

Time: (03) hours

Total Marks: 100

N.B. (i) Question No.1 is compulsory.

(ii) Attempt any FOUR questions from remaining six questions.

(iii) Figures to the right indicate full marks.

- Q.1 (a) Prove that 3

$$\int_0^{\infty} \frac{x^8(1-x^6)}{(1+x)^{24}} dx = 0$$
- (b) Solve 3

$$\frac{d^3 y}{dx^3} + 4 \frac{d^2 y}{dx^2} + \frac{dy}{dx} - 6y = 0$$
- (c) Evaluate 3

$$\int_0^1 \int_0^1 \int_0^1 yz + zx + xy \, dx \, dy \, dz$$
- (d) Evaluate 3

$$\int_0^1 \int_0^x e^{y/x} \, dy \, dx$$
- (e) Solve $(4x + 3y - 4)dx + (3x - 7y - 3)dy = 0$ 4
- (f) Using Euler's method find the approximate value of y where 4
 $\frac{dy}{dx} = x - y$, $y(0) = 1$ at $x = 1$ taking $h = 0.2$
- Q.2 (a) Evaluate 6

$$\int_0^1 \int_0^{\sqrt{1-y^2}} (x^2 + y^2) \, dx \, dy$$
- (b) Evaluate $\iiint (x^2 + y^2 + z^2) \, dx \, dy \, dz$ over the first octant of the sphere 6
 $x^2 + y^2 + z^2 = a^2$
- (c) Evaluate 8

$$\int_0^1 \frac{x^a - 1}{\log x} \, dx = \log(1+a) \quad a \geq 0$$
 Hence evaluate $\int_0^1 \frac{x^7 - 1}{\log x} \, dx$

- Q.3 (a) Solve 6

$$(x^2y - 2xy^2) dx - (x^3 - 3x^2y) dy = 0$$
- (b) Find by double integration the mass of a thin plate bounded by 6
 $y^2 = x$ and $y = x^3$ if the density of any point varies as the square of its distance from the origin
- (c) Solve 8

$$\frac{d^2y}{dx^2} - 4\frac{dy}{dx} + 3y = (x^2e^x)^2$$
- Q.4 (a) Solve 6

$$\frac{dy}{dx} + \frac{2x}{(x^2+1)} y = \frac{1}{(x^2+1)^2}$$
- (b) Change the order of integration and evaluate 6

$$\int_0^5 \int_{2-x}^{2+x} dy dx$$
- (c) Using Taylor's series method solve 8
 $\frac{dy}{dx} = x^2 - y$, with $x_0 = 0, y_0 = 1$. Find y when $x = 0.1$
- Q.5 (a) Find the length of the cardioid $r = a(1 + \cos\theta)$ 6
- (b) Find the volume of the solid that lies under the plane $3x + 2y + z = 12$ and 6
above the rectangle $R = \{(x, y) | 0 \leq x \leq 1, -2 \leq y \leq 3\}$
- (c) Solve numerically (using Runge - Kutta Method of Fourth order) the 8
differential equation $\frac{dy}{dx} = xy$ with initial conditions $y(1) = 2$ and find y at
 $x = 1.2, 1.4$

Q.6 (a) Evaluate

6

$$\int_0^1 x^6 \sqrt{1-x^2} dx$$

(b) Evaluate

6

$\iint_R x(x-y) dx dy$ where R is a triangle whose vertices are $(0, 0)$, $(1, 2)$ and $(0, 4)$

(c) Solve $(D^2 - 1)y = \frac{2}{\sqrt{1-e^{-2x}}}$ by method of variation of parameter

8

Q.7 (a) Evaluate

6

$$\int_0^4 \sqrt{x} (4-x)^{3/2} dx$$

(b) Evaluate

6

$\iint r^3 dr d\theta$ over the area included between the circles $r = 2 \sin \theta$ and $r = 4 \sin \theta$

(c) The charge q on the plate of a condenser of capacity C charged through a resistance R by a steady voltage V satisfies the differential equation

8

$R \frac{dq}{dt} + \frac{q}{C} = V$. If $q = 0$ at $t = 0$, show that $q = CV(1 - e^{-t/RC})$. Find also

the current flowing into the plate.

[OLD COURSE]

(2 Hours)

[Total Marks : 75

- N.B. :** (1) Question No. 1 is Compulsory.
(2) Attempt **any four** questions from Q. No. 2 to 7.
(3) Figures to the **right** indicate **full** marks.
(4) Assume suitable data wherever required.

1. Solve **any five** from the following.

15

- Define diffraction of light. Why is it not evident in daily life?
- What is population inversion? Why is it necessary for lasing?
- Explain why Newton's rings are circular with a dark centre.
- What is the physical significance of the wave function Ψ of matter wave?
- A step index fibre in air has N.A of 0.16, a core n₁ of 1.45 and a core diameter of 60 μ m. Determine the normalized frequency for the fibre when light of wavelength of 0.9 μ m is transmitted.
- What is magnetic circuit? Define magneto-motive force and reluctance.
- Calculate the velocity and de-Broglie wavelength of α -particle of energy 1 keV. (Given: mass of α -particle = 6.68×10^{-27} kg.)

2. (a) By using time independent Schrodinger's wave equation, prove that, the energy levels of a particle in one dimensional box are quantized where as for free particle energy is continuous.

