

BACHELOR OF CHEMICAL ENGINEERING EXAMINATION 2018
1st YEAR, 1st SEMESTER

Subject: PHYSICS**Time: Three Hours****Full Marks: 100**

Answer any **five** questions.

1. (a) What is the significance of gradient of a scalar field Φ .
 (b) Find a unit vector which is perpendicular to the surface of the paraboloid of revolution, $z = x^2 + y^2$ at the point (1, 2, 5).
 (c) From conservation of energy, show that for conservative force field $\mathbf{F} = -\nabla\Phi$ and $\nabla \times \mathbf{F} = 0$.
(5+ 5+10)
2. (a) For what value of a will the vector $\mathbf{A} = (axy - z^3)\hat{i} - (a - 2)x^2\hat{j} + (1 - a)xz^2\hat{k}$ is irrotational?
 (b) For $\Phi = 2x^3y^2z^4$, find $\nabla \cdot \nabla\Phi$
 (c) If $\mathbf{A} = x^2y\hat{i} - 2xz\hat{j} + 2yz\hat{k}$, find curl (curl \mathbf{A})
 (d) Prove that $\nabla \cdot (\Phi\mathbf{A}) = (\nabla\Phi) \cdot \mathbf{A} + \Phi (\nabla \cdot \mathbf{A})$
(5+ 5+5 + 5)
3. (a) Describe the Young's Double Slit experiment for interference. Find out the expression for the fringe width of the interference pattern produced by the double slit.
 (b) Young's experiment is performed with light of wavelength 5815 Å. If the fringes are measured with a micrometer eyepiece at a distance 100 cm from the double slit, it is found that 25 of them occupy a distance of 12.87 mm between centers. Find the distance between the centers of the two slits.
 (c) What are the conditions for sustained interference?
(10+5+ 5)
4. (a) In a Newton's ring experiment the diameter of the 10th bright ring changes from 1.40 cm to 1.27 cm. When a liquid is introduced between the lens and the plate. Calculate the refractive index of the liquid.
 (b) Derive an expression for the intensity at a point in the Fraunhofer type of diffraction produced by a single slit illuminated by monochromatic light.
 (c) What is the highest order spectrum which may be seen with monochromatic light of wavelength 6000 Å by means of a diffraction grating with 5000 lines/cm.
(5+ 10+5)

5. (a) How do you explain by a quassistatic process? Give examples.
 (b) Deduce an expression for workdone for an adiabatic process.
 (c) Air is compressed adiabatically to half of its volume. Calculate the change of its temperature.
 (d) How do you explain the law of conservation of energy from the first law of thermodynamics?
 (4+5+6+5)

6. (a) Explain fully what do you understand by the entropy of a system. Show that the change in entropy of a substance in cyclic process is zero.
 (b) Show how the second law of thermodynamics enables us to define a scale of temperature independent of the properties of any working substance. How is the scale realized in practice?
 (c) A Carnot's engine is operated between two reservoirs at temperatures of 450 K and 350 K. If the engine receives 1000 calories of heat from the source in each cycle, calculate the amount of heat rejected to the sink in each cycle. Calculate also the efficiency of the engine and workdone by the engine in each cycle. (1 calorie = 4.2 Joules).

[(3+ 6)+(4+2)+5]

7. (a) Explain the different forms of energy when a liquid is in motion? In Fluid dynamics explain and deduce the equation of continuity.
 (b) Water flows through a horizontal pipe line of varying cross-section. At a point where the pressure of water is 0.05 m of Hg, the velocity of flow is 0.25 m/s. Calculate the pressure at another point where the velocity of flow is 0.4 m/s. Density of water = 10^3 kg/m^3 .
 (c) Define the coefficient of viscosity and derive its dimension.
 (d) Distinguish between streamline and turbulent motion. What is Reynold's number?
 (e) What corrections are actually needed during the determination of the coefficient of viscosity by Poiseuille's method?

[5+5+4+3+3]

8. (a) Deduce an expression for the total energy of a particle executing simple harmonic motion.
 (b) What is resonance and forced vibration?
 (c) Derive the equation of a one dimensional travelling wave and hence its solution.
 (d) What do you mean by group velocity and phase velocity?

[7+3+ 7+3]

9. (a) What are the assumptions for the kinetic theory of gases? Starting from the assumption deduce an expression for the pressure exerted by the gas molecules.
 (b) Write down the Maxwell's velocity distribution formula and explain the results graphically.
 (c) State the law of equipartition of energy.
 (d) At what Celsius temperature will the oxygen molecules have the same root mean square velocity as that of hydrogen molecules at -100°C ?

[(3+7)+4+2+4]