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ESTD:2002

2019-20

Internal assessment Question paper with scheme of evaluation

SHRIDEVI

SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
II-semester:I-Internal assessment Test: April -2019
18MAT21:Advanced calculus and Numerical Methods
(Common to all branches)

FS 543067
An ISO 9001:2015 Certified In

Note: Answer any **two full questions** choosing one from each part

Time: 75min] [Max marks: 30

PART-I

1. a) Solve : $(4D^4 - 8D^3 - 7D^2 + 11D + 6)y = 0$ **(5 marks)**
   b) Solve : $\frac{d^3y}{dx^3} + 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} + 6y = e^x + 1$ **(5 marks)**
   c) Solve : $x^2y^{11} + xy^1 + y = 2Cos^2(logx)$ **(5 marks)**

OR

2. a) Solve : $\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 4y = e^{2x} + cos2x - 4$ **(5 marks)**
   b) Solve: $x^3\frac{d^3y}{dx^3} + 3x^2\frac{d^2y}{dx^2} + x\frac{dy}{dx} + y = x + logx$ **(5 marks)**
   c) Solve : $(3x + 2)^2\frac{d^2y}{dx^2} + 5(3x + 2)\frac{dy}{dx} - 3y = x^2 + x + 1$ **(5 marks)**

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PART-II

3. **a)** Use the Regula- Falsi metjod to find a real root of the equation $x^3 - 2x - 5 = 0$ correct to three decimal places. **(5 marks)**

b) The area of a circle (A) corresponding to the diameter (D) is given below

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

Find the area corresponding to diameter 105 using an appropriate formula. **(5 marks)**

c) Construct the interpolation polynomial for the data given below using Newton's general interpolation formula for divided differences. **(5 marks)**

x	2	4	5	6	8	10
y	10	96	196	350	868	1746

OR

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

b) Find the interpolating polynomial $f(x)$ satisfying $f(0) = 0, f(2) = 4, f(4) = 56,$ $f(6) = 204, f(8) = 496, f(10) = 980$ and hence find $f(3), f(5)$ & $f(7)$. **(5 marks)**

c) Use Lagrange's interpolation formula to find f(4) for given data **(5 marks)**

x	0	2	3	6
f(x)	-4	2	14	158

II Semester: I Internal Test

Advanced Calculus And Numerical Methods

Part-I

1 (a) $m = 2$

$4m^3 - 7m - 3 = 0 \Rightarrow$

$m = -1 \Rightarrow 4m^2 - 4m - 3 = 0 \Rightarrow m = -1/2, 3/2$

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

$y = CF = C_1 e^{-1/2 x} + C_2 e^{-x} + C_3 e^{2x} + C_4 e^{3/2 x}$ — 4M + 1M

(b) $m = -1, \; m^2 + 5m + 6 = 0$

$m = -2, -3.$

$CF = C_1 e^{-x} + C_2 e^{-2x} + C_3 e^{-3x}$ — 3M

$PI = \frac{1}{D^3 + 6D^2 + 11D + 6} e^{x} + \frac{1}{D^3 + 6D^2 + 11D + 6} e^{0x}$

$PI = \frac{1}{24} e^{x} + \frac{1}{6}$ — 2M

$\boxed{y = CF + PI}$

(c) $x = e^t \Rightarrow t = \log x$

$xy' = Dy, \; x^2 y'' = D(D-1)y$

$(D^2 + 1)y = 2\cos^2 t$

AE is $m^2 + 1 = 0 \Rightarrow \boxed{m = 0 \pm i}$ $CF = e^{0t}(C_1 \cos t + C_2 \sin t)$ — 2M

$PI = \frac{1}{F(D)} R(t)$

$= \frac{1}{D^2+1}\left(\frac{1 + \cos 2t}{2}\right) = \frac{1}{D^2+1} e^{0t} + \frac{1}{D^2+1} \cos 2t = 1 - \frac{1}{3}\cos 2t$ — 3M

$y = CF + PI = C_1 \cos(\log x) + C_2 \sin(\log x) + 1 - \frac{1}{3}\cos 2(\log x)$

2. (a) $(D^2 - 4D + 4)y = e^{2x} + \cos 2x - 4$

$m = 2, 2 \quad \boxed{CF = (C_1 + C_2 x)e^{2x}}$ — 2M

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$PI = \frac{1}{D^2 - 4D + 4} e^{2x} + \frac{1}{D^2 - 4D + 4} \cos 2x - 4 \frac{1}{D^2 - 4D + 4} e^{0x}$

$= \frac{x^2}{2} e^{2x} + \frac{\sin 2x}{8} - 4 \cdot \frac{1}{4}$ — 3M

$\boxed{y = CF + PI}$

(b) $x = e^t \Rightarrow t = \log x \Rightarrow (D^3 + 1)y = e^t + t$ — 1M

$m^3+1=0 \Rightarrow (m+1)(m^2-m+1)=0 \Rightarrow m=-1, \frac{1}{2}\pm\frac{\sqrt{3}}{2}i$ — 1M

$CF = C_1e^{-t} + e^{\frac{1}{2}t}\left(C_2\cos\frac{\sqrt{3}}{2}t + C_3\sin\frac{\sqrt{3}}{2}t\right)$

$PI = \frac{1}{D^3+1}(e^t+t) = \frac{1}{D^3+1}e^t + \frac{1}{D^3+1}t = \frac{1}{2}e^t + t$ — 2M

$y = CF + PI$

$= C_1e^{-\log x} + e^{\frac{1}{2}\log x}\left(C_2\cos\frac{\sqrt{3}}{2}\log x + C_3\sin\frac{\sqrt{3}}{2}\log x\right) + \frac{1}{2}e^{\log x} + \log x$ — 1M

(c) $3x+2=e^t \Rightarrow t=\log(3x+2)$

$x=\frac{e^t-2}{3} \Rightarrow (3x+2)\frac{dy}{dx}=3Dy \quad (3x+2)^2\frac{d^2y}{dx^2}=9D(D-1)y$ — 1M

$(3D^2+2D+1)y = \frac{e^{2t}-e^t+7}{27}$

$3m^2+2m-1=0 \Rightarrow m=-1, 1/3 \Rightarrow CF = C_1e^{-t}+C_2e^{\frac{1}{3}t}$ — 2M

$PI = \frac{1}{F(D)}R(t) = \frac{1}{3D^2+2D-1}\frac{1}{27}(e^{2t}-e^t+7)$

$y = CF+PI = C_1e^{-t}+C_2e^{\frac{1}{3}t}+\frac{1}{27}\left[\frac{e^{2t}}{15}-\frac{e^t}{4}-7\right]$ — 2M

Part-III

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

(2,3) is root $\Rightarrow (2, 2.1)$ — 1M

$x_1=2.096, \quad x_2=2.094$ — 4M

(b)

648			
	40		
688			4
	38	−2	
726			
	40	2	
766			

— 2M

$y_x = y_0 + x\Delta y_0 + \frac{x(x+1)}{2!}\Delta^2 y_0 + \cdots$ — 1M

$x=1$ — 1M

$y(105)=866$ — 1M

(c)

43			
	19		
100			2
	2		
154			0
	35		
259			0
	45		
439			

— 2M

$y = f(x_0)+(x-x_0)f(x_0,x_1)+(x-x_0)(x-x_1)f(x_0,x_1,x_2)$ — 1M

$y = 2x^3-3x^2+5x-4$ — 2M

(4)(a)(b)

4 (a) $x = \sqrt{N} \Rightarrow x^2 = N \Rightarrow f(x) = x^2 - N \Rightarrow f'(x) = 2x$. — (1M)

$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} = \frac{x_n^2 + N}{2x_n}$ (3)

$x_0 = 3$; $x_1 = \frac{1}{2}\left[x_0 + \frac{N}{x_0}\right] = 3.5$ $x_2 = 3.4642$ — (3M)

$x_3 = 3.4641$ $x_4 = 3.4641$

$\boxed{\sqrt{12} = 3.4641}$ — (1M)

(b)

0			
26	6		
74	12	1	0
146	18	1	0
242	24	1	

(2M)

$y = f(x_0) + (x - x_0) f(x_0, x_1) + (x - x_0)(x - x_1) f(x_0, x_1, x_2) + \ldots$ (1M)

$= x^3 - 2x$.

$\boxed{\begin{array}{l} y(3) = 21 \\ y(5) = 115 \\ y(7) = 329 \end{array}}$ — (2M)

(c)

$x_0 = 0$ $x_1 = 2$ $x_2 = 3$ $x_3 = 6$

$y_0 = -4$ $y_1 = 2$ $y_2 = 14$ $y_3 = 158$ — (1M)

$$y = \frac{(x-x_1)(x-x_2)(x-x_3)}{(x_0-x_1)(x_0-x_2)(x_0-x_3)} y_0 + \frac{(x-x_0)(x-x_2)(x-x_3)}{(x_1-x_0)(x_1-x_2)(x_1-x_3)} y_1 + \frac{(x-x_0)(x-x_1)(x-x_3)}{(x_2-x_0)(x_2-x_1)(x_2-x_3)} y_2 + \frac{(x-x_0)(x-x_1)(x-x_2)}{(x_3-x_0)(x_3-x_1)(x_3-x_2)} y_3$$ — (4M)

$= 40.003$

$\boxed{y = 40}$ — (1M)

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SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06

DEPARTMENT OF MATHEMATICS

IV-semester: I-Internal assessment Test: March -2019

17MAT41:Engineering mathematics-IV (Common to all branches)

Note: Answer any **two full questions** choosing one from each part

Time: 75min] [Max marks:30

PART-I

1. **a)** Employing taylor's series method,find the approximate solution for the following initial value problem at the points $x_1 = 0.1 \; and \; x_2 = 0.2$, $\frac{dy}{dx} = 2y + 3e^x, y(0) = 0$ (5 Marks)

   b) Use modified euler's method to solve the equation $\frac{dy}{dx} = x + |\sqrt{y}| \; in \; the \; range \; 0 \leq x \leq 0.2$ by taking h=0.2 given that $y = 1 \; when \; x = 0$ (5 Marks)

   c) Use milne's predictor & corrector method to find the value of $y \; at \; x = 0.8 \; given$ $\frac{dy}{dx} = x - y^2, y(0) = 0, y(0.2) = 0.02, y(0.4) = 0.0795, y(0.6) = 0.1762$ (5 Marks)

OR

2. **a)** Employ the Runge-Kutta method of fourth order to solve $\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$ $y(0) = 1$ at the point $x = 0.2 \; taking \; h = 0.2$ (5 Marks)

   b) The following table gives the solutions of the equation $\frac{dy}{dx} = x^2 + \frac{y}{2} \; for \; 1 \leq x \leq 1.3$ at the steps of 0.1 find y at 1.4 using the adam's predictor & corrector method (5 Marks)

x	1	1.1	1.2	1.3
y	2	2.2156	2.4649	2.7514

   c) Solve $\frac{dy}{dx} = -xy^2$ under the initial condition $y(0) = 2$ by using the modified euler's method at the point $x = 0.1 \; taking \; h = 0.1$ and Carryout two iteration. (5 Marks)

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PART-II

3. a) State and prove Cauchy Riemann equation in the Cartesian form. (5 Marks)

b) Show that $w = z + e^z$ is analytic and hence find $\frac{dw}{dz}$ (5 Marks)

c) Find the analytic function $f(z)$ whose imaginary part is $e^x(x\,siny + y\,cosy)$ (5 Marks)

OR

4. a) If $\phi + i\,\psi$ represents the complex potential of on electrostatic field where $\psi = x^2 - y^2 + \frac{x}{x^2+y^2}$, find ϕ and also the complex potential as a function of z. (5 Marks)

b) Evaluate $\int_c z^2\,dz$ (5 Marks)

i) along the straight line from $z = 0$ to $z = 3 + i$

ii) along the curve made up of two line segments ,one from $z = 0$ to $z = 3$ and another from $z = 3$ to $z = 3 + i$

c) State and prove Cauchy's Theorem. (5 Marks)

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1. I Internal Assesment Test

Scheme of Evaluation

Sub: Engg. Maths-IV (17MAT41)

1 (a) $\frac{dy}{dx} = 2y + 3e^x$

$y = y_0 + (x-x_0)y_0' + \frac{(x-x_0)^2}{2!}y_0'' + \cdots$ — (1) — 1M

$y' = 2y + 3e^x \quad y_0' = 3$

$y'' = 2y' + 3e^x \quad y_0'' = 9$

$y''' = 2y'' + 3e^x \quad y_0''' = 21.$ — 3M

$y(0.1) = 0.3485 \quad y(0.2) = 0.8108$ — 1M

(b) $\frac{dy}{dx} = x + |\sqrt{y}|$

1 stage: $x_0 = 0,\ y_0 = 1,\ f(x,y) = x + \sqrt{y},\ h = 0.2$ — 1M

Euler's $y_1^{(0)} = y_0 + h f(x_0, y_0)$

$y_1^{(0)} = 1.2$

M-E

$y_1^{(1)} = y_0 + \frac{h}{2}[f(x_0,y_0) + f(x_1, y_1^{(0)})] = 1.2295$

$y_1^{(2)} = y_1 + \frac{h}{2}[f(x_0,y_0) + f(x_1, y_1^{(1)}] = 1.2309$ — 3M

$y_1^{(3)} = 1.2309.$

Thus $y(0.2) = 1.2309$ — 1M

(c) $\frac{dy}{dx} = x - y^2$

$y_0' = 0 - 0 = 0 \quad y_2' = 0.3937$

$y_1' = 0.1996 \quad y_3' = 0.5689$ — 2M

$y_4^{(p)} = y_0 + \frac{4h}{3}[2f_1 - f_2 + 2f_3] = 0.3049$ — 1M

$y_4' = x_4 - y_4^2 = 0.707$

$y_4^{(c)} = y_2 + \frac{h}{3}[f_2 + 4f_3 + f_4] = 0.3046$ — 1M

$\boxed{y(0.8) = 0.3046}$ — 1M

3

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2 (a) $\frac{dy}{dx} = \frac{y^2-x^2}{y^2+x^2}$ $x_0=0,\ y_0=1,\ h=0.2$

$k_1 = h f(x_0, y_0) = 0.2$ $\quad k_3 = hf\left[x_0+\frac{h}{2}, y_0+\frac{k_2}{2}\right) = 0.1967$

$k_2 = hf\left[x_0+\frac{h}{2}, y_0+\frac{k_1}{2}\right) = 0.1967$ $\quad k_4 = hf(x_0+h, y_0+k_3) = 0.1891$ — (3)

$y = y_0 + \frac{1}{6}(k) \quad = 1.196.$ — (2M)

(b) $\frac{dy}{dx} = x^2 + \frac{y}{2}$ $\quad 1 \le x \le 1.3$

$y_0' = 2,\ y_1' = 2.3178,\ y_2' = 2.67845,\ y_3' = 3.0657$ — (2M)

$y_4^{(P)} = y_0 + \frac{4h}{3}(2f_1 - f_2 + 2f_3) = 3.0798$

$y_4' = x_4^2 + \frac{y_4}{2} = 3.49965$ — (2M)

$y_4^{(C)} = y_2 + \frac{h}{3}(f_2 + 4f_3 + f_4) = 3.0794$

$y(1.4) = 3.0794$ — (1M)

2 (c) $\frac{dy}{dx} = -xy^2$

$y_1^{(0)} = y_0 + h f(x_0, y_0) = 2.$ — (1M)

$y_1^{(1)} = y_0 + \frac{h}{2}\left[f(x_0, y_0) + f(x_1, y_1^{(0)})\right] = 1.980$

$y_1^{(2)} = y_0 + \frac{h}{2}\left[f(x_0, y_0) + f(x_1, y_1^{(1)})\right] = 1.980$ — (3M)

$\boxed{y(0.1) = 1.980}$ — (1M)

3 @.. C-R eqns in cartesian form

Statement: $f(z)$ is Analytic ——— 1M (10)

Proof: $f'(z) = \lim_{\delta z \to 0} \frac{f(z+\delta z) - f(z)}{\delta z}$ Exists. } ——— 3M

(i) $f'(z) = \frac{\partial u}{\partial x} + i\frac{\partial v}{\partial x}$

(ii) $f'(z) = -i\frac{\partial u}{\partial y} + \frac{\partial v}{\partial y}$

$\frac{\partial u}{\partial x} = \frac{\partial v}{\partial y}$, $\frac{\partial v}{\partial x} = -\frac{\partial u}{\partial y}$ ——— 1M

(b) $w = z + e^z$

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

$u + iv = [x + e^x \cos y] + i[y + e^x \sin y]$ ——— 1M

C-R eqns are satisfied.

$\frac{dw}{dz} = \frac{\partial u}{\partial x} + i\frac{\partial v}{\partial x} = 1 + e^{x+iy} = 1 + e^z$ ——— 4M

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

$v_y = e^x[x\cos y - y\sin y + \cos y]$ } ——— 2M

$v_x = e^x[\sin y + x\sin y + y\cos y]$

$f'(z) = v_x + i v_x$

put $x = z$ & $y = 0$ we get ——— 1M

$f'(z) = e^z(z+1)$ } ——— 2M

Int $f(z) = ze^z + c$

4 @. $\psi = x^2 - y^2 + \frac{x}{x^2+y^2}$

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

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

$f'(z) = \frac{\partial \phi}{\partial x} + i\frac{\partial \psi}{\partial x}$

$= \frac{\partial \psi}{\partial y} + i\frac{\partial \psi}{\partial x}$

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——— 1M

$f'(z) = i\left[z^2 + \frac{1}{z}\right] + C$

$f(z) = i\left[(x+iy)^2 + \frac{1}{x+iy}\right] + C$ — 1M

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

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

4 (b) $\int_C z^2 dz = \int_0^{3+i} z^2 dz$

(i) (0,0) to (3,1) $\quad \frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$

$\Rightarrow y = \frac{x}{3} \Rightarrow x = 3y$

$dx = 3dy.$

$\int z^2 dz = \int_0^1 (24y^2 - 6y^2) + i\int (18y^2 + 8y^2)\, dy$ — 3M

$= \frac{18}{3} + i\frac{26}{3}$

(ii) (0,0) to (3,0) & then from (3,0) to (3,1)

$\int_C z^2 dz = \int_{C_1} z^2 dz + \int_{C_2} z^2 dz.$ — 2M

$= 6 + \frac{26}{3}i$

4c Cauchy's Thm

St: $\int_C f(z)\, dz = 0.$ — 1M

Pf: $\int_C f(z) dz = \int (u+iv)(dx+idy)$

$= \int (udx - vdy) + i\int vdx + udy$ — ①.

$= \iint \left(-\frac{\partial v}{\partial x} + \frac{\partial v}{\partial x}\right) dx\,dy + i\iint \left(\frac{\partial v}{\partial y} - \frac{\partial v}{\partial y}\right) dx\,dy$ — 4M

$= 0.$

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DEPARTMENT OF MATHEMATICS

IV-semester:II-Internal assessment Test: April -2019

17MAT41:Engineering mathematics-IV (Common to all branches)

Note: Answer any **two full questions** choosing one from each part

Time: 75min] [Max marks:30

PART-I

1. a) Using RK method solve the following differential equation at $x = 0.1$ under the given condition $\frac{d^2y}{dx^2} = x^3\left(y + \frac{dy}{dx}\right), y(0) = 1, y'(0) = 0.5$ by taking step length h=0.1 (5 Marks)

b) Using milne's method obtain an approximate solution at the point $x = 0.4$ of the problem

$$\frac{d^2y}{dx^2} + 3x\frac{dy}{dx} - 6y = 0, y(0) = 1, y'(0) = 0.1, y(0.1) = 1.03995, y'(0.1) = 0.6955,$$

$y(0.2) = 1.138036, y'(0.2) = 1.258, y(0.3) = 1.29865, y'(0.3) = 1.873$ (5 Marks)

c) Prove that $J_{\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\sin x$ (5 Marks)

OR

2. a) Derive a series solution of Bessel's differential equation leading to Bessel's function of first kind. (5 Marks)

b) Derive a series solution of Legendre's differential equation. (5 Marks)

c) Prove that $J_{-\frac{1}{2}}(x) = \sqrt{\frac{2}{\pi x}}\cos x$ (5 Marks)

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PART-II

3. a) Verify cauchy's theorem for the function $f(z) = z^2$ where c is the square having vertices $(0,0), (1,0), (1,1) and\ (0,1)$. (5 Marks)

b) State and prove cauchy's integral formula. (5 Marks)

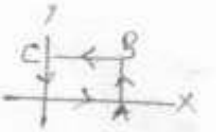
c) Evaluate $\int_c \frac{e^{2z}}{(z+1)(z-2)}dz$ where c is the circle $|z| = 3$ (5 Marks)

OR

4. a) Evaluate using residue theorem for $\int_c \frac{e^{2z}}{(z+1)^3}dz$ where c is the circle $|z| = \frac{3}{2}$ (5 Marks)

b) Evaluate using residue theorem $\int_c \frac{\sin\pi z^2 + \cos\pi z^2}{(z-1)^2(z-2)}dz$ where c is the circle $|z| = 3$ (5 Marks)

c) Discuss the transformation $w = z^2$ transforms the straight line parallel to co-ordinate axes (5 Marks)



Scheme of Evaluation for II I.A. Test.

Sub: Engg. Mathematics - IV (17MAT41)

Time: 75 min

Marks: 30

PART - I

1 a) $\frac{d^2y}{dx^2} = x^3\left(y + \frac{dy}{dx}\right)$, $y(0)=1$, $y'(0)=0.5$, $h=0.1$

Put $y'=z$, $y''=z'$

$\frac{dz}{dx} = x^3(y+z)$ $\quad f(x,y,z)=z$, $\quad g(x,y,z)=x^3(y+z)$

$y(x_0+h) = y_0 + \frac{1}{6}(k_1+2k_2+2k_3+k_4)$

$k_1 = hf(x_0,y_0,z_0)$ $\quad l_1 = hg(x_0,y_0,z_0)$

$= (0.1) f(0, 1, 0.5)$ $\quad l_1 = 0.$

$k_1 = 0.05$ $\quad l_2 = 0$

$k_2 = 0.05$ $\quad l_3 = 0.$

$k_3 = 0.05$ $\quad l_4 = 0$

$k_4 = 0.05$

$y(0.1) = 1 + \frac{1}{6}[0.05 + 2(0.05) + 2(0.05) + 0.05]$

$\boxed{y(0.1) = 1.05}$

(b). $y'=z$ $\quad y''=z'$

$z_0 = 0.1$ $\quad z_0' = 6$

$z_1 = 0.6955$ $\quad z_1' = 6.0311$

$z_2 = 1.258$ $\quad z_2' = 6.0734$

$z_3 = 1.873$ $\quad z_3' = 6.1062.$

Milnes $\frac{dz}{dx} + 3xz - 6y = 0. \Rightarrow \frac{dz}{dx} = 6y - 3xz$

$y_4^{(P)} = y_0 + \frac{4h}{3}[2z_1 - z_2 + 2z_3] = 1.5172$

$z_4' = 6.0710$, $\quad z_4^{(P)} = 2.5268$

$y_4^{(C)} = y_2 + \frac{h}{3}[z_2 + 4z_3 + z_4] = 1.5139$

$z_4^{(C)} = 2.4770.$ $\quad z_4' = 6.1110.$

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(c). $J_{1/2} = \sqrt{\frac{2}{\pi x}}\sin x.$

$J_n(x) = \sum_{r=0}^{\infty} (-1)^r \left(\frac{x}{2}\right)^{2r+n} \frac{1}{\Gamma(n+r+1)\, r!}$ ——— (1)

Put $n=1/2$ in (1). $J_{1/2}(x) = \sqrt{\frac{x}{2}}\left[\frac{1}{\sqrt{3/2}} + (-1)\left(\frac{x^2}{2}\right)^2 \frac{1}{\Gamma(5/2)\,1!} + (-1)^2\left(\frac{x}{2}\right)^4 \frac{1}{\Gamma(7/2)} \cdot \frac{1}{2!}\right]$

$\Gamma(n+1) = n\,\Gamma(n)$ $\quad \Gamma(3/2) = \frac{\sqrt{\pi}}{2}$ $\quad \Gamma(1/2) = \frac{3\sqrt{\pi}}{4}$

$$J_{1/2}(x) = \sqrt{\frac{x}{2}}\left[\frac{2}{\sqrt{\pi}} - \frac{2}{4}\times\frac{4}{3\sqrt{\pi}} + \frac{x^4}{16}\times\frac{8}{15\sqrt{\pi}\,2!} + \cdots\right]$$

$$= \sqrt{\frac{2}{\pi x}}\left[x - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots\right]$$

$$J_{1/2}(x) = \sqrt{\frac{2}{\pi x}}\sin x$$

---

2 (a) Bessels D.E Book work

$$\int_0^1 x\,J_n(\alpha x)\,J_n(\beta x) = \begin{cases} 0 & \text{if } \alpha \neq \beta \\ \left(\frac{J_{n+1}(\alpha)}{2}\right)^2 & \text{if } \alpha = \beta \end{cases}$$

(b) $y = a_0 F(x) + a_1 G(x)$ $\quad a_0 \neq 0,\ a_1 \neq 0$

$a_2 = -\frac{n(n+1)}{2}a_0$ $\quad a_3 = -\frac{[n(n+1)-2]}{6}a_1$

(c) $$J_{-1/2}(x) = \sum (-1)^r \left(\frac{x}{2}\right)^{2r-1/2}\frac{1}{\Gamma(1/2)\,r!}$$

$$= \left(\frac{2}{x}\right)^{1/2}\frac{1}{\sqrt{\pi}}\left[1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \cdots\right]$$

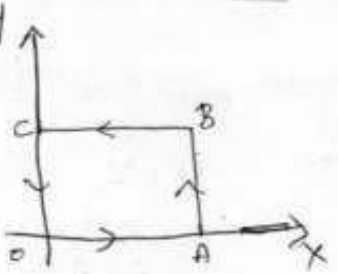
$$J_{-1/2}(x) = \sqrt{\frac{2}{\pi x}}\cos x$$

---

3 (a) Along OA $\int_{OA} z^2\,dz = 1/3$

$$\int_{AB} z^2\,dz = -1 + 2/3\,i$$

$$\int_{BC} z^2\,dz = 2/3 - i \qquad \int_{CO} z^2\,dz = i/3$$



$$\int_{OA} z^2\,dz + \int_{AB} z^2\,dz + \int_{BC} z^2\,dz + \int_{CO} z^2\,dz = \frac{1}{3} - 1 + \frac{2i}{3} + \frac{2}{3} - i + i/3 = 0.$$

$$\int_C z^2\,dz = 0.$$

(b) $\int_C \frac{f(z)}{z-a}\,dz = 2\pi i f(a)$ proof Book work.

