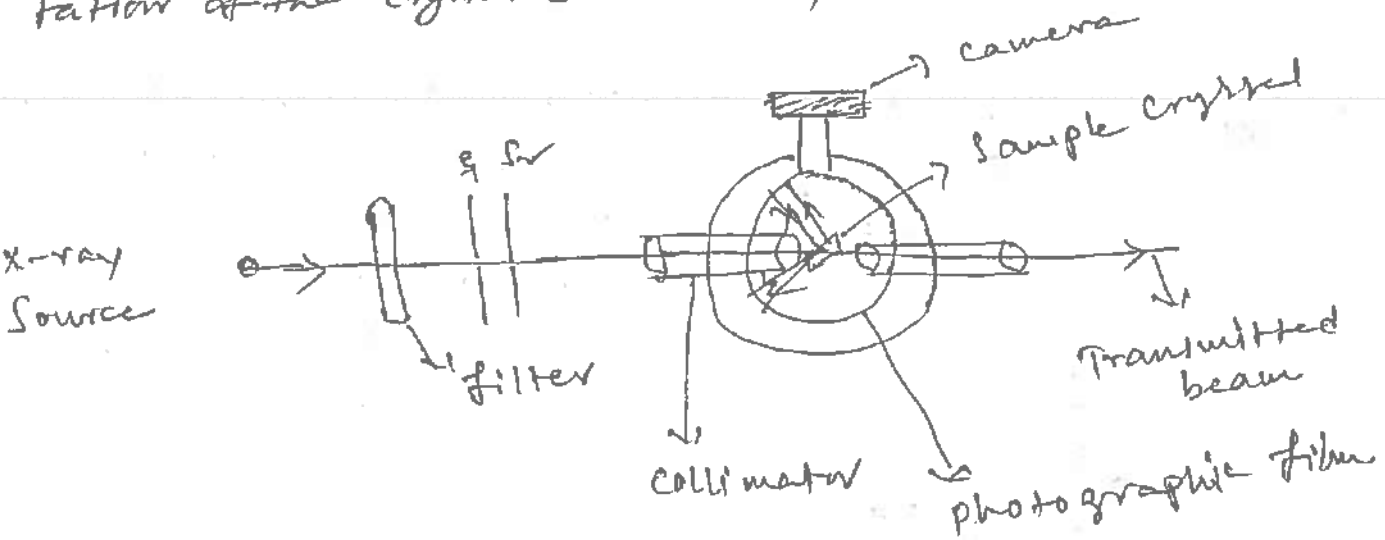
$$6, 4, 3$$

∴ The miller indices are (643).

comment: For Different planes and for different Intercepts, the miller indices are same as (643).

15(b). Powder method of X-ray diffraction:-

→The powder method is an x-ray diffraction technique used to Study the structure of tiny crystallites in the form of powder. This method gives the information regarding the size and orientation of the crystallites in the powder.



It consists of a cylindrical camera, whose length is small when compared to the diameter.

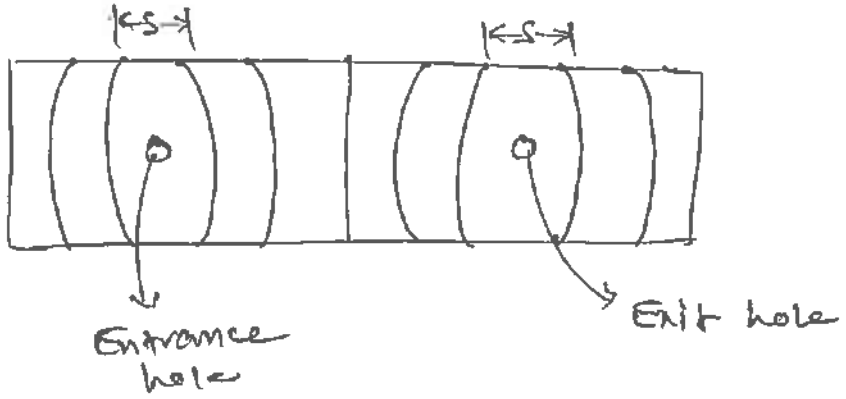
The powdered sample is filled in a capillary tube and mounted at the centre of the camera.

The X-rays are allowed to pass through a filter to emit a monochromatic beam and is passed through a slit system S1 & S2

to become a fine and sharp beam.
The x-rays enter the camera through the collimator and strike the powdered sample.
The diffraction takes place for the values of 'd' and 'θ' which satisfy the Bragg's condition.

i.e $\boxed{2d \sin\theta = n\lambda}$

The transmitted x-rays move out of the camera through an exit hole located opposite to the entrance hole.
A photographic film is attached to the inner side of the curved surface of the camera. Each cone of the reflected beam leaved two impressions on the film, which are in the form of arcs on either side of the exit hole with their centers coinciding with the holes.
Similarly, cones produced by back-scattered x-rays produce arcs on either side of the entrance hole.
The film is exposed for a few hours in order to obtain arcs of sufficiently high intensity.
It is then removed from the camera and developed.
The circular arcs are observed on the film.



From the figure, the angle θ corresponding to a particular pair of arcs is related to the distance S b/w the arcs

$$\therefore 4\theta \text{ (radians)} = \frac{S}{R} \quad (\because \text{arc length} = \text{angle} \times \text{radius})$$

where, R is the radius of the camera
If 'θ' is the measured in degrees then the above equation modified as

$$\theta \text{ (degrees)} = \frac{S}{R}\left(\frac{180}{\pi}\right)$$

$$= \frac{57.296\,S}{R}$$

Using the above, expression, θ can be calculated. Then the interplanar spacing for various sets of parallel planes can be calculated from the Braggs law as follows,

$$d = \frac{\lambda}{2\sin\theta}$$

Knowing all the parameters, the crystal structure can be determined.

HOD 11/8/22

10/08/22

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NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	EEE/CSE/CSM/CSD			Academic Year	2021 - 2022
Course Code	20BSX23	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	APPLIED CHEMISTRY						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define glass transition temperature of plastics	20BSX23.1	L1
2	State the Nernst Equation.	20BSX23.2	L1
3	Define Bond order.	20BSX23.3	L1
4	How many signals appear in Toluene in 13C-NMR Spectroscopy?	20BSX23.4	L1
5	What is supramolecular chemistry?	20BSX23.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Differentiate addition polymerization from condensation polymerization.	6M	20BSX23.1	L2
6 (b)	Differentiate between thermoplastics and thermosetting plastics	6M	20BSX23.1	L2
	OR			
7 (a)	Explain the mechanism of free radical chain polymerization of PVC.	6M	20BSX23.1	L2
7 (b)	Write the preparation properties and applications of i. Nylon 6, 6 ii. Bakelite.	6M	20BSX23.1	L2
8 (a)	Explain the construction and working of Pb-Acid battery.	6M	20BSX23.2	L2
8 (b)	Explain construction, working principle of Calomel Electrode.	6M	20BSX23.2	L2
	OR			
9 (a)	Explain construction, working and applications of MeOH-O_2 fuel cell.	6M	20BSX23.2	L2
9 (b)	Discuss in detail about Electro chemical sensors with examples.	6M	20BSX23.2	L2
10 (a)	Draw the energy level diagrams of CO and N_2 molecule. Explain their magnetic nature and bond order.	7M	20BSX23.3	L2
10 (b)	Describe about a particle in 1-D box with suitable example.	5M	20BSX23.3	L2
	OR			
11 (a)	Explain the crystal field splitting in tetrahedral complex and properties of $[Ni(CN)_4]^{-2}$.	6M	20BSX23.3	L2
11 (b)	Illustrate energy level diagram of 1,3-Butadiene.	6M	20BSX23.3	L2
12 (a)	Explain principle and instrumentation of FT-IR Spectroscopy.	6M	20BSX23.4	L2
12 (b)	Define Lamberts-Beers law. Explain principle and Instrumentation of UV-Visible spectroscopy.	6M	20BSX23.4	L2
	OR			
13 (a)	What are the principles involved in HPLC?	6M	20BSX23.4	L2
13 (b)	Explain the pH metric methods help to determine the endpoint in acid-base titration.	6M	20BSX23.4	L2
14 (a)	Write about computational chemistry.	6M	20BSX23.5	L2
14 (b)	Describe about Rotaxanes and give their applications.	6M	20BSX23.5	L2
	OR			
15 (a)	Write a note on template synthesis of Macro cyclic ligands.	4M	20BSX23.5	L2
15 (b)	Discuss about cation binding, anion binding and simultaneous cation and anion binding.	8M	20BSX23.5	L2

Semester End Regular/Supplementary Examination August, 2022

Scheme

Degree: B.Tech (U.G) Programme: EEE/CSE/CSM/CSD

Course Code: 20BSX23 Semester: II (APPLIED CHEMISTRY)

PART-A [5X2 = 10 M]

(1) Define glass transition temperature of plastics — 2m

(2) State the Nernst Equation — 2m

(3) Define Bond Order — 2m

(4) How many signals appears in Toluene in 13C NMR spectroscopy — 2m

(5) What is supramolecular chemistry — 2m

PART-B [5X12 = 60 M]

(6) (a) Differentiate addition polymerization from condensation polymerization — 6m

(b) Differentiate b/w thermoplastics & thermosetting plastic — 6m

(7) (a) Explain the mechanism of free radical chain polymerization of PVC — 6m

(b) write the preparation & properties and applications of nylon 6, 6, Bekelite — 3m + 3m

(8) (a) Explain the construction and working of pb-Acid battery — 6m

(b) Explain the construction, working principle of calomel Electrode — 6m

(9) (a) Explain construction, working and applications of methyl oxy fuel cell — 6m

(b) Discuss in detail about Electro chemical sensors with example

(10) (a) Draw the energy level diagrams of co and N_2 molecule — 6m

(b) Describe about a particle in 1-D box with suitable example — 6m

(11) (a) Explain the crystal field splitting in tetrahedral complex and properties of $[Ni(CN)_4]^{-2}$ — 6m

(b) Illustrate energy level diagram of 1,3 Butadiene — 6m

(12) (a) Explain principle & instrumentation of ft-IR spectroscopy — 6m

(b) Define Lambert's-Beers law, Explain principle and instrumentation of UV- Visible spectroscopy — 6m

(13) (a) What are the principles involved in HPLC — 6m

(b) Explain the pH metric methods help to determine the endpoint in acid-base titration — 6m

(14) (a) write about computational chemistry — 6m

(b) Describe about Rotaxanes & give their applications — 6m

(15) (a) write a note on templates synthesis of macrocyclic ligands — 6m

(b) Discuss about cation binding, anion binding and simultaneous cation and anion binding — 6m

Semester End Regular/Supplementary Examinations
August, 2022

Key

Degree : B.Tech (U.G) Programm : CSD/EEE/CSE/CSM Max marks : 70
Course code : 20BSX23 Semester : II

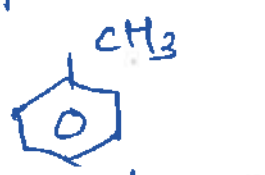
1) The glass transition temperature is the temperature range where the polymer substrate changes from a rigid glassy material to a soft (not melted) material and is usually measured in terms of the stiffness or modulus

2) The equation which helps to find the electric potential values at any given concentration is called Nernst equation. It is measured using standard Hydrogen Electrode

$$E = E_0 + \frac{2.303\,RT}{nF} \log_{10}\left(M^{n+}\right)$$

3) Bond order $= \frac{\text{Bonding orbitals} - \text{Anti bonding orbitals}}{2}$

4) Four signals appears in Toluene in ^{13}C NMR spectroscopy



Toluene

5) Supramolecular chemistry is defined as chemistry behind the molecular or the chemistry which deals with non-covalent bonds.

PART-B [5X12=60M]

(6) (a) Addition polymerisation

(1) It is also known as chain growth polymerisation
(2) It is formed by monomers of multiple bonds
(3) It is done by the elimination of simple molecules
(4) Reactions fast and polymers are made at once
(5) There is a little change in molecular mass
(6) They can produce only thermoplastics
Ex:- polyvinyl chloride(PVC). polythene

Condensation polymerisation

1) It is also known as step growth polymerisation
2) takes place in monomers having active functional gro
3) takes place with the elimination of simple molecules like H_2O, NH_3 and HCl
4) polymers are made gradual in steps
5) molecular mass increases with in the process
6) they can produce either thermoplastics or thermosetting plastics.
Ex:- Bakelite, nylon 6,6

(b) Thermoplastics

1) Thermosetting plastics are followed by the addition polymerisation
2) Long chain linear structure
3) soften on heating
4) It can reshaped and reused
5) It is soluble in organic solvent
6) Examples include
1) Poly vinyl chloride (PVC)
2) high density polyethylene (PEX)

Thermosetting plastics

2) Thermosetting plastics are followed by the condensation polymerised
2) 3D structure
3) Do not soften on heating
4) It can't be reshaped and reused
5) It is insoluble in organic solvent
6) Examples include
1) alkyds (polyesters)
2) urea formaldehyde (UF)

Free radical mechanism :-

It is a type of polymerisation in which the reactive centre of a polymer chain is free-radical. Means this polymerisation mechanism is initiated by free radical which is produced by homolytic fission of initiator (H_2O_2) in presence of light agitation (or) heat.

- This mechanism is involved in 3 steps :
  1. Initiation
  2. propogation
  3. termination

1. Initiation :-

- Initiators are unstable compounds and undergoes homolytic fission & produce free-radicals
- These free radicals reacts with π electrons of monomer to produce monomer free radical.

$$\underset{\text{(initiator)}}{I-I} \xrightarrow{h\nu} \underset{\text{(free radical)}}{I\cdot} + \underset{\text{(free radical)}}{I\cdot}$$

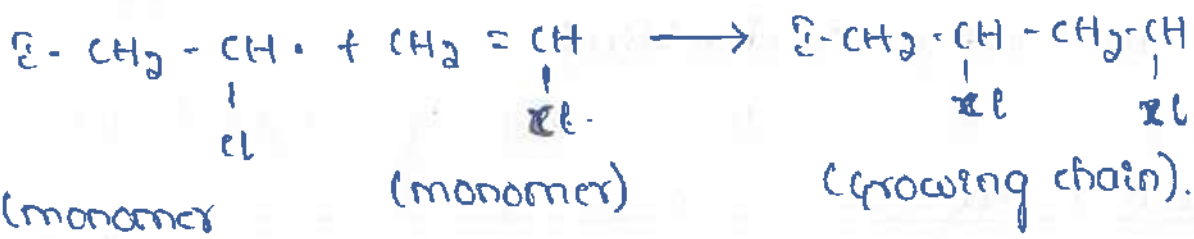
$$I\cdot + CH_2=\underset{\underset{Cl}{|}}{CH} \longrightarrow I-CH_2-\underset{\underset{Cl}{|}}{CH}\cdot$$

(free radical) (monomer) (monomer free radical).

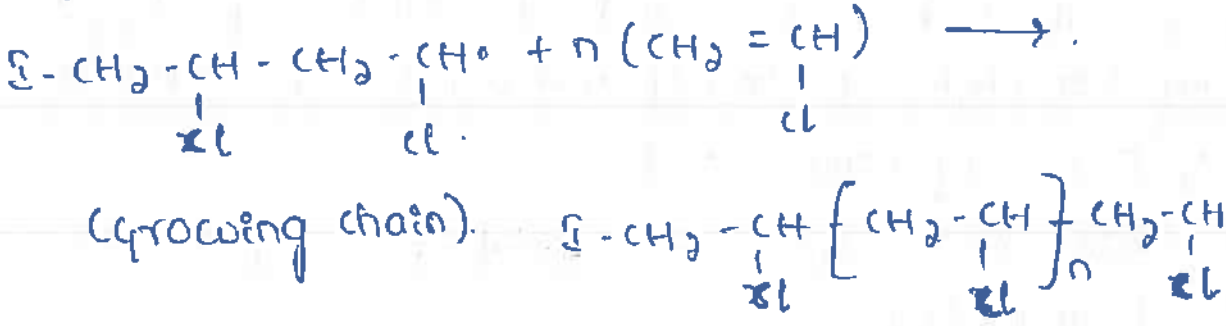
2. propogation :-

- The monomer free radical reacts with no. of monomers to form chain growth with free

radical site at the end of the chain producing a living polymer and it is called as propogation.



(monomer free radical) (monomer) (Growing chain).

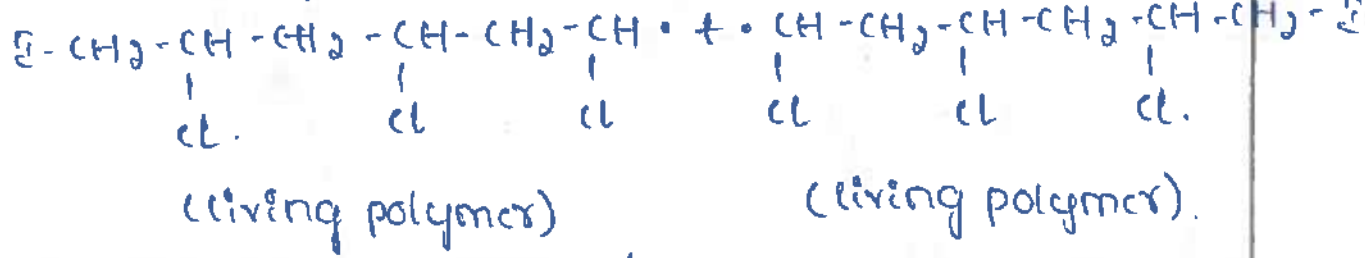


(Growing chain) (living polymer)

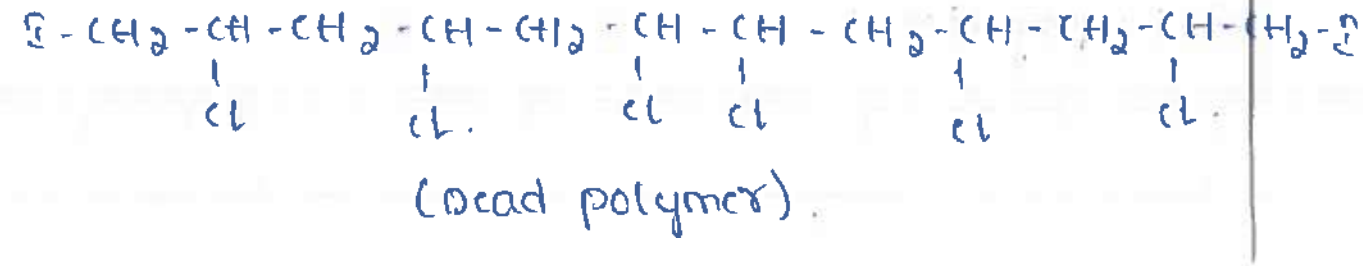
3. Termination :

- At some point, the propogation polymers stops growing and terminates to produce death polymer and this process is known as termination.
- This termination can be carried out by coupling and by disproportion / disproportination.

By coupling : combination



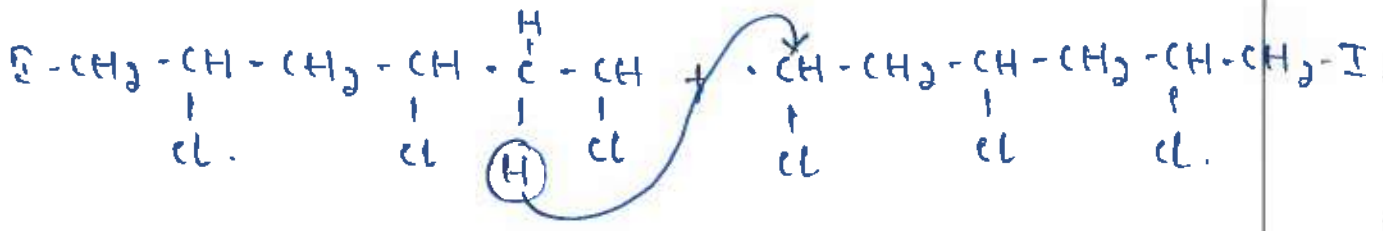
(living polymer) (living polymer).



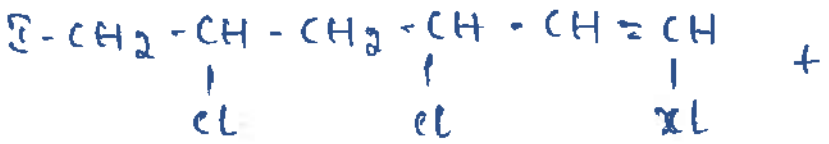
(Dead polymer).

By disproportionation :-

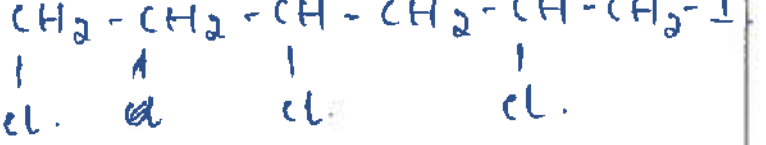
- In this a H- atom from one living polymer is transferred to another free radical centre of other living polymer chain & form. 2 polymer molecules like unsaturated and saturated polymer.



(living polymer) (living polymer)



(unsaturated polymer)



(saturated polymer).

7(b) i. Nylon - 6, 6 :-

7(b) Preperations :-

It is prepared by the reaction between adipic acid and hexa methylene di amine.

$$n\left[HOOC-(CH_2)_4-COOH\right] + n\left[H_2N-(CH_2)_6-NH_2\right]$$

(adipic acid) (hexa methylene di amine)

$$\downarrow -H_2O.$$

$$\left[\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_6-NH\right]_n.$$

(Nylon - 6, 6) $+ 2nH_2O$

Properties :-

- It is translucent, whitish, horny, high melting points
- It posses high temperature stability & good. scartch resistance.
- It is soluble in phenol and formic acid and insoluble in organic solvents like benzene and acetone.

Applications :-

- It is used for fibre.
- It is used for moulding purpose for gears, bearings, making filaments for ropes, bristles for brushes.

ii. Bakelite :-

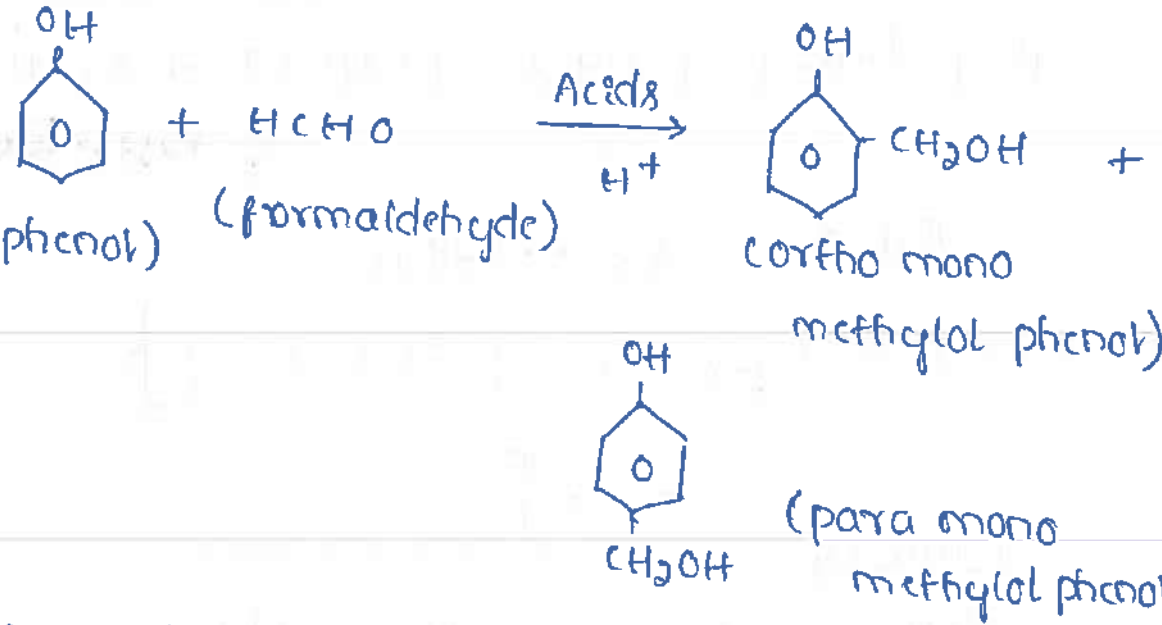
Preperations :-

It is prepared by the condensation polymerisation with formaldehyde in the presence of acids (or) acid catalyst

- It is formed by 3 steps.

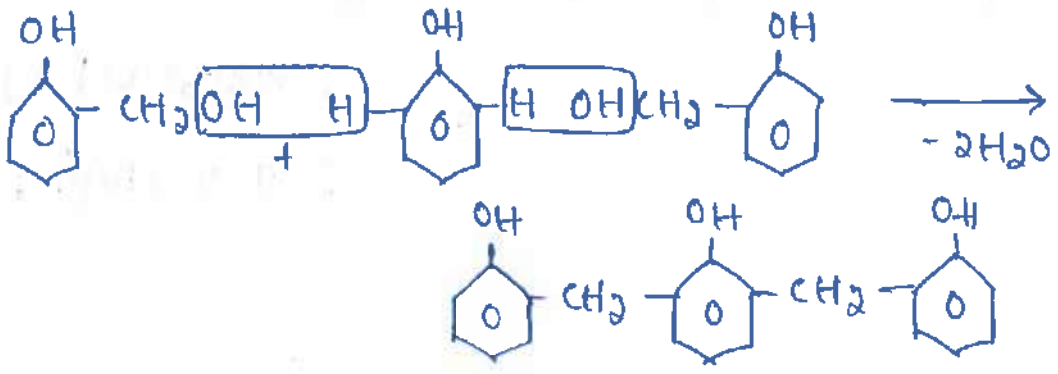
Step-1 :-

Phenol reacts with formaldehyde in the presence of acid to form ortho mono methylol phenol & para mono methylol phenol.



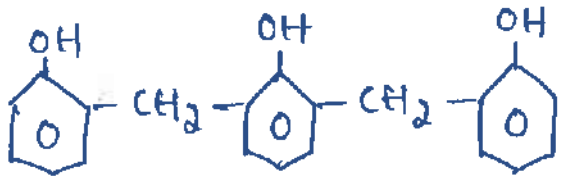
Step-2 :-

Ortho mono methylol phenol reacts with phenol to form linear molecule known as Novalac.

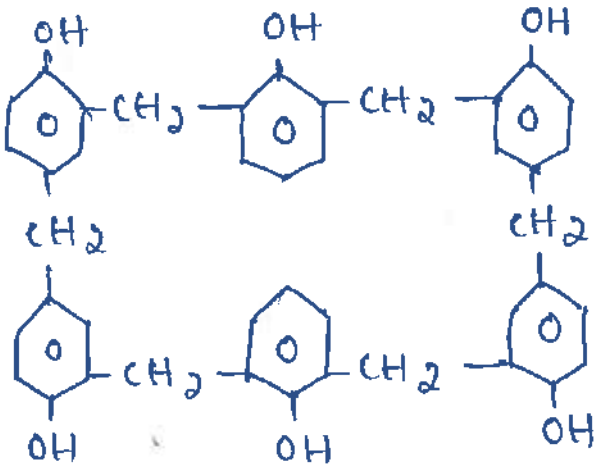


Step-3 :-

During moulding catalyst HMTA is added. It means it provides excess formaldehyde which converts fusable Novalac into hard infuseable product is known as Bakelite.



(Novalac)



(Bakelite).

Properties :-

- It is hard, rigid and strong.
- It is scratch resistant and water resistant polymer.
- It has got good chemical resistance, resistant to acids, salts and many organic solvents but it is attacked by alkalis due to the presence of -OH group.
- It is a good anion exchange resins, exchanges -OH group with any other anion

Applications :-

- It is used widely for making electrical

insulator parts like switches, switch boards, heater handles etc.

- Moulded articles like telephone parts, cafinets for radio & TV.
- Tarpaulins, wood laminations & glass laminations.
- As an anion exchanger in water purification by ion exchange method in boilers.
- As an adhesive for grinding wheels etc.
- For making bearings and used in propellers shafts, paper industry and rolling mills.

(8) (a) **Lead-acid cell** :- To increase the current output of each cell, the cathode and the anode plates are joined together, keeping them in alternate positions. The cells are connected parallel to each other. The cell is represented as

$$Pb \mid PbSO_4(s), H_2SO_4 \mid PbSO_4(s) \mid Pb$$

Anode : Pb

Cathode PbO_2

Electrolyte H_2SO_4 (20-22%)

EMF = 2V

Discharging reaction

At anode $Pb \longrightarrow Pb^{+2} + 2e^-$

$Pb^{2+} + SO_4^{2-} \longrightarrow PbSO_4 \downarrow$

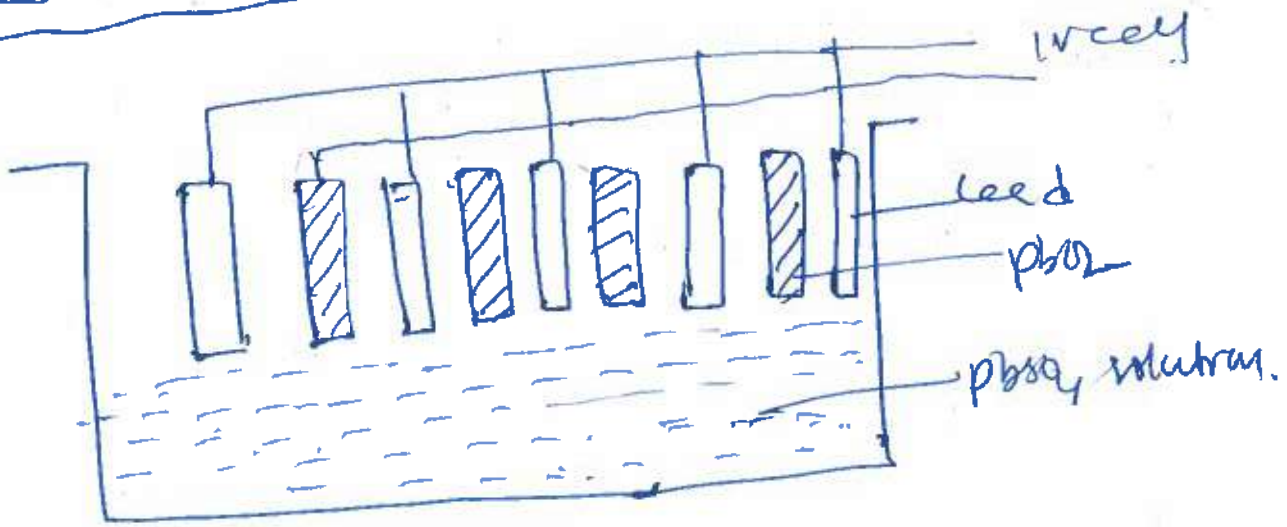
At cathode $PbO_2(s) + 4H^+ + 2e \longrightarrow Pb^{+2} + 2H_2O$

$Pb^{+2} + SO_4^{2-} \longrightarrow PbSO_4$

Therefore, the overall reaction is

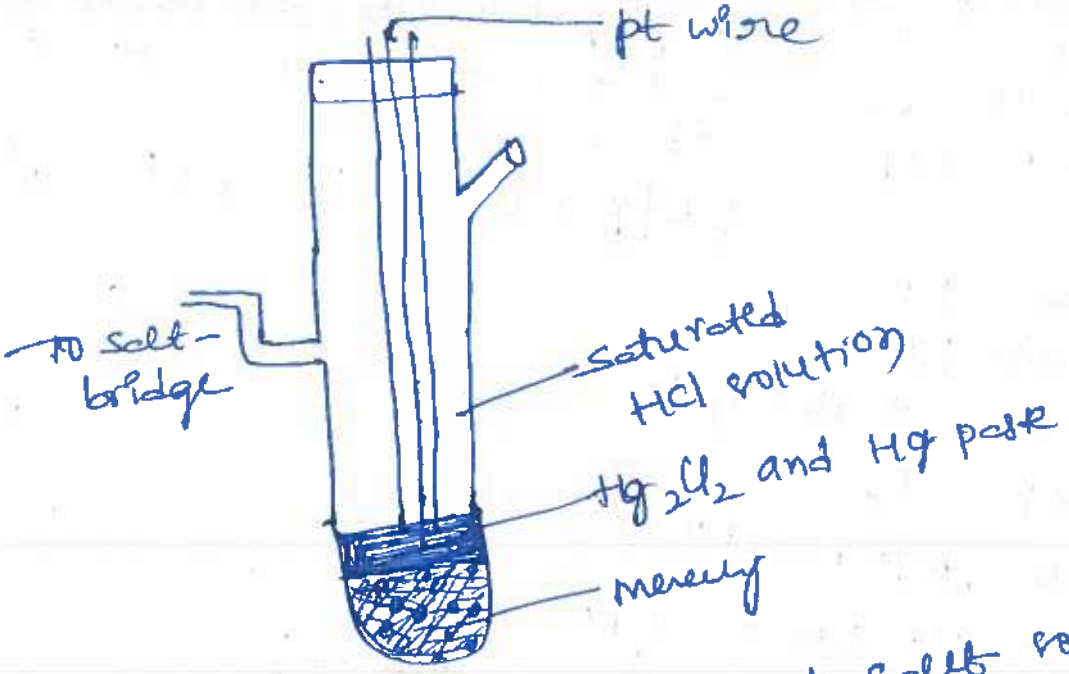
$$Pb(s) + PbO_2 + 4H_2SO_4(aq) \longrightarrow 2PbSO_4 + 2H_2O + Energy$$

Saturated Calomel Electrode



Secondary cell Eg:- Lead-Acid cell

(b) Saturated calomel Electrode



Calomel electrode is a metal-metal salt solution. It consists of mercury, mercurous chloride and a solution of KCl. mercury is placed at the bottom of a pyrex tube having a side tube on each side. mercury is covered by a paste of mercurous chloride (calomel) with mercury & KCl

A solution of KCl is introduced above the paste through the side tube. A platinum wire sealed in a glass tube is dipped into mercury & used to provide the external electrical contact. The concentration of KCl used is either saturated. The electrode is known as decinormal normal saturated calomel electrode.

The electrode, whose potential is to be determined is connected to, thus salt bridge.

The net reversible electrode reaction is,

$$Hg + Cl(s) + 2\bar{e} \rightleftharpoons 2Hg(l) + 2\bar{Cl}$$

Nernst Equation:

$$E = E^{\circ}_{(Hg)} - \frac{2.303RT}{2F} \log [\bar{Cl}]^2$$

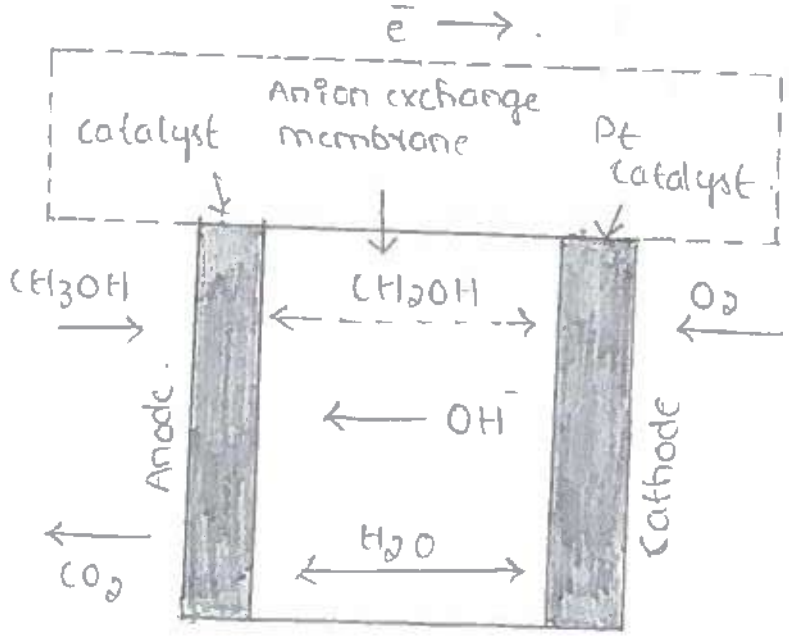
$$= E^{\circ} - \frac{2.303RT}{F} \log [\bar{Cl}]$$

$$= E^{\circ} = 0.059 \log [Cl^-]$$

9(a)

MeOH - O_2 fuel cell :

In this fuel cell CH_3OH is used as a fuel & O_2 as oxident to generate electrical energy the methyl - oxygen fuel cell has two electrodes. the anode consists of porous nickel electrode impregnated with Pt/Pd catalyst. porous nickel electrode coated with silver catalyst constitutes a cathode of the cell. the electrolyte KOH, is taken in between the two electrodes. CH_3OH & O_2 are sent continuously into their respective electrodes as shown. and the electrical energy is produced with the continuous replenishment of the fuel, CH_3OH at the anode.



At anode : $CH_3OH + 6OH^- \longrightarrow CO_2 + 5H_2O + 6e^-$

At cathode : $\frac{3}{2}O_2 + 3H_2O + 6e^- \longrightarrow 6OH^-$

Net reaction :. $CH_3OH + \frac{3}{2}O_2 \longrightarrow CO_2 + 2H_2O$.

Applications :

The major application of methyl alchol oxygen fuel cells is a fuel for fuel cell motor vehicles like NECAR-5 in Japan, USA etc.

(9b) Electrochemical sensors :.

Electrochemical sensors are the devices which are used to measure electrical parameters such as potential difference, current, conductance etc of the sample under analysis. The sensor which is measure the potential difference is called potentiometric sensors and which measures current is called amperometric sensor.

Electrochemical sensors produces an electrical signal which is related to the sample under study : Biological processes such as analysis of glucose in blood and urea are analysed by potentiometric (or) amperometric sensors.

Electrochemical sensors

Potentiometric sensors. Amperometric sensors. Conductometric sensors.

Potentiometric sensors :-

A potentiometric sensor is a kind of electrochemical sensor that can be utilized to compute the insightful grouping of certain logic gas (or) arrangement segments. such sensors measure an anode's electrical likely when there is no flow present. the impact of focus on the equilibrium of redox responses happening at anode electrolyte interface of an electrochemical cell is used by. potentiometric sensors.

The redox reaction takes on the electrode surface

$$\text{oxident} + ze \rightleftharpoons \text{Reduced product}.$$

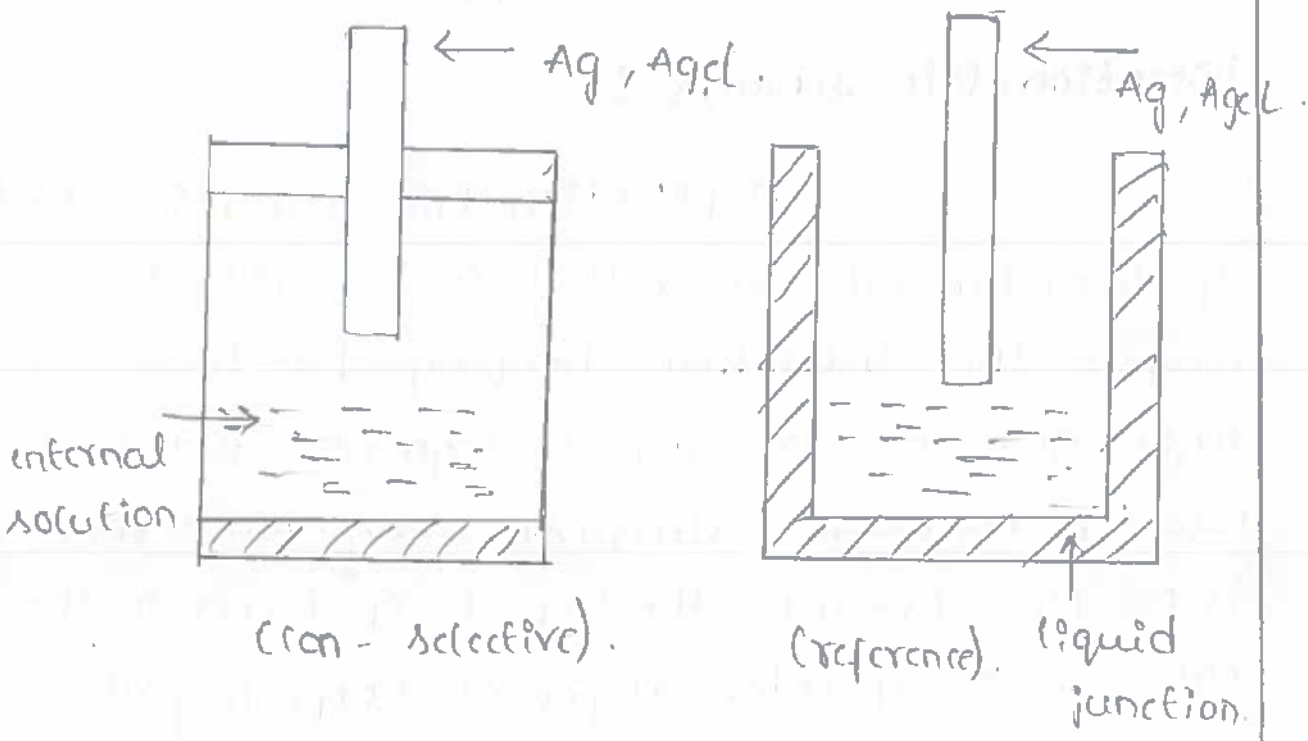
z is the number of electrons involved in the redox reaction.

