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ESTD: 2002

2020-21

Internal assessment Question paper with scheme of evaluation

SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
IV-semester: I-Internal assessment Test: March-2020
18MAT41-Complex analysis,Fourier series and statistical methods

Note: 1. Answer any two full questions choosing one from each part 2. All questions carry Equal marks

Time: 90min] [Max marks:40

PART-A

1) a) State and Prove Cauchy Rieman equation in the Cartesian form. **(CO1) (5marks)**
b) Show that $w = z + e^z$ is analytic and hence find $\frac{dw}{dz}$ **(CO1) (5marks)**
c) Find the analytic function f(z) whose imaginary part is $e^x(x\,siny - y\,cosy)$ **(CO1) (5marks)**

OR

2) a) Prove that real and imaginary part of an analytic function are harmonic. **(CO1) (5marks)**
b) If $\phi + i\,\psi$ represents the complex potential of an electrostatic field , where $\psi = x^2 - y^2 + \frac{x}{x^2+y^2}$. Find ϕ and also the complex potential f(z) as function of z. **(CO1) (5marks)**
c) Show that $f(z) = z^n$ (where n is a positive integer) is holomorphic and hence find its derivative **(CO1) (5marks)**

PART-B

3) a) Fit a parabola of second degree $y = ax^2 + bx + c$ by using the method of least squares. **(CO4) (5marks)**

x	1.0	1.5	2.0	2.5	3.0	3.5	4.0
y	1.1	1.3	1.6	2.0	2.7	3.4	4.1

b) Find a geometrical curve $y = ax^b$ by using the method of least squares. **(CO4) (5marks)**

x	1	2	3	4	5
y	0.5	2	4.5	8	12.5

c)Find the correlation of coefficient for the following data **(CO4) (5marks)**

x	92	89	87	86	83	77	70	63	53	50
y	86	83	91	77	68	85	54	82	37	57

OR

4) a) If θ is the angle between two regression lines , Show that $tan\theta = \frac{1-r^2}{r}\left(\frac{\sigma_x\,\sigma_y}{\sigma^2_x+\sigma^2_y}\right)$. Explain the significance when r=0 and r=±1 **(CO4) (5marks)**
b) The two regression lines of variables x and y are $x = 19.13 - 0.87y$ and $y = 11.64 - 0.50x$ find Mean 's of x & y and correlation coefficient of x and y. **(CO4) (5marks)**
c) Find the correlatin coefficient and equation of regression lines for the following data: **(CO4) (5marks)**

x	1	2	3	4	5
y	2	5	3	8	7

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Subject: Advanced Complex Analysis, Fourier Series & Statistics

1st IA Test : March 2020. (9)

Part-A

1. (a) CR Equation in Cartesian form : $u_x = v_y$ & $u_y = -v_x$.

Book Work. — (5M)

(b) $u+iv = (x+iy) + e^{(x+iy)}$

$= (x+iy) + e^x(\cos y + i\sin y)$

$= (x+e^x\cos y) + i(y+e^x\sin y)$ — (1M)

$u_x = 1+e^x\cos y$ | $v_x = e^x\sin y$.

$u_y = -e^x\sin y$ | $v_y = 1+e^x\cos y$. — (2M)

$\frac{dw}{dz} = u_x + iv_x = 1+e^{x+iy} = 1+e^z$. — (1M)

(c) $v = e^x(x\sin y + y\cos y)$.

$v_x = \{\sin y + x\sin y + y\cos y\}e^x$

$v_y = e^x(x\cos y - y\sin y + \cos y)$. } — (2M)

$f'(z) = u_x + iv_x = e^z(z+1)$ $\{x=z, y=0\}$

$\int f'(z) = \int e^z(z+1)dz$ } — (3M)

$\boxed{f(z) = ze^z + c}$

2. (a) $u_{xx} + u_{yy} = 0$ & $v_{xx} + v_{yy} = 0$. } — (5M)

Book Work

(b) $\varphi_x = 2x + \frac{y^2-x^2}{(x^2+y^2)^2}$, $\varphi_y = -2y - \frac{2xy}{(x^2+y^2)^2}$ } — (2M)

$f'(z) = \phi_y + i\varphi_x$

$= i(2z - 1/z^2)$

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On integration, $f(z) = i\left\{z^2 + \frac{1}{z}\right\} + c$.

(b) $f(z) = i(z^2 + \tfrac{1}{2}) + C$ — (1M)

$\phi + i\psi = i\left\{(x+iy)^2 + \frac{1}{(x+iy)}\right\} + C$

$= i(x^2 - y^2) - 2xy + \frac{ix}{x^2+y^2} + \frac{y}{x^2+y^2} + C$

$\phi + i\psi = \left(-2xy + \frac{y}{x^2+y^2}\right) + i\left\{(x^2-y^2) + \frac{x}{x^2+y^2}\right\} + C$ — (3M)

$\Rightarrow \phi = -2xy + \frac{y}{x^2+y^2}$ — (1M)

(c) $f(z) = r^n e^{in\theta}$

$u = r^n \cos n\theta \qquad v = r^n \sin n\theta$

$u_r = n r^{n-1} \cos n\theta \qquad v_r = n r^{n-1} \sin n\theta$

$u_\theta = -r^n \sin n\theta \cdot n \qquad v_\theta = r^n n \cos n\theta$ — (4M)

Thus $u_r = \frac{1}{r} v_\theta$; $u_\theta = -r u_r$ are satisfied. — (1M)

(2) (a) $\Sigma x = 17.5$, $\Sigma y = 16.2$, $\Sigma xy = 4765$, $\Sigma x^2 = 50.75$, $\Sigma x^3 = 161.875$ — (3M)

$\Sigma x^4 = 548.1875$, $\Sigma x^2 y = 154.475$

$a\Sigma x^4 + b\Sigma x^3 + c\Sigma x^2 = \Sigma x^2 y$

$a\Sigma x^3 + b\Sigma x^2 + c\Sigma x = \Sigma xy$

$a\Sigma x^2 + b\Sigma x + nc = \Sigma y$ $\Rightarrow a = 0.244$, $b = -0.198$, $c = 1.04$ — (2M)

$y = (0.244)x^2 - (0.198)x + 1.04$

(b)

(c) $\Sigma x = 750$, $\Sigma y = 720$, $\Sigma x^2 = 2156$, $\Sigma y^2 = 2822$, $\Sigma xy = 1784$

$\bar{x} = \frac{\Sigma x}{n} = 75$, $\bar{y} = \frac{\Sigma y}{n} = 72$

$\Sigma x^2 = 2156$, $\Sigma y^2 = 2822$, $\Sigma xy = 1784$. — 3M (10)

$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}} = 0.72$. — 2M

(4) (a) $m_1 = r\frac{\sigma_y}{\sigma_x}$ $m_2 = \frac{1}{r}\frac{\sigma_y}{\sigma_x}$.

$\tan\theta = \frac{m_2 - m_1}{1 + m_1 m_2} = \frac{(1-r^2)}{r}\frac{\sigma_x \sigma_y}{\sigma_x^2 + \sigma_y^2}$ — 3M

(i) $r = 0$, $\theta = \pi/2$, lines are $\perp^r$ to each other

(ii) $r = \pm 1$, $\theta = 0$ or π, line are perfect Correlation b/w the two variable. — 2M

(b) $\bar{x} + 0.87\bar{y} = 19.13$.

$0.50\bar{x} + \bar{y} = 11.64$

$\Rightarrow \bar{x} = 15.93$, $\bar{y} = 3.67$ — 2M

$b_{xy} = r\frac{\sigma_x}{\sigma_y} = -0.87$

$b_{yx} = r\frac{\sigma_y}{\sigma_x} = -0.50$ — 2M

$r = \sqrt{b_{yx} b_{xy}} = \sqrt{0.435} = 0.6595$ — 1M

(c) $\Sigma x = 15$, $\Sigma y = 25$, $\Sigma x^2 = 55$, $\Sigma y^2 = 151$, $\Sigma xy = 88$ — 2m

$r = \frac{n\Sigma xy - \Sigma x \Sigma y}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma y)^2}} = \frac{65}{80.6225} = 0.8062$ — 1m

$y = a + bx$

$\Sigma y = na + b\Sigma x$.

$\Sigma xy = a\Sigma x + b\Sigma x^2$.

$25 = 5a + 15b$

$88 = 15a + 55b$

$a = 1.1$, $b = 1.3$

$\boxed{y = 1.1 + 1.3x}$.

$x = a + by$

$\Sigma x = na + b\Sigma y$.

$\Sigma xy = a\Sigma y + b\Sigma y^2$

$15 = 5a + 25b$.

$88 = 25a + 151b$.

$a = 0.5$, $b = 0.5$

$\boxed{x = 0.5 + 0.5y}$ — 2M

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SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06

DEPARTMENT OF MATHEMATICS

II-semester: I-Internal assessment Test: March-2020

18MAT21-Advanced Calculus and Numerical Methods

(Common to B & D sections)

Note: 1. Answer any two full questions choosing one from each part 2. All questions carry Equal marks

Time: 90min] [Max marks:30

PART-A

1 a) Find the real root of equation $x^3 - 2x - 5 = 0$ by Regula Falsi method correct to three decimal places. **(CO5) (5marks)**

b) Using Newton –Raphson method find the real root of the equation $xe^x - 2 =$ up to four decimal places. **(CO5) (5marks)**

c) The area A of a circle of diameter D is given for the following values. Find the area corresponding to diameter 105 using an appropriate interpolation. **(CO5) (5marks)**

D	80	85	90	95	100
A	5026	5674	6362	7088	7854

OR

2 a) Compute the real root of $x \log_{10} x - 1.2 = 0$ by Regula falsi method. Carry out three iterations. **(CO5) (5marks)**

b) Use Newton –Raphson method derive an iterative formula for $\sqrt{N}$ and hence find $\sqrt{12}$ **(CO5) (5marks)**

c) From the following table, estimate the number of students who obtained marks between 40 and 45. **(CO5) (5marks)**

Marks	30-40	40-50	50-60	60-70	70-80
Number of students	31	42	51	35	31

PART-B

3) a) Solve : $\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} + 6y = 0$ **(CO2) (5marks)**

b) Solve : $(4D^4 - 4D^3 - 23D^2 + 12D + 36)y = 0$ **(CO2) (5marks)**

c) Solve : $\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 5y = 0$ given that $y = 2$ and $\frac{dy}{dx} = \frac{d^2y}{dx^2}$ when $x = 0$ **(CO2) (5marks)**

OR

4) a) Solve : $(D^3 - 3D + 2)y = 0$ **(CO2) (5marks)**

b) Solve : $y^{11} + 2y^1 + y = cosh(x/2)$ **(CO2) (5marks)**

c) Solve : $6\frac{d^2y}{dx^2} + 17\frac{dy}{dx} + 12y = e^{-x}$ **(CO2) (5marks)**

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Sub: Advanced calculus and Numerical methods (18MAT21)

I Internal Assesment Test

Scheme of Evaluation (2)

Max marks : 30.

PART-A

Time : 90 min

1 a) $x^3 - 2x - 5 = 0$.

$f(x) = x^3 - 2x - 5$

$f(2) = -1 < 0$ $f(3) = 16 > 0$ Root (2, 3). — (1m)

nbd $f(2.1) = 0.061 > 0$ (2, 2.1)

I-Appn: $x_1 = \frac{a f(b) - b f(a)}{f(b) - f(a)} = 2.0942$ } — (3m)

II-Appn:

$x_2 = 2.09455$

Root 2.0945 — (1m)

b) $xe^x - 2 = 0$

Let $f(x) = xe^x - 2 \Rightarrow f'(x) = xe^x + e^x$

$f(0) = -2 < 0$ $f(1) = 0.7183 > 0$ Root (0,1) — (1m)

Let $x_0 = 1$

$x_1 = x_0 - \frac{f(x_0)}{f'(x_0)} = 1 - \frac{f(1)}{f'(1)} = 0.8679$ } — (3m)

$x_2 = x_1 - \frac{f(x_1)}{f'(x_1)} = 0.8528$

$x_3 = 0.8526$. 0.853 — (1m)

c)

D	A	∇A	$\nabla^2 y$	$\nabla^3 y$	$\nabla^4 y$
80	5026				
		648			
85	5674		40		
		688		-2	
90	6362		38		4
		726		+2	
95	7088		40		
		766			
100	7854				

} — (3m)

$y_r = y_n + r \nabla y_n + \frac{r(r+1)}{2!} \nabla^2 y_n + \cdots$ } — (2m)

$r = \frac{x - x_n}{h} = 1$

$y = 8666$

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2 a). $x \log_{10} x - 1.2 = 0$.

Let $f(x) = x \log_{10} x - 1.2$

$f(2) = -0.6 < 0 \quad f(3) = 0.23 > 0 \quad (2,3)$

nbd $f(2.7) = -0.0353$, $f(2.8) = 0.052$ } Root $(2.7, 2.8)$ —— (1m)

I-Appn $x_1 = \dfrac{a f(b) - b f(a)}{f(b) - f(a)} = 2.7404$

II-Appn $x_2 = 2.7406$

III-Appn $x_3 = 2.7406$ } —— (3m)

2.7406 —— (1m)

b). Let $x = \sqrt{N} \Rightarrow x^2 - N = 0$.

$f(x) = x^2 - N \Rightarrow f'(x) = 2x$. —— (1m)

WKT $x_{n+1} = x_n - \dfrac{f(x_n)}{f'(x_n)} = x_n - \dfrac{(x_n^2 - N)}{(2x_n)}$

$x_{n+1} = \frac{1}{2} \dfrac{(x_n^2 + N)}{x_n} = \frac{1}{2}\left[x_n + \dfrac{N}{x_n}\right]$ —— (2m)

$x_1 = \frac{1}{2}\left[x_0 + \dfrac{N}{x_0}\right] = 3.5$ Here $N = 12$

$= 3.46$

$x_2 =$

$x_3 =$ } —— (2m)

c)

x	y	Δy	$\Delta^2 y$	$\Delta^3 y$	$\Delta^4 y$
40	31				
		42			
50	73		9		
		51		−25	37
60	124		−16		
		35		12	
70	159		−4		
		31			
80	190				

} —— (3m)

$y_r = y_0 + r\Delta y_0 + \dfrac{r(r-1)}{2!}\Delta^2 y_0 + \cdots$

$r = \dfrac{x - x_0}{h} = 0.5$

$f(45) = 47.86 \approx 48$

$f(45) - f(40) = 48 - 31 = 17$ } —— (2m)

3 a) $(D^3+6D^2+11D+6)y=0$.

$m^3+6m^2+11m+6=0$. } ——— (4m) (3)

$m=-1,-2,-3$.

$y=C_1e^{-x}+C_2e^{-2x}+C_3e^{-3x}$ ——— (1m)

b) $(4D^4-4D^3-23D^2+12D+36)y=0$.

$4m^4-4m^3-23m^2+12m+36=0$ } ——— (4m)

$m=2,2,-3/2,-3/2$

$y=(C_1+C_2x)e^{2x}+(C_3+C_4x)e^{-3x/2}$ ——— (1m)

c) $(D^2+4D+5)y=0$.

$m=-2\pm i$ ——— (1m)

$y=e^{-2x}(C_1\cos x+C_2\sin x)$

$y'=e^{-2x}(-C_1\sin x+C_2\cos x)-2y$ } ——— (2m)

$y''=e^{-2x}(-C_1\cos x-C_2\sin x)-2e^{-2x}(-C_1\sin x+C_2\cos x)-2y'$

$C_1=2,\ C_2=2$. } ——— (2m)

$y=2e^{-2x}(\cos x+\sin x)$

4 a) $(D^3-3D+2)y=0$

$m^3-3m+2=0$. $m=-2,1,1$ } ——— (4m)

$y=(C_1+C_2x)e^x+C_3e^{-2x}$. ——— (1m)

b) $(D^2+2D+1)y=\cosh(x/2)$

$m^2+2m+1=0$. $m=-1,-1$

$y_c=(C_1+C_2x)e^{-x}$

$y_p=\frac{1}{2}\left[\frac{e^{x/2}+e^{-x/2}}{(D+1)^2}\right]=\frac{1}{2}\left[\frac{4}{9}e^{x/2}+\frac{1}{2}\cdot\frac{e^{-x/2}}{(1/2)}\right]$

$=\frac{2}{9}e^{x/2}+2e^{-x/2}$.

c) $(6D^2+17D+12)y=e^{-x}$

$6m^2+17m+12=0$. $m=-3/2,-4/3$

$y_c=C_1e^{-3/2x}+C_2e^{-4/3x}$

$y_p=\frac{e^{-x}}{6D^2+17D+12}=\frac{e^{-x}}{1}$

$y=y_c+y_p$.

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SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
II-semester: ONLINE-Internal assessment Test: May-2020
18MAT21-Advanced Calculus and Numerical Methods
(Common to B& D sections)

Note: Answer all three questions and all questions carry equal marks

Time: 2hrs] [Max marks:60

1.a) Solve $\frac{\partial^2 z}{\partial x \partial y} = sinx\ siny$ for which $\frac{\partial z}{\partial y}$ = -2 siny when $x = 0\ and\ z$=0 if y is an odd multiple of $\frac{\pi}{2}$ **(CO3)(6marks)**

b) Solve $\frac{\partial^2 z}{\partial x^2} + 3\frac{\partial z}{\partial x} - 4z = 0$ subject to the conditions that z=1 and $\frac{\partial z}{\partial x} = y$ when x=0 **(CO3)(7marks)**

c) Derive one dimensional wave equation. **(CO3)(7marks)**

2. a) Solve: $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = z$ **(CO3)(6marks)**

b) Find the various possible solution of the one dimensional heat equation $u_t = c^2 u_{xx}$ by the method of separation of variables. **(CO3)(7marks)**

c) Find the directional derivative of $\emptyset = x^2yz + 4xz^2$ at (1, -2 ,-1) along 2i-j-2k **(CO1)(7marks)**

3. a) Find div$\vec{F}$ and curl$\vec{F}$ where $\vec{F} = \nabla(x^3 + y^3 + z^3 - 3xyz)$ **(CO1)(6marks)**

b) Show that $\vec{F} = (y + z)i + (z + x)j + (x + y)k$ is irrotational. Also find a scalar function $\emptyset$ such that $\vec{F} = \nabla\emptyset$ **(CO1)(7marks)**

c) If $\vec{F} = (x + y + az)i + (bx + 2y - z)j + (x + cy + 2z)k$. Find a, b, c such that curl$\vec{F} = 0$ and then find $\emptyset$ such that $\vec{F} = \nabla\emptyset$ **(CO1)(7marks)**

15/5/20
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Sub: Advanced Calculus and Numerical methods. (18MAT21) (1)

Online Internal Assesment Test – May 2020 (5)

Scheme of Evaluation.

Max. marks: 60 Time: 2hrs.

1 a) $\frac{\partial^2 z}{\partial x \partial y} = \sin x \sin y$

$\Rightarrow \frac{\partial}{\partial x}\left(\frac{\partial z}{\partial y}\right) = \sin x \sin y$

Int w.r.t. x $\quad \frac{\partial z}{\partial y} = \sin y(-\cos x) + f(y)$ —— (1). 1M

Int w.r.t. y $\quad z = (-\cos x)(-\cos y) + F(y) + g(x)$

$z = \cos x \cos y + F(y) + g(x)$ —— (2). 1M

By data: $\frac{\partial z}{\partial y} = -2\sin y$, $x = 0$

(1) $\Rightarrow$ $-2\sin y = -\sin y + f(y)$ $\quad \boxed{f(y) = -\sin y}$

$F(y) = \int f(y)\,dy = \int -\sin y\,dy = \cos y$.

$z = \cos x \cos y + \cos y + g(x)$ —— (3) 2M

By data $x = 0$ & $y = (2n+1)\pi/2$

(3) $\Rightarrow \boxed{g(x) = 0}$

$\therefore \boxed{z = \cos y(\cos x + 1)}$ 2M

(b) $\frac{\partial^2 z}{\partial x^2} + 3\frac{\partial z}{\partial x} - 4z = 0$

Soln: z is a f^n of x only.

$\frac{d^2 z}{dx^2} + 3\frac{dz}{dx} - 4z = 0$.

$(D^2 + 3D - 4)z = 0$.

A.E. is $m^2 + 3m - 4 = 0$.

$m^2 + 4m - m - 4 = 0$

$(m+4)(m-1) = 0$. $\quad m = +1, -4$ 2M

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$z = c_1 e^{x} + c_2 e^{-4x}$ — (1) — $z = f(y)e^{x} + g(y)e^{-4x}$ (1M)

$\frac{\partial z}{\partial x} = f(y)e^{x} + g(y)(-4)e^{-4x}$ — (2)

By data: $z = 1$ when $x = 0$ & $\frac{\partial z}{\partial x} = y$ when $x = 0$.

(1) & (2) $1 = f(y) + g(y)$ — (3)

$y = f(y) - 4g(y)$ — (4)

Solving (3) & (4). (3) − (4) $\Rightarrow$ $1 + y = 5g(y)$ $\boxed{g(y) = \frac{1+y}{5}}$

$4 \times (3) + (4) \Rightarrow 4 + y = 5f(y)$ $\boxed{f(y) = \frac{4+y}{5}}$ (3M)

$\therefore \boxed{z = \left(\frac{4+y}{5}\right)e^{x} + \left(\frac{4+y}{5}\right)e^{-4x}}$ (1M)

1 (c). Wave eqn

$T_1 \cos\alpha = T_2 \cos\beta = T$ — (1). (2M)

$T_2 \sin\beta - T_1 \sin\alpha = m\delta x \frac{\partial^2 y}{\partial t^2}$ — (2).

(2) ÷ (1). $\tan\beta - \tan\alpha = \frac{m\delta x}{T}\frac{\partial^2 y}{\partial t^2}$

$\frac{\partial^2 y}{\partial t^2} = \frac{T}{m\delta x}\left[\left(\frac{\partial y}{\partial x}\right)_{x+\delta x} - \left(\frac{\partial y}{\partial x}\right)_x\right]$

$\frac{\partial^2 y}{\partial t^2} = \frac{T}{m}\frac{\partial^2 y}{\partial x^2}$ (2M)

$\frac{\partial^2 y}{\partial t^2} = c^2 \frac{\partial^2 y}{\partial x^2}$ $\quad c = T/m$ (2M)

$\boxed{u_{tt} = c^2 u_{xx}}$

2 (a). $x\frac{\partial z}{\partial x} + y\frac{\partial z}{\partial y} = z$ (1M)

$\Rightarrow Pp + Qq = R.$

$P = x, \quad Q = y, \quad R = z$ (1M)

A.E is $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$

$$\frac{dx}{x} = \frac{dy}{y} = \frac{dz}{z}$$ (6) 1M

Consider $\frac{dx}{x} = \frac{dy}{y}$ $\qquad$ $\frac{dy}{y} = \frac{dz}{z}$

Int $\log x - \log y = \log c_1$ $\qquad$ $\log y - \log z = \log c_2$

$\log(x/y) = \log c_1$ $\qquad$ $\log(y/z) = \log c_2$

$x/y = c_1$ $\qquad$ $y/z = c_2$

3M

G.S. is $\phi(x/y, y/z) = 0$.

(b) $u_t = c^2 u_{xx}$

$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$

$\frac{\partial}{\partial t}(XT) = c^2 \frac{\partial^2 (XT)}{\partial x^2}$

$X \frac{dT}{dt} = c^2 T \frac{d^2X}{dx^2}$

$\frac{1}{c^2 T} \frac{dT}{dt} = \frac{1}{X} \frac{d^2X}{dx^2}$ *

$\frac{1}{c^2 T} \frac{dT}{dt} = k$ $\qquad$ $\frac{1}{X} \frac{d^2X}{dx^2} = k$.

$DT - kc^2 T = 0$. $\qquad$ $D^2X - kX = 0$.

$(D - kc^2)T = 0$ $\qquad$ $(D^2 - k)X = 0$. 1M

(i) When $k = 0$.

$DT = 0$ $\qquad$ $D^2X = 0$.

$m = 0$ $\qquad$ $m^2 = 0 \Rightarrow m = 0, 0$

$T = c_1 e^{0t}$ $\qquad$ $X = (c_2 + c_3 x) e^{0.x}$

$u = XT = (c_1)(c_2 + c_3 x)$ 2M

(ii) When $k = +p^2$

$(D - p^2c^2)T = 0$ $\qquad$ $(D^2 - p^2)X = 0$.

$m - p^2c^2 = 0$ $\qquad$ $m^2 - p^2 = 0$.

$m = p^2c^2$ $\qquad$ $m = \pm p$

$T = c_1' e^{p^2c^2 t}$ $\qquad$ $X = c_2' e^{px} + c_3' e^{-px}$

$u = XT = (c_1' e^{p^2c^2 t})(c_2' e^{px} + c_3' e^{-px})$ 2M

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$$\frac{dx}{x} = \frac{dy}{y} = \frac{dz}{z}$$ (6) 1M

Consider $\frac{dx}{x} = \frac{dy}{y}$ $\qquad$ $\frac{dy}{y} = \frac{dz}{z}$

Int $\log x - \log y = \log c_1$ $\qquad$ $\log y - \log z = \log c_2$

$\log(x/y) = \log c_1$ $\qquad$ $\log(y/z) = \log c_2$

$x/y = c_1$ $\qquad$ $y/z = c_2$

3M

G.S. is $\phi(x/y, y/z) = 0$.

(b) $u_t = c^2 u_{xx}$

$\frac{\partial u}{\partial t} = c^2 \frac{\partial^2 u}{\partial x^2}$

$\frac{\partial}{\partial t}(XT) = c^2 \frac{\partial^2 (XT)}{\partial x^2}$

$X \frac{dT}{dt} = c^2 T \frac{d^2X}{dx^2}$

$\frac{1}{c^2 T} \frac{dT}{dt} = \frac{1}{X} \frac{d^2X}{dx^2}$ *

$\frac{1}{c^2 T} \frac{dT}{dt} = k$ $\qquad$ $\frac{1}{X} \frac{d^2X}{dx^2} = k$.

$DT - kc^2 T = 0$. $\qquad$ $D^2X - kX = 0$.

$(D - kc^2)T = 0$ $\qquad$ $(D^2 - k)X = 0$. 1M

(i) When $k = 0$.

$DT = 0$ $\qquad$ $D^2X = 0$.

$m = 0$ $\qquad$ $m^2 = 0 \Rightarrow m = 0, 0$

$T = c_1 e^{0t}$ $\qquad$ $X = (c_2 + c_3 x) e^{0.x}$

$u = XT = (c_1)(c_2 + c_3 x)$ 2M

(ii) When $k = +p^2$

$(D - p^2c^2)T = 0$ $\qquad$ $(D^2 - p^2)X = 0$.

$m - p^2c^2 = 0$ $\qquad$ $m^2 - p^2 = 0$.

$m = p^2c^2$ $\qquad$ $m = \pm p$

$T = c_1' e^{p^2c^2 t}$ $\qquad$ $X = c_2' e^{px} + c_3' e^{-px}$

$u = XT = (c_1' e^{p^2c^2 t})(c_2' e^{px} + c_3' e^{-px})$ 2M

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(ii) When $k = -p^2$

$(D + p^2c^2)T = 0$ $\qquad (D^2 + p^2)X = 0$.

$m + p^2c^2 = 0$. $\qquad m^2 + p^2 = 0$.

$m = -p^2c^2$ $\qquad m^2 = -p^2 \quad m = \pm ip$

$T = C_1'' e^{-p^2c^2t}$ $\qquad X = C_2'' \cos px + C_3'' \sin px$

$u = XT = (C_1'' e^{-p^2c^2t})(C_2'' \cos px + C_3'' \sin px)$ 2M

(c) $\phi = x^2yz + 4xz^2$ at $(1, -2, -1)$

$\nabla\phi = \frac{\partial\phi}{\partial x} i + \frac{\partial\phi}{\partial y} j + \frac{\partial\phi}{\partial z} k$ 4M

$\nabla\phi = 8i - j - 10k$. 2M

$\hat{D} = \frac{\vec{D}}{|\vec{D}|} = \frac{2i - j - 2k}{3}$ 1M

$\nabla\phi \cdot \hat{D} = \frac{37}{3}$.

3(a) $\phi = x^3 + y^3 + z^3 - 3xyz$

$\nabla\phi = \frac{\partial\phi}{\partial x} i + \frac{\partial\phi}{\partial y} j + \frac{\partial\phi}{\partial z} k$ 2M

$= (3x^2 - 3yz) i + (3y^2 + 3xz) j + (3z^2 - 3xy) k$ 2M

$\text{div}\,\vec{F} = \nabla \cdot \vec{F} = 6(x + y + z)$ 2M

$\text{Curl}\,\vec{F} = \nabla \times \vec{F} = 0$.

(b) $\nabla \times \vec{F} = \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ y+z & z+x & x+y \end{vmatrix} = 0$. is irrotational 4M

$\frac{\partial\phi}{\partial x} i + \frac{\partial\phi}{\partial y} j + \frac{\partial\phi}{\partial z} k = (y+z) i + (z+x) j + (x+y) k$ 3M

$\phi = xy + xz + f_1(y, z)$

$\phi = xy + yz + zx$

(c) $\nabla \times \vec{F} = \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x+y+1 & 1 & -x-y \end{vmatrix} = -i - j - k$ 4M

$\vec{F} \cdot \text{curl}\,\vec{F} = 0$. 3M

(ii) When $k = -p^2$

$(D^2 + p^2c^2)T = 0$ $\qquad (D^2 + p^2)X = 0$.

$m^2 + p^2c^2 = 0$. $\qquad m^2 + p^2 = 0$.

$m = -p^2c^2$ $\qquad m^2 = -p^2 \quad m = \pm ip$

$T = C_1'' e^{-p^2c^2t}$ $\qquad X = C_2'' \cos px + C_3'' \sin px$

$u = XT = (C_1'' e^{-p^2c^2t})(C_2'' \cos px + C_3'' \sin px)$ (2M)

(c) $\phi = x^2yz + 4xz^2$ at $(1, -2, -1)$

$\nabla\phi = \frac{\partial\phi}{\partial x} i + \frac{\partial\phi}{\partial y} j + \frac{\partial\phi}{\partial z} k$ (4M)

$\nabla\phi = 8i - j - 10k$. (2M)

$\hat{D} = \frac{\vec{D}}{|\vec{D}|} = \frac{2i - j - 2k}{3}$ (1M)

$\nabla\phi \cdot \hat{D} = \frac{37}{3}$.