(c) $A = -1/3$, $B = 1/3$. $\int_C \frac{e^{2z}}{(z+1)(z-2)}\,dz = \int \frac{-1/3\,e^{2z}}{z-1}\,dz + \frac{1}{3}\int \frac{e^{2z}}{z+2}\,dz$

$$= \frac{2\pi i}{3}\left[e^2 - \frac{1}{e^2}\right]$$

4 (a) $\int \frac{e^{2z}}{(z+1)^3} dz = \int \frac{e^{2z}}{(z-(-1))^3} dz$ (12)

$z=-1$ is a pole of order $m=3$

$|z| = 3/2$ Eq^n of circle with centre as $(0,0)$ & $r = 3/2$

$(-1,0)$ lies inside the circle

Cauchy's Int. formula

$$\int_C \frac{f(z)}{(z-a)^{n+1}} dz = \frac{2\pi i}{n!}$$

$$R[m,a] = \frac{1}{(m-1)!} \lim_{z \to a} \frac{d^{m-1}}{dz^{m-1}} [(z-a)^m f(z)]$$

$$R[3,-1] = \frac{1}{2!} \lim_{z \to -1} \frac{d^2}{dz^2} \left[(z+1)^3 \frac{e^{2z}}{(z+1)^3} \right]$$

$$= \frac{1}{2} \lim_{z \to -1} (4e^{2z}) = \frac{1}{2}(4e^{-2})$$

$$= 2e^{-2}$$

Cauchy's Residue Thm $\int_C f(z)\,dz = 2\pi i [P_i]$

$= 2\pi i (2e^{-2})$

$= 4\pi i e^{-2}$

(b) $\int \frac{\sin \pi z^2 + \cos \pi z^2}{(z-1)^2 (z-2)} dz = \int \frac{A}{z-1} + \int \frac{B}{(z-1)^2} + \int \frac{C}{z-2} dz$

$A=-1, \quad B=-1, \quad C=1$

$I = I_1 + I_2 + I_3$

$I_1 = 2\pi i, \quad I_2 = 4\pi^2 i, \quad I_3 = 2\pi i$

$I = 4\pi i + 4\pi^2 i.$

(c) $w = \bar{z}^2 \quad u = x^2 - y^2 \quad v = 2xy.$

(i) $x = a$, then $v^2 = -4a^2(u - a^2)$

(ii) $y = b$ then $v^2 = 4b^2(u + b^2)$

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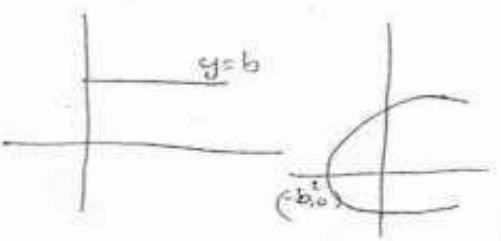
(i)

(ii)



SHRIDEVI

SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
IV-semester: III-Internal assessment Test: May -2019
17MAT41: Engineering Mathematics -IV(Common to all branches)

Time:75min] [Max marks: 30

Note: Answer any **Two full questions** choosing one from each part

Part -1

1. a) The Probability distribution of finite random variables is form by the following table find k, $P(x < 6), P(3 < X \leq 6)$ **(5 marks)**

x	0	1	2	3	4	5	6	7
P(x)	0	k	2k	2k	3k	k^2	$2k^2$	$7k^2 + k$

b) Obtain the Mean and Standard deviation of Binomial distribution **(5 marks)**

c) In a certain town the duration of shower is exponentially distributed with mean 5 minutes. What is the probability that a shower will last for: **(5 marks)**

(i) 10 minutes or more (ii) less than 10 minutes (iii)between 10 and 12 minutes

OR

2. a) Obtain the Mean and Standard deviation of poisson distribution **(5 marks)**

b) The probability that of pen manufactured by a company will be defective is 0.1. If such pens selected find the probability that (i) exactly 2 will be defective (ii) Atleast 2 will be defective (iii) none will be defective **(5 marks)**

c) In an examination 7% of students score less than 35% marks and 89% of students score less that 60 % marks. Find the mean and standard deviation if the marks are normally distributed .It is given that if

$\phi(z) = \frac{1}{\sqrt{2\pi}} \int_0^z e^{-\frac{z^2}{2}} dz$ *then* $p(1.2263)$=0.39 and p(1.4757)=0.43 **(5 marks)**

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Part –II

3. a) A die was thrown 9000 times and a throw of 5 or 6 was obtained 3240 times. On the assumption of random throwing , do the data indicacte on unbiased die . **(5 marks)**

b) A certain stimulus administrated to each of 12 patients resulted in the following of blood pressure 5,2,8,-1,3,0,-2,2,5,0,4,6.Can it be conclded that the stimulus will in general be occumpained by an increase in blood pressure. **(5 marks)**

c) Eleven students were given a test, they were given a maths first and a second test of equal difficulty was held. Is the marks given evidence that the students have benefited by extra loading. **(5 marks)**

Boys	1	2	3	4	5	6	7	8	9	10	11
Marks I Test	23	20	19	21	18	20	18	17	23	16	19
Marks II Test	24	19	22	19	20	20	22	20	23	20	17

OR

4. a) In an experiment of pea breedings the frequency of seed were obtained : **(5 marks)**

Round & Yellow	Wrinkled & Yellow	Round & Green	Wrinkled & Green	Total
315	101	108	32	558

Theory Predicts that the frequencies should be in the proportions 9:3:3:1. Examine correspondence between theoretical experiment $[\chi^2_{0.05} = 7.815]$ **(5 marks)**

b) Show that $P = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ \frac{1}{2} & \frac{1}{2} & 0 \end{bmatrix}$ is regular stochastic matrix and also find associated unique fixed probability vector. **(5 marks)**

c) With reference to the stochastic matrix $A = \begin{bmatrix} \frac{3}{4} & \frac{1}{4} \\ \frac{1}{2} & \frac{1}{2} \end{bmatrix}$ verify the property that the sequence A^2, A^3, A^4 approaches the matrix whose rows are each fixed probability vector **(5 marks)**

Scheme of Evaluation

Sub: Engg. Mathematics - IV (17MAT41)

III Internal Assesment Test

12

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1 (a). $P(x_i) \geq 0$ & $\sum P(x_i) = 1$

$\Rightarrow 9K + 10K^2 = 1 \Rightarrow K = -1$ & 0.1

$\boxed{K = 0.1}$

$P(x < 6) = p(0) + p(1) + p(2) + p(3) + p(4) + p(5) = 0.81$

$P(3 < x \leq 6) = p(4) + p(5) + p(6) = 0.33$

(b). Mean and Std. deviation of Binomial distb^n

Mean $\mu = \sum x p(x) = \sum x \, nCx \, p^x q^{n-x}$

$\boxed{\mu = np}$

Variance $V = \sum x^2 p(x) - \mu^2$

$\boxed{V = npq}$

Std. deviation $\sigma = \sqrt{V} = \sqrt{npq}$.

(c) $f(x) = \alpha e^{-\alpha x}$ $x > 0$. $\alpha > 0$.

$\mu = \frac{1}{\alpha} = 5 \Rightarrow \alpha = \frac{1}{5}$

$f(x) = \left(\frac{1}{5}\right) e^{-x/5}$ $x > 0$.

(i) $P(x \geq 10) = \int_{10}^{\infty} \frac{1}{5} e^{-x/5} \, dx = 0.1353$

(ii) $P(x \leq 10) = \int_{0}^{10} \frac{1}{5} e^{-x/5} \, dx = 0.8646$.

2 (b) $p = 0.1 \quad q = 1-p = 0.9$

$$P(x) = {}^{n}C_x p^x q^{n-x} = {}^{12}C_x (0.1)^x (0.9)^{12-x}$$

(i) $P(x=2) = {}^{12}C_2 (0.1)^2 (0.9)^{10} = 0.2301$

(ii) $P(x \geq 2) = 1 - P(x<2) = 0.34108$

(iii) $P(x=0) = {}^{12}C_0 (0.1)^0 (0.9)^{12} = 0.2824$

(c) $Z = \frac{x-\mu}{\sigma}$

Data: $P(x<35) = 0.07, \quad P(x<60) = 0.89$

$Z = \frac{35-\mu}{\sigma} = z_1$ (say), $Z = \frac{60-\mu}{\sigma} = z_2$ (say)

$P(Z<z_1) = 0.07$

$\Rightarrow 0.5 + \phi(z_1) = 0.07$

$\Rightarrow \phi(z_1) = 0.43$

$\phi(z_1) = -\phi(1.4757)$

$\boxed{z_1 = -1.4757}$

$P(Z<z_2) = 0.89$

$0.5 + \phi(z_2) = 0.89$

$\Rightarrow \phi(z_2) = 0.39$

$\Rightarrow \phi(z_2) = \phi(1.2263)$

$\boxed{z_2 = 1.2263}$

$\therefore \quad \boxed{\mu = 48.65 \text{ & } \sigma = 9.25}$

3 (a) $p = \frac{2}{6} = \frac{1}{3}$ (no. 5 or 6 in a dice)

$q = 1-p = 1-\frac{1}{3} = \frac{2}{3}$.

$n = 9000, \quad x = 3240.$

$$Z = \frac{x-np}{\sqrt{npq}} = \frac{3240 - 9000(\frac{1}{3})}{\sqrt{9000 \times \frac{1}{3} \times \frac{2}{3}}} = 5.36$$

$|Z| > 2.58$. Hypothesis will be rejected & we conclude that Dice biased

(b) Mean $\mu = 0$ & S.D. σ.

$$\bar{x} = \frac{\sum f(x)}{n} = \frac{5+2+8-1+3+0-2+9+5+10+47}{12}$$

$$= 2.583$$

(b) $\bar{x} = \frac{\sum f(x)}{n} = 2.583$

$S = \frac{1}{(n-1)} \sum (x-\bar{x})^2$ $\quad t = \frac{\bar{x}-\mu}{S}\sqrt{n}$ (15)

$S = 3.090$ $\quad t = 2.895$

$\therefore t = 2.895 > 2.556$

∴ The hypothesis rejected.

(c) $n_1 = 11$, $n_2 = 11$, $\bar{x} = 19.45$, $\bar{y} = 20.45$

$S^2 = \frac{1}{n_1+n_2-2}\left[\sum (x-\bar{x})^2 + \sum (y-\bar{y})^2\right]$

$\boxed{S = 2.18}$

$t = \frac{\bar{x}-\bar{y}}{S\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} = \frac{19.48-20.45}{2.18\sqrt{\frac{1}{11}+\frac{1}{11}}}$

$t = -1.073$

The value of t is not significant at 5% of significance ($t < 2.583$) i.e. The provide numbers of students that the students have benefitted extra coaching.

1 (a) $9+3+3+1 = 16$.

$\Rightarrow \frac{9}{16} \times 556 = 313$, $\quad 556 \times \frac{3}{16} = 104.25$

$\Rightarrow 556 \times \frac{3}{16} = 104$ $\quad 556 \times \frac{1}{16} = 35$ $\quad \therefore 313, 104, 104, 35$

$\chi^2 = \frac{(315-313)^2}{313} + \frac{(101-104)^2}{104} + \frac{(108-104)^2}{104} + \frac{(32-35)^2}{35}$

$\chi^2 = \sum \frac{(O_i-E_i)^2}{E_i} = 0.51 < 7.8185 = \chi^2_{0.05}$ (1.2886)

∴ There is a high degree of agreement b/w theory & expt.

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(b) $P = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1/2 & 1/2 & 0 \end{bmatrix}$ $P^2 = \begin{bmatrix} 0 & 0 & 1 \\ 1/2 & 1/2 & 0 \\ 0 & 1/2 & 1/2 \end{bmatrix}$

$P^3 = \begin{bmatrix} 1/2 & 1/2 & 0 \\ 0 & 1/2 & 1/2 \\ 1/4 & 1/4 & 1/2 \end{bmatrix}$ $P^4 = \begin{bmatrix} 0 & 1/2 & 1/2 \\ 1/4 & 1/4 & 1/2 \\ 1/4 & 1/2 & 1/2 \end{bmatrix}$

$P^5 = \begin{bmatrix} 1/4 & 1/4 & 1/2 \\ 1/4 & 1/2 & 1/4 \\ 1/8 & 3/8 & 1/2 \end{bmatrix}$ All entries in P^5 is positive given P is a Regular Stochastic matrix.

(c) $[x\ y\ z] = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1/2 & 1/2 & 0 \end{bmatrix} = [x\ y\ z]$

$[0+0+z/2 \quad x+0+z/2 \quad 0+y+0] = [x\ y\ z]$

$\frac{z}{2} = x \qquad x + \frac{z}{2} = y \qquad y = z$

$z = 2x \qquad 2x = y \qquad y = z$

$x+y+z = 1 \Rightarrow 1-3x = 2x \Rightarrow 5x = 1 \Rightarrow x = 1/5$

$[1/5 \quad 2/5 \quad 2/5]$ is pblity vector.

(c) $A = \begin{bmatrix} 3/4 & 1/4 \\ 1/2 & 1/2 \end{bmatrix}$

$A^2 = \begin{bmatrix} 0.6875 & 0.3125 \\ 0.625 & 0.375 \end{bmatrix}$ $A^3 = \begin{bmatrix} 0.67 & 0.3283 \\ 0.6162 & 0.3437 \end{bmatrix}$

$A^9 = \begin{bmatrix} 0.666 & 0.3316 \\ 0.663 & 0.3359 \end{bmatrix}$

$[x\ y] \begin{bmatrix} 3/4 & 1/4 \\ 1/2 & 1/2 \end{bmatrix} = [x\ y]$

$\Rightarrow 3/4\,x + 1/2\,y = x$

$1/2\,x + 1/2\,y = y.$

$x = 2/3, \quad y = 1/2.$

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SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06

DEPARTMENT OF MATHEMATICS

IV-semester: ONLINE Internal assessment Test -II: May-2020

18MAT41-Complex analysis, probability and statistical methods (ECE branch)

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

17

Time: 2 hrs] **[Max marks: 60**

1. a) Find the constant K such that $f(x) = \begin{cases} kx^2, 0 < x < 3 \\ 0, \ otherwise \end{cases}$ *is* a probability density function. Also compute $(i)\ p(1 < x < 2)\ \ (ii) p(x \leq 1)\ (iii)\ p(x > 1)\ (iv) mean\ (v)\ variance$ **(CO5)(6marks)**

b) The joint probability distribution of two random variables X and Y is as follows: Determine: $(i)$the marginal probability distribution of X and Y $(ii)\ E(X), E(Y)\ and\ E(XY)$ $(iii)\ \sigma_x\ and\ \sigma_y\ \ (iv)\ cov(X,Y)\ \ (v)\ \rho(X,Y)$ **(CO5)(7marks)**

X\Y	-2	-1	4	5
1	0.1	0.2	0	0.3
2	0.2	0.1	0.1	0

c) The joint probability function for two discrete random variables X and Y is given by $f(x,y) = k(2x + y)$ where x and y can assume all integral values such that $0 \leq x \leq 2, 0 \leq y \leq 3$ and $f(x,y) = 0$ otherwise. Find (i) *the value of constant* $k\ \ (ii)\ P(X \geq 1, Y \leq 2)\ (iii)\ P(X + Y \leq 1)\ (iv)\ P(X + Y > 1)$ **(CO5)(7marks)**

2. a) A coin is tossed 3 times. Let X be equal to '0' or '1' according as a head or a tail occurs on the first toss. Let Y be equal to the total number of heads which occur. Determine: $(i)$the marginal probability distribution of X and Y $(ii)\ E(X), E(Y)\ and\ E(XY) (iii)\ \sigma_x\ and\ \sigma_y\ \ (iv)\ cov(X,Y)\ \ (v)\ \rho(X,Y)$ **(CO5)(6marks)**

b) The joint probability distribution of two random variables X and Y is as follows: Determine: $(i)$the marginal probability distribution of X and Y $(ii)\ E(X), E(Y)\ and\ E(XY)$ $(iii)\ \sigma_x\ and\ \sigma_y\ \ (iv)\ cov(X,Y)\ \ (v)\ \rho(X,Y)$ **(CO5)(7marks)**

x\y	-4	2	7
1	1/8	1/4	1/8
5	1/4	1/8	1/8

c) Evaluate $\int_c z^2\, dz$ $(a) along\ the\ straight\ line\ from\ z = 0\ to\ z = 3 + i$ $(b)\ along\ the\ curve\ made\ up\ of\ two\ line\ segments, one\ from\ z = 0\ to\ z = 3$ $\&\ z = 3\ to\ z = 3 + i$ **(CO2)(7marks)**

3. a) Derive CR equation in polar form. **(CO1)(6marks)**

b) Find the bilinear transformation which maps $z = \infty, i, 0\ \ into\ w = -1, -i, 1$. Also find the fixed points of the transformation. **(CO2)(7marks)**

c) Discuss the transformation $w = z^2$ **(CO2)(7marks)**

(Dr. CHETANA C)
HOD

(Dr. NARENDRA VISWANATH)
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IV Semester : IInd IA Test

Scheme & Solution of Valuation. {CSE Branch} (18)

18MATH41 : Complex Analysis, Probability & Statistics Method.

(1) (a) $f(x) \geq 0$ if $k \geq 0$, also $\int_{-\infty}^{\infty} f(x)\,dx = 1$

ie, $\int_0^3 kx^2\,dx = 1 \Rightarrow \frac{kx^3}{3}\Big]_0^3 = 1$ (or) $9k = 1 \therefore k = 1/9$ — 1M

(i) $P(1<x<2) = \int_1^2 \frac{x^2}{9}\,dx = \frac{x^3}{27}\Big|_1^2 = \frac{7}{27}$ — 1M

(ii) $P(x \leq 1) = \int_0^1 \frac{x^2}{9}\,dx = \frac{x^3}{27}\Big|_0^1 = \frac{1}{27}$ — 1M

(iii) $P(x > 1) = \int_1^3 \frac{x^2}{9}\,dx = \frac{x^3}{27}\Big|_1^3 = \frac{26}{27}$ — 1M

(iv) Mean, $\mu = \int_{-\infty}^{\infty} x\,f(x)\,dx = \int_0^3 x \cdot \frac{x^2}{9}\,dx = \frac{x^4}{36}\Big|_0^3 = \frac{81}{36} = \frac{9}{4}$ — 1M

(v) Variance, $V = \int_{-\infty}^{\infty} x^2 f(x)\,dx - (\mu)^2 = \int_0^3 x^2 \frac{x^2}{9}\,dx - \left(\frac{9}{4}\right)^2 = \frac{27}{80}$ — 1M

(b) (i) Marginal distribution of X : Marginal distribution of Y

x_i	1	2
$f(x_i)$	0.6	0.4

y_j	-2	-1	4	5
$g(y_j)$	0.3	0.3	0.1	0.3

— 1M

(ii) $E[X] = \sum_i x_i f(x_i) = (1)(0.6) + 2(0.4) = 1.4$

$E[Y] = \sum_j y_j g(y_j) = (-2)(0.3) + (-1)(0.3) + 4(0.1) + 5(0.3) = 1.$

$E[XY] = \sum_{i,j} x_i y_j T_{ij} = (1)(-2)(0.1) + (1)(-1)(0.2) + (1)(4)(0) + (1)(5)(0.3)$
$+ (2)(-2)(0.2) + (2)(-1)(0.1) + (2)(4)(0.1) + (2)(5)(0.$
$= 0.9.$ — 2M

(iii) $\sigma_x^2 = E(x^2) - \mu_x^2 \Rightarrow \sigma_x^2 = 0.24 \Rightarrow \sigma_x = 0.49$

$\sigma_y^2 = E(y^2) - \mu_y^2 \Rightarrow \sigma_y^2 = 9.6 \Rightarrow \sigma_y = 3.1$ — 2M

(iv) $Cov(X,Y) = E(XY) - E(X)E(Y) = -0.5$ — 1M

(v) $\rho(X,Y) = \frac{Cov(X,Y)}{\sigma_X \sigma_Y} = \frac{-0.5}{(0.49)(3.1)} = -0.3$ — 1M

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(c) (i)

x \ y	0	1	2	3
0	0	K	2K	3K
1	2K	3K	4K	5K
2	4K	5K	6K	7K

$f(x,y) = k(2x+y)$

$f(0,0) = 0$, $f(1,2) = 4K$
$f(0,1) = K$, $f(1,3) = 5K$
$f(0,2) = 2K$, ~~$f(2,3) = 4K$~~
$f(0,3) = 3K$, $f(2,0) = 4K$
$f(1,0) = 2K$, $f(2,1) = 5K$
$f(1,1) = 3K$, $f(2,2) = 6K$
$f(2,3) = 7K$

(2m)

$\Rightarrow \sum_i \sum_j P_{ij} = 1 \Rightarrow 42K = 1 \Rightarrow K = 1/42$ (1m)

(ii) $P(X=2, Y=1) = P_{31} = 5K = 5/42$

(iii) $P(X \geq 1, Y \leq 2) = P(x=1, y \leq 2) + P(x=2, y \leq 2)$
$= P(x=1, y=0) + P(X=1, Y=1) + P(X=1, y=2) + P(x=2, y=0) +$
$P(x=2, y=1) + P(x=2, y=2) = P_{21} + P_{22} + P_{23} + P_{31} + P_{32} + P_{33}$ (2m)
$= 24/42 = 4/7$ (1m)

(iv) $\cdot X+Y \leq 1$
(a) $x=0$ & $y=1$ (b) $x=1$ & $y=0$.
$\therefore P(X+Y \leq 1) = P_{12} + P_{21} = 3/42 = 1/14$ (1m)

(v) $P(X+Y > 1) = 1 - P(X+Y \leq 1) = 1 - \frac{1}{14} = 13/14$

(2) (a)

x \ y	0	1	2	3
0	0	1/8	2/8	1/8
1	1/8	2/8	1/8	0

$E[X] = \sum x_i f(x_i) = (0 \times 4/8) + (1 \times 4/8) = 1/2$

$E[Y] = \sum y_j g(y_j) = (0 \times 1/8) + (1 \times 3/8) + (2 \times 3/8) + (3 \times 1/8) = 3/2$

$E[XY] = \sum_i \sum_j P_{ij} x_i y_j = (0)(0)(0) + (0)(1)(1/8) + (0)(2)(2/8) + (0)(3)(1/8)$
$+ (1)(0)(1/8) + (1)(1)(2/8) + (1)(2)(1/8) + (1)(3)(0)$ (2m)
$= 1/2$

$\sigma_x^2 = E[X^2] - \mu_x^2 = 1/4 \Rightarrow \sigma_x = 1/2$ (2m)

$\sigma_y^2 = E[Y^2] - \mu_y^2 = 3/4 \Rightarrow \sigma_y = \sqrt{3}/2$ (1m)

$Cov(X,Y) = E[XY] - \mu_x \mu_y = -1/4$ (1m)

$\rho(X,Y) = \frac{Cov(X,Y)}{\sigma_x \sigma_y} = -1/\sqrt{3}$

(5) (i)

x_i	1	5
$f(x_i)$	1/2	1/2

Marginal distribution of X

y_j	-4	2	7
$g(y_j)$	3/8	3/8	1/4

Marginal distribution of Y (1m)

(ii) $E[X] = \sum x_i f(x_i) = 3$. (1m)

$E[Y] = \sum y_j g(y_j) = 1$.

$E[XY] = \sum x_i y_j J_{ij} = 3/2$.

(iii) $\sigma_X^2 = E[X^2] - \mu_X^2 = 4 \Rightarrow \sigma_X = 2$.

$\sigma_Y^2 = E[Y^2] - \mu_Y^2 = 75/4 \Rightarrow \sigma_Y = \sqrt{\frac{75}{4}} = 4.33$. (2m)

(iv) $Cov(X,Y) = E(XY) - E[X]E[Y] = -3/2$ (1m)

(v) $\rho(X,Y) = \frac{Cov(X,Y)}{\sigma_X \sigma_Y} = -0.1732$. (1m)

(c) $\int_{-\infty}^{\infty} f(x)dx = 1 \Rightarrow \int_{-\infty}^{\infty} \frac{K}{1+x^2} dx = 1 \Rightarrow 2\int_0^{\infty} \frac{K}{1+x^2} dx = 1$.

$2K[\tan^{-1}x]_0^{\infty} = 1 \Rightarrow 2K[\pi/2 - 0] = 1 \Rightarrow K = 1/\pi$ (2m)

(i) $P(x \geq 0) = \int_0^{\infty} f(x)\,dx = \frac{1}{\pi}\int_0^{\infty} \frac{1}{1+x^2} dx = \frac{1}{\pi}\tan^{-1}x\Big|_0^{\infty} = 1/2$ (2m)

(ii) $P(0 < x < 1) = \frac{1}{\pi}\int_0^1 \frac{1}{1+x^2} dx = \frac{1}{\pi}\tan^{-1}\Big|_0^1 = 1/4$. (2m)

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(3) (a) $N = 3$

Population mean $\mu = \frac{1+2+3}{3} = 2$.

Population Variance, $\sigma^2 = \frac{1}{3}\{(1-2)^2 + (2-2)^2 + (3-2)^2\} = \frac{2}{3}$ (1m)

Case(i): (1,1), (1,2), (1,3), (2,1) (2,2), (2,3) (3,1) (3,2) (3,3)

$N^n = 3^2 = 9$

The mean of these are respectively 1, 1·5, 2, 1·5, 2, 2·5, 2, 2·5, 3

The frequency distribution is

x	1	1·5	2	2·5	3
f	1	2	3	2	1

(3m)

$\mu_{\bar{x}} = \frac{\sum fx}{\sum f} = 2$, $\sigma_{\bar{x}}^2 = \frac{\sum f(x-\mu_{\bar{x}})^2}{\sum f} = \frac{1}{3}$ & $\frac{\sigma^2}{n} = \frac{1}{3}$

Case(ii): ${}^3C_2 = 3$ Sample,

(1,2), (2,3), (3,1) & associated means are 1·5, 2·5, 2

Mean, $\mu_{\bar{x}} = \frac{1.5+2.5+2}{3} = 2$.