Principle :-

The signal is resolved between the working cathode and the reference terminal as the likely contrast. the capacity of the working cathode must be reliant on the

analyte focus in the gas (or) arrangement stage.

To give a given reference potential, a reference cathode is required.



10(a)

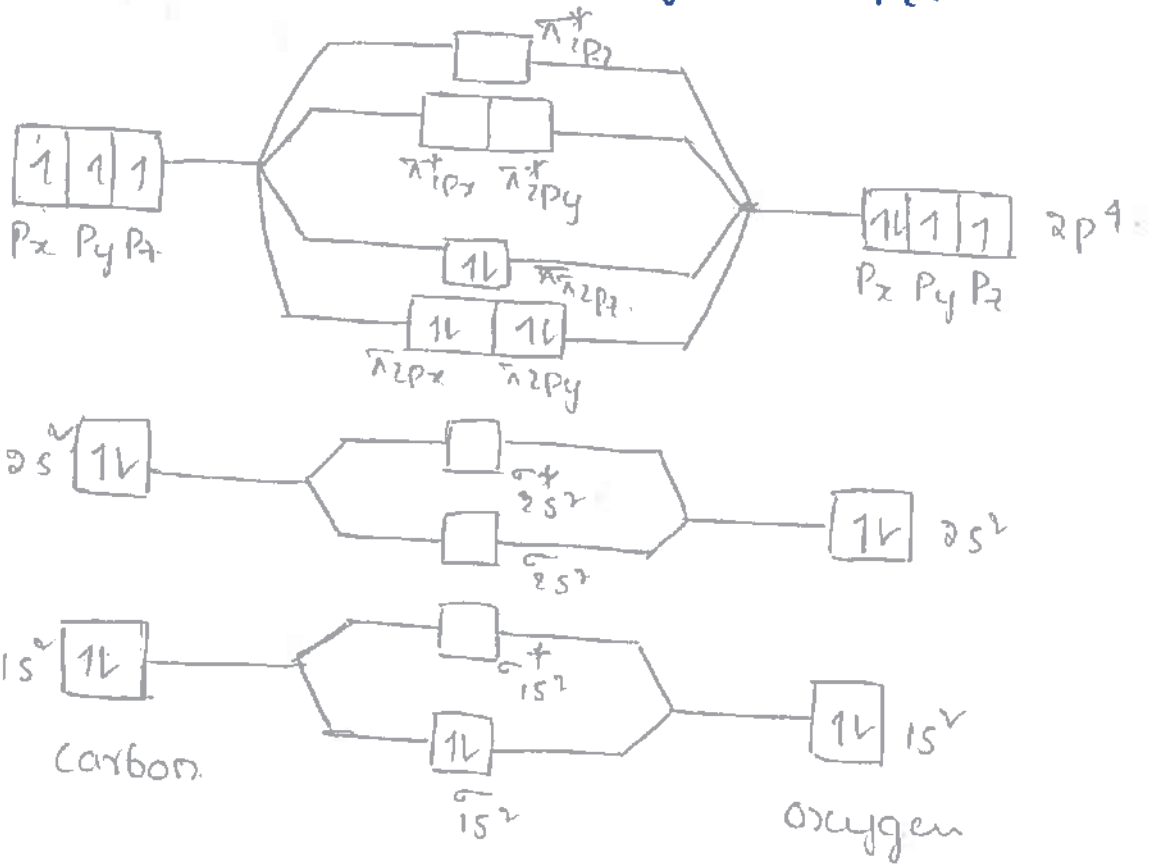
Energy level diagram of CO molecule :-

- The electronic configuration of carbon and oxygen atoms are.

  Carbon (C) = 6 = $1s^2 2s^2 2p_x^1 2p_y^1$

  Oxygen (O) = 8 = $1s^2 2s^2 2p_x^2 2p_y^1 2p_z^1$

- The outermost shell of carbon and oxygen have 4 & 6 valency electrons respectively thus CO molecule has total 10 electrons in Bonding.
- Molecular energy level diagram is shown below.
- Molecular ortial configuration of CO molecule is $\sigma_{1s}^2 < \sigma^*_{1s^2} < \sigma_{2s}^2 < \sigma^*_{2s^2} < \pi_{2p_x}^2 = \pi_{2p_y}^2 < \sigma_{2p_z}^2 < \pi^*_{2p_x} = \pi^*_{2p_y} < \sigma^*_{2p_z}$



From molecular diagram,

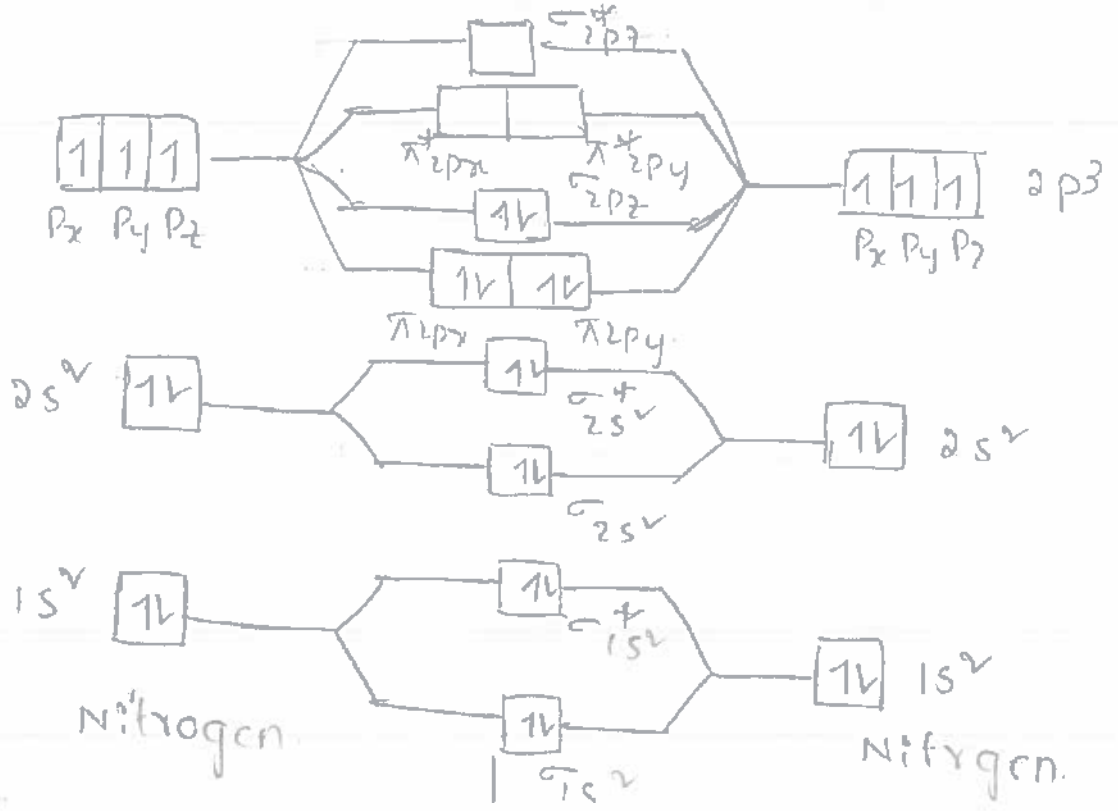
Bond order (BO) $= \frac{N_B - N_{AB}}{2} = \frac{10-4}{2} = \frac{6}{2}$

$= 3$.

- It has diamagnetic nature due to absence of unpaired electrons.

Energy level diagram of N_2 molecule :-

- Each of the 2 Nitrogen atoms with an electronic configuration of $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$ contributes 5 valency electrons to the N_2 molecule.
- The molecular orbital diagram is shown below.
- The molecular orbital configuration of the N_2 molecule is $\sigma_{1s}^2 < \sigma^*_{1s}{}^2 < \sigma_{2s}^2 < \sigma^*_{2s}{}^2 < \pi_{2p_x}^2 = \pi_{2p_y}^2 < \sigma_{2p_z}^2 < \pi^*_{2p_x} = \pi^*_{2p_y} < \sigma^*_{2p_z}$.



From molecular diagram,

Bond order (BO) $= \frac{N_B - N_{AB}}{2} = \frac{10-4}{2}$

$= \frac{6}{2} = 3.$

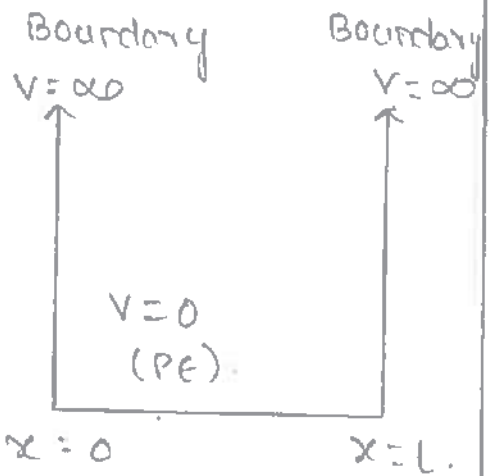
- this molecule is diamagnetic nature due to absence of unpaired electrons.

---

10 (b)

Particle in 1- Dimensional Box :-

- consider a particle that is constrained to move only in x - direction from $x = 0$ to $x = L$.



- It means the particle is moving x - direction only from $x = 0$ to $x = l$ inside the box within the boundaries.
- As the particle is moving inside the box, it connot come outside the box, so cannot come outside the box, so finding probability in outside will be zero.
- As the particle inside the box, the potential energy (V) will be equals to 0 ($V = 0$) while, at the boundaries and outside box potential energy (V) will be infinity ($V = \infty$).
- then schrodinger wave equation in. Hamiltonian operator form can be.

expressed as.

$$\hat{H}\psi = E\psi \longrightarrow (1).$$

$$\hat{H} = \frac{-h^2}{8\pi^2 m}\frac{d^2}{dx^2} + V.$$

Put the $\hat{H}$ values in Eq (1).

$$\left(\frac{-h^2}{8\pi^2 m}\frac{d^2}{dx^2} + V\right)\psi = E\psi.$$

$$\frac{-h^2}{8\pi^2 m}\frac{d^2\psi}{dx^2} + V\psi = E\psi$$

$$\frac{-h^2}{8\pi^2 m}\frac{d^2\psi}{dx^2} + V\psi - E\psi = 0.$$

$$-\left(\frac{-h^2}{8\pi^2 m}\frac{d^2\psi}{dx^2} + V\psi - E\psi\right) = 0.$$

$$\frac{h^2}{8\pi^2 m}\frac{d^2\psi}{dx^2} - V\psi + E\psi = 0.$$

$$\frac{h^2}{8\pi^2 m}\frac{d^2\psi}{dx^2} + (E - V)\psi = 0. \longrightarrow (2)$$

Now,

multiple the eq (2) with $\frac{8\pi^2 m}{h^2}$

$$\frac{8\pi^2 m}{h^2} \times \frac{h^2}{8\pi^2 m}\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - V)\psi = 0.$$

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m(E - V)\psi}{h^2} = 0 \longrightarrow (3).$$

Now,

Applying the two conditions.

i) particle is in outside the box.

ii) particle is inside the box.

Outside the box :

- the potential energy (V) will be infinity ($V = \infty$)
- Put this value in Eq (3).

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - \infty)\psi = 0$$

this is possible only when $\psi = 0$.
ie particle is not outside the box.

Inside the Box :

- the potential Energy (V) will be zero ($V = 0$)

Put this value in Eq (3)

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - 0)\psi = 0.$$

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 mE\psi}{h^2} = 0$$

$$\frac{d^2\psi}{dx^2} + K^2\psi = 0. \quad \left(\because K^2 = \frac{8\pi^2 mE\psi}{h^2}\right)$$

Now,

wave function can be represented as.

$$\psi(x) = A\sin Kx + B\cos Kx.$$

∴) when $x = 0$

finding probability ψ will be '0'.

$$\psi(0) = 0$$

$$0 = A\sin Kx + B\cos Kx$$

$$0 = A\sin K(0) + B\cos K(0)$$

$$0 = A(0) + B(1) \Rightarrow \boxed{B = 0}$$

ii) when $x = l$, finding probability ψ will be '0'.

$$\psi(L) = 0.$$

$$0 = A\sin kL + B\cos kL.$$

$$0 = A\sin kL + 0.$$

$$A\sin kL = 0 \Rightarrow \sin kL = 0.$$

$$\sin kL = \sin n\pi.$$

$$kL = n\pi$$

$$\boxed{k = \frac{n\pi}{L}}$$

$$k^2 = \frac{n^2\pi^2}{l^2} \quad \& \quad k^2 = \frac{8\pi^2 mE}{h^2}.$$

from above k^2 values, $\frac{n^2\pi^2}{l^2} = \frac{8\pi^2 mE}{h^2}$.

$$n^2h^2 = 8mEl^2$$

$$\boxed{E = \frac{n^2h^2}{8ml^2}}$$

from the above formula, we can calculate energy and this energy in one-dimensional is quantised.

$n = 1$, $E_1 = \frac{(1)^2h^2}{8ml^2} = x$.

$n = 2$, $E_2 = \frac{(2)^2h^2}{8ml^2} = 4x$.

$n = 3$, $E_3 = \frac{(3)^2h^2}{8ml^2} = 9x$.

wave function inside a BOX :-

in previous wave function,

$$\psi_n(x) = A \sin kx .$$

$$\psi_n(x) = A \sin\left(\frac{n\pi}{L}\right)x .$$

the probability of finding the particle in a small space between x and $x+dx$, is given by $\psi^2(x)\,dx$.

Means, the finding probability of an electron some where underlying is unity.

$$\int_0^L \psi^2(x)\,dx = 1$$

$$\int_0^L A^2\left(\sin\left(\frac{n\pi}{L}\right)^2 x\right) dx = 1.$$

$$\frac{A^2}{2}\int_0^L 1\,dx = 1 \quad \Rightarrow \quad \frac{A^2}{2}[x]_0^L = 1.$$

$$\frac{A^2}{2}[L-0] = 1.$$

$$\frac{A^2}{2} L = 1 \quad \Rightarrow A^2 = \frac{2}{L}.$$

$$\boxed{A = \sqrt{\frac{2}{L}}}$$

Now, put this 'A' value in wave function,

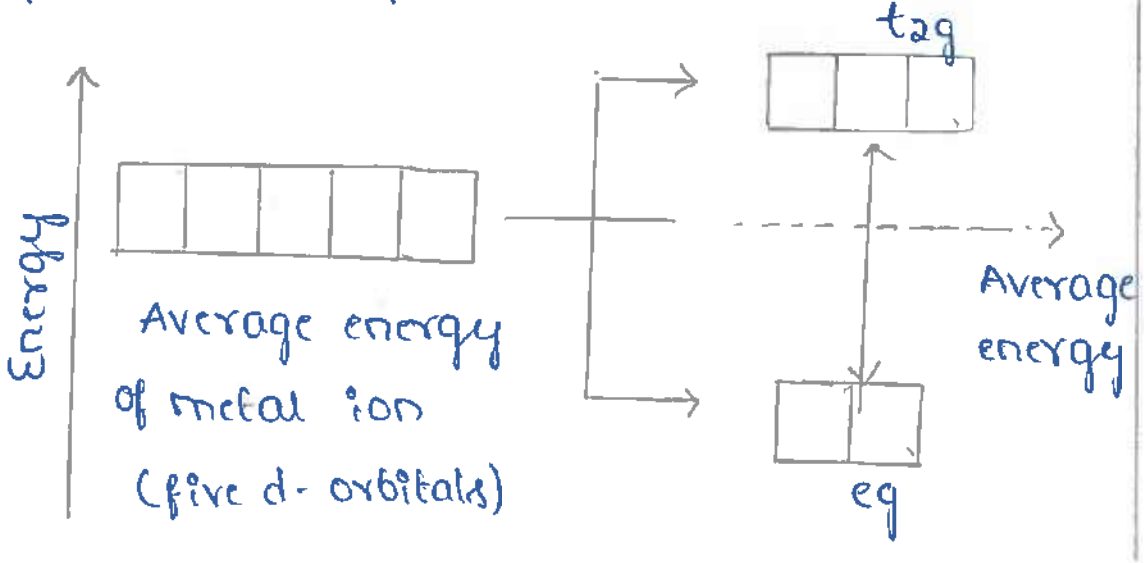
if can be represented as normalised wave function.

$$\psi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi}{L}\right) x$$

11(a)
(a)

Crystal field splitting in tetrahedral complex :-

- In tetrahedral complex, four (4) ligands may occupied alternate corners of the cube and surround the metal ion at the centre of the cube.
- Imagine the tetrahedral complex as per Below figure.
- In this situation, the t_{2g} set of orbitals ie lobes present between the axis like d_{xy}, d_{yz}, d_{zx} like relatively nearer to the approaching ligands
- Therefore, t_{2g} set of d-orbitals have higher energy than eg ($d_{x^2-y^2}$ & d_{z^2}) set of orbitals.
- However, the energy of t_{2g} set of orbitals raised maximum, since they are closed to the ligands. consequently crystal field splitting, opposite to that in octahedral complexes takes place.



where

t_{2g} : high-lying energy set of orbitals.

e_g : low-lying energy set of orbitals.

Δ_t = CFSE.

relationship between Δ_t and Δ_o is like $\Delta_t = \frac{4}{9}\Delta_o$.

properties of $[Ni(CN)_4]^{-2}$:

$[Ni(CN)_4]^{-2}$ is weak field ligands with first low transition metal ion give tetrahedral complexes.

Q1(b)

Energy level diagram of 1,3-Butadiene :

- 1,3-buta diene is an organic compound having the formula.

$$CH_2 = CH - CH = CH_2.$$

- Each carbon is in buta-di-ene sp^2 hybridised and leading one $\bar{e}$ in unhybridised orbital.
- Electronic configuration of carbon in ground state is

Ground state. $C = 1s^2\ 2s^2\ 2p^2$

- In excited state configuration of carbon is.

$1s^1\ 2s^1\ 2p^3$

- So, buta di-ene has 4 unhybrid orbitals ie 4-p orbitals overlaps and produce 4 molecular orbitals
- Among these 3 are bonding molecular orbitals (π_1, π_2) another 2 are anti bonding molecular orbitals (π_3^*, π_4^*).
- In this energy representation of molecular orbital diagram, lowest energy containing NO nodal plane.
- one of the bonding molecular orbitals contain a single nodal plane, one of the anti-bonding contain two nodal planes while the highest energy molecular orbital contains 3 nodal planes.
- The lowest energy molecular orbital (π_1) will have p-orbitals with phases in complete alignment with each other

π_1

- The second-lowest energy molecular orbitals (π_2) in buta-diene will have 1 node. phases flip in the centre of the pi orbital.

π_2

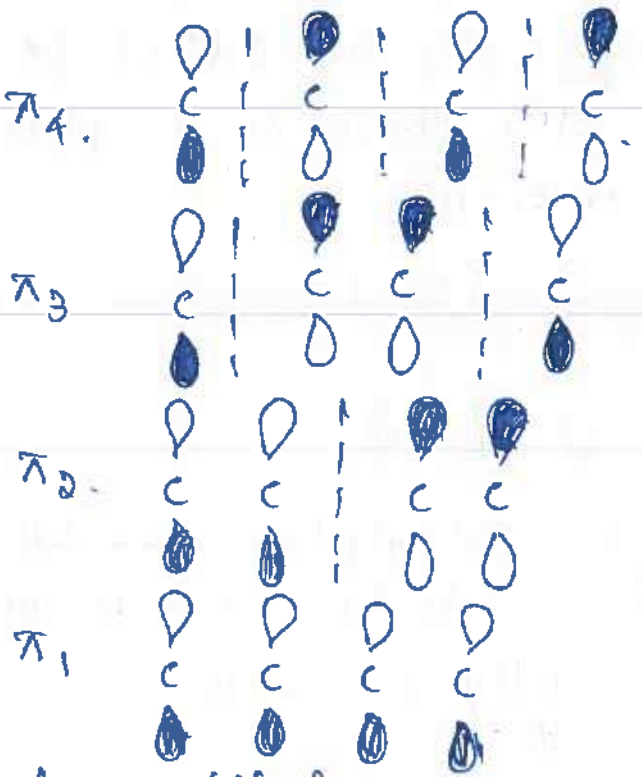
the third - lowest energy antibonding molecular orbital (π_3^*). they have two nodes.

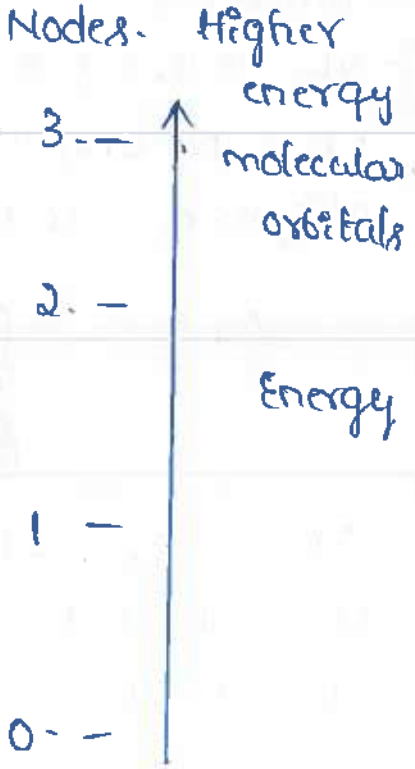
π_3^* 

- the highest energy antibonding molecular orbital (π_4^*) has 3 nodes.

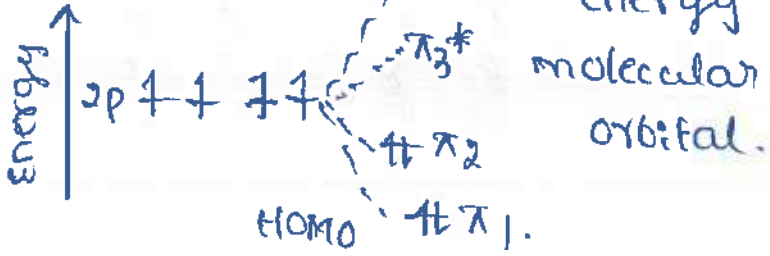
π_4^* 

molecular orbitals for the buta dienyl system ($n=4$). have 3 nodes.





molecular orbital energy level diagram of butadiene

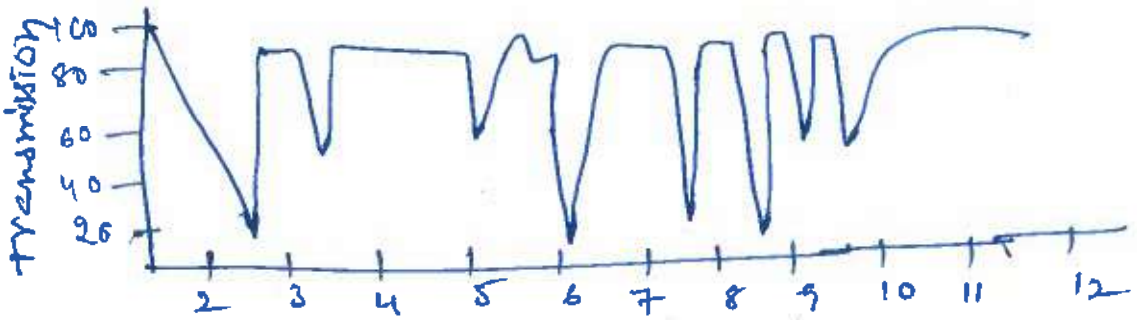


(12) (a) **FT-IR spectroscopy** → FT-IR means Fourier transform Infrared is the preferred method of IR spectroscopy

→ It is used to for the measurment of vibration-rotations of diatomic molecules especially in gaseous phase

→ This instrument was designed to measure by determining the velocity of light in two properties perpendicularly (at angle of 90) directions.

→ It means it is depends on mite Generator which produces a unique type of signal.



FT-IR spectra

Instrumentation: In this spectroscope the source of light is Nernst filament consisting of rod of rare earth oxides about 1 inch long & 0.1 inch diameter

→ In this a parallel beam of radiation is directed from the source to the interferometer system.

b) **Beer-Lambert Laws:** It explains the relation between concentration and absorbance of solution & it can be expressed by using Beer-Lambert's law.

It is the combined form of Beer's law and Lambert's law, It states when a beam of monochromatic light of passed through a solution,

If a monochromatic light of intensity (I) passes through a solution of molar concentration (c) and the length of the path is x cm,

and then the mathematically form of Beer-Lambert's law is,

$$A = \log \frac{I_0}{I} = \varepsilon c x$$

I_0 = Intensity of incident light

units, where, ε = molar absorption coefficient (or) $dm^3 mol^{-1} cm^{-1}$

A = absorbance = dimensionless

c = molar concentration = $mol \cdot dm^{-3}$

x = length = cm

If $c=1$, $x=1$, then extinction $A=\varepsilon$,

$$T = \log \frac{I}{I_0} \quad (or) \quad T = \varepsilon c b$$

(13)

(9) HPLC (High performance liquid chromatography)

Principle :- In this it relies on pumps to pass a pressurized liquid solvent containing the sample mixture through a column filled with a solid adsorbent material.

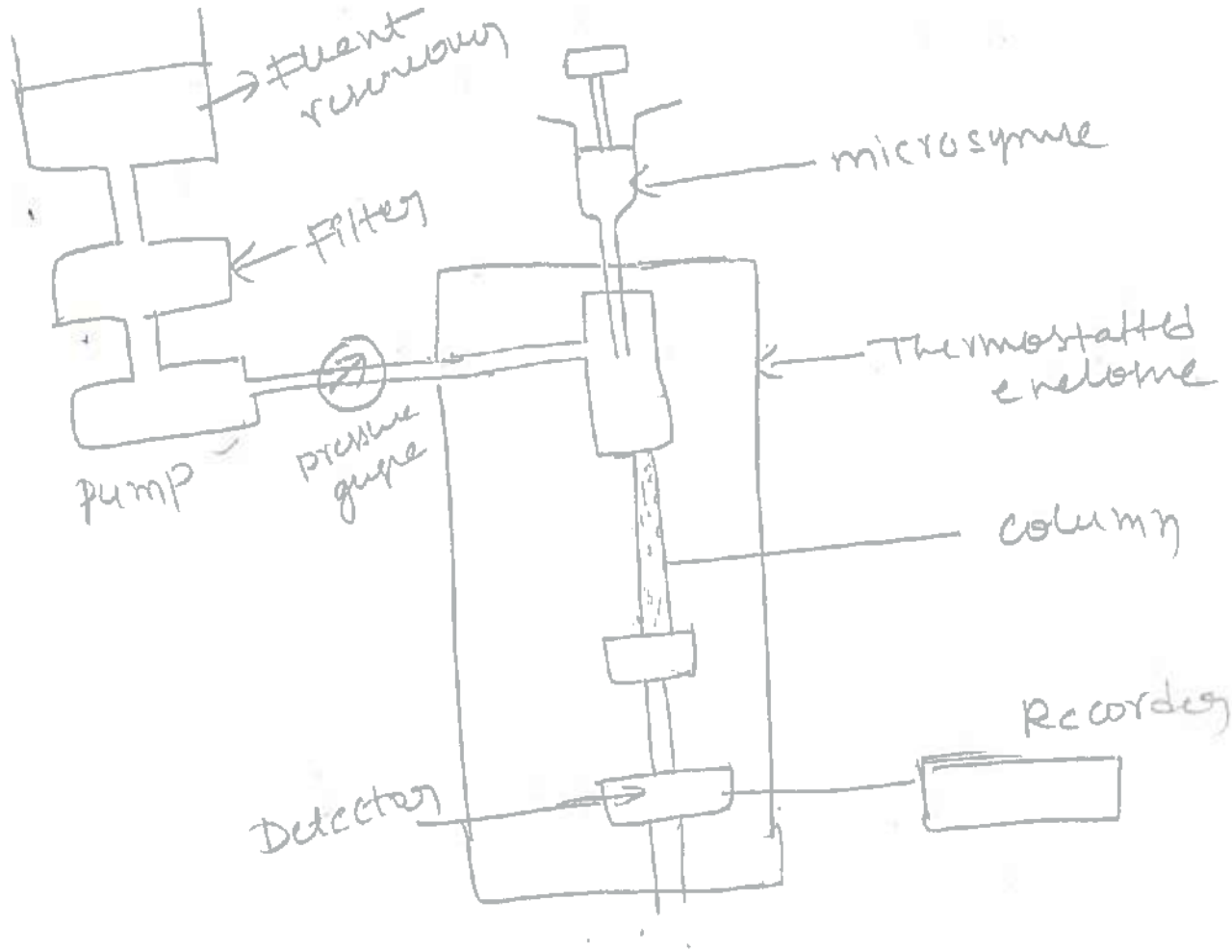
Each component in the sample interacts slightly differently with the adsorbent material, causing different flow rates for the different compounds and leading to the separation of the components as they flow out of the column.

Theory and Instrumentation :-

→ However because liquids are more viscous than gases, so the pressure used to make them pass through a column is greater than in GLC. between 20 and 200 atm

→ Such high pressure require a strong column which is often about 25 cm length

→ This principle is much the same as in GLC



b)

pH metry :- pH metry involves the measurment of pH with the addition of the reactants similar to potentiometric titrations. the change in pH is noted with addition of reagent. from the burette & the end point. can be determined graphically by plotting the pH against the volume of the titrant added.

→ The pH is measured with the help of pH meter

→ pH meter measures the potential difference in (mV) between the electrodes and converts it to a pH display.

→ A combined glass electrode (calomel electrode and glass electrode) is used for pH measurements.

→ The combined electrode is dipped in the solution under study & pH is read directly from the display of the pH meter.

→ In this A buffer solutions whose pH does not vary with the addition of small quantities of acid or base are used to standardise the pH meter

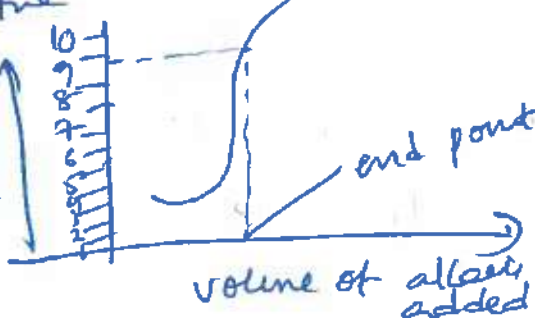
→ But in these days, buffer tablets are commercialy available

→ Buffer tablets of pH 4, 7 & 9.2 are commonly available & a tablet dissolved in 100 ml distilled water gives the solution of the required pH

→ In this end point can be determined by pH metry titrations

→ pH metric titrations: titrations of strong acid versus strong base

1) The acid to be titrated is taken in a beaker.
2) The combined glass electrode connected to the pH meter is dipped in the beaker & the pH is noted
3) strong base is filled in the burette, and is added gradualy to this solution.
4) The volume of pH 7 (neutral) pH gives the end point.



(14)

9) Computational chemistry

→ It is a chemistry which uses computational which helps in solving some problems in chemistry

→ As the name suggests computational chemistry involves logical, mathematical and computational seaurements inorder to solve a problem

→ In the early years of introducing computational chemistry, it is used to predict the structure and properties of molecules.

→ This chemistry involves in using instruments like microscope etc to help find the structure and behavious of particular molecules a organic

→ This is used to determine the
1) molecular geometry
2) structured geometry
3) properties of molecules
4) Logical involvement in basic structure

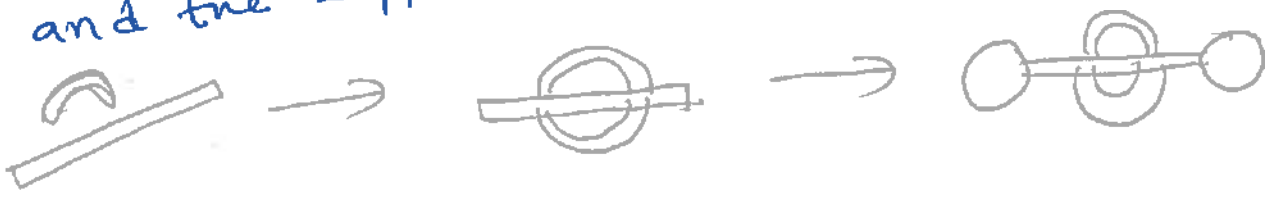
→ computation chemistry being used in petrol fields non-a-days such as medical, pharmaceutical, agricultural etc.

(b) Rotaxanes :- Rotaxanes are organic molecules in which inter macrocyclic structus present around a dnesell shaped structue

Synthesis of Rotaxane :-

Synthesis of Rotaxane involves the esterification process. this involves the aminolysis of pyrotarus which is composed of phenol ether using linked structue. this is done in many ways methods,

(1) capping :- This process involves active template and the supports are capped once the enz is inserted



2. clipping :- clipping proces takes place only after the supports are attached

3. slipping :- In slipping proces, the ring is formed such that the ring slips into the dumbell shape which favours the proces.

Applications of Rotaxanes

1) molecular machines :- Rotaxanes are applied in molecular machines or motors as a switch to on or off the bonding
2) chemical sensors :- used in chemical sensors molecular

(15) (9)

15(a)

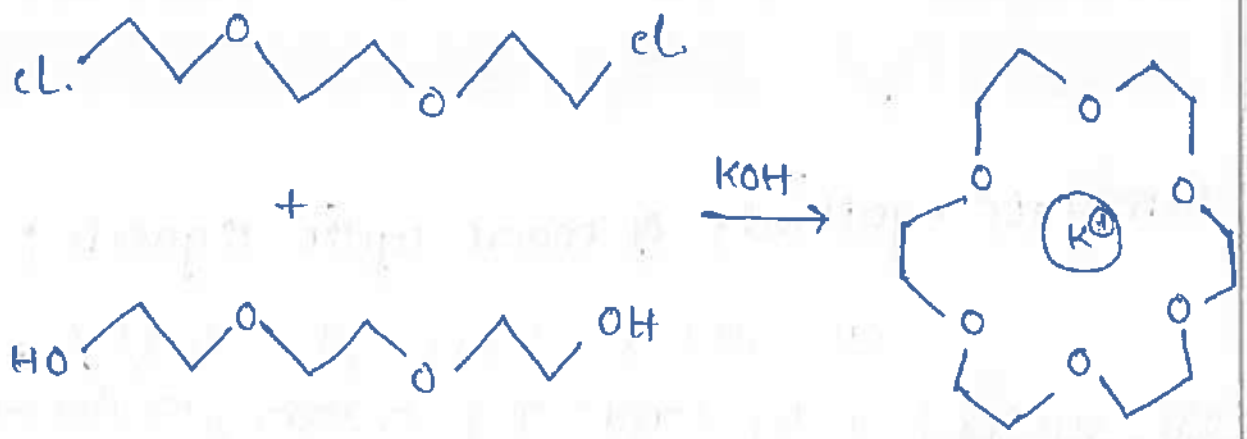
Template synthesis of macro cyclic ligands :-

In general, macrocyclic complexes are synthesized by combining macrocyclic ligands and metal ions.

In template reactions, macrocyclic ligands are synthesized in the presence of metal ions. In the absence of the metal ion, the same organic reactants may produce different, often polymeric products. the metal ion may direct the condensation preferentially to cyclic rather than polymeric products or stabilize the macrocycle once formed (the thermodynamic template effect).

The template effects makes use of the pre-organisation provided by the coordination sphere of the metal.

- The coordination modifies the electronic properties such as the acidity and electrophilicity of the ligands. when the metal atom is not desired in the final product, a disadvantage of templated synthesis is the difficulty in removing the templating metal from the macrocyclic ligand.

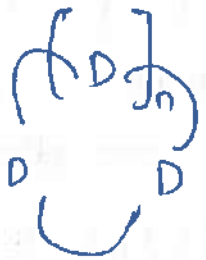


(15(b))

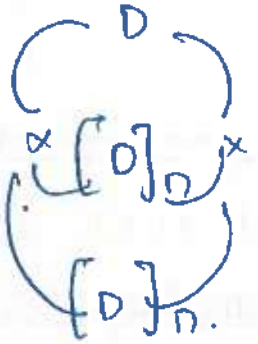
cation binding :-

Pederson introduced crocun ethers as the selective complexing agents for cations. these neutral ligands proride cavities of different sizes to accommodate the guest species. the crocun ether and related neutral ligands may be classified into three groups from the topological point of view. these are podands (open chain), coronands (⊙) conands (monocyclic) and cryptands (spherical).

Podand.
(open chain).



corand.
(cyclic).



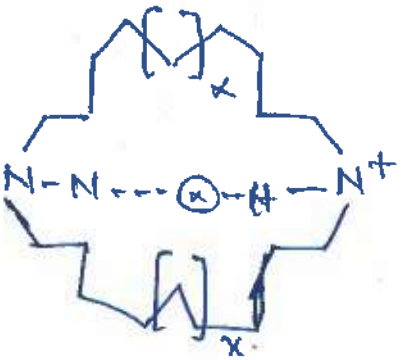
cryptand
(spherical)

Anion Binding :-

Anion binding and anion recognition are both biologically and chemically important. polydentate lewis acids can used as anion binding. Antierowns and anti cryptands are representative examples of polydentate lewis acids to acts as the anion receptors.

Katapinands are the macrocyclic receptors for anion binding through the electrostatic and $-NH^+ \cdots X^-$ H-bonding. the corresponding complex is called katapinate.

Selectively of anion depends on the value of x ie. cavity size of the protoriated katapinand.



katapinate.

for x = 1, the selectivity sequence is $Cl^- > Br^-$

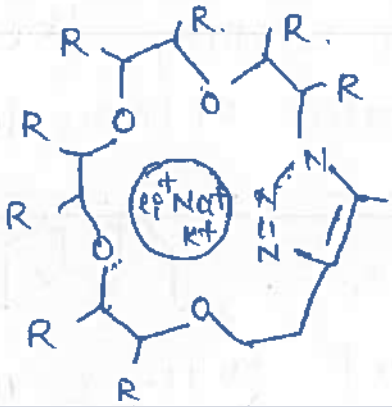
Simultaneous Cation and anion Binding :-

The simultaneous recognition of cations [H^+, Na^+ and K^+] and anions (F^-, Cl^-, I^-) using a macrocycle comprising a simple crown ether and an iodine - triazole unit is formed.

In compounds containing -CN and -OH groups the oxygen atoms in the crown ether show lower ability to interact with the

$Na^+ \cdots OH$ interactions counter balance the lower ability of the crown ether oxygens to interact with the Na^+ cation.

I^- recognition is enhanced by the presence of -OH and more strongly, -CN groups, occuring due to the increased π-hole area in the receptor -CN structure, as supported by a $C{-}N \cdots I^-$ interaction in the receptor -OH compound.



$I \cdots F^-, Cl^-$ (OH) $I^\ominus$ R = H, OH (OH) CN

12/8/22

12/8/22

HOD

E. Madhavi
12/8/22

NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	**Program**	ECE			**Academic Year**	2021 - 2022
Course Code	20BSX33	**Test Duration**	3 Hrs.	**Max. Marks**	70	**Semester**	II
Course	APPLIED PHYSICS						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define interference.	20BSX33.1	L1
2	List any four characteristics of LASER.	20BSX33.2	L1
3	List any two applications of dielectric materials.	20BSX33.3	L1
4	List any two merits of classical free electron theory.	20BSX33.4	L1
5	Classify Semiconductors.	20BSX33.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6	Derive the conditions for bright and dark fringes in the case of interference in thin films due to reflection.	12M	20BSX33.1	L2
	OR			
7 (a)	Describe in detail Fraunhofer's diffraction due to a double slit.	8M	20BSX33.1	L2
7 (b)	A monochromatic light of wavelength 6.56×10^{-7} m incident normally on a grating of 2 cm wide. The first order spectrum is produced at an angle of 18° from the normal. Calculate the total number of lines in the grating.	4M	20BSX33.1	L2
8 (a)	Discuss in detail the construction and working of Ruby Laser.	10M	20BSX33.2	L2
8 (b)	List any two applications of LASER.	2M	20BSX33.2	L2
	OR			
9 (a)	Deduce the expression for numerical aperture and acceptance angle.	10M	20BSX33.2	L2
9 (b)	The refractive indices of core and cladding of an optical fiber cable are 1.3 and 1.2 respectively. Determine the numerical aperture and acceptance angle of the optical fiber cable.	2M	20BSX33.2	L2
10	Classify various types of magnetic materials.	12M	20BSX33.3	L2
	OR			
11 (a)	Deduce the expression for electronic polarizability with the relevant sketch.	8M	20BSX33.3	L2
11 (b)	Define Ionic and Orientation polarizations.	4M	20BSX33.3	L2
12 (a)	Derive Schrodinger's time dependent wave equation.	10M	20BSX33.4	L2
12 (b)	Determine the energy corresponding to the Ground state and the first excited state of an electron trapped inside a one-dimensional infinite potential well of width 1 A^0. (Note: mass of the electron, $m = 9.1 \times 10^{-31}$kg; Planck's constant, $h = 6.62 \times 10^{-34}$ J-S).	2M	20BSX33.4	L2

	OR			
13 (a)	Write a note on Classical free electron theory. Discuss its merits and demerits.	10M	20BSX33.4	L2
13 (b)	Define the Fermi – Energy.	2M	20BSX33.4	L2
14 (a)	Write a detailed note on the concept of effective mass.	6M	20BSX33.5	L2
14 (b)	Discuss Bloch's theorem.	6M	20BSX33.5	L2
	OR			
15 (a)	Distinguish between Conductors, Semi Conductors and Insulators based on band theory of solids.	10M	20BSX33.5	L2
15 (b)	The hall coefficient of a semiconductor is $3.66X10^{-4}$ m^3c^{-1}. Find the carrier concentration.	2M	20BSX33.5	L2

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20BSx33: Applied physics Aug-2022

Scheme of valuation

Part - A

(1) Basic definition of Interference 2M

(2) Any 4 characteristics of LASER (each $\frac{1}{2}$ mark) $4 \times \frac{1}{2} = 2M$

(3) Any 2 applications of dielectrics (each 1M) $2 \times 1 = 2M$

(4) Any 2 merits of classical free electron theory (each 1M) 2M

(5) classification of semiconductors 2M.