3(a) $\phi = x^3 + y^3 + z^3 - 3xyz$

$\nabla\phi = \frac{\partial\phi}{\partial x} i + \frac{\partial\phi}{\partial y} j + \frac{\partial\phi}{\partial z} k$ (2M)

$= (3x^2 - 3yz) i + (3y^2 + 3xz) j + (3z^2 - 3xy) k$ (2M)

$\text{div}\,\vec{F} = \nabla \cdot \vec{F} = 6(x + y + z)$ (2M)

$\text{Curl}\,\vec{F} = \nabla \times \vec{F} = 0$. (4M)

(b) $\nabla \times \vec{F} = \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ y+z & z+x & x+y \end{vmatrix} = 0$. is irrotational

$\frac{\partial\phi}{\partial x} i + \frac{\partial\phi}{\partial y} j + \frac{\partial\phi}{\partial z} k = (y+z) i + (z+x) j + (x+y) k$ (3M)

$\phi = xy + xz + f_1(y, z)$

$\phi = xy + yz + zx$

(c) $\nabla \times \vec{F} = \begin{vmatrix} i & j & k \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ x+y+1 & 1 & -x-y \end{vmatrix} = -i - j - K$ (4M)

$\vec{F} \cdot \text{curl}\,\vec{F} = 0$. (3M)

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SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
III-semester: I-Internal assessment Test: OCTOBER -2020
18MAT31: Transform calculus, fourier series and numerical techniques
(Common to all branches)

Time: 90 min] [Max marks: 40

Note: Answer all the questions

1. a) Obtain the Z-tranform of $\cos hn\theta$ *and* $\sin hn\theta$ **(6 M)(CO3)**

b) Find the Z-tranform of $a^n\, sinn\theta$ *and* $a^{-n}cosn\theta$ **(7 M)(CO3)**

c) Given $z[u_n] = \frac{2z^2+3z+4}{(z-3)^3}, |z| > 3$. Show that $u_1 = 2, u_2 = 21, u_3 = 139$ **(7 M)(CO3)**

2.a) Use Taylor's series method to find y *at* $x = 0.1, 0.2, 0.3$ considering terms upto the third degree given that $\frac{dy}{dx} = x^2 + y^2$ *and* $y(0) = 1$ **(6 M)(CO4)**

b) Using modified euler's method find $y(20.2)$*and* $y(20.4)$*given that* $\frac{dy}{dx} = \log_{10}\left(\frac{x}{y}\right)$ *with* $y(20) = 5$ *taking* $h = 0.2$ **(7 M)(CO4)**

c) Using RK method of fourth order find $y(0.2)$ for the equation $\frac{dy}{dx} = \frac{y-x}{y+x}$, $y(0) = 1$ *taking* $h = 0.2$ **(7 M)(CO4)**

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III Sem: I - Internal Assessment Test

October - 2020.

18MAT31 - Transform Calculus, Fourier Series & Numerical Techniques

1. (a) Book Work. (2)

$$Z[\cosh n\theta] = \frac{Z(Z-\cosh\theta)}{Z^2-2Z\cosh\theta+1} \quad \text{——— (3M)}$$

$$Z[\sinh n\theta] = \frac{Z\sinh\theta}{Z^2-2Z\cosh\theta+1} \quad \text{——— (3M)}$$

(b) (i) $Z[\sin n\theta] = \dfrac{Z\sin\theta}{Z^2-2Z\cos\theta+1}$ ——— (1M)

From Damping rule,

$$Z[k^n \sin n\theta] = \left[\frac{Z\sin\theta}{Z^2-2Z\cos\theta+1}\right]_{Z\to Z/k}$$

$$\therefore Z[a^n \sin n\theta] = \left[\frac{Z\sin\theta}{Z^2-2Z\cos\theta+1}\right]_{Z\to Z/a}.$$

$$\boxed{Z[a^n \sin n\theta] = \frac{Za\sin\theta}{Z^2-2Za\cos\theta+a^2}} \quad \text{——— (3M)}$$

(ii) $Z[\cos n\theta] = \dfrac{Z(Z-\cos\theta)}{Z^2-2Z\cos\theta+1}$

$$Z[k^n \cos n\theta] = \left[\frac{Z^2-Zk\cos\theta}{Z^2-2Zk\cos\theta+k^2}\right]_{Z\to Z/a}$$

$$\therefore \boxed{Z[a^{-n}\cos n\theta] = \frac{Z(Z-a^{-1}\cos\theta)}{Z^2-2Za^{-1}\cos\theta+a^{-2}}} \quad \text{——— (3M)}$$

(c)

$$u_0 = \lim_{Z\to\infty} \bar{u}(z) = 0 \quad \text{——— (1M)}$$

$$u_1 = \lim_{Z\to\infty} Z\{\bar{u}(z)-u_0\} = 2 \quad \text{——— (2M)}$$

$$u_2 = \lim_{Z\to\infty} Z^2\left\{\bar{u}(z)-u_0-\frac{u_1}{Z}\right\} = 21 \quad \text{——— (2M)}$$

$$u_3 = \lim_{Z\to\infty} Z^3\left\{\bar{u}(z)-u_0-\frac{u_1}{Z}-\frac{u_2}{Z^2}\right\} = 139 \quad \text{——— (2M)}$$

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(2) (a) $y(x) = y(x_0) + \frac{(x-x_0)}{1!}y'(x_0) + \frac{(x-x_0)^2}{2!}y''(x_0) + \frac{(x-x_0)^3}{3!}y'''(x_0) + \cdots$ — (1) ... (2)

$y(x) = y(0) + xy'(0) + \frac{x^2}{2!}y''(0) + \frac{x^3}{3!}y'''(0)$ — (1M)

$y'(x) = x^2 + y^2(x) \Rightarrow y'(0) = 1$

$y''(x) = 2x + 2yy' \Rightarrow y''(0) = 2$ — (4M)

$y'''(x) = 2 + 2\{yy'' + (y')^2\} \Rightarrow y'''(0) = 8$

$\therefore \boxed{y(x) = 1 + x + x^2 + \frac{4}{3}x^3}$ — (1M)

(b) Step 1: $f(x,y) = \log_{10}\left(\frac{x}{y}\right)$, $x_0 = 20$, $y_0 = 5$, $h = 0.2$.

$y_1^{(0)} = y_0 + hf(x_0, y_0) = 5.1204$

$y_1^{(1)} = y_0 + \frac{h}{2}\{f(x_0,y_0) + f(x_1, y_1^{(0)})\} = 5.1198$

$y_1^{(2)} = y_0 + \frac{h}{2}\{f(x_0,y_0) + f(x_1, y_1^{(1)})\} = 5.1198$

$\boxed{y_1 = y(20.2) = 5.1198}$ — (4M)

Step 2: $x_0 = 20.2$, $y_0 = 5.1198$, $x_1 = 20.4$, $y(20.4) = ?$

$y_1^{(0)} = 5.2390$, $y_1^{(1)} = 5.2384$, $y_1^{(2)} = 5.2384$.

$\boxed{y_1 = y(20.4) = 5.2384}$ — (3M)

(c) $x_0 = 0$, $y_0 = 1$, $h = 0.2$, $y(0.2) = ?$

$y(x) = y_0 + \frac{1}{6}(K_1 + 2K_2 + 2K_3 + K_4)$ — (1) — (1M)

$K_1 = hf(x_0, y_0) = 0.2$.

$K_2 = hf(x_0 + \frac{h}{2}, y_0 + \frac{K_1}{2}) = 0.1666$

$K_3 = hf(x_0 + \frac{h}{2}, y_0 + \frac{K_2}{2}) = 0.1661$. — (5M)

$K_4 = 0.1414$.

$\therefore \boxed{y(0.2) = 1.1678}$ — (1M)

(3)

SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
III-semester: II-Internal assessment Test: November -2020
18MAT31: Transform calculus, Fourier series and numerical techniques
(Common to all branches)

Time: 90 min] [Max marks: 40

NOTE: ANSWER ALL THE QUESTIONS

1. a) Solve by Using Z-transformation: $y_{n+1}+\frac{1}{4}y_n=\left(\frac{1}{4}\right)^n (n\geq 0), y_0=0$ **(6 Marks – CO 3)**

b) Find the Complex Fourier transformation of the function $f(x)=\begin{cases}1 & for \ |x|\leq a\\ 0 & for \ |x|\geq a\end{cases}$

Hence evaluate $\int_0^\infty \frac{\sin x}{x}dx$ **(7 Marks – CO 3)**

c) If $f(x)=\begin{cases}1-x^2 & for \ |x|<1\\ 0 & for \ |x|\geq 1\end{cases}$, Find the Fourier transform of f(x) and hence find the value of

(i) $\int_0^\infty \frac{x\cos x-\sin x}{x^3}dx$ (ii) $\int_0^\infty \frac{x\cos x-\sin x}{x^3}\cos\left(\frac{x}{2}\right)dx$ **(7 Marks - CO3)**

2. a) Given $\frac{dy}{dx}=x^2(1+y)$ and y(1) = 1, y(1.1) = 1.233, y(1.2) = 1.548, y(1.3) = 1.979. Evaluate y(1.4) by Adams-Bashforth method. **(6 Marks – CO 5)**

b) By Runge-Kutta method, Solve $\frac{d^2y}{dx^2}=x\left(\frac{dy}{dx}\right)^2-y^2$ for x = 0.2 correct to four decimal places, using the initial conditions y = 1 and $y^1=0$ when x = 0. **(7 Marks – CO 5)**

c) Apply Milne's method to compute y(0.8) given that $\frac{d^2y}{dx^2}=1-2y\frac{dy}{dx}$ and the following table of initial values. **(7 Marks – CO 5)**

x	0	0.2	0.4	0.6
y	0	0.02	0.0795	0.1762
y^1	0	0.1996	0.3937	0.5689

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26/11/2020

18MAT31 : TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES (4)

III - Semester : II - Internal Assesment Test : November - 2020

SCHEME of Evaluation (Common to All Branches)

1] (a) $Z_T(y_{n+1}) + \frac{1}{4} Z_T(y_n) = Z_T\left[\left(\frac{1}{4}\right)^n\right]$

$z[\bar{y}(z) - y_0] + \frac{1}{4}\bar{y}(z) = \frac{z}{z-\frac{1}{4}}$

$\frac{\bar{y}(z)}{z} = \frac{1}{(z-\frac{1}{4})(z+\frac{1}{4})} = \frac{A}{z-\frac{1}{4}} + \frac{B}{z+\frac{1}{4}}$ → 2 Marks

put $z = \frac{1}{4}$; $A = 2$.

$z = -\frac{1}{4}$; $B = -2$ → 2 Marks

$Z_T^{-1}[\bar{y}(z)] = 2\left\{Z_T^{-1}\left[\frac{z}{z-\frac{1}{4}}\right] - Z_T^{-1}\left[\frac{z}{z+\frac{1}{4}}\right]\right\}$

$\boxed{y_n = 2\left[\left(\frac{1}{4}\right)^n - \left(-\frac{1}{4}\right)^n\right]}$ → 2 Marks

(b) $F(u) = \int_{x=-\infty}^{\infty} f(x)\, e^{iux}\, dx = \int_{x=-a}^{a} 1 \cdot e^{iux}\, dx$

$\boxed{F(u) = \frac{2\sin au}{u}}$ → 2 Marks

Inverse fourier transform is

$\frac{1}{2\pi}\int_{-\infty}^{\infty} F(u)\, e^{-iux}\, du = f(x)$ → 1 Mark

$f(x) = \frac{1}{2\pi}\int_{-\infty}^{\infty} \frac{2\sin au}{u}\, e^{-iux}\, du$ put $x = 0$ → 2 Marks

$\frac{1}{\pi}\int_{-\infty}^{\infty} \frac{\sin au}{u}\, du = 1$

$\frac{2}{\pi}\int_{0}^{\infty} \frac{\sin au}{u}\, du = 1$

$\boxed{\int_0^{\infty} \frac{\sin x}{x}\, dx = \frac{\pi}{2}}$ → 2 Marks

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(c) $F(u) = \int_{-\infty}^{\infty} f(x)\, e^{iux}\, dx = \int_{-1}^{1} (1-x^2)\, e^{iux}\, dx$ → 1 Mark

$$F(u) = -\frac{2}{u^2}\left(e^{iu} + \bar{e}^{iu}\right) - \frac{2i}{u^3}\left(e^{iu} - \bar{e}^{iu}\right)$$

$$F(u) = -4\frac{\cos u}{u^2} + 4\frac{\sin u}{u^3}$$

$$\boxed{F(u) = 4\left(\frac{\sin u - u\cos u}{u^3}\right)}$$ → 2 Marks

(i) $f(x) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(u)\cdot e^{-iux}\, dx$

$$\int_0^{\infty} \frac{x\cos x - \sin x}{x^3}\, dx = -\frac{\pi}{4}$$ → 2 Marks

(ii) Put $x = 1/2$

$$\int_0^{\infty} \frac{x\cos x - \sin x}{x^3} \cos\frac{x}{2}\, dx = -\frac{3\pi}{16}$$ → 2 Marks

2] (a) $y_0' = 2$, $y_1' = 2.70193$, $y_2' = 3.66912$, $y_3' = 5.03451$

$$y_4^{(P)} = y_3 + \frac{h}{24}\left[55y_3' - 59y_2' + 37y_1' - 9y_0'\right]$$

$$\boxed{y_4^{(P)} = 2.5722}$$ → 3 Marks

$y_4' = f(x_4, y_4) = 7.0015$

$$y_4^{(C)} = y_3 + \frac{h}{24}\left[9y_4' + 19y_3' - 5y_2' + y_1'\right]$$

$$\boxed{y_4^{(C)} = 2.5749}$$ → 2 Marks

→ $y_4' = 7.0068$

$$\boxed{y_4^{(C)} = 2.5751}$$

Thus $\boxed{y(1.4) = 2.5751}$ → 1 Mark

(b) (5)

$$\frac{d^2y}{dx^2} = x\left(\frac{dy}{dx}\right)^2 - y^2$$

$$\frac{dz}{dx} = xz^2 - y^2 \quad \text{with } y=1, z=0 \text{ at } x=0 \longrightarrow 1 \text{ Mark}$$

$K_1 = 0$, $K_2 = -0.02$, $K_3 = -0.01998$,

$K_4 = -0.03916 \longrightarrow 2$ Marks

$l_1 = -0.2$, $l_2 = -0.1998$, $l_3 = -0.1958$,

$l_4 = -0.19055 \longrightarrow 2$ Marks

$$y(x_0+h) = y_0 + \frac{1}{6}[K_1 + 2K_2 + 2K_3 + K_4]$$

Thus $\boxed{y(0.2) = 0.9801}$ $\longrightarrow 2$ Marks

(c)

$z' = 1 - 2yz$

$z_0' = 1$, $z_1' = 0.992$, $z_2' = 0.9374$, $z_3' = 0.7995 \longrightarrow 2$ Marks

$$y_4^{(P)} = y_0 + \frac{4h}{3}(2z_1 - z_2 + 2z_3)$$

$$z_4^{(P)} = z_0 + \frac{4h}{3}(2z_1' - z_2' + 2z_3')$$

$\boxed{y_4^{(P)} = 0.3049}$ & $\boxed{z_4^{(P)} = 0.7055}$ $\longrightarrow 2$ Marks

$$y_4^{(C)} = y_2 + \frac{h}{3}[z_2 + 4z_3 + z_4]$$

$$z_4^{(C)} = z_2 + \frac{h}{3}[z_2' + 4z_3' + z_4']$$

$z_4' = 0.5698$

$\boxed{y_4^{(C)} = 0.3045}$ & $\boxed{z_4^{(C)} = 0.7074}$ $\longrightarrow 2$ Marks

Again $\boxed{y_4^{(C)} = 0.3046}$

Thus $\boxed{y(0.8) = 0.3046}$ $\longrightarrow 1$ Mark

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20-21
II Sem

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II Semester: I-Internal assessment test **Date: 22-06-2021**

Sub: Engineering Chemistry (18CHE12)

Time: 2.00PM to 4.00PM **Section: A&B** **Max Marks: 30**

Note:	*1.*	**Answer the following questions.**

		Module-1	Marks	CO
1	a)	Derive Nernst equation for single electrode potential	(5)	CO 1
	b)	Explain the construction, working and uses of Ni-MH battery	(5)	CO 1
	c)	An electrolytic concentration cell is constructed by coupling two half cell in which two Cadmium electrodes are immersed CdSO4 solution represented as follows. Cd (S) / CdSO4 (0.05M) // CdSO4 (XM) / Cd (S). Write the cell reactions and calculate the value of X. If the potential of the cell at 298K is found to be 0.0591 V.	(5)	CO 1
2	a)	Define Corrosion? Explain the electrochemical theory of corrosion	(5)	CO 2
	b)	Explain the anodizing process of aluminium	(5)	CO 2
	c)	What is metal finishing? Mention the technological importance of metal finishing	(5)	CO 2

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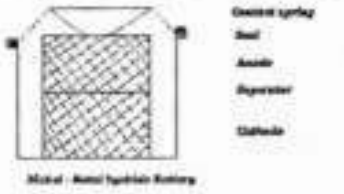
2-21

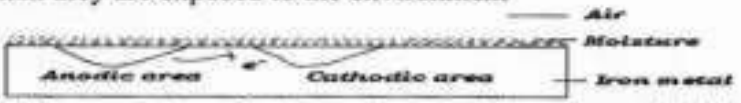
SHRIDEVI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II semester: I-Internal assessment test

Scheme of valuation

Sub: Engineering Chemistry (18CHE12) **Date: 22-06-2021**

Q.no	Scheme	Mark
1. (a)	**Derive Nernst equation for single electrode potential**	**5Mar**
	The maximum work available from a reversible chemical process is equal to the maximum amount of electrical energy that can be obtained; it shows decrease in free energy.	1mark
	$W_{max} = -\Delta G$	
	Therefore $\Delta G = -nFE$	
	$E = \frac{\Delta G}{-nF}$	1mark
	$E^0 = \frac{\Delta G^0}{-nF}$	
	Consider the following reversible electrode reaction, $M^{n+} + ne^- \rightleftharpoons M$	1mark
	For the above reaction the equilibrium constant [Kc] can be written as, $K_c = \frac{[M]}{[M^{n+}]}$	
	Kc and ΔG are related according to the following thermodynamic equation $\Delta G = \Delta G^0 + RT \ln K_c$ ----------→ 1	1mark
	Dividing the equation 1 by $-nF$ and Substituting the value of Kc, $\frac{\Delta G}{-nF} = \frac{\Delta G^0}{-nF} + \frac{RT \ln [M]/[M^{n+}]}{-nF}$ ----------→ 2	
	Substituing the values of $\frac{\Delta G}{-nF}$ and $\frac{\Delta G^0}{-nF}$ in equation 3,	
	Equation 3 => $E = E^0 + \frac{RT \ln [M^{n+}]}{nF}$ When [M] = 1	
	$E = E^0 + \frac{2.303RT}{nF} \log_{10} [M^{n+}]$ ——→ Nernst equation	1mark
(b)	**Explain the construction, working and uses of Ni-MH battery**	**5Mar**
		Fig and Labeling 1mark
		Explanation 3mark
		Reactions 1mark
	At Anode: $xLiC \rightleftharpoons C + xLi^+ + xe^-$	
	At Cathode: $LiCoO_2 + xLi^+ + xe^- \rightleftharpoons Li\,CoO_2$	
	Net cell reaction $xLiC + LiCoO_2 \rightleftharpoons C + Li\,CoO_2$	
	• Nickel Metal hydride battery is made up of anode containing metal hydride such as ZrH_2, VH_2 and TiH_2 with hydrogen storage metal alloy such as $La\,Ni_5$ or TiNi.	
	• Cathode consisting of nickel oxy hydroxide	
	• Anode and cathode are separated by polypropylene seperator.	
	• KOH is used as electrolyte.	
	• The cell is represented as: $MH_2/KOH(5.35M)//Ni(OH)_2,NiO(OH)$	
(c)	**An electrolytic concentration cell is constructed by coupling two half cell in which two Cadmium electrodes are immersed CdSO4 solution. The concentration of CdSO4 in one of the half cell is 100 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K**	**5Mar**
	• Cell representation: Cd (S) / $CdSO_4$ (1M) // $CdSO_4$ (100M) / Cd (S)	1mark
	• Cell Reactions:	

	• At anode : Cd (S) $\longrightarrow$ Cd^{++} (1M) + $2e^-$ • At cathode : Cd^{++}(100M) + $2e^-$ $\longrightarrow$ Cd (S) • Net Cell Reaction: Cd^{++}(100M) $\longrightarrow$ Cd^{++} (1M)	1mark
	$E_{cell} = \frac{0.0591}{n} \log \frac{[M2]}{[M1]}$	1mark
	E cell = $\frac{0.0591}{2}$ log $\frac{[100M]}{[1M]}$	1mark
	E cell = 0.0591 Volts.	1mark
2.(a)	**Define corrosion? Explain the electrochemical theory of corrosion**	
	According to electrochemical theory, corrosion of metals occurs due to the following changes, when they are exposed to the environment	1mark
		1mark
	1) A large number of minute galvanic cells are formed which acts as anodic and cathodic areas.	1mark
	2) At anodic area the metal undergoes oxidation and electrons are liberated which migrates towards Cathodic region. M $\longrightarrow$ M^{n+} + ne^- Metal Metal ions	1mark
	Ex: when iron is exposed to the environment it undergoes oxidation as Fe $\longrightarrow$ Fe^{2+} + $2e^-$	1mark
	3) At Cathodic area different reduction reactions takes place as follows a) In acidic and deaerated medium: Hydrogen ions are reduced to hydrogen gas by reacting with electrons. $2H^+ + 2e^- \longrightarrow H_2$ b) In alkaline and deaerated medium: Moisture of the environment reacts with electrons producing hydroxyl ions and Hydrogen gas at cathode. $2H_2O + 2e^- \longrightarrow 2OH^- + H_2$ c) In neutral and aerated medium: Moisture of the environment reacts with electrons and Oxygen and produces hydroxyl ions at cathode. $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ 4) Formation of corrosion product: The hydroxyl ions formed at Cathodic area reacts with metal ions (M^{n+} ions) formed at Anodic area and forms metal hydroxides which further reacts with moisture and oxygen forming an insoluble Metal oxide corrosion product. In the case of iron OH- reacts with Fe^{2+} ions, O_2 and moisture producing an insoluble hydrated ferric oxide known as brown rust. $2Fe^{++} + 4OH^- \longrightarrow 2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + nH_2O \longrightarrow Fe_2O_3.nH_2O$ (rust)	
(b)	**Explain the anodizing process of aluminium**	5Mark
	➢ Pretreatment: The article be anodized is degreased and followed by electro polished	1mark
	➢ Aluminum is connected to positive terminal and made as anode.	2mark
	➢ Steel or copper is connected to negative terminal and made as cathode	1mark
	➢ The anode and cathode are dipped in electrolyte solution containing 5-10% chromic acid.	1mark
	➢ The temperature of the bath is maintained at 35^0c	
	➢ Voltage is applied between 0-50V.	
	➢ First ten minutes potential is increased to 0-40V.	
	➢ After 20 minutes voltage is applied from 40-50V	
	➢ The voltage is kept constant at 50 V for five minutes.	
	➢ During this period, 2-8 micrometer thick aluminum oxide layer is obtained.	
	➢ Finally the object is treated with Ni or Cobalt acetate fallowed by boiling water treatment to improve corrosion resistance.	
	➢ For higher thickness 10% H_2SO_4 is used as electrolyte.	

	At anode: $2Al(s) + 3H_2O(l) \longrightarrow Al_2O_3(s) + 6H^+ + 6e^-$ At cathode: $6H^+ + 6e^- \longrightarrow 3H_2(g)$ Over all reaction: $2Al(s) + 3H_2O(l) \longrightarrow Al_2O_3(s) + 3H_2$	
(C)	**What is metal finishing? Mention the technological importance of metal finishing**	**5Marks**
	It is a process of modifying surface properties of metals by deposition of a layer of another metal or polymer on its surface, by the formation of an oxide film. **Technological importance of metal finishing.** Imparting the metal surface to higher corrosion resistance. Imparting improved wear resistance. Providing electrical and thermal conducting surface. Imparting thermal resistance and hardness. Providing optical and thermal reflectivity. In the manufacture of electrical and electronic components such as PCB's, capacitors, etc	1mark 2mark 1mark 1mark

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SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II Semester: III-Internal assessment test **Date: 20-09-2021**

Sub: Engineering Chemistry (18CHE12)

Time: 90 minutes **Section: A** **Max Marks: 40**

Note:	1.	Answer any *TWO FULL* questions.

		Module-1	Marks	CO
1	a)	Define the terms a) free energy b) entropy c) Cell potential	(7)	CO 1
	b)	What are Ion Selective Electrodes? Explain the construction of Ion selective electrode	(7)	CO 1
	c)	A cell is constructed by coupling Ni electrode dipped in 0.01 *M* NiSO4 and Pb electrode dipped in 0.5 *M* PbSO4. Write the cell representation, cell reactions. Calculate the EMF of cell, given that reduction potentials of Ni and Pb are – 0.24 and – 0.13 volt respectively	(6)	CO 1
		(OR)		
2	a)	Define Battery and Explain the classification of Batteries	(7)	CO 1
	b)	Explain the construction, working and uses of Lithium ion batteries ($LiCoO_2$)	(7)	CO 1
	c)	An electrolytic concentration cell is constructed by coupling two half cell in which two Cadmium electrodes are immersed CdSO4 solution. The concentration of CdSO4 in one of the half cell is 10 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K	(6)	CO 1

		Module-2	Marks	CO
3	a)	Explain differential metal corrosion. Give an example	(7)	CO 2
	b)	Explain the effect of the following factors on the rate of corrosion i) Nature of corrosion product ii) Temperature iii) PH	(7)	CO 2
	c)	An electrolytic concentration cell is constructed by coupling two half cell in which two Silver electrodes are immersed AgCl solution. The concentration of AgCl in one of the half cell is 10 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K.	(6)	CO 1
		(OR)		
4	a)	What is electro less plating? Distinction between electroplating and electro less plating	(7)	CO 2
	b)	Explain the process of galvanization. Mention the uses of galvanization	(7)	CO 2
	c)	An electrolytic concentration cell is constructed by coupling two half cell in which two Aluminium electrodes are immersed in 0.1M $Al_2(SO_4)_3$ and 10 M $Al_2(SO_4)_3$ solution. Write the cell representation, cell reactions and calculate the voltage of the cell at 25^0C	(6)	CO 1

Name of the Course Instructor	Dr. Chandrasekhar. N
Signature	
Signature of the HoD	
Signature of the Principal	

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20-21

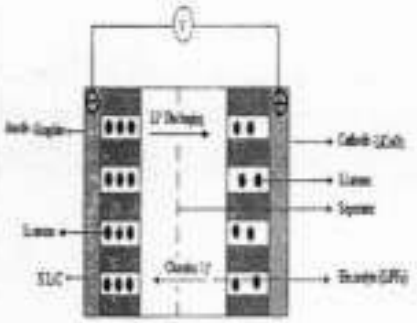
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II semester: III-Internal assessment test **Date: 20-09-2021**

Scheme of valuation

Sub: Engineering Chemistry (18CHE12)

Q.no	Scheme	Marks
1. (a)	**Define the terms a) free energy b) entropy c) Cell potential**	**7Marks**
	a) **Free energy:** It is a thermodynamic function. It is defined as the amount of work that thermodynamic system can perform. Or Free energy is a measure of energy that is available to do work. free energy=Internal energy of a system-Amount of energy used to perform work Gibbs free energy is defines as the enthalpy of a system-product of temperature and entropy. G=H-TS The change in free energy of a system is given by ▲ G= ▲ H-T ▲ S	2mark 2mark
	b) Entropy: It is thermodynamic function represents the unavailability of thermal energy of a system for the conversion into use full work. It is measure of molecular disorder or randomness of a system, because the work obtained by ordered molecular motion. **c) Cell potential:** The potential difference between the two electrodes of a galvanic cell which causes the flow of current from the electrode with higher reduction potential to the the electrode with lower reduction potential is called cell potential. It is represented as E cell. E cell = $E_{Cathode}$ - E_{Anode}	3mark
(b)	**What are Ion Selective Electrodes? Explain the construction of Ion selective electrode**	**7Marks**
	These are the electrodes, which responds to specific ions only and develops a potential against those ions while ignoring the other ions present in the solution. Ex: Glass electrode  **Construction:** Glass electrode is H^+ ions sensitive electrode It is widely used for pH determinations. It is consisting of a long glass tube at the bottom of which a thin and delicate glass bulb. The glass bulb is made up of special type of glass (12 % Na_2O, 6% of CaO, 72% of SiO_2) with low melting point and high electrical conductance The glass bulb is filled with 0.1.M HCl solution. Ag / AgCl is used as a internal reference electrode. A platinum wire is used for electrical contact. The glass electrode can be represented as **Ag/AgCl(s) /0.1M (HCl) / Glass.**	1mark (Def.) 2mark (Fig) 4mark (Explanation)
(c)	**A cell is constructed by coupling Ni electrode dipped in 0.01 *M* NiSO4 and Pb electrode dipped in 0.5 *M* PbSO4. Write the cell representation, cell reactions. Calculate the EMF of cell, given that reduction potentials of Ni and Pb are – 0.24 and – 0.13 volt respectively.**	**6Marks**
	Cell representation: Ni / Ni^{++} (0.01 *M*) // Pb^{++} (0.5M) / Pb. Cell reactions: At anode Ni → Ni^{++} + $2e^-$ At cathode Pb^{++} + $2e^-$ → Pb E^0cell = E^0 cathode – E^0 anode = E0 Pb^{++} /Pb – E^0 Ni^{++}/Ni = – 0.13 – (– 0.24)	1mark 1mark 1mark