Variance, $\sigma_{\bar{x}}^2 = \frac{1}{3}\{(1.5-2)^2 + (2.5-2)^2 + (2-2)^2\} = \frac{0.5}{3} = 1/6$ (3m)

WKT, $\mu_{\bar{x}} = \mu = 2$ $\therefore \sigma_{\bar{x}}^2 = \left[\frac{N-n}{N-1}\right]\frac{\sigma^2}{n} = \frac{1}{6}$.

(b) (i) $\mu = 6$, $\sigma^2 = 10.8 \Rightarrow \sigma = \sqrt{10.8}$ (2m)

(ii) $N^n = 5^2 = 25$ Samples.

(2,2), (2,3) (2,6) (2,8) (2,11) (3,2) (3,3) (3,6) (3,8)
(3,11) (6,2) (6,3) (6,6) (6,8) (6,11) (8,2) (8,3) (8,6) (8,8)
(8,11), (11,2) (11,3) (11,6) (11,11) (11,11).

Mean of Sample in respective order:

(2, 2·5, 4, 5, 5·5) (2·5, 3, 4·5, 5·5, 7) (4, 4·5, 6·7, 8·5)
(5, 5·5, 7, 8, 9·5) (6·5, 7, 8·5, 9·5, 11)

frequency distribution:

(3m)

x	2	2·5	3	4·5	5	5·5	6	6·5	7	8	8·5	9·5	11
f	1	2	1	2	2	2	1	2	4	1	2	2	1

$\mu_{\bar{x}} = \frac{\sum fx}{\sum f} = \frac{150}{25} = 6$, $\sigma_{\bar{x}}^2 = \frac{\sum fx^2}{\sum f} - [\mu_{\bar{x}}]^2 = 5.4 \Rightarrow \sigma_{\bar{x}} = \sqrt{5.4}$.

(iii) (2,3) (2,6) (2,8) (2,11) (3,6), (3,8) (3,11) (6,8) (6,11) (8,11)

Mean of Samples are 2·5, 4, 5, 6·5, 4·5, 5·5, 7, 7, 8·5, 9·5

$\mu_{\bar{x}} = 6$, $\sigma_{\bar{x}}^2 = 4.05 \Rightarrow \sigma_{\bar{x}} = \sqrt{4.05}$ (2m)

(c) (i) $\mu = 9 \quad \sigma^2 = 20 \Rightarrow \sigma = \sqrt{20}$. (2m)

With replacement: (3,3), (3,7) (3,11) (3,15) (7,3) (7,7) (7,11) (7,15) (11,3) (11,7) (11,11) (11,15) (15,3) (15,7) (15,11) (15,15).

Sampling means are as follows: (3,5,7,9) (5,7,9,11), (7,9,11,13) (9,11,13,15).

Frequency distribution of Sampling means

$\bar{x}$	3	5	7	9	11	13	15
f	1	2	3	4	3	2	1

$\mu_{\bar{x}} = \frac{\sum f\bar{x}}{\sum f} = 9 \quad \sigma_{\bar{x}}^2 = \frac{\sum f\bar{x}^2}{\sum f} - [\mu_{\bar{x}}]^2 = \frac{1456}{16} - 9^2 = 10$

$\mu_{\bar{x}} = 9$ and $\sigma_{\bar{x}} = \sqrt{10}$. (4m)

(ii) Consider Samples without replacement.

(3,7), (3,11), (3,15) (7,11) (7,15) (11,15)

Sampling means are 5, 7, 9, 9, 11, 13.

$\mu_{\bar{x}} = \frac{1}{6}(5+7+9+9+11+13) = 9$. Thus $\mu_{\bar{x}} = \mu$

$\sigma_{\bar{x}}^2 = \frac{1}{6}\{(5-9)^2 + (7-9)^2 + \cdots + (13-9)^2\} = 20/3$.

Consider $\sigma_{\bar{x}}^2 = \frac{\sigma^2}{n}\left[\frac{N-n}{N-1}\right]$.

$RHS = \frac{20}{2}\left[\frac{4-2}{4-1}\right] = 10 \times 2/3 = 20/3 = \sigma_{\bar{x}}^2 = LHS$. (3m)

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PART-II

3. a) Find the inverse Laplace Transform of $\frac{e^{-\pi s}}{s^2+1} + \frac{se^{-2\pi s}}{s^2+4}$. (5 Marks)

b) Verify Convolution theorem for the pair of function : f(t) = t , g(t) = cost (5 Marks)

c) Solve Initial value problem by using Laplace transform $y^{11}(t) + 4y^{1}(t) + 4y(t) = e^{-t}$ $with\ y(0) = 0 = y^{1}(0)$ (5 Marks)

OR

4. a) Find the inverse Laplace Transform of $\frac{1}{s(s+1)(s+2)(s+3)}$ (5 Marks)

b) Using Convolution theorem obtain the inverse Laplace transform of the function $\frac{1}{s(s^2+a^2)}$ (5 Marks)

c) Solve:$y^{11}(t) + 6y^{1}(t) + 9y(t) = 12t^2e^{-3t} with\ y(0) = 0 = y^{1}(0)$ with by using Laplace transform (5marks)

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SUB: Transform calculus, Fourier series & Numerical Techniques (18MAT31)

II INTERNAL TEST

1. a. $\frac{dy}{dx} = xy^2 - 1 \quad y(0) = 0$

$y'(x) = x^2 y(x) - 1 \quad y'(0) = -1$

$y''(x) = 2xy(x) + x^2 y'(x) \quad y''(0) = 0$

$y'''(x) = 2y(x) + 2xy'(x) + 2xy'(x) + x^2 y''(x) \quad y'''(0) = 0.$

} — (3M)

Taylor's series

$y(x) = y(x_0) + \frac{(x-x_0)}{1} y'(x_0) + \frac{(x-x_0)^2}{2} y''(x_0) + \dots\dots$

$y(x) = 0 - x - \dots$

$\boxed{y(0.1) = -0.1}$ $\boxed{y(0.2) = -0.2}$ } — (2M)

b. $\frac{dy}{dx} = x + |y| \quad x_0 = 0, y_0 = 1$

Step 1: Euler's $y_1^{(0)} = y_0 + hf(x_0, y_0)$

$y_1^{(0)} = 1.1$

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

$y_1^{(1)} = 1.1074$

$y_1^{(2)} = 1.1076$

$y_1^{(3)} = 1.1076$ $\boxed{y(0.1) = 1.1076}$ — (3M)

Step 2: Euler's $y_2^{(0)} = 1.2228$

ME $= y_2^{(1)} = 1.2305$

$y_2^{(2)} = 1.12307$

$y_2^{(3)} = 1.2307$ $\boxed{y(0.2) = 1.2307}$ — (2M)

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(c) $\frac{dy}{dx} = x - y^2$

x	0	0.2	0.4	0.6	0.8
y	0	0.02	0.0795	0.1762	?
$y' = x - y^2$	0	0.1996	0.3937	0.5689	

} — (2M)

By Milnes $y_4^{(p)} = y_0 + \frac{4h}{3}[2f_1 - f_2 + 2f_3] = 0.3049$

$y_4' = 0.707$

} — (2M)

Milnes corrector $y_4^{(c)} = y_2 + \frac{h}{3}[f_2 + 4f_3 + f_4] = 0.3046$

2 (a) $\frac{dy}{dx} = \frac{y^2 - x^2}{y^2 + x^2}$, $y(0) = 1$

$k_1 = hf(x_0, y_0) = 0.2$

$k_2 = hf\left(x_0 + \frac{h}{2}, y_0 + \frac{k_1}{2}\right) = 0.1967$

$k_3 = hf\left(x_0 + \frac{h}{2}, y_0 + \frac{k_2}{2}\right) = 0.1967$

$k_4 = hf(x_0 + h, y_0 + k_3) = 0.1891$

$k = \frac{1}{6}(k_1 + 2k_2 + 2k_2 + k_4)$

$= 0.1960$

} — (4M)

$y = y_0 + k = 1.1960$ — (1M)

(b) $\frac{dy}{dx} = x^2 + \frac{y}{2}$ $\quad 1 \le x \le 1.3$

x	1	1.1	1.2	1.3	1.4
y	2	2.2156	2.4649	2.7513	?
y'	2	2.3178	2.3176	2.6725	

} — (2M)

By Adam's predictor & corrector

$y_4^{(p)} = y_3 + \frac{h}{24}[55f_3 - 59f_2 + 37f_1 - 9yf_0] = 3.0792$

$y_4^{(c)} = y_3 + \frac{h}{24}[9f_4 + 19f_3 - 5f_2 + f_1] = 3.0792$

} — (3M)

(c) $\frac{dy}{dx} = -xy^2$, $y_0 = 0$, $h = 0.1$ — (2M)

Euler $y_1^{(0)} = y_0 + hf(x_0, y_0) = 2$.

M.E $y_1^{(1)} = y_0 + \frac{h}{2}[f(x_0, y_0) + f(x_1, y_1^{(0)})] = 1.99$.

$y_1^{(2)} = 1.9901$

$y(0.1) = 1.9901$

} — (3M)

$y_1^{(2)} = 1.9991$

$\boxed{y(0.1) = 1.9901}$ } ——— (3M)

3 (a) $L^{-1}\left\{\frac{e^{-\pi s}}{s^2+1}\right\} + L^{-1}\left\{e^{-2\pi s}\cdot\frac{s}{s^2+4}\right\}$

$= \sin(t-\pi)\,u(t-\pi) + \cos 2(t-2\pi)\,u(t-2\pi)$ ——— (2M)

$L\{e^{at} f(t)\} = f(t-a)$

$L\left\{\frac{1}{s^2+1}\right\} = \sin t$ } ——— (3M)

$L\left\{\frac{s}{s^2+4}\right\} = \cos 2t$

(b) $L\{f(t)\} = L\{t\} = \frac{1}{s^2} = \bar{f}(s)$

$L\{g(t)\} = L\{\cos t\} = \frac{s}{s^2+1} = \bar{g}(s)$. } ——— (2M)

$f(t) * g(t) = \int_0^t f(u)\,g(t-u)\,du$. ——— (1M)

$= \int_0^t u\cdot\cos(t-u)\,du$

$= \left[u\cdot\frac{\sin(t-u)}{(-1)} - 1\cdot\frac{[-\cos(t-u)]}{(-1)^2}\right]\Big|_{u=0}^{t}$

$= (t(0) + \cos 0) - (0 + \cos t) = 1 - \cos t$

$L\{f(t) * g(t)\} = L\{1-\cos t\} = \frac{1}{s} - \frac{s}{s^2+1} = \frac{s^2+1-s^2}{s(s^2+1)} = \frac{1}{s(s^2+1)}$ ——→ (1)

$\bar{f}(s)\cdot\bar{g}(s) = \frac{1}{s^2}\cdot\frac{s}{s^2+1} = \frac{1}{s(s^2+1)}$ ——→ (2) ——— (2M)

from (1) & (2). The thm is Verified.

(c) $y'' + 4y' + 4y = e^{-t}$

$L\{y''\} + 4L\{y'\} + 4L\{y\} = L\{e^{-t}\}$.

$[s^2L\{y(t)\} - sy(0) - y'(0)] + [4sL\{y(t)\} - 4y(0)] + 4L\{y(t)\} =$

$= \frac{1}{s+1}$

——— (2M)

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$(s^2+4s+4)\,L\{y(t)\} = \frac{1}{s+1}$

$L\{y(t)\} = \frac{1}{(s+1)(s+2)^2}$

$y(t) = L^{-1}\left\{\frac{1}{s+1}\right\} + L^{-1}\left\{\frac{-1}{s+2}\right\} + L^{-1}\left\{\frac{-1}{(s+2)^2}\right\}$ — (3M)

$y(t) = e^{-t} - e^{-2t} - te^{-2t}$

4 (a). $L^{-1}\left\{\frac{1}{s(s+1)(s+2)(s+3)}\right\} = L^{-1}\left\{\frac{A}{s}\right\} + L^{-1}\left\{\frac{B}{s+1}\right\} + L^{-1}\left\{\frac{C}{s+2}\right\} + L^{-1}\left\{\frac{D}{s+3}\right\}$ — (1M)

$= L^{-1}\left\{\frac{1/6}{s}\right\} + L^{-1}\left\{\frac{-1/2}{s+1}\right\} + L^{-1}\left\{\frac{1/2}{s+2}\right\} + L^{-1}\left\{\frac{-1/6}{s+3}\right\}$. — (3M)

$= \frac{1}{6} - \frac{1}{2}e^{-t} + \frac{1}{2}e^{-2t} - \frac{1}{6}e^{-3t}$ — (1M)

(b) $\frac{1}{s(s^2+a^2)} = \frac{1}{s} \cdot \frac{1}{s^2+a^2}$

$\bar{f}(s) = \frac{1}{s}$ $\qquad$ $\bar{g}(s) = \frac{1}{s^2+a^2}$

$L^{-1}\{\bar{f}(s)\} = L^{-1}\left\{\frac{1}{s}\right\}$ $\qquad$ $L^{-1}\{\bar{g}(s)\} = L^{-1}\left\{\frac{1}{s^2+a^2}\right\}$ — (2M)

$f(t) = 1$ $\qquad$ $g(t) = \frac{1}{a}\sin at$

$L^{-1}\{\bar{f}(s)\cdot\bar{g}(s)\} = \int_0^t f(u)\,g(t-u)\,du.$ — (3M)

$= \int_0^t \frac{\sin(at-au)}{a}\,du.$

$= \frac{1}{a}\left[\frac{-\cos(at-au)}{(-a)}\right]\Big|_0^t = \frac{1}{a^2}(1-\cos at)$

(c) $L\{y''(t)\} + 6L\{y'(t)\} + 9L\{y(t)\} = 12\,L\{t^2e^{-3t}\}$ — (2M)

$[s^2L\{y(t)\} - sy(0) - y'(0)] + 6[sL\{y(t)\} - y(0)] + 9L\{y(t)\} = \frac{12 \cdot 2!}{(s+3)^3}$

$(s^2+6s+9)\,L\{y(t)\} = \frac{24}{(s+3)^3} \Rightarrow L\{y(t)\} = \frac{24}{(s+3)^5}$

$y(t) = 24 \cdot e^{-3t} \cdot \frac{t^4}{4!} = t^4e^{-3t}$ — (3M)

SHRIDEVI

SHRIDEVI INSTITUTE OF ENGINEERING & TECHNOLOGY, TUMKUR-06
DEPARTMENT OF MATHEMATICS
III-semester: III-Internal Assessment Test: NOVEMBER-2019
18MAT31: Transform calculus, Fourier series and Numerical techniques (Common to all branches)
Note: Answer any **two full questions** choosing **one** from **each part**

Time:75min] [Max marks:30

PART-I

1. **a)** Compute $y(0.1)$ given $\frac{d^2y}{dx^2} = y^3$ *and* $y = 10$, $\frac{dy}{dx} = 5$ *at* $x = 0$ by Runge kutta method of fourth order. **(5 marks)**

   b) State and prove Euler's equation. **(5marks)**

   c) Find the extremal of the functional $\int_{x_1}^{x_2}(y' + x^2y'^2)dx$ **(5 marks)**

OR

2. **a)** Obtain the solution of the equation $2\frac{d^2y}{dx^2} = 4x + \frac{dy}{dx}$ by computing the value of the dependent **(5 marks)** Variable corresponding to the value 1.4 of the independent variable by applying Milne's method using:

   $y(1) = 2$, $y'(1) = 2$, $y(1.1) = 2.2156$, $y'(1.1) = 2.3178$,
   $y(1.2) = 2.4649$, $y'(1.2) = 2.6725$, $y(1.3) = 2.7514$, $y'(1.3) = 3.0657$

   b) Prove that the shortest distance between two points in a plane is along the straight line joining them. **(5Marks)**

   c) A heavy cable hangs freely under gravity between two fixed points. Show that the shape of the cable is a catenary. **(5 marks)**

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PART-II

3. a) Find the fourier series of $f(x) = \frac{\pi - x}{2}$ $in\ 0 < x < 2\pi$. Hence deduce that

$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + - - - = \frac{\pi}{4}$ **(5 marks)**

b) Obtain half range fourier sine series of $f(x) = x^2\ in\ 0 < x < \pi$ **(5 marks)**

c) Determine the constant term and the first cosine and sine terms of fourier series expansion of y from the following data: **(5 marks)**

x	0	45	90	135	180	225	270	315
y	2	$^3/_2$	1	$^1/_2$	0	$^1/_2$	1	$^3/_2$

OR

4. a) Find the fourier series of the periodic function defined by $f(x) = 2x - x^2\ in\ 0 < x < 3$ **(5 marks)**

b) Find the half range fourier cosine series of the function $f(x) = x(\pi - x)\ \ in\ 0 < x < \pi$ **(5 marks)**

c) Obtain the constant term and the co-efficients of the first cosine and sine terms in the Fourier expansion of y from the table: **(5 marks)**

x	0	1	2	3	4	5
y	9	18	24	28	26	20

III Sem : III Internal Test : Scheme of evaluation.

18MAT31 : Numerical Tech, FT and LT

1 (a) $\frac{d^2y}{dx^2} = y^3$, $\frac{dy}{dx} = 5$.

Put $\frac{dy}{dx} = z$, $\frac{dz}{dx} = y^3$, $y=10$, $z=5$, $x=0$ —— (1M)

$k_1 = hf(x_0, y_0, z_0) = 0.5$ $k_3 = 5.885$

$l_1 = 100$ $l_3 = 207.27$

$k_2 = 5.5$ $k_4 = 21.227$

$l_2 = 107.7$ $l_4 = 400.83$

} —— (3M)

—— (1M)

$y(x_1) = 17.4162$

(b) Euler's : Book work —— (5M)

(c) $I = \int_{x_1}^{x_2} (y' + x^2 y^2) dx$. $y' = \frac{k_1 - 1}{2x^2}$

$\Rightarrow \frac{d}{dx}(1 + 2x^2 y') = 0$. $\boxed{y = \frac{c_1}{x} + c_2}$ $c_1 = \frac{1-k_1}{2}$.

$\Rightarrow 1 + 2x^2 y' = k_1$

2 (a) $z_0' = 3$ $z_0 = 2$.

$z_1' = 3.3589$ $z_1 = 2.3178$

$z_2' = 3.73625$ $z_2 = 2.6725$

$z_3' = 4.1328$ $z_3 = 3.0657$

} —— (3M)

$y_4^{(P)} = 3.0793$

$z_4^{(P)} = 3.4996$

$y_4^{(C)} = 3.0794$

$z_4^{(C)} = 3.4997$

(b) $y = c_1 x + c_2$: Book work —— (5M)

(c) $T = \int_{x_1}^{x_2} 2\pi y \frac{ds}{dx} dx = \int_{x_1}^{x_2} y\sqrt{1+y'^2}\, dx$.

$y = c \cosh\left(\frac{x+a}{c}\right)$ is catenary

} —— (5M)

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③ (a) $a_0 = a_n = 0$ — (2M)

$FS = \frac{a_0}{2} + \sum a_n \cos nx + \sum b_n \sin nx.$

$b_n = \frac{2}{\pi}\int_0^{\pi} f(x)\sin nx\,dx = \frac{1}{n}$ — (1M)

$x = \pi/2,\ \frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} + \cdots$ — (1M)

(b) $b_n = \frac{2}{\pi}\int_0^{\pi} x^2 \sin nx\,dx = \frac{2}{\pi}\left\{\frac{(-1)^{n+1}\pi^2}{n} - \frac{2}{n^3}(1-(-1)^n)\right\}$ — (4M)

$f(x) = \sum b_n \sin nx$ — (1M)

(c) $a_0 = 2$

$a_1 = 0.8535$

$b_1 = 0$

$\Sigma y = 8$

$\Sigma y\cos x = 3.4142$

$\Sigma y \sin x = 0$

— (3M)

④ (a) $l = 3/2$

$a_0 = \frac{2}{3}\int_0^3 (2x - x^2)\,dx = 0.$

$a_n = -9/n^2\pi^2,\ b_n = 3/n\pi.$

— (1M)

$f(x) = \sum \frac{-9}{n^2\pi^2}\cos\frac{2n\pi x}{3} + \sum \frac{3}{n\pi}\sin\left(\frac{2n\pi x}{3}\right)$ — (1M)

(b) $f(x) = \frac{a_0}{2} + \sum a_n \cos nx$ — (1M)

$a_0 = \frac{2}{\pi}\int_0^{\pi} (\pi x - x^2)\,dx = \frac{\pi^2}{2}$

$a_n = \frac{2}{\pi}\int_0^{\pi} (\pi x - x^2)\cos nx\,dx = \frac{-2}{n^2\pi^2}(1+(-1)^n)$

— (2M)

$f(x) = \frac{\pi^2}{6} - \frac{2}{\pi^2}\sum \frac{1}{n^2}(1+(-1)^n)\cos nx$ — (1M)

(c) $f(x)$ series. — (1M)

$a_0 = \frac{2}{N}\Sigma y = 41.67$ $\quad \Sigma y = 125$

$a_1 = \frac{2}{N}\Sigma y\cos\theta = -8.33$ $\quad \Sigma y\cos\theta = -25$

$b_1 = \frac{2}{N}\Sigma y\sin\theta = -1.153$ $\quad \Sigma y\sin\theta = -3.464$

— (3M)

19-20 II Sem

SHRIDEVI

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II Semester: I-Internal assessment test | Date: 13-03-2020

Sub: Engineering Chemistry (18CHE22)

Time: 90 minutes | Section: A & B | Max Marks: 30

Note:	1.	Answer any *TWO FULL* questions choosing one full question from each unit.

		Module-1	Marks	CO
1	a)	Derive Nernst equation for single electrode potential.	(5)	CO 1
	b)	With a neat diagram, *explain* the construction and working of Calomel electrode.	(5)	CO 1
	c)	Calculate the voltage of the cell, $Fe \mid Fe^{++}(0.01) \parallel Ag^{+}(0.1) \mid Ag$ at 25 °C, if the standard electrode potentials of Fe and Ag are -0.44V & 0.80V respectively. Write the cell reactions.	(5)	CO 1

(OR)

2	a)	What are electrolytic concentration cells? Explain with an example.	(5)	CO 1
	b)	*Discuss* the construction and working of Nickel-Metal hydride batteries. *Mention* their uses.	(5)	CO 1
	c)	Calculate the emf *of the* electrolytic concentration cell *represented as* $Cu(s)\ /Cu\ SO_4\ (0.01M)\ //\ Cu\ SO_4\ (1M)\ /\ Cu(s)$ *at 298K. Write the cell reactions.*	(5)	CO 1

		Module-2	Marks	CO
3	a)	*Explain* the electrochemical theory of corrosion with reactions taking corrosion of iron as an example.	(5)	CO 2
	b)	*Explain* differential metal corrosion with an example.	(5)	CO 2
	c)	What is metal finishing? Mention the technological importance of metal finishing	(5)	CO 2

(OR)

4	a)	*Explain* how (i) Ratio of Anodic to Cathodic area (ii) pH,influences the rate of corrosion.	(5)	CO 2
	b)	*What is Cathodic protection? Describe* corrosion control by sacrificial anode method.	(5)	CO 2
	c)	*Explain the anodizing process of aluminium*	(5)	CO 2

Name of the Course instructor	Dr. Chandrasekhar N
Signature	
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19-20

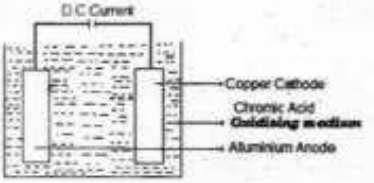
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II semester: I-Internal assessment test Date: 13-03-2020

Scheme of valuation Sub: Engineering Chemistry (18CHE22)

Q.No	Scheme of valuation	Marks
1. (a)	**Derive Nernst equation for single electrode potential**	5Marks
	ΔG, ΔG^*	1mark
	Reversible electrode reaction $M^{+n} + ne^- \leftrightarrow M$ & K_C	1mark
	$\Delta G = \Delta G^* + RT\ln K_c$	1mark
	Substitution	1mark
	$E = E^* + \frac{0.0591}{n}\log\frac{[M]}{[M^{+n}]}$	1mark
(b)	**Explain the construction, working and advantages of Calomel electrode**	5Marks
	Diagram with labeling	1mark
	Explanation:	2mark
	Reactions	
	Anode: $2Hg + 2Cl^- \longrightarrow Hg2Cl_2 + 2e^-$	1mark
	Cathode: $Hg2Cl_2 + 2e^- \quad 2Hg + 2Cl^-$	1mark
	• Advantages(Any two)	
	• It can be used to determine the potential of a redox reaction.	
	• It is used in corrosion studies	
	• It is used as a reference electrode.	
	• It is simple to construct.	
	• The electrode potential is reproducible and stable	
(c)	Calculate the voltage of the cell, $Fe \mid Fe^{++}(0.01) \parallel Ag^+(0.1) \mid Ag$ at 25 °C, if the standard electrode potentials of Fe and Ag are -0.44V & 0.80V respectively. Write the cell reactions.	5Marks
	Cell reactions: At Anode: $Fe \rightarrow Fe^{2+} + 2e^-$	1mark
	At Cathode: $2Ag^+ + 2e^- \rightarrow 2Ag$	1mark
	Formula $E = E^* + \frac{0.0591}{n}\log\frac{[Mn+]cathode}{[M^{n+}]anode}$	1mark
	Substitution $E = 1.24 + \frac{0.0591}{2}\log\frac{[0.1]2}{[0.01]}$	1mark
	Answer:1.24V	1mark
2. (a)	**What are electrolytic concentration cells? Explain with an example**	5Marks
	Definition of Electrolytic concentration cell:	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	1mark
	Diagram with labeling:	
	Explanation:	2mark
	Reactions :	
	At anode : $Cu(S) \longrightarrow Cu^{2+}(M_1) + 2e^-$	1mark
	At cathode : $Cu^{2+}(M_2) + 2e^- \longrightarrow Cu(S)$	
(b)	**Explain the construction, working and uses of Ni-MH battery.**	5Marks
	Diagram with labeling:	1mark
	Explanation	2mark
	Reactions	
		1mark

	At anode : $MH + OH^- \rightleftharpoons M + H_2O + e^-$ At cathode : $NiO(OH) + e^- + H_2O \rightleftharpoons Ni(OH)_2 + OH^-$ NCR : $MH + NiO(OH) \rightleftharpoons M + Ni(OH)_2$ Uses :Used in electric vehicles, laptops, cellular phones etc	1mark
(c)	Calculate the emf *of the* electrolytic concentration cell *represented as Cu(s) /Cu SO_4 (0.01M) // Cu SO_4 (1M) / Cu(s) at 298K. Write the cell reactions.*	**5Marks**
	Cell reactions: At Anode: $Cu \rightarrow Cu^{2+} + 2e^-$ At Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$ Formula $E = \frac{0.0591}{n} \log \frac{[M1M]cathode}{[M2M\ ]anode}$ Substitution $E = \frac{0.0591}{2} \log \frac{[1]}{[0.01]}$ Answer:0.0591V	1mark 1mark 1mark 1mark 1mark
3.(a)	Explain the electrochemical theory of corrosion with reactions taking corrosion of iron as an example.	**5Marks**
	Formation of minute galvanic cells Anode:$Fe \rightarrow Fe^{2+} + 2e^-$ Cathode: reactions (Any two reactions) a) In acidic medium: $2H^+ + 2e^- \longrightarrow H_2$ b) In alkaline and in the absence of O_2: $2H_2O + 2e^- \longrightarrow 2OH^- + H_2$ c) In neutral and aerated medium: $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ Corrosion product : $2Fe^{++} + 4OH^- \longrightarrow 2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 2(Fe_2O_3 . 3H_2O)$ rust.	1mark 1mark 2mark 1mark
(b)	Explain differential metal corrosion with an example.	**5Marks**
	Diagram Explanation Reactions At anode : $Fe \longrightarrow Fe^{++} + 2e^-$ At cathode : $H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ Corrosion Product: $2Fe^{++} + 4OH^- \longrightarrow 2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 2(Fe_2O_3 . 3H_2O)$ rust.	1mark 3mark 1mark
(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.	1mark 4mark
4. (a)	*Explain* how (i) Ratio of Anodic to Cathodic area (ii) pH influences the rate of corrosion.	**5Marks**
	(i) Ratio of Anodic to Cathodic area If a metal has small anodic and large cathodic area the rate of corrosion increases and vice versa. This is because when anode is small the electrons liberated during oxidation are completely consumed on large cathodic surface for the reduction reactions	3mark

	and rate of corrosion increases. (ii) pH. In general at lower PH value the rate of corrosion is more at higher pH value (more than pH = 10) the rate of corrosion ceases due to the formation of protective coating of hydrous oxides on the metal. Corrosion rate is maximum between PH 3 and 10 in presence of oxygen.	2mark
(b)	*What is Cathodic protection? Describe* corrosion control by sacrificial anode method.	**5Marks**
	Definition of Cathodic protection: Cathodic protection is a method in which the base metal to be protected from corrosion is made to act as cathodic by attaching more active anodic metal to it. Construction - diagram Explanation 	1mark 1mark 3mark
(c)	**Explain the anodizing process of aluminium**	**5Marks**
	Construction –Diagram with labeling Explanation : ➢ 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 both is maintained at 35°c ➢ 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 Reactions : 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: $2Al(s) + 3H_2O(l) \longrightarrow Al_2O_3(s) + 3H_2$	1mark 3mark 1mark

Name of the Course instructor	Dr. Chandrasekhar N
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19 - 20

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II Semester: II-Internal assessment test **Date: 01-05-2020**

Sub: Engineering Chemistry (18CHE22)

Time: 90 minutes **Section: A & B** **Max Marks: 30**

Note:	1.	Answer any *TWO FULL* questions choosing one full question from each unit.