Part - B.

(6) Thin films, description & diagrams 4M

condition for bright 4M

Condition for dark 4M

(OR)

(7) (a) Fraunhofer double slit, diagrams & description 4M

Intensity conditions 4M

(b) Problem data collection 1M

Formula 1M

Calculation 1M

Result 1M.

(8) (a) Ruby LASER, introduction & diagrams 4M
Construction 3M
Working 3M

(b) Any 2 application of LASER each 1M 2x1 = 2M

(OR)

(9) (a) Derivation of Acceptance angle 5M
Numerical Aperture 5M

(b) Problem, collection of data 1M
Formula & Result 1M

(10) magnetic materials Basic classification 2M
Properties of Dia, para, ferro 10M
Anti Ferro, ferri

(OR)

(11) (a) Electronic polarizability definition & diagram 4M
expression 4M

(b) Definitions of Ionic polarization (2M)
orientational polarization (2M)

(12) (a) Schroedinger time dependent wave equation derivation 10M
(By eliminating 'E' from time independent equation)

(b) Problem, Ground state Energy 1M
1st Excited State Energy. 1M

(OR)

(13)(a) classical free electron theory — Basic introduction 2M

merits of theory 3M

Demerits of theory 5M

(b) Basic definition of Fermi Energy 2M

(14) (a) Effective mass — definition 2M

derivation 4M

(b) Bloch theorem — diagrams 2M

Periodic potential 2M

Bloch function 2M

(OR)

(15) (a) Insulators, Semiconductors, conductors

Band diagram 3M

Description with examples 7M

(b) Problem — Formula 1M

Result 1M

Dr. K.S.D.L. Kalyan prasad.

10/8/22

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Answer Key

Part-A

(1) **Interference**: Intensity variation due to superposition of 2 (or) more coherent waves is known as interference.

(2) LASERs are highly coherent, highly directional, highly monochromatic and highly intense.

(3) Dielectric materials:
- (i) Used as insulation materials.
- (ii) Used in fabricating dielectric capacitors.

(4) Merits of classical free electron theory
- (i) ohm's law can be verified
- (ii) optical properties of metals can be verified.

(5) Semi conductors are classified in to intrinsic and extrinsic
Again Extrinsic are classified as n-type & p-type

Part - B

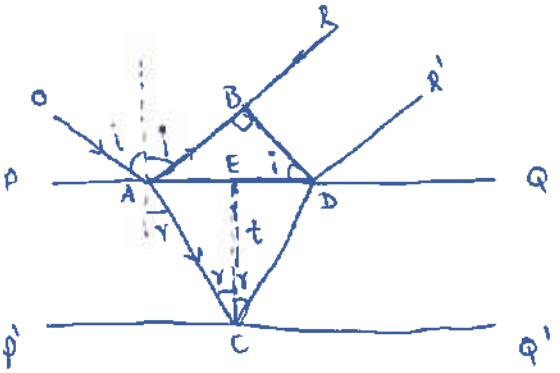
(6) **Interference in thin films (Reflected light)**

PQ & P'Q' forms a parallel thin film of thickness 't'. with refractive index 'μ'

OA ray is incidenting with an angle 'i'

Refracting along 'AC' & reflecting along 'AB'

The ray diagram is as shown in fig.



The path difference between two reflected rays AR & BR'

= Path AC+CD in medium − path AB in air

= μ(AC + CD) − AB

From triangle $\triangle AEC$ $\quad \cos r = \frac{CE}{AC} \Rightarrow AC = \frac{CE}{\cos r} = \frac{t}{\cos r}$

$\triangle AEC$ & $\triangle CED$ are similar

$\therefore \quad AC = CD \qquad AE = ED$

$\therefore \quad AC + CD = \frac{t}{\cos r} + \frac{t}{\cos r} = \frac{2t}{\cos r}$

From $\triangle ABD$ $\quad \sin i = \frac{AB}{AD} \Rightarrow AB = AD \sin i$

From Snell's law $\quad \mu = \frac{\sin i}{\sin r} \Rightarrow \sin i = \mu \sin r$

$\therefore \quad AB = AD \mu \sin r$

From Triangle $\triangle AEC$ $\quad \tan r = \frac{AE}{CE} \Rightarrow AE = CE \tan r$
$= t \tan r$

$AD = AE + ED = 2t \tan r$

Hence $\quad AB = 2t \tan r \, \mu \sin r = 2\mu t \frac{\sin r}{\cos r} \sin r$

$= 2\mu t \frac{\sin^2 r}{\cos r}$

$\Rightarrow$ Path difference $= \frac{2\mu t}{\cos r} - \frac{2\mu t \sin^2 r}{\cos r}$

$= \frac{2\mu t}{\cos r} [1 - \sin^2 r]$

$= \frac{2\mu t}{\cos r} \cos^2 r = 2\mu t \cos r$

As the ray is moving from rarer to denser medium path difference becomes $\quad \boxed{\delta = 2\mu t \cos r - \lambda/2}$

$\therefore$ condition for bright is

$2\mu t \cos r - \lambda/2 = n\lambda$

$\boxed{2\mu t \cos r = (2n+1)\frac{\lambda}{2}}$, $n = 0, 1, 2, 3, \ldots$

condition for dark is

$2\mu t \cos r - \frac{\lambda}{2} = (2n-1)\frac{\lambda}{2}$

$\boxed{2\mu t \cos r = n\lambda}$ $\quad n = 0, 1, 2, 3, \ldots$

$$\frac{D^2}{4} = (2n-1)\frac{\lambda R}{2}$$

$$D^2 = 2(2n-1)\lambda R$$

$$D = \sqrt{2(2n-1)\lambda R}$$

$$D_n \propto \sqrt{2n-1}$$

→ Diameter of the bright rings is directly proportional to square root of of odd natural numbers.

For dark ring

$$2\frac{r^2}{2R} = n\lambda$$

$$r^2 = n\lambda R$$

$$\therefore \quad \frac{D^2}{4} = n\lambda R$$

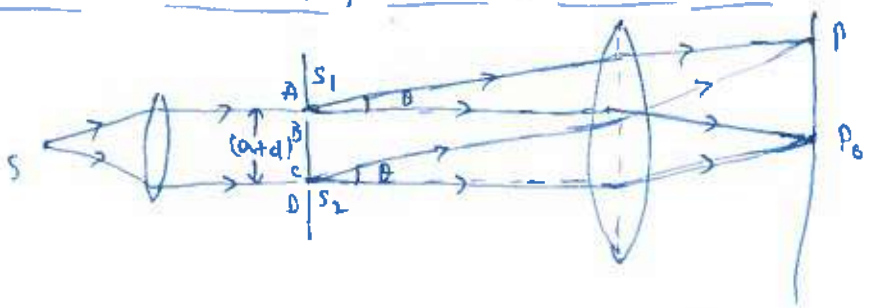
$$D^2 = 4n\lambda R$$

$$D = 2\sqrt{n\lambda R}$$

$$D_n \propto \sqrt{n}.$$

→ Diameter of the dark ring is directly proportional to square root of natural numbers.

(7) (a) Fraunhofer diffraction due to double slit.



AB and CD are two slits seperated by a distance 'd' of each slit width 'a'.

From theory of singh slit $R = A\frac{\sin\beta}{\beta}$, where $\beta = \frac{\pi a \sin\theta}{\lambda}$

The path difference between S_1 and S_2 waves is

$$= (a+d)\sin\theta.$$

$$\text{Phase difference} = \frac{2\pi}{\lambda}(a+d)\sin\theta.$$

By applying cosine rule we can get resultant intensity

$$I = R^2 = 4\left(A\frac{\sin\beta}{\beta}\right)^2 \cos^2\delta/_2$$

Resultant intensity depends on

$\left(\frac{A\sin\beta}{\beta}\right)^2$ diffraction pattern due to single slit

$\cos^2\delta/2$ interference due to diffracted rays.

Minima obtained in the direction

$\sin\beta = 0 \quad \beta \neq 0$

$\beta = \pm m\pi$, $m = 1, 2, 3, \ldots$

$\frac{\pi a \sin\theta}{\lambda} = \pm m\pi$

$a\sin\theta = \pm m\lambda$

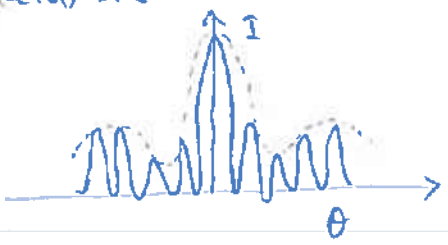
Position of secondary maxima at $\beta = \pm \frac{3\pi}{2}, \pm \frac{5\pi}{2}, \ldots$

Maxima obtained in the direction

$\cos^2 \delta/2 = 1$

$\delta/2 = \pm n\pi$

$(a+d)\sin\theta = \pm n\lambda$ $\quad n = 0, 1, 2, \ldots$



(b) $\lambda = 6.56 \times 10^{-7}$ m

First order spectrum produced at angle 18°

Total no. of lines on the grating $= ? = N$

$n = 1$

$\frac{\sin\theta}{Nn} = \lambda$

$N = \frac{\sin\theta}{\lambda n} = \frac{\sin 18}{6.56 \times 10^{-7}} = \frac{0.3090}{6.56 \times 10^{-7} \times 10^{-2}}$

$= 0.047103 \times 10^{7} \times 10^{2} = 471036$ Lines per 2 cm

$\therefore$ per 1 cm $\quad N = \frac{471036}{2} = 2355.18$ Lines/cm

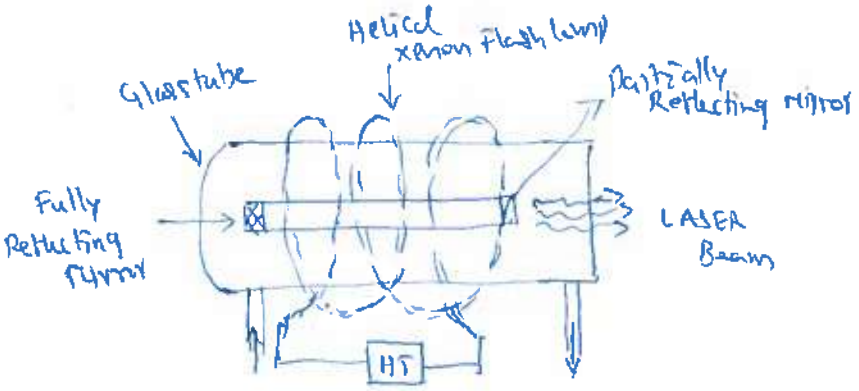
(8)(a) Ruby LASER

Introduction

Ruby is a solid state LASER, it is a 3-level LASER system.

Invented by Maimann in 1960.

It is pulsed LASER.



Construction

Ruby is $Al_2O_3 + Cr_2O_3$

Al_2O_3 99.95%.

Cr_2O_3 0.05%.

It is in the form of a rod of few centimeters length.

At one end partially coated mirror and at other end fully coated mirrors are placed. These are parallel to each other.

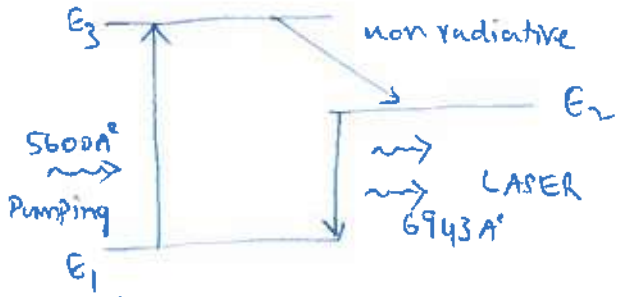
Xenon Flash lamp is winded around the ruby rod for pumping.

Working

Working of Ruby LASER can be explained with energy level diagram.

Cr^{+3} ions are active participants.

They are pumped from $E_1 \rightarrow E_3$ using Xenon Flash lamp (5600A°)



But E_3 life time is very low. / So maximum population transfer to E_2. E_2 is metastable state.

So population inversion took place between E_2 & E_1

A triggering photon can cause stimulated transition. After multiple reflections between mirrors final LASER output of 6943 A° can be obtained in pulsed form.

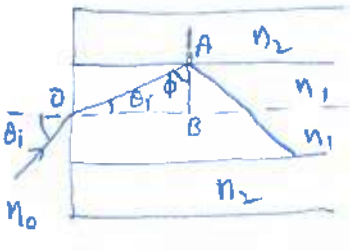
(b) Applications of LASERS

(1) used in Holography separation.

(2) Industrial high quality drilling & welding.

(7) Acceptance angle.

The maximum angle with which we can launch light in to the optical fiber



According to snell's law

$$n_0 \sin\theta_i = n_1 \sin\theta_r$$

$$\sin\theta_i = \frac{n_1}{n_0}\sin\theta_r$$

But from ΔOAB $\quad \theta_r + \phi = 90^\circ$

$$\theta_r = 90 - \phi$$

$$\sin\theta_r = \sin(90-\phi) = \cos\phi$$

$$\Rightarrow \quad \sin\theta_i = \frac{n_1}{n_0}\cos\phi$$

$$\sin\theta_{i\max} = \frac{n_1}{n_0}\cos\theta_c$$

But wkt $\quad \sin\theta_c = \frac{n_2}{n_1}$

$$\cos\theta_c = \sqrt{1-\sin^2\theta_c} = \sqrt{1-\frac{n_2^2}{n_1^2}} = \frac{\sqrt{n_1^2-n_2^2}}{n_1}$$

$$\Rightarrow \quad \sin\theta_{i\max} = \frac{\sqrt{n_1^2-n_2^2}}{n_0}$$

For air medium $n_0 = 1$ $\quad \boxed{\sin\theta_{i\max} = \sqrt{n_1^2-n_2^2}}$

Numerical Aperture

The light gathering capacity of a fiber is known as Numerical Aperture.

It is equivalent to sin of acceptance angle.

$$NA = \sin\theta_a = \frac{\sqrt{n_1^2-n_2^2}}{n_0}$$

For air medium $n_0 = 1$

$$NA = \sqrt{n_1^2 - n_2^2} = \sqrt{(n_1+n_2)(n_1-n_2)}$$

$$NA = \sqrt{2n_1(n_1-n_2)}$$

$$\boxed{NA = n_1\sqrt{2\Delta}}$$

Where $\Delta = \frac{n_1 - n_2}{n_1}$ is known as fractional refractive index change.

(b) $n_1 = 1.3 \qquad n_2 = 1.2$

$$NA = \sqrt{n_1^2 - n_2^2} = \sqrt{1.3^2 - 1.2^2}$$

$$NA = \sqrt{1.69 - 1.44} = \sqrt{0.25}$$

$$NA = 0.5$$

WKT $NA = \sin\theta_a$

$$\Rightarrow \theta_a = \sin^{-1}(NA)$$

$$\theta_A = \sin^{-1}(0.5)$$

$$\theta_a = 30^\circ$$

(10)

Diamagnetic

weakly magnetized in the opposite direction of the field

NO permanent dipolemoment

Magnetic lines force expel from the material.

Susceptibility in negative

It is independent of temperature.

These materials are repelled by magnets.

Eg: Bi, Au, Si, He.

Paramagnetic

weakly magnetized materials in the direction of the field.

free suspended material Points geographical north & south.

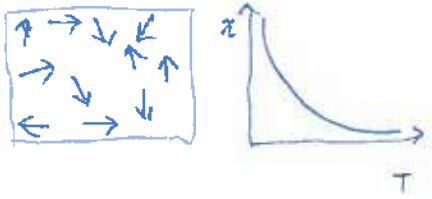
Magnetic Susceptibility is small but positive. 10^{-3}.

Relative Susceptibility is slightly greater than '1'

In the absence of field, no net magnetization (dipolemoment)

Paramagnetic Susceptibility depends on temperature

$$\chi_p = \frac{C}{T}$$



Eg: Al, Pt, $FeCl_2$

Ferro magnetic

Materials possess permanent magnetic dipolemoment.

Very strong magnetic materials

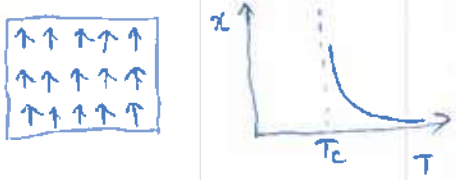
Magnetic Susceptibility and Relative permeability are very high.

$\chi \approx 10^6$ $\quad \mu_r \simeq 10^3$

Magnetic flux lines flows (attracted) in to the material.

Even in the absence of the magnetic field magnetization is present : i.e Spontaneous magnetization.

$$\chi_f = \frac{C}{T - T_c}, \quad T > T_c$$



Beyond T_c the material becomes paramagnetic

Eg: Fe, Ni, Co

Exhibits hysteresis

Anti Ferromagnetic

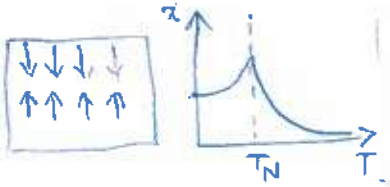
Atomic dipoles are arranged in opposite to each other.

Net dipolemoment is zero.

Exhibits positive χ and its of the order 10^{-3} to 10^{-5}

Susceptibility attains max value at Neel temperature

$$\chi_{AF} = \frac{C}{T + T_N}, \quad T > T_N$$



Beyond Neel temperature material becomes paramagnetic material.

Eg: NiO, MnTe

Ferrimagnetic

These are special class of ferromagnetic materials.

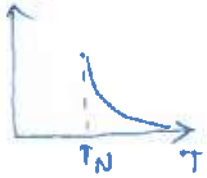
Dipoles arranged opposite to each other, but magnitudes are not equal.

Net dipolemoment is not zero

Exhibits hysteresis

χ varies with temperature.

Below Neel temperature material acts like Ferro and beyond that behaves like Paramagnetic



Eg: Fe_3O_4

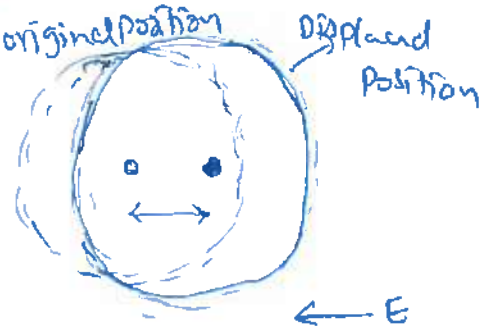
$NiFe_2O_4$

(11) (a) Electronic polarization

The polarization results due to displacement of nuclei with respect to electron cloud in the presence of electric field.

It is commonly occured polarization in all dielectric materials

It can respond upto 10^{15} - 10^{16} Hz of frequencies.



$$\mu_e \propto E \Rightarrow \mu_e = \alpha_e E$$

where α_e is Electronic polarizability

and is given by $\boxed{\alpha_e = 4\pi\epsilon_0 R^3}$

where R is Atomic Radius

(b) Ionic polarization:

when two ions are separated to create a dipole in the presence of applied field, then it is called Ionic polarization

Orientational Polarization

The polarization results due to the orientation of the dipoles in the presence of applied field is known as orientational polarization.

(12) (a) Time dependent schroedinger wave equation

Time dependent equation can be obtained from time independent wave equation

WKT $$\nabla^2\psi + \frac{2m}{\hbar^2}(E-V)\psi = 0$$

and $$\psi = \psi_0 e^{-i\omega t}$$

diff. wrt 't' $$\frac{\partial\psi}{\partial t} = -i\omega\psi_0 e^{-i\omega t}$$

$$\frac{\partial\psi}{\partial t} = -i(2\pi\nu)\psi_0 e^{-i\omega t}$$

$$\frac{\partial \psi}{\partial t} = -2\pi i E \psi$$

$$\frac{\partial \psi}{\partial t} = -\frac{2\pi i E}{h} \psi$$

$$\frac{\partial \psi}{\partial t} = -\frac{iE}{\hbar} \psi$$

$$\Rightarrow \quad E\psi = i\hbar \frac{\partial \psi}{\partial t}$$

Replace $E\psi$ in the very first equation.

$$\nabla^2 \psi + \frac{2m}{\hbar^2}\left(i\hbar \frac{\partial \psi}{\partial t} - V\psi\right) = 0$$

$$\nabla^2 \psi = -\frac{2m}{\hbar^2}\left(i\hbar \frac{\partial \psi}{\partial t} - V\psi\right)$$

$$-\frac{\hbar^2}{2m}\nabla^2 \psi + V\psi = i\hbar \frac{\partial \psi}{\partial t}$$

$$\left(-\frac{\hbar^2}{2m}\nabla^2 + V\right)\psi = i\hbar \frac{\partial \psi}{\partial t}$$

This is Schroedinger time dependent wave equation.

(b) Potential well width $L = 1\ \text{Å}$

$$m = 9.1 \times 10^{-31}\ \text{kg}$$

$$h = 6.62 \times 10^{-34}\ \text{JS}$$

$$E_n = \frac{n^2 h^2}{8mL^2}$$

for ground state $n = 1$

$$E_1 = \frac{(6.625 \times 10^{-34})^2}{8 \times 9.1 \times 10^{-31} \times 1 \times 10^{-10}}$$

$$= 0.603 \times 10^{-17}\ \text{J}$$

$$= \frac{0.603 \times 10^{-17}}{1.6 \times 10^{-19}} = 37.68\ \text{eV}$$

for first excited state $n = 2$

$$E_2 = \frac{(6.625 \times 10^{-34})^2 \times 4}{8 \times 9.1 \times 10^{-31} \times 1 \times 10^{-10}}$$

$$= 150.75\ \text{eV}$$

(13) (a) Classical free electron theory

Invented in 1900 by Drude, lorentz (theory.)

Merits of the theory

(i) It verifies ohm's law

(ii) It explains electrical and thermal conductivities of metals.

(iii) Derives Wiedemann - Franz law

(iv) It explains optical properties of metals.

Demerits of the theory

(i) Theory & experimental values of specific heat of metals are not in agreement.

(ii) Dependence of conductivity on cuentration can not be explained

(iii) At low temperatures, fails to explain Wiedmann-franz law.

(iv) Photo electric effect, compton effect, BlackBody radiation etc. can not explain.

(v) Electrical conductivity of semiconductors & Insulators can not explain.

(vi) Paramagnetism can not be explained.

(vii) ferromagnetism can not be explained.

(b) Fermi Energy

Top most filled energy level at 0K is known as Fermi Energy.

(or)

when the T > 0K, the energy level with 1/2 probability of finding the particle is known as Fermi level, and its energy Fermi Energy.

(4) (a) **Effective mass of electron**

When electric field is applied to an electron in a periodic lattice, then mass of the e^- varies and is different than free electron mass, this is known as effective mass of electron. Effective mass depends on the nature of the crystal.

Group velocity $v_g = \frac{d\omega}{dk} = 2\pi \frac{d\nu}{dk}$

$= \frac{2\pi}{h} \frac{dE}{dk}$

$= \frac{1}{\hbar} \frac{dE}{dk}$

Acceleration $a = \frac{dv_g}{dt} = \frac{1}{\hbar} \frac{d^2E}{dk\,dt} = \frac{1}{\hbar} \frac{d^2E}{dk^2} \frac{dk}{dt}$

When field $\bar{E}$ is applied a force of eE is applied on electron. $eE = ma \Rightarrow a = \frac{eE}{m}$

and the force does some work $dw = F\,ds = eE\,v_g\,dt$

$dE = eE \frac{1}{\hbar} \frac{dE}{dk} dt$

$\frac{dk}{dt} = eE \frac{1}{\hbar}$

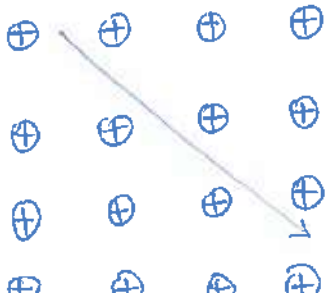
$a = \frac{1}{\hbar} \frac{d^2E}{dk^2} \left(\frac{eE}{\hbar}\right) = \frac{eE}{\frac{1}{\hbar}\left(\frac{d^2E}{dk^2}\right)^{-1}} = \frac{F}{m^*}$

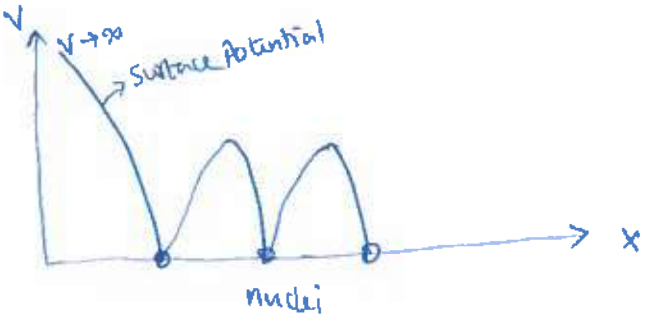
Since $a = \frac{F}{m}$

$\Rightarrow$ $m^* = \frac{\hbar^2}{\frac{d^2E}{dk^2}}$

This is the expression for effective mass of the electron.

(b) **Bloch theorem** Bloch introduced the concept of periodic potential.





The potential is minimum at the positive ion site and maximum between the two ions site.

Periodic potential $V(x)$ may be defined by Lattice Const. 'a'

$$V(x) = V(x+a)$$

solution for the Schroedinger equation is

$$\psi(x) = e^{ikx} u_k(x)$$

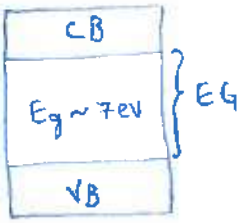
where $u_k(x) = u_k(x+a)$

In 3-d the solution is $\psi_k(r) = e^{ikr} u_k(r)$

(15) (a) Solids can be classified in to 3 categories based on Band theory of solids. And they are Insulators, semiconductors and conductors

Insulators: In Insulators the conduction band is completely empty, valence band is filled.

But there is a huge gap between valence band and conduction band.

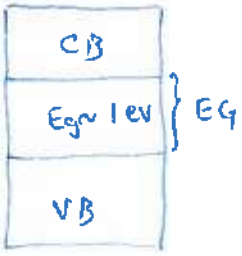


Electron from valence Band can not jump into conduction Band as there is large gap. So the resistivity of material is very high.

Eg: Diamond, Wood

Semiconductors:

In semiconductors the energy gap between valence band and Conduction band is small.



At 0K all semiconductors are perfect insulators.

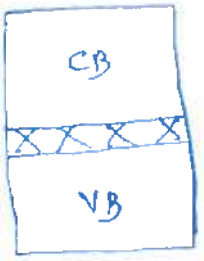
At room temperature valence band and conduction band are partially filled.

with minimum amount of external energy the electron in valence band can jump into conduction Band leaving hole in

the valence band. The conductivity of the semiconductors lies between Insulators and Conductors.

Eg: Si, Ge, GaAs.

Conductors: In conductors valence band overlaps with the conduction band. Hence there is no energy gap. Therefore even at room temperature conduction electrons are available in the conduction band.



the conduction of in the conductors is very smooth, Because of the fact that electrical conductivity is very high. With increasing temperature the conductivity decreases. Hence metals have true temperature coefficient.

Eg: Al, Cu.

(b) Hall coefficient $R_H = 3.66 \times 10^{-4}\ m^3/C$

carrier concentration $p = ?$

$e = 1.6 \times 10^{-19} C$

WKT $R_H = \frac{1}{pe}$

$p = \frac{1}{R_H e} = \frac{1}{3.66 \times 10^{-4} \times 1.6 \times 10^{-19}}$

$= \frac{10^{23}}{5.856}$

$= 0.1707 \times 10^{23}\ /m^3.$

NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	Civil Engineering			Academic Year	2021- 2022
Course Code	20CE201	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	BUILDING MATERIALS AND CONSTRUCTION COMPONENTS						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	List out the Geological Classification of rocks.	20CE201.1	L1
2	What is fiber reinforced concrete?	20CE201.2	L1
3	Define hydration of cement	20CE201.3	L1
4	What are the functions of lintel and arches?	20CE201.4	L1
5	Classify aggregates based on size.	20CE201.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6	Explain the causes for deterioration of stones and types preservation of stones.	12 M	20CE201.1	L2
	OR			
7 (a)	Describe the requirement of good bricks and explain the manufacturing methods of bricks.	8 M	20CE201.1	L2
7 (b)	Describe the properties of class I type of bricks.	4 M	20CE201.1	L2
8	Sketch the elevation of a brick wall built in i) English bond ii) Flemish bond. Iii) Compare the merits and demerits of English bond and Flemish bond.	12M	20CE201.2	L2
	OR			
9 (a)	Sketch random rubble masonry in stones in elevation and section.	6M	20CE201.2	L2
9 (b)	What do you understand by mild steel bar and deformed steel bar? What are different properties of structural steel?	6M	20CE201.2	L1
10 (a)	What are the characteristics of lime?	6M	20CE201.3	L1
10 (b)	What is meant by setting time for cement? Explain the initial and final setting time.	6M	20CE201.3	L2
	OR			
11	Describe briefly, with applications, (i) High early strength cement, (ii) Low alkali cement, and (iii) Rapid hardening cement	12M	20CE201.3	L2
12	With a neat sketch explain the types of stairs and what is the requirement of good stairs.	12M	20CE201.4	L2
	OR			
13 (a)	Write short notes on scaffolding, shoring and underpinning.	6M	20CE201.4	L2
13 (b)	Differentiate between king post and queen post	6M	20CE201.4	L2
14	List the various tests conducted on a coarse aggregate and explain any two of them in brief.	12M	20CE201.5	L2
	OR			
15 (a)	Explain the coarse and fine aggregates.	6M	20CE201.5	L2
15 (b)	Explain bulking and specific gravity on coarse aggregate.	6M	20CE201.5	L2

1) The geological classification of rocks

Igneous rocks: The magma comes out from the earth surface called Igneous rocks

Ex: Granite, Basalt

Sedimentary rocks: It is formed due to weathering of Pre existing rocks.

Ex: Sand stone, lime stone

Metamorphic rocks: These are formed by the changes in character of pre-existing Igneous rocks and sedimentary rocks when they are subjected to heat and pressure for long times.

Ex: Marble, Quartzite, slate, phyllite, schist, Gneiss.

2) Fiber reinforced concrete:

* it is a composite material.
* the ratio of $\frac{L}{D}$ of fibre is known as aspect ratio. and it ranges from 30-150
* the most commonly used fibre is steel fibre. generally round shape fibres are preffred diameter varry from 0.25 – 0.75mm.

③ ~~Def~~ Hydration of cement:- the chemical reaction between water and cement called hydration of cement.

There are two types:

① through solution

② solid state.

④ The function of lintel and arches:-

Lintels:- A lintel is one type of beam which is used to support the above wall openings like door, windows. necessary to provide a building structure.

Arches:- The arches of the foot, formed by the tarsal and metatarsal bones, strengthened by ligaments and tendons allow the foot to support the weight.

It can be classified into two types

⑤ Coarse Aggregate:- 80mm to 4.75mm

fine Aggregate:- 4.75mm to .75μ

6) The causes for deterioration of stones and types of preservation of stones:

→ Deterioration of stones and preservation of stones are process of the Break down the decay.

→ Agencies used:- rain temperature, wind frost and living organisms are deterioration of stones and these agencies are gives physical and chemical changes.

→ Some of these deterioration work. they will reduce the effect.

→ Some of preservation of stones materials are required coaltaar, Barium Hydrated & linseed oil, and soap solution.

→ Some of above materials are used for (or) applying. the preservation of stones don't get decay.

7a) Manufacturing of Bricks

* preparation of clay
* moulding
* Drying
* Burning

1) Preparation of clay Earth:

Clay of Bricks is prepared in the following order.

1) unsoiling
2) Digging
3) Clearing
4) Weathering
5) Blending
6) Tempering - pressing / kneading / pugging

Unsoiling:

Top 20 cm depth of soil is cut and thrown away

Digging:

· clay is then Dug out from the ground.
This dug out clay is spread on the level ground

Cleaning:

Soil should be cleaned of stones, pebbles, vegetable matter etc.

Weathering:

clay is then exposed to atmosphere for mellowing of clay

Varries from few weeks to full season.

Blending:

To the prepared loose clay material adding of any ingredients Spread out at top surface and turning it up and down in vertical direction is called blending

Tempering:

To make the clay upto proper degree of hardness By adding moisture content and made it fit for moulding with required consistency is called Tempering.

2) Moulding:

Moulding

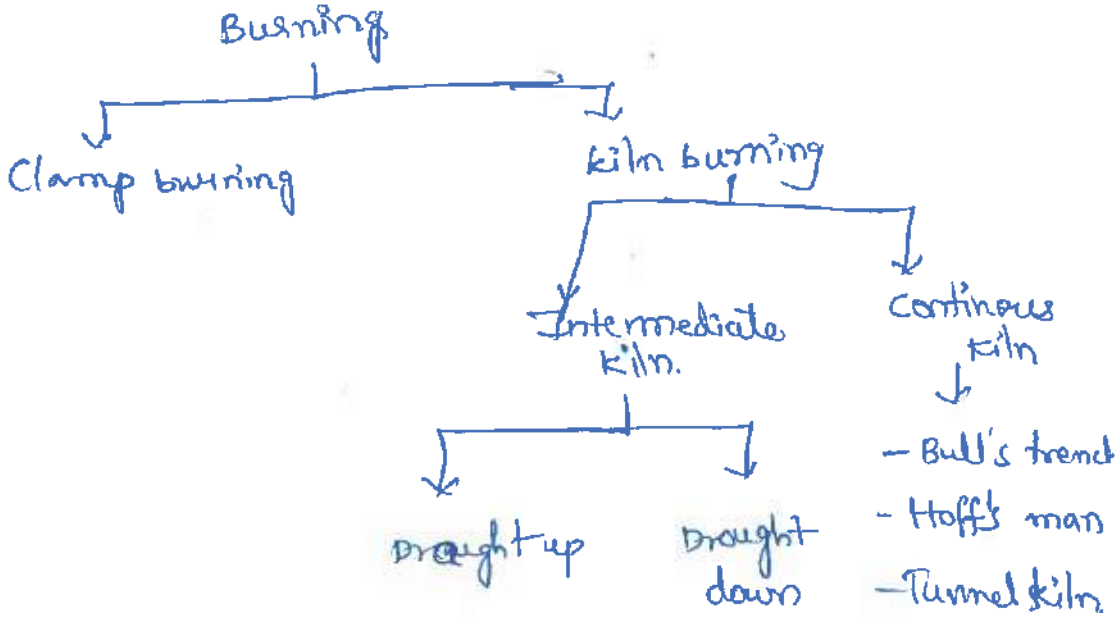
- Hand Moulding
  - * mould may be steel/wood.
  - * steel mould is better than wood mould
  - * Moulds are made larger by 8-12%.
    - Ground moulded Bricks
      - * Ground is leveled and sand sprinkled over it
      - * The lump of tempered clay is dashed into the mould.
        - slope moulded Bricks
          - * Bricks prepared by dipping mould in water Every time
        - Sand moulded Bricks
          - * Fine sand may be sprinkled on inside surface of mould
    - Table moulded Bricks
      - * person should stand at table of 2m x 1m
      - * No of table moulding ↓ gradually
- Machine Moulding
  - * This process is economical
  - * High quantity of Bricks can be manufactured in short time
    - plastic clay machine
      - * The Pugged clay is placed in the machine, Bricks are cut by wire
      - * Bricks are called wire cut Bricks
    - Dry clay machine
      - * paste is placed in the machine and pressed
      - * these can use for the direct burning

3) Drying:

* moisture content is drop down to 2% for Burning operation.
* The Damp Bricks if burnt are likely to get cracked and distorted.
* For drying bricks are laid longitudnally in stacks of width Equal to 2 Bricks
* For artifical drying the moulded bricks are allowed to pass through special dryers which are in the form of Tunnels

④ Burning:

* The reaction between the mineral constituents of clay are acheived at high temperature and these reactions are necessary to give strength, hardness, durability and low moisture absorption will attained when the temperature of about 900 - 1200°c is reached.
* If temperature is raised Beyond 1200°c a great amount of fusible glazzy mass is formed.

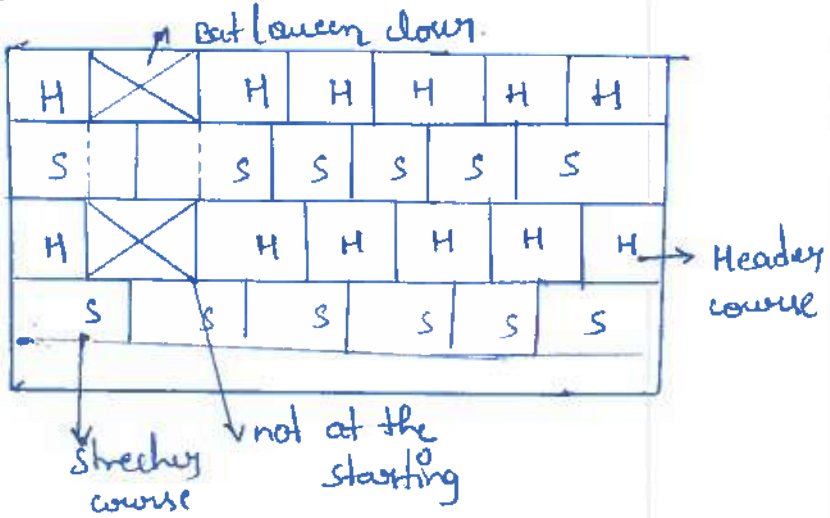


7b) The properties of class-I type of bricks:

* Table moulded
* All good quality of Bricks
* Standard shape, Edges are sharp, Square, Smooth (or) Straight
* Burnt in kilns
* minimum crushing strength 10.5 N/mm²
* % water absorption ≯20% of dry brick weight.

⑧ English bond

→ English bond consists of alternate header course and strecher courses (not is same line)



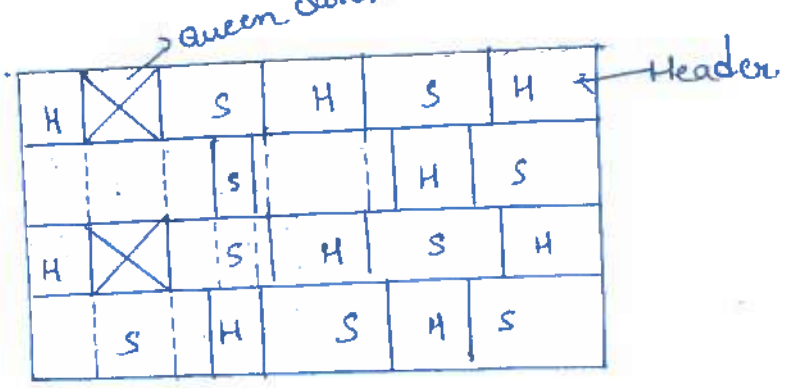
1 Brick wall – Queen closer

1 1/2 Brick wall – Queen closer + Bat

2 Brick wall – Queen closer + QC

flemish bond

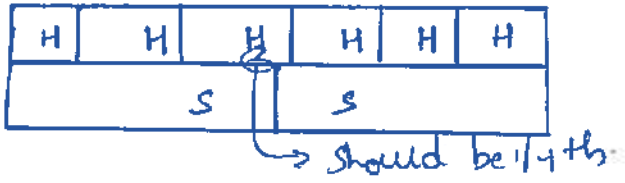
→ on flemish bond each course of bricks consists of alternate headers and stretchers in the same line.



→ In this bond vertical joints in the header courses come over each other and vertical joints in the stretcher courses are also in the same vertical line.

→ For breaking of same vertical joints in the successive courses a Queen closer is used after the first header and Queen closer used in header course only

→ In the stretcher course the stretcher should have a minimum lap of 1/4 length over the headers.



→ In this bond vertical joints in the header courses come over each other and vertical joints in the stretcher courses are also in the same vertical line.

→ the alternative headers of each course (same line) are placed exactly at the centre over the strechers in the course below.

→ Every alternate course starts with a header at the corner should end with the header.

→ for breaking the vertical joints in the successive courses Queen closers are used after first header.

English bond :

(i) Merits :

* strongest bond among all other bonds.
* constructed for almost all wall thickness.

demerits :

* Doesn't have much inherent strength.
* that it needs to be used in combination with other bonding patterns. like header & stretcher.

Flemish bond

Merits :-

* For backing and hearting ., cheap bricks can be used.
* used for the construction of walls.

demerits

* the mortar joints are unsightly and need to be kept clean.
* it difficult & it requires greater skill to arrange it properly.