	= **0.11 V** $E_{cell} = E^{\circ}_{cell} + \frac{0.0591}{n} \log_{10} \frac{[M^{n+}] \text{ at cathode}}{[M^{n+}] \text{ at anode}}$ $= E^{\circ}cell + \frac{0.0591}{n} \log 10 \frac{[Pb^{++}]}{[Ni^{++}]}$ $= 0.11 + \frac{0.0591}{2} \log 10 \frac{[0.5]}{[0.01]}$ $= 0.11 + 0.02955 \log 50$ $= \mathbf{0.1602\ V.}$	1mark 1mark 1mark
2. (a)	**Define Battery and Explain the classification of Batteries**	**7Marks**
	Battery is a device consisting of two or more electrochemical cells connected either in series or in parallel to get required amount of voltage. **Classification of Batteries** Batteries are classified into three types as follows. a) Primary b) Secondary c) Reserved. **a) Primary Batteries:** These are the batteries which serve as a source of energy only as long as the active chemical species are present in the battery. These batteries cannot be chargeable as the cell reactions are irreversible. These are designed for only single discharge. **Ex:** Dry Cell(Zn-MnO_2), Li-MnO_2 Battery etc., **b) Secondary Batteries:** These batteries are chargeable and can be used again and again as the cell reactions are reversible and are often called reversible batteries. During charging the cell acts like electrolytic cell by converting electric energy into chemical energy, hence these batteries are called as storage batteries. **Ex:** Lead acid battery, Ni-Cd battery, Ni-MH battery, Li-Ion battery etc. **c) Reserved Batteries:** The batteries which can be stored as inactive state and made ready for use by activating them prior to the applications (usage) are called as reserved batteries. The key components of the battery such as electrolyte etc., is separated from the battery and the batteries can be stored for a longer time. The key components of the batteriy is replaced before its usage. The advantages of the reserved batteries are, Batteries can be stored for a longer period. To prevent corrosion at contact points during storage. Self-discharging reactions during storage can be eliminated or avoided. **Ex:** Mg – water activated batteries (Mg- AgCl & Mg CuCl), Zn-O_2 batteries etc., Batteries etc.	1mark 2mark 2mark 2mark
(b)	**Explain the construction, working and uses of Lithium ion batteries ($LiCoO_2$)**	**7Marks**
	 Fig and Labeling Explanation Reactions Uses At Anode: $xLiC \rightleftharpoons C + xLi^{+} + xe^{-}$ At Cathode: $LiCoO_2 + xLi^{+} + xe^{-} \rightleftharpoons Li\,CoO_2$ **Net cell reaction** $xLiC + LiCoO_2 \rightleftharpoons C + Li\,CoO_2$ **Construction:** $LiCoO_2$ battery contains anode made-up of layered graphite and contains Lithium atoms in	1mark 4mark 1mark 1mark

	between the layers (Intercalation). The cathode of the battery is made-up of layered Cobalt oxide and contains Lithium atoms in between the layers. The cathode and anode are separated by Polymeric separator Lithium salts like such as $LiPF_6$ is used as electrolyte During discharge the Lithium atoms undergoes oxidation and moves towards Cathode. At Cathode Co^{4+} ions are reduced to Co^{3+} ions and Lithium ions enters into the Cobalt oxide layer as Lithium atoms	
(c)	**An electrolytic concentration cell is constructed by coupling two half cell in which two Cadmium electrodes are immersed CdSO4 solution. The concentration of CdSO4 in one of the half cell is 10 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K**	**6Marks**
	Cell representation: Cd (S) / $CdSO_4$ (1M) // $CdSO_4$ (100M) / Cd (S) Cell Reactions: At anode : Cd (S) $\longrightarrow$ Cd^{++} (1M) + $2e^-$ At cathode : Cd^{++}(100M) + $2e^-$ $\longrightarrow$ Cd (S) Net Cell Reaction: Cd^{++}(10M) $\longrightarrow$ Cd^{++} (1M) $E_{cell} = \frac{0.0591}{n} \log \frac{[M_2]}{[M_1]}$ E cell = $\frac{0.0591}{2} \log \frac{[10M]}{[1M]}$ E cell = 0.02955 Volts.	1mark 2mark 1mark 1mark 1mark
3.(a)	**Explain differential metal corrosion. Give an example**	**7Marks**
	This type corrosion occurs when two different metals are in contact with each other due to the formation of galvanic cell. The metal having less standard reduction potential value acts as anode and under goes oxidation by liberates electrons, which migrates to the Cathodic region. The other metal having high SRP value acts as cathode and reduction reaction takes places on its surface. The anodic metal undergoes corrosion and Cathodic metal is unaffected. The rate of corrosion depends on the potential difference between the two metals. If the difference is more corrosion occurs faster and vice versa. The reactions that occurs are At Anode Fe $\longrightarrow$ Fe^{2+} + $2e^-$ At Cathodic $2H_2O + 2e^-$ $\longrightarrow$ $2OH^- + H_2$ Corrosion Product $2Fe^{++} + 4OH^-$ $\longrightarrow$ $2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + nH_2O$ $\longrightarrow$ $Fe_2O_3 . nH_2O$ (rust) **Example:** Iron metal in contact with Copper metal Brass tap in contact with Iron pipe etc	4mark 2mark 1mark
(b)	**Explain the effect of the following factors on the rate of corrosion i) Nature of corrosion product ii) Temperature iii) PH**	**7Marks**
	i) Nature of corrosion product: If the nature of corrosion product formed on the metal surface is protective in nature (i.e., thin, invisible, uniform and adherent), it prevents the further corrosion of metal . If the corrosion product on the metal surface is non- protective in nature (i.e., thick, visible, non-uniform and non-adherent), it does not prevent the corrosion of metal is and it leads to further corrosion of metal. **Example:** In oxidizing environment metals like Al, Cr, Ti etc. forms protective metal oxide films on their surfaces which prevent further corrosion of metals. Metals like Zn, Fe, Mg, etc .do not form protective layer on their surfaces and are readily under goes corrosion. **ii) Temperature:** Increases in temperature results in an increase in the conductance of the aqueous medium and rate of corrosion also increases and vice versa. The rate of corrosion is	3mark 2mark

maximum between the temperatures 30^0C to 60^0C.

iv) PH:

In general at lower PH value the rate of corrosion is more and at higher pH value (more than pH = 10) the rate of corrosion ceases due to the formation of protective coating of hydrous oxides layer on the metal. Corrosion rate is maximum between PH 3 and 10 in presence of oxygen. — 2mark

(c) **An electrolytic concentration cell is constructed by coupling two half cell in which two Silver electrodes are immersed AgCl solution. The concentration of AgCl in one of the half cell is 10 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K.** — **6Marks**

Cell representation: Ag (S) / AgCl (1M) // AgCl (10M) / Ag (S) — 1mark

Cell Reactions:

At anode : $Ag(S) \longrightarrow Ag^+(1M) + e^-$ — 2mark

At cathode : $Ag^+(10M) + e^- \longrightarrow Ag(S)$

Net Cell Reaction: $Ag^+(10M) \longrightarrow Ag^+(1M)$

$$E_{cell} = \frac{0.0591}{n} \log \frac{[M2]}{[M1]}$$ — 1mark

$$E_{cell} = \frac{0.0591}{1} \log \frac{[10M]}{[1M]}$$ — 1mark

$= 0.0591$ Volts — 1mark

4. (a) **What is electro less plating? Distinction between electroplating and electro less plating** — **7Marks**

It is process of deposition of a metal from its salt solution on a catalytically active surface of a substrate by using suitable reducing agent and without using electrical energy. — 2mark

Metal ions + Reducing agent → Metal + Oxidized product. — 1mark

Electroplating	Electro less plating
1. Requires electrical power source and accessories.	1.Does not require electrical power source and accessories.
2. Deposition can't be made on non-conductors such as plastics, ceramics etc.	2. Deposition can be made on non-conductors such as plastics, ceramics etc.
3. Requires Levelers	3. Does not require Levelers
4. Plating baths don't have excellent throwing power.	4. Plating baths have excellent throwing power.

4mark

(b) **Explain the process of galvanization. Mention the uses of galvanization** — **7Marks**

It is a process of coating the Iron metal surface with Zinc metal by hot dipping Method — 6mark

It involves the following steps.

The Iron metal surface is washed with organic solvents to remove oil, grease etc content on the metal surface.

Then the metal is passed through dilute sulphuric acid to remove rust and other depositions

Finally the metal is washed with water and dried.

The metal is treated with a mixture of aqueous solution of zinc chloride and ammonium chloride and dried

The metal is then dipped in molten Zinc

The excess Zinc is removed by passing through the rollers or by wiping.

Uses: Galvanization is used for roofing sheets, buckets, bolts, nuts, nails, pipes etc. — 1mark

(c) **An electrolytic concentration cell is constructed by coupling two half cell in which two Aluminium electrodes are immersed in 0.1M $Al_2(SO_4)_3$ and 10 M $Al_2(SO_4)_3$ solution. Write the cell representation, cell reactions and calculate the voltage of the cell at 25^0C** — **6Marks**

	Cell representation: Al (S) / $Al_2(SO_4)_3$ (0.1M) // $Al_2(SO_4)_3$ (10M) / Al (S)	1mark
	Cell Reactions:	
	At anode : Al (S) $\longrightarrow$ Al^{3+} (0.1M) + $3e^-$	
	At cathode : Al^{3+} (10M) + $3e^-$ $\longrightarrow$ Al (S)	2mark
	Net Cell Reaction: Al (10M) $\longrightarrow$ Al^{3+} (0.1M)	
	$E_{cell} = \frac{0.0591}{n} \log \frac{[M2]}{[M1]}$	1mark
	$E_{cell} = \frac{0.0591}{3} \log \frac{[10M]}{[0.1M]}$	1mark
	E_{cell} = 0.0394 Volts.	1mark

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I Sem

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

I Semester: I-Internal assessment test **Date: 18-02-2021**

Sub: Engineering Chemistry (18CHE12)

Time: 90 minutes **Section: C** **Max Marks: 30**

Note:	1.	Answer any *TWO FULL* questions.

		Module-1	Marks	CO
1	a)	Derive Nernst equation for single electrode potential	(5)	CO 1
	b)	What are reference electrodes? Describe the construction, working and advantages of Calomel electrode.	(5)	CO 1
	c)	Calculate the emf of the cell Fe / Fe++ (0.01) // Ag+ (0.1) /Ag at 298K if standard electrode potentials of Fe and Ag electrodes are -0.42 and 0.8 V respectively.	(5)	CO 1
		(OR)		
2	a)	What are electrolytic concentration cells? Explain the construction and working of Electrolytic Concentrations cell with an example	(5)	CO 1
	b)	Explain the construction, working and uses of Ni-MH battery	(5)	CO 1
	c)	An electrolytic concentration cell is constructed by coupling two half cell in which two Cadmium electrodes are immersed $CdSO_4$ solution. The concentration of $CdSO_4$ in one of the half cell is 100 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K	(5)	CO 1

		Module-2	Marks	CO
3	a)	Explain the electrochemical theory of corrosion	(5)	CO 2
	b)	Explain the anodizing process of aluminium	(5)	CO 2
	c)	Explain the differential metal corrosion with example.	(5)	CO 2
		(OR)		
4	a)	What is metal finishing? Mention the technological importance of metal finishing	(5)	CO 2
	b)	Explain the electro plating process of Chromium and mention its applications	(5)	CO 2
	c)	Explain the electro less plating process of Copper and mention its applications	(5)	CO 2

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Name of the Course instructor	Dr. Chandrasekhar. N
Signature	
Signature of the HoD	
Signature of the Principal	

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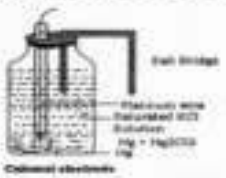
20-21

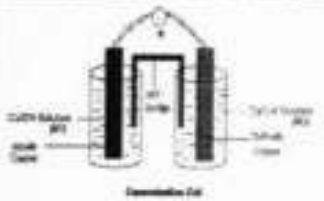
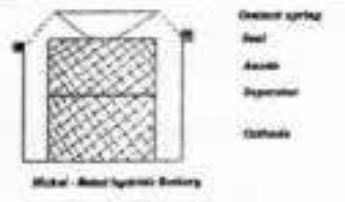
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

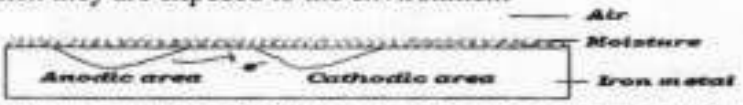
I semester: I-Internal assessment test **Date: 18-02-2021**

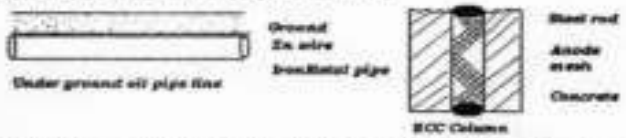
Scheme of valuation

Sub: Engineering Chemistry (18CHE12)

Q.no	Scheme	Marks
1. (a)	**Derive Nernst equation for single electrode potential**	**5Marks**
	The maximum work available from a reversible chemical process is equal to the maximum amount of electrical energy that can be obtained; it shows decrease in free energy.	1mark
	$W_{max} = -\Delta G$	
	Therefore $\Delta G = -nFE$	
	$E = \frac{\Delta G}{-nF}$	1mark
	$E^\circ = \frac{\Delta G^\circ}{-nF}$	
	Consider the following reversible electrode reaction, $M^{n+} + ne^- \rightleftharpoons M$	1mark
	For the above reaction the equilibrium constant (Kc) can be written as, $Kc = \frac{[M]}{[M^{n+}]}$	
	Kc and ΔG are related according to the following thermodynamic equation $\Delta G = \Delta G^\circ + RT \ln Kc$ ----------→ 1	1mark
	Dividing the equation 1 by $-nF$ and Substituting the value of Kc, $\frac{\Delta G}{-nF} = \frac{\Delta G^\circ}{-nF} + \frac{RT \ln [M]/[M^{n+}]}{-nF}$ ----------→ 2	
	Substituing the values of $\frac{\Delta G}{-nF}$ and $\frac{\Delta G^\circ}{-nF}$ in equation 3,	
	Equation 3 => $E = E^\circ + \frac{RT \ln [M^{n+}]}{nF}$ When $[M] = 1$	
	$E = E^\circ + \frac{2.303RT}{nF} \log_{10} [M^{n+}]$ ——→ Nernst equation	1mark
(b)	**Explain the construction, working and advantages of Calomel electrode.**	**5Marks**
	 Fig and Labeling	1mark
	Explanation	3mark
	Reactions	1mark
	• Calomel electrode consisting of a glass container at the bottom of which mercury is placed and above which a layer of mercury and mercurous chloride (called calomel) is placed • 3/4th of bottle is filled with saturated KCl solution. • Calomel Electrode potential depends on the concentration of chloride ions. • The calomel electrode acts as both anode and cathode depending upon the other electrode used. • The platinum wire is used for electrical connections. Salt bridge is used to couple with other half cell. • The calomel electrode can be represented as $Hg(l) / Hg_2Cl_2(S) / Cl^-$ • When it acts as anode the electrode reactions is, • $2Hg + 2Cl^- \longrightarrow Hg_2Cl_2 + 2e^-$ • When it acts as cathode the electrode reaction is	

	• $Hg_2Cl_2 + 2e^- \longrightarrow 2Hg + 2Cl^-$	
(c)	**Calculate the emf of the cell Fe / Fe++ (0.01) // Ag+ (0.1) /Ag at 298K if standard electrode potentials of Fe and Ag electrodes are – 0.42 and 0.8 V respectively.**	**5Marks**
	$E^0cell = E^0$ cathode $- E^0$ anode $= E^0 Ag^+/Ag - E^0 Fe^{++}/Fe$ $= 0.8 - (-0.42)$ **= 1.22 V.**	1mark 1mark
	$E_{cell} = E^0_{cell} + \frac{0.0591}{n} \log_{10} \frac{[M^{n+}] \text{ at cathode}}{[M^{n+}] \text{ at anode}}$	1mark
	$= E^0cell + \frac{0.0591}{n} \log 10 \frac{[Ag^+]^2}{[Fe^{++}]}$ $= 1.22 + \frac{0.0591}{2} \log 10 \frac{[0.1]^2}{[0.01]}$	1mark
	$= 1.22 + 0.02955 \log 1$ **= 1.22 V.**	1mark
2. (a)	**What are electrolytic concentration cells? Explain with an example**	**5Marks**
		Fig and Labeling 1mark Explanation 2mark Reactions 1mark Formula 1mark
	• These are the galvanic cells consisting of same metal electrodes as anode and cathodes dipped in same electrolytic solution but are different in the electrolyte concentration. • **Ex:** Consider the following concentration cell constructed by dipping two copper electrodes in $Cuso_4$ solutions of concentration M_2 molar and M_1 molar, where $M_2M > M_1M$. • The two half-cell are internally connected by a salt bridge and externally connected by a metallic wire through voltmeter • The electrode, which is dipped in less electrolytic concentration solution (M_1M) act as anode and undergoes oxidation. The electrode, which is dipped in more electrolytic concentration solution (M_2M) act as cathode and undergoes reduction. • At anode : $Cu\,(S) \longrightarrow Cu^{2+}(M_1) + 2e^-$ • At cathode : $Cu^{2+}(M_2) + 2e^- \longrightarrow Cu\,(S)$ • Net Cell Reaction: $Cu^{2+}(M_2) \longrightarrow Cu^{2+}(M_1)$ • E of cell = E cathode – E anode. • $E_{cell} = \left(E^\circ + \frac{0.0591}{n} \log [M2]\right) - \left(E^\circ + \frac{0.0591}{n} \log [M1]\right)$ $E_{cell} = \frac{0.0591}{n} \log \frac{[M2]}{[M1]}$	
(b)	**Explain the construction, working and uses of Ni-MH battery**	**5Marks**
		Fig and Labeling 1mark Explanation 3mark Reactions 1mark
	At Anode: $xLiC \rightleftharpoons C + xLi^+ + xe^-$ At Cathode: $LiCoO_2 + xLi^+ + xe^- \rightleftharpoons Li\,CoO_2$ **Net cell reaction** $xLiC + LiCoO_2 \rightleftharpoons C + Li\,CoO_2$	
	• Nickel Metal hydride battery is made up of anode containing metal hydride such as ZrH_2, VH_2 and TiH_2 with hydrogen storage metal alloy such as $La\,Ni_5$ or TiNi. • Cathode consisting of nickel oxy hydroxide • Anode and cathode are separated by polypropylene seperator.	

	• KOH is used as electrolyte. • The cell is represented as: $MH_2/KOH(5.35M)//Ni(OH)_2,NiO(OH)$	
(c)	**An electrolytic concentration cell is constructed by coupling two half cell in which two Cadmium electrodes are immersed CdSO4 solution. The concentration of CdSO4 in one of the half cell is 100 times greater than the other. Write the cell representation, cell reactions and calculate the voltage of the cell at 298K**	**5Marks**
	• Cell representation: Cd (S) / $CdSO_4$ (1M) // $CdSO_4$ (100M) / Cd (S) • Cell Reactions: • At anode : Cd (S) $\longrightarrow$ Cd^{++} (1M) + $2e^-$ • At cathode : $Cd^{++}(100M) + 2e^- \longrightarrow Cd$ (S) • Net Cell Reaction: $Cd^{++}(100M) \longrightarrow Cd^{++}(1M)$ $E_{cell} = \frac{0.0591}{n} \log \frac{[M2]}{[M1]}$ E cell = $\frac{0.0591}{2} \log \frac{[100M]}{[1M]}$ E cell = 0.0591 Volts.	1mark 1mark 1mark 1mark 1mark
3.(a)	**Explain the electrochemical theory of corrosion**	**5Marks**
	According to electrochemical theory, corrosion of metals occurs due to the following changes, when they are exposed to the environment  1) A large number of minute galvanic cells are formed which acts as anodic and cathodic areas. 2) At anodic area the metal undergoes oxidation and electrons are liberated which migrates towards Cathodic region. M $\longrightarrow$ M^{n+} + ne^- Metal Metal ions Ex: when iron is exposed to the environment it undergoes oxidation as Fe $\longrightarrow$ Fe^{2+} + 2e- 3) At Cathodic area different reduction reactions takes place as follows a) In acidic and deaerated medium: Hydrogen ions are reduced to hydrogen gas by reacting with electrons. $2H^+ + 2e^- \longrightarrow H_2$ b) In alkaline and deaerated medium: Moisture of the environment reacts with electrons producing hydroxyl ions and Hydrogen gas at cathode. $2H_2O + 2e^- \longrightarrow 2OH^- + H_2$ c) In neutral and aerated medium: Moisture of the environment reacts with electrons and Oxygen and produces hydroxyl ions at cathode. $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ 4) Formation of corrosion product: The hydroxyl ions formed at Cathodic area reacts with metal ions (M^{n+} ions) formed at Anodic area and forms metal hydroxides which further reacts with moisture and oxygen forming an insoluble Metal oxide corrosion product. In the case of iron OH- reacts with Fe^{2+} ions, O_2 and moisture producing an insoluble hydrated ferric oxide known as brown rust. $2Fe^{++} + 4OH^- \longrightarrow 2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + nH_2O \longrightarrow Fe_2O_3 . nH_2O$ (rust)	1mark 1mark 1mark 1mark 1mark
(b)	**Explain the anodizing process of aluminium**	**5Marks**
	➢ Pretreatment: The article be anodized is degreased and followed by electro polished ➢ Aluminum is connected to positive terminal and made as anode. ➢ Steel or copper is connected to negative terminal and made as cathode ➢ The anode and cathode are dipped in electrolyte solution containing 5-10% chromic acid. ➢ The temperature of the bath is maintained at 35^0c ➢ Voltage is applied between 0-50V.	1mark 1mark

	➢ First ten minutes potential is increased to 0-40V. ➢ After 20 minutes voltage is applied from 40-50V ➢ The voltage is kept constant at 50 V for five minutes. ➢ During this period, 2-8 micrometer thick aluminum oxide layer is obtained. ➢ Finally the object is treated with Ni or Cobalt acetate fallowed by boiling water treatment to improve corrosion resistance. ➢ For higher thickness 10% H_2SO_4 is used as electrolyte. At anode: $2Al(s) + 3H_2O(l) \longrightarrow Al_2O_3(s) + 6H^+ + 6e^-$ At cathode: $6H^+ + 6e^- \longrightarrow 3H_2(g)$ Over all reaction: $2Al(s) + 3H_2O(l) \longrightarrow Al_2O_3(s) + 3H_2$	2mark 1mark
(c)	**Explain the Sacrificial anodic protection method of corrosion**	**5Marks**
	In this method the more active metals like Zn, Mg, and Al etc are attached to base metal. The anodic metals being more reactive undergoes corrosion but base metal remains unaffected .The sacrificial anodes have to be replaced from time to time after complete corrosion. The method is used for protecting buried pipeline, ship hulls, industrial water tanks and steel rods in RCC columns.  	4mark 1mark
4. (a)	**What is metal finishing? Mention the technological importance of metal finishing**	**5Marks**
	It is a process of modifying surface properties of metals by deposition of a layer of another metal or polymer on its surface, by the formation of an oxide film. **Technological importance of metal finishing.** Imparting the metal surface to higher corrosion resistance. Imparting improved wear resistance. Providing electrical and thermal conducting surface. Imparting thermal resistance and hardness. Providing optical and thermal reflectivity. In the manufacture of electrical and electronic components such as PCB's, capacitors, etc	1mark 4mark
(b)	**Explain the electro plating process of Chromium**	**5Marks**
	Plating bath: Chromic acid and H_2SO_4 in 100:1 proportion. — 1mark Temperature: $45\text{-}60^0C$. — 1mark Current Density: $100\text{-}200mA/Cm^2$. — 1mark Anode: Insoluble anodes Pb-Sb or Pb-Sn coated with PbO_2. — 1mark Cathode: Object to be plated. Chromium anodes are therefore not used in Cr plating for following reason. • Chromium metal passivates strongly in acid sulphate medium & • Chromium anode gives rise to Cr (III) ions on dissolution. In presence of large concentration of Cr (III) ions, a black Cr deposit is obtained. Anodic reaction: $H_2Cr_2O_7 \longrightarrow Cr_2O_7^{--} + 2H^+ + 2e^-$ $Cr_2O_7^{--} + 14H^+ + 6e^- \longrightarrow 2Cr + 7H_2O$ Cathodic reactions: $Cr^{3+} + 3e^- \longrightarrow Cr$ — 1mark	
(c)	**Explain the electro less plating process of Copper**	**5Marks**
	Plating bath Solution: $CuSO_4.5H_2O$ (12 g per dm^3), NaOH (15 g per/L, Rochelle salt (14 g per dm^3), EDTA (15 g per dm^3) — 1mark Reducing Agent: Formaldehyde (8 g per dm^3) — 1mark Complexing agent: EDTA Solution. — 1mark P^H: 11 - 12 — 1mark Temperature: $25\ ^0c$ At Anode: $2HCHO + 4OH^- \rightarrow 2HCOO^- + 2H_2O + H_2 + 2e^-$ At Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$ — 1mark	

PRINCIPAL
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SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

I Semester: II-Internal assessment test Date: 19-03-2021

Sub: Engineering Chemistry (18CHE12)

Time: 90 minutes Section: C Max Marks: 30

Note:	1.	Answer any *TWO FULL* questions.

		Module-3	Marks	CO
1	a)	Explain the determination of calorific value of solid fuel using Bomb Calorimeter	(5)	CO 3
	b)	What is Knocking of petrol engine? Explain the mechanism of Knocking	(5)	CO 3
	c)	A coal sample with 93% carbon, 5% of Hydrogen and 2% Ash is subjected to combustion in a bomb calorimeter the following data is obtained. Calculate GCV and NCV of the sample. Mass of the coal sample = 0.95g Mass of water in copper calorimeter = 2000g. Water equivalent wt of calorimeter = 700g. Rise in temp = 2.8^{0}C Specific heat of water = 1 cal/g/^{0}C	(5)	CO 3
		(OR)		
2	a)	Explain the construction, working and uses of Methanol – Oxygen fuel cell.	(5)	CO 3
	b)	Explain the construction, working and uses of Solid oxide fuel cells (SOFC)	(5)	CO 3
	c)	Explain the construction and working of photovoltaic cell	(5)	CO 3

PTO

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

I Semester: II-Internal assessment test Date: 19-03-2021

Sub: Engineering Chemistry (18CHE12)

Time: 90 minutes Section: C Max Marks: 30

Note:	1.	Answer any *TWO FULL* questions.

		Module-3	Marks	CO
1	a)	Explain the determination of calorific value of solid fuel using Bomb Calorimeter	(5)	CO 3
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	c)	A coal sample with 93% carbon, 5% of Hydrogen and 2% Ash is subjected to combustion in a bomb calorimeter the following data is obtained. Calculate GCV and NCV of the sample. Mass of the coal sample = 0.95g Mass of water in copper calorimeter = 2000g. Water equivalent wt of calorimeter = 700g. Rise in temp = 2.8^{0}C Specific heat of water = 1 cal/g/^{0}C	(5)	CO 3
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	c)	Explain the construction and working of photovoltaic cell	(5)	CO 3

PTO

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		Module-4	Marks	CO
3	a)	Explain the Sources, effects and control of Carbon monoxide air pollution	(5)	CO 4
	b)	Explain the Sources, effects and control of Oxides of nitrogen air pollution	(5)	CO 4
	c)	Explain the Sources, effects and control of hydrocarbons air pollution	(5)	CO 4

(OR)

4	a)	Explain the Sources, effects and control of Particulated matter air pollution	(5)	CO 4
	b)	Explain the Sources, effects and control of ozone air pollution and write a note on ozone depletion	(5)	CO 4
	c)	Explain the Sources, effects and control Mercury pollution	(5)	CO 4

Name of the Course instructor	Dr. Chandrasekhar. N
Signature	
Signature of the HoD	
Signature of the Principal	

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	c)	Explain the Sources, effects and control Mercury pollution	(5)	CO 4

Name of the Course instructor	Dr. Chandrasekhar. N
Signature	
Signature of the HoD	
Signature of the Principal	

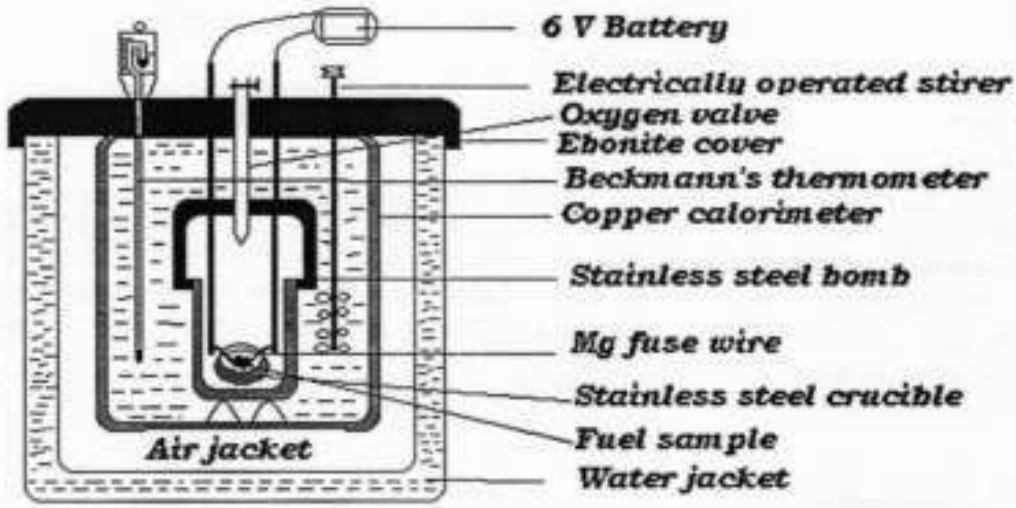
2021

SHRIDEVI INSTITUTE OF ENGINEERING AND TECHNOLOGY

I semester: II-Internal assessment test

Scheme of valuation

Sub: Engineering Chemistry (18CHE12) Date: 19-03-2021

Q.no	Scheme	Mark
1. (a)	**Explain the determination of Calorific value of solid fuel using Bomb calorimeter**	5Mar
		1mark 1mark 1mark 1mark
	Bomb Calorimeter	
	A small quantity of a fuel is weighed accurately (M Kg) and is placed in the Bomb. The bomb is placed in known amount water taken in a copper calorimeter. The initial temp of water is noted as a t_1^0C with the help of thermometer. Oxygen gas is pumped under pressure 20 to 25 atm through the O_2 valve provided. The fuel is ignited by passing electric current through the wires provided. As the fuel undergoes combustion and liberates heat, which is absorbed by surrounding water. The water is stirred continuously to distribute the heat uniformly and the final temp attained by water is noted t_2^0C. & gross calorific value of the fuel is calculated as follows:-	
	Calculation:	1mark
	Mass of the fuel = M Kg. Initial temp of the water = t_1^0C Final temp of the water = t_2^0C Change in temp = $t = \triangle - t_1)^0$ C Specific heat of water = S Water equivalent of calorimeter = W Kg. GCV = $\frac{W \times S \times t}{M} \triangle$ J/Kg or GCV = $\frac{(W+w) \times S \times t\triangle}{M}$ J/Kg NCV = GCV – 0.09 x %H_2 x 587 cal/g	
(b)	**What is knocking of petrol engine? Explain the mechanism of knocking.**	5Mar
	The explosive combustion of petrol and air mixture produces shock waves in I.C. engine, which hit the walls of the cylinder and piston producing a rattling sound is known as knocking.	1mark 3mark
	Mechanism of Knocking	1mark
	Beyond a particular compression ratio the petrol mixture suddenly burns into flame. The rate of flame propagation increases from 20 to 25m/s to 2500m/s, which propagates very fast, producing a	

rattling sound. The activated peroxide molecules decomposes to give number of gases products which produces thermal shock waves which hit the walls of the cylinder and piston causing a rattling sound which is known as knocking.