		Module-1	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)	Explain the construction, working and uses of Methanol – Oxygen fuel cell	(5)	CO 3
		(OR)		
2	a)	Explain the construction, working and uses of Solid oxide fuel cell (SOFC)	(5)	CO 3
	b)	Explain the construction and working of photovoltaic cell.	(5)	CO 3
	c)	Calculate GCV and NCV of a fuel from the following data. Mass of fuel =0.75g, W1= 2500 g, W_2 = 650 g, t_2 =27.2^{0}C, t_1 = 24.0^{0}C, % H_2 = 5% and S = 4.187 J/Kg/^{0}C.	(5)	CO 3

		Module-2	Marks	CO
3	a)	Define Chemical fuel and explain the classification of Chemical fuels with examples.	(5)	CO 3
	b)	Write a note on a) Unleaded Petrol b) Power alcohol	(5)	CO 3
	c)	What is Biodiesel? How it is produced? Mention the advantages of Biodiesel	(5)	CO 3
		(OR)		
4	a)	Define Calorific Value and Explain the types	(5)	CO 3
	b)	What are Fuel Cells? Mention the differences between the fuel cells and conventional cells	(5)	CO 3
	c)	Explain the preparation of solar grade silicon by Union Carbide Process	(5)	CO 3

Name of the Course instructor	Dr. Chandrasekhar N
Signature	
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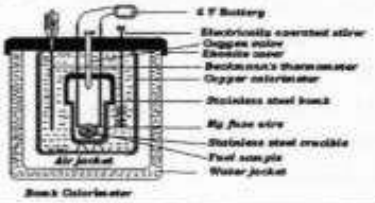
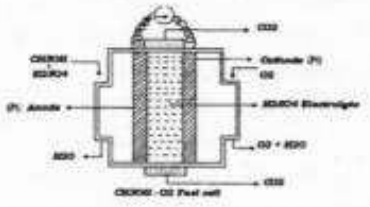
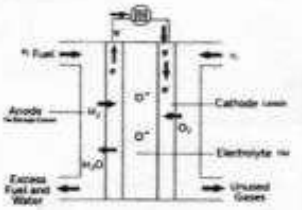
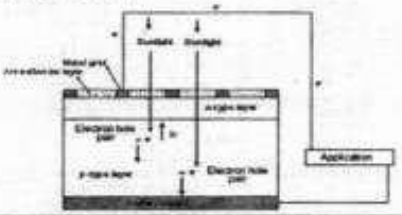
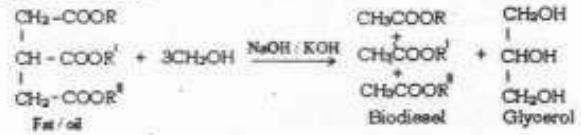
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II semester: II-Internal assessment test **Date: 01-05-2020**

Scheme of valuation Sub: Engineering Chemistry (18CHE22)

Q.No	Scheme of valuation	Marks
1. (a)	Explain the determination of calorific value of solid fuel using Bomb calorimeter	5Marks
	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. & from the data obtained the gross and net calorific values of the fuel can be calculated as GCV = $\frac{(W_1+W_2) \times S \times \triangle t \times 4.187}{M}$ J /Kg NCV = GCV – 0.09 x %H_2 x 587 x 4.187 J /Kg 	1mark 3mark 1mark
(b)	What is Knocking of petrol engine? Explain the Mechanism of Knocking	5Marks
	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. **Mechanism of Knocking** 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 gaseous 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 $C_2H_6 + 3\frac{1}{2}O_2 \longrightarrow 2CO_2 + 3H_2O$ (Normal combustion reaction) $C_2H_6 + O_2 \longrightarrow CH_3\text{-}O\text{-}O\text{-}CH_3$ (Explosive combustion reaction) $CH_3\text{-}O\text{-}O\text{-}CH_3 \longrightarrow CH_3\text{-}CHO + H_2O$ $CH_3\text{-}CHO + 1\frac{1}{2}O_2 \longrightarrow HCHO + CO_2 + H_2O$ $HCHO + O_2 \longrightarrow CO_2 + H_2O$	1mark 2mark 2mark
(c)	Explain the construction, working and uses of Methanol – Oxygen fuel cell	5Marks
	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. The cell reactions are as follows. At anode : $CH_3OH + H_2O \longrightarrow CO_2 + 6H^+ + 6e^-$ At cathode : $\frac{3}{2}O_2 + 6H^+ + 6e^- \longrightarrow 3H_2O$ NCR : $CH_3OH + \frac{3}{2}O_2 \longrightarrow CO_2 + 2H_2O$ 	3mark 1mark 1mark
2. (a)	Explain the construction, working and uses of Solid oxide fuel cell (SOFC)	5Marks
	Solid oxide fuel contains solid oxide ceramic material as the electrolyte and operates at high temperature about 600^{0}C -1000^{0}C. The cathode is made up of porous Lanthanum Manganite ($LaMnO_3$) doped with Strontium (Sr). The anode is made up of porous Nickel zirconia cermet (Ni-ZrO_2) The anode and cathode are separated by Yttrium stabilized Zirconia (YSZ)	1mark

	Hydrogen gas is supplied at anode and oxygen gas is supplied at cathode The cell reactions are At anode : $H_2 + O^{--} \longrightarrow H_2O + 2e^-$ At cathode : $\frac{1}{2} O_2 + 2e \longrightarrow O^{--}$ NCR : $H_2 + \frac{1}{2} O_2 \longrightarrow H_2O$ 	3mark 1mark
(b)	Explain the construction and working of photovoltaic cell.	**5Marks**
	A typical silicon photovoltaic cell is composed of a thin wafer consisting of an ultra thin layer of phosphorus doped. (n-type) silicon on top of boron doped (p-type) silicon. 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 to the semiconductor. The cell's other electrical contacts is formed by a metallic layer on the back of the solar cell. When light radiation falls on the p-n junction diode, electron – hole pairs are generated by the absorption of the 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, there is a flow of current between the two ends through the external circuit. Thus photoelectric current is produced. 	4mark 1mark
(c)	Calculate GCV and NCV of a fuel from the following data. Mass of fuel =0.75g, W1= 2500 g, W_2 = 650 g, t_2 =27.2°C, t_1 = 24.0°C, % H_2 = 5% and S = 4.187 J/Kg/°C.	**5Marks**
	GCV = $\frac{(W_1+W_2) \times \triangle t \times S}{M}$ = $\frac{(2200+200) \times 10^{-3}\ kg \times 3.02\ ^{0}C \times 1 \times 4.187\ J/kg/^{0}C}{0.75 \times 10^{-3}\ kg}$ GCV = **40463.16 J/Kg** NCV = GCV –0.09 x %H_2 x 587 x 4.187 = 40463.16 J/kg – 0.09 x 5 x 587 x 4.187 J/kg = 40463.16 J/kg –1105.99 J/kg NCV = **39357.17 J/Kg**	1mark 1mark 1mark 1mark 1mark
3.(a)	Define Chemical fuel and explain the classification of Chemical fuels with examples.	**5Marks**
	Chemical fuel and its classification A chemical fuel is defined as naturally occurring or artificially manufactured combustible carbonaceous material which serves particularly as source of heat and light and also in few cases as a source of raw material. **Classification of fuels** Fuels are classified into a two types. 1) Based on their origin they are classified into a) Primary fuels b) Secondary fuels. a) **Primary Fuels:** There are naturally occurring fuels which serves as source of energy without any chemical processing. Ex: Wood, Coal, Crude oil, Natural gas, Peat, Lignite, Anthracite.. b) **Secondary Fuels:** - They are derived from primary fuels & serves as source of energy only after subjecting to chemical processing. Ex: Charcoal, Coke, producer gas, Petrol, Diesel etc., 2) Bases on their physical state fuel are classified into a) Solid b) Liquid c) Gaseous fuels.	1mark 2mark 2mark

(b)	Write a note on a) Unleaded Petrol b) Power alcohol	**5Marks**
	a) Unleaded Petrol: The petrol, which contains antiknocking agent other than lead, is known as unleaded petrol. Ex: MTBE is used, as an antiknocking agent in place of TEL or TML and the petrol is known as unleaded petrol. **b) Power alcohol** A mixture of ethyl alcohol and gasoline blend, which can be used as fuel in internal combustion engine, is known as power alcohol or gasohol. Absolute alcohol is mixed with ether, benzene etc compounds and one volume of this is mixed with four volumes of petrol and is used as a fuel. Advantages: ➢ The power out put is good. ➢ It has better antiknock property. ➢ Ethanol is biodegradable; hence it is environmental friendly fuel.	2mark 3mark
(c)	What is Biodiesel? How it is produced? Mention the advantages of Biodiesel	**5Marks**
	Biodiesel refers is a mono alkyl long-chain alkyl fatty acid esters (methyl, propyl or ethyl) esters which is produced by trans -esterification of vegetable oils or animal fats. Biodiesel is produced by trans-esterification of vegetable oil or animal fat by treating with any alcohol in presence of NaOH or KOH as catalyst. The most commonly used alcohol is methanol to produce methyl esters (commonly referred to as Fatty Acid Methyl Ester (FAME) as it is the cheapest alcohol available. Ethanol can be used to produce an ethyl ester (commonly referred to as Fatty Acid Ethyl Ester(FAEE) biodiesel.  Fat / oil Biodiesel Glycerol Advantages • Renewable: • Less noxious, non-toxic • Unlike petroleum diesel, it is biodegradable. • Simple to make, and can be produced from waste vegetable oil.	1mark 3mark 1mark
4. (a)	Define Calorific Value and Explain the types	**5Marks**
	Calorific value is defined as the amount of heat liberated when a unit mass of fuel is burnt completely in presence of air or oxygen. Calorific value is of two types as follows:- 1) Higher calorific value. (HCV) or Gross calorific value. (GCV) 2) Lower calorific value. (LCV) or Net calorific value. (NCV) 1) HCV: - It is the amount of heat liberated when a unit mass of fuel is burnt completely in the presence of air or oxygen and the products of combustion are cooled to room temperature. Here it includes the heat liberated during combustion and the latent heat of steam. Hence its value is always higher than lower calorific value. 2) LCV: - It is amount of heat liberated when a unit mass of fuel is burnt completely in the presence of air or oxygen and the product of combustion are let off completely into air. It does not include the latent heat of steam. Therefore it is always lesser than HCV. NCV = HCV – Latent heat of steam. = HCV –0.09X % H_2 X 587 cal/g	1mark 2mark 2mark
(b)	What are Fuel Cells? Mention the differences between the fuel cells and conventional cells	**5Marks**
	Fuel cells are the galvanic cells which converts the chemical energy of the fuel is directly into electrical energy.	1mark

	Conventional cell	Fuel cell	
	1. A battery stores the chemical reactants, usually metal compounds once used up you must recharge or throw away the battery.	1. A fuel cell produces electricity through reactants stored externally and the device can be reused.	4mark
	2.Harmfull products are formed	2.Ecofriendly	
	3. Low efficiency of the energy conversion.	3. High efficiency of the energy conversion.	
	4. These can be chargeable	4. These can't be chargeable.	

(c) Explain the preparation of solar grade silicon by Union Carbide Process **5Marks**

i) Production of metallurgical grade silicon 1mark

Metallurgical grade silicon of purity of 98.5% Si is produced in submerged electrical arc furnace. The furnace consists of a crucible filled with quartz and carbon (metallurgical coke or coal). Silicon is formed as follows. 3mark

$$SiO_2 + 2C(s) \longrightarrow Si\ (l) + 2CO\ (g)$$

Silicon is formed as molten state and is tapped from the bottom of the furnace. The carbon monoxide further oxidized to carbon dioxide and released into the atmosphere.

ii) Refining of silicon:

The crude silicon obtained in the above method is taken in a large ladle and treated SiO_2 and lime/limestone ($CaO/CaCO_3$). The less noble elements than silica such as Al, Ca and Mg are oxidized as their oxides.

iii) Production of semiconductor grade silicon

The metallurgical grade silicon obtained in the above process is further processed to get semiconductor grade silicon or polysilicon.

The metallurgical grade silicon is treated with dry HCl gas at 300^0 C to form trichlorosilane & a small amount of tetrachlorosilane. The mixture is distilled to get pure trichlorosilane. 1mark

$$Si + 3\,HCl \longrightarrow HSiCl_3 + H_2$$

$$Si + 4\,HCl \longrightarrow SiCl_4 + 2H_2$$

The tetrachloro silane ($SiCl_4$) is reduced with hydrogen at 1000^0 C in a reactor to get tri chloro silane ($HSiCl_3$).

$$SiCl_4 + H_2 \longrightarrow HSiCl_3 + HCl$$

The tri chloro silane is then passed through fixed bed columns containing quaternary ammonium ion exchange resins catalysts to get Silicon hydride or silane (SiH_4)

$$2HSiCl_3 \longrightarrow H_2SiCl_2 + SiCl_4$$

$$3HSiCl_2 \longrightarrow SiH_4 + 2\,H_2SiCl_3$$

Silicon hydride or silane is further purified by distillation & passed into a reactor containing heated silicon seed rods. Silane gets pyrolysed to form polysilicon (semiconductor grade silicon)

$$SiH_4 \longrightarrow Si + 2H_2$$

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

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

II Semester: II-Online Internal assessment test **Date: 19-05-2020**

Sub: Engineering Chemistry (18CHE22)

Time: 02 Hours **Section: A & B** **Max Marks: 60**

Note:	1.	Answer all the following questions.

			Marks	CO
1	a)	Define free energy. Derive Nernst equation for single electrode potential.	(7)	CO 1
	b)	Explain Electroplating process of chromium? Give the reasons why chromium anodes are not used. Mention the applications.	(7)	CO 2
	c)	What voltage will be generated by a cell that consisting of an Iron electrode immersed in 0.5M $FeSO_4$ solution and Copper electrode immersed in 1M $CuSO_4$ solution at 298K. Given that E^0_{Fe} = -0.44V & E^0_{Cu} 0.34V. Write the cell representation and cell reactions.	(6)	CO 1

2	a)	What is corrosion? Illustrate electrochemical theory of corrosion taking iron as an example.	(7)	CO 2
	b)	Explain the determination sulphate content in water by gravimetric method	(7)	CO 4
	c)	Calculate GCV and NCV of a fuel from the following data. Mass of fuel =0.95g, W1= 2400 g, W2 = 250 g, t2 =29.2^{0}C, t1 = 25.3^{0}C, % H_2 = 6% and S = 4.187 J/Kg/^{0}C.	(6)	CO 3

			Marks	CO
3	a)	Describe the synthesis of nanoparticles by Sol-gel method. Mention the applications.	(7)	CO 5
	b)	Explain the titration curve for mixture of strong acid and a weak acid with a strong base.	(7)	CO 5
	c)	Define COD? In a COD test 30.6 cm^3 and 15.5 cm^3 0.05 N FAS solution required for Blank and sample titration respectively. The volume of test solution used was 25 cm^3. Solve the COD of the water sample solution.	(6)	CO 4

19/05/2020

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Dr. Narendra Viswanath
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14-20

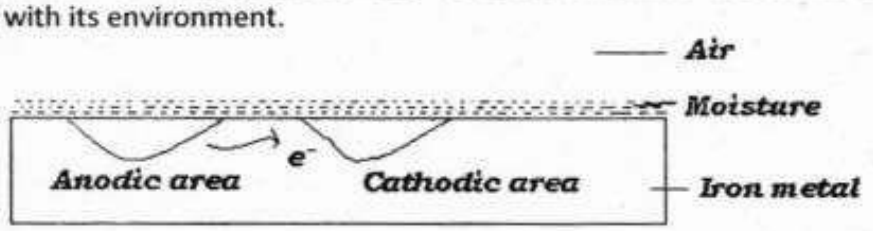
SHRIDEVI

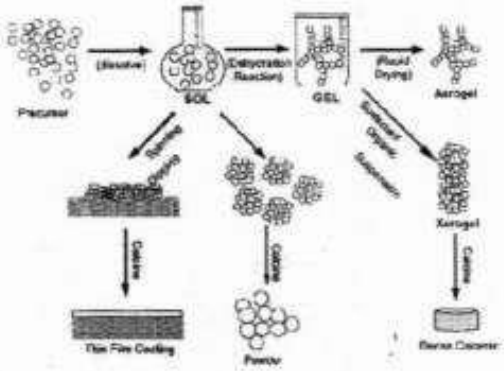
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

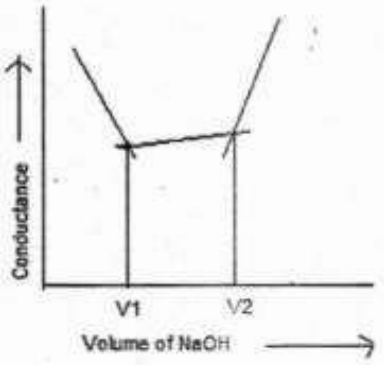
II semester:III-Online Internal assessment test Date: 19-05-2020

Sub: Engineering Chemistry (18CHE22)

Q.No	Scheme of valuation	Marks
1. (a)	**Derive Nernst equation for single electrode potential**	
	Free energy: It is a thermodynamic function. It is defined as the amount of work that thermodynamic system can perform.	1mark
	The change in free energy of a system is given by $\triangle G = \triangle H - T\triangle S$	
	ΔG, ΔG^*	1mark
	Reversible electrode reaction $M^{n+} + ne^- \leftrightarrow M$	1mark
	$K_C = [M]/[M^{n+}]$	1mark
	$\Delta G = \Delta G^* + RT\ln K_c$	1mark
	Substitution	1mark
	$E = E^\circ + \frac{0.0591}{n}\log\frac{[M]}{[M^{n+}]}$	1mark
(b)	**Explain Electroplating process of chromium? Give the reasons why chromium anodes are not used. Mention the applications.**	
	Plating bath: Chromic acid and H_2SO_4 in 100:1 proportion.	1mark
	Temperature: 45-600C.	1mark
	Current Density: 100-200mA/Cm².	1mark
	Anode: Insoluble anodes Pb-Sb or Pb-Sn coated with PbO_2.	1mark
	Cathode: Object to be plated.	1mark
	Chromium anodes are therefore not used in Cr plating for following reason.	1mark
	• 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: $H_2Cr_2O_7 \longrightarrow Cr_2O_7^{--} + 2H^+ + 2e^-$	
	Cathodic reactions $Cr_2O_7^{--} + 14H^+ + 6e^- \longrightarrow 2Cr + 7H_2O$	1mark
	Overall reaction: $Cr3+ + 3e^- \longrightarrow Cr$	
	Applications:	
	a) Decorative chromium provides a durable finish on cycles, automobiles, furniture's, air craft and surgical instruments etc.	
	b) Hard Chromium is used in cutting tools, piston rings, cylinder liners, crankshafts of marine & aero engines, bearings etc.	1mark
	c) Black Chromium is used in optical instruments, machine tools & electronic parts.	
	d) It is also used for non-glase finishes on automobiles, & as an efficient coating for solar energy collectors.	
(c)	**What voltage will be generated by a cell that consisting of an Iron electrode immersed in 0.5M $FeSO_4$ solution and Copper electrode immersed in 1M $CuSO_4$ solution at 298K. Given that $E^\circ Fe$ = -0.44V & $E^\circ Cu$ 0.34V. Write the cell representation and cell reactions.**	
	Cell representation : $Fe \mid Fe^{++}(0.5M) \parallel Cu^{++}(1M) \mid Cu$	1mark
	Cell reactions: At Anode: $Fe \rightarrow Fe^{2+} + 2e^-$	
	At Cathode: $Cu^{++} + 2e^- \rightarrow Cu$	1mark
	E^0cell=E cathode-E anode	
	=0.34-(-0.44)	1mark
	= 0.78 V	
	Formula $E = E^\circ + \frac{0.0591}{n}\log\frac{[Mn+]cathode}{[M^{n+}]anode}$	1mark

	Substitution $E = 0.78 + \frac{0.0591}{2} \log \frac{[1]}{[0.5]}$ Answer:0.7889 V	1mark 1mark
2. (a)	**What is corrosion? Explain the electrochemical theory of corrosion**	
	Corrosion is defined as the destruction or deterioration of a metal or its alloy and consequent loss of metal, caused due to direct chemical action or electrochemical reactions with its environment.  Figure: Formation of minute galvanic cells consisting of anodic and Cathodic areas Anode: $Fe \longrightarrow Fe^{2+} + 2e^-$ Cathode: reactions (Any two reactions) a) In acidic medium: $2H^+ + 2e^- \longrightarrow H_2$ b) In alkaline and in the absence of O_2: $2H_2O + 2e^- \longrightarrow 2OH^- + H_2$ c) In neutral and aerated medium: $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$ Corrosion product : $2Fe^{++} + 4OH^- \longrightarrow 2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 2(Fe_2O_3 . 3H_2O)$ rust.	1mark 1mark 1mark 1mark 2mark 1mark
(b)	**Explain the determination sulphate content in water by gravimetric method**	
	Principle: The sulphate ions in the water sample are precipitated by the addition of barium chloride solution to water sample acidified with hydrochloric acid & kept near the boiling point. $SO_4^{2-} + Ba^{2+} \longrightarrow BaSO_4$ **Procedure:** 1. Transfer 200ml of water sample to a beaker 2. Add conc. hydrochloric acid drop wise till to become just acidic. & add three drops in excess. 3. Boil the sample to reduce its volume to 50ml. 4. Add hot barium chloride solution (10 %) slowly with constant stirring until all the sulphate is precipitated. 5. Digest at its boiling temperatures for a few hours. 6. Filter through a gooch crucible & wash the precipitate with hot distilled water until the washings are free from chlorides. 7. Dry the precipitate & weigh barium sulphate. **Calculation:** Weight of $BaSO_4$ be W g 233.3 g $BaSO_4$ contains 96.0g of SO_4^{2-} W g of $BaSO_4$ contains $\frac{96.3 \times W \text{ g of } SO_4^{2-}}{233.3}$ = mg Sulphate content = $\frac{m \times 1000}{200}$ mg/L	2mark 3mark 2mark
(c)	**Calculate GCV and NCV of a fuel from the following data.** **Mass of fuel =0.95g, W1= 2400 g, W2 = 250 g, t2 =29.2°C, t1 = 25.3°C, % H2 = 6% and S = 4.187 J/Kg/°C.**	
	GCV $= \frac{(W1 + W2) \times S \times \Delta t}{M}$ $= \frac{(2400+250) \times 10^{-3} \text{ kg} \times 4.187 \text{ J/Kg/°C} \times (29.2-25.3°C)}{0.95 \times 10^{-3} \text{ kg}}$ **= 45550.15 J/Kg** NCV = GCV – 0.09 x %H2 x 587x4.187 J/kg. = 45550.15 J/kg – 0.09 x 6 x 587 x 4.187KJ/kg.	1mark 1mark 1mark 1mark 1mark