8

(b) A plane transmission grating having 6000 lines/cm is used to obtain a spectrum of light from a sodium lamp in the second order. Calculate the angular separation between the two sodium lines whose wavelengths are 5890 \AA and 5896 \AA .

7

3. (a) Explain division of amplitude in a thin film. Obtain the condition for maxima and minima for interference in a thin parallel film in reflected light.

8

(b) Explain the refractive index profile of step index and graded index fibres. The refractive index of core and cladding for SI fibres are 1.52 and 1.41 respectively. Calculate i) critical angle ii) N.A. iii) the maximum incidence angle.

7

[TURN OVER]

4. (a) Two plane glass surfaces in contact along one edge are separated at the opposite edge by a thin wire. If 20 interference fringes are observed between these edges in sodium light at normal incidence. What is the thickness of the wire? (Given $\lambda=5893 \text{ \AA}$) 5
- (b) Show that electron cannot pre-exist in free state in a nucleus using Uncertainty principle. 5
- (c) Describe the construction and working of semiconductor laser. Write its importance? 5
5. (a) A magnetizing field of 1600 A/m produces a magnetic flux of $2.4 \times 10^{-5} \text{ wb}$ in an iron bar of cross sectional area 0.2 cm^2 . Calculate permeability and susceptibility of the bar. 5
- (b) Derive an expression for the Numerical Aperture of a step index fibre. 5
- (c) Derive the condition for absent spectra in grating. 5
6. (a) Explain the construction and working of scanning electron microscope. 5
- (b) Discuss Weiss theory of ferromagnetism and derive Curie-Weiss law. 5
- (c) What is Rayleigh criterion of resolution? Define resolving power of a grating. 5
7. (a) Explain the working principle of a pirani gauge. 5
- (b) Write a short note on Holography as an application of laser. 5
- (c) Sketch the hysteresis loop and explain the terms retentivity, coercivity, magnetization and magnetic susceptibility. 5

(2 Hours)

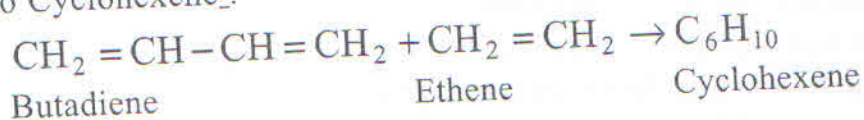
[Total Marks : 75

- N.B. :** (1) Question No. 1 is compulsory.
 (2) Attempt **any four** questions out of remaining six.
 (3) **Figures** to the **right** indicates **full** marks.
 (4) Atomic weights : C=12, H=1, N=14, O=16, Na =23, mg =24, S=32,
 Cl = 35.5, Ca=40, Ba= 137.5

1. Answer **any five** from the following :- 15
- Define fuels. Classify fuels with suitable examples.
 - What is corrosion? List the various types of corrosion.
 - Give composition, properties and uses of Gun metal.
 - Write the classification of composite materials.
 - Write a short note on green fuel.
 - What is catalyst? Give the various types with examples.
 - 0.5 g of coal sample was burnt in Bomb calorimeter produced 0.07 g of BaSO_4 . Calculate % of S in the sample.
2. (a) What are metallic coatings? Distinguish between galvanizing and tinning. 6
- (b) A sample of coal has the following composition by weight 5
 C= 70%, O = 20%, H = 8% S=0.8%
 N=0.2% Ash = remaining Calculate the GCV and NCV of the coal by using Dulong's formula.
- (c) Distinguish between brasses and bronzes. 4
3. (a) The composition of gas was found to be: 6
 $\text{H}_2 = 10\%$, $\text{CH}_4 = 16\%$, $\text{C}_2\text{H}_6 = 20\%$, $\text{CO} = 22\%$
 $\text{CO}_2 = 18\%$ $\text{N}_2 = 6\%$ and $\text{O}_2 = 8\%$ Calculate the Volume of O_2 and air required for complete combustion of 8m^3 of this gas.
- (b) Define paints. Explain the various constitutions of paints with their functions.
- (c) Explain the effect of following alloying elements on steel. 5
- | | | | | |
|--------|---------|----------|---------|---|
| (i) Ni | (ii) Mo | (iii) Cr | (iv) W. | 4 |
|--------|---------|----------|---------|---|
4. (a) What is cracking? With a schematic diagram, explain **any one** method of catalytic cracking. 6
- (b) Explain structural composites. 5

[TURN OVER]

- (c) Calculate the percentage atom economy for the following reaction w.r.to Cyclohexene. 4



5. (a) Define catalysis. Explain the adsorption theory of heterogeneous catalysis. 6
- (b) Explain concentration cell corrosion with the help of suitable example. 5
- (c) Write a note on 4
- (i) Atomization (ii) Sintering
- 6 (a) Explain the traditional and Greener route for production of Indigo dye. Highlight the green chemistry principle involved. 6
- (b) Answer the following :- 5
- (i) Give the compositions, properties and uses of German silver
- (ii) What are the characteristics of a good fuel? 4
- (c) How do the following factors affect the rate of corrosion.
- (i) Position of metal in galvanic series.
- (ii) Relative areas of anodic and cathodic parts. 6
7. (a) How does catalyst affect the establishment of equilibrium state and activation energy of a reaction? Explain with necessary graph. 5
- (b) What are the fiber reinforced composites? Give their types. 4
- (c) Define octane and cetane number. Give their significance.