The reactions of normal and explosive combustion of fuel can be given as follows taking ethane as an example

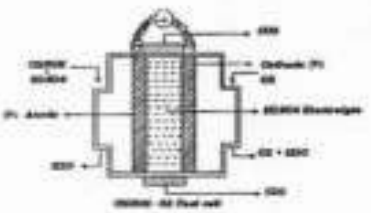
$C_2H_6 + 3\frac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O$ (Normal combustion reaction)

$C_2H_6 + O_2 \rightarrow CH_3\text{-}O\text{-}O\text{-}CH_3$ (Explosive combustion reaction)

$CH_3\text{-}O\text{-}O\text{-}CH_3 \rightarrow CH_3\text{-}CHO + H_2O$

$CH_3\text{-}CHO + 1\frac{1}{2}O_2 \rightarrow HCHO + CO_2 + H_2O$

$HCHO + O_2 \rightarrow CO_2 + H_2O$

(c)	**A coal sample with 93% of carbon, 5% of hydrogen, 2% of ash is subjected to combustion in a bomb calorimeter the following data is obtained. Calculate GCV and NCV of the sample. Mass of the coal sample is 0.95g, mass of the water in copper colorimeter is 2000g. water equivalent weight of calorimeter is 700g. rise in temperature is 2.8°C. specific heat of water is 1cal/g/°C.**	5Mark
	GCV $= \frac{(W+w) \times S \times t\triangle}{M}$	1mark
	$= \frac{(2000+700) \times 10^{-3}\ kg \times 1\ cal/g/^0C \times 2.8^0C \times 4.184}{0.95 \times 10^{-3}\ kg}$	1mark
	$= 33295.83$ J/kg.	1mark
	NCV $= GCV - 0.09 \times \%H_2 \times 587 \times 4.184$ J/kg.	1mark
	$= 33295.83$ J/kg $- 0.09 \times 5 \times 587$ J/kg.	1mark
	$= 32190.62$ J/kg	
2.(a)	**Explain the construction, working and uses of Methanol oxygen fuel cell**	5Mark
	It consists of two electrodes made up of platinum as anode and cathode and in between the electrodes H_2SO_4 is placed as a electrolyte. Methanol and H_2SO_4 is supplied at the anode and pure oxygen gas is supplied at the cathode. The methanol is oxidized to CO_2 & H_2O with the liberation of 1.20v of electrical energy.	1mark 1mark
		1mark 1mark
	The cell reactions are as follows.	1mark

At anode : $CH_3OH + H_2O \longrightarrow CO_2 + 6H^+ + 6e^-$

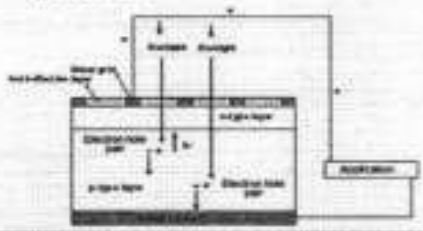
At cathode : $\frac{3}{2}O_2 + 6H^+ + 6e^- \longrightarrow 3H_2O$

NCR : $CH_3OH + \frac{3}{2}O_2 \longrightarrow CO_2 + 2H_2O$

Applications:

1) Used in Military applications.

Used for large scale power production stations.

(b)	**Explain the construction, working and uses of solid oxide fuel cells**	5Mar
	These contains ZrO_2, Y_2O_3 are solid electrolytes. Cathode is made up of porous strontium doped with $LaMnO_3$ or In_2O_3 and SnO_2. Anode is made up of cobalt, nickel, or ZrO2 Operating temperature is 1000^0C. Uses: These cells are used in KW power plants	1mark 2mark 1mark 1mark
(C)	**Explain the construction, working of photo voltaic cell.**	
	A typical silicon photovoltaic cell is composed of a thin layer of phosphorus doped. (n-type) semiconductor on the top and a thick layer boron doped p-type semiconductor at the bottom. Hence a p-n junction is formed. A metallic grid forms one of the electrical current contacts of the diode and allows light to fall on the semiconductor between the grid lines. An antireflective layer (TiO_2 or silicon nitride) between the grid lines increases the amount of light transmitted. When light radiation falls on the p-n junction, electron – hole pairs are generated by the absorption of the sun radiation. The electrons are moves and collect at the n-type end and the holes moves to p-type end. When these two ends are electrically connected through a conductor, photoelectric current is produced. 	1mark 1mark 1mark 1mark 1mark
3.(a)	**Explain the sources and ill effects and control of CO air pollution.**	5Mar
	CO is found in fumes produced any time you burn fuel in cars or trucks, small engines, stoves, lanterns, grills, fireplaces, gas ranges, or furnaces. CO can build up indoors and poison people and animals who breathe it. The most common symptoms of CO poisoning are headache, dizziness, weakness, upset stomach, vomiting, chest pain, and confusion. CO symptoms are often described as "flu-like." If you breathe in a lot of CO it can make you pass out or kill you. People who are sleeping or drunk can die from CO poisoning before they have symptoms. Limited burning of charcoal indoors. Burning charcoal – red, gray, black, or white – gives off CO. Do not use portable flameless chemical heaters indoors. Check or changing the batteries in CO detector every six months.	
(b)	**Explain the sources and ill effects and control lead pollution.**	
	Lead-based paint and lead-contaminated dust in older buildings are common sources of lead poisoning in children. Other sources include contaminated air, water and soil. Adults who work with batteries, do home renovations or work in auto repair shops also might be exposed to lead. Signs and symptoms of lead poisoning in children include: High blood pressure Joint and muscle pain Irritability Loss of appetite Weight loss Sluggishness and fatigue Abdominal pain Vomiting Constipation Hearing loss Seizures. • Wash hands and toys. To help reduce hand-to-mouth transfer of contaminated dust or soil, wash your children's hands after outdoor play, before eating and at bedtime. Wash their toys	1mark 1mark 1mark 1mark 1mark

	regularly. • Controlling: • Clean dusty surfaces: Cleaning the floors. • Run cold water. • Prevent children from playing on soil. Eat a healthy diet.	
c)	**Explain the sources and ill effects and control of hydrocarbon pollution.**	
	Contamination of hydrocarbon occurs due to toxic organic substances, petroleum, and pesticides which is a serious concern for the environment. Contamination caused by petroleum hydrocarbon is a matter of worry because these are harmful for various life forms. Anthropogenic sources Petroleum inputs Partial burning of fuels Fires of forest and grass Biosynthesis of hydrocarbons by marine or terrestrial organisms Diffusing from the petroleum source rocks, reservoirs, or mantle Some hydrocarbons can cause other effects, including coma, seizures, irregular heart rhythms or damage to the kidneys or liver. Examples of products that contain dangerous hydrocarbons include some solvents used in paints and dry cleaning and household cleaning chemicals. The remediation of hydrocarbon polluted wastewater can be achieved by three methods, which are phytoremediation, bioremediation and chemical remediation. Phytoremediation entails the use of plants to reduce the volume, mobility and toxicity of contaminants in soil and water.	1mark 1mark 1mark 1mark 1mark
4.a)	**Explain the sources and ill effects and control of perticulate matter pollution.**	
	There are numerous natural processes injecting particulate matter into the atmosphere (800-2000 million tonnes each year). Examples are volcanic eruptions, blowing of dust and soil by the wind, spraying of salt and other solid particles by the seas and oceans, etc. The contributions from man-made activities are flyash from power plants, smelters and mining operations, and smoke from incomplete combustion processes. *Statistics regarding man-made particulate pollution indicates that fuel combustions from stationary sources (coal, fuel oil, natural gas, wood), industrial processes, and miscellaneous sources (forest fires, structural fires, coal refuse burning and agricultural burning) share almost equally (one-third each) the total particulate emission (200–450 million tonnes per year). In developed countries like USA, the annual particulate emission is about 20×10^6 tonnes, including 5×10^6 tonnes of fine particles (less than 3 μ).*	1mark 1mark 1mark 1mark 1mark
B)	**Explain the sources and ill effects and control of Ozone layer depletion.**	
	Ozone layer depletion is the gradual thinning of the earth's ozone layer in the upper atmosphere caused due to the release of chemical compounds containing gaseous bromine or chlorine from industries or other human activities." Sources: Chlorofluorocarbons Unregulated Rocket Launches Nitrogenous Compounds Natural Causes Ill effects: it has, Effects on Human Health and Animal Health Effects on Aquatic Ecosystems Effects on Air Quality Effects on Materials Controling: Avoid Using ODS Reduce the use of ozone depleting substances. E.g. avoid the use of CFCs in refrigerators and air conditioners, replacing the halon based fire extinguishers, etc. Minimise the Use of Vehicles The vehicles emit a large amount of greenhouse gases that lead to global warming as well as ozone	1mark 1mark 1mark 1mark 1mark

	depletion. Therefore, the use of vehicles should be minimised as much as possible.	
c)	**Explain the sources and ill effects and control of Hg pollution.**	
	Natural sources of mercury include volcanic eruptions and emissions from the ocean. Anthropogenic (human-caused) emissions include mercury that is released from fuels or raw materials, or from uses in products or industrial processes. Mercury may have toxic effects on the nervous, digestive and immune systems, and on lungs, kidneys, skin and eyes. Some of the health effects exposure to mercury may cause include: irritation to the eyes, skin, and stomach; cough, chest pain, or difficulty breathing, insomnia, irritability, indecision, headache, weakness or exhaustion, and weight loss. Minamata Disease is a poisoning disease that nervous system, mainly central nervous system, is damaged by methylmercury. Avoid buying products that contain mercury except for fluorescent light bulbs. Fluorescent bulbs use less electricity than incandescent bulbs. Keep mercury-containing items out of the trash.	1mark 1mark 1mark 1mark 1mark

PRINCIPAL
SIET., TUMAKURU.

Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: I Internal Assessment Test: - February 2021

18PHY16-Engineering Physics

Time: 90 Min **Max. Marks: 30**

Note: 1. ***Answer any Two full Questions.***

2. ***Physical constants*****, Velocity of light, $c = 3 \times 10^8$ m/s,**
Planck's constant, $h = 6.63 \times 10^{-34}$ JS, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg,
Charge of electron, $e = 1.602 \times 10^{-19}$ C, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K

1	a.	Define SHM. Mention the characteristics and examples of SHM. Derive the differential equation of motion for it using Hook's law.	**(CO1 06 Marks)**
	b.	With a neat diagram explain the construction and working of Reddy shock tube.	**(CO1 06 Marks)**
	c.	Mention the applications of shock waves.	**(CO1 03 Marks)**

OR

2	a.	Discuss the theory of forced vibrations and hence obtain the expression for amplitude and Phase.	**(CO1 06 Marks)**
	b.	What are damped oscillation? Give the theory of damped oscillation and hence discuss the case of critical damping.	**(CO1 06 Marks)**
	c.	The distance between two pressure sensors in a shock tube is 150 mm, the time taken by a shock wave to travel this distance is 0.3 ms, if the velocity of sound under the same condition is 340 m/s. find the mach number of shock wave.	**(CO1 03 Marks)**

Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: I Internal Assessment Test: - February 2021

18PHY16-Engineering Physics

Time: 90 Min **Max. Marks: 30**

Note: 1. ***Answer any Two full Questions.***

2. ***Physical constants*****, Velocity of light, $c = 3 \times 10^8$ m/s,**
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	b.	What are damped oscillation? Give the theory of damped oscillation and hence discuss the case of critical damping.	**(CO1 06 Marks)**
	c.	The distance between two pressure sensors in a shock tube is 150 mm, the time taken by a shock wave to travel this distance is 0.3 ms, if the velocity of sound under the same condition is 340 m/s. find the mach number of shock wave.	**(CO1 03 Marks)**

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3 a. Derive the relation between bulk modulus (K) , Young's modulus (Y) and Poisson's ration (σ). **(CO1 06 Marks)**

b. Derive the expression for the depression and Y at the free end of a beam of loaded cantilever. **(CO1 06 Marks)**

c. Explain the basics of conservation of mass, momentum and energy. **(CO1 03 Marks)**

OR

4 a. Derive the Expression for couple per unit twist of a solid cylinder. **(CO1 06 Marks)**

b. Derive the relation between Young's modulus (Y), rigidity modulus (n) and Poisson's ration (σ). **(CO1 06 Marks)**

c. For a particle executing SHM , its acceleration is found to be $15cm/s^2$ when it is at 3cm from its mean position. Calculate time period. **(CO1 03 Marks)**

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HOD 19/02/2021

Principal

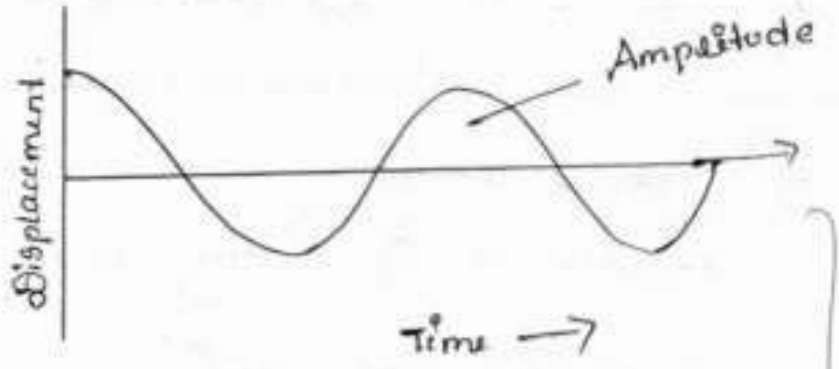
Question Number	Scheme and Solution	Marks allocated
	Sub: Engineering physics Sub code: 18PHY22	

1 a. Defination of SHM —— (1)

characteristics and examples of SHM. —(2)

Derivation of differential equation of motion for using hook's law.

06



$F = -ky$ $\quad F = ma.$ —(3)

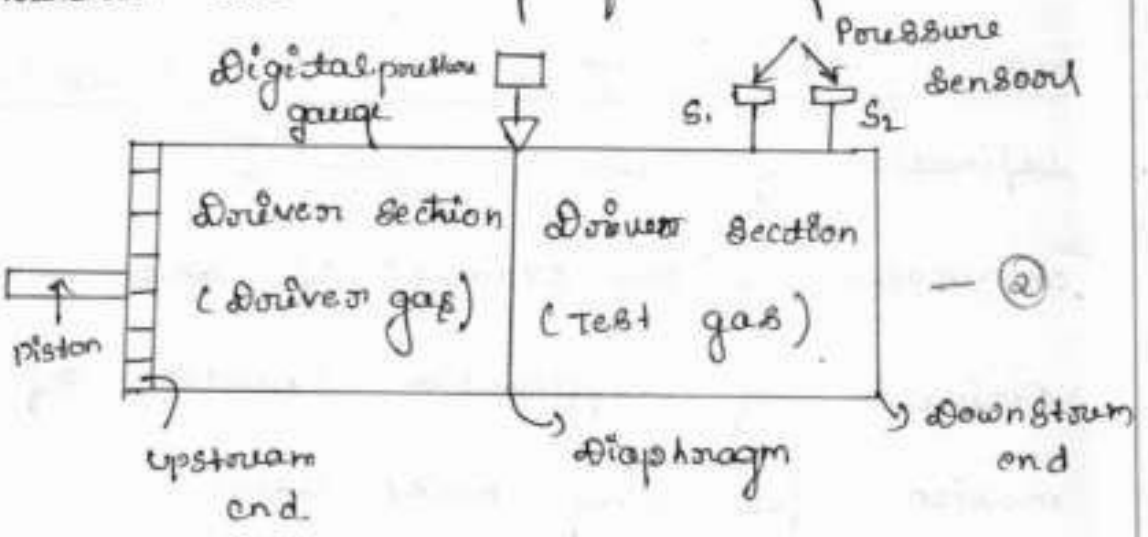
$$\frac{m\,d^2y}{dt^2} = -ky$$

$$\frac{d^2y}{dt^2} = \frac{-k}{m}y$$

$$\frac{d^2y}{dt^2} + \frac{k}{m}y = 0$$

$$\omega = \sqrt{k/m}.$$

1.b Construction and working of reddy shock tube.



06

Explanation of construction and working — (4)

1.c Application of shock waves.

- Used in treatement of kidney stones — (1)
- Used to preserve wood. — (1)
- Used in pencil industry — (1)
- Used in treatment of dry bronchitis — (1)

03

2.a Explanation of Theory of forced vibrations

Expression for amplitude & phase

Resultant force $= -r\frac{dx}{dt} - kx + F\sin pt$ — (1)

Resultant force $= m\frac{d^2x}{dt^2} \Rightarrow \omega^2 = \frac{k}{m}$ — (1)

$$\frac{d^2x}{dt^2} + 2b\frac{dx}{dt} + \omega^2 x = \frac{F}{m}\sin(pt)$$ — (1)

$\left(\frac{F}{m}\right) \sin [(pt - \alpha) + \alpha)$ —— (1)

$2 bap = \frac{F}{m} \sin \alpha$ —— (1) 06

$$x = \frac{(F/m)}{\sqrt{4b^2p^2 + (\omega^2 - p^2)^2}} \sin (pt - \alpha)$$ —— (1)

2.b. Damped Oscillation :- it is type of motion executed by a body subjected to the combined action of both the restoring and resistive forces —— (1)

Theory of damped vibration

resistive force $= -r \frac{dx}{dt}$ —— (1)

Restoring force $= -kx$ —— (1)

06

$$\left.\begin{aligned} m \frac{d^2x}{dt^2} + r \frac{dx}{dt} + kx = 0 \\ \frac{d^2x}{dt^2} + 2b \frac{dx}{dt} + \omega^2 x = 0 \end{aligned}\right\}$$ —— (1)

$a^2 + 2ab + \omega^2 = 0$. $x_0 = c + D$ —— (1)

$$x = \frac{n_0}{2} \left\{ \left[1 + \frac{b}{\sqrt{b^2 - \omega^2}} \right] e^{(-b + \sqrt{b^2+\omega^2})t} + \left[1 - \frac{b}{\sqrt{b^2-\omega^2}} \right] e^{(-b\sqrt{b^2-\omega^2})t} \right\}$$

—— (1)

2.c. Given Data:-

Distance between the two pressure sensors.

$d = 150 \times 10^{-3}$ m

Time taken to travel d is $t = 0.3 \times 10^{-3}$ s.

velocity of sound $a = 340\ ms^{-1}$ —— (1)

03

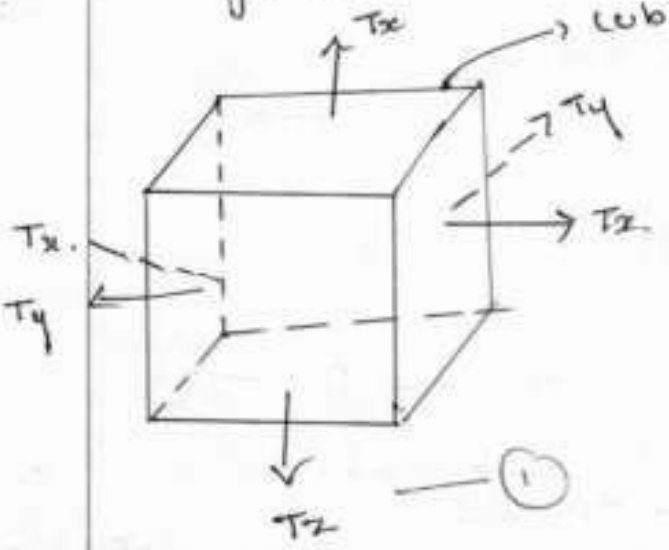
To find : $M = ?$

Shock speed $U_s = d/t = \frac{150 \times 10^{-3}}{0.3 \times 10^{-3}} = 500 ms^{-1}$ —— (1)

mach no, $M = \frac{U_s}{a} = \frac{500}{340} = 1.47$

mach number of shock wave is 1.47 —— (1)

3.a. Derivation of relation between bulk modulus (K) Young's (Y) and poisson's ratio (σ)



—— (1)

along x-direction

$1 + \alpha T_x - \beta T_y - \beta T_z$ —— (1)

along y-direction.

$1 + \alpha T_y - \beta T_z - \beta T_x$

along z-direction.

$1 + \alpha T_z - \beta T_x - \beta T_y$

—— (1)

Value of cube = $1 + (\alpha + 2\beta)3T$

Volume Strain = $\frac{\text{change in volume}}{\text{original volume}}$ — (1)

= $\frac{3P(\alpha - 2\beta)}{1}$ — (1)

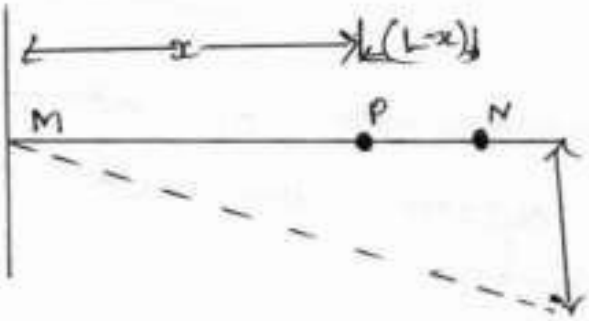
06.

Bulk modulus $K = \frac{\text{Pressure}}{\text{volume Strain}}$

$K = \frac{P}{3P(\alpha - 2\beta)}$

$K = \frac{Y}{3(1-2\sigma)}$ — (1)

3.6) Expression for the deposition and Y at the free end of a beam of loaded cantilever.



— (1)

— (1)

Bending moment = $W \times (L - x)$

$\frac{dy}{dx} = \frac{W}{YI_q}\left[Lx - x^2/2\right] + C_1$ — (1)

$y = \frac{W}{YI_q}\left[\frac{Lx^2}{2} - \frac{x^3}{6}\right] + C_2$ — (1)

$$y_0 = \frac{W}{YI_g}\left[\frac{L \cdot L^2}{2} - \frac{L^3}{6}\right] \quad \text{—— (1)}$$

$$y_0 = \frac{W}{YI_g}\left[\frac{L_3}{2} - \frac{L^3}{6}\right]$$

06.

$$y_0 = \frac{WL^3}{3YI_g}$$

$$Y = \frac{WL^3}{3y_0 I_g} \quad \text{—— (1)}$$

3. c) * Law of conservation of mass:

The total mass of any isolated remains unchanged and is independent of any chemical and physical changes that could occur within system

$$P_1 U_1 = P_2 U_2 \quad \text{—— (1)}$$

* Law of conservation of momentum:

In a closed system, the total momentum remains constant.

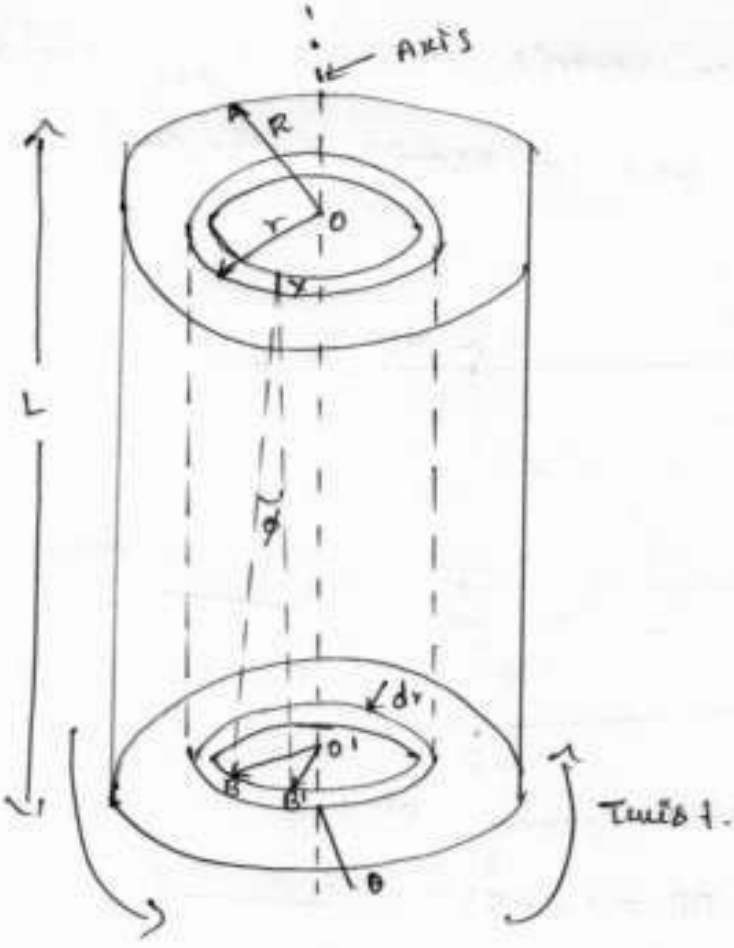
$$P_1 + P_1 U_1^2 = P_2 + P_2 U_2^2 \quad \text{—— (1)}$$

* Law of conservation of energy:

The total energy of a closed remains constant and is independent of any changes occuring within the system

$$h_1 + \frac{U_1^2}{2} = h_2 \frac{U_2^2}{2} \quad \text{—— (1)}$$

4.a)



—— (1)

06.

$\angle BXB' = \phi \quad \angle BO'B' = \theta$ —— (1)

$$\phi = \frac{r\theta}{L}$$

$F = T(2\pi r dr)$ —— (1)

Rigidity modulus $n = \dfrac{\text{Shearing stress}}{\text{Shearing strain}} = \dfrac{T}{\phi}$

$T = n\phi \qquad T = \dfrac{nr\theta}{L}$ —— (1)

$$F = \frac{2\pi n\theta}{L} r^2 \, dr \qquad OO' = \frac{2\pi n\theta}{L} r^3 dr$$

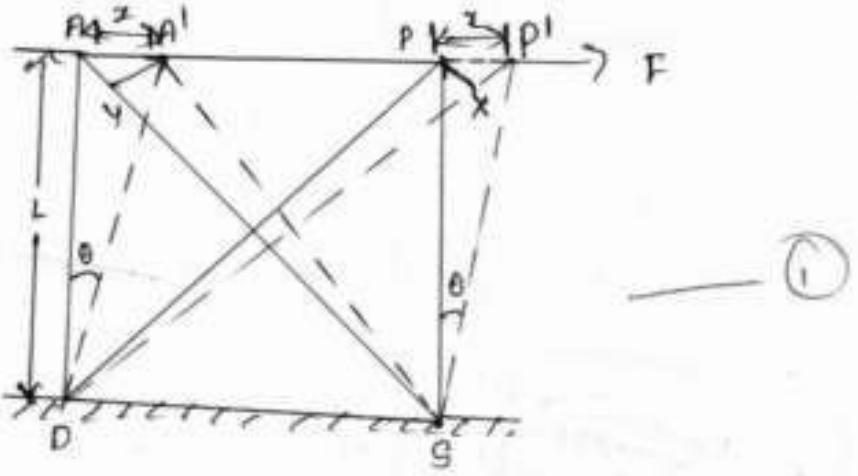
—— (1)

$$OO' = \int_{r=0}^{r=R} \frac{2\pi n\theta r^3}{L} dr$$

$$OO' = \frac{\pi n R^4 \theta}{2L}$$

$$\boxed{C = \frac{\pi n R^4}{2L}}$$ —— (1)

4.b] Relation between young's modulus (Y), rigidity modulus (n) and poisson's ratio (σ)



Total extention along DP.

$P'X = DP \cdot T(\alpha+\beta)$ —— (1)

$P'X = (\sqrt{2}L)\, T\, (\alpha+\beta)$

$2(\alpha+\beta) = x/TL$

Inverting $\frac{1}{2(\alpha+\beta)} = \frac{T^2}{x} = \frac{T}{x/L} = \frac{T}{\theta} = n$

—— (1)

$n = \frac{1/2}{2(1+\sigma)}$ —— (1)

$Y = \frac{\text{Stress}}{\text{L. Strain}} = \frac{1}{\text{L.S/Stress}}$ —— (1)

$Y = \frac{1}{\text{Strain along DP / unit stress}}$

$n = \frac{Y}{2(1+\sigma)} \Rightarrow \boxed{Y = 2n(1+\sigma)}$ —— (1)

06

4.c)

4.c) Given data :- $a = 15\,cm/s^2$

$x = 3cm$

03

To find out :- $T = ?$

Solution :- $x = a \sin\omega t$.

$v = \frac{dx}{dt} = a\cos\omega t\,(\omega)$

$a = \frac{d^2x}{dt^2} = -a\omega^2 \sin\omega t.$

$\omega = \sqrt{\frac{a}{x}} = \sqrt{\frac{15\times10^2}{3\times10^{-2}}} = 2.24$ rad/s.