	= 45550.15 J/kg – 1327.19 kJ/kg **= 44222.81 J/kg**	1mark
3.(a)	**Explain the synthesis of nanoparticles by Sol-gel method. Mention the applications.**	
	 **1. Preparation of sol** In Sol-gel synthesis, either a metal salt or metal alkoxide is used as precursor (starting reactions) to synthesize nanoparticles of a metal oxide. First, a sol is prepared by dispersing precursors in a solvent. **2. Conversion of sol into gel** Sol is further converted into a gel by hydrolysis and condensation of precursors. Hydrolysis and condensation reactions are initiated by addition of an acid or base as catalyst. Hydrolysis : - M -OR + H_2O → M- OH + R-OH Condensation: M- OH + M -OR→ M- O-M+ R-OH **3. Aging of a gel** Gel on aging for a known period of time, finally condenses to nano-scale clusters of metal hydroxides. **4. Removal of solvent** The solvent can be removed from gel by evaporative drying. **5. Heat treatment** The obtained sample is heated at high temperature to from nanoparticles. **Applications** 1. It can be used in ceramics manufacturing processes, investment casting material, or as a means of producing very thin films of metal oxides for various purposes. 2. Sol-gel derived materials have diverse applications in optics, electronics, energy, space, (bio) sensors, medicine (e.g. controlled drug release) and separation (e.g. chromatography) technology. 3. Other products fabricated with this process include various ceramic membranes for microfiltration, ultra filtration, nano-filtration, and reverse osmosis.	2mark 3mark 2mark
(b)	**Explain the titration curve for mixture of strong acid and a weak acid with a strong base.**	
	1. When a mixture of a weak acid (CH_3 COOH) and strong acid (HCl) is titrated against a strong base (NaOH), the conductance initially decreases uponadding NaOH to the acid mixture because of removal of highly mobile H^+ ions of HCl to form unionized H_2O.	1mark

	$HCl + NaOH \longrightarrow NaCl + H_2O$ 2. The first end point corresponds to the neutralization of strong acid (HCL) as it is strong acid, it neutralized first because of its complete dissociation. 3. The second end point corresponds to the neutralization of weak acid (CH_3COOH) as the weak acid is neutralized after the strong acid because of it's partial dissociation. $CH_3COOH + NaOH \longrightarrow CH_3COO^- + Na^+ + H_2O$ 4. Further, addition of NaOH after the neutralization point the conductance increases due to the addition of OH^- ions. 5. The point of intersection of two lines in the graph gives the equivalence points as shown in the below graph. 6. From the equivalence points the concentration of HCl and CH_3COOH can be determined.  	1mark 1mark 1mark 1mark 1mark
(c)	**Define COD? In a COD test 30.6 cm^3 and 15.5 cm^3 0.05 N FAS solution required for Blank and sample titration respectively. The volume of test solution used was 25 cm^3. Solve the COD of the water sample solution.**	
	COD is defined as the amount of oxygen in mg required for the complete chemical oxidation of total oxidisable matter present in a liter of sewage effluent by a suitable oxidizing agent such as acidified potassium dichromate. $COD = \frac{N_{FAS} \times (a-b) \times 8 \times 1000}{25}$ $COD = \frac{0.05 \times (30.6-15.5) \times 8 \times 1000}{25}$ $COD = 241.6$ mg of Oxygen/dm^3 Mentioning units of COD (mg of Oxygen/dm^3)	2mark 1mark 1mark 1mark 1mark

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2019-20 I Sem

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

Semester: I | **Internal assessment test: I** | **Date: 25-09-19**

Sub: Engineering Chemistry (18CHE12)

Time: 90minutes | **Section: C & D** | **Max Marks: 30**

***NOTE*: Answer any *TWO FULL* questions.**

1. (a) Derive Nernst equation for single electrode potential
   (b) Explain the construction, working and advantages of Calomel electrode.
   (c) Calculate the voltage of the cell Fe(S) / Fe^{++} (0.01M) // Ag^{+} (0.1M) /Ag (S) at 298K. Write the cell representation and cell reactions. Given E^0 of Fe= -0.42V & E^0 Ag=0.80V **(5+5+5)**

(OR)

2. (a) Explain the construction and working Glass electrode
   (b) What are electrolytic concentration cells? Explain with an example
   (c) Explain the determination of PH using Glass electrode **(5+5+5)**

3. (a) Explain the Sources, ill effects and control of Carbon monoxide air pollution
   (b) Explain the Sources, ill effects and control of particulate matter pollution
   (c) Explain the Sources, ill effects and control of Mercury pollution **(5+5+5)**

(OR)

4. (a) Explain the Sources, ill effects and control of ozone depletion
   (b) Explain the Sources, ill effects and control of Hydrocarbon pollution
   (c) Explain the Sources, ill effects and control of Lead pollution **(5+5+5)**

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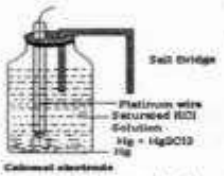
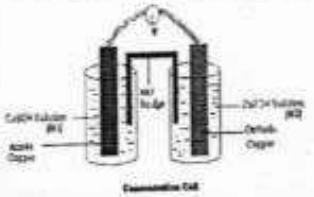
SHRIDEVI INSTITUTE OF ENGINEERING AND TECHNOLOGY

I semester: I-Internal assessment test

Scheme of valuation

Sub: Engineering Chemistry (18CHE12) Date: 25-09-2019

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, $K_c = \frac{[M]}{[M^{n+}]}$	
	Kc and ΔG are related according to the following thermodynamic equation $\Delta G = \Delta G^\circ + RT \ln K_c$ ----------→ 1	1mark
	Dividing the equation 1 by $-nF$ and Substituting the value of Kc, $\frac{\Delta G}{-nF} = \frac{\Delta G^\circ}{-nF} + \frac{RT \ln [M]/[M^{n+}]}{-nF}$ ----------→ 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
	$Ecell = E^0cell + \frac{0.0591}{n} \log_{10} \frac{[M^{n+}] \text{ at cathode}}{[M^{n+}] \text{ at anode}}$	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)	Explain the Construction and working of Glass electrode? 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	1mark
	 Glass Electrode	1mark 1mark 1mark
	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
2. (b)	**What are electrolytic concentration cells? Explain with an example**	**5Marks**
	 Fig and Labeling Explanation Reactions Formula	1mark 2mark 1mark 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. • $E_{cell} = (E^\circ + \frac{0.0591}{n} \log [M2]) - (E^\circ + \frac{0.0591}{n} \log [M1])$ $E_{cell} = \frac{0.0591}{n} \log \frac{[M2]}{[M1]}$	

(C)	Explain the determination of PH using glass electrode?
	Fig and Labeling
	Explanation
	 
	To determine pH of unknown solution the glass electrode is combined with secondary reference electrode such as calomel electrode and the glass - calomel electrode assembly is dipped in the solution whose pH is to be determined.
	The two electrodes are connected to potentiometer or pH meter.
	The combined electrodes can be represented as.
	Hg(l) /Hg_2Cl_2(S)/Saturated KCl //solution of unknown PH/glass/0.1M HCl/AgCl (s)/ Ag
	The emf of the above cell is given by
	E cell = E Cathode – E Anode
	E cell = E Glass – E Calomel (since EGlass = $E^\circ G$–0.0591 PH)
	E cell = $E^\circ G$–0.0591 pH - E Calomel
	PH = $\frac{E^\circ Glass - E\,Calomel - E\,cell}{0.0591}$
		5marks
		1
		1
		1
		1

3.(a)	Explain the sources and ill effects and control of CO air pollution.	5marks
	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.	1 1 1 1 1
(b)	Explain the sources and ill effects and control of perticulate matter pollution.	5
	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).	1 1 1 1 1
(C).	Explain the sources and ill effects and control of mercury pollution.	5
	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,	1 1

	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.	1 1 1
4.(a)	Explain the sources and ill effects and control of ozone layer depletion.	5
	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 depletion. Therefore, the use of vehicles should be minimised as much as possible.	1 1 1 1 1
(b)	Explain the sources and ill effects and control of hydrocarbon pollution.	5
	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.	1 1 1 1 1
(c)	Explain the sources and ill effects and control of lead pollution.	5
	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	1 1 1

	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 regularly. • Controlling: • Clean dusty surfaces: Cleaning the floors. • Run cold water. • Prevent children from playing on soil. • Eat a healthy diet.	1 1

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SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

Semester: I | **Internal assessment test: II** | **Date: 02-11-19**

Sub: Engineering Chemistry (18CHE12)

Time: 90minutes | **Section: C & D** | **Max Marks: 30**

***NOTE*: Answer any *TWO FULL* questions.**

1. (a) Explain the construction and working of Nickel - metal hydride Battery
   (b) Explain the electrochemical theory of corrosion
   (c) What is metal finishing? Mention the technological importance of metal finishing? **(5+5+5)**

(OR)

2. (a) Explain the process of Anodizing of aluminum
   (b) Explain the Differential metal corrosion with an example
   (c) What is cathodic protection? Explain sacrificial anodic protection method **(5+5+5)**
3. (a) Explain the determining sulphate content in water by gravimetric method
   (b) Explain boiler corrosion
   (c) Explain the desalination of water by Reverse osmosis method **(5+5+5)**

(OR)

4. (a) Explain the determination of Fluoride content in water by colorimetric method
   (b) Explain the sources, characteristics & disposal methods of solid waste management
   (c) Define COD. In a COD experiment 25 cm^3 of an effluent sample required 12cm^3 0.02 N FAS solution in sample titration and 29.8 cm^3 0.02 N FAS solution in blank titration. Calculate COD of the effluent sample. **(5+5+5)**

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SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

Semester: I | **Internal assessment test: II** | **Date: 02-11-19**

Sub: Engineering Chemistry (18CHE12)

Time: 90minutes | **Section: C & D** | **Max Marks: 30**

***NOTE*: Answer any *TWO FULL* questions.**

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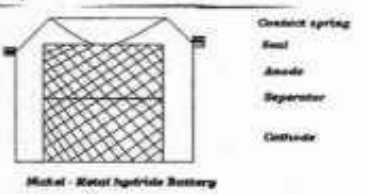
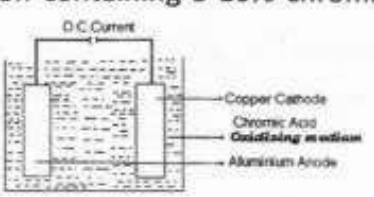
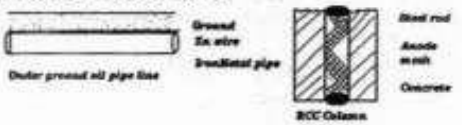
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

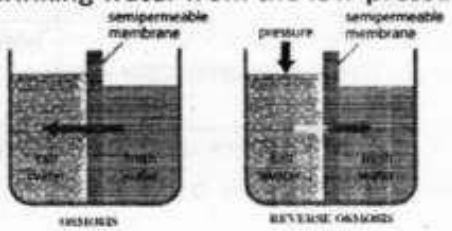
Semester: I | **Internal assessment test: II** | **Date: 02-11-19**

Sub: Engineering Chemistry (18CHE12)

Time: 90minutes | **Section: C & D** | **Max Marks: 30**

Q.No	Scheme of valuation	Marks
1. (a)	**Explain the construction and working of Nickel - metal hydride Battery**	5marks
	Diagram with labeling: 	1mark
	Explanation	2mark
	Reactions	
	At anode : $MH + OH^- \rightleftharpoons M + H_2O + e^-$	
	At cathode : $NiO(OH) + e^- + H_2O \rightleftharpoons Ni(OH)_2 + OH^-$	
	NCR : $MH + NiO(OH) \rightleftharpoons M + Ni(OH)_2$	1mark
	Uses :Used in electric vehicles, laptops, cellular phones etc	1mark
(b)	**Explain the electrochemical theory of corrosion**	5marks
	Formation of minute galvanic cells	1mark
	Anode: $Fe \rightarrow Fe^{2+} + 2e^-$	1mark
	Cathode: reactions (Any two reactions)	
	a) In acidic medium: $2H^+ + 2e^- \longrightarrow H_2$	2mark
	b) In alkaline and in the absence of O_2: $2H_2O + 2e^- \longrightarrow 2OH^- + H_2$	
	c) In neutral and aerated medium: $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$	
	Corrosion product : $2Fe^{++} + 4OH^- \longrightarrow 2Fe(OH)_2$	1mark
	$2Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 2(Fe_2O_3 . 3H_2O)$ rust.	
(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.	1mark
	Technological importance of metal finishing.	4mark
	• 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.	
2. (a)	**Explain the process of Anodizing of aluminum**	5marks
	Construction –Diagram with labeling	1mark
	Explanation :	
	➢ Pretreatment: The article be anodized is degreased and followed by electro polished	
	➢ Aluminum is connected to positive terminal and made as anode.	3mark
	➢ 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 both is maintained at 35°c	
	➢ 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 Reactions : At anode: $2Al\,(s) + 3\,H_2O\,(l) \longrightarrow Al_2O_3(s) + 6H^+ + 6e^-$ At cathode: $6H^+ + 6e^- \longrightarrow 3H_2\,(g)$ Over all reaction: $2Al\,(s) + 3\,H_2O\,(l) \longrightarrow Al_2O_3(s) + 3H_2$	1mark
(b)	**Explain the Differential metal corrosion with an example**	**5marks**
	Diagram Explanation Reactions At anode : $Fe \longrightarrow Fe^{++} + 2e^-$ At cathode : $H2O + O2 + 4e- \longrightarrow 4OH-$ Corrosion Product: $2Fe^{++} + 4OH- \longrightarrow 2Fe(OH)_2$ $2Fe(OH)_2 + O_2 + 2H_2O \longrightarrow 2(Fe_2O_3.3H_2O)$ rust.	1mark 3mark 1mark
(c)	**What is cathodic protection? Explain sacrificial anodic protection method**	**5marks**
	Definition of Cathodic protection: Cathodic protection is a method in which the base metal to be protected from corrosion is made to act as cathodic by attaching more active anodic metal to it. Construction - diagram Explanation 	1mark 1mark 3mark
3.(a)	**Explain the determining sulphate content in water by gravimetric method**	**5marks**
	Principle: The sulphate ions in the water sample are precipitated by the addition of barium chloride solution to water sample acidified with hydrochloric acid & kept near the boiling point. $SO_4^{2-} + Ba^{2+} \longrightarrow BaSO_4$ Procedure: 1. Transfer 200ml of water sample to a beaker 2. Add conc. hydrochloric acid drop wise till to become just acidic. & add three drops in excess. 3. Boil the sample to reduce its volume to 50ml. 4. Add hot barium chloride solution (10 %) slowly with constant stirring until all the sulphate is precipitated. 5. Digest at its boiling temperatures for a few hours. 6. Filter through a gooch crucible & wash the precipitate with hot distilled water until the washings are free from chlorides. 7. Dry the precipitate & weigh barium sulphate. Calculation: Weight of BaSO4 be W g 233.3 g BaSO4 contains 96.0g of SO42- W g of BaSO4 contains 96.3 X W g of SO42- = mg Sulphate content = $\frac{233.3}{200}$ m X 1000 mg/L	1mark 3mark 1mark
(b)	**Explain boiler corrosion**	**5marks**
	Boiler corrosion is a decay process in which the boiler surface gets degraded by the attack of feed water. It is caused due to the presence of dissolved gases such as oxygen and carbon dioxide in boiler feed water. Raw water generally has about 8-9 ppm of dissolved oxygen. Oxygen levels of more than 7 ppm cause boiler corrosion, and so have to be kept in check. The dissolved oxygen can	2mark

	attack the iron in the boiler and produce rust. $4Fe+2H_2O+O_2 \rightarrow 4Fe(OH)_2$ $4Fe(H)_2+O_2 \rightarrow 2[Fe_2O_3.\ 2H_2O]$ Rust Carbon dioxide is found in the boiler water either from air or due to the presence of residual temporary hardness. $Ca(HCO_3)_2 \rightarrow CaCO_3 + CO_2.H_2O$ $Mg(HCO_3)_2 \rightarrow Mg(OH)_2 + CO_2$ It dissolves in water to produce carbonic acid, which is slightly acidic and corrosive in nature. $H_2O+CO_2 \rightarrow H_2CO_3 \rightarrow H^+ HCO^-_3$ When the boiler water pH drops below 8.5, corrosion may occur due to acidic nature of feed water. The acid may get formed due to the presence of magnesium compounds in the feed water. $MgCl_2 + 2H_2O \rightarrow Mg(OH)_2 + 2HCl$ This acid may then attack the boiler to form rust: $Fe+2HCl \rightarrow FeCl_2+H_2$ $FeCl_2+2H_2O \rightarrow Fe(OH)_2+2HCl$	2mark 1mark
-)	**Explain the desalination of water by Reverse osmosis method**	**5marks**
	Reverse osmosis is the process of forcing a solvent from a region of high solute concentration through a semi permeable membrane to a region of low solute concentration by applying a pressure in excess of the osmotic pressure A reverse osmosis unit consists of a pre flirtation unit which removes fine sediments of the water, reverse osmosis membrane to remove all the molecules like Na, Ca, Mg, bacteria viruses nitrates, heavy metals etc, and a vessel for storing water & a high pressure pump. The membranes are generally made up of cellulose acetate or nylon and are usually fabricated in a cylindrical shape. The seawater or brackish water is pressurized against one surface of the membrane, causing transport of salt-depleted water across the membrane and emergence of potable drinking water from the low-pressure side  	4mark 1mark
4. (a)	**Explain the determination of Fluoride content in water by colorimetric method**	**5marks**
	Principle: Under acidic conditions, fluorides react with Zirconium SPANDNS solution & the color of SPADNS reagent gets bleached. Bleaching is a function of fluoride ions & is directly proportional to the concentration of fluoride ions. **Procedure:** Transfer the given standard Sodium fluoride (NaF) solutions (2mg/L) to a burette and draw out 2.5, 5.0, 7.5, 10.0 and 12.5 cm^3 of the solution into 100 cm^3 volumetric flasks. Add 1 drop of $NaAsO_2$ solution (0.5%) to remove any residual chlorine to each of the standard solutions. Add 10ml of Zirconyl- SPANDNS reagent to each flask and dilute to 100ml with distilled water and mix well	**1mark** **4mark**

	Prepare a blank solution by adding 10ml SPANDNS solution in to 100 ml standard volumetric flask and add HCl solution (7ml conc. HCl diluted to 10ml) and make up to the mark. Use this blank solution to set zero in the colorimeter at 570nm. Take suitable aliquot of water sample as test solution, add 1 drop of $NaAsO_2$ solution (0.5%) to remove any residual chlorine. Add 10ml of Zirconyl- SPANDNS reagent and dilute to 100ml with distilled water. Read the optical density of bleached color at 570 nm in the colorimeter. Draw a calibration curve by plotting concentration of Sodium fluoride versus absorbance and calculate the concentration of Fluoride ions.	
(b)	**Explain the sources, characteristics & disposal methods of solid waste management**	**5marks**
	Sources: Residential solid waste management: Residence and homes where people live in large number generates major solid garbage waste which includes food waste, plastic waste, paper waste, lather waste, metal waste. Unused clothes, oils etc	**2mark**
	Characteristics of solid waste: Physical Characteristics: The following physical characteristics are measured which helps for the disposal of solid waste. a) Density of solid b) Moisture content in the solid waste c) Size distribution of the material Chemical Characteristics: a) Carbohydrate content b) Lipid content c) Protein content d) Natural fibrous content	**2mark**
	Disposal of solid waste: The solid waste can be disposed from the following methods. 1) Land fill: It is the oldest method of solid waste management which includes disposal of garbage in unused land on remote areas. 2) Composting: The biodegradable solid waste is subjected to microbial decomposition to produce compost which can be used as organic fertilizer for the plants	**1mark**
(c)	**Define COD. In a COD experiment 25 cm^3 of an effluent sample required 12cm^3 0.02 N FAS solution in sample titration and 29.8 cm^3 0.02 N FAS solution in blank titration. Calculate COD of the effluent sample.**	**5marks**
	COD is defined as the amount of oxygen in mg required for the complete chemical oxidation of total oxidisable matter present in a liter of sewage effluent by a suitable oxidizing agent such as acidified potassium dichromate.	**1mark**
	$COD = \frac{N_{FAS} \times (a-b) \times 8 \times 1000}{V}$	**1mark**
	$COD = \frac{0.02 \times (29.8-12) \times 8 \times 1000}{25}$	**1mark**
	$COD = 113.92$ mg of Oxygen/dm^3	**1mark**
	Mentioning units of COD (mg of Oxygen/dm^3)	**1mark**

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SHRIDEVI

SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

Semester: I | **Internal assessment test: III** | **Date: 17-12-19**

Sub: Engineering Chemistry (18CHE12)

Time: 90minutes | **Section: C & D** | **Max Marks: 30**

***NOTE*: Answer any *TWO FULL* questions.**

1. (a) Explain the determination of calorific value of solid fuel using Bomb calorimeter.
   (b) What is Knocking of petrol engine? Explain the Mechanism of Knocking
   (c) Explain the construction and working of Methanol – Oxygen fuel cell. **(5+5+5)**

(OR)

2. (a) Explain the construction and working of Solid oxide fuel cell (SOFC)
   (b) Explain the construction and working of photovoltaic cell.
   (c) Calculate GCV and NCV of a fuel from the given data. Mass of fuel =0.65g, W_1= 2800g, W_2 = 700 g, t_2 =27.2^{0}C, t_1 = 23.4^{0}C, % H_2 = 1.5 and S = 1 cal/g/^{0}C. **(5+5+5)**

3. (a) Explain Theory, Instrumentation and applications of Flame Photometry.
   (b) Explain the titration curve for mixture of strong acid and a weak acid with a strong base
   (c) Explain Properties and applications of Graphenes. **(5+5+5)**

(OR)

4. (a) Explain theory, instrumentation and applications of Colorimetry.
   (b) Explain the synthesis of nanoparticles by Sol-gel method.
   (c) Explain Properties and applications of fullerenes. **(5+5+5)**

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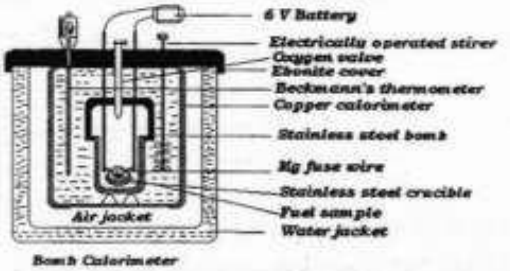
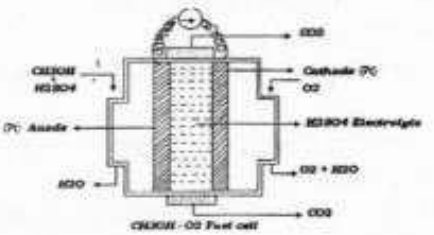
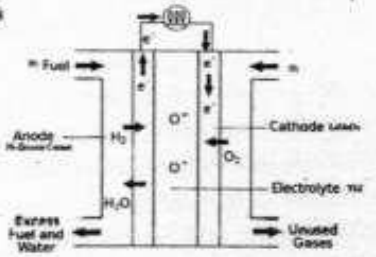
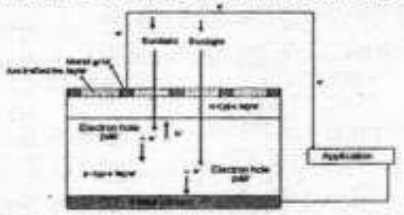
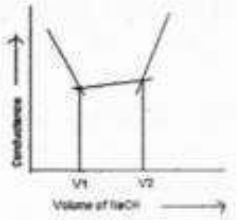
SHRIDEI INSTITUTE OF ENGINEERING AND TECHNOLOGY

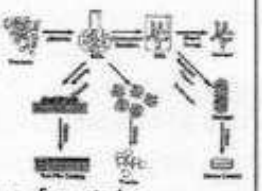
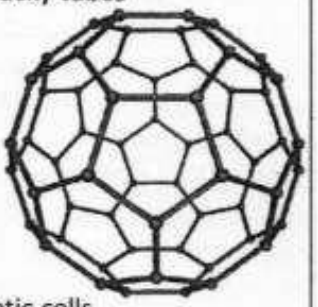
I semester: III-Internal assessment test Date: 17-12-19

Scheme of valuation Sub: Engineering Chemistry (14CHE22)

Q.No	Scheme of valuation	Marks
1. (a)	Explain the determination of calorific value of solid fuel using Bomb calorimeter.	5Marks
	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.	1mark
	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. & from the data obtained the gross and net calorific values of the fuel can be calculated as	3mark
	$GCV = \frac{(W_1 + W_2) \times S \times \triangle t \times 4.187}{M}$ J/Kg $NCV = GCV - 0.09 \times \%H_2 \times 587 \times 4.187$ J/Kg  Bomb Calorimeter	1mark
a)	What is Knocking of petrol engine? Explain the Mechanism of Knocking	5Marks
	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
	Mechanism of Knocking 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 gaseous products which produces thermal shock waves which hit the walls of the cylinder and piston causing a rattling sound which is known as knocking.	2mark
	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) $CH_3\text{-}O\text{-}O\text{-}CH_3 \rightarrow CH_3\text{-}CHO + H_2O$ $CH_3\text{-}CHO + 1\frac{1}{2}O_2 \rightarrow HCHO + CO_2 + H_2O$ $HCHO + O_2 \rightarrow CO_2 + H_2O$	2mark
(c)	Explain the construction and working of Methanol – Oxygen fuel cell	5Marks
	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.	3mark
	The cell reactions are as follows. At anode : $CH_3OH + H_2O \rightarrow CO_2 + 6H^+ + 6e^-$ At cathode : $\frac{3}{2}O_2 + 6H^+ + 6e^- \rightarrow 3H_2O$ NCR : $CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O$  CH3OH - O2 Fuel cell	1mark
		1mark
2. (a)	Explain the construction and working of Solid oxide fuel cell (SOFC)	5Marks
	Solid oxide fuel contains solid oxide ceramic material as the electrolyte and operates at high temperature about 600^{0}C -1000^{0}C.	1mark