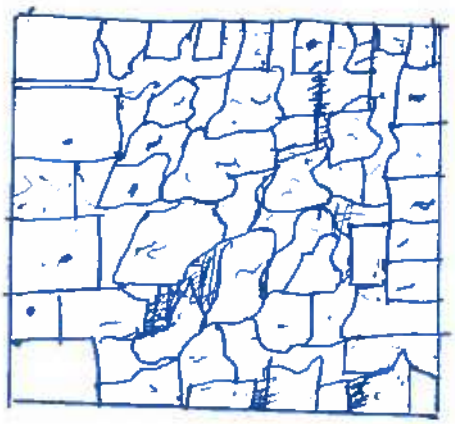
9b) Mild steel bar and deformed steel bars:

Though mild steel contains very little carbon; it is ductile and weldable but having low strength. Also, mild steel is highly prone to corrosion. High yield strength. deformed bars are manufactured under heat treatment followed by either heat rolled (or) cold twisted for shaping

Properties of structural steel:

* structural steel differs from concrete in its attributed compressive strength as well as tensile strength.
* It is used materials in commerical and industries building construction
* Having high strength, stiffness, toughness and ductile
* Greater flexibility
* Increasing effective life of building

9a) Random rubble masonry stones elevation



Elevation

Section

10) a) The characteristics of lime

FAT LIME

* it slakes vigorously.
* Pure white in colour
* it does not posses hydraullic Property.
* % of Impurities < 5%.
* it absorbs ~~oxyg~~ CO_2 from oxygen to form CO_3

HYDRAULLIC LIME

* it slakes slowly.
* not white in colour. than fat lime
* it does posses hydraullic property.
* % of impurities more than fat lime.
* It is present in water but not air.

10)b) Define setting times of the cement?

Apparatus: Vicat's Needle apparatus.

dimension

1mm of square shape of 50mm length

Materials required:

① cement - 500gms

② water - 0.85P (∵ P = standard consistency of water)

Mould dimensions

80mm Base of Mould

70mm Top of Mould

40mm height of Mould & 50mm

→ For initial setting time:

The time interval for which the cement products remain in plastic condition is called initial setting time.

initial setting time $\geq$ 30 minutes.

- During the test needle should penetrate 33-35 mm From Top out of which 40mm length

(or)

The height of Needle from the Bottom of the Mould is 5-7mm.

→ Final setting time. (Needle 5mm ϕ - Annular ring)

The time at which the cement ends its setting process and Becomes hard. for this hardening the time should not be more than 10hrs ≯ 10hrs
< 10hrs

Setting time - 30 min to 10hrs

NOTE: Apparatus used for final setting time is vicat Annular collar width needle dimension of 5mm.

13a) Scaffolding:

* When construction is done above 1.5 (or) 2m height
* Then a support structure is used for construction which is known as scaffolding

Eg: Aerial lifts, wooden & Bamboo scaffolding

Shoring:

* When any building structure get weaker.
* It tends to fall so in order to support falling structure the support is known as shoring.

Eg: Soil nails and shot crete

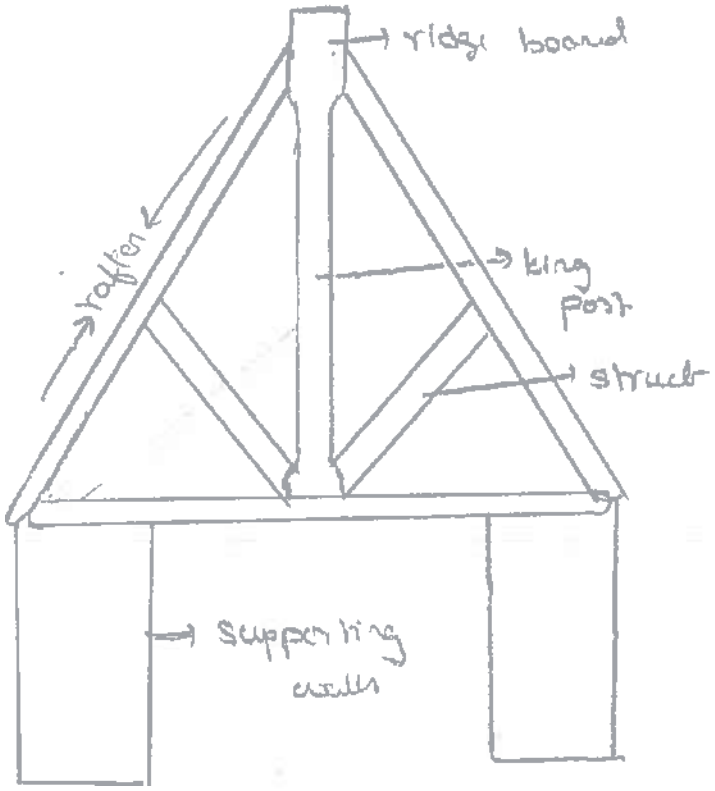
Underpinning:

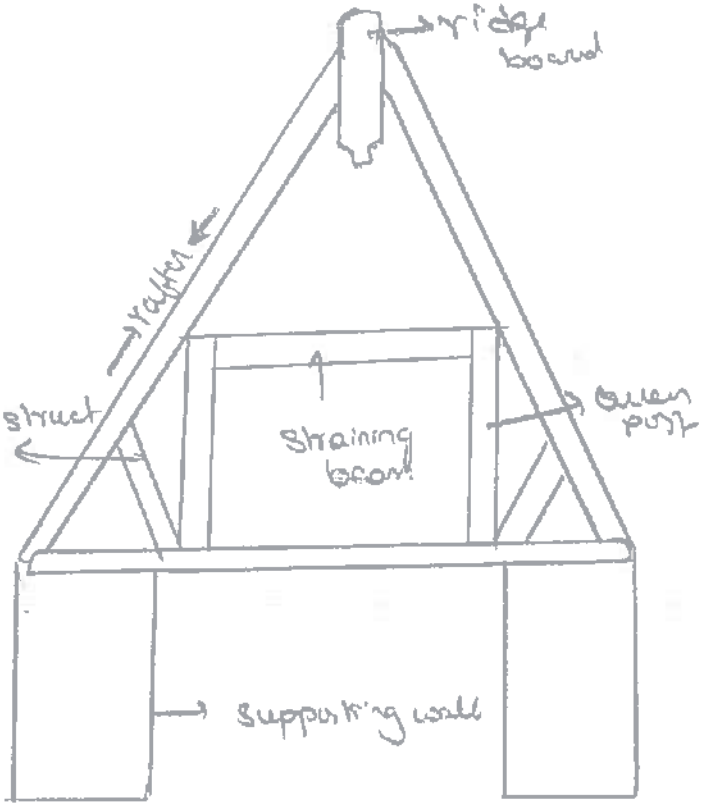
* We want to strength then the foundation. It is known as underpinning.

Eg: A support (or) foundation.

13b)

King post	Queen post
* The vertical post provided in center are called 'king post'.	* Two vertical post provided in two sides are called 'queen post'
* If span length is 5 - 8mts king post trussed is used	* If span length is 8 - 12 mts Queen post trussed is used
* Staining beam is not required	* Staining beam is required





15a) Aggregates.

Two type of aggregates.

→ Fine aggregates

→ Coarse aggregates

→ Fine aggregates:

- It pass through 4.75mm
- It retained on 75µ

Fine aggregates = 4.75m – 75µ

Example

1) Sand, 2) Crushed stone dust, Surki.

→ pit sand
→ river sand

Coarse Aggregates :

→ It passes through 80mm - 4.75mm

→ It retained on 4.75mm

Coarse Aggregates = 80mm - 4.75mm

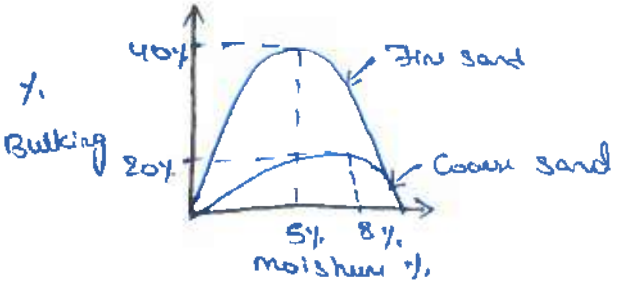
Ex: Stones, gravel, Ballast.

15b.

Sol) **Bulking** (or) **Bulk density**

- Due to the presence of moisture content a thin film of moisture form around the fine aggregates.
- The film formed around the aggregates exerted surface tension due to which the volume of material (fine sand, coarse sand) will increase.
- The increase in volume due to the force tension surface tension is called bulking of aggregates.
- Fine sand Bulks more than coarse sand

Fine Sand	Coarse Sand
• Bulks more	• Bulks less
• max bulking is at 40 %.	• max Bulking at 20%.
• moisture content is 4 to 6 %. ≅ 5 %	• moisture Content of 8 %.



(4 - 6%) ≅ 5 %.

→ Specific gravity of Aggregates :

Value should be B/W 2.6 – 2.8

S. Lovaraju
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NSRIT

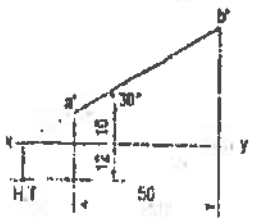
Semester End Regular/Supplementary Examination, August, 2022

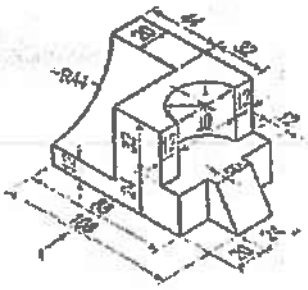
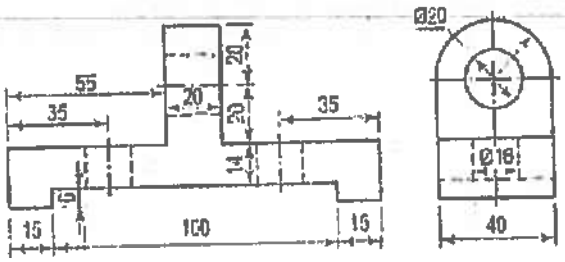
Degree	B. Tech. (U. G.)	Program	EEE			Academic Year	2021 - 2022
Course Code	20ESX01	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	ENGINEERING DRAWING						

Part A (Short Answer Questions 2 x 5 = 10 Marks)

No.	Questions (1 through 2)	Learning Outcome (s)	DoK
1	Draw a parabola having 65 mm base and 110 mm axis using rectangular method.	20ESX01.2	L2
2	A thin circular plate of 90 mm diameter is resting on its circumference such that its plane is inclined 35° to the H.P. Draw the projections of the plate.	20ESX01.3	L3

Part B (Long Answer Questions 5 x 12 = 60 Marks)

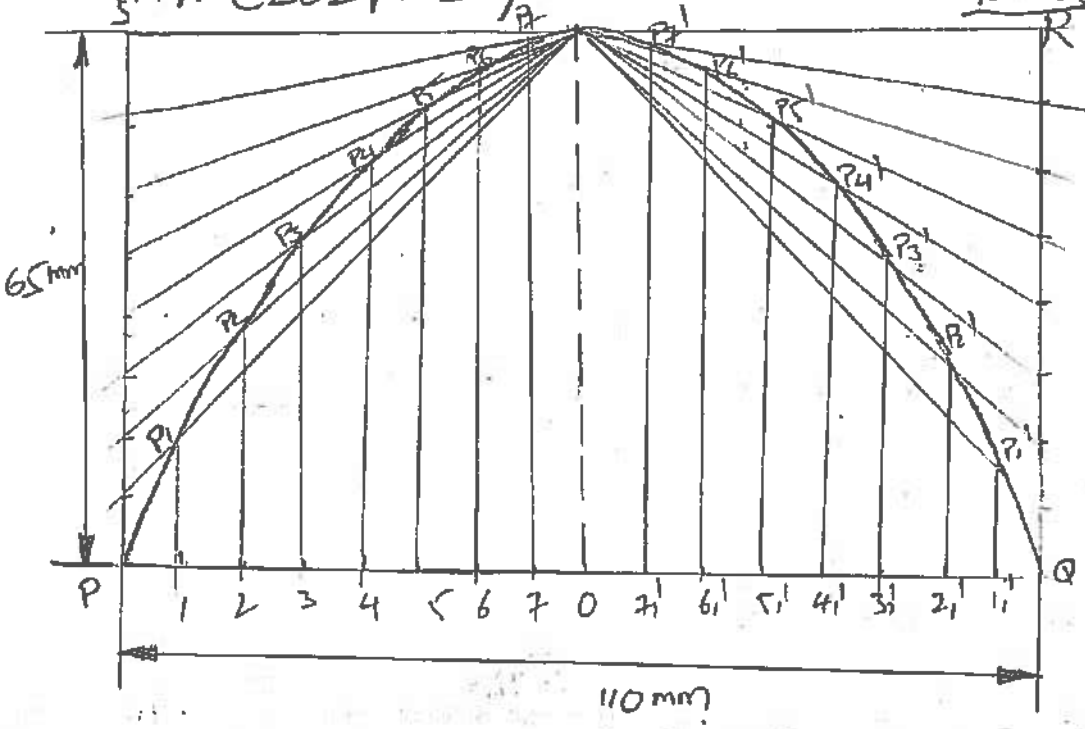
No.	Questions (3 through 12)	Marks	Learning Outcome (s)	DoK
3 (a)	Construct an ellipse when the distance of focus from the directrix is 60 mm, eccentricity is 2/3. Draw a normal and tangent to the curve at a point 50 mm from the directrix.	8M	20ESX01.1	L3
3 (b)	Define first angle projection and draw the projections of the conventional indicator/symbol for first angle projection with complete dimensions.	4M	20ESX01.1	L2
	OR			
4 (a)	Construct a scale of R.F. = 1/84480 to show miles and furlongs and long enough to measure upto 8 miles.	6M	20ESX01.1	L2
4 (b)	The area of a field is 50,000 sq m. The length and the breadth of the field, on the map is 12 cm and 10 cm respectively. Construct a diagonal scale which can read upto one metre. Mark the length of 245 metre on the scale. What is the R.F. of the scale?	6M	20ESX01.1	L3
5 (a)	A line AB, inclined at 40° to the V.P., has its ends 50 mm and 30 mm above the H.P. The length of its front view is 65 mm and is 15 mm above the H.P. Determine the true length of AB, its inclination with the H.P.	4M	20ESX01.2	L2
5 (b)	A point P is 25 mm above the H.P. and 30 mm in front of the V.P. Another point Q is 15 mm behind the V.P. and 30 mm below the H.P. Draw projections of P and Q keeping the distance between their projectors equal to 100 mm. Draw straight lines joining (i) their top views and (ii) their front views.	8M	20ESX01.2	L3
	OR			
6 (a)	A point P is in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and Auxiliary vertical plane, perpendicular to the H.P. and V.P. is 60 mm and it is equidistant from principal planes (H.P. and V.P.). Draw the projections of the point and determine its distance from the H.P. and V.P.	6M	20ESX01.2	L2
6 (b)	The front view a'b' and the H.T. of a line AB, inclined at 28° to the f-1.P. are given in figure. Determine the true length of AB, its inclination with the V.P. and its V. T 	6M	20ESX01.2	L3

7 (a)	Draw the projections of a regular hexagon of 45 mm side, having one of its sides in the H.P. and inclined at 60° to the V.P., and its surface making an angle of 45° with the H.P.	6M	20ESX01.3	L2
7 (b)	A circular plate of negligible thickness and 50 mm diameter appears as an ellipse in the front view, having its major axis 60 mm long and minor axis 40 mm long. Draw its top view when the major axis of the ellipse is horizontal.	6M	20ESX01.3	L3
	OR			
8 (a)	Draw the projections of a circle of 60 mm diameter resting in the H.P. on a point A on the circumference, its plane inclined at 45° to the H.P. and the top view of the diameter AB making 30° angle with the V.P.	6M	20ESX01.3	L2
8 (b)	A pentagonal plate of 50 mm side has a circular hole of 30 mm diameter in its centre. The plane stands on one of its sides on the H.P. with its plane perpendicular to V.P. and 45° inclined to the H.P. Draw the projections.	6M	20ESX01.3	L3
9 (a)	Draw the projections of a cone, base 65 mm diameter and axis 90 mm long, lying on the H.P. on one of its generators with the axis parallel to the V.P.	8M	20ESX01.4	L2
9 (b)	A square prism, base 30 mm side and height 75 mm, has its axis inclined at 45° to the H.P. and has an edge of its base, on the H.P. Draw its projections.	4M	20ESX01.4	L3
	OR			
10 (a)	Draw the projections of a pentagonal prism, base 30 mm side and axis 60 mm long, resting on one of its rectangular faces on the H.P., with the axis inclined at 45° to the V.P.	6M	20ESX01.4	L2
10 (b)	A square pyramid, base 48 mm side and axis 60 mm long, is freely suspended from one of the corners of its base. Draw its projections, when the axis as a vertical plane makes an angle of 45° with the V.P. When a pyramid is suspended freely from a corner of its base, the imaginary line joining that corner with the centre of gravity of the pyramid will be vertical.	6M	20ESX01.4	L3
11	Draw the front view, top view and both sides view from the isometric view. All dimensions are in mm. 	12M	20ESX01.5	L4
	OR			
12	Draw the isometric view of figure, all dimensions are in mm. 	12M	20ESX01.5	L4

1). I B.Tech (EEE) I-II Sem. Drawing
A.Y: C2021-22) Evaluation

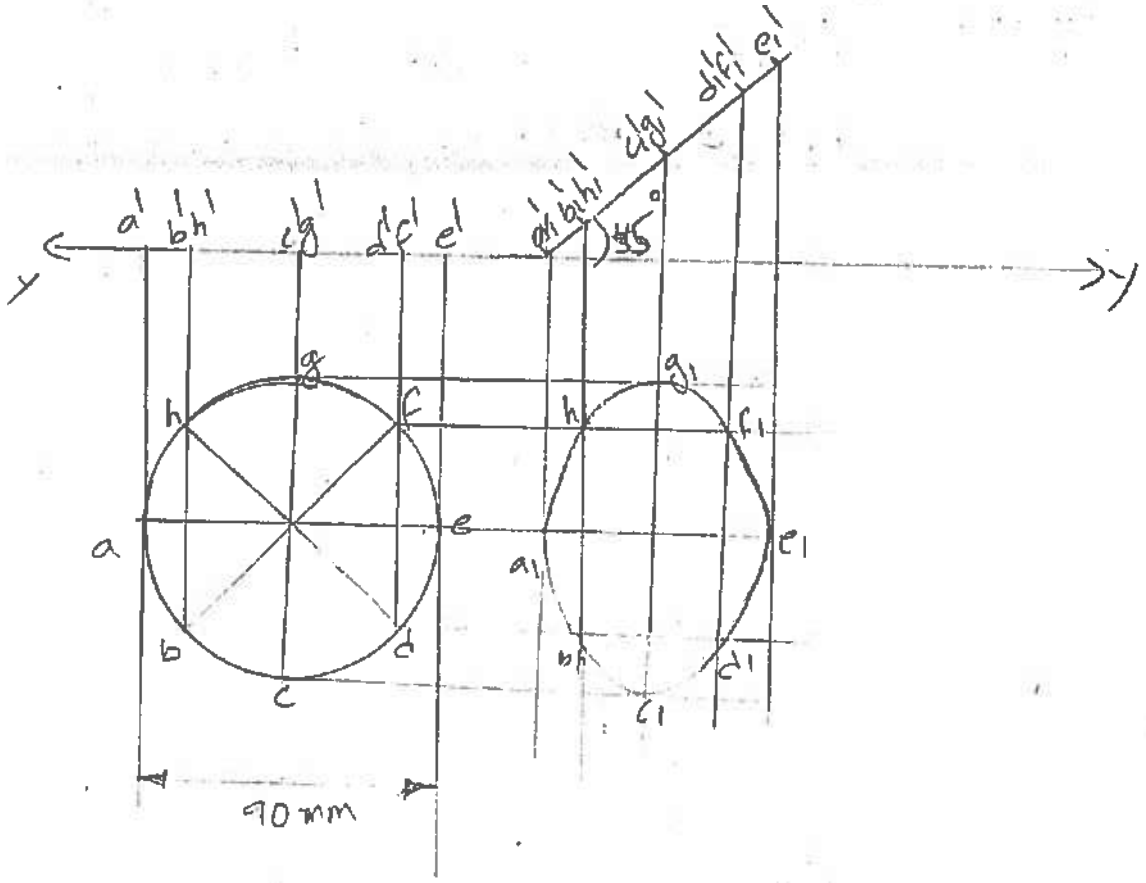
5M

Eg:



2)

5M

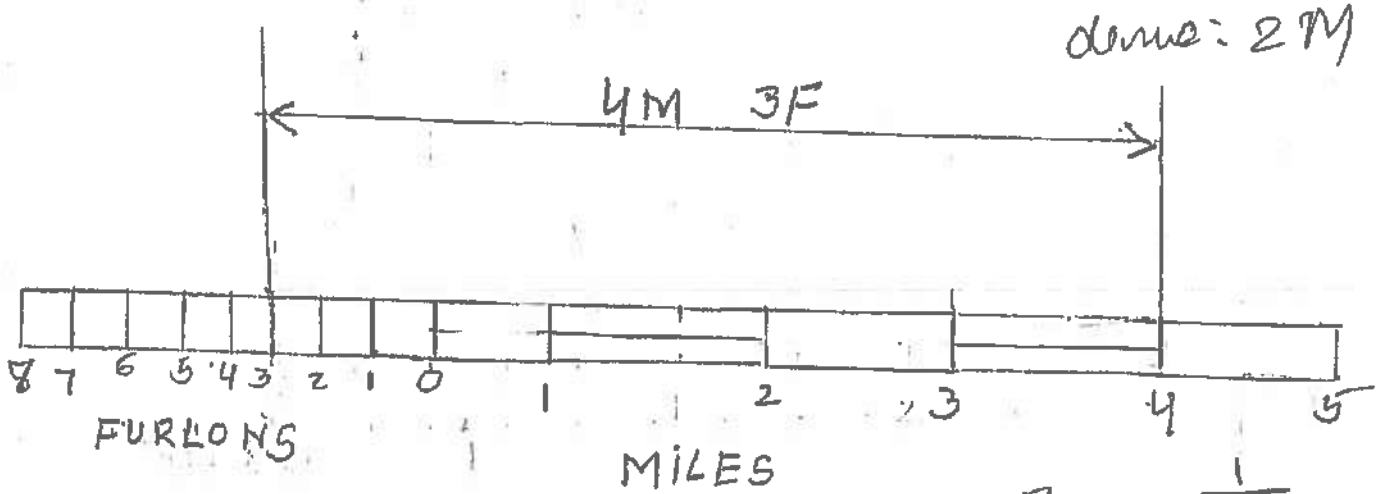


4a)

6M

Eg : 4M

draw: 2M



R.F = $\frac{1}{84480}$

(i) Length of scale = $\frac{1}{84480} \times 6 = \frac{1}{14080}$ mils = $4\frac{1}{2}$

Draw a line $4\frac{1}{2}$" long and divide 6 equal parts

The distance 4 miles 3 furlongs.

4(b) The area of field = 50,000 sq.m.

Area = $10 \times 12 = 120\ cm^2$

1 sq cm = $\frac{50,000}{120} = 416.67$

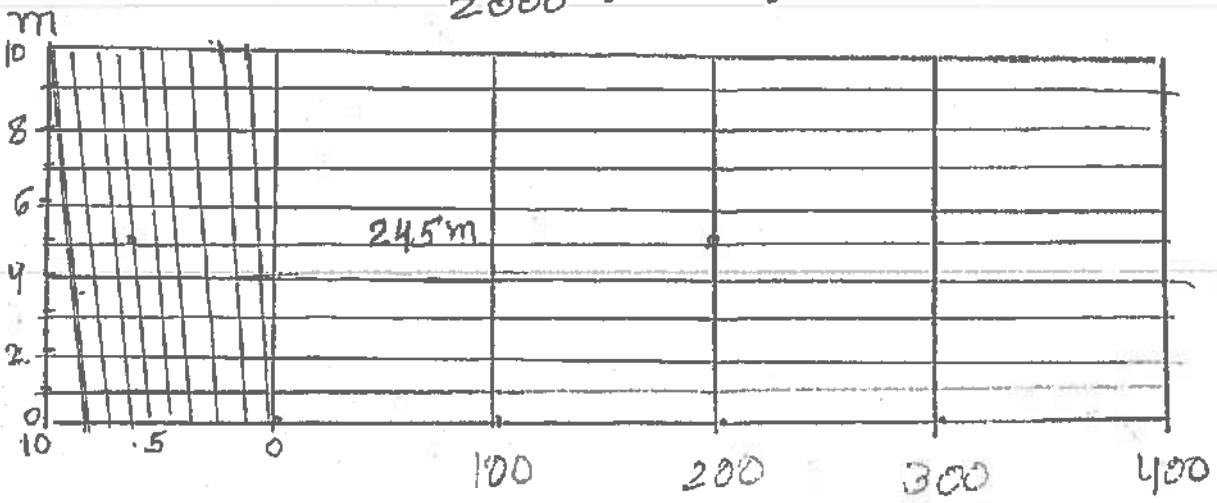
6M

Eg : 4M

dim : 2M

1cm = 20m ; $\frac{1cm}{2000}$.

$\frac{1}{2000} \times 500 \times 100 = 25$ cm.

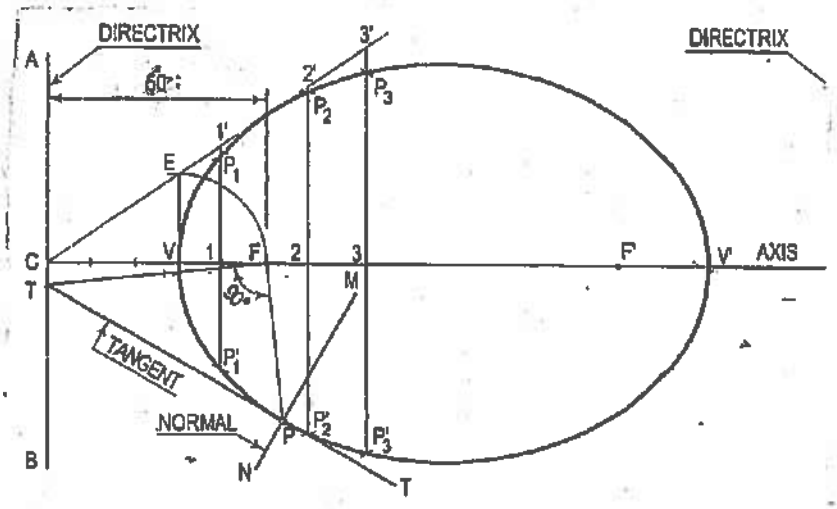


RF = $\frac{1}{2000}$

Take 25 cm length divide 5 equal parts

8M

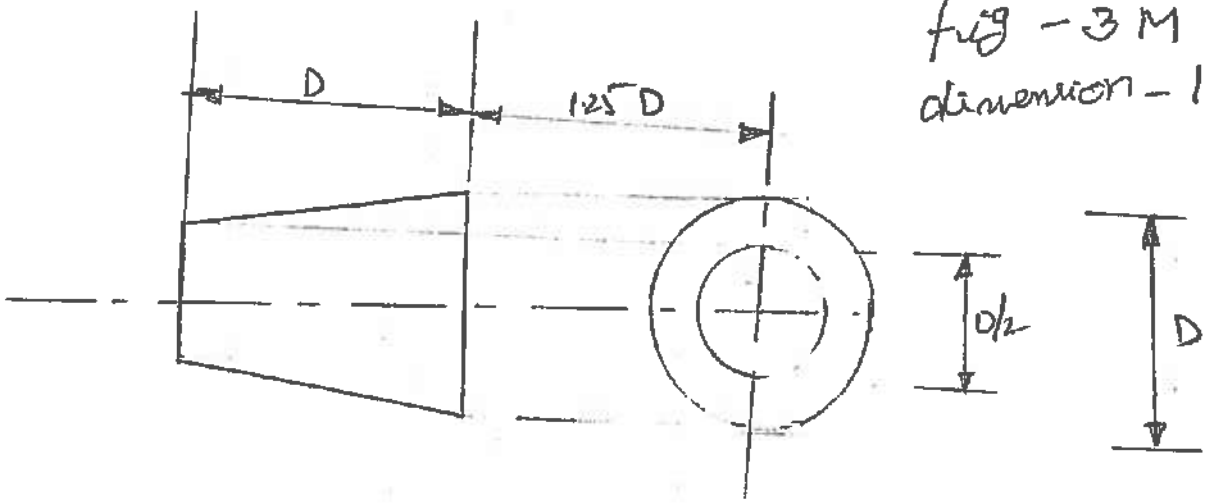
3(a)



curve: 6M
Tangent: 2M

3) b)

4M
fig - 3M
dimension - 1M



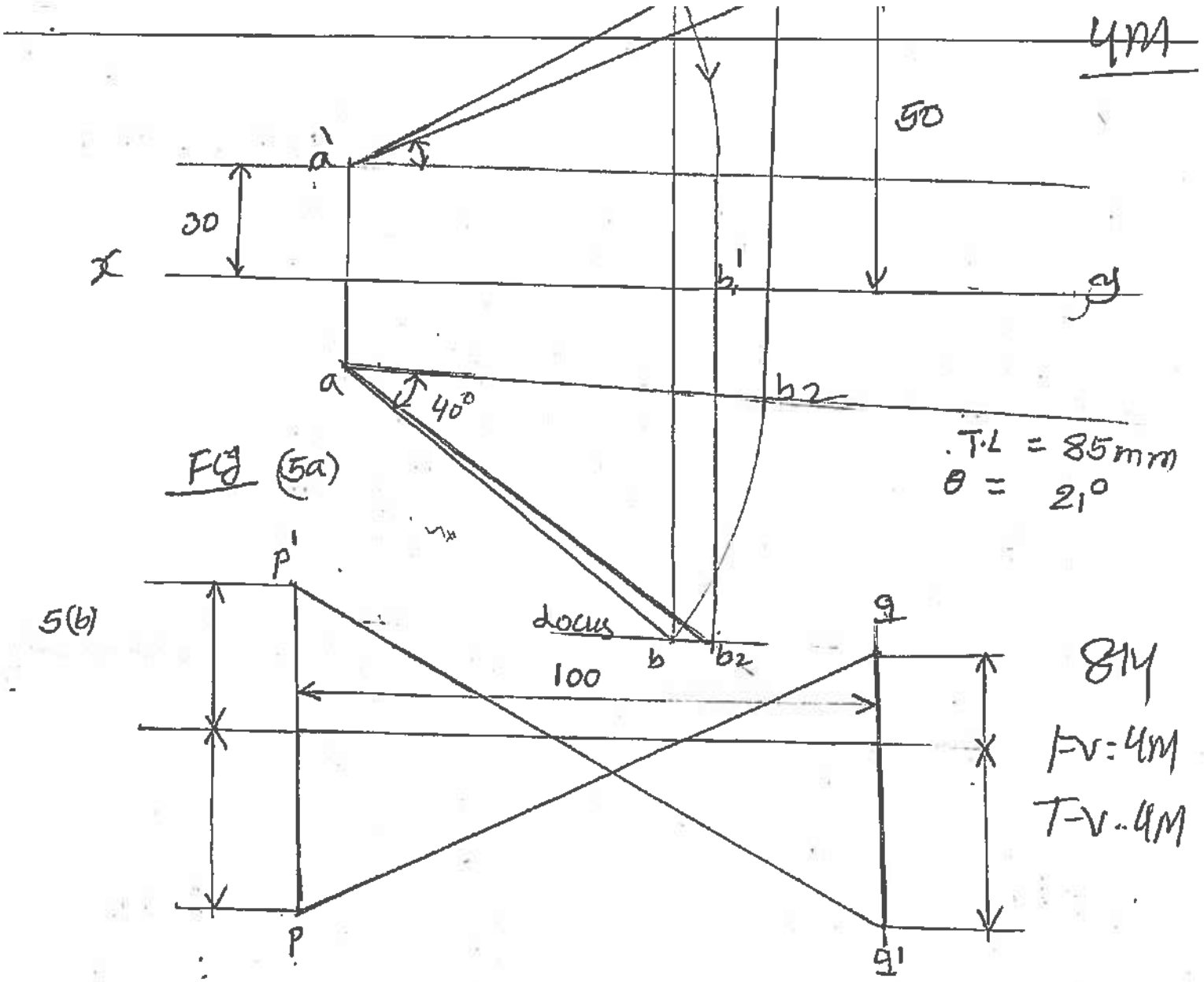

4M
50
a'
30
x
b1'
y
a
40°
b2
T.L = 85mm
θ = 21°

Fig (5a)

5(b)
p'
locus
b
b2
100
q
8M
F.V: 4M
T.V. 4M
p
q1

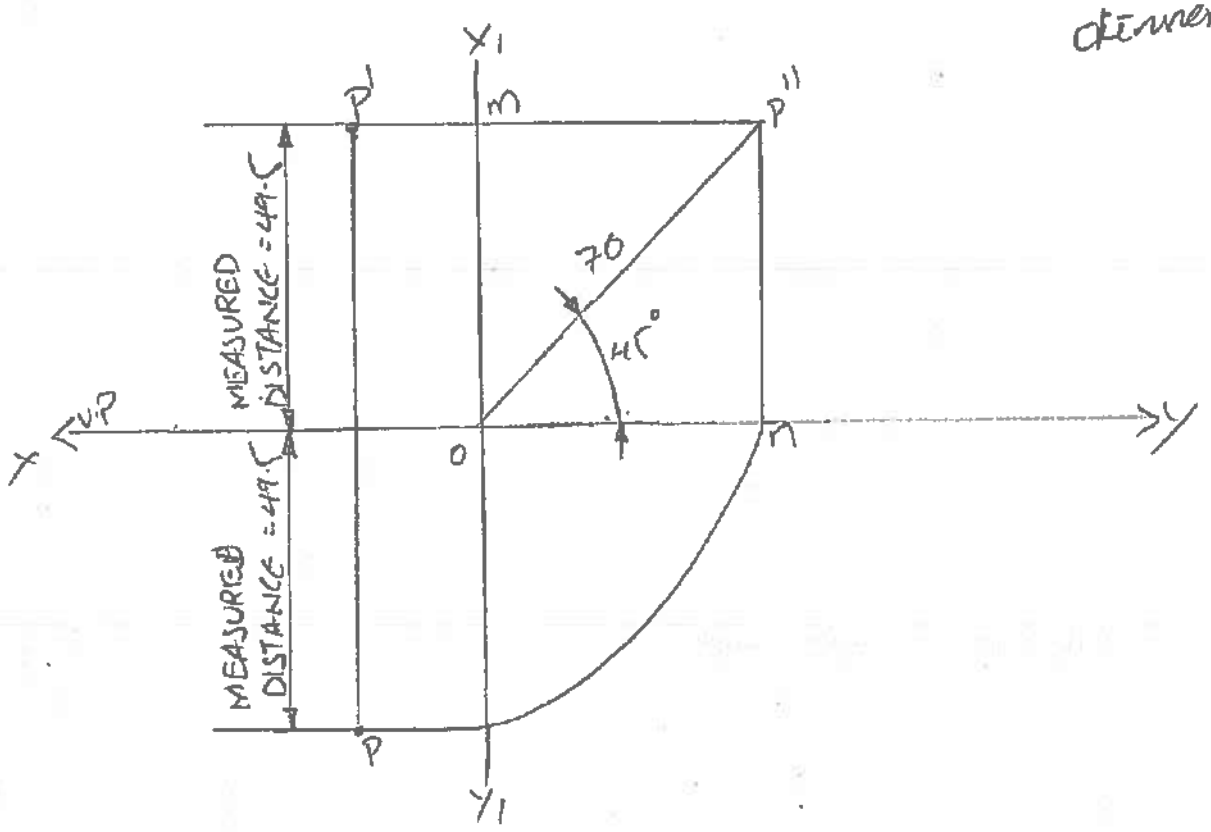
Fig 5(b)

6(a)

GM

Fig : 5M

dimension : 1M

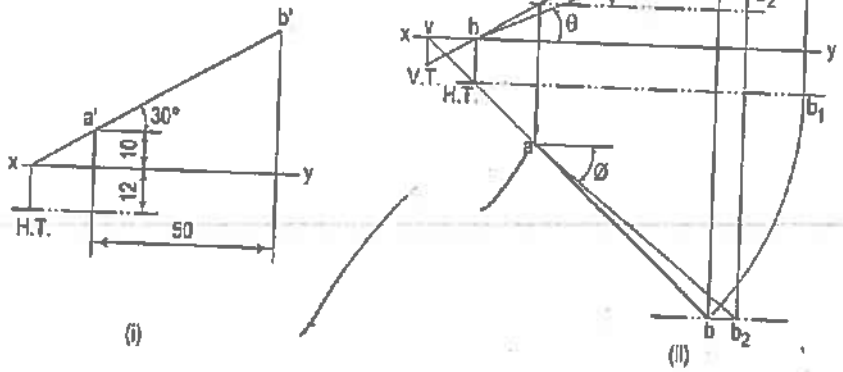


6(b)

GM

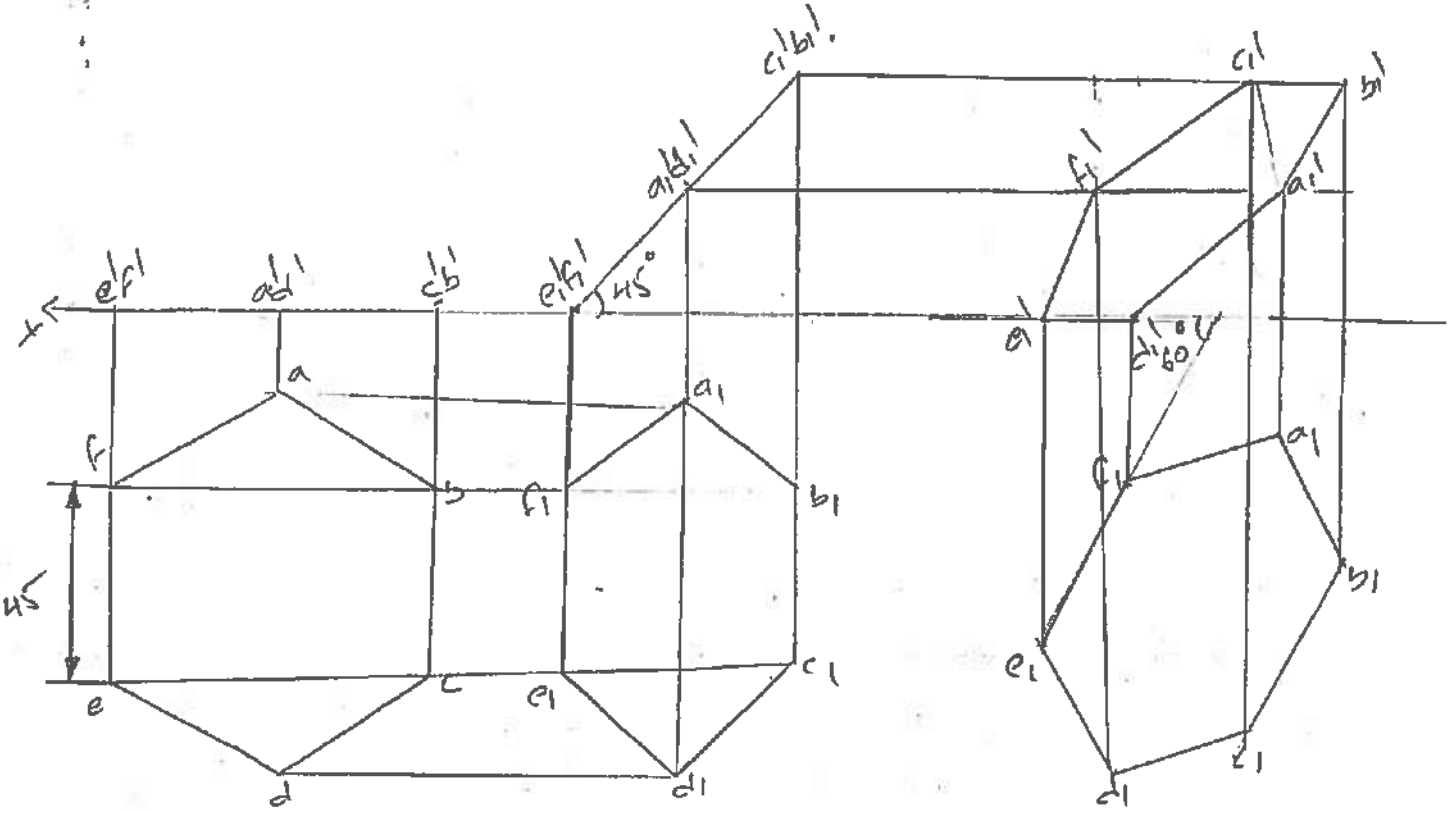
Fig : 5M

dimension : 1M

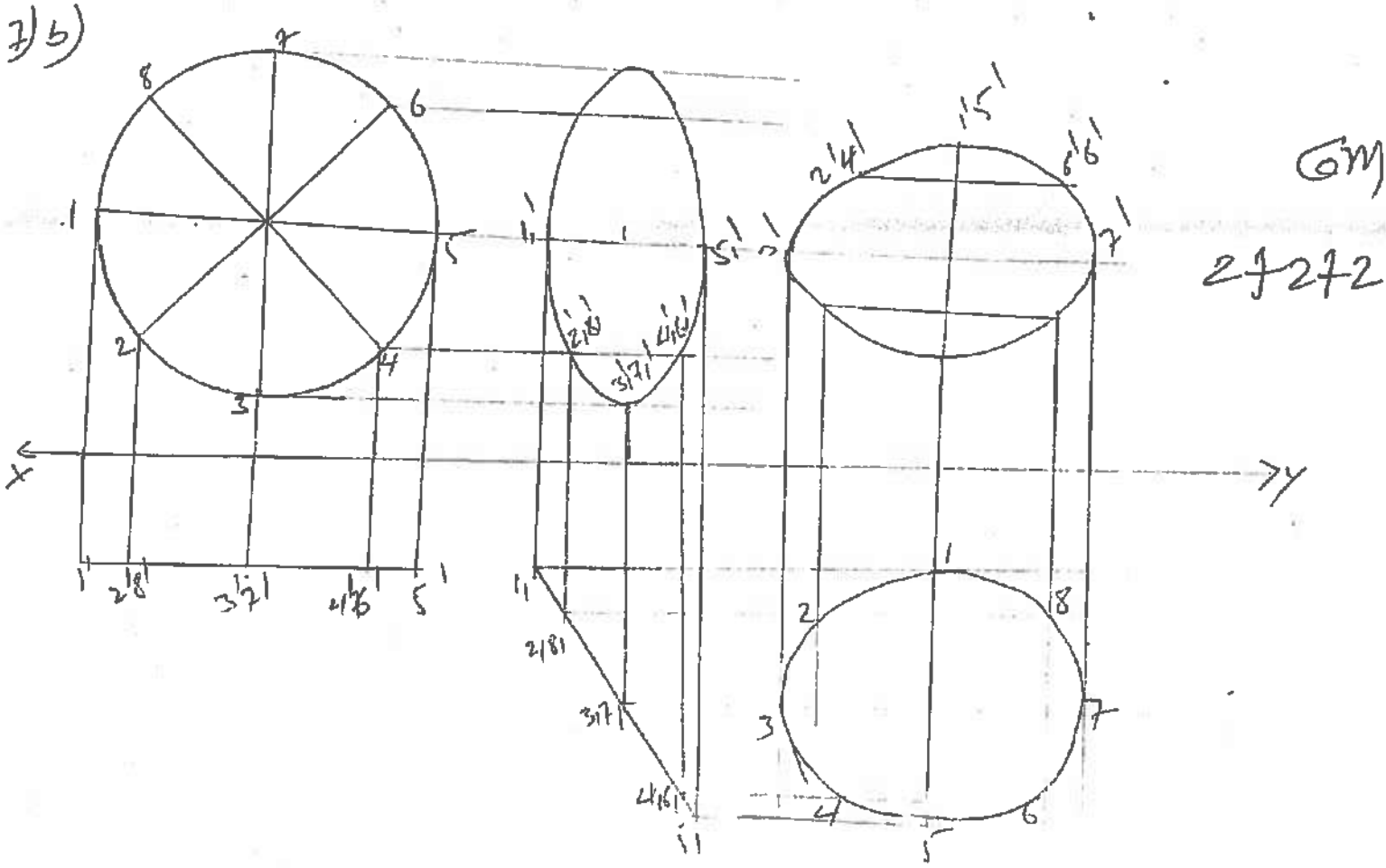


7) a)