$\omega = 2\pi f.$

$\omega = \frac{2\pi}{T}$

$T = \frac{2\pi}{\omega} = \frac{2\times3.142}{2.24} = 2.8$ Seconds.

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SHRIDEVI EDUCATION

Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: II Internal Assessment Test: March-2021

18PHY22-Engineering Physics

Time: 90 Min **Max. Marks: 30**

Note: 1. ***Answer any TWO full Questions.***

2. ***Physical constants*****, Velocity of light, $c = 3 \times 10^8$ m/s,**
Planck's constant, $h = 6.63 \times 10^{-34}$ JS, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg,
Charge of electron, $e = 1.602 \times 10^{-19}$ C, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K

1	a.	What is Hall Effect? Obtain the expression for Hall voltage in terms of Hall co-efficient.	**(CO5 06Marks)**
	b.	Define Fermi factor & Discuss the variation of Fermi factor with Temperature and effect on occupancy of energy levels.	**(CO5 06 Marks)**
	c.	Calculate the probability of an electron occupying an energy level 0.02eV above the Fermi level at 200K and 400K.	**(CO5 03 Marks)**
		OR	
2	a.	Define internal field in case of solid dielectrics. Derive Clausius- Mossotti equation.	**(CO5 06 Marks)**
	b.	What are the assumption of quantum free electron theory (QFET)? Explain the merits of QFET	**(C05 06 Marks)**
	c.	What are dielectrics? Give the relation between dielectric constant and polarization.	**(C05 03 Marks)**

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(P.T.O)

3 a. Assuming the time independent Schrodinger wave equation, discuss the solution for a particle in one dimensional potential well of infinite height. Hence obtain the normalized wave function. **(C03 06 Marks)**

b. State and explain Heisenberg's Uncertainty principle. Show that the electron cannot exist inside the nucleus. **(C03 06 Marks)**

c. Mention the properties of wave function. **(C04 03 Marks)**

OR

4 a. Setup one dimensional time independent Schrodinger wave equation. **(C03 06 Marks)**

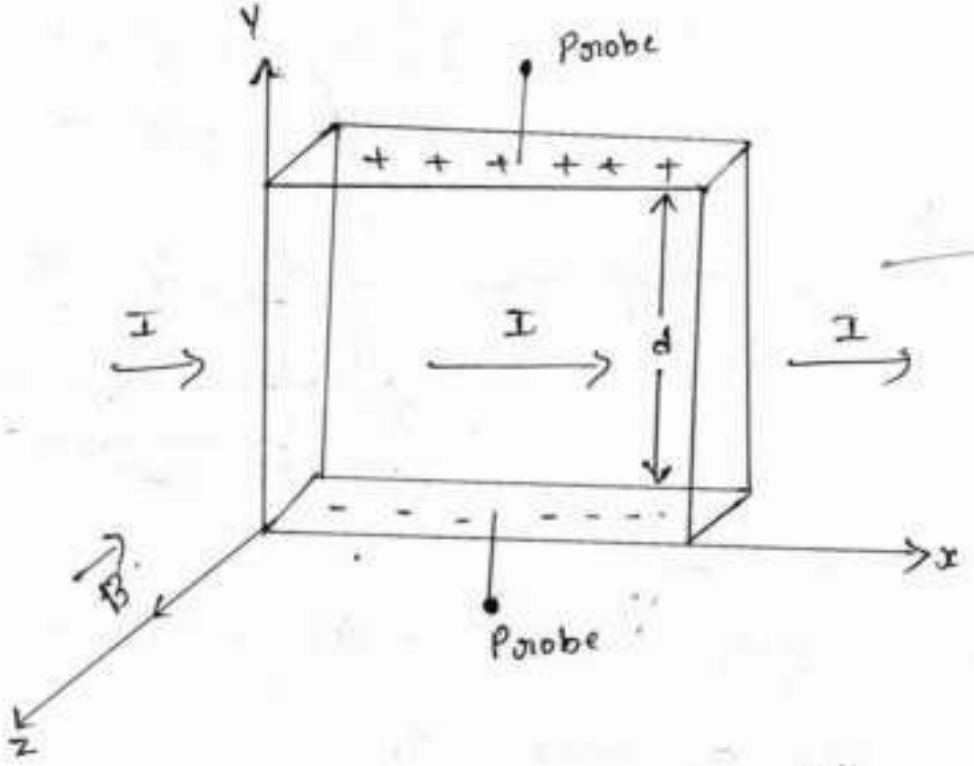
b. What is Fermi Energy? Derive an expression for Fermi Energy at zero Kelvin. **(C05 06 Marks)**

c. Calculate the Force required to produce an extension of 1mm in steel wire of length 2m and diameter 1mm ($Y = 2 \times 10^{11}$ **N/ m^3**). **(C02 03 Marks)**

Question Number | Scheme and Solution | Marks allotted

Sub: Engineering Physics | Sub code: 18PH122

1. a) Hall effect explanation ——— (1)



——— (1)

06

$F_L = -Bev$ ——— (1)

$F_H = -eE_H$

$E_H = Bv$

$V_H = \frac{BI}{\rho w}$ ——— (1)

$\rho = \frac{BI}{V_H w}$ ——— (1)

$E_H = R_H J B$

$R_H = 1/\rho$ ——— (1)

b) Definition of fermi factor

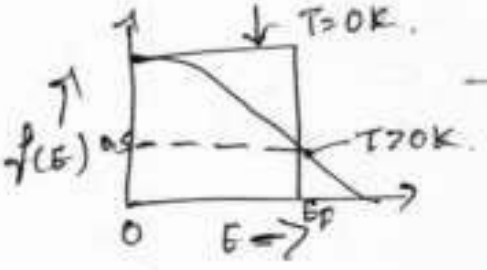
$$f(E) = \frac{1}{e^{\frac{E-E_F}{KT}} + 1}$$ } ——— (1)

At $T = 0$ for $E > E_f$ $f(E) = 0$

$E < E_f$ $F(E) = 1$

$E = E_f$ $P(E) = 0.5$ } 4

ordinary Temp $T > 0$,



— (1)

06

1.c Data : $E - E_f = 0.02 eV = 0.02 \times 1.6 \times 10^{-19}$ J.

(i) $f(E)$ at 200k = T_1

(ii) $f(E)$ at 400k = T_2.

$$f(E) = \frac{1}{e^{\left(\frac{E-E_F}{kT}\right)} + 1} \quad \text{—— (1)}$$

03

(i) $$f(E) = \frac{1}{e^{\frac{0.02 \times 1.6 \times 10^{-19}}{(1.38 \times 10^{-23})(200)}}} = 0.24 \quad \text{—— (1)}$$

(ii) $$f(E) = \frac{1}{e^{\frac{(0.02 \times 1.6 \times 10^{-19})}{(1.38 \times 10^{-23})(200)}}} = 0.36. \quad \text{—— (1).}$$

2. a) Explination of clusius mosotti equation —— (1)

Dipole moment / unit volume = $N\mu$. —— (1)

$$\mu = \alpha_e E_i^0 \quad \text{—— (1)}$$

$$P = N\alpha_e E_i^0$$

$$E_i^0 = \frac{P}{N\alpha_e} \quad \text{—— (1)}$$

06.

$$P = \varepsilon_0 (\varepsilon_r - 1) E \qquad E = \frac{P}{\varepsilon_0(\varepsilon_r - 1)}$$

—— (1)

$$E_i^0 = E + \gamma \frac{P}{\varepsilon_0}$$

$$\frac{P}{N\alpha_e} = \frac{P}{\varepsilon_r(\varepsilon_r - 1)} + \gamma \frac{P}{\varepsilon_0}$$

$$\frac{(\varepsilon_r - 1)}{(\varepsilon_r + 2)} = \frac{N\alpha_e}{3\varepsilon_0} \quad \text{—— (1)}$$

2. b) Write 4 assumption of QFET. —— (3)

Explination of 3 merits of QFET. 06

* Specific heat —— (1)
* Temperature dependence of electorical conductivity —— (1)
* Dependence of electorical conductivity on electron concentoraction. —— (1)

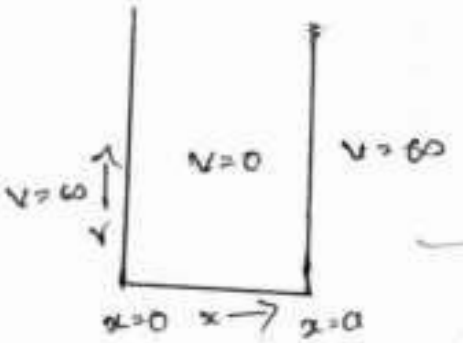
3.C. A dielectric materials is an insulator and it has no free electrons. But in the presence of an external field it gets electrically polarized —(1) 03.

The relation between dielectric constant and polarisation given by.

$$\vec{P} = \varepsilon_0 (\varepsilon_r - 1) \vec{E} \quad \text{—— (2)}$$

$\vec{E}$ = Applied electric field.

3.a



—— (1)

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2} E\psi = 0 \quad \text{—— (1)}$$

$$k^2 = \frac{8\pi^2}{h^2} E$$

$$\psi = C \cos kx + D \sin kx \quad \text{—— (1)} \qquad 06$$

$$\psi_n = D \sin \frac{n\pi}{a} x$$

$$E = \frac{n^2 h^2}{8ma^2} \rightarrow E_{zero\text{-}point} = \frac{h^2}{8ma^2}. \quad \text{—— (1)}$$

Normalisation wave function.

$$\int_0^a |\psi_n|^2 \, dx = 1 \quad \text{—— (1)}$$

$$\int_0^a D^2 \sin^2 \frac{n\pi}{a} x \, dx = 1$$

$$D = \sqrt{\frac{2}{a}} \quad \text{—— (1)}$$

3. b) Explination of Heisenberg's uncertainty.

Poinciple —— (1)

$$\Delta x \, \Delta p \geq \frac{h}{4\pi}$$

Non - Existence of electron in the atomic nucleus —— (1)

$$E = mc^2$$

$$E = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \because m = \frac{m_0}{\sqrt{1 - v^2/c^2}} \quad \text{—— (1)}$$

06

$$p = mv \qquad p = \frac{m_0 v}{\sqrt{1 - \frac{v^2}{c^2}}} \quad \text{—— (1)}$$

$$E^2 = p^2 c^2 + m_0^2 c^4 \quad \text{—— (1)}$$

$$\Delta P \geq \frac{h}{4\pi \Delta x} \quad \text{—— (1)}$$

$$\Delta P \geq 1.1 \times 10^{-26} \text{ kgms}^{-1}$$

$$E \geq 20.6 \text{ mev}$$

3.c. Explaination of properties of wave fuction. 03

— 3

4.a concept of $\lambda = \frac{h}{p}$ with explanation — (1)

$\psi = A\, e^{i(kx - \omega t)}$ with explanation. — (1)

Steps involve upto $\frac{1}{\lambda^2} = \frac{-1}{4\pi^2\psi} \frac{d^2\psi}{dx^2}$. — (2) 06

$KE = \frac{-h^2}{8\pi^2 m} \frac{1}{\psi} \frac{d^2\psi}{dx^2}$ — (1)

$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - V)\psi = 0$ — (1)

4.b) Explination of fermi energy. — (1)

Explination of expression for fermi energy at OK, — (2) 06

$N(E)\, dE = g(E)\, dE \times f(E)$. — (1).

$g(E)\, d(E) = \frac{8\sqrt{2}\pi m^{3/2}}{h^3} E^{1/2}\, dE$ — (1)

$E_{F(0)} = \left(\frac{h^2}{8m}\right)\left(\frac{3n}{\pi}\right)^{2/3}$. — (1)

H.C. Given Data:-

Extension to be produced $x = 10^{-3} m$

Length of the wire $L = 2m$

Diameter $d = 1mm = 10^{-3} m$

young's modulus $Y = 2 \times 10^{11} N/m^2$.

To find :- The force required to.

Produce the extension $F = ?$

$$R = \frac{d}{2} = \frac{10^{-3}}{2} = 0.5 \times 10^{-3}$$

$$Y = \frac{FL}{ax} \qquad F = \frac{\pi R^2 Yx}{L} \quad \text{---(1)}$$

$$Y = \frac{FL}{\pi R^2 x} \qquad F = \frac{\pi (0.5 \times 10^{-3})^2 \times 2 \times 10^{11} \times 10^{-3}}{2} \quad \text{---(1)}$$

$$= \qquad F = 78.54. \quad \text{---(1)}$$

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Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: III Internal Assessment Test: - April - 2021

18PHY12-Engineering Physics

Time: 90 Min **Max. Marks: 30**

Note: 1. ***Answer any Two full Questions.***

2. ***Physical constants*****, Velocity of light, $c = 3 \times 10^8$ m/s,**
Planck's constant, $h = 6.63 \times 10^{-34}$ JS, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg,
Charge of electron, $e = 1.602 \times 10^{-19}$ C, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K

1	a.	Define fractional Index change (Δ). Derive the expression for Numerical aperture and acceptance angle of an optical fiber.	**(CO2 06 Marks)**
	b.	State and prove the Gauss divergence theorem.	**(CO2 06 Marks)**
	c.	Define attenuation. Explain the types of fiber losses.	**(CO2 04 Marks)**

OR

2	a.	Derive the expression for displacement current. Mention Maxwell's equations for time varying field and static field.	**(CO2 06 Marks)**
	b.	Describe different types of optical fiber with neat diagram.	**(CO2 06 Marks)**
	c.	The refractive index if core and clad are 1.50 and 1.48 respectively in an optical fiber find the numerical aperture and angle of acceptance.	**(CO2 04 Marks)**

PTO

Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: III Internal Assessment Test: - April 2021

18PHY12-Engineering Physics

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3 a. Setup one dimensional time independent Schrodinger wave equation. **(CO3 06 Marks)**

b. Describe the construction of the CO_2 laser and explain its working with the help of energy level diagram. **(CO4 06 Marks)**

c. An electron is bound in an one dimensional potential well of width 1Å, but if infinite wall height. Find its energy values in the ground state, and also in the first excited states. **(CO3 04 Marks)**

OR

4 a. Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein's co-efficient. **(CO4 06 Marks)**

b. Prove that electron cannot exist inside the nucleus of an atom. **(CO3 06 Marks)**

c. The ratio of population of two energy levels is 1.059×10^{-30}. Find the wavelength of light at 330K. **(CO4 04 Marks)**

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HOD

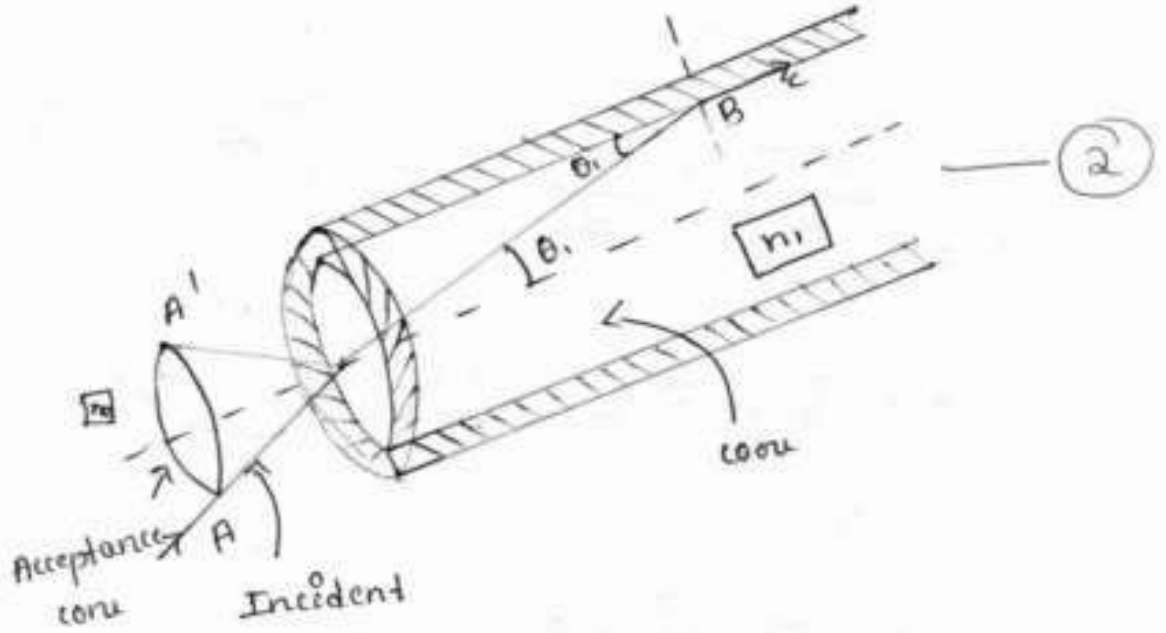
Principal

Question number	Scheme and Solution	Marks Allotted

Sub :- Engineering Physics Subcode :- 18PHY22

1. a. Fractional index change - it is the ratio of the refractive index difference between the core and cladding to the refractive index of core of an optical fiber. —— (1)

Expression for acceptance angle and Numerical aperture



06

—— (2)

$$n_0 \sin\theta_0 = n_1 \sin\theta_1 \quad \text{—— (1)}$$

$$\cos\theta_1 = \frac{n_2}{n_1}$$

$$\sin\theta_0 = \sqrt{n_1^2 - n_2^2} \qquad NA = \sqrt{n_1^2 - n_2^2} \quad \text{—— (1)}$$

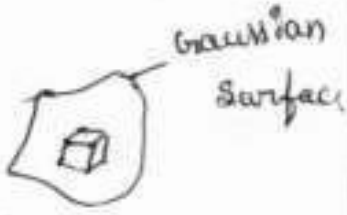
$$\sin\theta_i \angle \sin\theta_0$$

$$\sin\theta_i \angle \sqrt{n_1^2 - n_2^2} \quad \text{—— (1)}$$

b. Gauss divergence theorem.

The integral of the normal componet of the flux density overy any closed surface in an electric field is equal to the volume integral of the divergence of the flux throught the space enclosed by the surface & is represent mathematically — (1) OR

$$\oint_S \vec{D} \cdot d\vec{S} = \int_V \nabla \cdot \vec{D}\, dv \quad — (1)$$



$$\rho_v = \lim_{\Delta v \to 0} \left[\frac{\Delta Q}{\Delta v}\right] = \frac{dQ}{dv} \quad — (1)$$

$$Q = \int_V \nabla \cdot \vec{D}\, dv \quad — (1)$$

$$\oint_S \vec{D} \cdot d\vec{S} = Q \quad — (1)$$

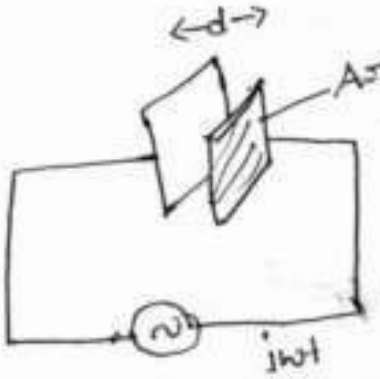
$$\oint_S \vec{D} \cdot d\vec{S} = \int_V \nabla \cdot \vec{D}\, dv \quad — (1)$$

1.c) **Attenuation**:- is the loss of power suffered by the optical signal as it propogated through the fiber. It is called attenuation. ——— (1)

Explination of 3 types of attenuation. 04

1. Absorption
2. Scattering
3. Radiation losses. ——— (3)

2.a Derivation for Expression for displacement current and motion for time varying field and Static field.



$V_0 e$ ——— (1)

$V = V_0 e^{jwt}$ ——— (1)

$D = \frac{\varepsilon V}{d} = \frac{\varepsilon}{d} V_0 e^{jwt}$

$I_D = \frac{jw\varepsilon A}{d} V_0 e^{jwt}$ ——— (1) 06.

Time varying field.

* $\nabla \cdot \vec{D} = \rho_v$
* $\nabla \times E = \frac{-\partial B}{\partial t}$
* $\nabla \cdot \vec{B} = 0$
* $\nabla \times \vec{H} = \vec{J} + \frac{\partial D}{\partial t}$

Static field:

* $\nabla \cdot \vec{D} = \rho_v$
* $\nabla \times \vec{E} = 0.$
* $\nabla \cdot \vec{B} = 0$
* $\nabla \times \vec{H} = J.$

——— (3)

2.b) Explination of 3 types of optical fiber.

* Single mode Step index optical fiber — (a)
* Multi mode Step index optical fiber — (a) 06.
* Multi mode Graded index optical fiber. — (a)

2.c) Data :-

Refractive index of the core $n_1 = 1.50$

Refractive index of the cladding $n_2 = 1.48$.

To find :- NA = ? θ = ?

Solution :-

$$N.A = \sqrt{n_1^2 - n_2^2}$$

$$= \sqrt{(1.50)^2 - (1.48)^2}$$

$$= 0.244$$

The angle of acceptance θ is related to NA through the equation.

$$\theta = \sin^{-1}(NA)$$

$$\theta = \sin^{-1}(0.244)$$

$$\theta = 14.1^\circ$$

3.a one dimensional time dependent Schrodinger wave equation.

$\lambda = h/p$ — (1)

$\psi = Ae^{i(kx - \omega t)}$ — (1)

$$\frac{1}{\lambda^2} = -\frac{1}{4\pi^2\psi}\frac{d^2\psi}{dx^2}$$

06

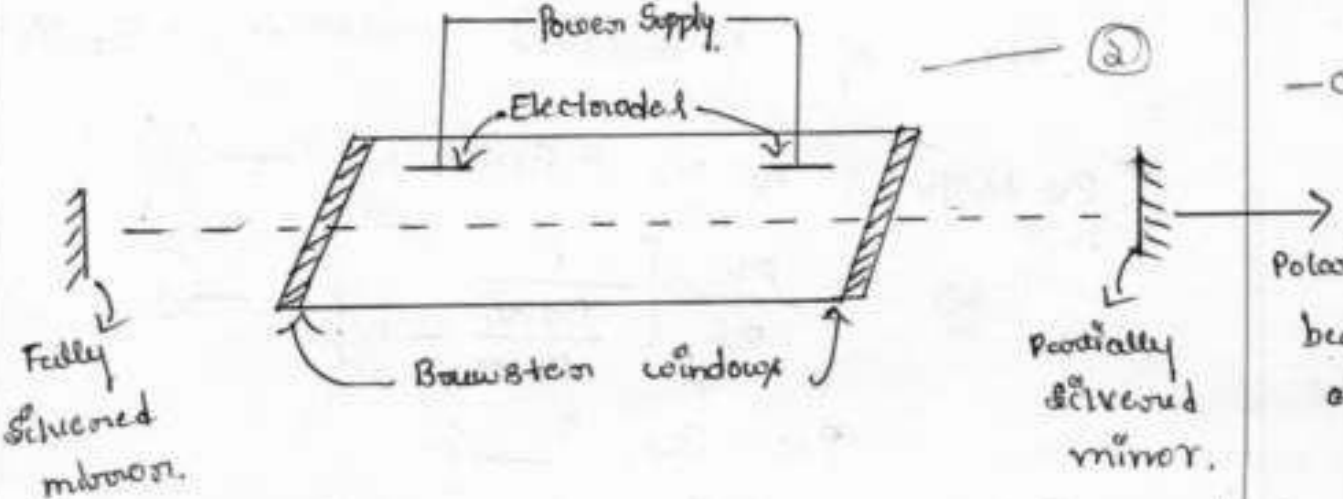
Kinetic Energy $= \frac{p^2}{2m}$ — (1)

$$K.E = -\frac{h^2}{8\pi^2 m}\frac{1}{\psi}\frac{d^2\psi}{dx^2}.$$ — (1)

$$E = -\frac{h^2}{8\pi^2 m}\frac{1}{\psi}\frac{d^2\psi}{dx^2} + V$$ — (1)

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2}(E - V)\psi = 0.$$ — (1)

3.b construction and working of CO_2 laser.



— (2) —06

Explination of construction and working with Energy level — (4)

3.c. Given data :-

Width of the potential well. $a = 1\text{Å} = 10^{-10}$ m.

To find $E_1 = ?$

Solution :- $E_n = \frac{n^2 h^2}{8ma^2}$

$$E_1 = \frac{h^2}{8ma^2} = \frac{(6.63\times10^{-34})^2}{8(9.11\times10^{-31})(10^{-10})^2}$$

$$E_1 = 6.0314\times10^{-18}\ J.$$

$$E_1 = 37.64\ eV$$

4.a) Derivation for energy density of radiation under equilibrium condition in terms of Einstein's co-efficient.

Rate of absorption $- B_{12} N_1 U_V$ — (1)

Rate of Spontaneous emission $= A_{21} N_2$ — (1) 06

Rate of Stimulated emission $= B_{21} N_2 U_V$.

$$B_{12} N_1 U_V = A_{21} N_2 + B_{21} N_2 U_V \quad \text{— (1)}$$

$$U_V = \frac{A_{21}}{B_{21}} \left[\frac{1}{\frac{B_{12} N_1}{B_{21} N_2} - 1} \right] \quad \text{— (1)}$$

$$B_{12} = B_{21} \quad \text{— (1)}$$

$$U_V = \frac{A}{B\left[e^{h\nu/kT} - 1\right]} \quad \text{— (1)}$$

4.b) $E = \frac{p^2}{2m}$ — (1)

$\Delta P_x \, \Delta x \geq \left(\frac{h}{4\pi}\right)$ — (1)

$\Delta P_x \geq \frac{h}{4\pi \, \Delta x}$

$\Delta x \leq 10^{-4} m$ — (1)

$\Delta P_x \geq \frac{6.63 \times 10^{-14}}{4\pi \times 10^{-14}}$ — (1)

$P_x \geq 0.5 \times 10^{-20} NS$ — (1)

$m = 9.11 \times 10^{-31} kg.$

$E \geq 1.372 \times 10^{-11} J$

$E \geq 85 MeV.$ — (1)

06

4.c) Given Data :-

$(N_2/N_1) = 1.059 \times 10^{-30}$. $T = 330 K.$

To find $\lambda = ?$

Solution :- $\frac{N_2}{N_1} = e^{-\frac{\Delta E}{KT}}$.

$\ln\left(\frac{N_2}{N_1}\right) = -\frac{\Delta E}{KT} = -\frac{hc}{\lambda KT} = -\left(\frac{hc}{k}\right)\left[\frac{1}{\lambda T}\right]$.

$\lambda = \frac{0.014413}{\ln(1.059 \times 10^{-30}) \times 330}$ $= 632 nm$

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SHRIDEVI

Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester: I Online Internal Assessment Test : June 22, 2021

18PHY22-Engineering Physics

Time: 2 hrs. **Max. Marks: 40**

Note: 1. *Answer all Questions.*

2. *Physical constants*, Velocity of light, $c = 3 \times 10^8$ m/s,
Planck's constant, $h = 6.63 \times 10^{-34}$ JS, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg,
Charge of electron, $e = 1.602 \times 10^{-19}$ C, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K

1	a.	Derive an expression for equivalent force constant for two springs in series. What is the expression for period of its oscillation?.	**(CO1 08 Marks)**
	b.	With a neat diagram explain the construction and working of Reddy shock tube.	**(CO1 08 Marks)**
	c.	For a particle executing SHM , its acceleration is found to be $15 cm/s^2$ when it is at 3cm from its mean position. Calculate time period.	**(CO1 04 Marks)**
2	a.	What are the assumption of Quantum free Electron Theory (QFET)? Explain merits of QFET.	**(CO5 08 Marks)**
	b.	Define Fermi energy and Fermi factor. Explain the dependence of Fermi factor on temperature and energy.	**(CO5 08 Marks)**
	c.	The distance between two pressure sensors in a shock tube is 150 mm, the time taken by a shock wave to travel this distance is 0.3 ms, if the velocity of sound under the same condition is 340 m/s. find the mach number of shock wave.	**(CO1 04 Marks)**

22/6/2021
HOD

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Scheme and Solutions

Question number | Marks allowed

Sub: Engineering Physics | Subcode :- 18PHY122

1.a)

According to Hook's law.

$F = -K_1 x_1$ — (1)

$F = mg$ hence $mg = -k_2 x_1$ — (1) — (2)

$x_1 = \frac{-mg}{K_1}$ — (1) $x_2 = \frac{-mg}{K_2}$ — (1)

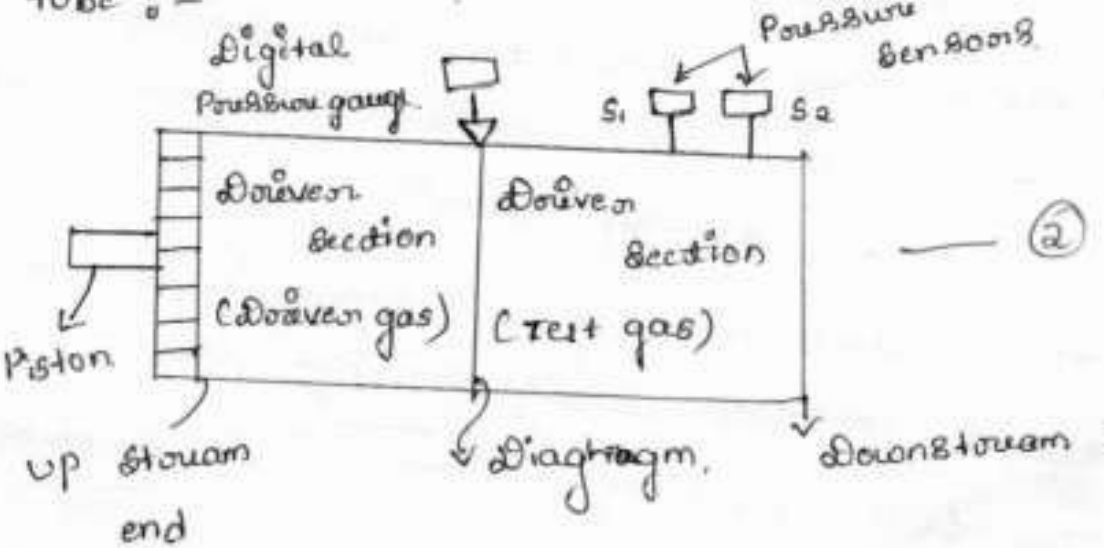
$x_1 + x_2 = \frac{-mg}{K_S}$ — (1)

$K_S = \frac{K_1 K_2}{K_1 + K_2}$ — (1)

08

1.b)

Construction and working of Reddy Shock tube :-



— (2)

Explanation of working and construction of reddy's tube. — (6)

08

1.c) Given data :- $a = 15cm\ 19^{2} = 15\times10^{-2}m/s^{2}$

$x = 3cm = 3\times10^{-2}m$

To find out :- $T = ?$

Solution :- $x = a\sin\omega t \Rightarrow v = \frac{dx}{dt} = a\cos\omega t(\omega)$

$a = \frac{d^2x}{dt^2} = -a\omega^2\sin\omega t \cdot \quad a = -\omega^2 x \Rightarrow \omega = \sqrt{\frac{a}{x}}$ 04

$\omega = \sqrt{\frac{15\times10^{-2}}{3\times10^{-2}}}$

$\omega = 2\pi f$

$= 2.24\ rad/s$

$\omega = \frac{2\pi}{T}$

$T = \frac{2\pi}{\omega} = \frac{2(3.142)}{2.24} = 2.8\ seconds$

2.a) Assumptions of quantum free electron Theory are.