	The cathode is made up of porous Lanthanum Manganite ($LaMnO_3$) doped with Strontium (Sr). The anode is made up of porous Nickel zirconia cermet (Ni-ZrO_2) The anode and cathode are separated by Yttrium stabilized Zirconia (YSZ) Hydrogen gas is supplied at anode and oxygen gas is supplied at cathode The cell reactions are At anode : $H_2 + O^{--} \longrightarrow H_2O + 2e^-$ At cathode : $\frac{1}{2} O_2 + 2e^- \longrightarrow O^{--}$ NCR : $H_2 + \frac{1}{2} O_2 \longrightarrow H_2O$ 	3mark 1mark
(b)	Explain the construction and working of photovoltaic cell.	5Marks
	A typical silicon photovoltaic cell is composed of a thin wafer consisting of an ultra thin layer of phosphorus doped. (n-type) silicon on top of boron doped (p-type) silicon. 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 to the semiconductor. The cell's other electrical contacts is formed by a metallic layer on the back of the solar cell. When light radiation falls on the p-n junction diode, electron – hole pairs are generated by the absorption of the 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, there is a flow of current between the two ends through the external circuit. Thus photoelectric current is produced. 	4mark 1mark
(c)	Calculate GCV and NCV of a fuel from the given data. Mass of fuel =0.65g, W_1= 2800g, W_2 = 700 g, t_2 =27.2^{0}C, t_1 = 23.4^{0}C, % H_2 = 1.5 and S = 1 cal/g/^{0}C.	5Marks
	$GCV = \frac{(W_1+W_2) \times \triangle t \times S}{M}$	1mark
	$= \frac{(2800 + 700) \times 10^{-3}\ kg \times (27.2 - 23.4)^0C \times 1 \times 4.187\ J/Kg/^0C}{0.65 \times 10^{-3}\ kg}$	1mark 1mark
	GCV = 85672.46 J/Kg	
	NCV = GCV –0.09 x%H_2 x 587 x 4.184 J/Kg = 85672.46 J/Kg – 0.09 x 1.5 x 587 x 4.187 J/Kg = 85672.46 J/Kg –331.79 J/Kg	1mark 1mark
	NCV = 85340.67 J/Kg	
3.(a)	Explain Theory, Instrumentation and applications of Flame Photometry.	5Marks
	Theory: The principle of flame photometry is atomic spectra arising due to the emission of light of different wavelengths when atoms are excited in a flame. Such spectra consist of emission lines characteristic of the elements present in a flame. Flame photometry Components 1. Flame: A burner that provides flame and can be maintained in a constant form and at a constant temperature. 2. Nebuliser and mixing chamber: Helps to transport the homogeneous solution of the substance into the flame at a steady rate. 3. Monochromator : helps in isolating the wavelength to be measured from that of any other extraneous emissions. 4. Photo detector: Detect the emitted light and measure the intensity of radiation emitted by the flame. That is, the emitted radiation is converted to an electrical signal with the help of photo detector. The produced electrical signals are directly proportional to the intensity of light **Applications**	4mark

	1. To Determine the availability of alkali and alkaline earth metals in soil. 2. To Determine Na^+ and K^+ ions in body fluids. 3. In the analysis of soft drinks, fruit juices and alcoholic beverages etc	1mark
(b)	Explain the titration curve for mixture of strong acid and a weak acid with a strong base.	**5Marks**
	1. When a mixture of a weak acid (CH_3 COOH) and strong acid (HCl) is titrated against a strong base (NaOH), the conductance initially <u>decreases</u> uponadding NaOH to the acid mixture because of removal of highly mobile H^+ ions of HCl to form unionized H_2O. $HCl + NaOH \longrightarrow NaCl + H_2O$ 2. The first end point corresponds to the neutralization of strong acid (HCL) as it is strong acid, it neutralized first because of its <u>complete dissociation</u>. 3. The second end point corresponds to the neutralization of weak acid (CH_3COOH) as the weak acid is neutralized after the strong acid because of it's partial dissociation. $CH_3COOH + NaOH \longrightarrow CH_3COO^- + Na^+ + H_2O$ 4. Further, addition of NaOH after the neutralization point the conductance <u>increases</u> due to the addition of OH^- ions. 5. The point of intersection of two lines in the graph gives the equivalence points as shown in the below graph. 6. From the equivalence points the concentration of HCl and CH_3COOH can be determined.  	4mark 1mark
(c)	Explain Properties and applications of Graphenes	**5Marks**
	• Graphene is an allotrope (form) of carbon consisting of a single layer of carbon atoms arranged in a hexagonal lattice. • It is the basic structural element of many other allotropes of carbon, such as graphite, diamond, charcoal, carbon nanotubes and fullerenes. • It can be considered as an indefinitely large aromatic molecule, the ultimate case of the family of flat polycyclic aromatic hydrocarbons. • Graphene has many uncommon properties. It is the strongest material ever tested, conducts heat and electricity efficiently, and is nearly transparent. Graphene shows a large and nonlinear diamagnetism, greater than that of graphite, and can be levitated by neodymium magnets. **Physical Properties** • The strongest material ever measured. Up to 150X stronger than the equivalent weight of steel. • Elastic as rubber and has the ability to stretch up to 120% of its length then recover its original shape. • Extremely light weight, its said that a single sheet of Graphene covering a whole football field would weigh less than 1g. • Very high electrical conductivity • Only known substance that is completely impermeable to gas • Graphene oxide reportedly has the ability to attract radioactive material **Uses of Graphene** • In early 2014 I.B.M announced that it had built the first integrated circuit for wireless devices. • Today a tennis racquet with a graphene layer has been manufactured. • Graphene is an ingredient to conductive inks for printing circuitry.	2mark 2mark 1mark
4. (a)	Explain theory, instrumentation and applications of Colorimetry.	**5Marks**
	Theory: • When a monochromatic light of intensity I_0 is incident on a transparent medium, apart I_a of it is absorbed, apart I_r is reflected and the remaining part I_t is transmitted.	2mark

	$I_o = I_a + I_r + I_t$ For a glass- air interface I_r is negligible. Therefore, $I_o = I_a + I_t$ It/Io = T called the transmittance log 1/T = log Io/It is called the absorbance or optical density A. The relation between absorbance A, concentration c (Expressed in mol/liter) And path length 1 (expressed in cm) is given by Beer Lambert's law. A = log Io/It = €Ct **Instrumentation:** colorimeter contains the following components. Light source: A tungsten lamp is used as light source for producing wavelength in the visible range 320-700 nm. Monochromator: These are used to select a light of one wavelength (monochromatic light) and monochromatic light is sent through the sample. Cuvette: Transparent glass cuvette is used to for reading the OD of samples. Detector: The detector detects the wavelength of light that has passed through the sample. Amplifier: The amplifier increases the signal so that it is easier to read against the background noise. **Applications** • Colorimeters are widely used to monitor the growth of a bacterial or yeast cultures. • Used to measure and monitor the color in various foods and beverages.	3mark 1mark
(b)	Explain the synthesis of nanoparticles by Sol-gel method.	**5Marks**
	1. Preparation of sol In Sol-gel synthesis, either a metal salt or metal alkoxide is used as precursor (starting reactions) to synthesize nanoparticles of a metal oxide. First, a sol is prepared by dispersing precursors in a solvent. **2. Conversion of sol into gel** Sol is further converted into a gel by hydrolysis and condensation of precursors. Hydrolysis and condensation reactions are initiated by addition of an acid or base as catalyst. Hydrolysis : - M -OR + H_2O → M- OH + R-OH Condensation: M- OH + M -OR→ M- O-M+ R-OH  **3. Aging of a gel** Gel on aging for a known period of time, finally condenses to nano-scale clusters of metal hydroxides. **4. Removal of solvent** The solvent can be removed from gel by evaporative drying. **5. Heat treatment** The obtained sample is heated at high temperature to from nanoparticles.	1mark 4mark
(c)	Explain Properties and applications of fullerenes	**5Marks**
	A fullerene is any molecule composed of carbon in the form of a hollow sphere, ellipsoid, tube, and many other shapes. Spherical fullerenes are also called buckyballs, and they resemble the balls used in football (soccer). Cylindrical ones are called carbon nanotubes or bucky tubes **Structure of C60 Fullerene** Contains 60 carbon atoms 12 Pentagon rings and 20 Hexagon rings Each pentagon ring is surrounded by 5 hexagon rings Each Hexagon ring is surrounded by 3 hexagon rings and 3 pentagon rings  **Applications of Fullerenes** 1) Fullerenes C60 molecule is used as optical limiter. 2) Polymer composite of C60 molecule is used in making organic photovolatic cells. 3) Polymer composite of C60 molecule is also used in photocopying aplications	3mark 1mark 1mark

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SHRIDEVI

Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: II-Internal Assessment Test: November-2019

18PHY12-Engineering Physics

Time: 75 Min **Max. Marks: 30**

Note: ***Answer any two full questions.***

1	a.	Give the theory of damped oscillations.	**05 Marks**
	b.	With a neat diagram explain the construction and working of Reddy shock tube.	**06 marks**
	c.	Mention the applications of shock waves.	**04 marks**

OR

2	a.	Discuss the theory of forced vibrations and hence obtain the expression for amplitude and Phase.	**06 marks**
	b.	Derive the relation between bulk modulus (K) , Young's modulus (Y) and Poisson's ration (σ).	**05 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^2).	**04 marks**

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a. Derive the expression for bending moment in terms moment of inertia. **05 marks**

b. Derive the expression for the depression and Y at the free end of a beam of loaded cantilever. **06 marks**

c. Calculate the torque required to twist a wire of length 1.5m, radius 0.0425×10^{-2}m, through an angle ($\pi/45$) radian, if the rigidity modulus of its material is 8.3×10^{10} N/m^2 **04 marks**

OR

4 a. Derive the Expression for couple per unit twist of a solid cylinder. **05 marks**

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

c. Explain stress-strain diagram. **04 marks**

Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: II-Internal Assessment Test: November-2019

An ISO 9001:2015 Certified Institution

Scheme and Solution

Subject: Engineering Physics **Subject Code: 18PHY12**

Question No.		Solution	Marks allotted
1	a	$m\frac{d^2x}{dt^2} = -r\frac{dx}{dt} - kx$ ——— 02 $x = Ae^{\alpha t}$ — 01 $\alpha^2 + 2b\alpha + \omega^2 = 0$ — 01 upto $x = e^{-bt}[(c+D)+(c-D)\epsilon t]$ — 01	05
	b	figure with construction — 03 working ——— 03	06
	c	mention the applications 4x1	04
2	a	$m\frac{d^2x}{dt^2} = -r\frac{dx}{dt} - kx + F\sin(pt)$ ——— 02 $x = a\sin(pt-\alpha)$ — 01, $\frac{F}{m}\sin[(pt-\alpha)+\alpha]$ - 01 $a = \frac{F/m}{\sqrt{4b^2p^2+(\omega^2-p^2)^2}}$ — 01, $\alpha = \tan^{-1}\left[\frac{2bp}{\omega^2-p^2}\right]$ - 01	06
	b	Figure + Explanation ——— 02 upto $k = \frac{Y}{3(1-2\sigma)}$ $(\because \sigma = \beta/\alpha)$ 03	05
	c	$Y = \frac{FL}{a\ell}$ — 1 Substitution, $F = 78.54$ N — 02	04

3	a	Figure + Explanation — 02 upto BM $= \frac{Y}{R} \Sigma a r^2$ — 03	05
	b	Figure + Explanation — 02 upto $y_0 = \frac{WL^3}{3Y I_g}$ — 04	06
	c	$C = \frac{\pi \eta r^4}{2L}$ — 01 substitution, $\tau = 1.98 \times 10^{-4}$ N.m — 03	04
4	a	Figure and Explanation — 01 $L\phi = r\theta$ @ $\phi = \frac{r\theta}{L}$ — 01 $F = T(2\pi r dr)$ — 01 upto $C = \left(\frac{\pi \eta r^4}{2L}\right)$ — 03	05
	b	Figure and Explanation — 01 upto $Y = 2n(1+\sigma)$ — 05	06
	c	Figure — 01 Explanation — 03	04

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Shridevi Institute of Engineering and Technology, Tumkur-06

I Semester: III-Internal Assessment Test: December-2019

18PHY12-Engineering Physics

Time: 75 Min **Max. Marks: 30**

Note: ***Answer any two full questions.***

1	a.	Explain the merits of QFET.	**06 marks**
	b.	Derive Clausius- Mossotti equation.	**05 marks**
	c.	Calculate the probability of an electron occupying an energy level 0.02 eV below the Fermi level at 200K.	**04 marks**

OR

2	a.	Define Fermi energy. Explain the variation of Femi factor with temperature.	**05 marks**
	b.	What is Hall Effect? Obtain the expression for Hall voltage in terms of Hall co-efficient.	**06 marks**
	c.	The electron concentration in a semiconductor is 5×10^{17} m^{-3}. Calculate the conductivity of the material if the drift velocity of electron is 350 ms^{-1} in an electric field of 1000 Vm^{-1}	**04 marks**

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3 a. State and prove the Gauss divergence theorem. **05 marks**

b. With a neat diagram derive an expression for numerical aperture and arrive at the condition for propagation. **06 marks**

c. The angle of acceptance of an optical fiber is 30^0 when kept in air. Find the angle of acceptance when it is in a medium of refractive index 1.33. **04 marks**

OR

4 a. Derive the EM wave equation in terms of electric field using Maxwell's equation. **05 marks**

b. With neat diagrams explain the different types of optical fibers. **06 Marks**

c. Explain the types of fiber losses. **04 marks**

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I Semester: III-Internal Assessment Test: December-2019

An ISO 9001:2015 Certified Institution

Scheme and Solution

Subject: Engineering Physics **Subject Code: 18PHY12**

Question No.		Solution	Marks allotted
1	a	Explanation of the merits of QFET * Specific heat ——— 02 * Conductivity ——— 02 * Electron concentration ——— 02	06
	b	$\mu = \chi_e E_i$ ——— 01 $P = N \chi_e E_i$, $E = \frac{P}{\varepsilon_0(\varepsilon_r - 1)}$ — 02 upto $\frac{(\varepsilon_r - 1)}{(\varepsilon_r - 2)} = \frac{N\chi_e}{3\varepsilon_0}$ ——— 02	05
	c	$f(E) = \frac{1}{e^{\frac{(E-E_f)}{KT}} + 1}$ ——— 01 Substitution — 01 $f(E) = 0.76$ — 02	04
2	a	Definition — 01 $E < E_f$, $f(E) = 1$ $E > E_f$ $f(E) = 0$ } — 03 $E = E_f$ $f(E) = 1/2$, Variation Figure — 01	05
	b	Definition — 01 , Figure — 01 upto $V_H = R_H \left(\frac{BI}{W}\right)$ — 04	06
	c	$\sigma_n = n e \mu_e$ ——— 01 Substitution ——— 01 upto $\sigma_n = 0.028 / \Omega m$ — 02	04

3	a	Statement with figure – 01 upto $\oint \vec{D} \cdot \vec{dl} = \int_V \nabla \cdot \vec{D}\, dv$ – 03	05
	b	Figure – 01 upto N.A $= \sqrt{n_1^2 - n_2^2}$ – 04 $\sin\theta_i < N.A$ – 01	06
	c	Derivation, $\sin\theta_0 = \sqrt{n_1^2 - n_2^2}$ – 01 upto $\nabla^2\vec{E} - \mu\varepsilon\frac{\partial^2\vec{E}}{\partial t^2} = \mu\frac{\partial\vec{J}}{\partial t} + \nabla\left(\frac{\rho_v}{\varepsilon}\right)$ Substitution, $\theta_0 = 22^\circ$ – 03	04
4	a	Explanation of three types of optical fibres with diagram 3×2 Derivation upto $\nabla^2\vec{E} - \mu\varepsilon\frac{\partial^2\vec{E}}{\partial t^2} = \mu\frac{\partial\vec{J}}{\partial t} + \nabla\left(\frac{\rho_v}{\varepsilon}\right)$	06 05
	b	Figures with Explanation of three types of optical fibres 3×2	06
	c	Figure – 01 Explanation of three types of optical fibres – 03	04

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Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester: I-Internal Assessment Test: March-2020

18PHY22-Engineering Physics

An ISO 9001:2015 Certified Institution

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.	Derive the expression for energy Eigen value for an electron in a potential well of infinite depth. Hence obtain the normalized wave function.	**(CO3 07 Marks)**
	b.	Explain requisites of laser system.	**(CO4 04 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)**

OR

2	a.	State Heisenberg's Uncertainity Principle. Using Uncertainity principle Explain non existence of electron in the nucleus.	**(CO3 06 Marks)**
	b.	Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein's co-efficient.	**(CO4 05 Marks)**
	c.	An electron is bound in a 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)**
3	a.	Mention the three modes of vibration in CO_2 molecule. Describe the construction of the CO_2 laser and explain its working with the help of energy level diagram.	**(CO4 07 Marks)**
	b.	Mention the four properties of wave functions.	**(CO3 04 Marks)**
	c.	A spectral line of wavelength 5461 Å has a width of 10^{-4} Å. Evaluate the minimum time spent by the electrons in the upper energy state between the excitation and de-excitation processes.	**(CO3 04 Marks)**

OR

4	a.	Describe construction and working of a semiconductor laser.	**(CO4 05 Marks)**
	b.	Set up time independent Schrodinger wave equation in one dimension.	**(CO3 06 Marks)**
	c.	An electron is confined to a box of length 10^{-9} m, calculate the minimum uncertainty in its velocity.	**(CO3 06 Marks)**

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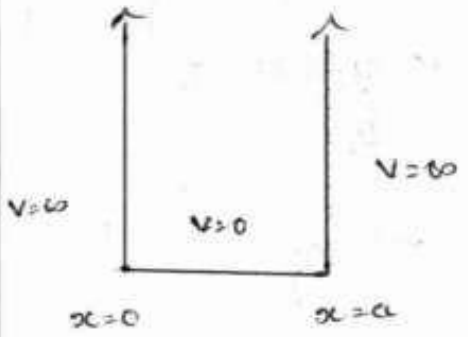
Question Number | Scheme & Solutions

Sub: Engineering physics | Sub code: 18PHY22

1. a]



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

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

$$C = 0, \quad D\sin ka = 0 \quad \text{— (1)}$$

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

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

Normalization of wave fuction

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

But $\psi_n = D\sin\frac{n\pi}{a}x$ — (1)

$$D = \sqrt{\frac{2}{a}}$$

$$\psi_n = \sqrt{\frac{2}{a}}\sin\frac{n\pi}{a}x \quad \text{— (1)}$$

7

1. b) Explination of
* Excitation source.
* Active medium.
* Thermal pumping. — (4)

4

1. c) mass of the particle $m = 0.5\ MeV/c^2$

Kinetic energy, $E = 100\ eV = 100 \times 1.60 \times 10^{-19}\ J$ } — (1)

$$m = \frac{0.5 \times 10^6 \times 1.602 \times 10^{-19}}{(3 \times 10^8)^2} = 8.9 \times 10^{-31}\ kg \quad \text{—— (1)}$$

$$\lambda = \frac{h}{\sqrt{2mE}} \quad \text{—— (1)}$$

$$\lambda = \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 8.9 \times 10^{-31} \times 100 \times 1.602 \times 10^{-19}}}$$

$$\lambda = 1.24 \times 10^{-10}\ m, \quad \text{—— (1)}$$

2. a) Statement of Heisenberg's uncertainty principle — (1)

Non Existance of electron in the atomic Nuclei

$$E = mc^2 \qquad P = mv$$

$$E^2 = \frac{m_0^2 c^4}{\left(1 - \frac{v^2}{c^2}\right)} = \frac{m_0^2 c^6}{(c^2 - v^2)} \quad \text{—— (1)}$$

$$p^2c^2 = \frac{m_0^2 v^2 c^4}{c^2 - v^2} \quad \text{—— (1)}$$

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

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

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

06

2.b) Rate of absorption = Stimulated emission + Spontaneous emission.

$$U_\nu = \frac{A_{21} N_2}{(B_{12} N_1 - B_{21} N_2)} \quad \text{— (1)}$$

$$\frac{N_1}{N_2} = e^{h\nu/KT} \quad \text{— (1)}$$

$$U_\nu = \frac{A_{21}}{B_{21}} \left[\frac{1}{\frac{B_{12}}{B_{21}} e^{h\nu/KT} - 1} \right] \quad \text{— (1)}$$

$$U_\nu = \frac{8\pi h \nu^2}{c^3} \left[\frac{1}{e^{h\nu/KT} - 1} \right] \quad \text{— (1).}$$

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

05

2.c. Data :- width of the potential well $a = 1\text{Å}$ — (1)

$$E = \frac{n^2 h^2}{8ma^2} \quad \text{— (1)}$$

$$E_0 = \frac{h^2}{8ma^2}$$

$$E_0 = 37.64\text{eV} \quad \text{— (1)}$$

$$E_1 = 4E_0$$

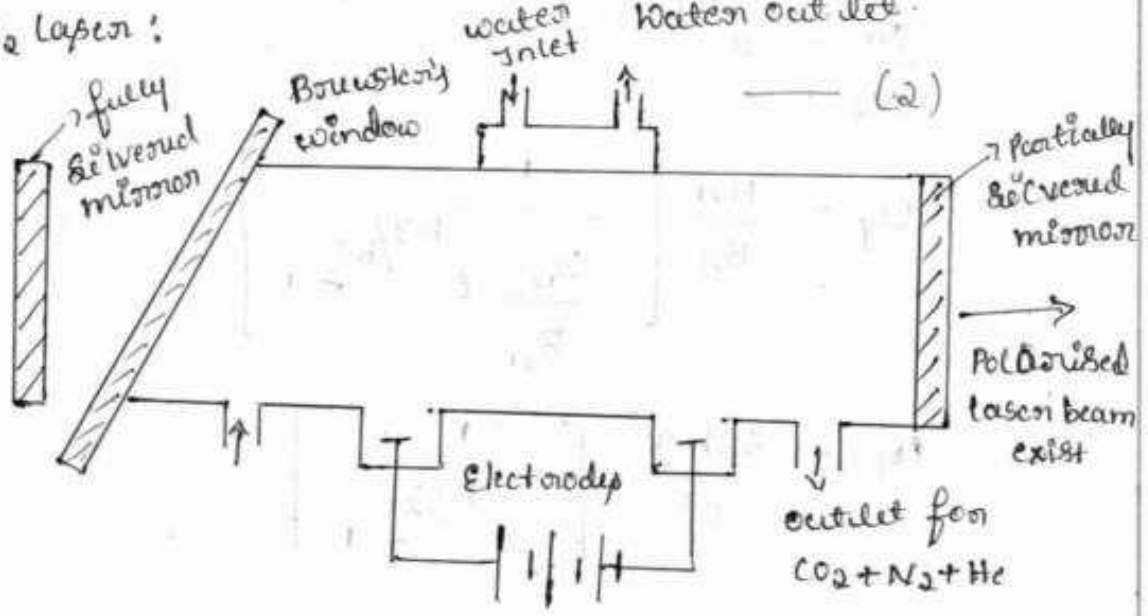
$$E_1 = 150.54\text{eV.} \quad \text{— (1)}$$

04.

3. a) Explain 3 modes of vibration.

1] Symmetric Stretching mode
2] Bending mode
3] Asymmetric Stretching mode } -(2)

CO_2 laser :



— (2)

Explain construction and working — (3)

3. (b) Wright H Properties of wave function.

(1) A wave function ψ is single valued anywhere

(2) A wave function ψ is finite anywhere

(3) ψ and it's first derivatives with respect to it's variable are continuous anywhere

(4). For bound states. ψ must vanish at Infinity.

3.c) Data :-

Wave length of the spectral line $\lambda = 5461 \times 10^{-10}$ m
width of the line $\Delta\lambda = 10^{-14}$ m. } — (1)

Solution :- $E = h\nu = \frac{hc}{\lambda}$

$\Delta E = hc \frac{\Delta\lambda}{\lambda^2}$

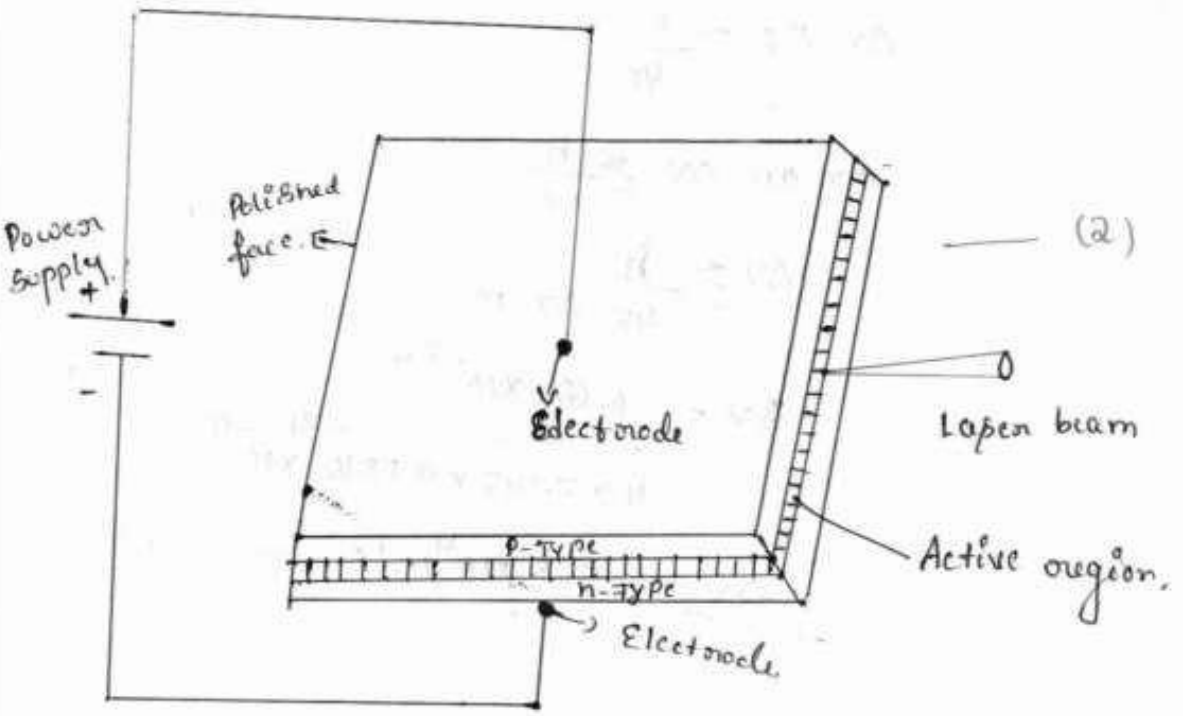
$\frac{h}{4\pi\Delta E} = \frac{h\lambda^2}{4\pi(hc\Delta\lambda)} = \frac{\lambda^2}{4\pi c\Delta\lambda}$ — (1)

$\frac{h}{4\pi\Delta E} = \frac{(5461 \times 10^{-10})^2}{4\pi \times 3 \times 10^8 \times 10^{-14}}$ — (1)

$= 0.8 \times 10^{-8}$ Second. — (1)

04.