2+2+2



7) b)

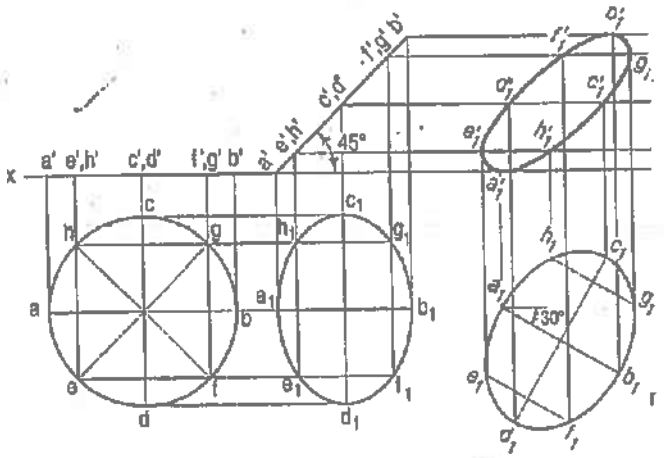


6M

2+2+2

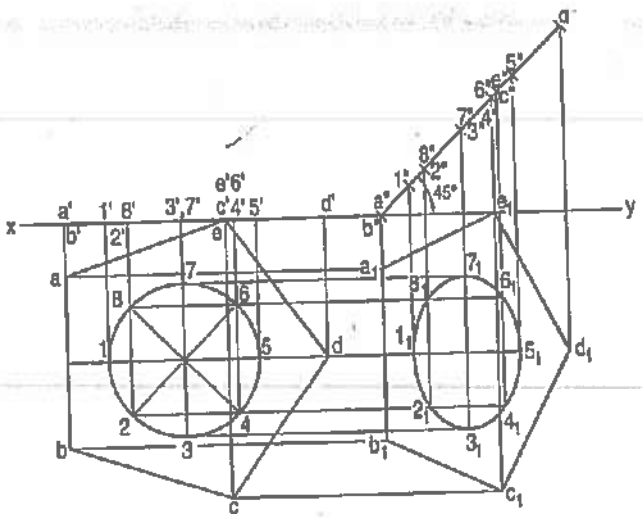
8) a) Page NO - 264

GM
2+2+2



8) b) Page NO - 267

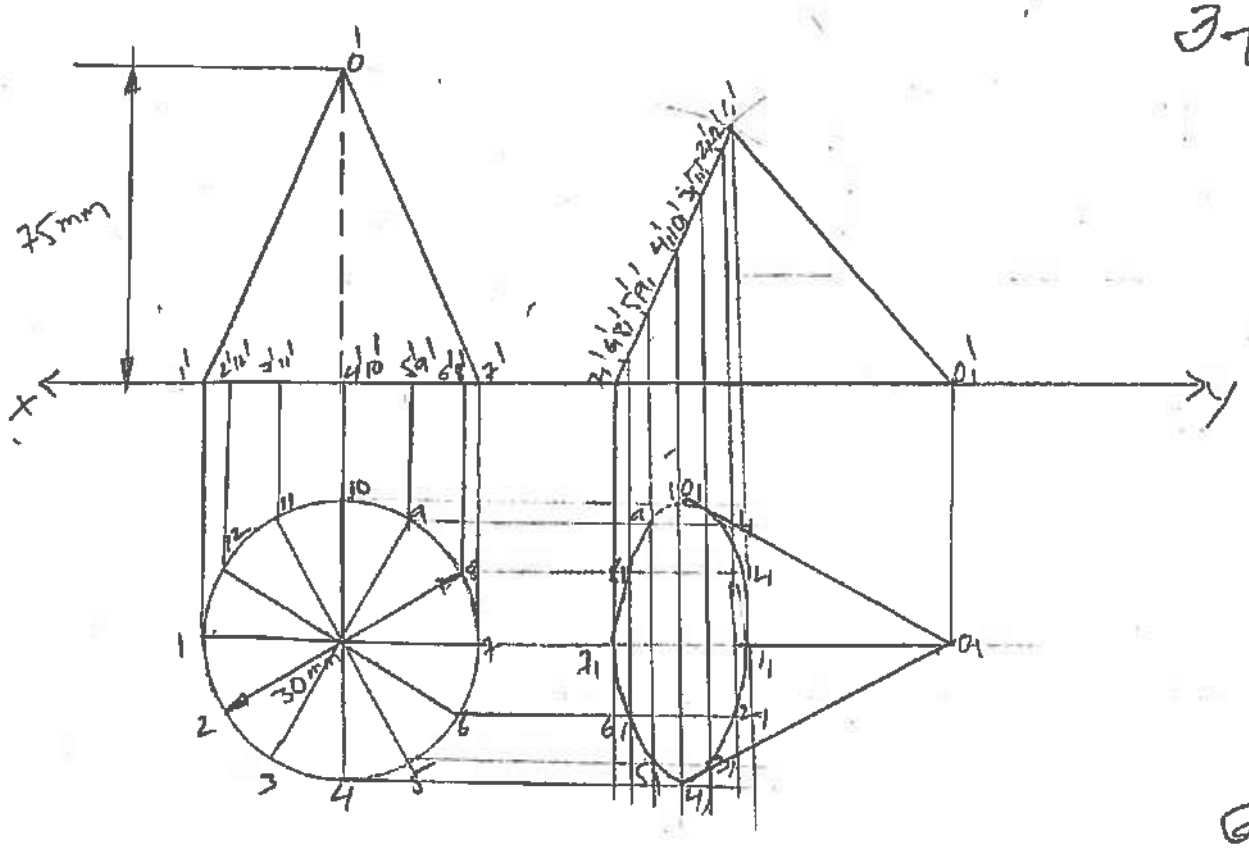
GM
3+3



9). a)

GM

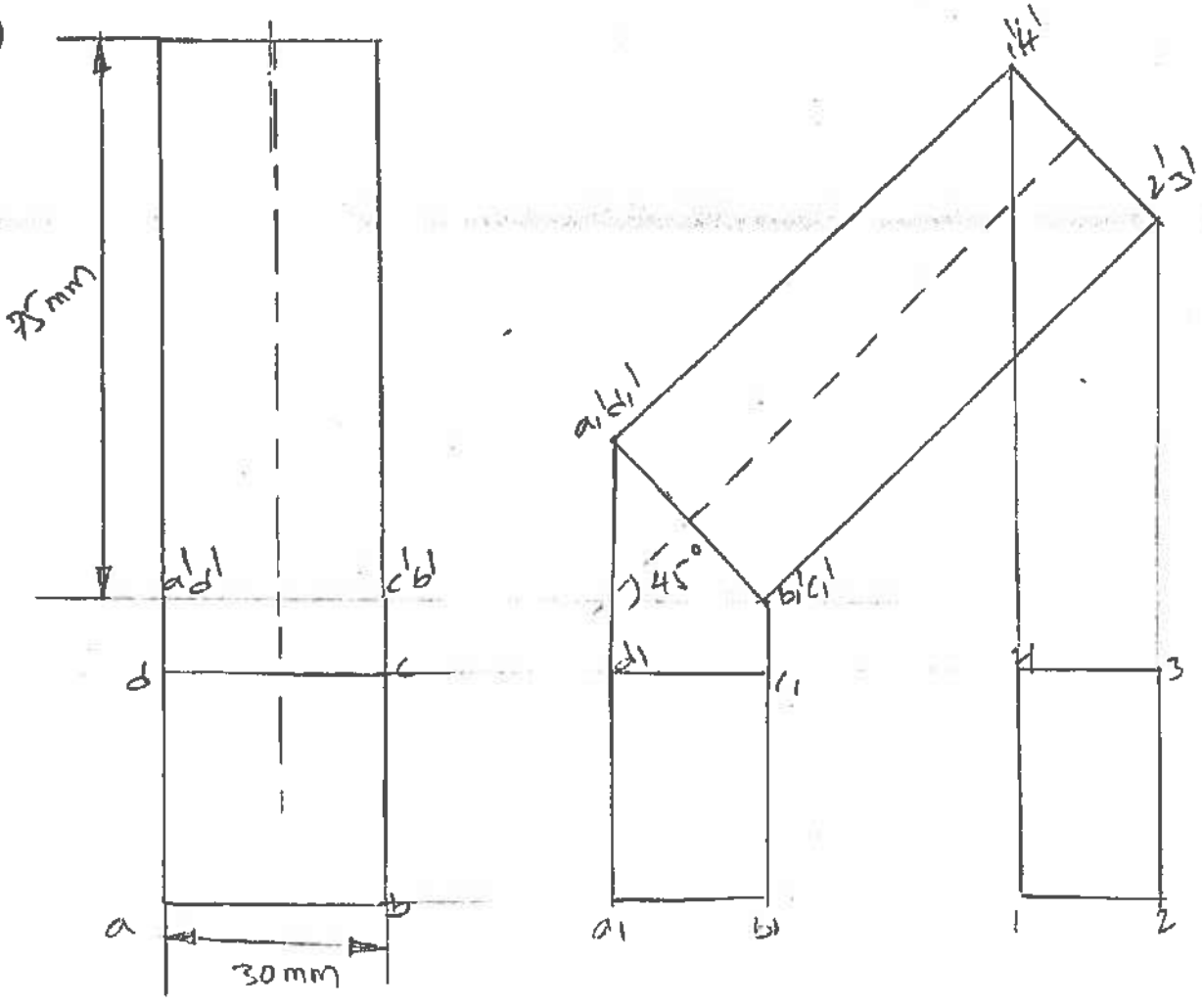
3+3



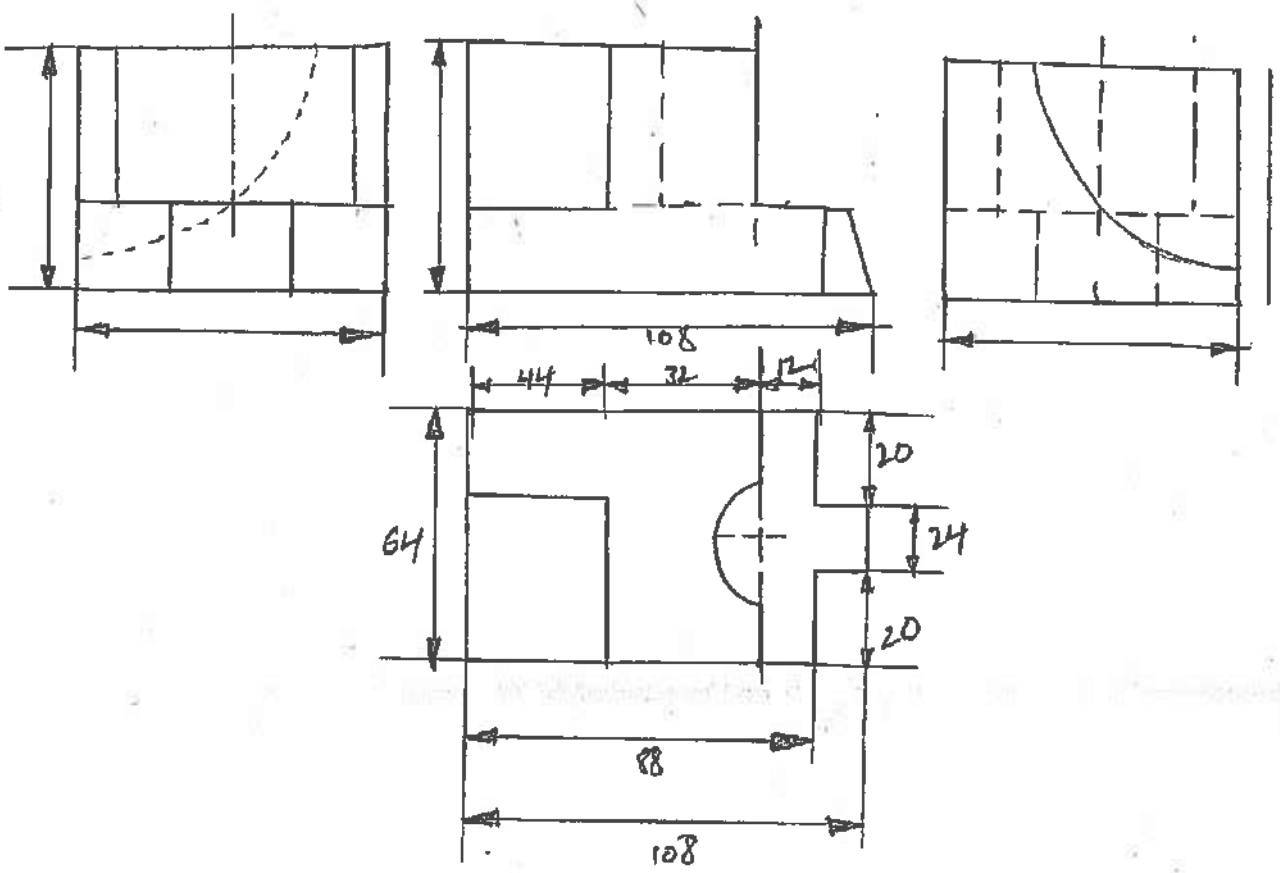
GM

3+3

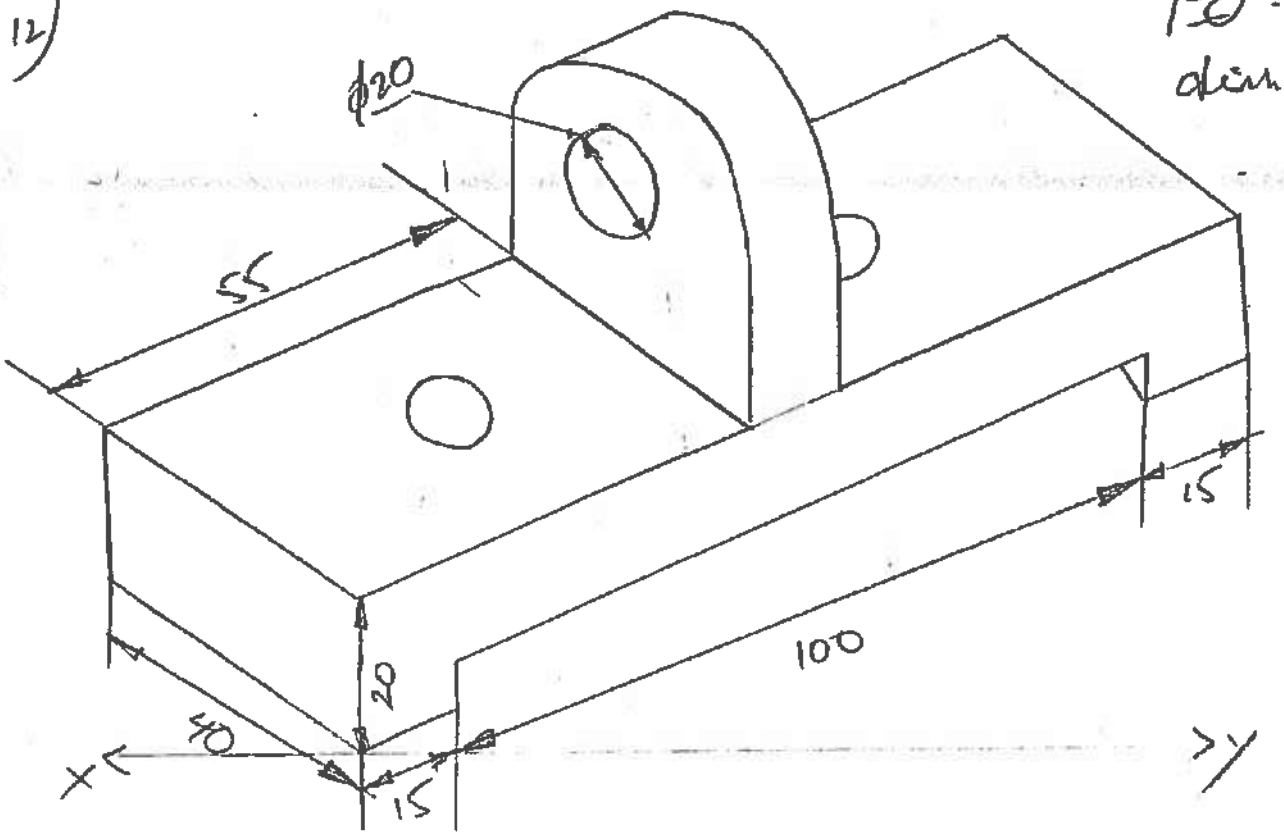
9) b)



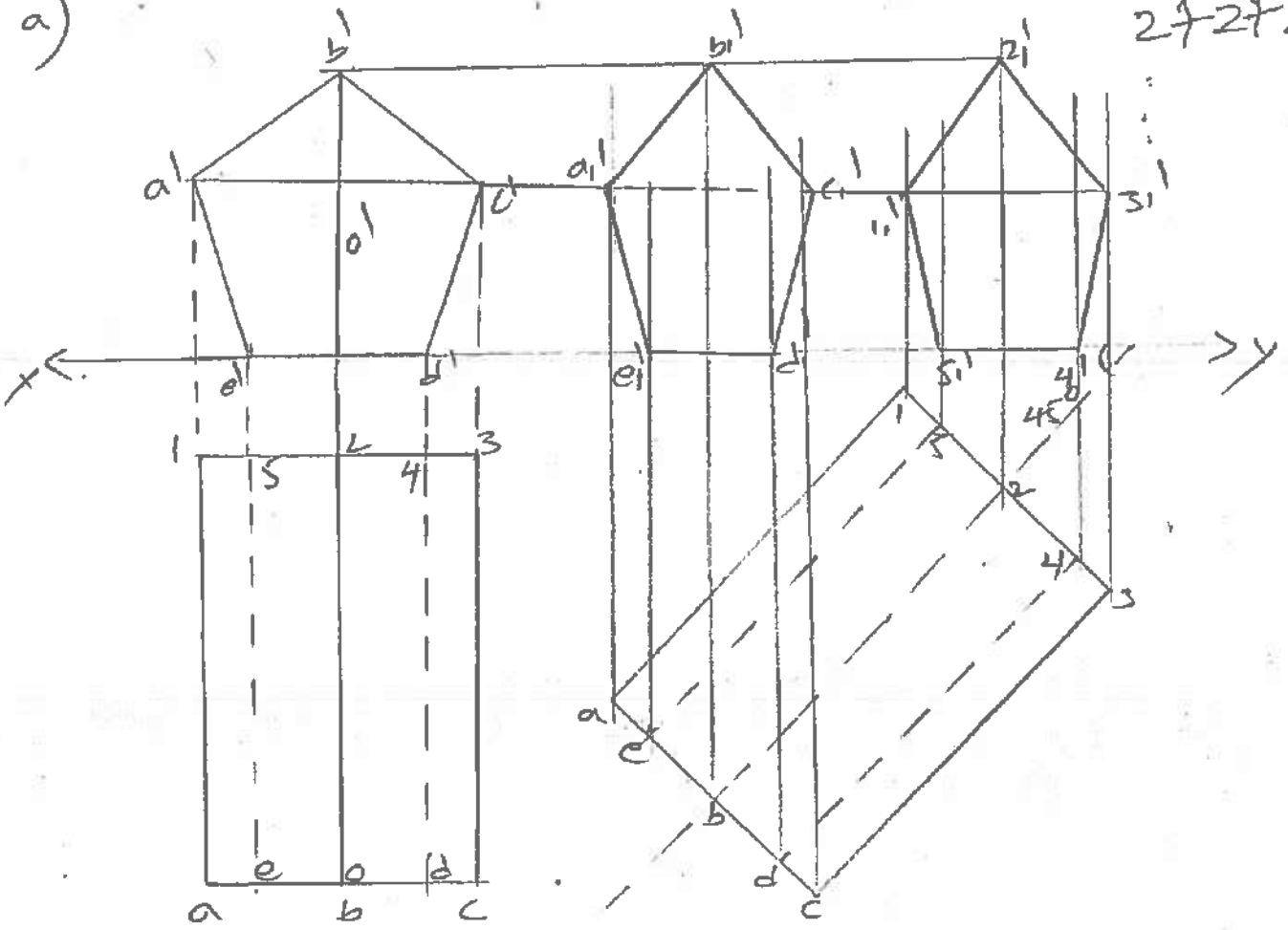
11)



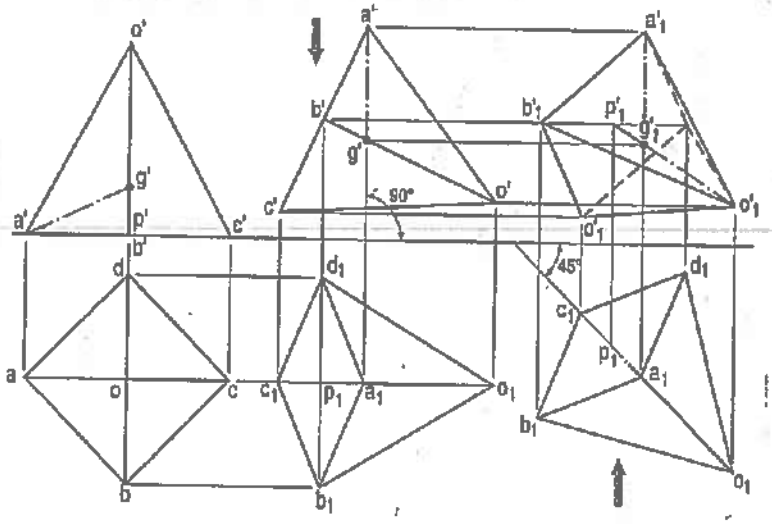
12)



10) a)



10) b) page no - 289



NSRIT

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	ECE			Academic Year	2020 - 2021
Course Code	20EC201	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	Principles of Electronics & Communication Systems						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Define drift current.	20EC201.1	L1
2	What is virtual ground?	20EC201.2	L1
3	List any two applications of FM system	20EC201.3	L1
4	Define Phase modulation.	20EC201.4	L1
5	Define critical angle.	20EC201.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	Describe the terms intrinsic and extrinsic semiconductors of both P type and N type.	6M	20EC201.1	L2
6 (b)	Explain how electrons and holes are created in an extrinsic Semiconductor.	6M	20EC201.1	L2
	OR			
7 (a)	Explain the distinction between metals, semiconductors and insulators with band diagrams.	6M	20CS403.1	L2
7 (b)	State and explain the Hall Effect. Mention its applications.	6M	20CS403.1	L2
8 (a)	Draw the block schematic of an op-amp and briefly explain each block.	6M	20EC201.2	L2
8 (b)	Obtain the gain expression for ideal inverting amplifier.	6M	20EC201.2	L2
	OR			
9 (a)	Derive the gain of closed loop differential OP-AMP.	6M	20EC201.2	L2
9 (b)	Obtain the output voltage adder circuit.	6M	20EC201.2	L2
10 (a)	List and state all the elementary continuous time signals.	6M	20EC201.3	L1
10 (b)	Compare continuous and discrete time signals.	6M	20EC201.3	L2
	OR			
11 (a)	What is amplitude modulation and write its mathematical expression with neat diagrams.	6M	20EC201.3	L2
11 (b)	List any 6 applications of AM system.	6M	20EC201.3	L1
12 (a)	Explain natural Sampling and Flat-top Sampling	6M	20EC201.4	L2
12 (b)	With a neat sketch, explain the principle and operation of DPCM.	6M	20EC201.4	L2
	OR			
13 (a)	Compare PAM, PPM and PWM with signal diagrams.	6M	20EC201.4	L2
13(b)	Explain the Digital modulation scheme.	6M	20EC201.4	L2
14(a)	Draw and explain the working principle of an Optical Communication system.	6M	20ESX02.5	L2
14 (b)	Explain the basic elements of optical communication system.	6M	20ESX02.5	L2
	OR			
15(a)	Explain the properties of light and ray theory.	6M	20EC201.5	L2
15(b)	Explain the basic elements of cellular communication systems.	6M	20EC201.6	L2

Degree : B.Tech (UG) Program : ECE AY : 2021-2022

courzecode : 20EC201

course : Principles of Electronics & communication Systems

Semester : II

KEY

PART-A

1. Define Drift current

Ans Drift current : The movement of holes and electrons constitute the electric current. This is known as drift current.

2. What is Virtual ground

Ans Virtual ground : A virtual ground is a node of a circuit that is at a steady reference potential without being directly connected to the reference potential.

3. List any Two applications of FM.

Ans
1. Radio broadcasting
2. Radar, Telemetry
3. EEG and Seismic prospecting
4. Video-transmission instruments

4. Define phase modulation.

Ans Phase Modulation : The phase of the carrier signal is varied in accordance with the instantaneous values of the message signal.

5 Define critical Angle

Ans Critical Angle: The critical angle is the angle of incidence, for which the angle of refraction is 90°.

6a. Describe the Terms intrinsic and extrinsic Semiconductor of both n-type, p-type.

Ans Semiconductors are classified as

1. Intrinsic Semiconductors
2. Extrinsic semiconductors.

1. Intrinsic semiconductors: A semiconductor is an extremely pure form is known as intrinsic semiconductors (or) A semiconductor in which electrons and holes are solely created by thermal exciation is called a pure or intrinsic semiconductor.

2. Extrinsic Semiconductors: At room temperature, the intrinsic Semiconductors has little current conduction capability. The added impurity is very small of the order of one atom per million atoms of the pure semiconductor. Such Semiconductors are called as impure or Extrinsic Semiconductors.

Depending on the impurity added, the extrinsic Semiconductors can be divided into two types.

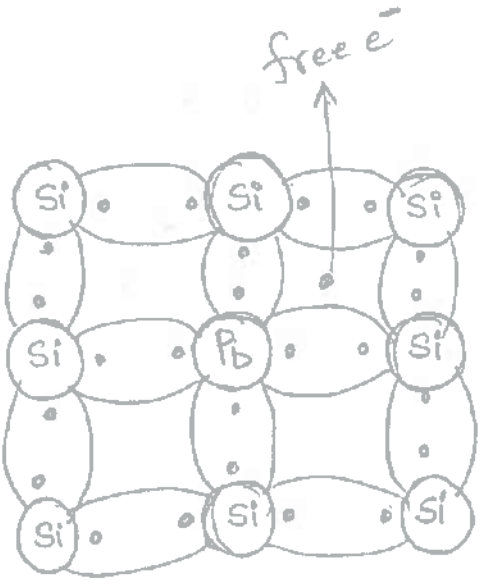
1. N-type (pentavalent impurity)
2. P-type (Trivalent impurity)

6b) Explain how holes and electrons are created in an extrinsic semiconductor.

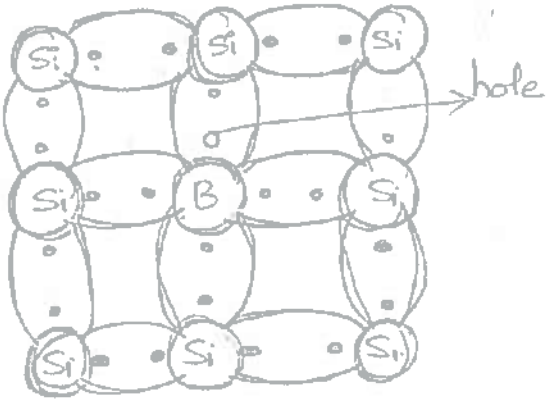
Ans Extrinsic Semiconductors are impure semiconductors. Depending on the impurity they are classified as n-type and p-type Semiconductors.

a) n-type Semiconductors: When a tetravalent atom such as Si or Ge is doped with a pentavalent atom, it occupies the position of an atoms in the crystal lattice of the ~~position~~ Si atom. The four of e^- of pentavalent with four neighbouring silicon atoms and fifth one remains weakly bound to the parent atom, this is an free e^-. Like this millions of e^-s are formed. electrons are majority charge carriers.

b) P-type Semiconductors: When a tetravalent atom such as Si or Ge is doped with trivalent impurity such as Al, B etc, the dopant atom has one less e^- than the surrounding atoms of Si or Ge. Thus the fourth atom of the tetravalent atom is free, and a hole or vacancy is generated in the trivalent atom. The holes are the charge carriers.



n-type Semiconductor



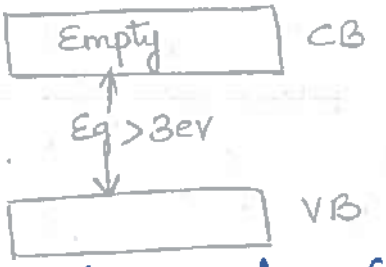
p-type Semiconductor

7a. Explain the distinction between metals, semiconductors and insulators with band diagram.

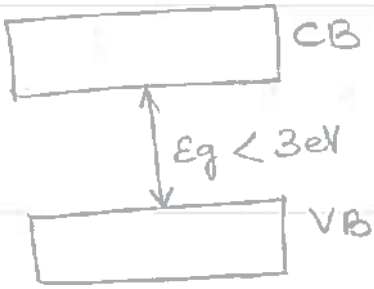
Ans Based on the band theory, the materials are classified into 3 types.

1. Insulators 2. semiconductors 3. metals

Insulators : A very poor conductor of electricity is called an insulator. VB is completely filled and CB is empty. The energy gap between VB and CB is more ($E_g > 3eV$).



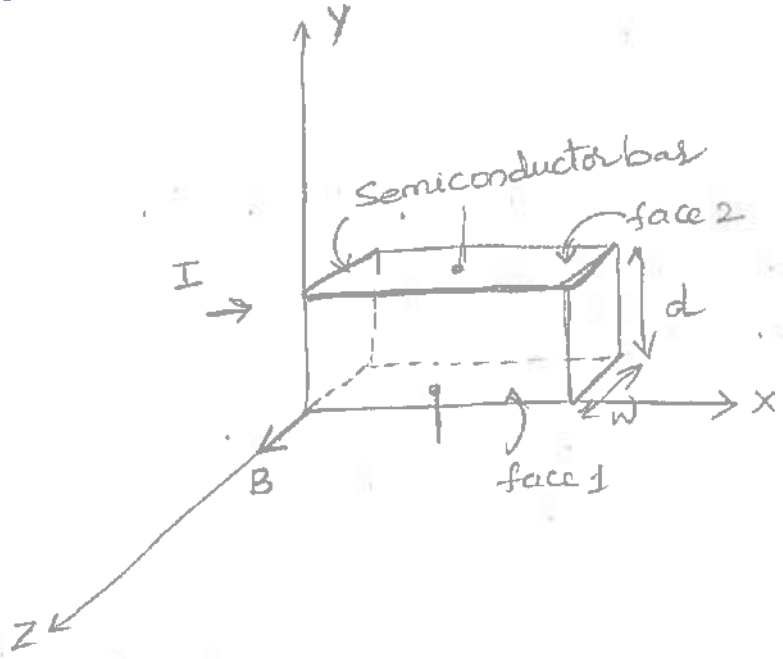
Semiconductors : A substance where conductivity lies between insulator and a conductor is a semiconductor. VB and CB has finite but small energy gap in between them ($E_g < 3eV$).



Conductor : An excellent conductor is a metal valance band & conduction band overlaps. As a result, the charge carriers already present in conduction band i.e ($E_g = 0$). metals are good conductors.

7b State and Explain Hall effect mention its applications.

Ans **Hall effect:** If a metal or semiconductor carrying a current 'I' is placed in a transverse magnetic field 'B' an electric field 'E' is induced in the direction ⊥lr to both the current and magnetic field direction. This phenomenon is called as "Hall effect"



→ Potential difference V_H is developed between two surfaces 1 and 2 which is called as Hall voltage. polarity of V_H helps us to determine the type of semiconductor.

→ In equilibrium state, E due to hall effect must exert a force on the carrier which just balances the magnetic force.

$$eE = BeV$$

$$E = \frac{V_H}{d} \Rightarrow V_H = Ed$$

$$V_H = BVd$$

current density $J = \frac{I}{A}$

$$= \frac{I}{wd}$$

$$= \rho v. \qquad \rho \rightarrow \text{charge density}$$

$$v = \frac{I}{\rho w d}$$

then $V_H = B.v.d = B\left(\frac{I}{\rho w d}\right) d = \frac{B.I}{\rho w}$

Hall coefficient R_H defined by

$$R_H = \frac{1}{\rho} = \frac{V_H \omega}{B I}$$

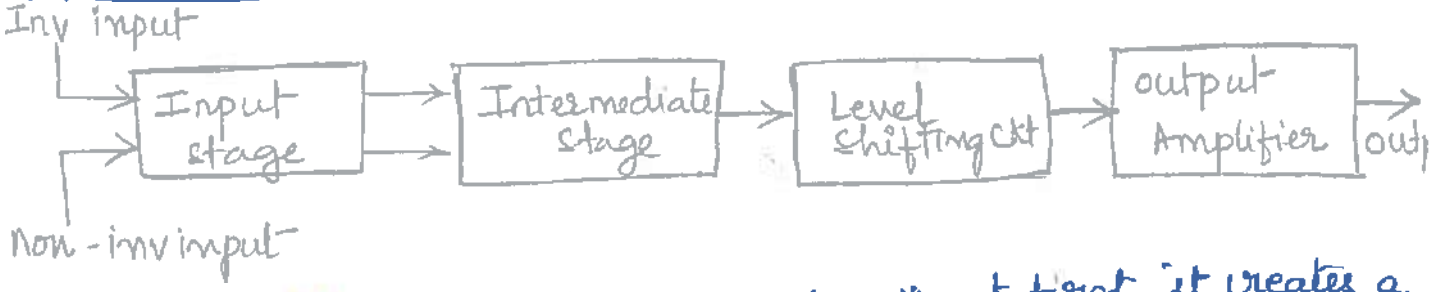
in a extrinsic semiconductor σ is due to charge of one sign. then $\sigma = p\mu$.

$$\mu = \frac{\sigma}{\rho}.$$

8a. Draw the block schematic of an op-amp and briefly explain each block.

Ans

Operational Amplifier:



Input stage: The main function of op-Amp is at first it creates a difference between two input signals and then amplify the differe s/g. It provides high input impedance

Intermediate stage: The output of the input stage is used as the input to intermediate stage. In this stages, the direct coupling happens.

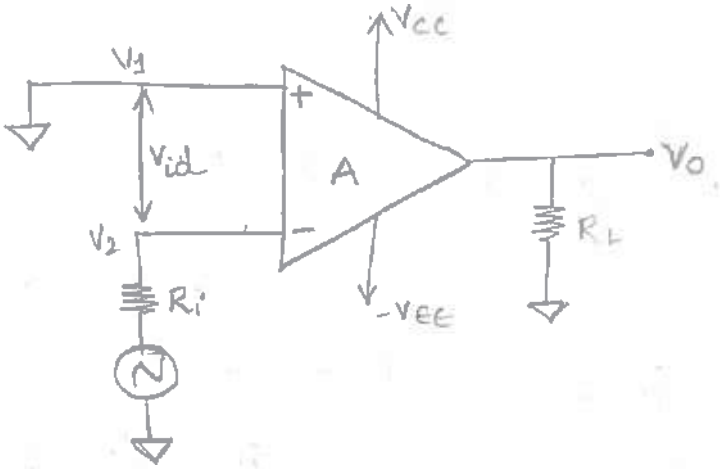
Level shifting: As in the stage shifting of voltage level happens that is why it is called level shifter. Here the emitter follower with constant current source is applied.

Output stage: In this stage pushpull amplifier is used the output of the level shifting stage is given to the input of the push-pull amplifier. This amplifier increases the output voltage and high current delivering capability of the operational amplifier.

8b obtain the gain expression for ideal inverting amplifier.

Ans **Inverting Amplifier:** only one input is applied to the inverting input terminal. The non-inverting terminal is grounded

Since $V_1 = 0$ and $V_2 = V_{in}$



The output voltage $V_o = A(V_1 - V_2)$

$$V_1 = 0$$

$$V_o = A(0 - V_{in})$$

$$V_o = A(-V_{in})$$

$$V_o = -AV_{in}$$

gain → $$A = \frac{-V_o}{V_{in}}$$

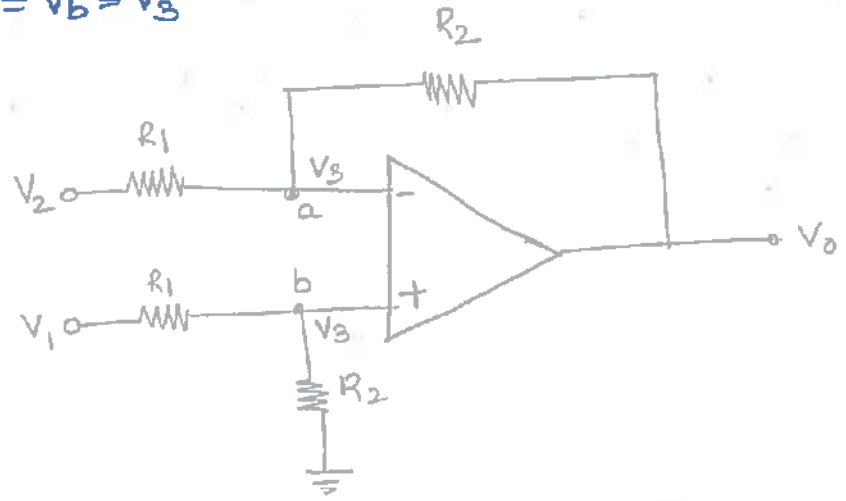
9a Derive the gain of closed loop differential Op-Amp.

Ans → A circuit Amplifies the difference between two signals is called a difference or differencial amplifier.

→ This type of amplifier is very useful in instrumentation circuits.