* The energy values of the conduction electrons are quantized, the allowed energy values are realized in terms of a set of energy levels —— (1)
* The distribution of electrons in the various allowed energy levels as per pauli's principle —— (1)
* The free electrons travel in a constant potential —— (1)
* The attraction between the free electrons and the repulsion between the electrons themselves are ignored. —— (1)

Explination of merit's of QFET.

* Temperature dependence of electrical conductivity. —

* Electrical conductivity and electron concentration — (2) 08

* Specific heat — (2)

2.b. Fermi Energy :-

The Energy corresponding to the highest occupaid level called Fermi energy

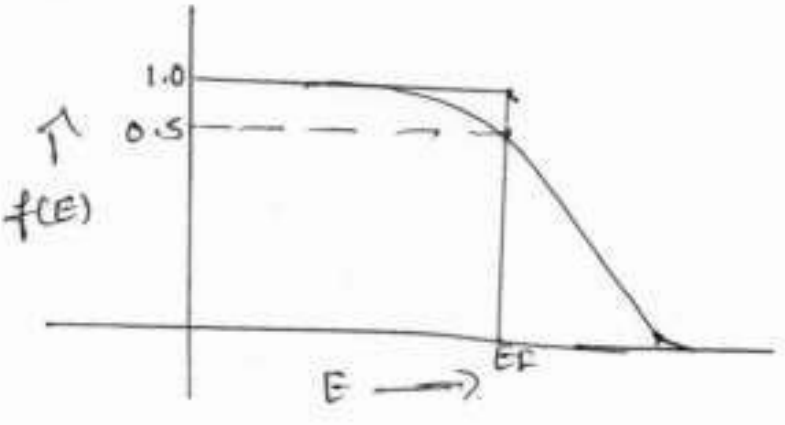
Fermi Factor :-

is the probability of occupation of a given energy state for a material in thermal equilibrium

(i) case - 1. $E < E_F$ $f(E) = 1$

(ii) case - 2 $E > E_F$ $f(E) = 0$

(iii) case - 3 $E = E_F$ $f(E) = 1/2$



3.c) Given Data :-

Distance between the two pressure sensors

$d = 150 \times 10^{-3}$ m

Time taken to travel d is $t = 0.3 \times 10^{-3}$ S

velocity of sound $a = 340\ ms^{-1}$

To find :

mach number of the shock wave M = ?

Shock speed $U_s = \frac{d}{t} = \frac{150 \times 10^{-3}}{0.3 \times 10^{-3}}$

$U_s = 500\ ms^{-1}$

mach no $M = \frac{U_s}{a} = \frac{500}{340} = 1.47$

$M = 1.47$

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SHRIDEVI

Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester: II Internal Assessment Test: - August 2021

18PHY22-Engineering Physics

Time: 90 Min **Max. Marks: 40**

Note: 1. ***Answer any Two full Questions.***

2. *Physical constants*, Velocity of light, $c = 3 \times 10^8$ m/s,
Planck's constant, $h = 6.63 \times 10^{-34}$ JS, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg,
Charge of electron, $e = 1.602 \times 10^{-19}$ C, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K

1 a. Derive the relation between Young's modulus (Y), rigidity modulus (n) and Poisson's ration (σ). **(CO1 08 Marks)**

b. Derive the expression for the depression and Y at the free end of a beam of loaded cantilever. **(CO1 08 Marks)**

c. Calculate the force required to produce an extension of 1mm in steel wire of length 2m diameter 1mm. ($Y = 2 \times 10^{11}$ N/m^2) **(CO1 04 Marks)**

OR

2 a. Derive the relation between bulk modulus (K) , Young's modulus (Y) and Poisson's ration (σ). **(CO1 08 Marks)**

b. Derive the Expression for couple per unit twist of a solid cylinder. **(CO1 08 Marks)**

c. Calculate the angular twist of a wire of length 0.3 m and radius 0.2×10^{-3} m when a torque of 5×10^{-4} Nm is applied (Rigidity modulus of the material is 8×10^{10} N/m^2. **(CO1 04 Marks)**

P.T.O

SHRIDEVI

Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester: II Internal Assessment Test: - August 2021

18PHY22-Engineering Physics

Time: 90 Min **Max. Marks: 40**

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1 a. Derive the relation between Young's modulus (Y), rigidity modulus (n) and Poisson's ration (σ). **(CO1 08 Marks)**

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3	a.	Define fractional Index change (Δ). Derive the expression for Numerical aperture and acceptance angle of an optical fiber.	**(CO2 08 Marks)**
	b.	Describe different types of optical fiber with neat diagram.	**(CO2 08 Marks)**
	c.	Find the attenuation in an optical fiber of length 500m when a light signal power 100mW emerges out of the fiber with a power 90mW.	**(CO2 04 Marks)**

OR

4	a.	Derive the expression for bending moment in terms of moment of inertia.	**(CO1 08 Marks)**
	b.	Define attenuation. Explain the types of fiber losses.	**(CO2 08 Marks)**
	c.	The refractive indices of core and clad are 1.50 and 1.48 respectively in an optical fiber. Find the numerical aperture and angle of acceptance.	**(CO2 04 Marks)**

3	a.	Define fractional Index change (Δ). Derive the expression for Numerical aperture and acceptance angle of an optical fiber.	**(CO2 08 Marks)**
	b.	Describe different types of optical fiber with neat diagram.	**(CO2 08 Marks)**
	c.	Find the attenuation in an optical fiber of length 500m when a light signal power 100mW emerges out of the fiber with a power 90mW.	**(CO2 04 Marks)**

OR

4	a.	Derive the expression for bending moment in terms of moment of inertia.	**(CO1 08 Marks)**
	b.	Define attenuation. Explain the types of fiber losses.	**(CO2 08 Marks)**
	c.	The refractive indices of core and clad are 1.50 and 1.48 respectively in an optical fiber. Find the numerical aperture and angle of acceptance.	**(CO2 04 Marks)**

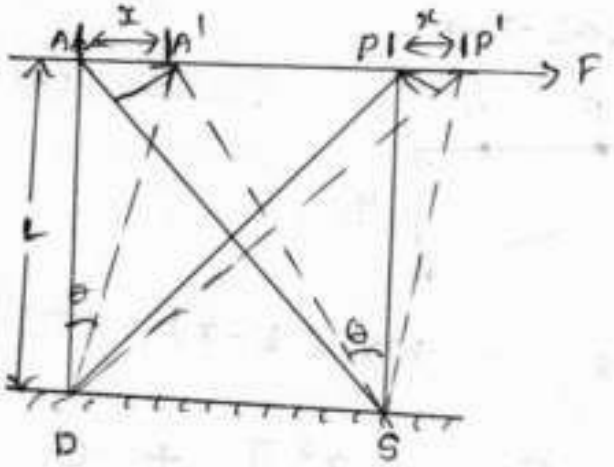
HOD 29/9/2021

Principal

Scheme of Evaluation.

Sub:- Engineering physics Sub code:- 18PHY22

1 a) Relation between young's modulus (Y), rigidity modulus (n), and poisson's ratio (σ)



08

Total extension along DP

$$P'x = DP \cdot T\ (\alpha+\beta)$$

$$P'x = (\sqrt{2}L)\ T\ (\alpha+\beta) \quad \text{---(1)}$$

$$2(\alpha+\beta) = x/TL$$

Inverting $\frac{1}{2(\alpha+\beta)} = \frac{T^2}{x} = \frac{T}{x/L} = \frac{T}{\theta} = n$ ---(1)

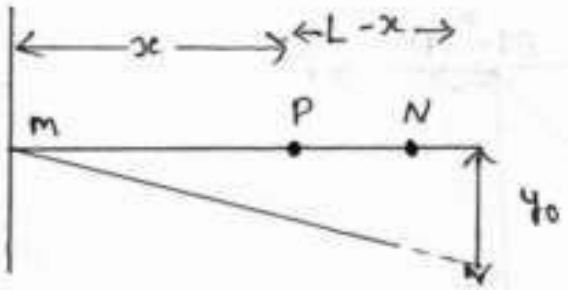
$$n = \frac{1/L}{2(1+\sigma)} \quad \text{---(1)}$$

$$Y = \frac{\text{Stress}}{\text{L. Strain}} = \frac{1}{\text{L.S/ stress}} \quad \text{---(1)}$$

$$Y = \frac{1}{\text{Strain along DP / unit stress}} \quad \text{---(1)}$$

$$n = \frac{Y}{2(1+\sigma)} \Rightarrow \boxed{Y = 2n(1+\sigma)} \quad \text{---(1)}$$

1. b) Expression for the deflection and Y at the free end of a beam of loaded cantilever.



Bending moment = $Wx(L-x)$ — (1)

$$\frac{dy}{dx} = \frac{W}{YIq}\left[Lx - \frac{x^2}{2}\right] + C_1 \quad \text{— (1)}$$

$$y = \frac{W}{YIq}\left[\frac{Lx^2}{2} - \frac{x^3}{6}\right] + C_2 \quad \text{— (1)}$$

$$y_0 = \frac{W}{YIq}\left[\frac{L \cdot L^2}{2} - \frac{L^3}{6}\right] \quad \text{— (1)}$$

$$y_0 = \frac{W}{YIq}\left[\frac{L_3}{2} - \frac{L^3}{6}\right] \quad \text{— (1)}$$

$$y_0 = \frac{WL^3}{3YIq}$$

$$Y = \frac{WL^3}{3y_0Iq} \quad \text{— (1)}$$

1.c] Given data :- $x = 10^{-3}\ m$, $L = 2m$, $d = 1mm$

$Y = 2 \times 10^{11}\ N/m^2$.

To find :- $F = ?$

Solution :-

Radius of the wire $R = d/2 = \frac{10^{-3}}{2} = 0.5 \times 10^{-3}\ m$

$$Y = \frac{FL}{ax}$$

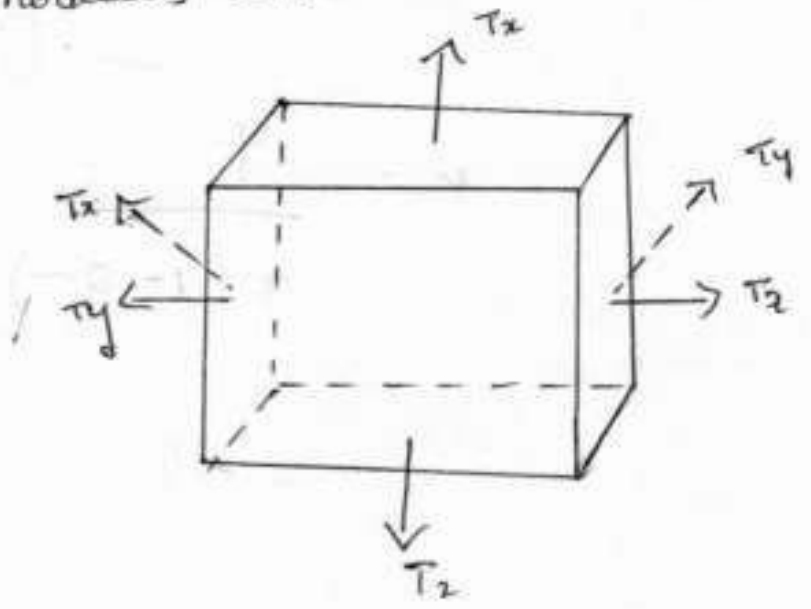
W.K.T $a = \pi R^2$

$$Y = \frac{FL}{\pi R^2 x} \Rightarrow F = \frac{\pi R^2 Y x}{L}$$

$$F = \frac{\pi \times (0.5 \times 10^{-3})^2 \times 2 \times 10^{11} \times 10^{-3}}{2}$$

$$= 78.5\ N$$

2.c] Relation between bulk modulus (k), Young's modulus (Y) and poisson's ratio (σ).



—— (2)

along x- direction ——— (1)

$1 + \alpha T_x - \beta T_y - \beta T_z$

along y- direction ——— (1)

$1 + \alpha T_y - \beta T_z - \beta T_x$

along z- direction ——— (1)

$1 + \alpha T_z - \beta T_x - \beta T_y$

Value of cube = $1 + (\alpha + 2\beta)\, 3T$ ——— (1) 08

Volume Strain = $\frac{\text{change in volume}}{\text{original volume}}$

$= \frac{3P(\alpha - 2\beta)}{1}$

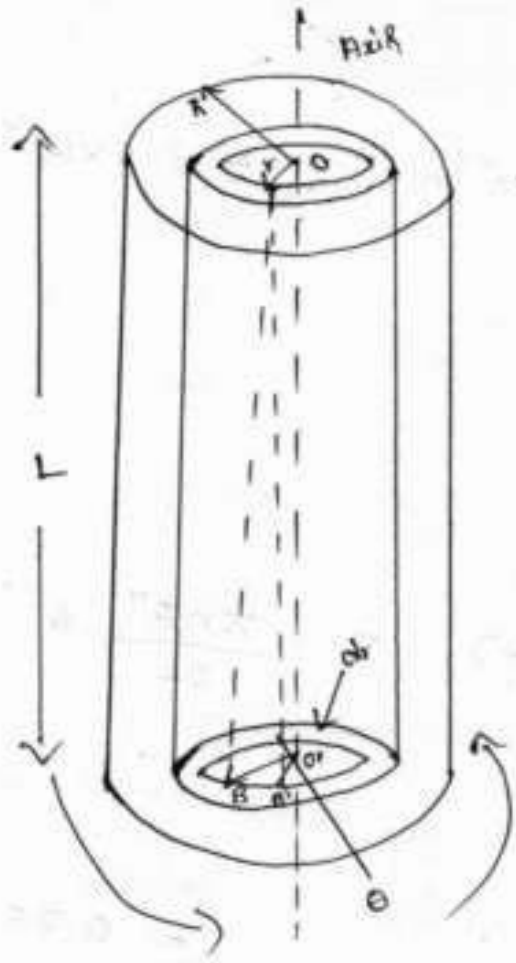
Bulk modulus $K = \frac{\text{Pressure}}{\text{volume Strain}}$

$K = \frac{P}{3P(\alpha - 2\beta)}$ ——— (1)

$K = \frac{Y}{3(1 - 2\sigma)}$

——— (1)

2b]



$\angle BXB' = \phi$

$\angle BOB' = \theta$

$BO' = B'O' = r$

$\phi = \frac{r\theta}{L}$ — (2)

$F = T\,(2\pi r\,dr)$ — (1)

Rigidity modulus $n = \frac{\text{Shearing Stress}}{\text{Shearing Strain}}$ — (1) 08

$= \frac{T}{\phi}$

$T = n\phi$ — (1)

$T = \frac{nr\theta}{L}$

$F = \frac{2\pi n\theta}{L} r^2\,dr$

$OO' = \frac{2\pi n\theta}{L} r^3\,dr$ — (1)

$OO' = \int_{r=0}^{r=R} \frac{2\pi n\theta r^3}{L}\,dr$ — (1)

$OO' = \frac{\pi n R^4 \theta}{2L}$

$C = \frac{\pi n R^4}{2L}$ — (1)

2.c) Given data :-

$L = 0.3\ m$, $R = 0.2 \times 10^{-3}\ m$, $\tau = 5 \times 10^{-4}\ Nm$

$n = 8 \times 10^{10}\ N/m^2$.

To find :- $\theta = ?$

Solution :- $\tau = C\theta$

where $C = \frac{\pi n R^4}{2L} \Rightarrow \tau = \frac{\pi n R^4}{2L}\theta$

$$\theta = \frac{2\tau L}{\pi n R^4}$$

$$\theta = \frac{2 \times 5 \times 10^{-4} \times 0.3}{3.1 \times 8 \times 10^{10} \times (0.2 \times 10^{-3})^4}$$

$= 0.75$ radian.

3.a) fractional index change (Δ) :-

~~the~~ incident angle of ~~the~~ light beam it is the ratio of the refractive index difference between the core and cladding to the refractive index of core of an optical fiber.

$$\Delta = \frac{n_1 - n_2}{n_1} \quad \text{——— (2)}$$

3.b) Explain 3 types of optical fiber with diagram

1. Single mode step index O.F — (2)
2. multi mode step index O.F — (3)
3. multi mode Graded index O.F — (3)

08

3.c) Given data :- $L = 500m$, $P_{in} = 100\ mW$

$P_{out} = 90\ mW$

To find : $\alpha = ?$

$$\alpha = \frac{-10}{L} \log_{10}\left[\frac{P_{out}}{P_{in}}\right] \ dB/km.$$

$$\alpha = \frac{-10}{0.5} \log_{10}\left[\frac{90}{100}\right]$$

$$= 0.915\ dB/km$$

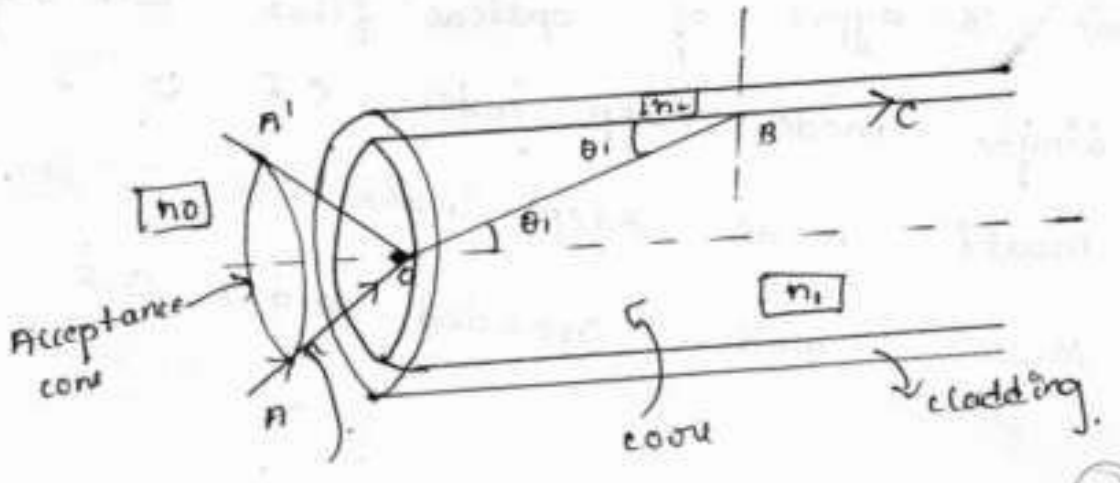
04

4.a] Figure and Explanation — 02

$CD = R\theta$

$\Lambda'B' = (R+x)\theta$ — 02

upto $F = \frac{yar}{R}$ — 01



(2)

Snell's law at the point O.

$$n_0 \sin\theta_0 = n_1 \sin\theta_1 \quad \text{---(1)}$$

Snell's law at point B.

$$n_1 \sin(90 - \theta_1) = n_2 \sin 90$$

$$\cos\theta_1 = \frac{n_2}{n_1} \quad \text{---(1)}$$

$$\sin\theta_0 = \frac{n_1}{n_0} \sin\theta_1$$

$$\sin\theta_0 = \frac{\sqrt{n_1^2 - n_2^2}}{n_0} \qquad n_0 = 1$$

$$\sin\theta_0 = \sqrt{n_1^2 - n_2^2} \quad \text{---(1)}$$

$$NA = \sqrt{n_1^2 - n_2^2} \quad \text{---(1)}$$

$$\sin\theta_i < \sqrt{n_1^2 - n_2^2}$$

$$RM = \frac{\sum ya r^2}{P} \quad \text{—— 02}$$

$$RM = \frac{Y}{P} I_g \quad \text{—— 01}$$

08

4.b] Defination of attenuation.

3 Types of attenuation

08

* absorption
* Scattering
* Radiation.

4.c)

Given data :-

$n_1 = 1.50$, $n_2 = 1.48$

To find :- $NA = ?$, $\theta = ?$

04

Solution :-

$$NA = \sqrt{n_1^2 - n_2^2}$$

$$= \sqrt{1.50^2 - 1.48^2}$$

$$= 0.244$$

$$\theta = \sin^{-1}(NA)$$

$$= \sin^{-1}(0.244)$$

$$= 14.1^0.$$

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Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester: III Internal Assessment Test: - September 2021

18PHY22-Engineering Physics

Time: 90 Min **Max. Marks: 40**

Note: 1. ***Answer any Two full Questions.***

2. ***Physical constants*****, Velocity of light, $c = 3 \times 10^8$ m/s,**
Planck's constant, $h = 6.63 \times 10^{-34}$ JS, Mass of electron, $m_e = 9.1 \times 10^{-31}$ kg,
Charge of electron, $e = 1.602 \times 10^{-19}$ C, Boltzmann constant, $K = 1.38 \times 10^{-23}$ J/K

1	a.	State Heisenberg's uncertainty principle. Show that electrons cannot exist inside the nucleus.	**(CO3 08 Marks)**
	b.	Set up time independent Schrödinger wave equation for free particle in one-dimension using complex wave function.	**(CO3 08 Marks)**
	c.	A particle of mass 940 MeV/c^2 has a kinetic energy 0.5 KeV. Find the de-Broglie wavelength. (c is the velocity of light).	**(CO3 04 Marks)**
		OR	
2	a.	Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein's co-efficient.	**(CO4 08 Marks)**
	b.	Describe the construction of the CO_2 laser and explain its working with the help of energy level diagram.	**(CO4 08 Marks)**
	c.	Mention the application of laser.	**(CO4 04 Marks)**

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3 a. State and prove the Gauss divergence theorem. **(CO2 08 Marks)**

b. Derive the expression for displacement current. Mention Maxwell's equations for time varying field and static field. **(CO2 08 Marks)**

c. Calculate the wavelength associated with an electron having K.E. 100 eV. **(CO3 04 Marks)**

OR

4 a. Derive the EM wave equation in terms of electric field using Maxwell's equation **(CO2 08 Marks)**

b. What is EM polarization? Explain various types of EM polarization Mechanisms. **(CO2 08 Marks)**

c. A particle of mass 0.5 MeV/c^2 has a kinetic energy 100 eV. Find the de-Broglie wavelength. (c is the velocity of light). **(CO3 04 Marks)**

HOD

Principal

Sept - 2021

Question Number

II Semester : III Internal Assessment Test.

18PHY22 - Engineering Physics

Marks

1. a. Statement of Heisenberg's Uncertainty principle.

In any simultaneous determination of the position and momentum of a particle the product of the corresponding uncertainties inherently present in the measurement is equal to (or) greater than $(h/4\pi)$ — (2)

Non - Existence of electron in the Nucleus :- 08

$$E = mc^2 = \frac{m_0 c^2}{\sqrt{1 - \frac{v^2}{c^2}}} \quad — 1$$

$$P = mv = \frac{m_0 v}{\sqrt{1 - \frac{v^2}{c^2}}} \quad — 1$$

$$P^2 c^2 = \frac{m_0^2 v^2 c^2}{(c^2 - v^2)} \quad — 1$$

$$E^2 = c^2 (P^2 + m_0^2 c^2) \quad — 1$$

$$\Delta P_x \, \Delta x \geq \left(\frac{h}{4\pi}\right) \quad — 1$$

$$E \geq 20.6 \text{ MeV}. \quad — 1$$

4.b Time independent Schrodinger wave equation.

$$\lambda = h/p \quad \text{—— 1}$$

$$\psi = A e^{i(kx - \omega t)} \quad \text{—— 1}$$

$$\psi = A e^{ikx}$$

$$\frac{d^2\psi}{dx^2} = \frac{1}{v^2} \frac{d^2\psi}{dt^2} \quad \text{—— 1}$$

$$\frac{d^2\psi}{dx^2} = -\frac{4\pi^2}{\lambda^2} \psi \quad \text{—— 1}$$

$$\frac{1}{\lambda} = -\frac{1}{4\pi^2\psi} \frac{d^2\psi}{dx^2} \quad \text{—— 1}$$

$$\text{Kinetic Energy} = -\frac{h^2}{8\pi^2 m} \frac{1}{\psi} \frac{d^2\psi}{dx^2}$$

$$\frac{d^2\psi}{dx^2} = -\frac{8\pi^2 m}{h^2} (E - V)\psi \quad \text{—— 1}$$

$$\frac{d^2\psi}{dx^2} + \frac{8\pi^2 m}{h^2} (E - V)\psi = 0. \quad \text{—— 1}$$

1.c Given :- $m = 940 \text{ MeV/c}^2$ $E = 0.5 \text{ keV}$.

To find out :- $\lambda = ?$

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.63 \times 10^{-34}}{\sqrt{2(1.67 \times 10^{-27})(0.5 \times 10^{3} \times 1.6 \times 10^{-19})}}$$

$$= 1.2 \times 10^{-12} \text{ m}.$$

2.a) Energy density of radiation under equilibrium condition in terms Einstein co-efficient,

Rate of absorption $= N_1 U_\nu B_{12}$ — 1

Rate of spontaneous emission $= A_{21} N_2$ — 1

Rate of stimulated emission $= B_{21} N_2 U_\nu$ — 1

Rate of absorption = Rate of spontaneous emission + Rate of stimulated emission — 1

$$U_\nu = \frac{A_{21} N_2}{B_{12} N_1 - B_{21} N_2} \quad \text{— 1}$$

$$\frac{N_2}{N_1} = e^{-\frac{h\nu}{KT}} \quad \text{— 1}$$

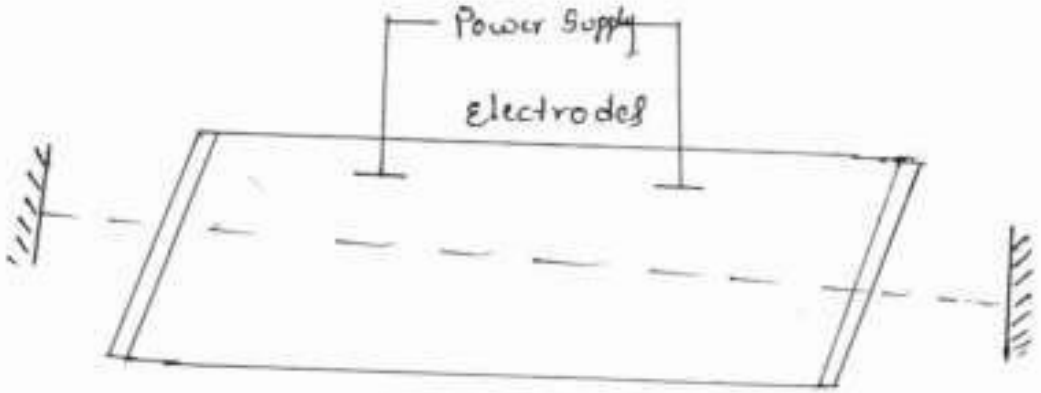
$$U_\nu = \frac{8\pi h\nu^3}{c^3} \left[\frac{1}{e^{\frac{+h\nu}{KT}} - 1} \right] \quad \text{— 1}$$

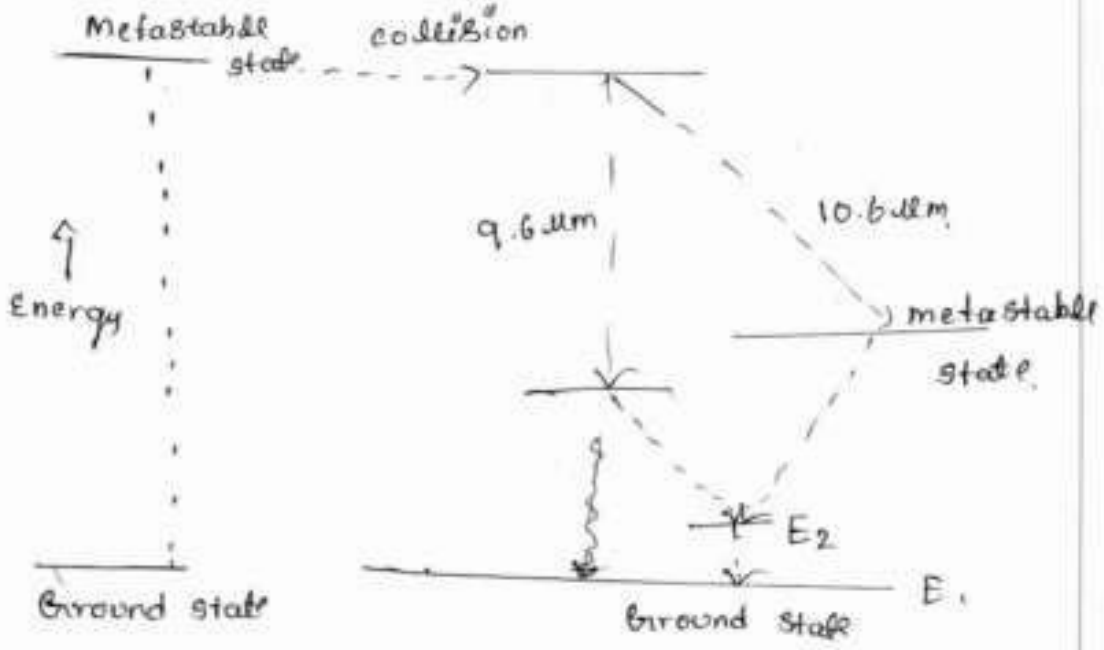
$$\frac{A_{21}}{B_{21}} = \frac{8\pi h\nu^3}{c^3} \qquad B_{12} = B_{21}$$

$$U_\nu = \frac{A}{B\left[e^{\frac{h\nu}{KT}} - 1\right]} \quad \text{— 1}$$

08

2.b. CO_2 Laser.