4.a) Semiconductor laser :



— (2)

Explain working and construction. — (3)

05.

4.b) Time independent Schrodinger's wave equation in one dimension,

$\lambda = \frac{h}{mv}$ $\quad \psi = Ae^{i(Kx-\omega t)}$ — (1)

$\psi = \psi e^{-i\omega t}$ $\quad \frac{d^2\psi}{dx^2} = e^{-i\omega t}\frac{d^2\psi}{dx^2}$ — (1)

$\frac{d^2\psi}{dt^2} = -\omega^2 e^{-i\omega t}\psi$ — (1)

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

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

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

06

4.c) Data :- $\Delta x = 10^{-10}$ m, $\Delta v = ?$ — (1)

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

$\Delta x \, m \, \Delta v \geq \frac{h}{4\pi}$. — (1)

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

$\Delta v = \frac{6.626 \times 10^{-34}}{4 \times 3.142 \times 9.1 \times 10^{-31} \times 10^{-9}}$ — (1)

$\Delta v = 5.8 \times 10^{4}$ m/s — (1)

04

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Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester: II Online Internal Assessment Test: May-2020

18PHY22-Engineering Physics

Time: 120 Min **Max. Marks: 60**

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.	Discuss the theory of forced vibrations and hence obtain the expression for amplitude and Phase.	**(CO1 08 Marks)**
	b.	With a neat diagram explain the construction and working of Reddy shock tube.	**(CO1 08 Marks)**
	c.	The distance between the 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 the shock waves.	**(CO1 04 Marks)**
2	a.	Set up time independent Schrodinger wave equation in one dimension.	**(CO3 08 Marks)**
	b.	Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein's co-efficient.	**(CO4 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)**
3	a.	What is Hall Effect? Obtain the expression for Hall voltage in terms of Hall co-efficient.	**(CO5 10 Marks)**
	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 04 Marks)**

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Question Number | Scheme & Solutions | Marks Allocated

Sub: Engineering physics | Sub. Code: 18PHY22

1 a) with explanation up to

Resultant force $= -r\frac{dx}{dt} - kx + F\sin(pt)$ — 2

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

$x = a\sin(pt - \alpha)$ — 1

$\frac{dx}{dt} = ap\cos(pt - \alpha)$ — 1

$\frac{d^2x}{dt^2} = -ap^2\sin(pt - \alpha)$ — 1

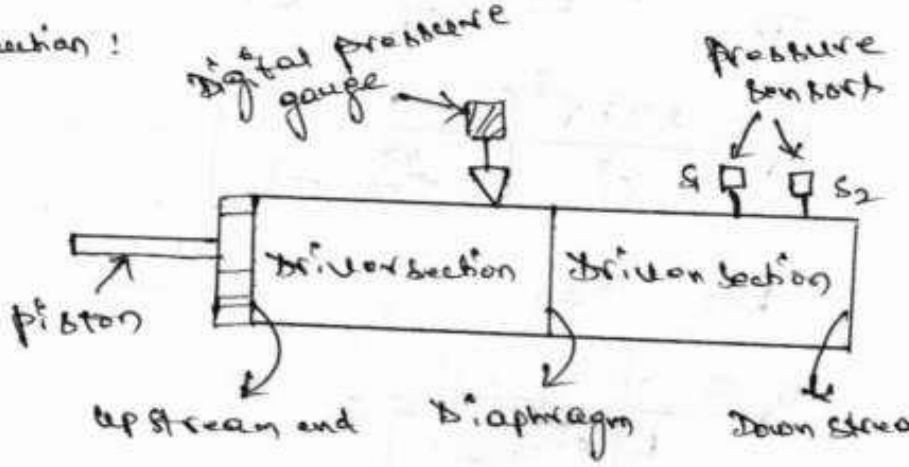
up to $a = \frac{(F/m)}{\sqrt{4b^2p^2 + (\omega^2 - p^2)}}$ — 1

$\alpha = \tan^{-1}\left[\frac{2bp}{\omega^2 - p^2}\right]$ — 1

8

b)

Construction:



— 4

Diameter 30mm, length 1m

length of each section 50cm

-thickness of diaphragm 0.1 mm — 4

and explanation of working

8

c)

$M = \frac{v}{a}$ — 1

$v = \frac{x}{t} = \frac{150\times10^{-3}}{0.3\times10^{-3}} = 500$ m/s — 1

$\therefore M = \frac{500}{340} = 1.47$ — 2

4

2

a) Concept of $\lambda = \frac{h}{p}$ with explanation ——— 1

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

Steps involved upto $\frac{1}{\lambda^2} = -\frac{1}{4\pi^2\psi}\frac{d^2\psi}{dx^2}$ ——— 3 8

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

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

b) with explanation up to $B_{12}N_1U_\gamma = A_{21}N_2 + B_{21}N_2U_\gamma$ — 3

$U_\gamma = \frac{A_{21}}{B_{21}}\left[\frac{1}{\frac{B_{12}N_1}{B_{21}N_2} - 1}\right]$ ——— 1

$\frac{N_2}{N_1} = e^{-\frac{h\nu}{KT}} \quad \frac{N_1}{N_2} = e^{\frac{h\nu}{KT}}$ ——— 1 8

$U_\gamma = \frac{8\pi h\nu^3}{c^3}\left[\frac{1}{e^{\frac{h\nu}{KT}} - 1}\right]$ ——— 1

$B_{12} = B_{21}$ ——— 1

$U_\gamma = \frac{A}{B\left[e^{\frac{h\nu}{KT}} - 1\right]}$ ——— 1

c)

$m = \frac{940 \times 10^6 \times 1.602 \times 10^{-19}}{(3 \times 10^8)^2} = 1.673 \times 10^{-27}$ kg

$E = 0.5 \times 10^3 \times 1.602 \times 10^{-19}$ ——— 1

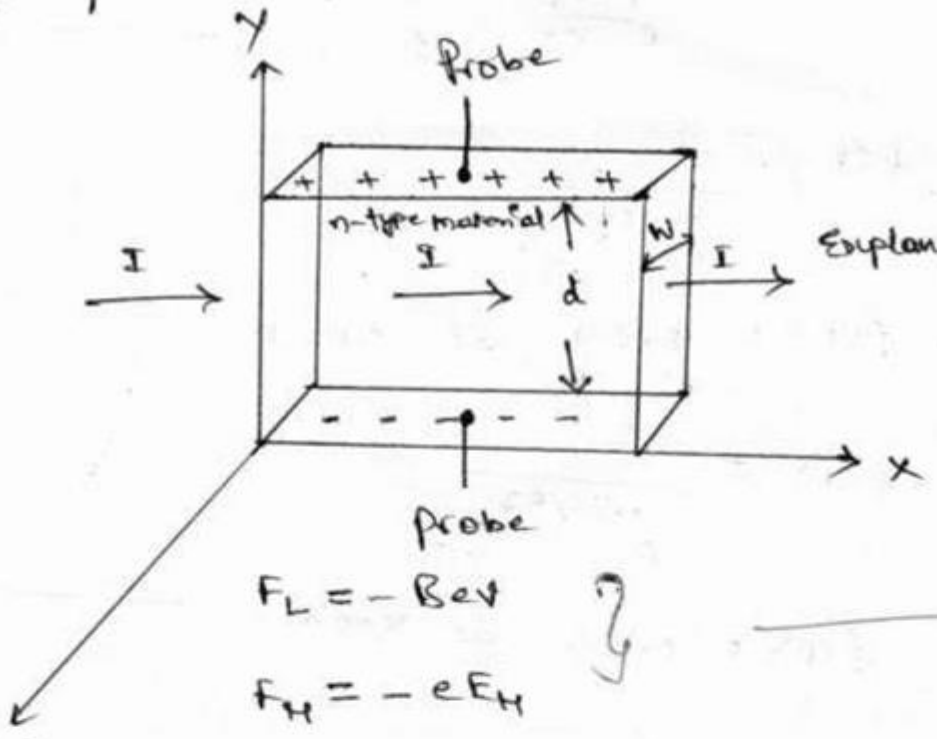
$E = 8.01 \times 10^{-17}$ J

$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 1.673 \times 10^{-27} \times 8.01 \times 10^{-17}}}$ ——— 2 4

$\lambda = 1.28 \times 10^{-12}$ m ——— 1

$\lambda = 1.28$ pm

3 a) Hall effect explanation ——— 1



—— 2

8

$F_L = -Bev$ ——— 1

$F_H = -eE_H$

$E_H = Bv$ ——— 1

$V_H = \frac{BI}{\rho W}$ ——— 1

$\rho = \frac{BI}{V_H W}$ ——— 1

$E_H = R_H J B$

$R_H = \frac{1}{\rho}$ ——— 1

b) Definition of Fermi factor ——— 1

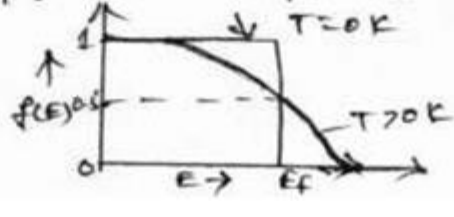
$$f(E) = \frac{1}{e^{\frac{E-E_f}{KT}} + 1}$$

At $T = 0$ for $E > E_f$ $f(E) = 0$ — 2

$E < E_f$ $f(E) = 1$ — 2

8

ordinary temp. $T > 0$ $E = E_f$ $f(E) = 0.5$ — 2



——— 1

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

$$f(E) = \frac{1}{e^{1.1894} + 1}$$ ——— 2 4

$f(E) = 0.24$ at 200 K

$$f(E) = \frac{1}{e^{0.5797} + 1}$$ ——— 1

$f(E) = 0.36$ at 400 K.

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Shridevi Institute of Engineering and Technology, Tumkur-06

2nd Semester: Online Assessment Test May 2020

18PHY22 Engineering Physics

Time : 90min Max.Marks: 30

Note : Answer any two full question

1 a. What are shock waves? Mention the characteristics and application of shocks waves. (CO1 05 Marks)

b. What are the damped oscillation? Give the theory of damped oscillation and hence discuss the case of critical damping. (CO1 10 Marks)

OR

2 a. Define SHM.Mention the characteristics of SHM.Give one example of SHM. (CO1 05 Marks)

b. With a neat diagram, explain the construction and working of Reddy's shock tube. Metion conservation of mass energy and momentum expressions. (CO1 10 Marks)

3 a. What are the assumption of free electron theory (QFET) ? Explain the merits of QFET. (CO5 05 Marks)

b. What is Hall effect ?Derive an expression for Hall voltage in terms of Hall coefficient. (CO5 10 Marks)

OR

4 a. What is Fermi energy ? Derive an expression for Fermi energy at zero Kelvin for a metal. (CO5 10 Marks)

b. Define Fermi factor, Explain the variation of Fermi factor with temperature. (CO5 05 Marks)

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S.I.E.T., TUMKUR -6.

PRINCIPAL
SIET., TUMAKURU.

Question number	Scheme & Solutions SUb: Engineering Physics Sub code: 18PH422	marks allocated
1. a]	A shock wave is a narrow surface that manifests as a discontinuity in a fluid medium in which it is propogating with supersonic speed, the disturbance is characterised by sudden increase in pressure. temparature and density of the gas through which it propogates. — (1) Explain characteristics and mention of application — (4)	5
b]	It is the type of motion executed by a body subjected to the combined action of both the restoring and the resistive forces and the motion always gets terminated with the body coming to a rest at the equilibrium position in a finite interval of time. — (2) Theory of damped oscillation. $m \frac{d^2x}{dt^2} = -r \frac{dx}{dt} - kx$ — (1) $\frac{d^2x}{dt^2} + \frac{r}{m} \frac{dx}{dt} + \frac{k}{m} x = 0.$ — (1)	10

$$x = A e^{\alpha t} \quad \text{— (I)}$$

$$\frac{d^2x}{dt^2} = A\alpha^2 e^{\alpha t}$$

$$C = \frac{x_0}{2}\left[1 + \frac{b}{\sqrt{b^2 - \omega^2}}\right] \quad \text{— (1)}$$

$$D = \frac{x_0}{2}\left[1 - \frac{b}{\sqrt{b^2 - \omega^2}}\right] \quad \text{— (1)}$$

$$x = \frac{x_0}{2}\left\{\left[1 + \frac{b}{\sqrt{b^2 - \omega^2}}\right] e^{(-b + \sqrt{b^2 - \omega^2})t} + \left[1 - \frac{b}{\sqrt{b^2 - \omega^2}}\right] e^{(-b - \sqrt{b^2 - \omega^2})t}\right\} \quad \text{— (1)}$$

Critical damping. $b^2 = \omega^2$.

$$x = C e^{(-b+\varepsilon)t} + D e^{(-b-\varepsilon)t}$$

$$x = b^{-bt}\left[C e^{\varepsilon t} + D e^{-\varepsilon t}\right] \quad \text{— 3}$$

$$e^{\varepsilon t} = 1 + \varepsilon t \qquad e^{-\varepsilon t} = 1 - \varepsilon t$$

$$x = e^{-bt}\left[(C+D) + (C-D)\varepsilon t\right].$$

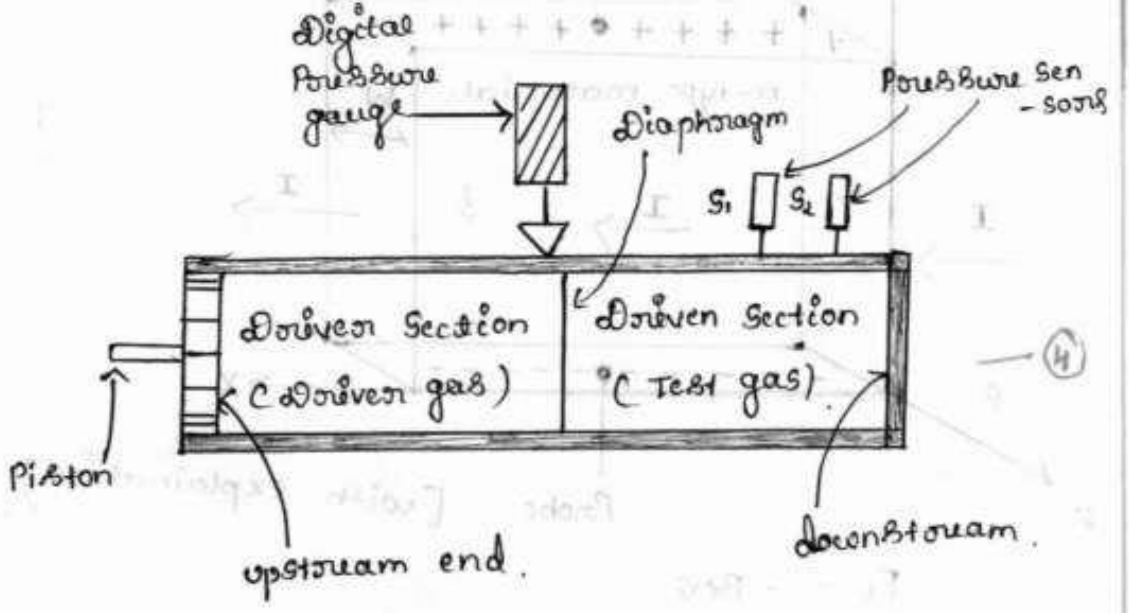
2. a) SHM is the oscillatory motion of a body where the restoring force is proportional to the negative of the displacement. — (1)

Explain characteristics of SHM — (3)

Mention one example. — (1)

5

b. Reddy tube



— (4)

Explain construction and working. — (4)

conservation of mass :- $P_1 U_1 = P_2 U_2$. — (1)

conservation of Energy :- $h_1 + \frac{U_1^2}{2} = h_2 + \frac{U_2^2}{2}$

— (1)

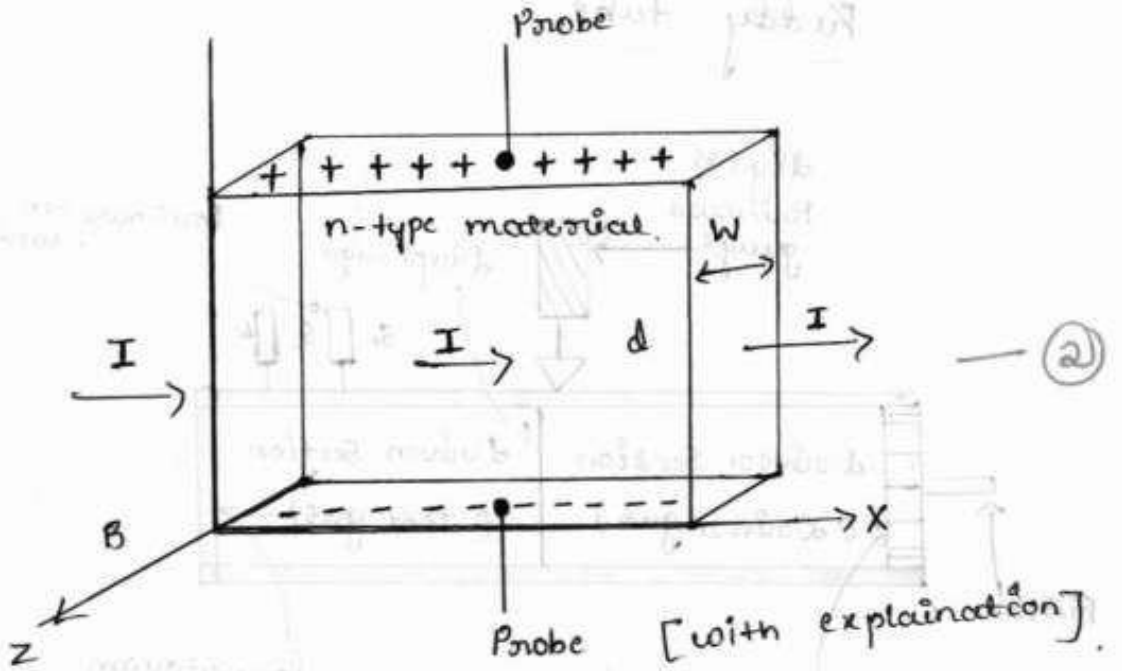
10.

3. a) Mention assumption of free electron theory. — (3)

Explain the merits of quantum free electron theory. — (2)

5.

b) Hall effect explanation. — (1)



— (2) [with explaination]

10

$F_L = -Bev$ } — (1)

$F_H = -eE_H$

$E_H = Bv$ — (1)

$V_H = \frac{BI}{\rho w}$ — (1)

$\rho = \frac{BI}{V_H w}$ — (1)

$E_H = R_H JB$ — (1)

$R_H = 1/\rho$ — (1).

4. a. defination of fermi energy. — (1)

$$N(E)\,dE = g(E)\,dE \times f(E) \quad — (2)$$

$$n = \int_{E=0}^{E_{max}} N(E)\,dE \quad — (1)$$

$f(E) = 1$ at $T = 0k$ — (1)

$$n = \int_{E=0}^{E_{max}} g(E)\,dE \times 1. \quad — (1)$$

$$n = \frac{8\sqrt{2}\,\pi\, m^{3/2}}{h^3} \times \frac{2}{3} (E_{F0})^{3/2} \quad — (1)$$

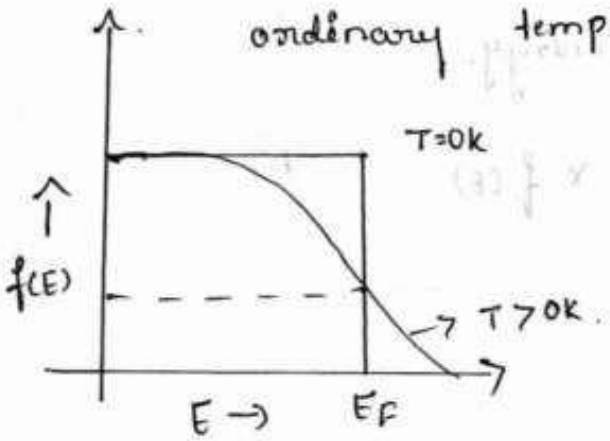
$$E_{F0} = \left(\frac{h^2}{8m}\right)\left(\frac{3n}{\pi}\right)^{2/3} \quad — (1)$$

$$E_{F0} = B n^{2/3} \quad — (1)$$

Ferm Explination of fermi energy at zero kilvin — (2).

b. Definaction of fermi factor. — (1)

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



At T=0, for $E > E_F$ $f(E) = 0$ — (1)

$E < E_F$ $f(E) = 1$ — (1)

$E = E_F$ $f(E) = 0.5$ — (1)

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18PHY22

Shridevi Institute of Engineering and Technology, Tumkur-06

II Semester B.E. Degree Online Preparatory Internal Assessment Examination, June- 2020

Engineering Physics

Time: 3 hrs **Max. Marks: 100**

Note: *1. Answer any FIVE full questions, choosing ONE full question from each module.*

2. Physical constants, Velocity of light, $c = 3 \times 10^8$ m/s, Avagadro number $N_A = 6.02 \times 10^{26}$ /K mole, 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

Module -1

1 a. Define SHM. Mention the characteristics of SHM. Derive the deferential equation for SHM using Hook's law 07 Marks

b. With a neat diagram explain the construction and working of Reddy shock tube. Mention the application of shock waves. 09 Marks

c. For the particle executing SHM, its acceleration is found to be 15cm/s^2 when it is at 3 cm from its mean position. Calculate time period. 04 Marks

OR

2 a. Discuss the theory of forced vibrations and hence obtain the expression for amplitude and Phase. 08 Marks

b. What are damped oscillations? Give the theory of damped oscillations. 08 Marks

c. The distance between the 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 the shock waves. 04 Marks

Module -2

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

b. Derive the expression for the depression and Y at the free end of a beam of loaded cantilever. 08 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^2) 04 Marks

OR

4 a. Derive the Expression for couple per unit twist of a solid cylinder. 08 Marks

b. Derive the relation between Young's modulus (Y), rigidity modulus (n) and Poisson's ration (σ). 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. 04 Marks

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Module -3

5 a. With a neat diagram derive an expression for numerical aperture and arrive at the condition for propagation. 08 Marks

b. State and prove the Gauss divergence theorem. 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. 04 Marks

OR

6 a. With neat diagrams explain the different types of optical fibers. 08 Marks

b. Derive the EM wave equation in terms of electric field using Maxwell's equation. 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. 04 Marks

Module -4

7 a. Mention the three modes of vibration in CO_2 molecule. Describe the construction of the CO_2 laser and explain its working with the help of energy level diagram. 08Marks

b. Set up time independent Schrodinger wave equation in one dimension. 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). 04 Marks

OR

8 a. State Heisenberg's Uncertainity Principle. Using Uncertainity principle Explain non existence of electron in the nucleus. 08 Marks

b. Obtain an expression for energy density of radiation under equilibrium condition in terms of Einstein's co-efficient. 08 Marks

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

Module -5

9 a. Give the assumptions of QFET. Explain the merits of QFET. 08 Marks

b. What is Hall Effect? Obtain the expression for Hall voltage in terms of Hall co-efficient. 08 Marks

c. Calculate the probability of an electron occupying an energy level 0.02 eV below the Fermi level at 200K and 400K. 04 Marks

OR

10 a. Define Fermi energy. Derive the expression for Fermi energy at 0 K for a metal. 08 Marks

b. What polar and non-polar dielectrics with examples. Derive Clausius- Mossotti equation. 08 Marks

c. The resistivity of intrinsic germanium at 27 ^{0}C is equal to 0.47 ohm-m. Assuming the electron and hole mobilities as 0.38 and 0.18 m^2/V-Sec respectively. Calculate the intrinsic carrier density. 04 Marks

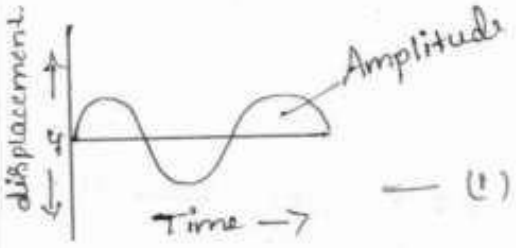
(Dr. Sadashivaiah P.T)
HOD of Physics

Principal

Question Numbers	Scheme & Solutions	Marks allocated
	Sub : Engineering physics Subcode : 18PHY22	

1. a) Defination of SHM — (1)

Write the characteristics of SHM. — (2)



$F = -ky$ — (1)

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

$m \frac{d^2y}{dt^2} = -ky$ — (1)

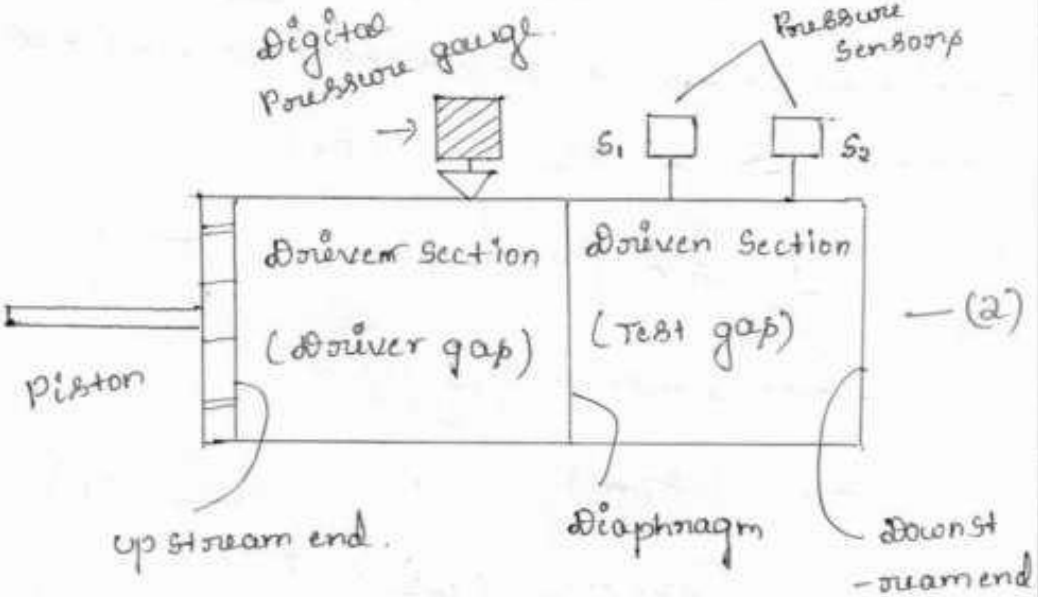
$\frac{d^2y}{dt^2} = \frac{-k}{m} y$

$\frac{d^2y}{dt^2} + \frac{k}{m} y = 0$ — (1)