→ Since the differential voltage at the input terminal of the op-amp is zero. I.e node a and b are same potential

let $V_a = V_b = V_3$



The nodal equation at node a | at node

$$\frac{V_3 - V_2}{R_1} + \frac{V_3 - V_0}{R_2} = 0 \rightarrow (1) \qquad \frac{V_3 - V_1}{R_1} + \frac{V_3}{R_2} = 0 \rightarrow (2)$$

rearranging the above equations.

$$V_3\left[\frac{1}{R_1} + \frac{1}{R_2}\right] - \frac{V_2}{R_1} = \frac{V_0}{R_2} \rightarrow (3) \qquad V_3\left[\frac{1}{R_1} + \frac{1}{R_2}\right] - \frac{V_1}{R_1} = 0 \rightarrow (4)$$

(3) − (4).

$$V_3\left[\frac{1}{R_1} + \frac{1}{R_2}\right] - \frac{V_2}{R_1} - V_3\left[\frac{1}{R_1} + \frac{1}{R_2}\right] + \frac{V_1}{R_1} = \frac{V_0}{R_2}$$

$$\Rightarrow \quad \frac{V_1}{R_1} - \frac{V_2}{R_1} = \frac{V_0}{R_2}$$

$$\Rightarrow \quad \frac{1}{R_1}\left[V_1 - V_2\right] = \frac{V_0}{R_2}$$

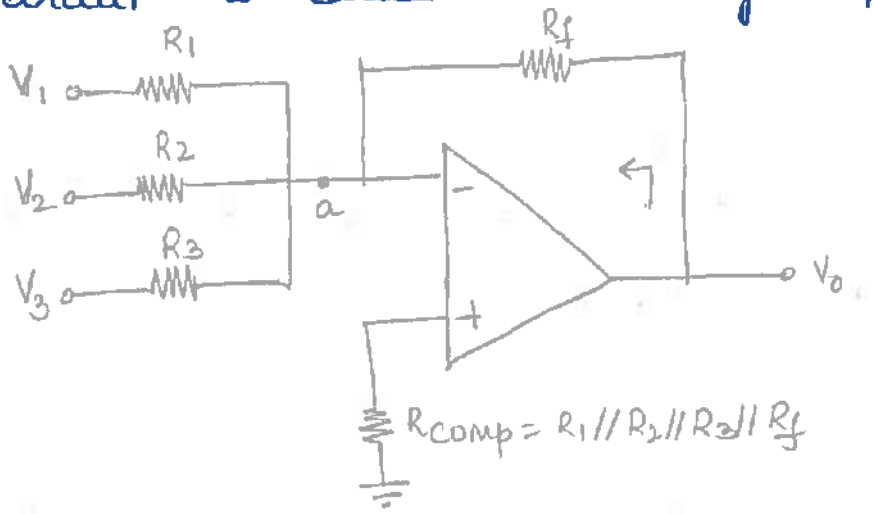
$$\Rightarrow \quad V_0 = \frac{R_2}{R_1}(V_1 - V_2)$$

output voltage $V_0 = \frac{R_2}{R_1}(V_1 - V_2)$

gain $\frac{V_0}{V_1 - V_2} = \frac{R_2}{R_1}$

Q6 obtain the output voltage of adder circuit

Ans **Adder** : An op-amp may be used to design a circuit whose o/p is the sum of several inputs Such a circuit is called a summing amplifier or adder.



→ This analysis is carried out assuming to be $A_{OL}=\infty$ $R_i=\infty$.

→ Since input bias current is assumed to be zero. there is no voltage drop across the resistor Rcomp hence non inverting terminal is at gnd potential

→ node voltage $V_a=0$

apply nodal analysis at node 'a'

$$\frac{V_a-V_1}{R_1}+\frac{V_a-V_2}{R_2}+\frac{V_a-V_3}{R_3}+\frac{V_a-V_o}{R_f}=0$$

$$\frac{-V_1}{R_1}-\frac{V_2}{R_2}-\frac{V_3}{R_3}=\frac{V_o}{R_f}$$

$$\frac{V_o}{R_f}=-\left(\frac{V_1}{R_1}+\frac{V_2}{R_2}+\frac{V_3}{R_3}\right)$$

$$V_o=-\left(\frac{R_f}{R_1}V_1+\frac{R_f}{R_2}V_2+\frac{R_f}{R_3}V_3\right)$$

In special case, when $R_1=R_2=R_3=R_f$,then

$$V_o=-(V_1+V_2+V_3)$$

the output is the inverted sum of the input signals

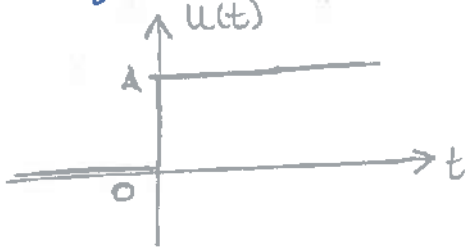
10a. List and State all the elementary continuous time signals

Ans Elementary signals :-

1- Step signal : Step signal is defined as

$u(t) = A$ for $t \geq 0$

$= 0$ for $t < 0$



2. Impulse signal : Impulse signal is defined as

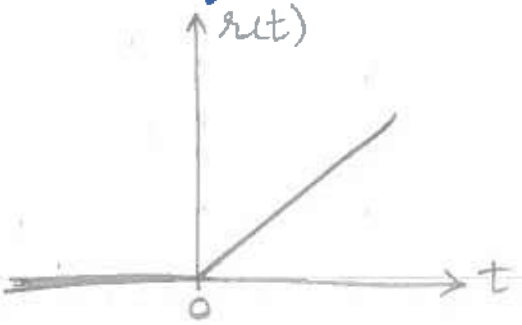
$\delta(t) = 1$ for $t = 0$

$= 0$ for $t \neq 0$

3. Ramp signal : Ramp signal is defined as

$r(t) = At$ for $t \geq 0$

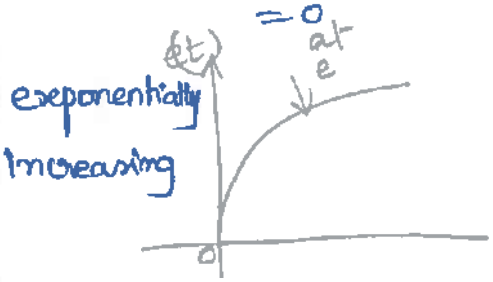
$= 0$ for $t < 0$

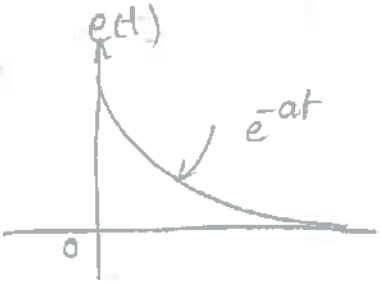


4. Exponential signal : Exponential signal is defined as

$e(t) = e^{at}$ or e^{-at} for $t \geq 0$

$= 0$ for $t < 0$



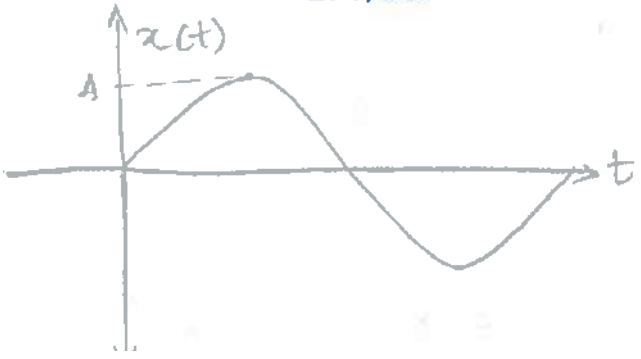


exponentially decreasing

5. Sinusoidal signal : Sinusoidal signals are defined as $x(t) = A\sin\omega t$ or $A\cos\omega t$

A → magnitude

ω → frequency Component

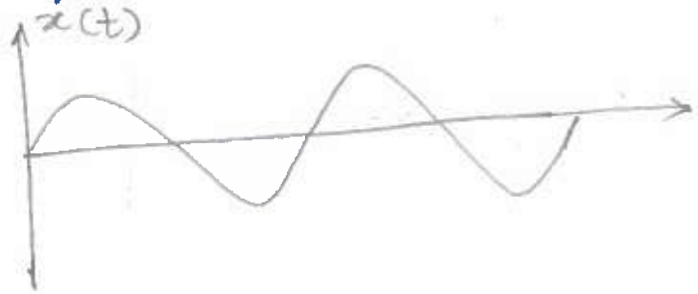


10b) Compare continuous and discrete time signals.

Ans

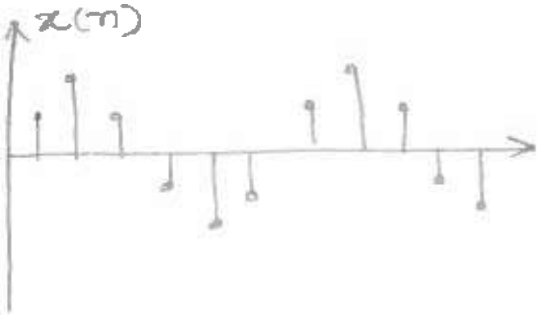
Continuous-time signal: A continuous-time signal is a function that is defined over a continuous range of time in which the amplitude may either have a continuous range or finite number of possible values

Both Amplitude and time are continuous x(t)



Discrete-time signal: A discrete-time signal is a sequence of values that correspond to particular instants in time.

In this Amplitude is continuous, but time is discrete x(n)



11a What is Amplitude modulation and write its mathematical expression with neat diagram.

Ans Amplitude Modulation: The amplitude of a carrier signal is varied in accordance with the instantaneous values of modulating signal.

Let us consider the modulating voltage be

$$m(t) = V_m(t) = V_m \cos\omega_m t$$

carrier signal

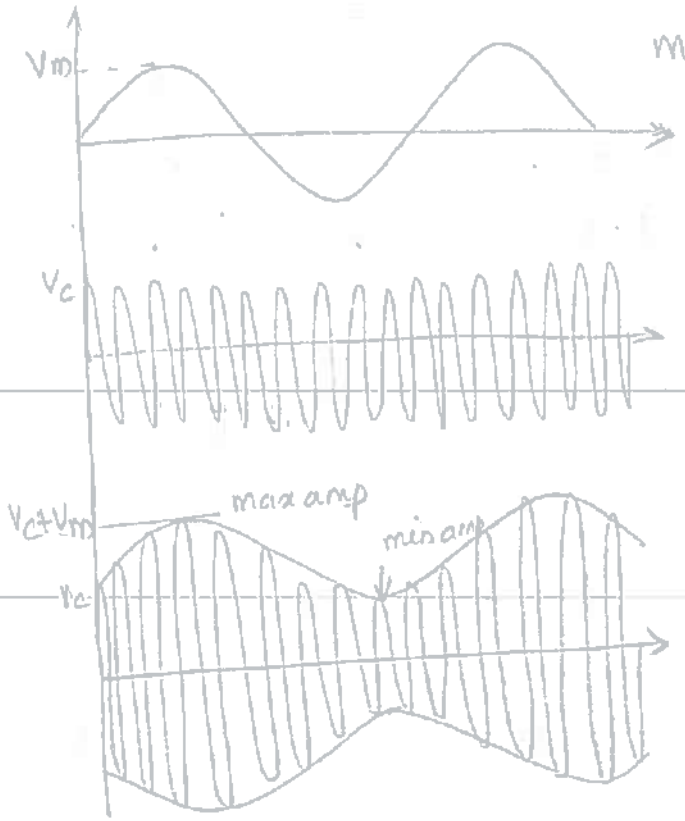
$$C(t) = V_c(t) = V_c \cos\omega_c t$$

the modulated signal $V_{AM} = V_c[1 + \mu \cos\omega_m t] \cos\omega_c t$

$$V_{AM} = V_c[1 + K_a m(t)] \cos\omega_c t \quad \left[\because K_a = \frac{1}{V_c}\right]$$

$K_a = \frac{1}{V_c}$ → amplitude sensitivity

$$V_{AM}(t) = V_c \cos\omega_c t + \frac{V_c \mu}{2} \cos(\omega_c + \omega_m)t + \frac{V_c \mu}{2} \cos(\omega_c - \omega_m)t$$



Modulating Index: $\mu = \frac{V_m}{V_c}$

$$V_{max} = V_c[1 + \mu] \qquad V_{min} = V_c[1 - \mu]$$

$$V_m = \frac{V_{max} - V_{min}}{2}$$

$$V_c = \frac{V_{max} + V_{min}}{2}$$

$$\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}}$$

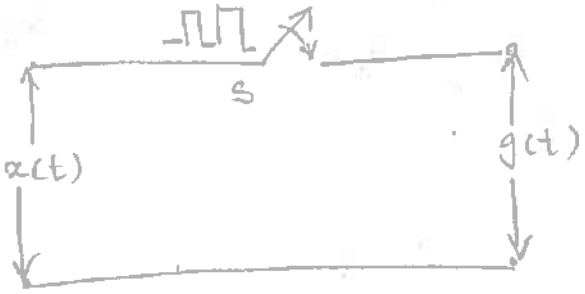
11b) List any 6 applications of AM System

Ans Applications of AM:

1. Communication between Aircraft
2. Broadcast transmission
3. Audio broadcasting on the long medium
4. Air band radio: VHF transmissions for many airborne applications still use AM.
5. Single side band used for HF radio links
6. Quadrature AM is used for transmission of data in everything short range wireless links such as wi-fi to cellular telecommunications.
7. Mainly used in Ethernet communication
8. It is used in photo-biology.
9. Broadcasting on long, medium and short wave bands.

12a) Explain natural and flat top sampling.

Ans Natural sampling: Sampling is done in accordance with the carrier signal which is digital in nature.



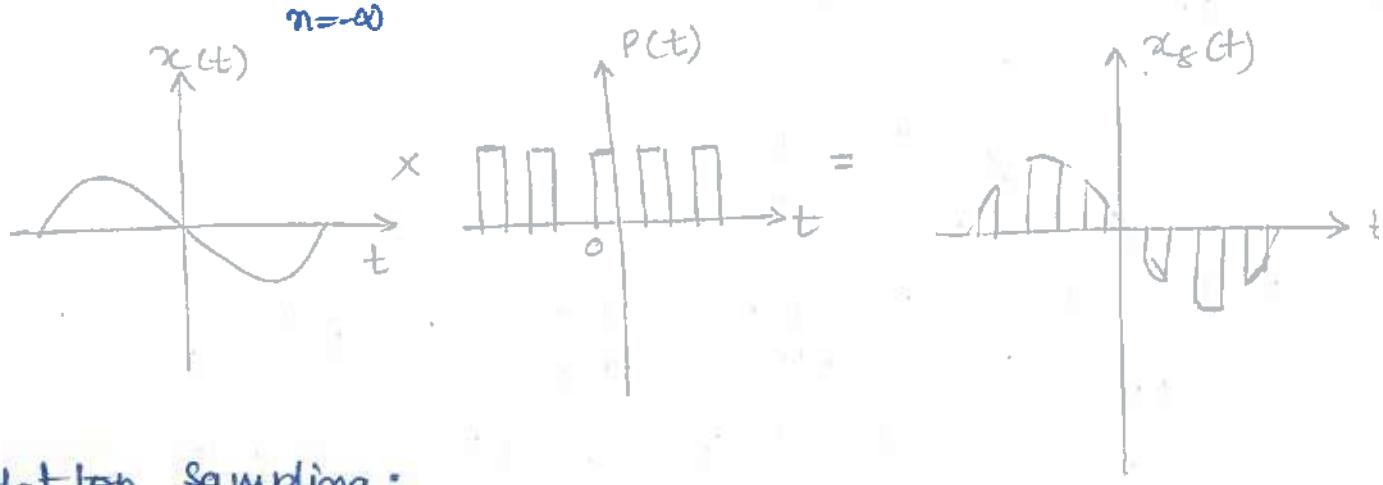
Input signal is x(t), here we will apply the pulse train at the switch

$$P(t) = \sum_{n=-\infty}^{\infty} P(t - nT_s)$$

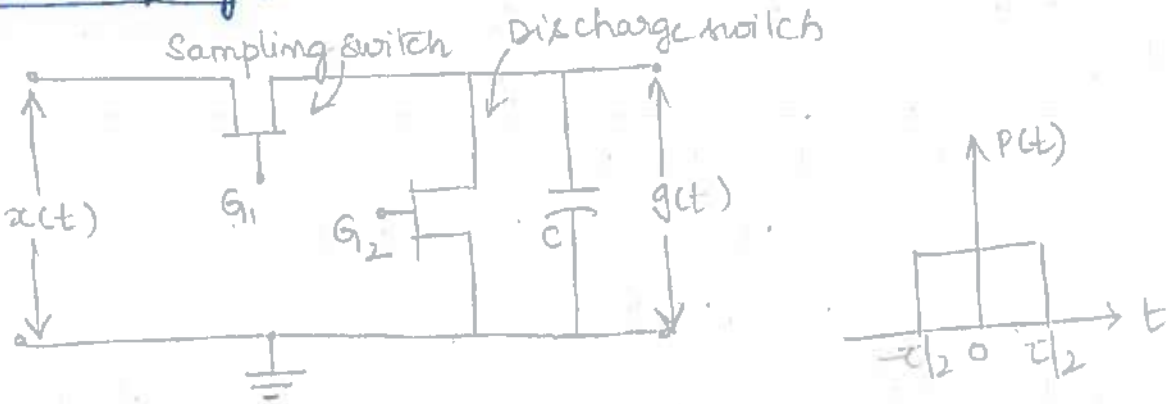
The sampled signal g(t) is obtained by multiplication of sampling function P(t) and the input signal x(t)

$$x_s(t) = x(t) \times P(t)$$

$$= \sum_{n=-\infty}^{\infty} x(t)\ P(t-nT_s)$$



Flat top Sampling :



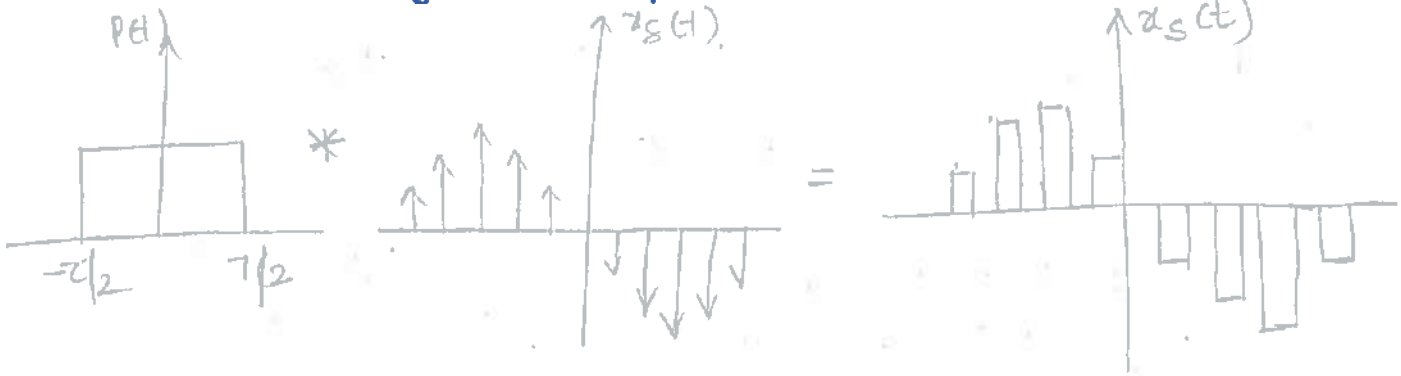
$x_s(t)$ is obtained by $x(t) \times P(t)$ where $P(t) = \sum_{n=-\infty}^{\infty} \delta(t-nT_s)$

Again this is convoluted with pulse train P(t) here sample and hold ckt starts working.

→ At the starting of the pulse, the sampler samples the input then hold circuit will hold that value for τ sec. we will get the output during τ only after that it will be zero

→ Again it starts sampling from next pulse. it will continue the same

→ so that we will get flat top samples at the output



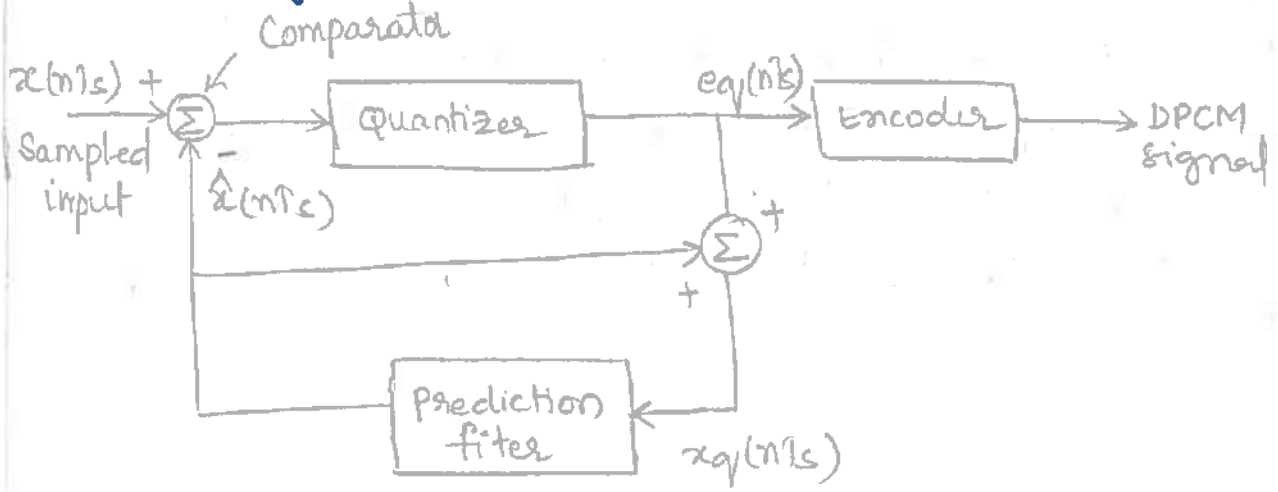
12b) With a neat sketch, explain the principle and operation of DPCM.

Ans **DPCM:** DPCM is a technique of analog to digital signal conversion. It samples the analog signal and quantizes the difference between the sampled value and its predicted value. then encodes the signal to form a digital value.

→ If redundancy is reduced, then the overall bit-rate will decrease and the number of bits required to transmit one sample will also reduce.

→ DPCM works on principle of prediction

→ The value of the present sample is predicted from the previous samples. The prediction may not be exact, but it is very close to the actual sample value.



$x(nT_s)$ → sampled signal, $\hat{x}(nT_s)$ → Predicted signal. comparator gives the output as difference between $x(nT_s)$ and $\hat{x}(nT_s)$, it is denoted by $e(nT_s)$

$$e(nT_s) = x(nT_s) - \hat{x}(nT_s) \rightarrow (1)$$

Prediction filter will produce the $\hat{x}(nT_s)$

the prediction filter will process the $x_q(nT_s)$

$$x_q(nT_s) = \hat{x}(nT_s) + e_q(nT_s) \rightarrow (2)$$

Quantizer output will be

$$e_q(nT_s) = e(nT_s) + q(nT_s) \rightarrow (3)$$

$q(nT_s)$ → quantization error

by substituting the value of $e_q(nT_s)$ from all equations then we get $x_q(nT_s) = \hat{x}(nT_s) + e(nT_s) + q(nT_s) \rightarrow (4)$

equation (1) can be written as

$$e_q(nT_s) + \hat{x}(nT_s) = x(nT_s)$$

then equation (4) can be

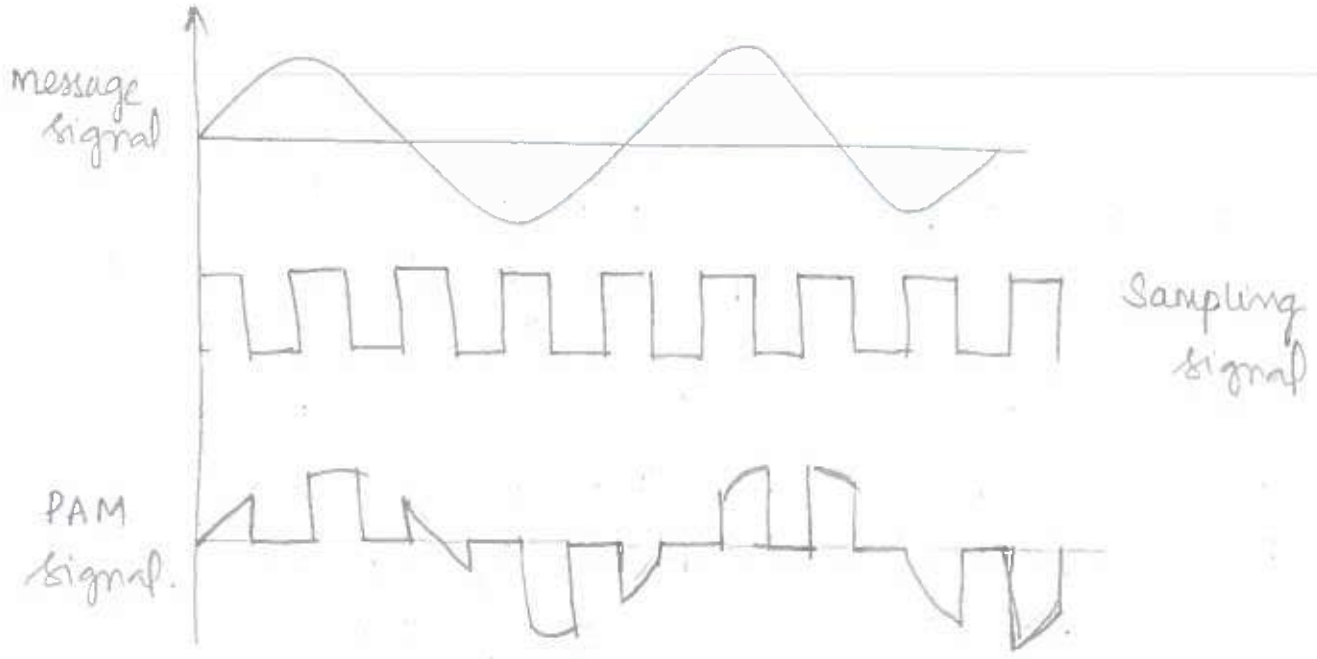
$$x_q(nT_s) = x(nT_s) + q(nT_s)$$

The quantized error can be positive or negative so the o/p of the prediction filter does not depend on its characteristics.

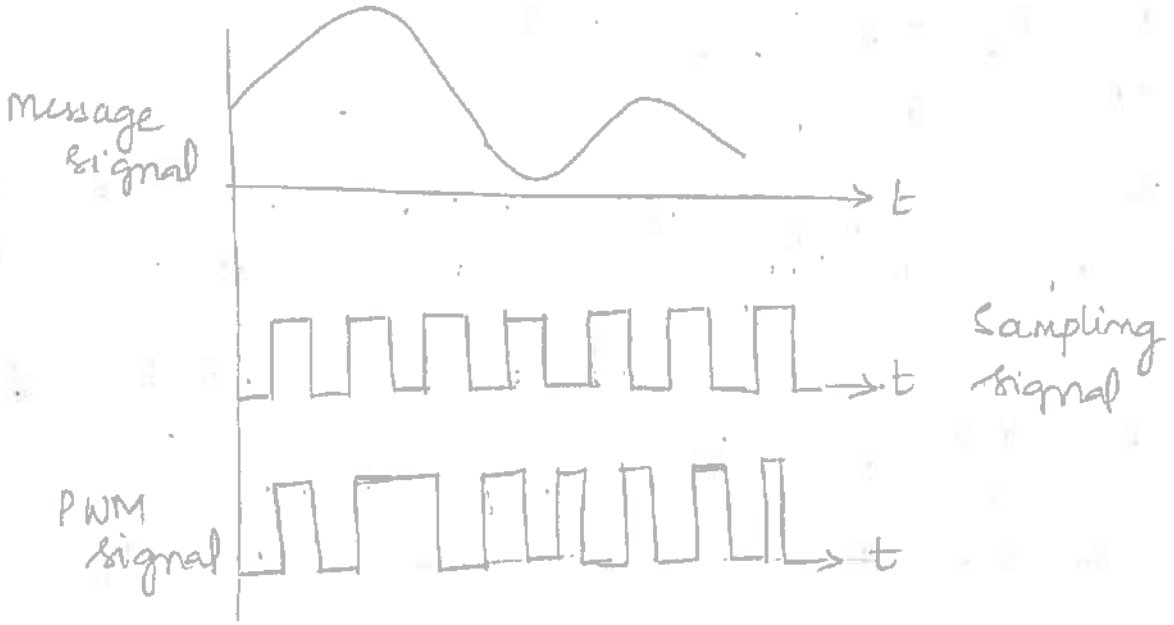
13a) Compare PAM, PWM and PPM with signal diagrams.

Ans PAM : (Pulse Amplitude Modulation).

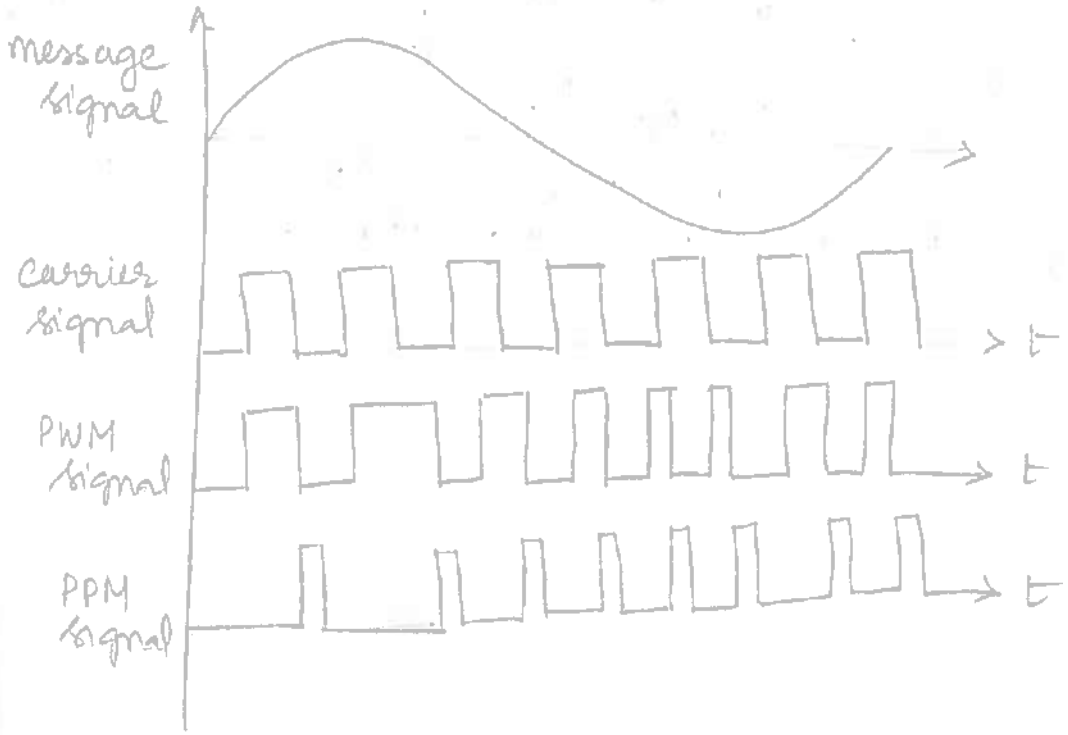
It is the simplest form of pulse modulation, each sample is made proportional to the amplitude of the signal at the instant of sampling. PAM signal follows the amplitude of the original signal.



Pulse width modulation : The width of the pulse is varied in proportional to the amplitude of the signal. It can also be called as pulse duration modulation.



Pulse Position Modulation : In this type of modulation, both amplitude and width of the pulse are kept constant. We vary the position of each pulse with reference to a particular pulse.



13b) Explain the digital modulation schemes.

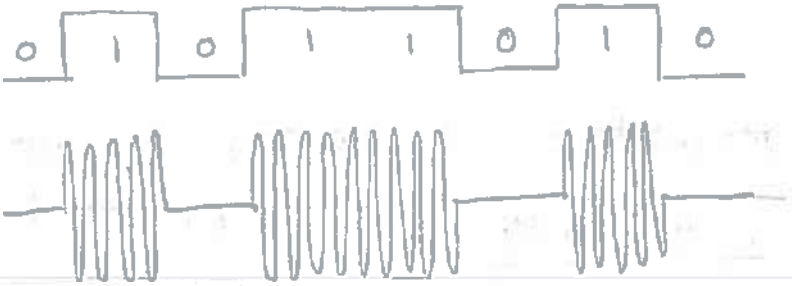
Ans Digital Modulation Schemes:

1. Amplitude Shift Keying (ASK)
2. Frequency Shift Keying (FSK)
3. Phase Shift Keying (PSK)

Amplitude Shift Keying: The amplitude of the resultant output depends upon the input data whether it should be a low level or high level.

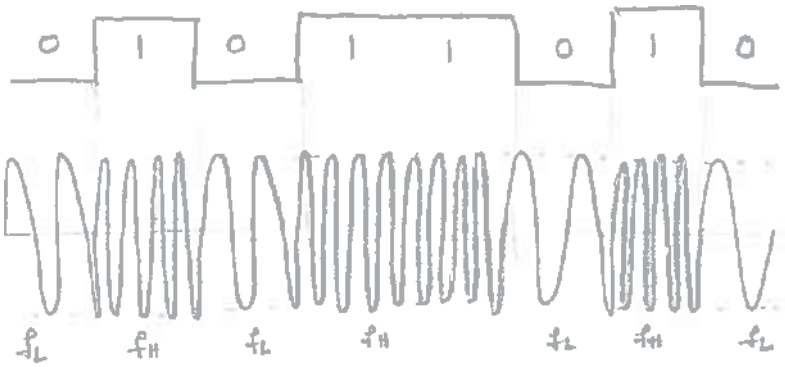
→ Because the data is an ON/OFF signal, and the output is also an ON/OFF signal whereever the carrier is there when data is 1 as well as the carrier is not present when data is 0.

→ This modulation scheme is known as ON/OFF Keying (OOK)



Frequency Shift Keying: FSK is defined as the changing or improving the frequency characteristics of an input binary signal according to the carrier signal, it is also known as Binary Frequency Shift Keying (BFSK).

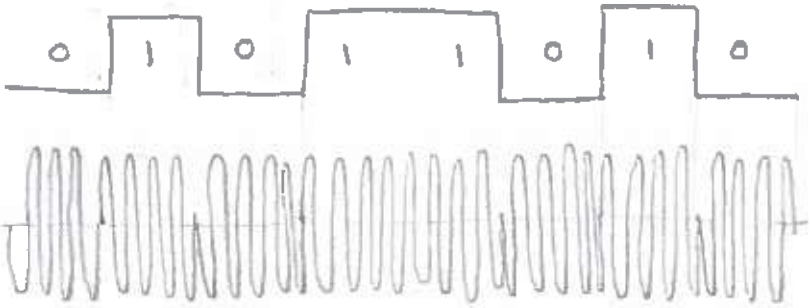
→ The frequency of the output signal will be either high or low, depending upon the input data applied.



Phase shift keying: In phase shift keying, the phase of the output signal gets shifted depending upon the input.

→ If the m(t) baseband signal is = 1, then carrier signal with in phase will be transmitted.

→ Similarly, if the baseband signal m(t) = 0, then carrier signal by out of phase is transmitted.

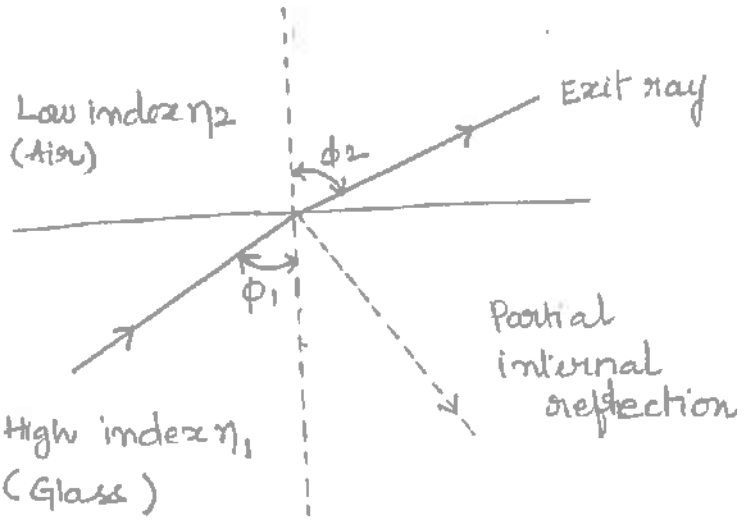


14a) Draw and explain the working principle of an optical communication system.

Ans → According to Ray theory, the refractive index of a dielectric medium plays a major role in the propagation of light

→ η gives the measure of the light speed, if the η is high, then the speed will be low and for a lower values of 'η' speed of the light will be high.

→ When a ray is incident on the interface between two dielectrics of different refractive index, refraction occurs as shown as below.



$\eta_1 \rightarrow$ refractive index of glass

$\eta_2 \rightarrow$ refractive index of air

$\phi_1 \rightarrow$ angle with respect to the normal at the surface of the interfac

$\phi_2 \rightarrow$ angle with normal in the medium of η_2, where ϕ_2 is greater tha ϕ_1

$\phi_1 \rightarrow$ incidence angle $\phi_2 \rightarrow$ refraction angle

relation between ϕ_1 & ϕ_2 is given by Snell's law.

$$\eta_1 \sin\phi_1 = \eta_2 \sin\phi_2$$

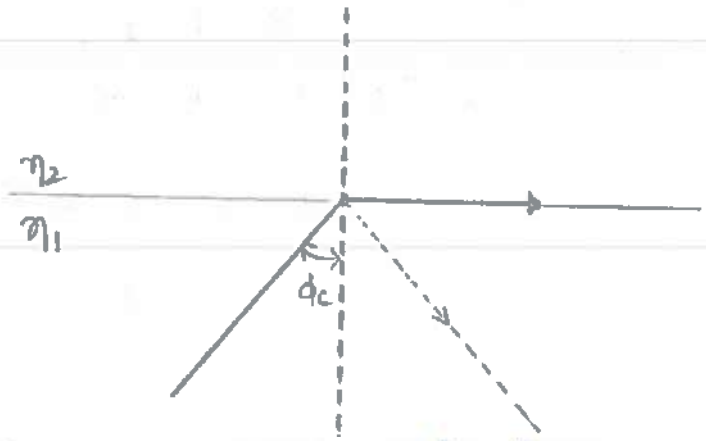
$$\frac{\sin\phi_1}{\sin\phi_2} = \frac{\eta_2}{\eta_1}$$

Since $\eta_1 > \eta_2$, then $\phi_2 > \phi_1$ always.

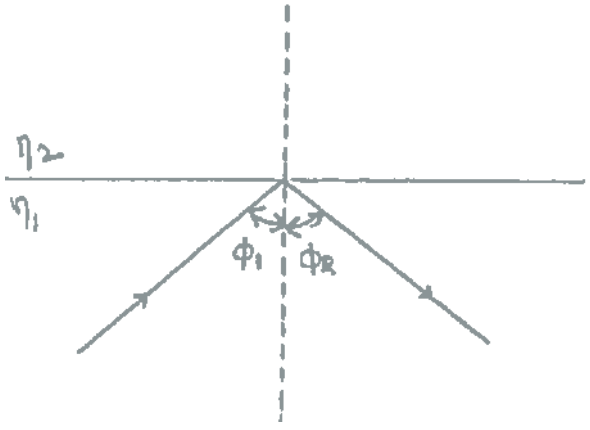
→ Thus if the ϕ_2 is 90° then the refracted ray emerges parallel to interface between two medium. where the angle of incidence stays lower than 90°

→ The angle of incident ϕ_1 at which the angle of refraction ϕ_2 becomes 90° is known as critical angle ϕ_c.

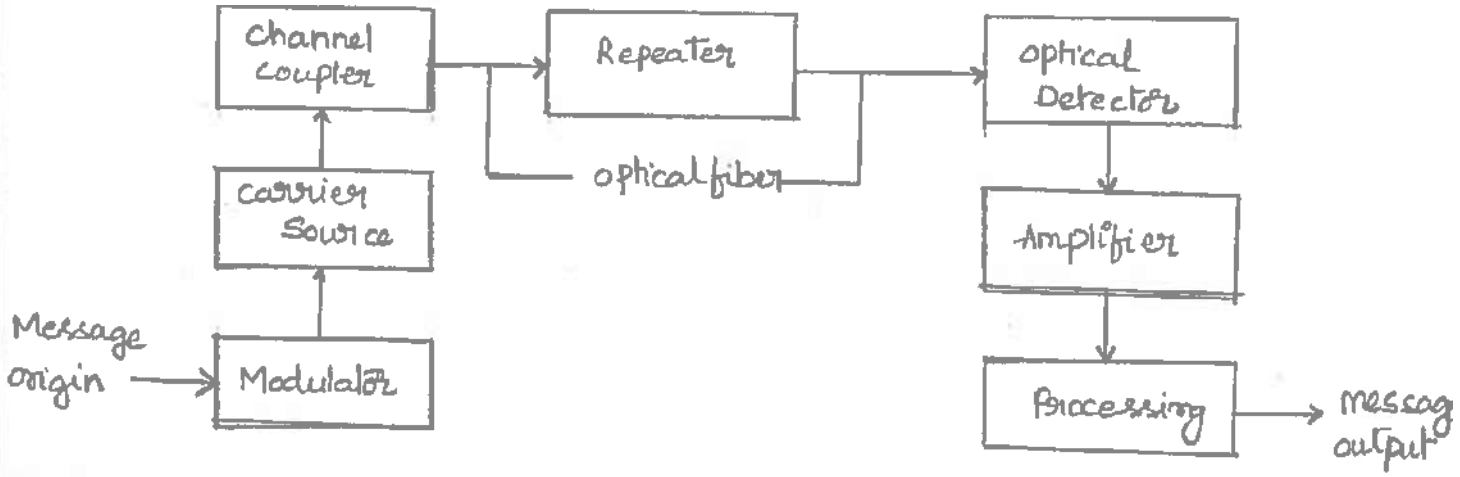
when $\phi_1 = \phi_c$ when $\phi_2 = 90°$.