Construction and working of CO_2 Laser.

2.c Application of Laser

* Laser Welding
* Laser cutting
* Laser drilling
* Laser Scanner.
* Medical uses.

3.a)

Gauss divergence theorem

The volume integral of the divergence of a vector function F over a volume V is equal to the surface integral of the normal component of the vector function F over the surface enclosing the volume V.

$$D = \frac{\text{flux } (\phi)}{\text{area } (A)}$$

$$D = \varepsilon \bar{E}$$

The electric flux $\phi = \oiint D \cdot ds = q$

$$\phi = \oiint D \cdot ds$$

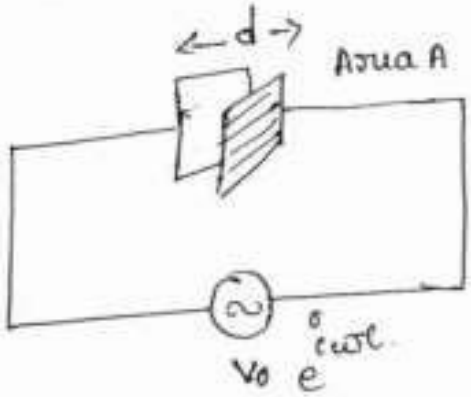
$$D = \frac{Q}{4\pi r^2} a_n$$

$$\phi = \frac{Q}{4\pi r^2} \iint ds a_n$$

Total flux = 0

$$\nabla \cdot D = \rho_v$$

3. b) Consider a parallel plate capacitor connected across an a.c. source



$V = V_0 e^{j\omega t}$ $\quad D = \varepsilon E$

$$D = \frac{\varepsilon V}{d} = \frac{\varepsilon}{d} V_0 e^{j\omega t}$$

$$I_D = \frac{j\omega \varepsilon A}{d} V_0 e^{j\omega t}$$

Maxwell's Equation Time-varying field.

Gauss law - $\nabla \cdot \vec{D} = \rho_v$

Faraday's law $\nabla \times E = -\frac{\partial \vec{B}}{\partial t}$

Gauss law for magnetic field $\nabla \cdot B = 0$

Ampere's law $\nabla \times \vec{H} = \vec{J} + \frac{\partial D}{\partial t}$

3.c. Given data :- $E = 100\,eV$

To find out :- $\lambda = ?$

Solution :- $p = \sqrt{2mE}$

$$= \sqrt{2 \times 9.11 \times 10^{-31} \times 100 \times 1.6 \times 10^{-19}}$$

$$= 5.39 \times 10^{-24}$$

$$\lambda = \frac{h}{p} = \frac{6.64 \times 10^{-34}}{5.39 \times 10^{-24}} = 1.22\,A^0$$

4.a) E-M wave equation.

$$\nabla \times H = \vec{J} + \frac{\partial D}{\partial t} \quad -1$$

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad -1$$

$$\nabla \times \vec{H} = \vec{J} + \varepsilon \frac{\partial \vec{E}}{\partial t} \quad -1$$

$$\nabla \times \vec{E} = -\mu \frac{\partial H}{\partial t}$$

$$\nabla \times \nabla \times \vec{E} = -\mu \frac{\partial}{\partial t} (\nabla \times \vec{H}) \quad -1$$

$$\nabla \left(\frac{\rho_v}{\varepsilon}\right) - \nabla^2 E = -\mu \frac{\partial}{\partial t} (\nabla \times \vec{H}) \quad -1$$

$$\nabla^2 \vec{E} - \mu\varepsilon \frac{\partial^2 \vec{E}}{\partial t^2} = \mu \frac{\partial \vec{J}}{\partial t} + \nabla \left(\frac{\rho_v}{\varepsilon}\right) \quad -1$$

$$\nabla^2 E - \mu\varepsilon \frac{\partial^2 E}{\partial t^2} = 0 \quad -1$$

06

4.b) Polarization is taken to refer to the manner in which the variation is observed in the electric field.

Types of electromagnetic polarization (2)

* Linear polarization
* Circular polarization
* Elliptical polarization

} 06

08

4.C

Given data:-

$m = 0.5\ Mev/c^2$

$E = 100\ ev = 100 \times 1.60 \times 10^{-19}$

To find:- $\lambda = ?$

Solution:- $m = 0.5\ Mev/c^2$

$= 0.5 \times 10^6\ ev/c^2$

$= (0.5 \times 10^6 \times 1.602 \times 10^{-19})\ J/c^2$

$m = \dfrac{0.5 \times 10^6 \times 1.602 \times 10^{-19}}{(3 \times 10^8)^2}$

$m = 8.9 \times 10^{-31}\ kg$

$\lambda = \dfrac{h}{\sqrt{2mE}} = \dfrac{6.63 \times 10^{-34}}{\sqrt{2 \times 8.9 \times 10^{-31} \times 100 \times 1.6 \times 10^{-19}}}$

$= 1.24 \times 10^{-10} m$

$= 1.24 A^0$

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PRINCIPAL
SIET, TUMAKURU.

SHRIDEVI INSTITUTE OF ENGINEERING AND TECHNOLOGY

(An ISO 9001-2008 Certified Institution)

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

ACADEMIC YEAR 2020-21

Internal Assessment Test II

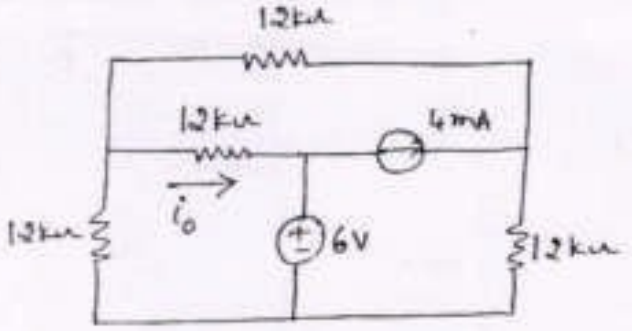
Course: Network Theory

Time: 90 min. Max Marks: 40

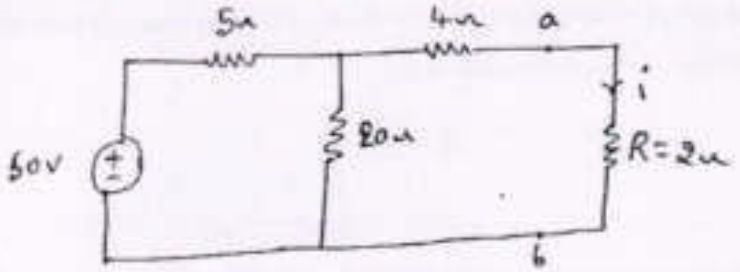
Course Code: 18EC32 Semester: III

Note: Answer all the questions.

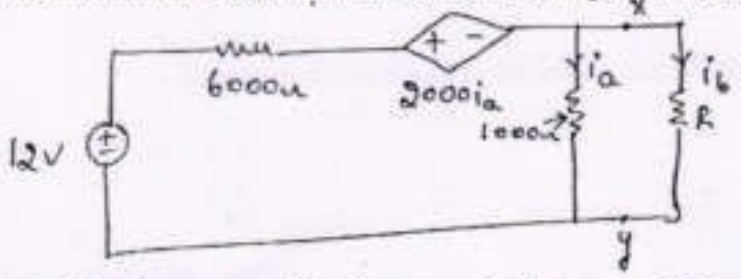
1) A) Use Super position theorem to find the current (i_o) shown in the fig. below. 6M



B) Find the Thevinen's equivalent circuit for the figure shown in below with respect to terminals a-b. Also find the current through 2Ω resistor. 6M

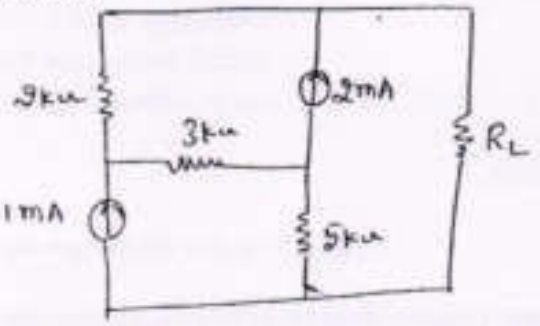


C) Refer the circuit shown below find the current I_b using Nortan's theorem. 5M

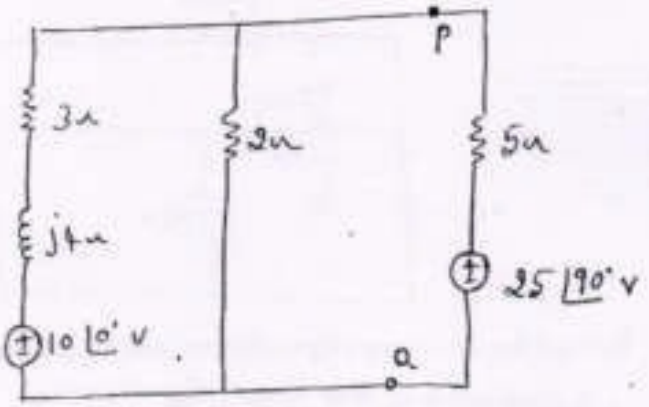


D) Briefly explain the super-position theorem related to network theory. 3M

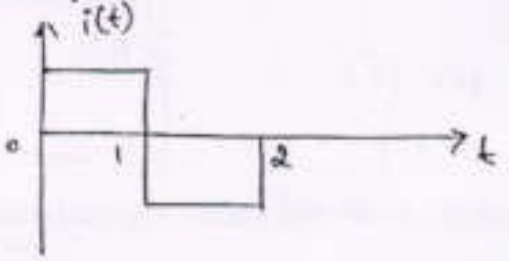
2) A) Find RL for maximum power transfer and the maximum power that can be transferred in the network shown below. **6M**



B) Find the current through 2 ohm resistor using Millman's theorem for the circuit shown in the fig. below. **6M**



C) Express the current pulse shown in the fig. below in terms of unit step. Also find the Laplace Transform of the given current pulse. **6M**



D) Find the Laplace Transform of RAMP function r(t). **2M**

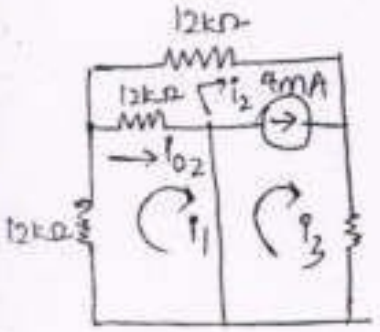
Solve Eqn ① and ②

$i_a = -0.2mA$ $\quad$ $i_b = 0.1mA$ $\quad$ $i_{01} = i_a - i_b = -0.3mA$

Step 2 :-

To find i_{02} which is the Contribution of 4mA Source acting alone.

Deactivating the 6V Source the circuit becomes



Constant Equations

$$i_3 - i_2 = 4mA$$

Applying KVL to Supermesh

$$12k(i_2 - i_1) + 12k i_2 + 12k i_3 = 0$$

$$-12k i_1 + 24k i_2 + 12k i_3 = 0$$

Applying KVL to mesh 1

$$12k i_1 + 12k (i_1 - i_2) = 0$$

$$24k i_1 - 12k i_2 = 0$$

Sol :- ①, ② and ③

$i_1 = -0.8mA$

$i_2 = 1.6mA$

$i_3 = 2.4mA$

$i_{02} = i_1 - i_2 = 0.8mA$

Step 3 :- to find i_o

By Superposition theorem

$i_{01} = i_{01} + i_{02}$

$i_o = -0.3m + 0.8m$

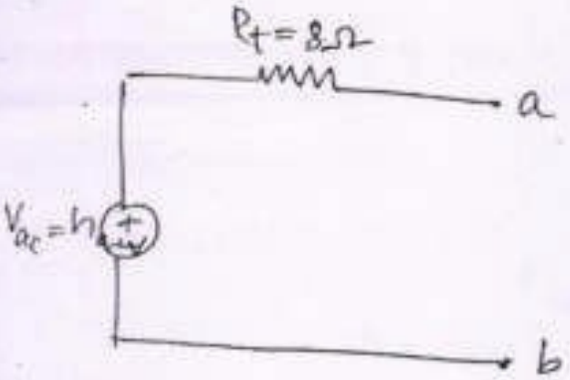
$i_o = 0.5mA$

applying KVL to the loop on the left gives

$$-50 + 25I = 0 \rightarrow I = 2A$$

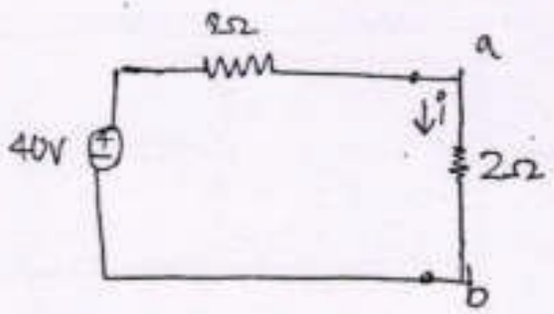
$$V_{ab} = V_{oc} = 20(I) = 40V$$

By thevenin's Equivalent



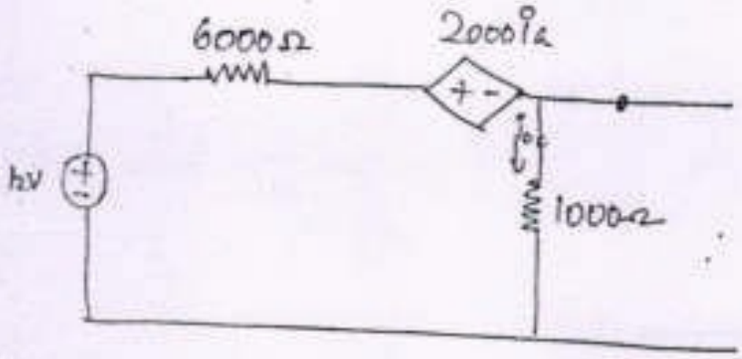
Reconnect the circuit B

$$E = \frac{40}{2+8} = 4A$$



1)

c)



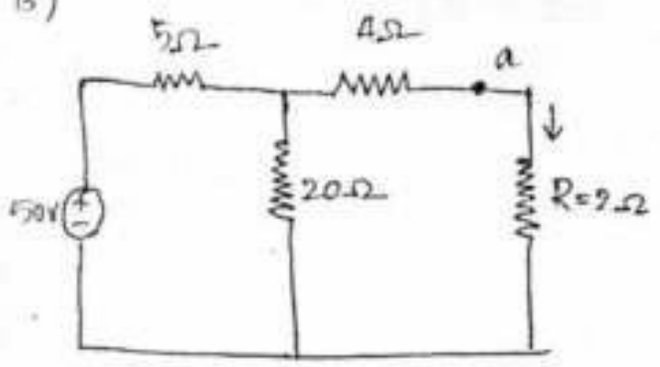
to find i_{oc}

by shorting the terminals x and y

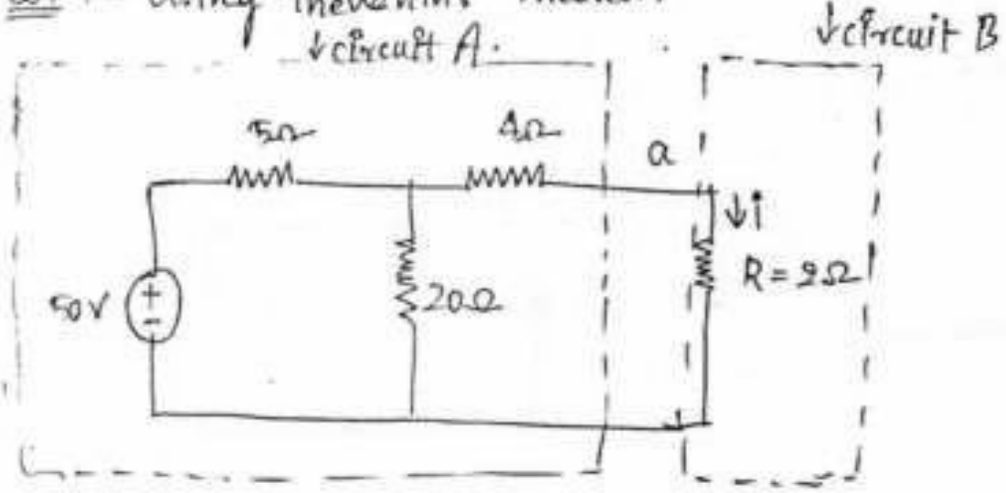
$$i_{oc} = \frac{0}{1000} = 0A$$

$$i_{oc} = \frac{12}{6000} A = 2mA$$

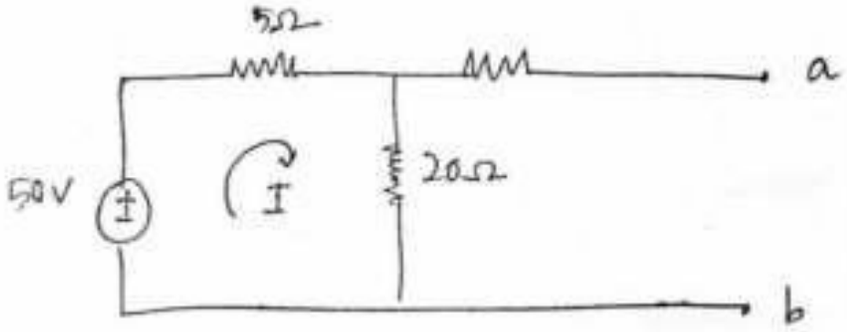
B)



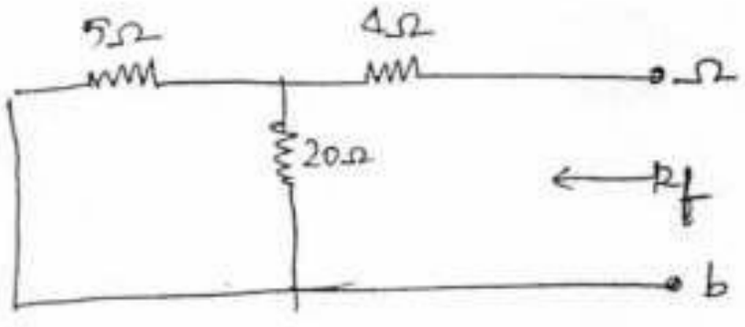
Sol :- Using thevenin's theorem



Remove the circuit-B

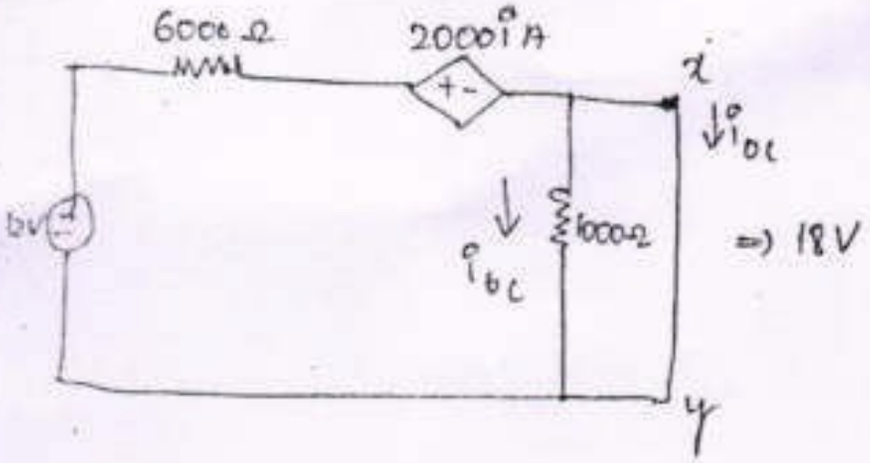


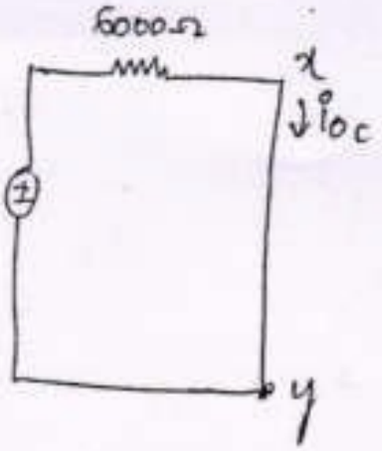
to find R_t, deactivate the independent Voltage in circuit



$R_t = (5\Omega \,||\, 20\Omega) + 4\Omega$

$= \frac{5 \times 20}{5+20} + 4 = 8\Omega$

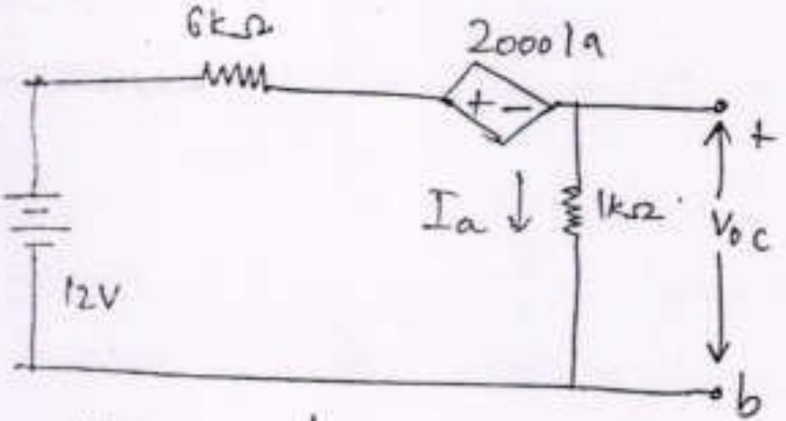




to find R_N :-

$$R_t = R_N = \frac{V_{oc}}{I_{oc}}$$

to find V_{oc}, make use of the circuit diagram shown in fig. Do not deactivate any source.



V_{cl} at node a :

$$\frac{V_{oc} + 2000 I_a - 12}{6k} + \frac{V_{oc}}{1k} = 0$$

$$2000 I_a + 7V_a = 12$$

Sub $I_a = \frac{V_{oc}}{1k}$ ⇒ $\boxed{V_{oc} = 4/3\ V}$

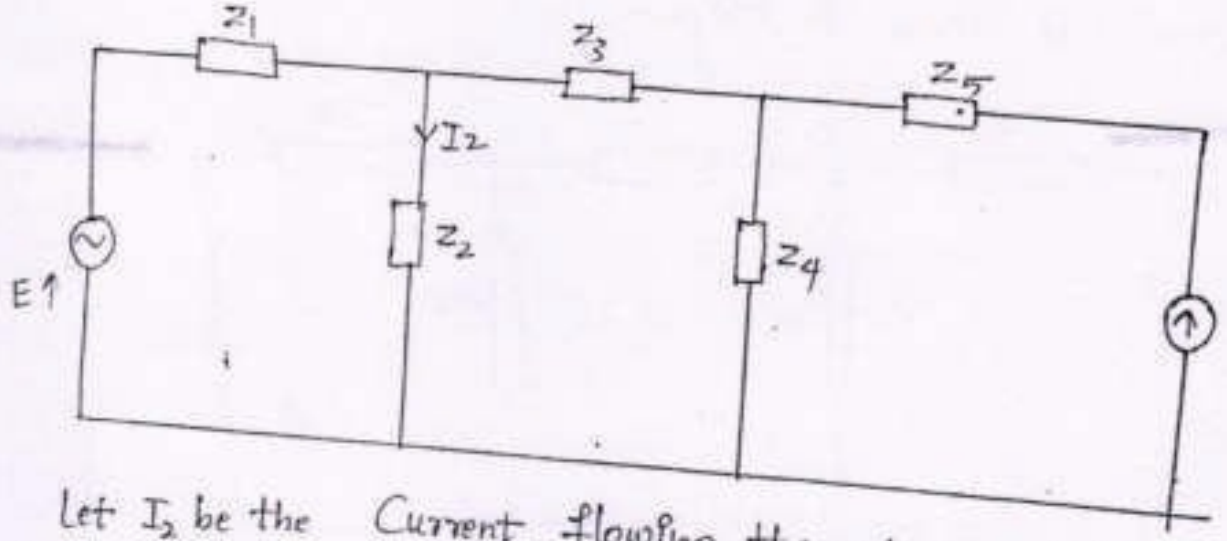
Therefore $R_N = \frac{V_{oc}}{I_{oc}} = 667\Omega$

1) D)

→ In any linear, bilateral network containing more than one independent source, the response in any element is equal to the algebraic sum of all responses due to each independent source acting the independent source acting into Zero.

If it is a Voltage Source, it is replaced by its initial Impedance or a Short circuit. If it is replaced by an Open circuit

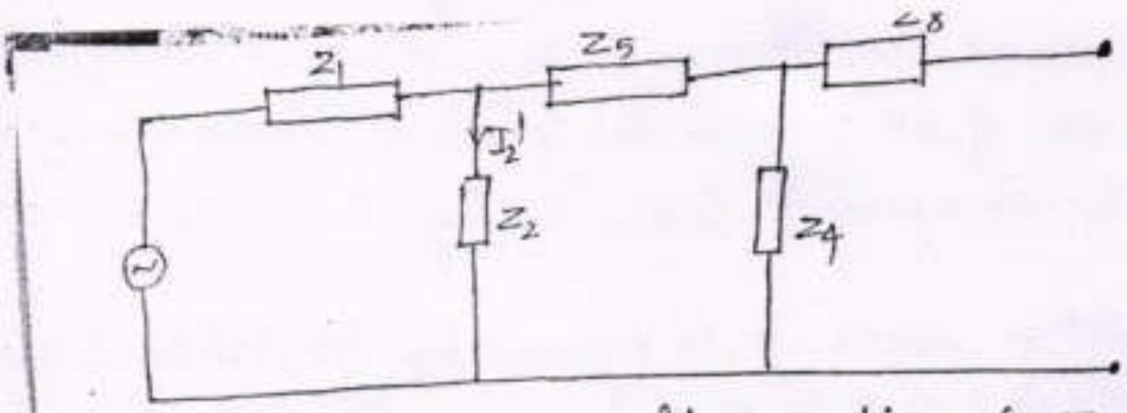
Explanation :- Consider an electrical ckt



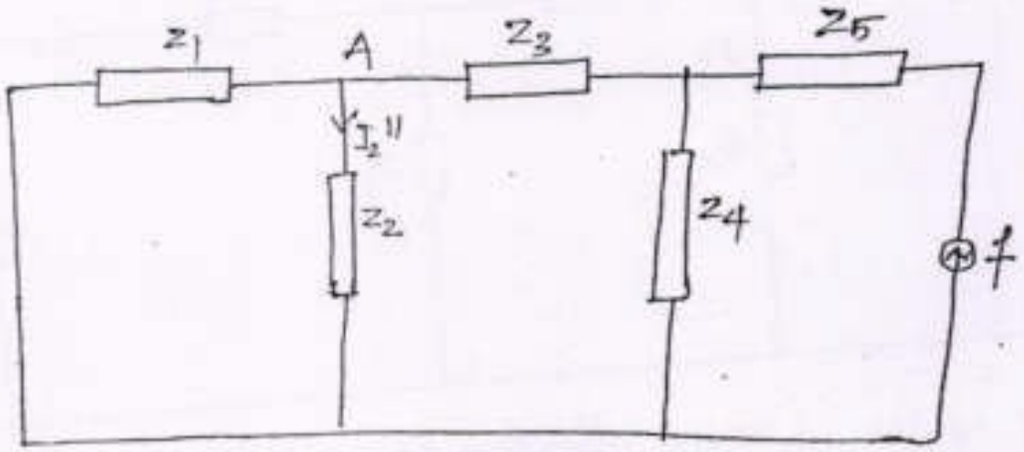
Let I_2 be the Current flowing through Z_2, When both are the Source E and I are present in the circuit

Now Consider the Source E only replacing the Current Source by an Open circuit :

The resulting network is shown in fig



let I_2' be the Current flowing through Z_2, Next, Consider the Source I Only, replacing the Voltage Source by a short circuit as shown in fig

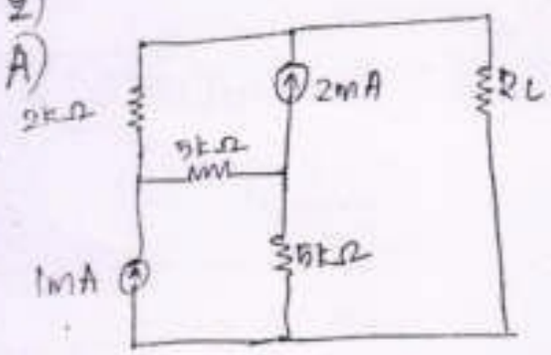


Let I_2'' be the Current flowing through Z_1 then according to Superposition theorem

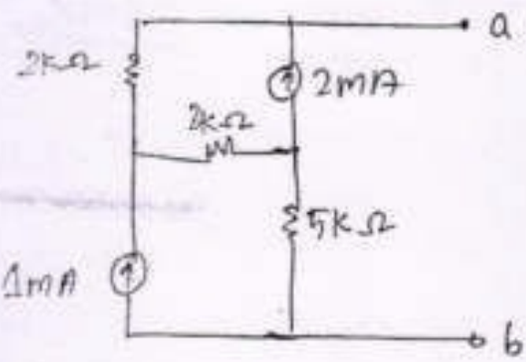
$$I_2 = I_1' + I_2''$$

2)

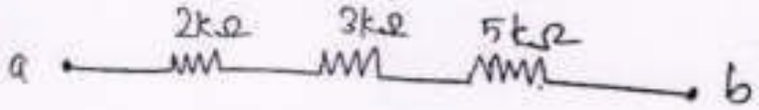
A)



101 :- Disconnect to the load resistor RL



to find R_t. let us deactivate all the Independent Sources



$$R_t = R_{ab} = 2k\Omega + 3k\Omega + 5k\Omega = 10k\Omega$$

for maximum power transfer $R_L = R_t = 10k\Omega$

Let us next find V_{oc} or V_t

$i_1 = -2mA$ & $i_2 = 1mA$

Applying KVL clockwise to the loop.