$y = a \sin \omega t$ — (1)

07

1, b)



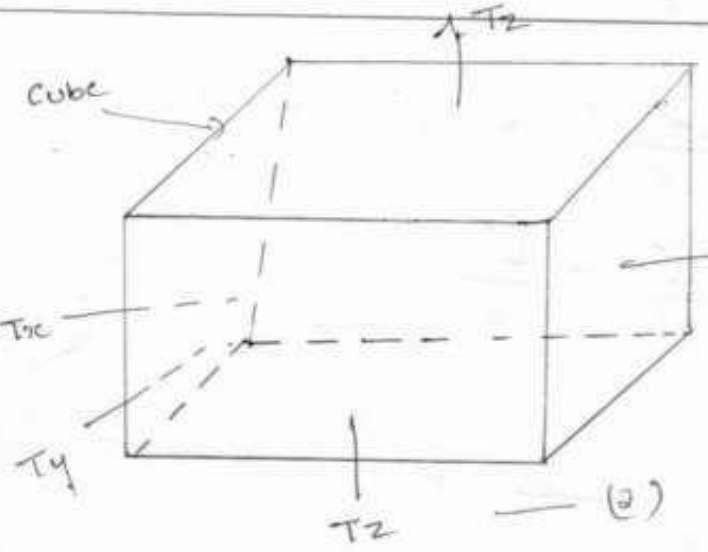
— (2)

Write construction, working and application of Reddy shock tube. — (4)

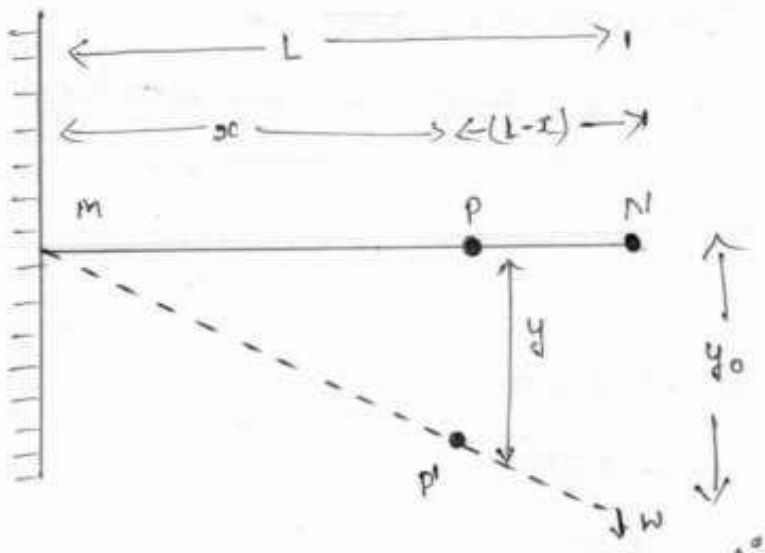
— (3)

09

Question Number		Marks allocated
1, C.	Given :- $a = 15 cm/s^2 = 15 \times 10^{-2} m/s^2$ — (1) $x = 3cm = 3 \times 10^{-2} m$ $T = ?$ $x = a \sin \omega t$ $\omega = \sqrt{\frac{a}{x}} = \sqrt{\frac{15 \times 10^{-2}}{3 \times 10^{-2}}} = 2.24 rad/s$ — (1) $\omega = 2\pi f$ — (1) $T = \frac{2\pi}{\omega} = \frac{2 \times 3.142}{2.24} = 2.8$ seconds. — (1)	04
2. a)	Write the theory of forced vibrations. — (2) Expression for amplitude and phase. Resultant force $= -r\frac{dx}{dt} = -kx + F \sin(pt)$ — (1) as per Newton's second law of motion resultant force $= m\frac{d^2x}{dt^2}$ — (1) $x = a \sin(pt - \alpha)$ — (1) $-ap^2 \sin(pt - \alpha) + 2b\,ap \cos(pt - \alpha) + \omega^2 a \sin$ $(pt - \alpha) \rightarrow = F/m \sin(pt)$. $\frac{F}{m} \sin[(pt - \alpha) + \alpha]$ — (1) $-ap^2 + a\omega^2 = F/m \cos\alpha$ $a = \frac{(F/m)}{\sqrt{4b^2p^2 + (\omega^2 - p^2)^2}}$ — (1) $\alpha = \tan^{-1}\left[\frac{2bp}{\omega^2 - p^2}\right]$ — (1)	08

Q.N		M.A
2. b)	Define damped oscillation. — (2) Write the theory of damped oscillations. — (6)	08
2,c)	Given data: $x = 150mm = 150 \times 10^{-3} m$ — (1) $t = 0.3 ms = 0.3 \times 10^{-3} s$ $a = 340 m/s$ $\quad M = ?$ $M = \frac{v}{a}$ $\quad v = \frac{x}{t}$ — (1) $v = \frac{150 \times 10^{-3}}{0.3 \times 10^{-3}} = 500 m/s$ — (1) $M = \frac{500}{340} = 1.47$ — (1)	04
3.a)	 — (2)	Explanation of cube. — (2) $1 + \alpha T_x - \beta T_y - \beta T_z$ $1 + \alpha T_y - \beta T_z - \beta T_x$ $1 + \alpha T_z - \beta T_x + \beta T_y$ — (1) $T_x = T_y = T_z = T$, Increasing volume $= 3T(\alpha - 2\beta)$. Volume Strain $= \frac{3P(\alpha - 3\beta)}{1}$ — (1) Bulk modulus $= K = \frac{Y}{3(1-2\sigma)}$ $\quad \because \sigma = \beta/2$ — (1) — (1)	08

3.b,



— (1)

Wright the explination of diagram. — (1)

Binding momentum = $W(L-x)$

$$\frac{Y}{R} I_g = W(L-x) \quad \text{— (1)}$$

$$\frac{1}{R} = \frac{W(L-x)}{Y I_g} \qquad \frac{1}{R} = \frac{d^2y}{dx^2} \quad \text{— (1)}$$

$$\frac{dy}{dx} = \frac{W}{YI_g}\left[Lx - \frac{x^2}{2}\right] + C_1$$

08

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

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

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

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

3. c) Given data :- $x = 10^{-3}m$, $L = 2m$, $d = 10^{-3}m$ $Y = 2 \times 10^{11} N/m^2$

$F = ?$

$R = \frac{d}{2} = \frac{10^{-3}}{2} = 0.5 \times 10^{-3}m$ — (1)

$Y = \frac{FL}{ax}$ $\quad F = \frac{\pi R^2 Y x}{L}$ — (1)

$F = \frac{\pi \times (0.5 \times 10^{-3})^2 \times 2 \times 10^{11} \times 10^{-3}}{2}$ — (1)

$F = 78.54$. — (1)

04.

4. (a)

$BXB' = \phi$

$BO'B' = \theta$ — (1)

$BO' = B'O' = r$.

$L\phi = r\theta$ (or) $\phi = \frac{r\theta}{L}$ —

$T = \frac{F}{2\pi r dr}$.

—(2) $T = \frac{n r \theta}{L}$ — (1)

$F = \frac{n\pi n\theta}{L} r^2 dr$. — (1)

$\theta O' = \left(\frac{2\pi n\theta}{L} r^2 dr\right) r$ — (1)

$= \frac{2\pi n \theta}{L} r^3 dr$.

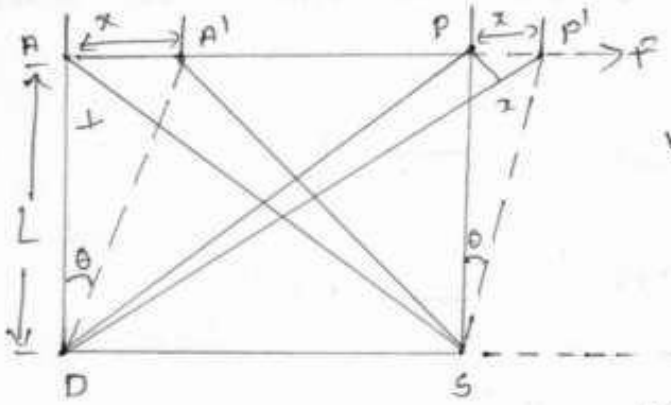
Twisting couple acting on the entire cylinder

$= \frac{\pi n R^4 \theta}{2L}$ — (1)

$C = \frac{\pi n R^4}{2L}$ — (1)

08.

4.b)



— (1)

Weight the explanation of the diagram.

— (2)

Total Extension along DP = DP. T (α+β)

$P\lambda = DP.T(\alpha+\beta)$

$(\sqrt{2}L)T(\alpha+\beta) = x/\sqrt{2}$.

Rearranging $2(\alpha+\beta) = x/\sqrt{2}$. — (1)

Inverting $\frac{1}{2}\frac{1}{(\alpha+\beta)} = \frac{T}{\theta} = n$. — (1)

$n = \frac{1/\alpha}{2(1+\sigma)}$ $\sigma = \beta/\alpha$. — (1)

$Y = \frac{\text{stress}}{\text{longitudinal strain}}$.

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

(08)

4.c)

Given data :- $L = 0.3m$, $R = 0.2\times10^{-3}m$, $\tau = 5\times10^{-4}$ Nm

$n = 8\times10^{10}$ N/m². $\theta = ?$ — (1)

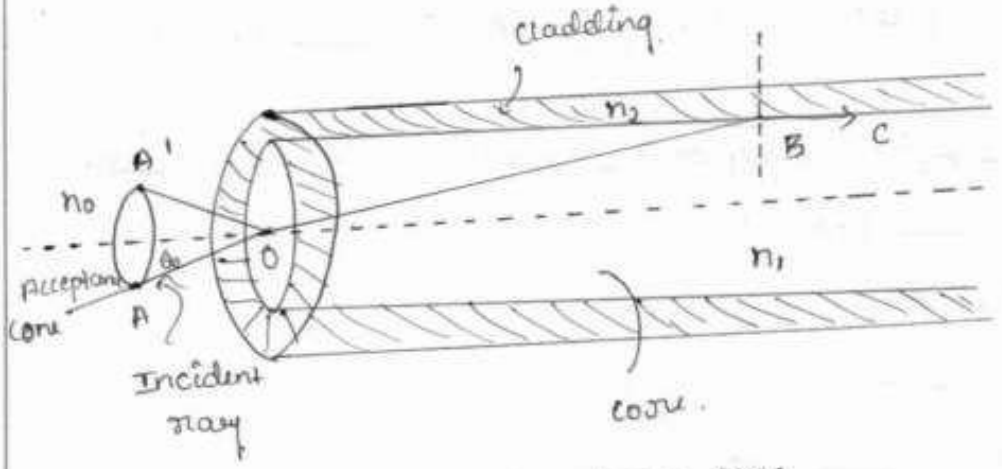
$\tau = C\theta$, $\theta = \frac{2\tau L}{\pi n R^2}$ — (1)

$= \frac{2\times5\times10^{-4}\times0.3}{3.1\times8\times10^{10}\times(0.2\times10^{-3})^4}$ — (1)

$= 0.75$ radian. — (1)

04.

5.a)



— (2)

Acceptance cone

08

$n_0 \sin\theta_0 = n_1 \sin\theta_1$ — (1)

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

$\sin\theta_0 = \frac{n_1}{n_2} \sqrt{1 - \left(\frac{n_2}{n_1}\right)^2}$ — (1)

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

$NA = \sqrt{n_1^2 - n_2^2}$ — (1)

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

condition for propogation $\sin\theta_i < NA$.

5.b)

Wright Statement. $\oint_S \vec{D} \cdot d\vec{s} = \int_V \nabla \cdot \vec{D} \, dv$.

— (2)

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

Proof :-

08

$dQ = \rho_v \, dv$. — (1)

— (1)

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

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

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

5.c) $n_1 = 1.50$, $n_2 = 1.48$. $NA = ?$, $\theta = ?$ — (1)

$NA = \sqrt{n_1^2 - n_2^2} = \sqrt{(1.50)^2 - (1.48)^2} = 0.244$ — (1) 04

$\theta = \sin^{-1}(N.A)$ — (1)

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

$= 14.1^0$ — (1)

6.a) With the neat diagram explain —

* Single mode step index optical fiber
* Multi mode step index optical fiber
* Multi mode graded index optical fiber. 08

6.b)

$\nabla \times \vec{H} = \vec{J} + \varepsilon \frac{\partial E}{\partial t}$ — (1)

$\nabla \times \vec{E} = -\mu \frac{\partial H}{\partial t}$ — (1)

$\nabla \times \vec{E} = -\mu \frac{\partial H}{\partial t}$ — (1)

$\nabla \times \nabla \times \vec{E} = -\mu \frac{\partial}{\partial t}(\nabla \times H)$ — (1)

$= \nabla\left(\frac{\rho_v}{\varepsilon}\right) - \nabla^2 \vec{E}$ — (1) 08

$\nabla^2 E - \mu\varepsilon \frac{\partial^2 E}{\partial t^2} = \mu \frac{\partial \vec{J}}{\partial t} + \nabla\left(\frac{\rho_v}{\varepsilon}\right)$ — (1)

$\nabla^2 \vec{E} - \mu\varepsilon \frac{\partial^2 \vec{E}}{\partial t^2} = 0.$ — (2)

6.c) $L = 500m = 0.5km$, $P_{in} = 100 \times 10^{-3} W$ $P_{out} = 90 \times 10^{-3} W$. — (1)

$$\alpha = \frac{-10}{L} \log_{10}\left(\frac{P_{out}}{P_{in}}\right) \text{ dB/km.} \quad — (1)$$

$$\alpha = \frac{-10}{0.5} \log_{10}\left(\frac{90}{100}\right) \quad — (1)$$

$$= 0.915 \text{ dB/km} \quad — (1)$$

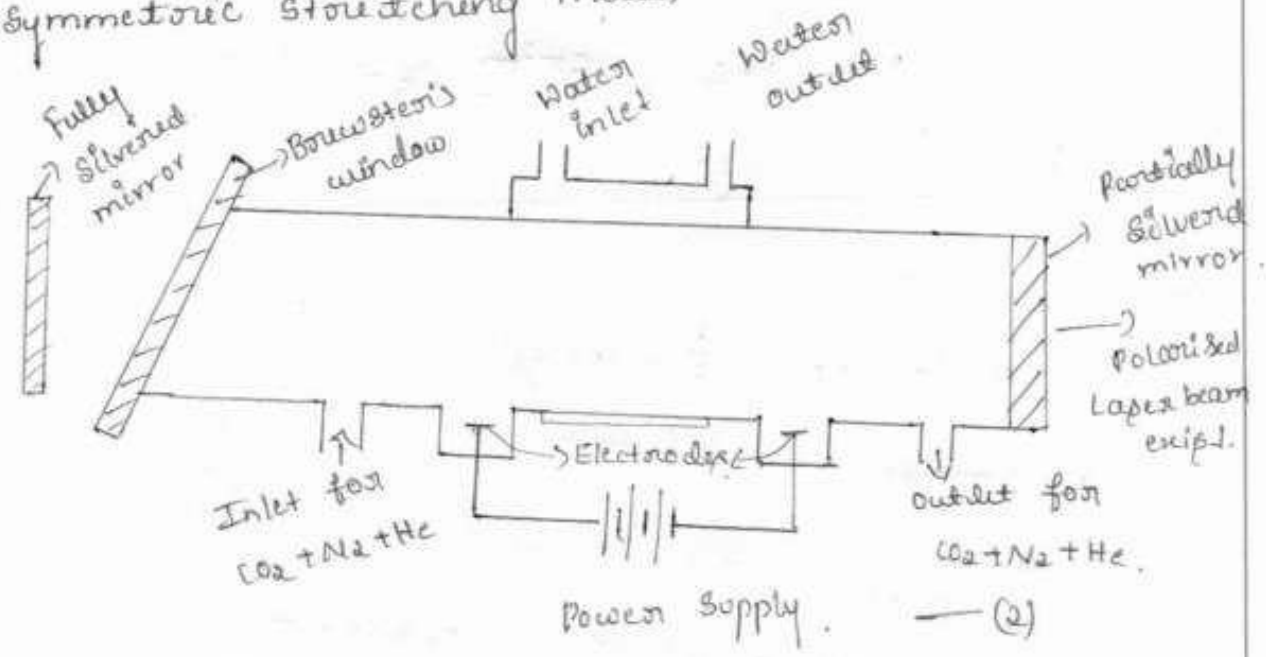
04

7.a) Explain 3 modes of vibration.

*Symmetric stretching mode. — (4)

* Bending mode.

* Asymmetric stretching mode.



08

Explain construction and working of CO_2 Laser — (2)

7.b) Time independent Schrodinger's wave equation in one dimension,

$$\lambda = h/mv \quad — (1)$$

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

$$\frac{d^2\psi}{dt^2} = -\omega^2 e^{-i\omega t}\psi \quad \text{—— (1)}$$

$$\frac{d^2\psi}{dx^2} = -\frac{\omega^2}{v^2}\psi \quad \text{—— (1)}$$

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

08

$$K.E = \frac{p^2}{2m} \quad \text{—— (1)}$$

$$E = KE + P.E$$

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

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

7.(B) Given data :-

$m = 0.5\ MeV/c^2$, $E = 100\ ev$;

De Broglie wavelength, $\lambda = ?$.

$$Mev/c^2 = 0.5\times10^6\ ev/c^2. \quad \text{—— (1)}$$

$$m = (0.5\times10^6) \times (1.602\times10^{-19})\ J/c^2$$

04.

$$m = \frac{0.5\times10^6 \times 1.602\times10^{-19}}{(3\times10^8)^2} = 8.9\times10^{-31}\ kg \quad \text{——(1)}$$

$$\lambda = \frac{h}{\sqrt{2mE}} = \frac{6.63\times10^{-34}}{\sqrt{2\times8.9\times10^{-31}\times100\times1.602\times10^{-19}}} \quad \text{——(1)}$$

$$= 1.24\times10^{-10}\ m. \quad \text{——(1)}$$

8.a) Wright the Statement of Heisenberg's Uncertainty Principle. —— (2)

Non - existence of electron in the atomic Nucleus.

$E = mc^2$. $P = mV$. —— (1)

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

$$p^2 = \frac{m_o^2 c^2}{\left(1 - \frac{v^2}{c^2}\right)} = \frac{m_o^2 v^2 c^2}{(c^2 - v^2)} \quad \text{—— (1)}$$

$$E^2 - p^2c^2 = \frac{m_o^2 c^4 (c^2 - v^2)}{c^2 - v^2} \quad \text{—— (1)}$$ 08.

$$\Delta P \geq \frac{h}{4\pi \Delta x}$$

$$\Delta P \geq 1.1 \times 10^{-20} kg\, ms^{-1} \quad \text{—— (1)}$$

$$E^2 \geq p^2c^2 + m_o^2 c^4$$

$$E^2 \geq 1.09 \times 10^{-23}$$

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

8.b) Rate of absorption = Stimulated emission + Spontaneous emission. —— (1)

$$U_f = \frac{A_{21} N_2}{(B_{12} N_1 - B_{21} N_2)} \quad \text{—— (1)}$$

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

$$\frac{N_1}{N_2} = e^{-h\nu/KT} \quad \text{— (1)}$$

$$U_\nu = \frac{A_{21}}{B_{21}} \left[\frac{1}{\frac{B_{12}}{B_{21}} e^{h\nu/KT} - 1} \right] \quad \text{— (1)}$$

03

$$U_\nu = \frac{8\pi h\nu^3}{c^3} \left[\frac{1}{e^{h\nu/KT} - 1} \right] \quad \text{— (1)}$$

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

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

Given data :- $a = 1A^0 = 10^{-10} m$, $E_1 = ?$ Eq. Es

— (1)

B.C)

$$E_n = \frac{n^2 h^2}{8ma^2} \quad \text{— (1)}$$

04.

$$E_1 = \frac{h^2}{8ma^2}$$

$$= \frac{(6.63 \times 10^{-34})^2}{8(9.11 \times 10^{-31})(10^{-10})^2} = 37.64 eV \quad \text{— (1)}$$

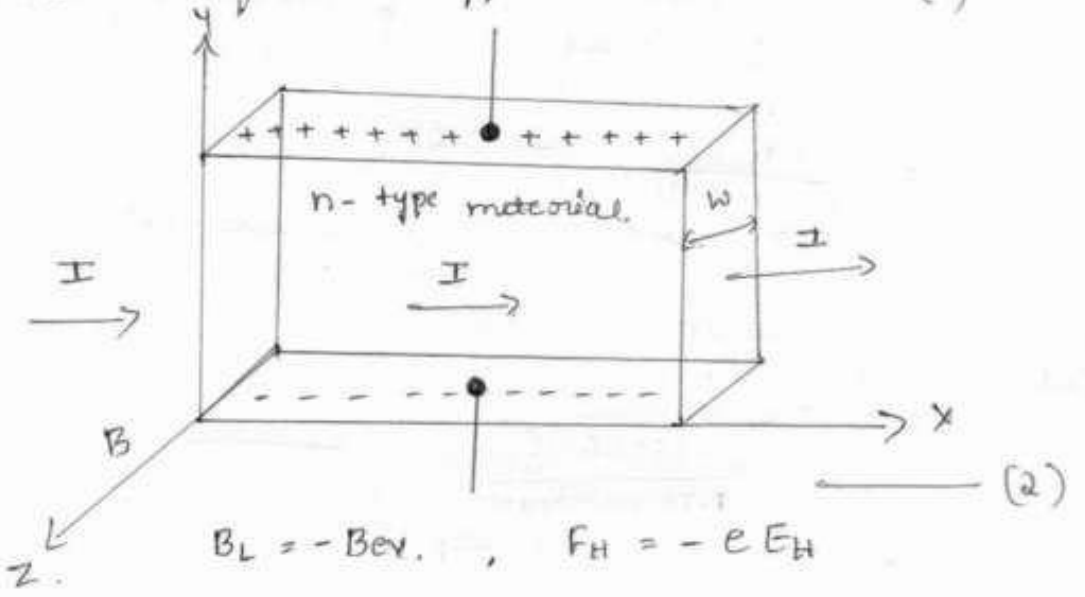
— (1)

$$E_0 = E_1 = 37.64 eV.$$

9, a) Weight assumptions of QFET —— (4)

Weight the merits of QFET. —— (4) 08

9, b) Explination of hall effect, —— (1)



—— (2)

$B_L = -Bev.$, $F_H = -eE_H$

$E_H = Bv.$ —— (1)

$V_H = Bvd.$ —— (1) 08.

$J = I/wd.$

$I = nevA$

$\rho v = I/wd$ / $v = I/\rho wd$ —— (1)

$\rho = \frac{BI}{V_H w.}$ —— (1)

Hall coefficient R_H : $E_H \propto JB$ —— (1)

$R_H = E_H / JB$

$R_H = 1/\rho.$ —— (1)

9.c) Given data :- $E - E_F = 0.02$ eV,

find out : (i) $f(E)$ at 200K = ?

(ii) $f(E)$ at 400K = ?

(i) $f(E) = \frac{1}{e^{\frac{E-E_F}{KT}} + 1} = \frac{1}{e^{\frac{0.02 \times 1.6 \times 10^{-19}}{1.38 \times 10^{-23} \times 200}}}$ —— (1) 04.

$= \frac{1}{1.1594} = 0.24.$

$e + 1$ —— (1)

(ii) $f(E) = \frac{1}{e^{\frac{0.02 \times 1.6 \times 10^{-19}}{1.38 \times 10^{-23} \times 400}} + 1}$ —— (1)

$= \frac{1}{1.7855 + 1} = 0.36.$ —— (1)

10,a) The energy coorresponding to the highest occupied level at obsolute zero, temperature is called fermi energy. —— (1)

Fermi energy at Zero kelvine.

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

$$n = \int_{E=0}^{E_{max}} N(E)\,(dE) = \int_{E=0}^{E_{max}} g(E)\, f(E)\, dE$$ —— (1)

$$n = \int_{E=0}^{E_{max}} g(E)\, dE \times 1.$$ —— (1)

$$n = \frac{8\sqrt{2}\pi m^{3/2}}{h^3} \times \left[\frac{2}{3} E^{3/2}\right]_0^{E_{max}} \quad \text{—— (1)}$$

$$(E_{F_0})^{3/2} = \frac{h^3}{(8m)^{3/2}} \left(\frac{3n}{\pi}\right) \quad \text{—— (1)}$$

08.

$$E_{F0} = \left(\frac{h^2}{8m}\right)\left(\frac{3n}{\pi}\right)^{2/3} \quad \text{—— (1)}$$

$$E_{F0} = Bn^{2/3} \quad \text{—(1)} \qquad B = 5.85 \times 10^{-38} \text{ J}$$

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10) b) Wright definaton of polar and non polar dielectrics with examples. —— (3)

clausius - Mossotti equation

Dipole moment / unit volume = $N\mu$

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

$$P = N\alpha_e E_i \qquad E = \frac{P}{\varepsilon_0(\varepsilon_r - 1)} \quad \text{—(1)}$$

08

$$E_i = E + rP/\varepsilon_0 \quad \text{—— (1)}$$

$$\frac{1}{N\alpha_e} = \frac{1}{\varepsilon_0}\left[\frac{1}{(\varepsilon_r - 1)} + r\right] \quad \text{—(1)}$$

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

10.c) Given data:-

$\sigma_i = 0.47\ \Omega m$, $\mu_e = 0.38\ m^2/Vs$ ——— (1)

$\mu_h = 0.18\ m^2/Vs$.

04.

To find out :- $n_i = ?$

$$n_i = \frac{1}{\rho_i e(\mu_e + \mu_h)} \quad \text{——— (1)}$$

$$= \frac{1}{0.47\ (1.602 \times 10^{-19})\ (0.38 + 0.18)} \quad \text{——— (1)}$$

$$= 2.3716 \times 10^{19}\ /m^3 \quad \text{——— (1)}$$

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