→ For the angles of incidence greater than the critical angle the light is reflected back into the originating dielectric medium and the process is known as total internal reflection.



4b) Explain the basic elements of basic optical communication system



Message Origin : generally message origin is from a transducer that converts non-electrical to electrical signal.

Modulator : It converts the electrical message into proper format It impresses the signal onto the wave generated by the Carrier source.

Carrier Source : Carrier source generator generates the wave on which the information is transmitted, this is called as carrier sig. for fiber optic system, LED or Laser diode is used

Channel Coupler: coupler feeds the power into information channel. The coupler must efficiently transfer the modulated light beam from source to optic fiber.

Information channel: Channel is a path between Tx & Rx. In OC glass or plastic fiber is used, it includes low attenuation and large light acceptance angle.

Optical detector: In the fiber system the optic wave is converted into an electric current by a photo detector.

Signal processing: It includes filtering, amplication for digital system. BER should be very small for a digital communicaton

message output: The electrical form of the message is transferred into a sound or visual image

15a. Explain the properties light ray and ray theory

Ans The concept of light propagation or transmission of light along an optical fiber, can be described by two theories

a) Ray theory b) mode theory

→ Ray theory (or) geometrical optics method describes light as a simple ray. mode theory describes light as an EM wave

→ According to ray theory two type of rays can propagates along an optical fiber they are

a) meridional rays b) Skew ray

→ meridional rays are used to explain the basic transmission properties of optical fibers.

→ Skew rays are the rays that travel through an optical fiber without passing through its axis

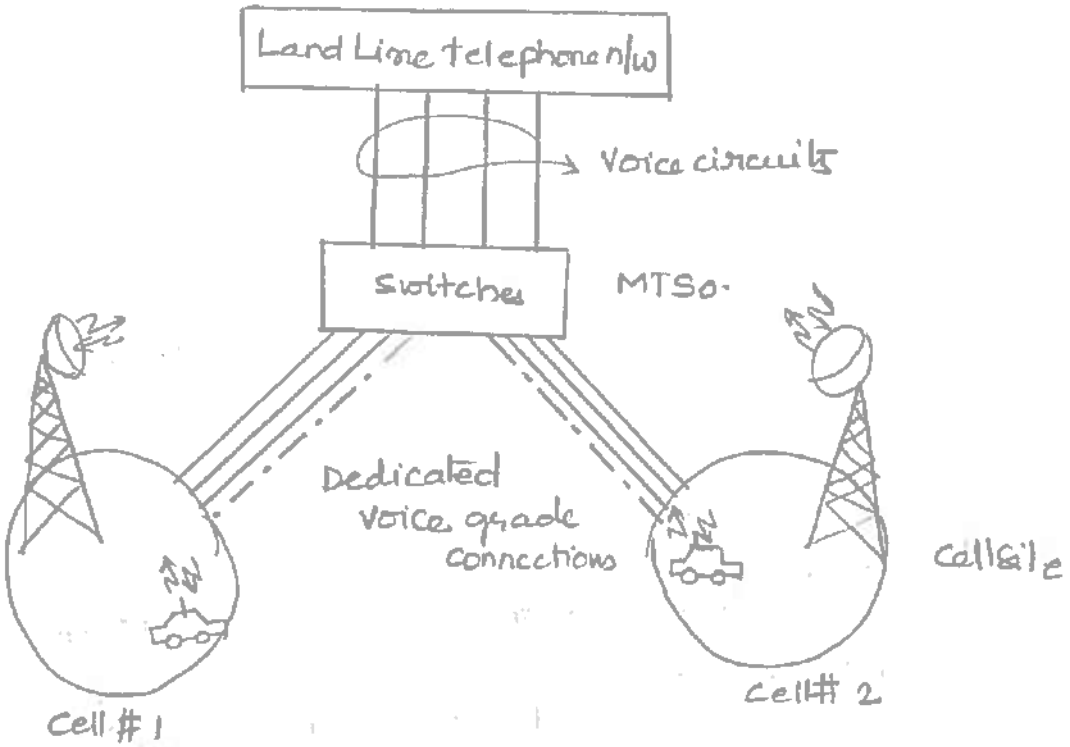
→ Ray theory used to approximate the light acceptance and guiding properties of optical fibers.

Advantages:

a) Absorption
b) Attenuation
c) Dispersion

15b Explain the basic elements of cellular communication system.

Ans



Mobile unit: A mobile telephone unit contains a control unit, a transceiver, and an antenna system.

Cell site: The cell site provides interface between the MTSO and the mobile units. It has control unit, radio cabinets, antennas a power plant, and data terminals

MTSO: This is the central coordinating element for all cell sites, contains cellular processor and cellular switch. Interface with telephone company zone offices, controls call processing, provides operation and maintenance, and handle billing activities

Connections: The radio and high-speed data links connect the subsystems. Each mobile unit can only use one channel at a time for the communication link. But channel is not fixed

Prepared by

(E. Manemma)

Semester End Regular/Supplementary Examination, August, 2022

Degree	B. Tech. (U. G.)	Program	CSE,CSM & CSD			Academic Year	2021 - 2022
Course Code	20EC203	Test Duration	3 Hrs.	Max. Marks	70	Semester	II
Course	Digital logic Design						

Part A (Short Answer Questions 5 x 2 = 10 Marks)

No.	Questions (1 through 5)	Learning Outcome (s)	DoK
1	Convert the following binary number into its equivalent gray code: 11010101	20EC203.1	L1
2	Convert the following gray code into its binary: 10101110	20EC203.2	L1
3	What is the purpose of decoder?	20EC203.3	L2
4	What is meant by race around condition? How can it be avoided?	20EC203.4	L2
5	What is mean by programmable logic devices?	20EC203.5	L1

Part B (Long Answer Questions 5 x 12 = 60 Marks)

No.	Questions (6 through 15)	Marks	Learning Outcome (s)	DoK
6 (a)	With examples, explain the significance of Octal number system and Hexadecimal number system in digital circuit designs.	6M	20EC203.1	L2
6 (b)	Perform each of the following conversions: a) (473)10 in to BCD code b) BAD in to ASCII c) (289)10 in to hexadecimal d) (110011.110)2 in to decimal e) (53)8 in to hexadecimal	6M	20EC203.1	L2
	OR			
7 (a)	Perform arithmetic operation using 2's complement method. a) -70 – 85 b) 130 – 65	6M	20EC203.1	L2
7 (b)	With examples, explain the conversion of a gray code to corresponding binary code sequence and vice-versa	6M	20EC203.1	L2
8 (a)	Find the standard sum of products (SOP) for the logic expression: F (A, B, C, D) = —— AB +AB D+ BCD	6M	20EC203.2	L3
8 (b)	Use K-map to minimize the expression: F (A, B, C, D) =Σ m (0, 1, 2, 3, 4, 9, 10, 12, 13, 14, 15)	6M	20EC203.2	L3
	OR			
9 (a)	Reduce the expression f= πM(0,1,2,3,4,7) using K-maps and implement it using NOR logic	6M	20EC203.2	L3
9 (b)	Reduce the following function f (A,B,C)= Σ m(0,1,3,5,7) and Draw the logi circuit	6M	20EC203.2	L3
10 (a)	Design a Excess-3 Adder Circuit	6M	20EC203.3	L3
10 (b)	Design the logic circuit for a BCD to decimal decoder	6M	20EC203.3	L3
	OR			
11 (a)	Differentiate Multiplexer and De-multiplexer. With simple examples, explain how they are implemented.	6M	20EC203.3	L3
11 (b)	Design a Full Adder Using Two Half Adder	6M	20EC203.3	L3

12 (a)	Implement the following function using PROM P(W,X,Y,Z)= Σ m(0,1,2,3,4,7,8,9,12,15) and Q(W,X,Y,Z)= Σ m(5,6,9,10,11,13) .	6M	20EC203.4	L3
12 (b)	Implement PLA for the following F_1= Σ m(0,1,2,4) and F_2= Σ m(0,5,6,7)	6M	20EC203.4	L3
	OR			
13 (a)	Compare PAL, PLA and FPGA	6M	20EC203.4	L3
13 (b)	Compare static RAM and dynamic RAM	6M	20EC203.4	L3
14	Explain in detail about SR Latch using NOR	12M	20EC203.5	L2
	OR			
15	Explain in detail about JK Flip Flop	12M	20EC203.5	L2

Semester End Reg / Supply Examinations, Aug 2022

Course Code :- 20EC203 AY:- 2021-22

Course :- Digital logic Design Sem :- II

Scheme of Valuation

Part A (Short answer Questions 5×2 = 10 Marks)

1) Convert the following binary number into its equivalent gray code. 11010101 — (2M)

Sol:- Given Binary number is

1 1 0 1 0 1 0 1

↓

1 0 1 1 1 1 1 1 → Gray Code

2) Convert the following gray code into its binary.

10101110 — (2M)

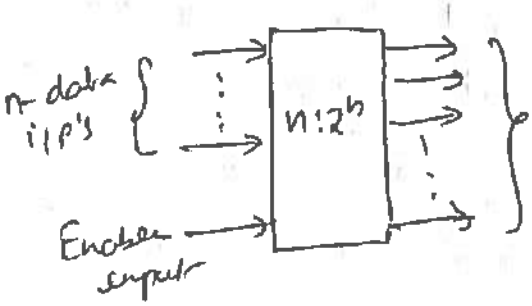
Sol:- Given gray code is 1 0 1 0 1 1 1 0

1 1 0 0 1 0 1 1

∴ The binary code is 11001011

3). What is the purpose of decoder? — (2M)

Sol:- A Decoder is a multiple-input multiple output logic circuit which converts coded inputs into coded outputs. It can implement any Combinational circuit.



4) What is meant by race around condition? How can it be avoided? (2M)

Sol:- In JK Flip Flop consider the J=K=1. If the width of the clock pulse 't_p' is too long the state of the flip flop will keep on changing from 0 to 1, 1 to 0, 0 to 1 and so on and at the end of the clock pulse, its state will be uncertain. This phenomenon is known as race around condition. This condition exists when $t_p \geq \Delta t$. This by keeping $t_p < \Delta t$, we can avoid race around condition.

A more practical method for overcoming the difficulty is the use of Master-Slave JK Flip Flop

5. What is mean by Programmable logic devices? (Dec)

Sol:- Programmable logic Devices is an approach that it can implement any sort of boolean function and can easily configurable.

PLD are classified as (i) PROM
(ii) PLA
(iii) PAL
(iv) CPLD
(v) FPGA

Part B (Long Answer Questions 5x12=60 Marks)

6 a):- With examples, explain the significance of Octal number system and Hexadecimal number system in digital circuit design.

Sol:- Octal Number System:- The Radix or Base value of Octal Number System is 8

$r = 8$

The digits used in the Octal number system is = 0 to r-1

$= 0 \text{ to } 8-1$

$= 0 \text{ to } 7$

∴ The digits used in Octal Number System is

0, 1, 2, 3, 4, 5, 6, 7

Its significance is in the digital circuit as that as it needs less circuitary to get information into and out of a digital system. It is easier to read, record and print out octal numbers than binary numbers.

Hexadecimal number System:- The Radix or Base Value of the Hexadecimal Number System is 16

$r = 16$

The digits used in hexadecimal number System is

$= 0 \text{ to } r-1$

$= 0 \text{ to } 16-1$

$= 0 \text{ to } 15$

∴ The digits used in Hexadecimal number System are 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

Significance :- It is particularly suited for microcomputers.

6 b) Perform each of the following conversions

(a) 473_{10} into BCD Code

(b) BAD into ASCII

(c) 289_{10} into Hexadecimal

(d) 1100111.110_2 into decimal

(e) 53_8 into hexadecimal.

Sol:- (a) $473_{(10)}$ into BCD Code

$4\ 7\ 3_{10}$

↓ ↓ ↓

0100 0111 0011

$\therefore 473_{(10)} = 0100\ 0111\ 0011$

(b) BAD into ASCII

Hexadecimal ASCII

B = VT

A = LF

D = CR

BAD = VTLFCR

(c) 289_{10} into Hexadecimal

16 | 289

16 | 18 — 1

1 — 2

$\therefore 289_{(10)} = 121_{(16)}$

(d) 110011.110_2 into decimal.

$2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0 \quad 2^{-1}\ 2^{-2}\ 2^{-3}$

$1\ 1\ 0\ 0\ 1\ 1 . 1\ 1\ 0 = 1\times2^5 + 1\times2^4 + 0\times2^3 + 0\times2^2$

$+ 1\times2^1 + 1\times2^0 + 1\times2^{-1} + 1\times2^{-2} + 1\times2^{-3}$

$= 32 + 16 + 0 + 0 + 2 + 1 + 0.5 + 0.25$

$+ 0.125$

$= 51.875_{(10)}$

(e) 53_8 into hexadecimal

$53_8 = 101\ 011$ binary

Step 1:- Convert given Octal into binary

The binary is 101 0011

Step 2: Convert the binary to Hexadecimal

0010 1011

2 B

$\therefore 53_{(8)} = 2B_{(16)}$

7a) Perform arithmetic Operation Using 2's Complement method.

(a) −70 − 85 (b) 130 − 65

(BM)

Soln: (a) −70 − 85

70 = 1000110

−70 = 0111001 → 1's Complement

+1

−70 = 0111010 → 2's Complement

85 = 1010101 → Subtrahend

0101010 → 1's Complement of Subtrahend

+1

0101011 → 2's Complement of Subtrahend

−70 = 0111010

−85 = 0101011

1100101 → Since no Carry generated result is negative and in 2's Complement form

0011010 → 1's Complement of Answer

+1

− 0011011 → 2's Complement of Answer

b) 130 − 65 —(3M)

Sol: 130 minuend
65 Subtrahend

Find the 2's Complement of Subtrahend and add it to minuend

65 = 1000001 → Subtrahend

0111110 → 1's Complement of Subtrahend

+1

0111111 → 2's Complement of Subtrahend

130 = 10000010 → minuend

130 = 10000010 → minuend
65 = +01111111 → 2's Compl of Subtrahend

11000001

There is no carry generated, so answer is negative and in 2's Complement form.

11000001 → Not in true form

0011111 0 → 1's Comp

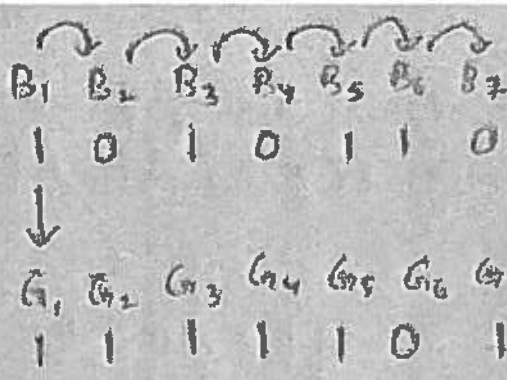
+1

0011111 1 → Final Result.

7 b) With examples, explain the conversion of a gray code to corresponding binary code sequence and vice-versa. —(6M)

Sol:- Conversion of Binary Code to Gray Code —3M

Example:- Given Binary is 1010110



$G_1 = B_1$

$G_2 = B_1 \oplus B_2$

$G_3 = B_2 \oplus B_3$

$G_4 = B_3 \oplus B_4$

$G_5 = B_4 \oplus B_5$

$G_6 = B_5 \oplus B_6$

$G_7 = B_6 \oplus B_7$

$\vdots$

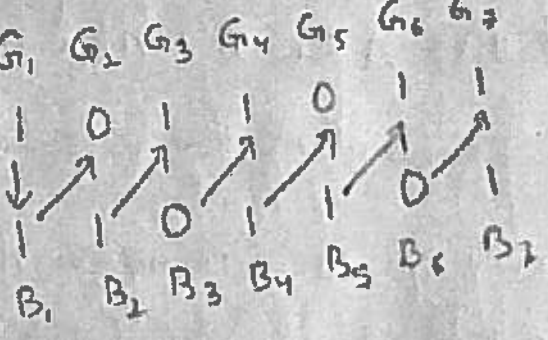
$G_n = B_{n-1} \oplus B_n$

$$\boxed{G_n = B_{n-1} \oplus B_n}$$

∴ The Gray Code is 1111101 for the given binary 1010110

Conversion of Gray Code to Binary. —3M

Example :- Consider Gray Code 1011011



$B_1 = G_1$

$B_2 = B_1 \oplus G_2$

$B_3 = B_2 \oplus G_3$

$B_4 = B_3 \oplus G_4$

$B_5 = B_4 \oplus G_5$

$B_6 = B_5 \oplus G_6$

$B_7 = B_6 \oplus G_7$

$B_n = B_{n-1} \oplus G_n$

∴ For the given gray code 1011011 the binary code is 1101101

$$\boxed{\therefore B_n = B_{n-1} \oplus G_n}$$

8a) Find the Standard Sum of products (SOP) for the logic expression. $F(A,B,C,D) = AB + ABD + BCD$ — 6M

Sol:- Given SOP is

$F(A,B,C,D) = AB + ABD + BCD$

Step 1:-

- $AB \rightarrow C, \bar{C}, D, \bar{D}$ literals are missing
- $ABD \rightarrow C, \bar{C}$ literal is missing
- $BCD \rightarrow A, \bar{A}$ literal is missing

$$F(A,B,C,D) = AB(C+\bar{C})(D+\bar{D}) + ABD(C+\bar{C}) + BCD(A+\bar{A})$$

$$= ABC + AB\bar{C}(D+\bar{D}) + ABCD + AB\bar{C}D + ABCD + \bar{A}BCD$$

$$= ABCD + AB\bar{C}\bar{D} + ABCD + AB\bar{C}D + ABCD + \bar{A}BCD$$

Step 2:- ANDing with missing literal and ORing with missing literal.

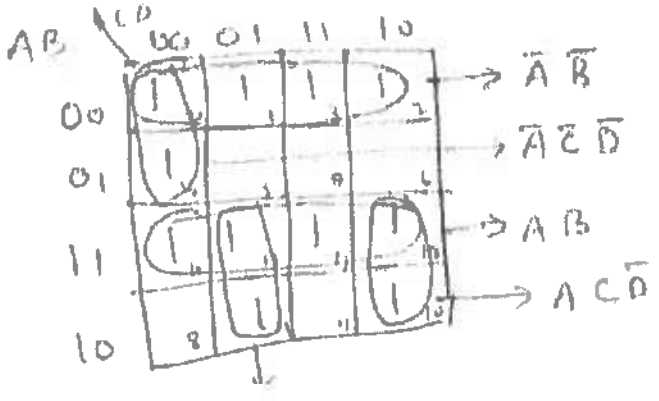
$$\therefore F(A,B,C,D) = ABCD + AB\bar{C}\bar{D} + AB\bar{C}D + \bar{A}BCD$$

Step 3:- Eliminating the repeated terms.

8b) Use K-map to minimize the expression (6M)

$F(A,B,C,D) = \Sigma m(0,1,2,3,4,9,10,12,13,14,15)$

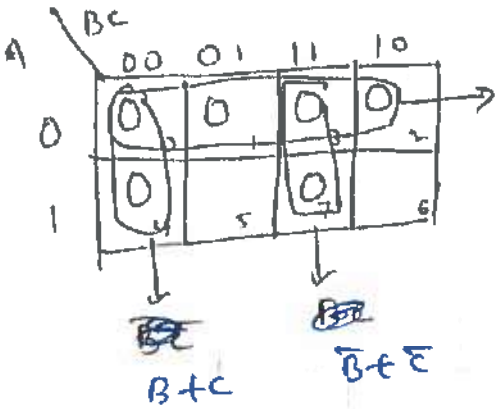
Sol:- Given $F(A,B,C,D) = \Sigma m(0,1,2,3,4,9,10,12,13,14,15)$



$\therefore F(A,B,C,D) = \bar{A}\bar{B} + AB + AC\bar{D} + A\bar{C}D + \bar{A}\bar{C}\bar{D}$

9a) Reduce the expression $f = \Pi M(0,1,2,3,4,7)$ using K-Maps and Implement it using NOR logic. —(6M)

Sol:- Given $f = \Pi M(0,1,2,3,4,7)$



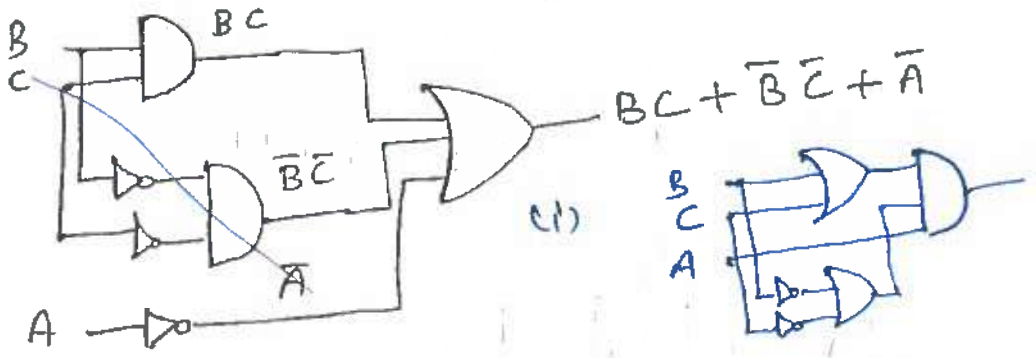
$\therefore f = \Pi M(0,1,2,3,4,7) = BC + \bar{B}\bar{C} + \bar{A}$ $\quad A(B+C)(\bar{B}+\bar{C})$

$f = BC + \bar{B}\bar{C} * \bar{A}$ $\quad A(B \oplus C)$

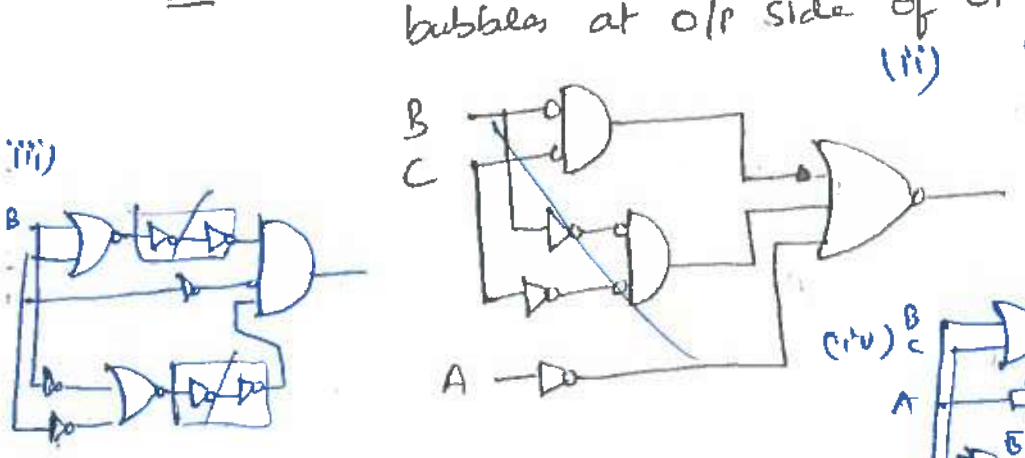
$A(B \oplus C)$

$f = BC + \bar{B}\bar{C} + \bar{A}$ Implementing using NOR logic

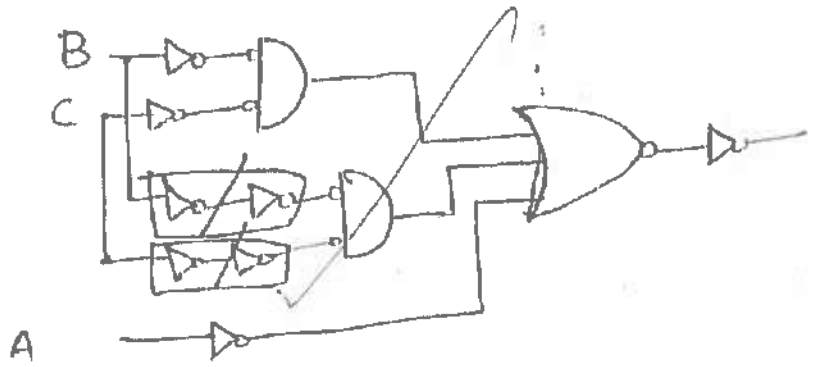
Step 1:-



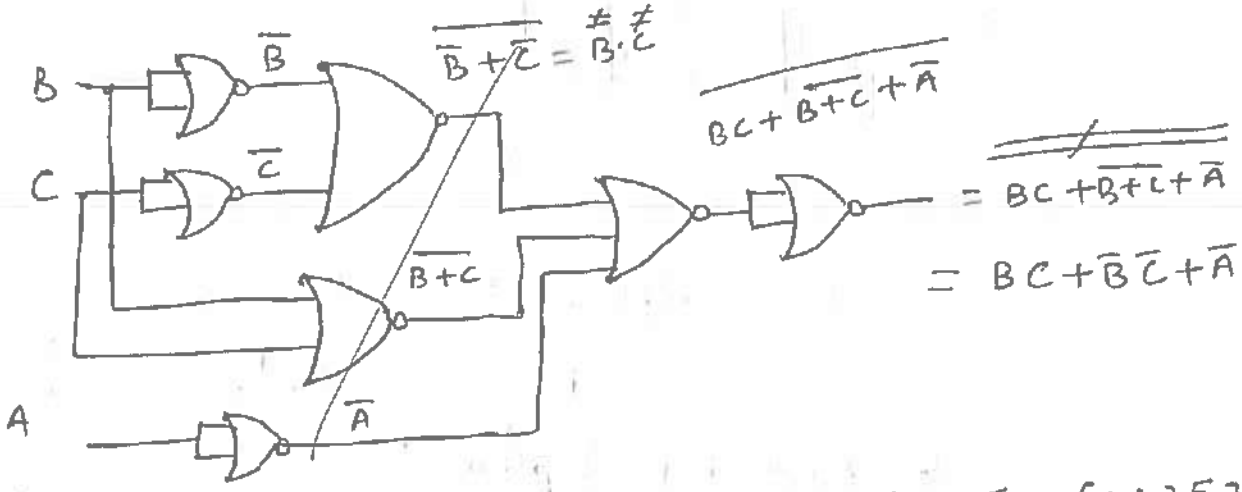
Step 2:- Add Bubbles at i/p side of AND & add bubbles at o/p side of OR



Step3:- Add inverters at Bubbles added & Eliminate inverter after Inverter on same line

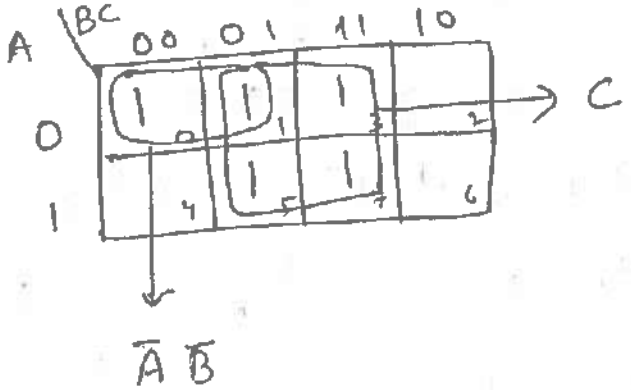


Step4:- Replace all the gates with NOR logic.

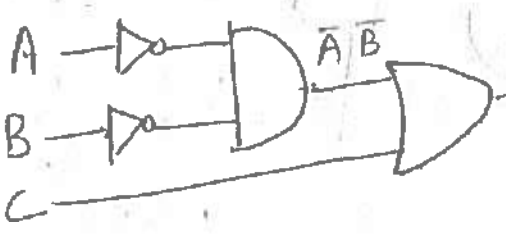


9b) Reduce the following function $f(A,B,C) = \Sigma m(0,1,3,5,7)$ and draw the logic circuit. — (6M)

Sol:- Given $f(A,B,C) = \Sigma m(0,1,3,5,7)$



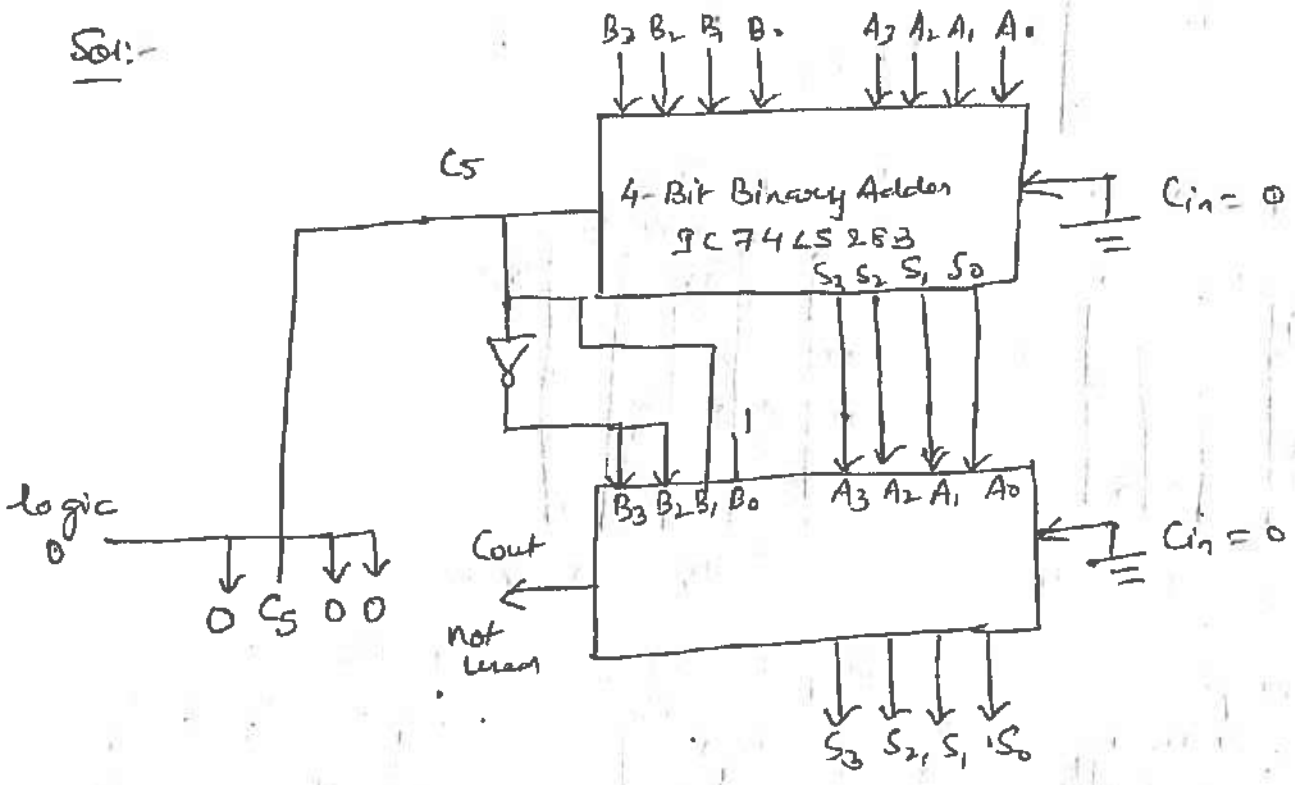
$\therefore f(A,B,C) = \overline{A}\,\overline{B} + C$



Logic circuit.

10 a) Design a Excess-3 Adder ccircuit — (6 M)

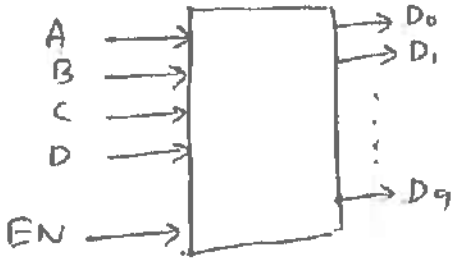
Sol:-



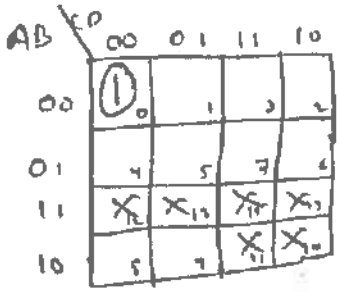
10 b) Design the logic circuit for BCD to decimal decoder. — (6 M)

Sol:-

BCD				D_0	D_1	D_2	D_3	D_4	D_5	D_6	D_7	D_8	D_9
A	B	C	D										
0	0	0	0	1	0	0	0	0	0	0	0	0	0
0	0	0	1	0	1	0	0	0	0	0	0	0	0
0	0	1	0	0	0	1	0	0	0	0	0	0	0
0	0	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	0	0	0	0	1	0	0	0	0	0
0	1	0	1	0	0	0	0	0	1	0	0	0	0
0	1	1	0	0	0	0	0	0	0	1	0	0	0
0	1	1	1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	0	0	0	0	0	0	0	0	1	0
1	0	0	1	0	0	0	0	0	0	0	0	0	1

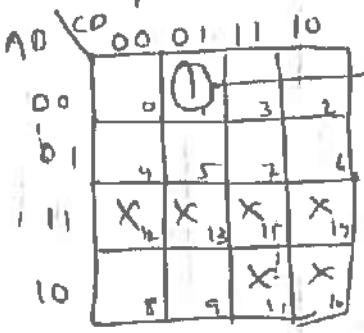


K-Map for D_0



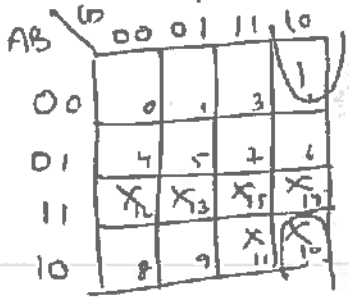
$\therefore D_0 = \bar{A}\bar{B}\bar{C}\bar{D}$

K- Map D_1



$\therefore D_1 = \bar{A}\bar{B}\bar{C}D$

K-Map D_2

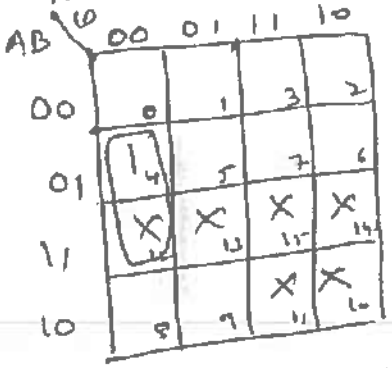


$\therefore D_2 = \bar{B}C\bar{D}$

K- Map D_3

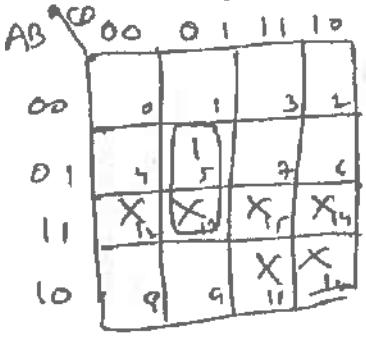
$\therefore D_3 = \bar{B}CD$

K-Map D_4



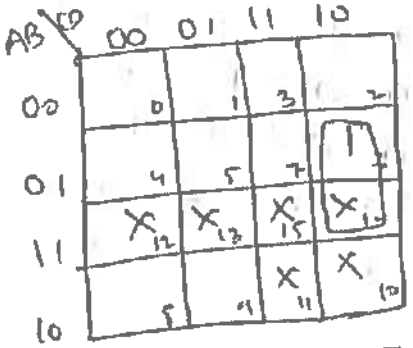
$\therefore D_4 = B\bar{C}\bar{D}$

K-Map D_5



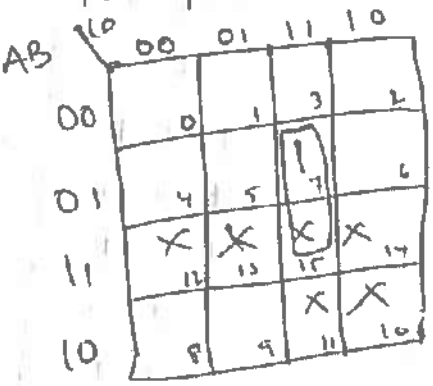
$\therefore D_5 = B\bar{C}D$

K-Map D6



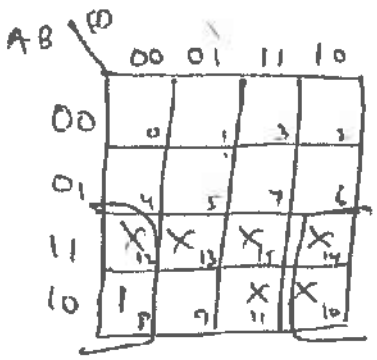
$\therefore D_6 = BC\bar{D}$

K-Map D7



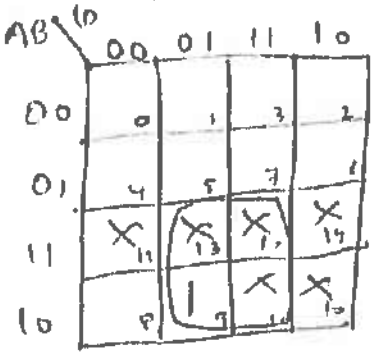
$\therefore D_7 = BCD$

k-Map D_8



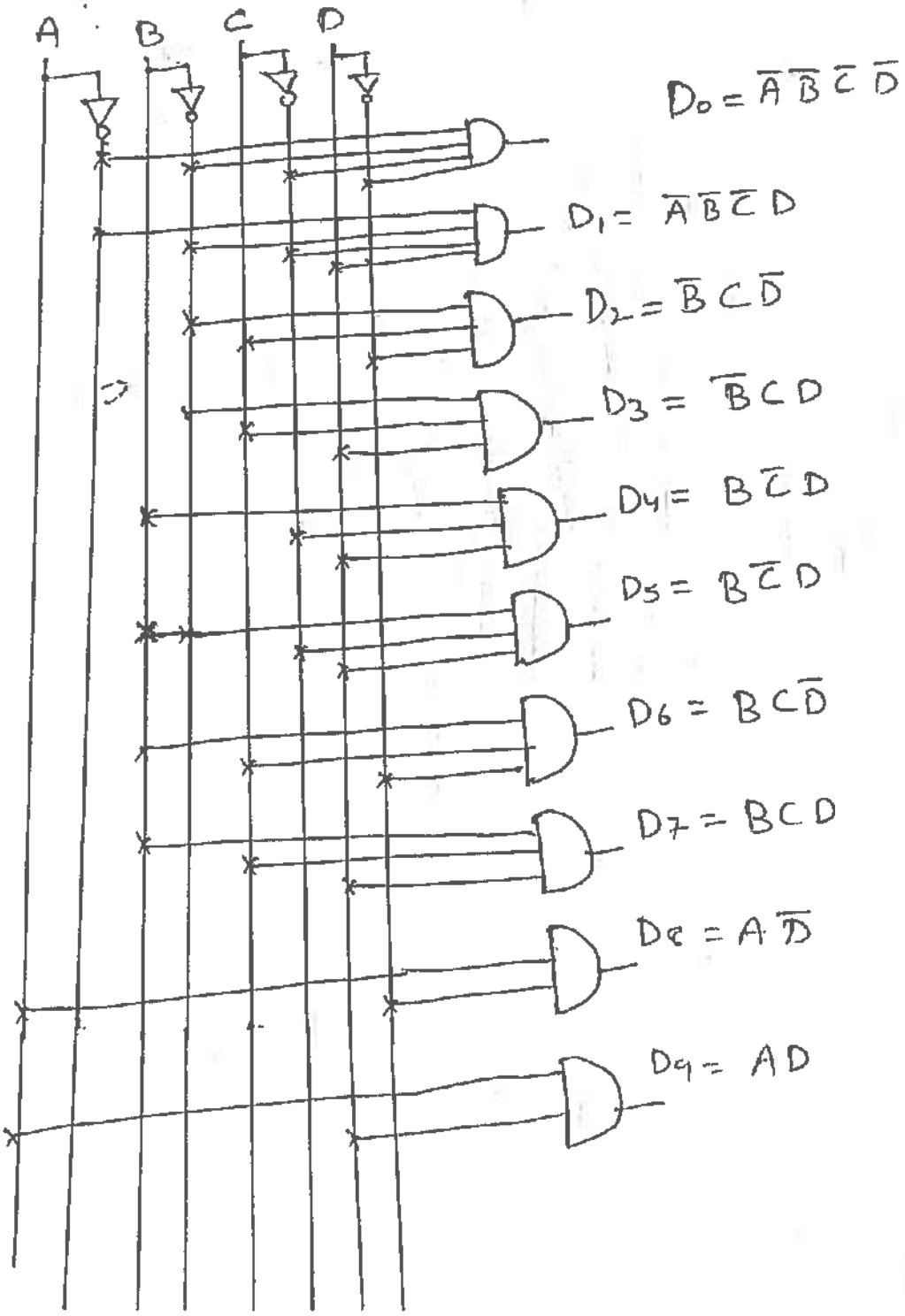
$\therefore D_8 = A\bar{D}$

k-Map D_9



$\therefore D_9 = AD$

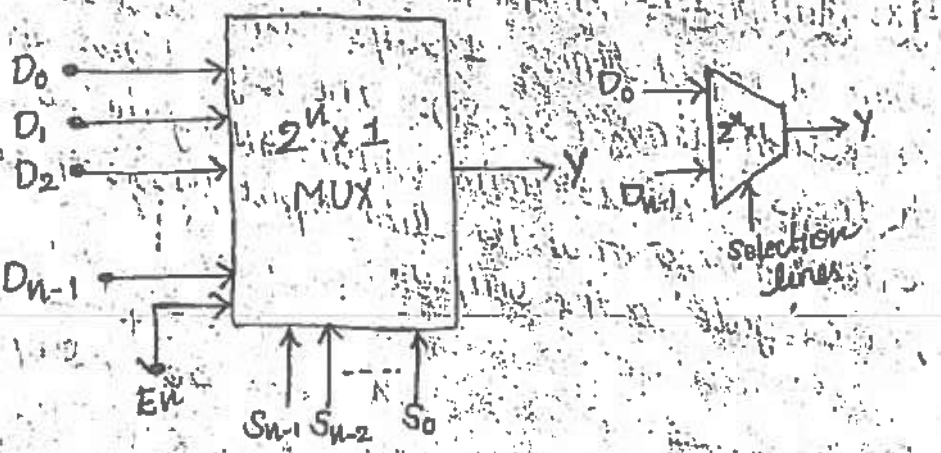
Logic Circuit Diagram for BCD to Decimal Decoder



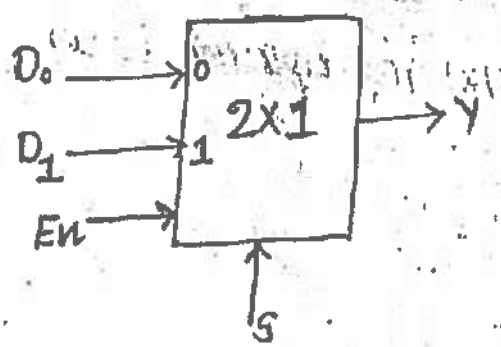
Multiplexer:- A multiplexer is a digital switch. It allows digital information from several sources to be routed onto a single output line. The basic multiplexer has several data-input lines and a single output line. The selection of a particular input line is controlled by a set of selection lines. Normally, there are 2^n input lines, 'n' selection lines whose bit combinations determine which input is selected.