$5k\Omega \longrightarrow 3k\Omega \longrightarrow 2k\Omega \longrightarrow a-b$

$-5k\times i_2 + 3k(i_1 - i_2) + 2k\times i_1 + V_1 = 0$

$\rightarrow -5\times10^3(1\times10^{-3}) + 3\times10^3(-2\times10^{-3} - 1\times10^{-3}) + 2\times10^3(-2\times10^{-3})$

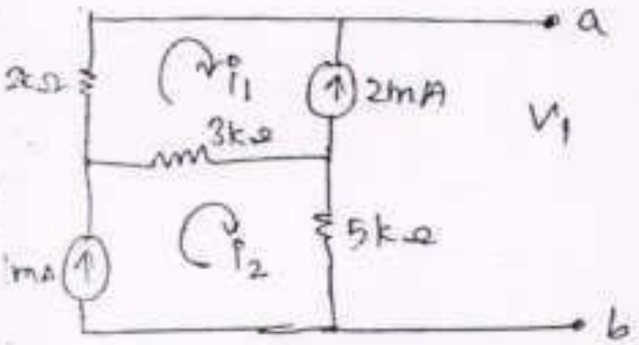
$+V_t = 0$

$\rightarrow \quad -5-9-4+V_t = 0$

$\boxed{V_t = 18V}$

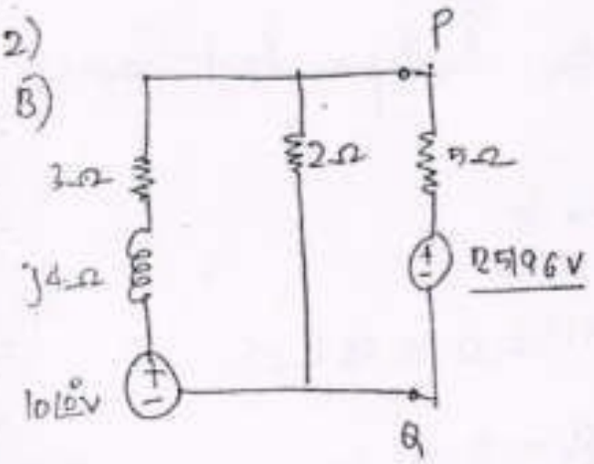
The thevenin's equivalent circuit with load resistor RL

$I = \frac{18}{(10+10)\times10^3} = \underline{0.9mA}$

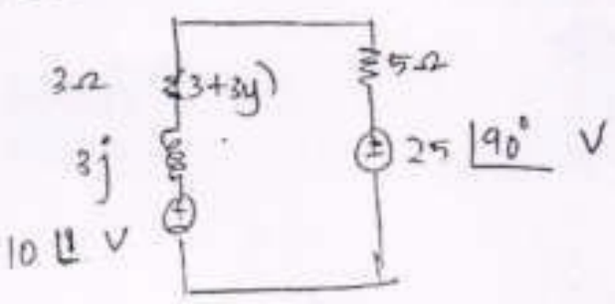


2)

B)



Sol:- Remove the 2Ω resistance



$$E = \frac{E_1 y_1 + E_2 y_2 + E_3 y_3}{y_1 + y_2 + y_3}$$

$$E = \frac{E_1 y_1 + E_2 y_2}{y_1 + y_2} \Rightarrow \frac{10 \times \frac{1}{3+3j} + 25 \angle 90 \; \frac{1}{5}}{\frac{1}{z_1} + \frac{1}{z_2}}$$

$$= \frac{10 \times \frac{1}{3+3j} + 25 \angle 90^\circ}{1/3 + 3j + 1/5} \Rightarrow \frac{10 \times (3-3j) + (5\cos 90 + j \sin 90)}{\frac{3-3j}{9+9j} + \frac{1}{5}}$$

$$= \frac{10(3-3j) + 5(0+1)}{\frac{3-3j}{9+9j} + \frac{1}{5}}$$

$$E = \frac{30 - 30j + 5j}{\frac{98}{3-3j} + 15} \Rightarrow \frac{30 - 60j}{1} \times \frac{5}{33 - 15j}$$

$$\Rightarrow (30 - 60j) \times \frac{5}{33-15j} \times \frac{33+15j}{33+15j}$$

$$E = 10.06 \angle 9712 \, V$$

$$E = \frac{30 - 3j + 90j}{18} = \frac{30 - 60j}{18}$$

$$\frac{5(3-3j) + 18}{90} \qquad \frac{15 - 15j + 18 \angle 90}{}$$

$$Z = \frac{1}{\frac{1}{z_1} + \frac{1}{z_2}} = \frac{1}{\frac{1}{(3+3j)} + \frac{1}{5}}$$

$Z = 2.8 \angle 26.56\ \Omega$

$$i_L = \frac{E}{2+Z} \Rightarrow \frac{10.06 \angle 97.12}{2+2.8 \angle 26.56}$$

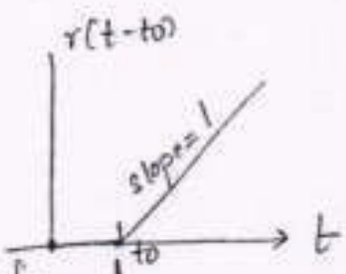
$$\Rightarrow \frac{10.06 \angle 97.12}{4.5 + j2.5}$$

$$\rightarrow \frac{10.06 \angle 97.12}{4.67 \angle 15.52}$$

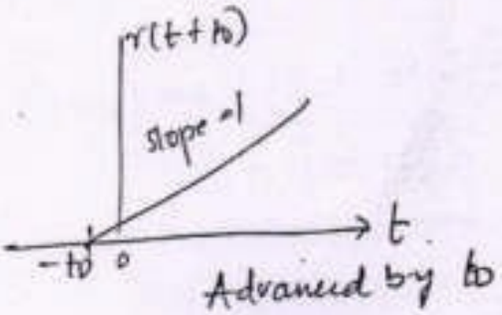
$$\boxed{i_L = 2.15 \angle -8.16}$$

2)

D)



A delayed ramp function by to



A delayed ramp function is shown in fig

Mathematically it is described as follows.

$$r(t-to) = \begin{cases} 0, & t \le to \\ t-to, & t \ge to \end{cases}$$

An advanced ramp function in fig, mathematically described

$$r(t+to) = \begin{cases} 0 & t \le -to \\ t+to, & t \ge -to \end{cases}$$

SHRIDEVI INSTITUTE OF ENGINEERING AND TECHNOLOGY
(An ISO 9001-2015 Certified Institution)
DEPARTMENT OF ELECTRONICS AND COMMUNICATION
ACADEMIC YEAR 2020-21

1st INTERNAL ASSESSEMENT TEST
Sub: Network Theory

Time: 90 minutes
Subject Code: 18EC32

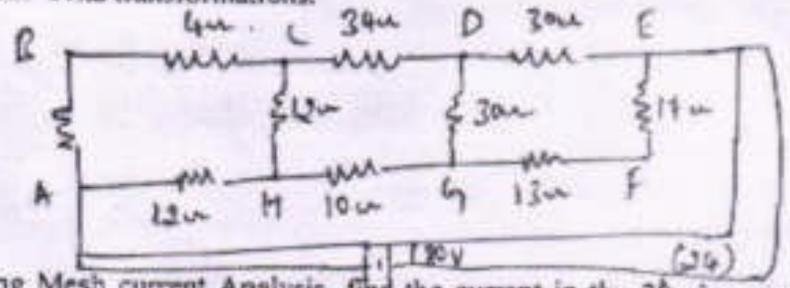
Max Marks: 40 M
Semester: III

Note: Answer all the questions

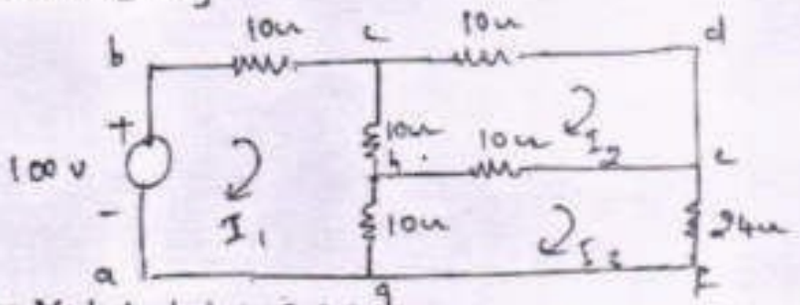
1) a) Explain the source transformation techniques in Electrical Networks. [CO1] 5M

b) Explain (a) Star-Delta Transformation (b) Delta-Star Transformation. [CO2] 5M

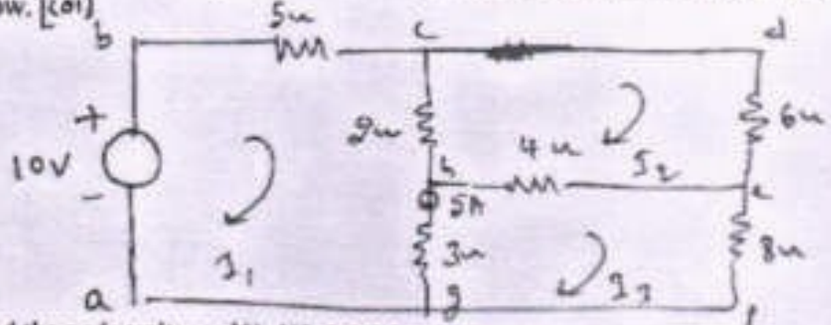
c) Find the current in 10 ohm resistor in the given network as shown in the fig. below using star-delta transformations. [CO1] 5M



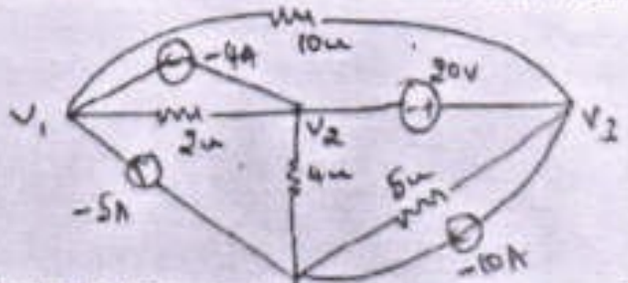
d) Using Mesh current Analysis, find the current in the 24 ohm resistor in the circuit shown below. [CO2] 5M



2) a) Using Mesh Analysis to find the various currents flowing in the networks shown below. [CO1] 7M



b) Find the node voltages V1, V2 & V3 in the circuit shown below. [CO2] 7M



c) Explain Thevinen's theorem in detail related electrical Network. [CO3] 6M

(Signature of the faculty)

(Signature of the HOD)

NAME:

USN:

BRANCH:- ECE

SUBJECT:- NETWORK THEORY (18EC32)

INTERNAL ACCESMENT-1

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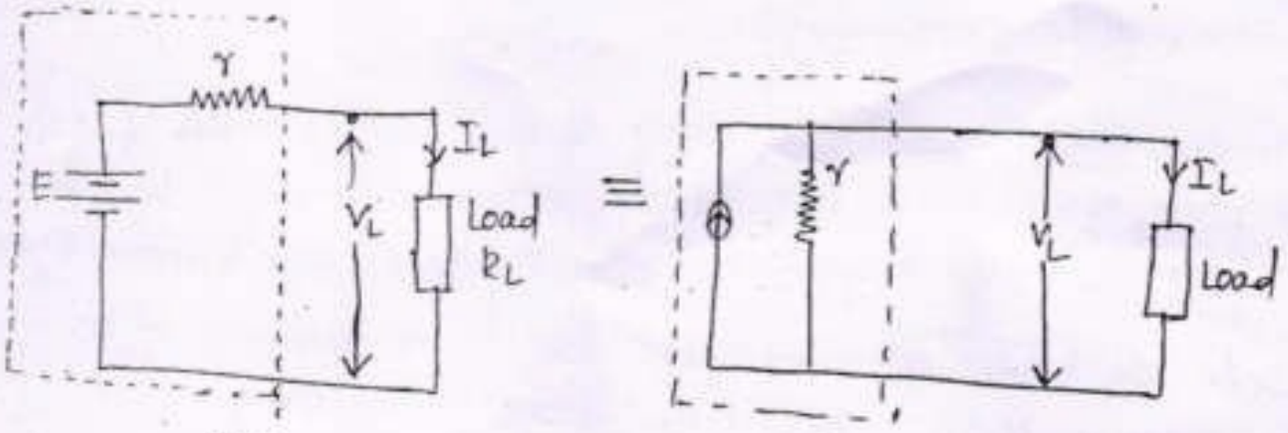
1)

a) Two Sources are said to be identical, when they produce identical terminal Voltage V_T and load Current I_L



(a) (b)

The ckts in fig (a) and (b) represent a practical Voltage source and a practical Current source respectively with load connected to both the Source. The terminal Voltage V_T is load Current I_L across their terminals are same. Hence, the practical Voltage Sources shown in dotted box in fig (a) is equivalent to the practical Current source shown in the dotted box of fig (b) The two equivalent source should also provide the source open ckt Voltage and short ckt Voltage.

from fig (a)

$$I_L = \frac{E}{r + R_L}$$

from fig (b)

$$I_L = \frac{r}{r + R_L}$$

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From this, it is evident that

$E = Ir$ and $I = E/r$

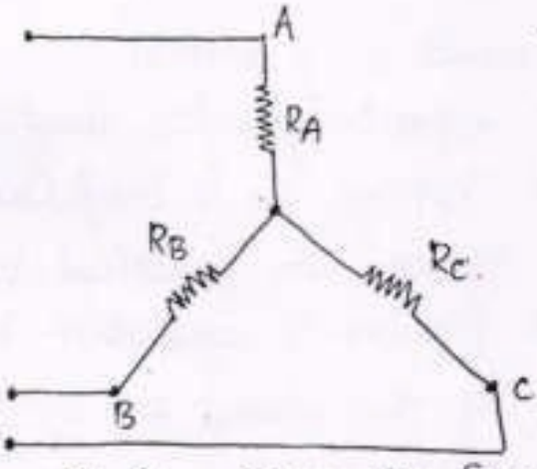
Hence, a Voltage Source E in Series with its internal resistance 'r' can be Converted into Current source $I = E/r$ with its internal resistance 'r' Connected in parallel with it. Similarly, a Current Source 'I' in parallel with its internal resistance 'r' can be Converted into a Voltage Source, $E = Ir$ in Series with its internal resistance 'r'.

---

1)

(b) (i) Star - delta transformations.

When an electrical ckt Consisting of a large numbers of elts the solution of such a networking using Kirchoff's law is difficult, as a large number of simultaneous eqn's have to be Solved. In such Case, the network has to be reduced to a Simple network using star-delta transformations.



(a) Star Connection (Y to Δ)

$$R_A R_B + R_B R_C + R_C R_A = \frac{R_{AB} R_{BC} . R_{CA} (R_{AB} + R_{BC} + R_{CA})}{(\Sigma R_{AB})^2}$$

$$= \frac{R_{BC}}{\Sigma R_{AB}} \times R_A \Sigma R_{AB} = R_A \cdot R_{BC}$$

$$\therefore R_{BC} = \frac{R_A R_B + R_B R_C + R_C R_A}{R_A}$$

$$R_{BC} = R_A + R_C + \frac{R_B R_C}{R_A}$$

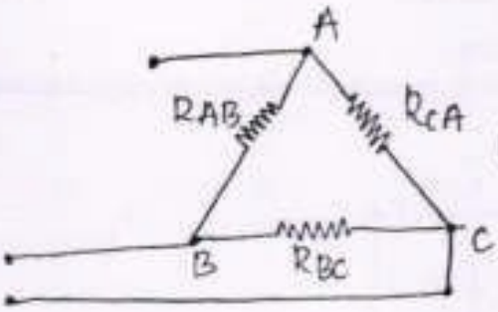
In a similar way, we can write equations for R_{AB} & R_{CA}

$$R_{AB} = R_A + R_C + \frac{R_B R_C}{R_A}$$

$$R_{CA} = R_C + R_A + \frac{R_A R_C}{R_B}$$

(b) Delta-star transformation (Δ to Y)

When an electrical ckt consists of a large number of elements, the solution of such a network using Kirchoff's law is difficult as a large number of simultaneous equations have to be reduced to a simple network using delta to star transformation



(b) Delta Connection.

The principle of conversion is that, the equivalent resistance b/w corresponding points in both the connection must be the same.

$$\therefore R_A + R_B = \frac{R_{AB}(R_{BC} + R_{CA})}{R_{AB} + R_{BC} + R_{CA}} = \frac{R_{AB}(R_{BC} + R_{CA})}{\Sigma R_{AB}} \quad \text{—①}$$

$$R_B + R_C = \frac{R_{BC}(R_{CA} + R_{AB})}{\Sigma R_{AB}} \quad \text{—②}$$

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$$R_C + R_A = \frac{R_{CA}\,(R_{AB} + R_{BC})}{\Sigma R_{AB}} \quad \text{—— (3)}$$

(1) − (2) gives:

$$R_A - R_C = \frac{R_{AB}\,R_{CA} - R_{BC}\,R_{CA}}{\Sigma R_{AB}} \quad \text{—— (4)}$$

$$2R_A = \frac{2R_{AB}\,R_{CA}}{\Sigma R_{AB}}$$

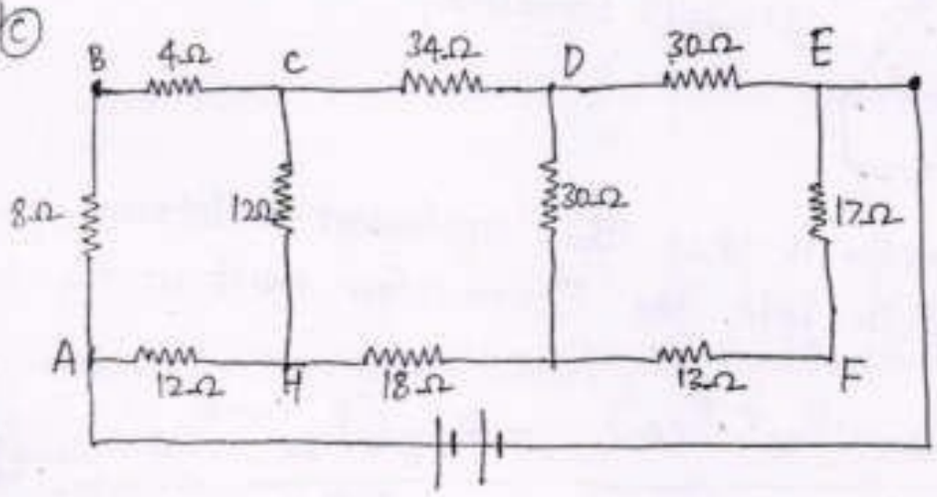
$$\therefore R_A = \frac{R_{AB}\,R_{CA}}{\Sigma R_{AB}}$$

In similar way, $R_B = \frac{R_{BC}\,R_{AB}}{\Sigma R_{AB}}$

$$R_C = \frac{R_{BC}\,R_{CA}}{\Sigma R_{AB}}$$

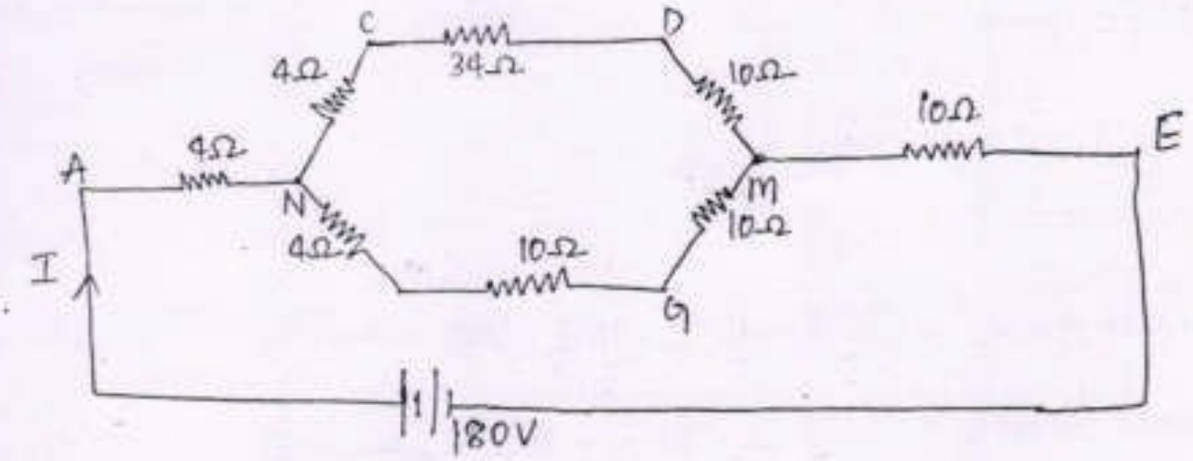
---

1) ©



→ 8Ω and 4Ω are in Series whose total resistance is 12Ω. Now, these 12Ω resistances are connected in delta b/w A, C & H They can be Converted into star. Each star resistance is 4Ω. Similarly, 13Ω and 17Ω are in series, which total resistance is

30Ω. These 30Ω resistances are connected in delta b/w C, D & E They can be converted into star, each star resistance is 10Ω The total resistance of the ckt is given by.



$$R = 4 + \frac{48 \times 24}{48+24} + 10 = \underline{30\Omega}$$

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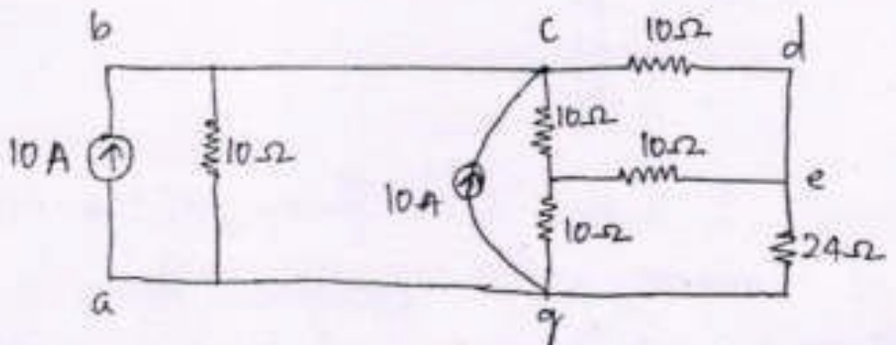
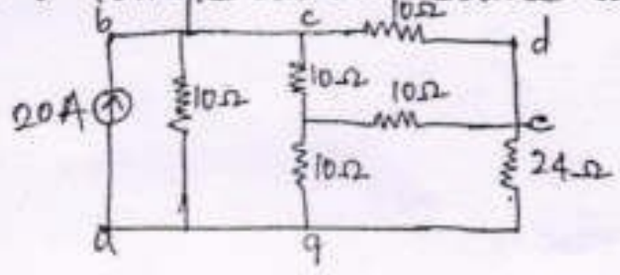
(1)

(d) The Current Source of 10A Cannot be Converted into a Voltage Source. Hence the Voltage Source of 10V is converted into Current Source. The ckt in fig may be written as shown in fig after this Conversion.



The two Current Sources, which are in parallel are Connected into a single Current Source as shown in fig



Now, the Current Source is replaced by a Voltage Source as shown in fig & mesh Currents I_1, I_2 and I_3 are assumed as shown.

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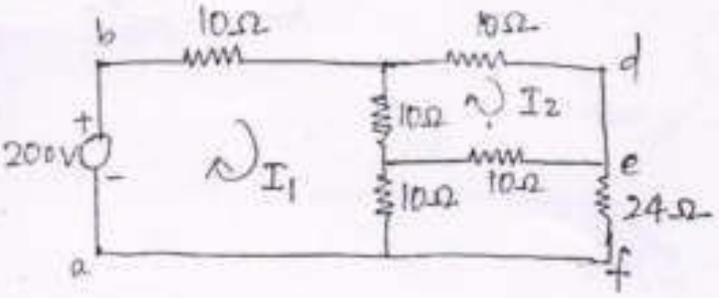


For mesh abcga = $30I_1 - 10I_2 - 10I_3 = 200$ ⟶ (1)

For mesh hedeh = $-10I_1 + 30I_2 - 10I_3 = 0$ ⟶ (2)

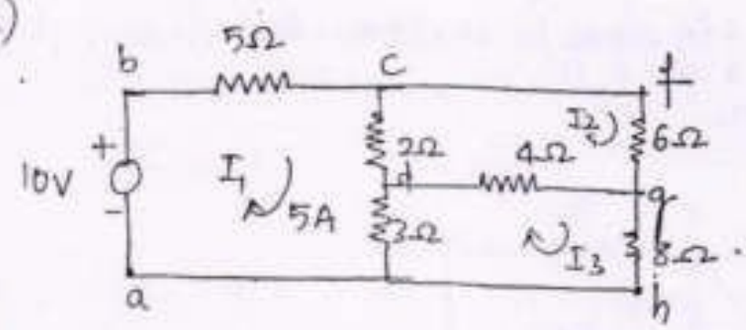
For mesh ghefg = $-10I_1 - 10I_2 + 44I_3 = 0$ ⟶ (3)

Solving Eqn's we get;

$I_{24\Omega} = I_3 = \underline{\underline{2.94\ A}}$

---

2) a)



Assume loop Currents I_1, I_2 and I_3 as shown, as the branch dc contains an ideal Current source abcdghea forms a Super loop. The Equation for this loop is

$10 - 5I_1 - 2(I_1 - I_2) - 4(I_3 - I_2) - 8I_3 = 0$

i.e $7I_1 - 6I_2 + 12I_3 = 10$ ⟶ (1)

for loop dcfgd

$-2(I_2 - I_1) - 6I_2 - 4(I_2 - I_3) = 0$

i.e $2I_1 - 12I_2 + 4I_3 = 0$ ——— (2)

and $I_1 - I_3 = 5$ ——— (3)

Solving Equations (1), (2) and (3), We get

$I_1 = 3.75A$

$I_3 = -1.25A$

and

$I_2 = 0.208A$

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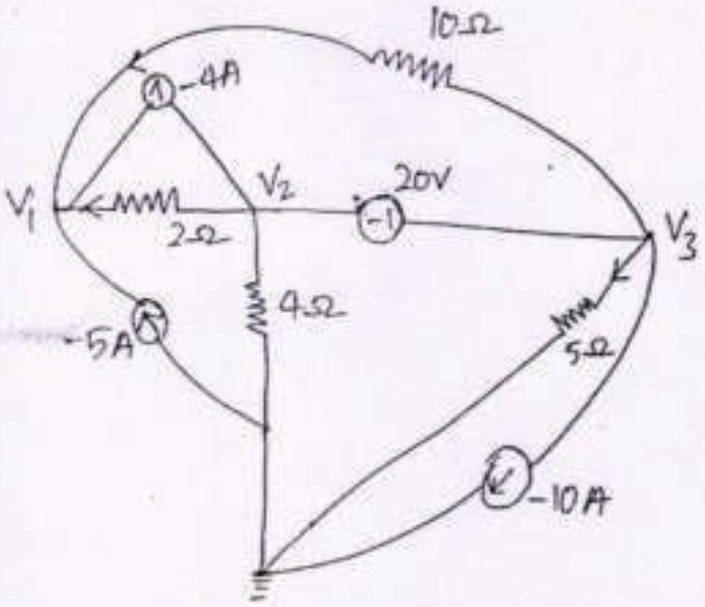
(2) (b)



For node V_1

$$\left[\frac{1}{2} + \frac{1}{10}\right]V_1 - \frac{1}{2}V_2 - \frac{1}{10}V_3 = -5-4$$

i.e $0.6V_1 - 0.5V_2 - 0.1V_3 = -9$ ——— (1)

for Super node $V_1 - V_2$

$$\frac{V_3 - V_1}{2} - 4 + \frac{V_2}{4} + \frac{V_3 - V_1}{10} + \frac{V_3}{5} - 10 = 0$$

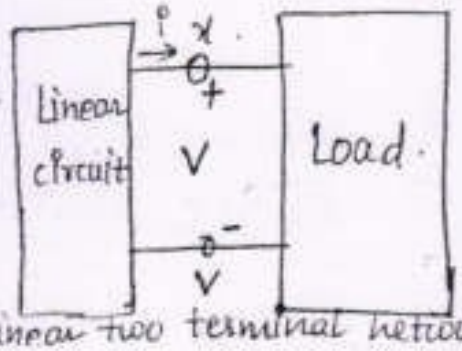
i.e $-0.6V_1 + 0.75V_2 + 0.3V_3 = 14$ ——— (2)

and $V_3 - V_2 = 20$ ——— (3)

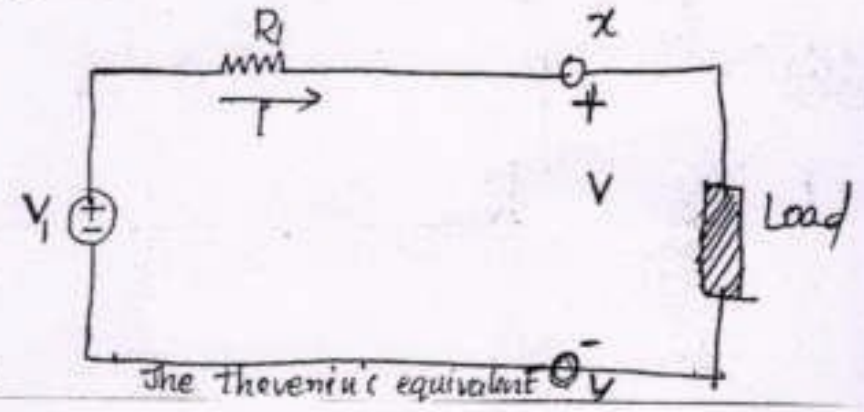
(2)(c)

We saw that the analysis of a circuit may be greatly reduced by the use of Superposition principle. The main Objective of thevenin's theorem is to reduce Some position of a circuit to an equivalent Source and a Single element.

This reduced Equivalent circuit Connected to the remaining part of the circuit will allow us to find the desired Current or Voltage. Thevenin's theorem is based on circuit equivalence A circuit equivalent to another circuits exhibits identical characteristics at identical terminals.



A linear two terminal network



The Thevenin's equivalent