

**B.E. CHEMICAL ENGINEERING
FIRST YEAR
FIRST SEMESTER EXAMINATION 2019 (OLD)**

Subject: PHYSICS

Time: Three Hours

Full Marks: 100

Answer any *five* questions.

1. (a) Find the value of a for which the vector $\vec{A} = (axy - z^3)\hat{i} - (a - 2)x^2\hat{j} + (1 - a)xz^2\hat{k}$ is irrotational?

(b) Show that for conservative force work done is path independent.

(c) Prove that $\vec{F} = (y^2 \cos x + z^3)\hat{i} + (2y \sin x - 4)\hat{j} + (3xz^2 + 2)\hat{k}$ is a conservative force field. Find the corresponding scalar potential.

(d) Prove that $\nabla \cdot (\nabla \times \mathbf{A}) = 0$. [5+4+(4+4)+3=20]

2. (a) Explain with example what do you mean by gradient, divergence and curl? What is the physical significance of gradient of a scalar field?

(b) Find the unit vectors normal to the surface $x^2(yz+1) + yzx^3 - 3xyz = 4$.

(c) Prove that $\vec{\nabla} \cdot \left(\frac{\vec{r}}{r^3} \right) = 0$ [(6+4)+5+5=20]

3. (a) Discuss the experimental setup for the formation of Newton's rings. Why do you expect concentric circular rings in the interference pattern? Discuss the theory of the Newton's ring experiment to estimate the wavelength of the light. Why the central spot of the Newton's ring for the interference between reflected rays is dark?

(b) In a Newton's ring experiment the diameter of the 15th dark ring was 0.590 cm and that of the 5th ring was 0.326 cm. If the radius of the Plano-convex lens is 120 cm, calculate the wavelength of the light used. [(4+4 +5+2)+5=20]

4. (a) What is polarization of light? Explain the term "plane of polarization" and "plane of vibration". Describe the phenomenon of double refraction.

(b) What do you mean by absent spectra of a grating. Show that in a diffraction grating with grating element 1.5×10^{-6} m and light of wavelength 500 nm, the third and higher order principal maxima are not visible.

(c) Find the half angular width of the central bright maximum in the Fraunhofer diffraction when a slit of width 120 μm is illuminated by a light of wavelength 6000 Å.

[(2+2+4)+(2+5)+5]

5. (a) What do you understand by quassistatic process? Give examples.
- (b) Using the first law of thermodynamics prove that $C_p - C_v = R$, where the symbols carry their usual meanings.
- (c) A motor car tyre has a pressure of 2 atmospheres at the room temperature of 27°C . If the tyre suddenly bursts, find the resulting temperature.
- (d) Discuss the significance of the first law of thermodynamics.

[4+8+5+3=20]

6. (a) Explain the concept of entropy. Show that the change in entropy of a substance in a cyclic process is zero.
- (b) Show how second law of thermodynamics enables us to define a scale of temperature independent of the properties of any working substance.
- (c) A Carnot engine whose low temperature reservoir is at 7°C has an efficiency of 50%. It is desired to increase the efficiency to 70%. By how many degrees should the temperature of the high temperature reservoir be increased?

[(3+5)+7+5=20]

7. (a) Discuss the different forms of energy possessed by a liquid in motion. What is Reynold's number and explain its significance.
- (b) State and deduce Stoke's law of viscosity.
- (c) Two equal drops of water (Surface tension T) each of radius r , are falling through air (viscosity η) with a steady velocity v . If the two drops coalesce to form a bigger drop, (i) compute the energy released and (ii) find the new velocity of fall.
- (d) What are the necessary corrections to be considered during the measurement of viscosity of a liquid by Poiseuilles method?

[(3+2)+ (1+6)+5+3=20]

8. (a) What are characteristics of de Broglie matter waves?
- (b) Calculate the de Broglie wavelength for an electron.
- (c) State and explain Heisenberg's uncertainty principle. An electron has a speed of 600 m/s with an accuracy of 0.005%. Calculate the certainty with which we can locate the position of the electron. [$h = 6.625 \times 10^{-34}$ Joule. s and mass of electron is 9.1×10^{-31} kg]
- (d) What is the physical significance of wave function? Write down the 1-D Schrodinger time-independent equation for particle of mass m moving inside a 1-D infinite potential well.
- (e) Prove that the particle velocity (v) is the same as the group velocity.

[2+4+ (2+4)+(2+1)+5 =20]

9. (a) Deduce an expression for the average kinetic energy of a particle executing simple harmonic oscillation.

(b) A spring whose force constant is 80 N/m , hangs vertically supporting a 1 kg mass at rest. Find the distance by which the mass should be pulled down so that on being released it may pass the equilibrium position with a velocity of 1 m/s .

(c) Show that a uniform circular motion is equivalent to two simple harmonic motions at right angles to each other.

(d) What is damped vibration?

[5+5+8+2=20]