→ Therefore, multiplexer is many to one and it provides digital equivalent of an analog selector switch.

→ A multiplexer is also known as a data selector.



2x1 Multiplexer:- A 2x1 multiplexer is a digital switch with 2 input lines, 1 output line and 1 selection line (S).



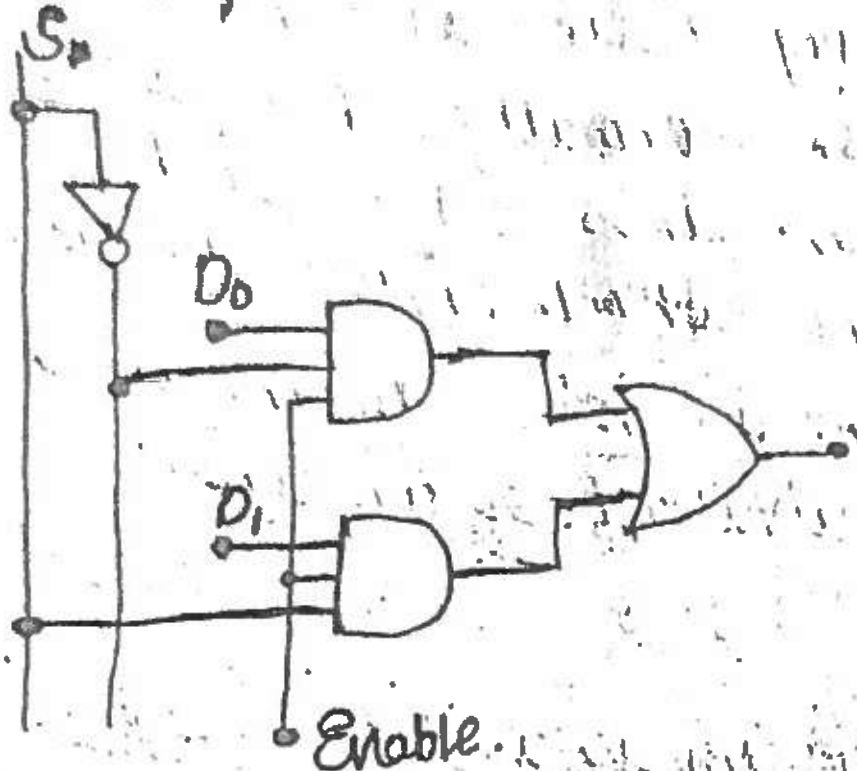
En	Selection lines S_0		output
0	X		0
1	0		D_0
1	1		D_1

Equation of 2x1

Boolean expression of multiplexer is

$$Y = \bar{S}D_0 + SD_1$$

Logic diagram



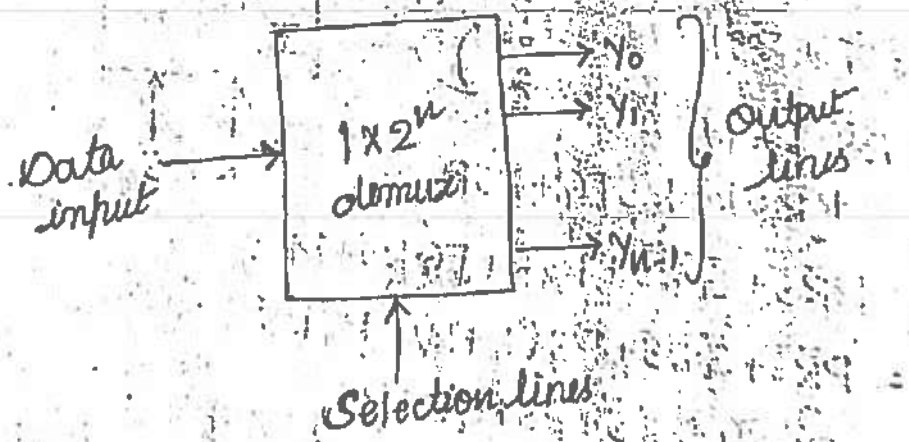
Multiplexer:-Applications

Multiplexer find various applications in digital systems.

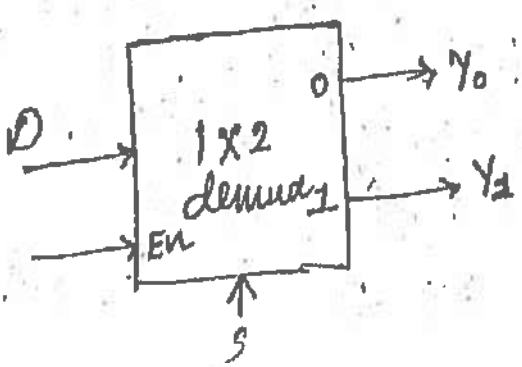
- ↳ Data selection
- ↳ Data routing
- ↳ Operation sequencing
- ↳ Parallel to serial conversion
- ↳ Waveform generation
- ↳ Logic function generator

Demultiplexer (Data distributor):-

A demultiplexer is a circuit that receives data on a single line and distributes it over several output lines. So a demultiplexer is known as data distributor. The selection of specific output line is controlled by the selection lines. Hence a demultiplexer is a 1×2^n device.



1x2 demultiplexer:-



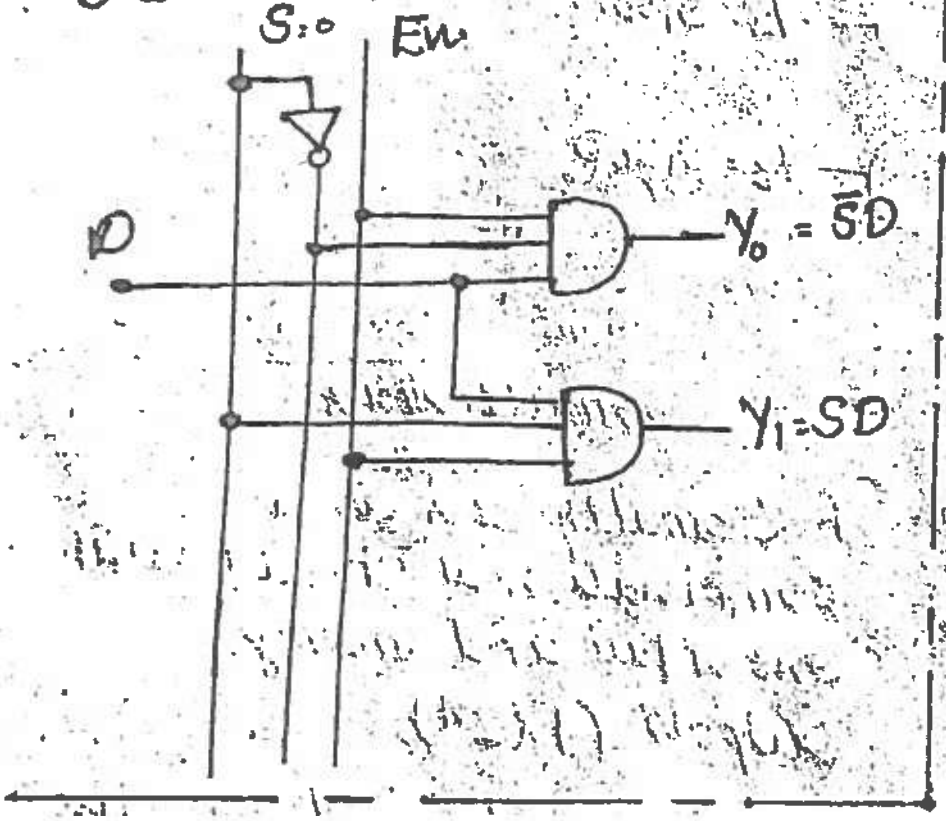
The functional table of 1x2 demux is as follows

En	S	D	Y_0	Y_1
0	x	x	0	0
1	0	0	0	0
1	0	1	1	0
1	1	0	0	0
1	1	1	0	1

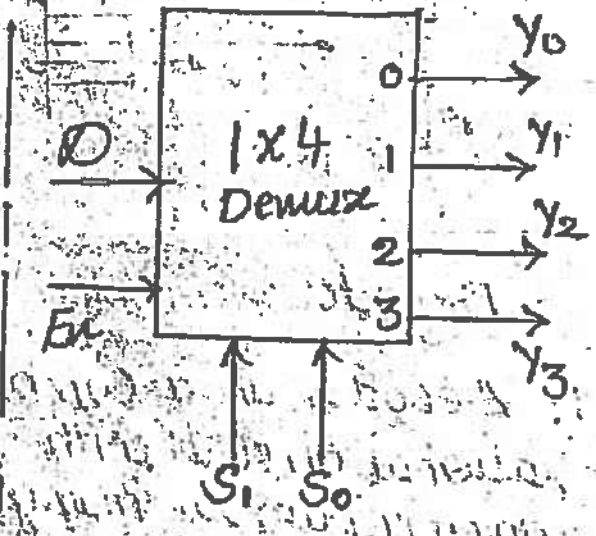
$Y_0 = \bar{S}D$

$Y_1 = SD$

Logic diagram

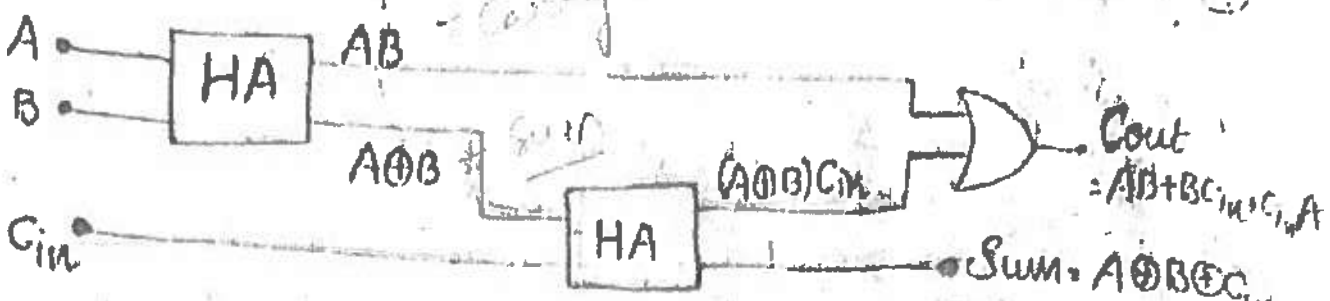


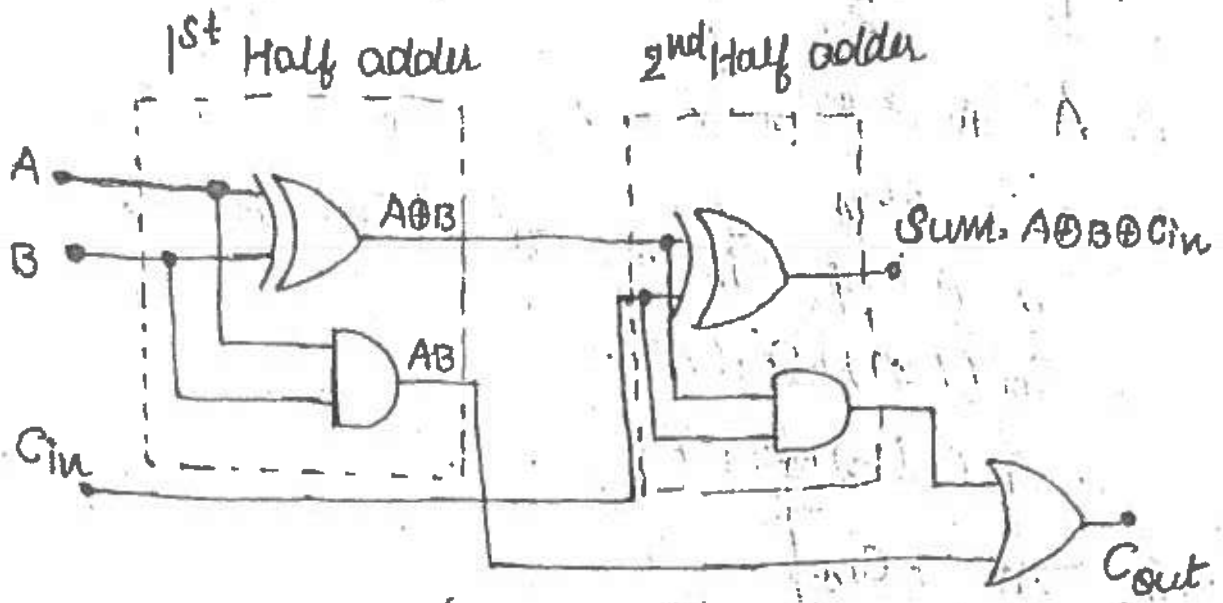
1x4 Demultiplexer



Tollurus

(5)





$C_{out} = AB + (A \oplus B)C_{in}$

$= AB + C_{in}(A\bar{B} + \bar{A}B)$

$= AB + A\bar{B}C_{in} + \bar{A}BC_{in}$

$= AB(C_{in}+1) + A\bar{B}C_{in} + \bar{A}BC_{in}$ $(\because C_{in}+1 = 1)$

$= ABC_{in} + AB + A\bar{B}C_{in} + \bar{A}BC_{in}$

$= AB + AC_{in}(B+\bar{B}) + \bar{A}BC_{in}$

$= AB + AC_{in} + \bar{A}BC_{in}$

$= AB(C_{in}+1) + AC_{in} + \bar{A}BC_{in}$

$= ABC_{in} + AB + AC_{in} + \bar{A}BC_{in}$

$= BC_{in}(A+\bar{A}) + AB + AC_{in}$

$\boxed{C_{out} = AB + BC_{in} + AC_{in}}$

14 a) Implement the following function using PROM

$P(W,X,Y,Z) = \Sigma m(0,1,2,3,4,7,8,9,12,15)$ and

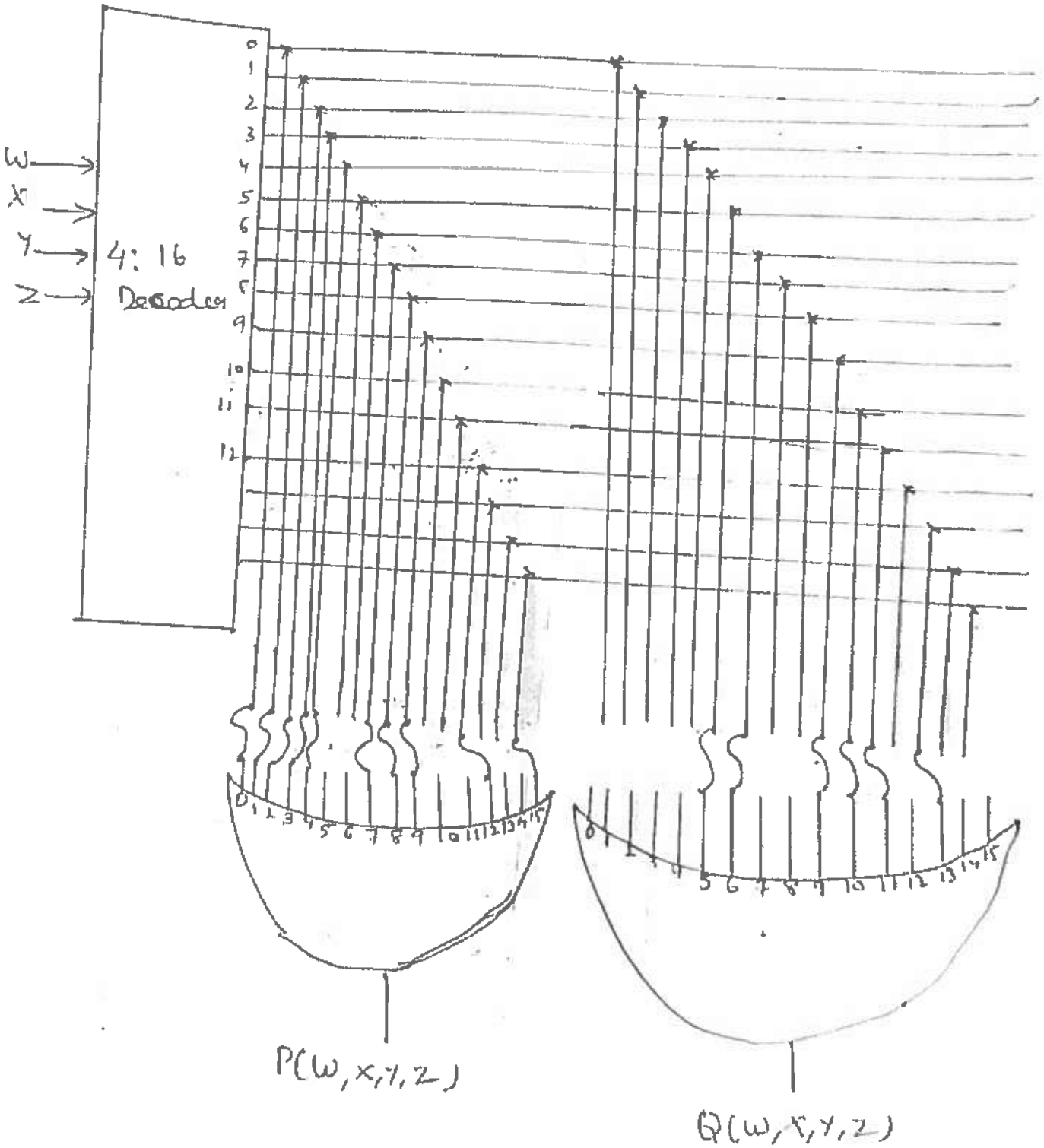
$Q(W,X,Y,Z) = \Sigma m(5,6,7,10,11,13)$

Sol:-

Given function is

$P(W,X,Y,Z) = \Sigma m(0,1,2,3,4,7,8,9,11,15)$ and

$Q(W,X,Y,Z) = \Sigma m(5,6,7,10,11,13)$

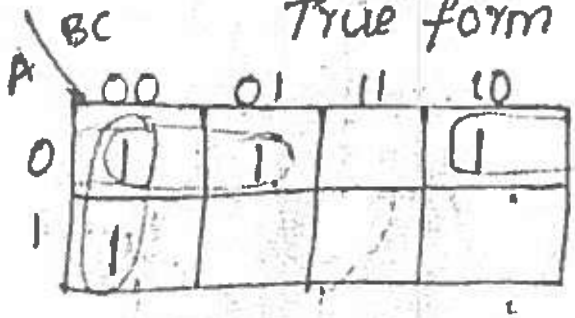


Q. Implement the following two boolean functions with a PLA.

$F_1(A,B,C) = \sum m(0,1,2,4)$ $F_2(A,B,C) = \sum m(0,5,6,7)$

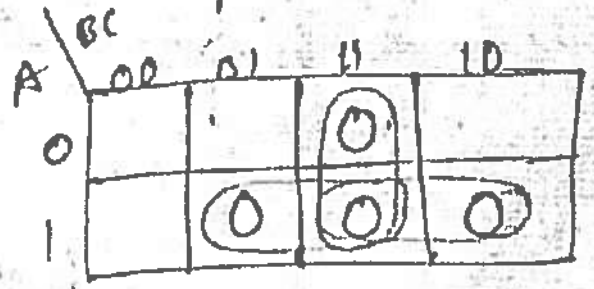
Sol:- K-Map for F_1

True form



$F_1 = \bar{B}\bar{C} + \bar{A}\bar{B} + \bar{A}\bar{C} = F_1(T)$

Complemented form

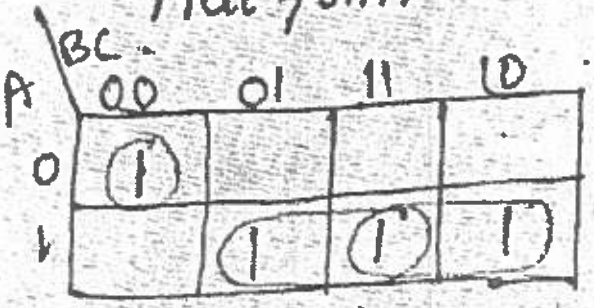


$\bar{F}_1 = AC + BC + AB$.

$F_1(C) = \overline{AC + BC + AB}$

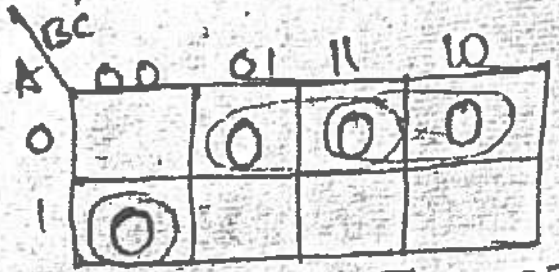
K-Map for F_2

True form.



$F_2(T) = AC + AB + \bar{A}\bar{B}\bar{C}$

Complemented form



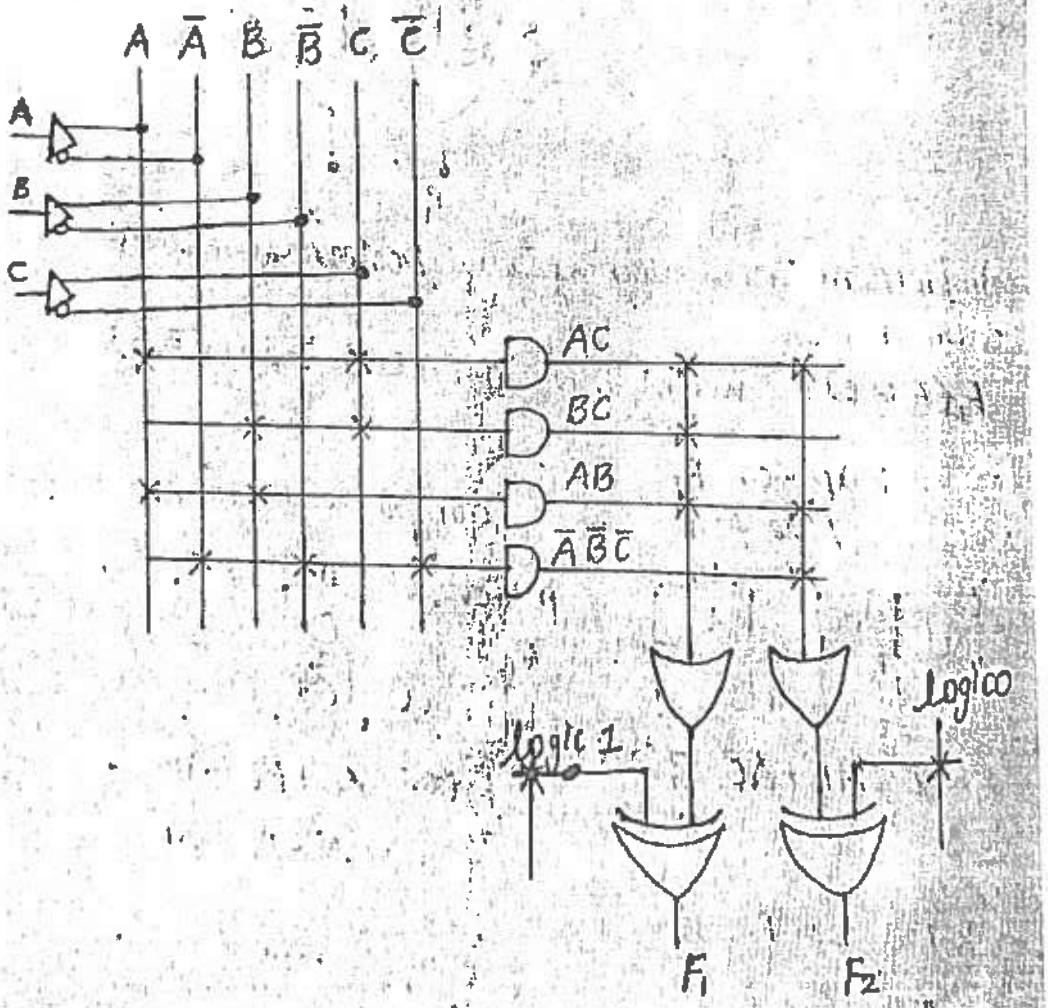
$\bar{F}_2 = \bar{A}C + \bar{A}B + AB\bar{C}$

⇒ $F_2(C)$: $\bar{A}C + A\bar{B} + AB\bar{C}$

Out of $F_1(T)$, $F_1(C)$, $F_2(T)$, $F_2(C)$, the combinations that gives the min number of product terms are:

$F_1(C)$ & $F_2(T)$

Product terms	Inputs A	B	C	Output $F_1(C)$	$F_2(T)$
1. AC	1	-	1	1	1
2. BC	-	1	1	1	-
3. AB	1	1	-	1	1
4. $\bar{A}\bar{B}\bar{C}$	0	0	0	-	1
				C	T



PLA	PAL
1. Both AND & OR array are programmable.	1. OR array is fixed & AND array is programmable
2. Costliest & more complex than PAL & PROM's.	2. Cheaper & simpler.
3. AND array can be programmed to get desired minterms	3. AND array can be programmed to get desired minterms.
4. Any boolean function in SOP form can be implemented using PLA.	4. Any boolean function in SOP form can be implemented using PAL.

* FPGA:- Field Programmable Gate Array

1) Suited for timing circuit because they have more registers
2) Timing reports will be different if same code is synthesized many times.
3) It can be used as high-end product
4) It can operate at very high speed,
5) It has more flexible as well as design capacity.
6) It could not work until the configuration is done.

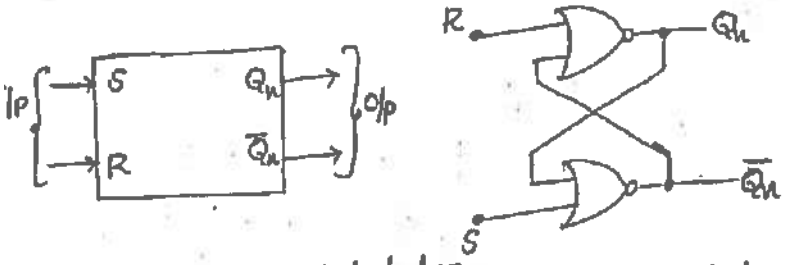
13b) Compare Static RAM and Dynamic RAM (6M)

Static RAM	Dynamic RAM
1) Made up of flip-flops	1) Made up of capacitors
2) Large in size	2) Small in size
3) Data store in the form of Voltage	3) Data store in the form of charge.
4) Much expensive as Compare to dynamic RAM	4) Less expensive as Compare to Static RAM.
5) Low Storage Capacity	5) High Storage Capacity.
6) Consume more power	6) Consume less power
7) Fast	7) Slow
8) Data sustain with time	8) Data loses with time, so need refreshing circuit.

S-R Latch:- It has two outputs labelled Q_n and $\bar{Q}_n$ and two inputs labelled 'S' & 'R'. The state of the latch corresponds to the level of Q_n and $\bar{Q}_n$ is the complement of that state. It can be constructed using either two cross-coupled NAND gates (or) two cross coupled NOR gates.

* using two NOR gates, an active HIGH S-R latch can be constructed and using two NAND gates an active-LOW S-R latch can be constructed.

NOR gate S-R Latch (Active-High SR Latch):-



Q_n represents the state before applying the inputs and Q_{n+1} represents the state after the application of the inputs.

Working: Case 1:- when S=0, R=0

$$Q_{n+1} = \overline{R+\bar{Q}_n} = \overline{0+\bar{Q}_n} = \bar{\bar{Q}}_n = Q_n$$

$$\bar{Q}_{n+1} = \overline{S+Q_n} = \overline{0+Q_n} = \bar{Q}_n$$

Case 2: when R=0, S=1

$$Q_{n+1} = \overline{R+\bar{Q}_n} = \overline{0+\bar{Q}_n} = \bar{\bar{Q}}_n = Q_n$$

$$\bar{Q}_{n+1} = \overline{S+Q_n} = \overline{1+Q_n} = \bar{1} = 0$$

$$\Rightarrow Q_{n+1} = 1$$

Case 3: when R=1 S=0

$$Q_{n+1} = \overline{R+\bar{Q}_n} = \overline{1+\bar{Q}_n} = \bar{1} = 0.$$

$$\bar{Q}_{n+1} = \overline{S+Q_n} = \overline{0+Q_n} = \bar{Q}_n = 1.$$

Case 4: when R=1 S=1

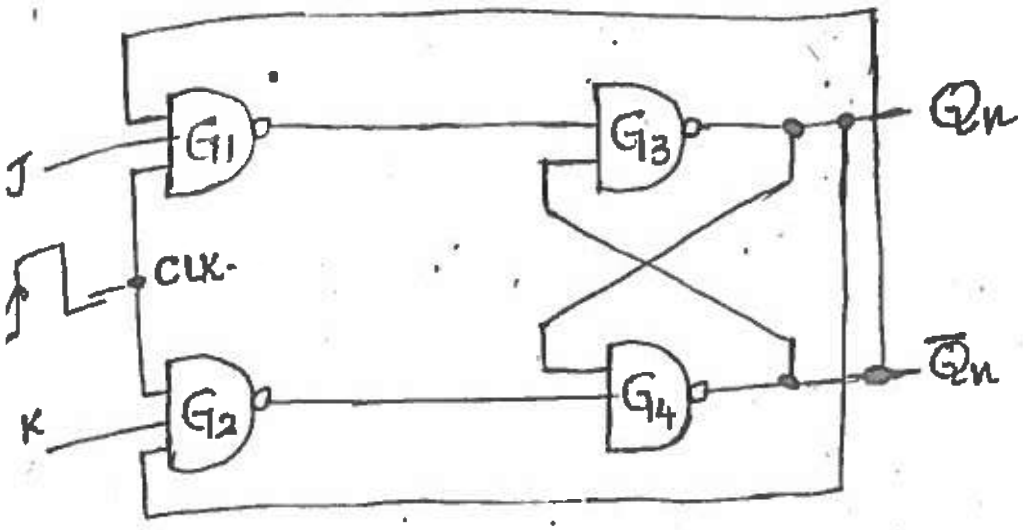
$$Q_{n+1} = \overline{R+\bar{Q}_n} = \overline{1+\bar{Q}_n} = \bar{1} = 0$$

$$\bar{Q}_{n+1} = \overline{S+Q_n} = \overline{1+Q_n} = \bar{1} = 0$$

Truth Table

R	S	Q_n	Q_{n+1}	Status
0	0	0	0	No change
0	0	1	1	
0	1	0	1	Set
0	1	1	1	
1	0	0	0	Reset
1	0	1	0	
1	1	0	x	Invalid
1	1	1	x	

R	S	Q_{n+1}
0	0	Q_n
0	1	1
1	0	0
1	1	Invalid



Working:-

case 1: When J=0, K=0, CLK = 1, then the output of $G_1 = \overline{0 \cdot 1 \cdot \overline{Q_n}} = \overline{0} = 1$

$G_2 = \overline{0 \cdot 1 \cdot Q_n} = \overline{0} = 1$

$G_3 = \overline{1 \cdot \overline{Q_n}} = \overline{\overline{Q_n}} = Q_n = Q_{n+1}$

$G_4 = \overline{1 \cdot Q_n} = \overline{Q_n} = \overline{Q_{n+1}}$

case 2: when J=0, K=1 then the output are

$G_1 = \overline{0 \cdot 1 \cdot \overline{Q_n}} = \overline{0 \cdot \overline{Q_n}} = \overline{0} = 1$

$G_2 = \overline{1 \cdot 1 \cdot Q_n} = \overline{Q_n}$

$G_3 = \overline{1 \cdot \overline{Q_n}} = \overline{\overline{Q_n}} = Q_n = Q_{n+1}$

$G_4 = \overline{\overline{Q_n} \cdot Q_n} = \overline{0} = 1 = \overline{Q_{n+1}}$

$\Rightarrow Q_{n+1} = 0$

case 3: when J=1, K=0, then the output are.

$G_1 = \overline{1 \cdot 1 \cdot \overline{Q_n}} = \overline{\overline{Q_n}} = Q_n$

$G_2 = \overline{0 \cdot 1 \cdot Q_n} = \overline{0} = 1$

$G_3 = Q_{n+1} = \overline{Q_n \cdot \overline{Q_n}} = \overline{0} = 1$

$G_4 = \overline{Q_{n+1}} = \overline{1 \cdot Q_n} = \overline{1} = 0$

Case4: when $J=1$, $K=1$, then the output

$G_1 = \overline{1 \cdot 1 \cdot \overline{Q_n}} = \overline{\overline{Q_n}} = Q_n$

$G_2 = \overline{1 \cdot 1 \cdot Q_n} = \overline{Q_n}$

$G_3 = Q_{n+1} = \overline{Q_n \cdot \overline{Q_n}} = \overline{0} = 1$ (for explanation only)

$G_4 = \overline{Q_{n+1}} = \overline{Q_n \cdot \overline{Q_n}} = \overline{D} = 1$

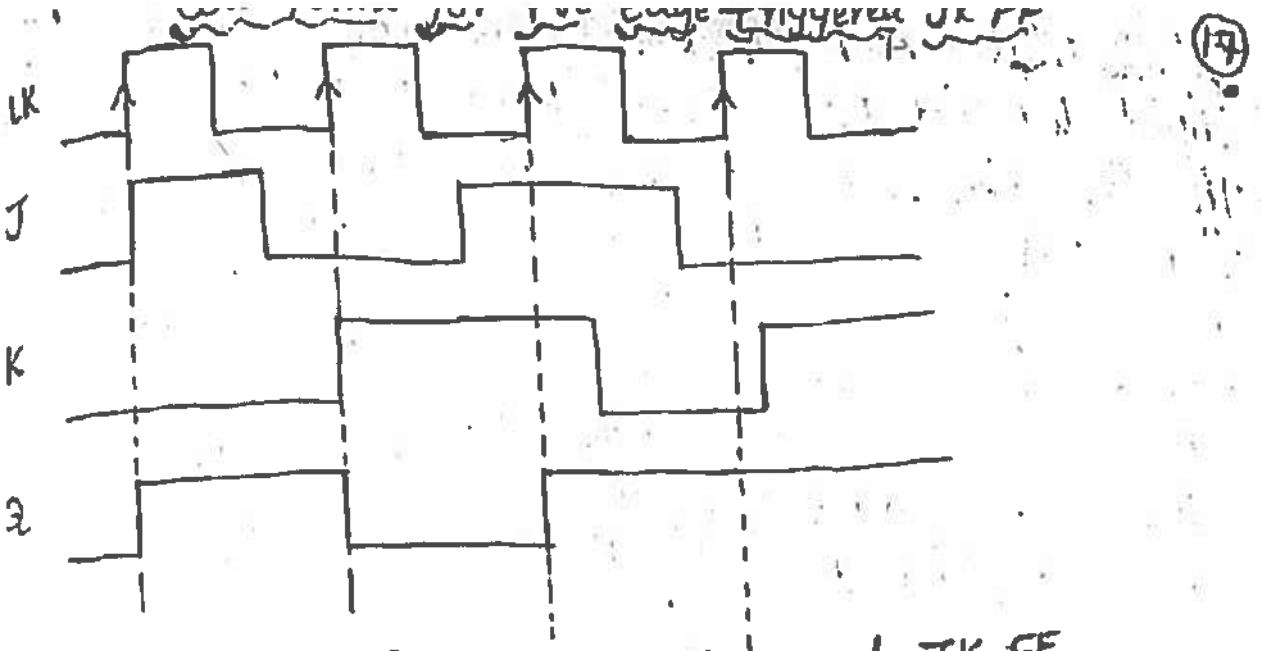
$G_3 = Q_{n+1} = \overline{Q_n \cdot 1} = \overline{Q_n}$

Truth Table:

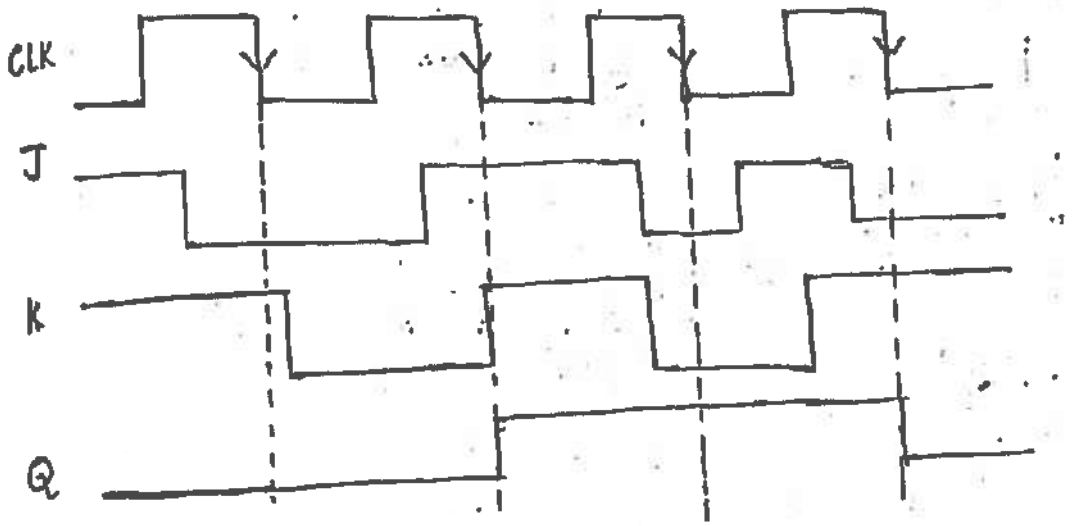
CLK	J	K	Q_n	Q_{n+1}	State
↑	0	0	0	0	No change
↑	0	0	1	1	
↑	0	1	0	0	Reset
↑	0	1	1	0	
↑	1	0	0	1	Set
↑	1	0	1	1	
↑	1	1	0	1	Toggle
↑	1	1	1	0	
0	x	x	0	0	No change
0	x	x	1	1	

CLK	J	K	Q_{n+1}
↑	0	0	Q_n
↑	0	1	0
↑	1	0	1
↑	1	1	$\overline{Q_n}$

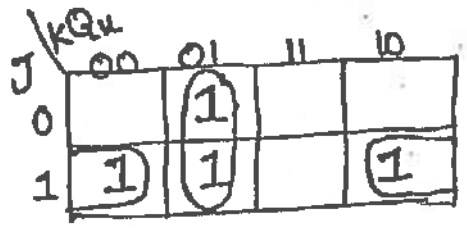
CLK	J	K	Q_{n+1}
↓	0	0	Q_n
↓	0	1	0
↓	1	0	1
↓	1	1	$\overline{Q_n}$



Waveforms for -Ve edge triggered JK FF



Characteristic equation of JK FF



$$Q_{n+1} = J\bar{Q}_n + \bar{K}Q_n$$

Excitation Table:

PS Q_n	NS Q_{n+1}	Req. Inputs J	K
0	0	0	X
0	1	1	X
1	0	X	1
1	1	X	0

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