B.E. PRINTING ENGINEERING
FIRST YEAR
FIRST SEMESTER EXAM 2019 (Old)

PHYSICS – IC

Time: Three Hours Full Marks: 100

Answer any ***five*** questions.

1. (a) Explain the interference of light in a Young's double slit experiment and hence derive the expression for the fringe width. Are the fringes equally spaced?
(b) A 10 μm transparent plate when placed in the path of one of the interfering beams of a double slit experiment [λ= 5800 Å], the central fringe shifts by a distance equal to ten fringes. Calculate refractive index, μ of the plate.
(c) 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.

[(10+2)+4+4]

2. (a) What are X-rays? What is its wavelength range? Discuss the types of X-rays.
(b) State and deduce Bragg's law of X-rays diffraction.
(c) Find the shortest wavelength present in the radiation from an X-ray machine whose accelerating potential is 50,000 V? What is the corresponding frequency?
(d) The K_α line from molybdenum has a wavelength of 0.7078 Å. Calculate the wavelength of K_α line of copper. Atomic number of molybdenum = 42 and Atomic number of copper = 29.

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

3. a) Describe Carnot's cycle and find out its efficiency in terms of source and sink temperatures.
b) The efficiency of a Carnot engine is 1/6. If the temperature of the sink is decreased by 60 Kelvin, efficiency becomes 1/3. Find out the original temperatures of source and sink.

[14+6]

4. (a) State and prove Gauss's law in electrostatics. Derive Coulomb's law from Gauss law in case of a single point charge.
(b) Using Gauss law, find the electric field at a distance r from the centre of a uniformly charged sphere of radius R (for the cases r < R and r > R). Plot the variation of the electric field with distance.

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

(5) (a) Given a vector $\vec{A} = 3\hat{\imath} + 4\hat{\jmath} - 4\hat{k}$, find a unit vector $\hat{B}$ that lies in the XY plane and is perpendicular to $\vec{A}$. Find also a unit vector $\hat{C}$ that is perpendicular to both $\vec{A}$ and $\hat{B}$.

(5) (b) A particle moving on the 2-dimensional plane has its dynamics suitably described in terms of the polar coordinates: (r, θ). Find the expressions for the *radial* and the *tangential* components of the acceleration of the particle (in plane polar coordinates).

(5) (c). Define a *Central Force* and give a few examples. State some of its important properties, and in particular prove that for motion under a central force, the angular momentum is always conserved.

(5) (d). Define *work* done by a force. What do you mean by a *conservative* force. A point mass moves under the action of an external force $\vec{F}$. Write down the expression for the total work done in moving the mass along an arbitrary closed loop, and hence establish that if $\vec{F}$ is conservative, this work done is zero. [6 + 5 + 5 + 4]

(6). A particle of mass m is moving in 3-dimensions and its coordinates satisfy (at any time t): $x = x_0 + at^2$, $y = bt$, $z = ct^3$. Find the force $\vec{F}$ acting on it and its angular momentum $\vec{L}$ at any time t. Define *torque* $\vec{\Gamma}$ due to a force and hence establish the relationship connecting the three vectors $\vec{\Gamma}, \vec{F}$ & $\vec{L}$. Please also check this explicitly by considering the above example. [6 + 5 + 4 + 5]

(7) (a) A rigid body is undergoing pure rotation about an axis with angular velocity $\vec{\omega}$. Define its *Moment of Inertia* and explain how is ths *Moment of Inertia* related to the rotational kinetic energy of the body ? Consider a right circular cylinder (of mass M and) with radius R and length L. Find its moment of inertia about its principal axis (the axis running parallel to its length). [3 + 3 + 6]

(7) (b) The trajectory of a body undergoing simple harmonic motion in one dimension is given by: $x = A_0 \cos(\omega t + \phi)$. Obtain the expression for its total energy at any point of its trajectory, and show that it is constant. [8]