BANGLADESH UNIVERSITY OF PROFESSIONALS
Military Institute of Science and Technology
B.Sc. in Environmental, Water Resources and Coastal Engineering, Term Final (Fall) Examination 2021: Jan-Feb 2022
Student Group: 0 < Earned Credit Hours ≤ 36

Subject: PHY-101, Waves and Oscillations, Optics and Modern Physics

Time: 3.00 hours **Full Marks: 180**

INSTRUCTIONS:

a. Use **SEPARATE** answer scripts for each section.
b. **Question-1** in **Section-A** and **Question-5** in **Section-B** are compulsory
c. Answer any other **TWO** questions out of **THREE** from each section.
d. Figures in the margin indicate **full marks**.
e. Assume reasonable data if necessary.
f. **Symbols** and **abbreviations** used have their usual meanings.

SECTION-A

Question 1 (Compulsory)

a. What is aberration? Distinguish between pin-cushion and barrel shaped distortion with necessary diagram. **10**

b. "The axial chromatic aberration for a thin lens (for an object at infinity) depends on the dispersive power of the material of the lens and the mean focal length." Explain this statement. **14**

c. Two glasses have dispersive powers in the ratio 1:2. These glasses are to be used in the manufacture of an achromatic objective of focal length 10 cm. What are the focal lengths of the lenses? **6**

Question 2

a. Consider a body oscillates with an angular frequency ω by a constant driving force. Clarify this phenomenon and establish a second order differential equation followed by this body. **10**

b. Starting from second order differential equation find out the complete solution for a body oscillating with an angular frequency ω by a constant driving force. **14**

c. A particle performs simple harmonic motion is given by the equation $y = 20\ \mathrm{Sin}(\omega t+\delta)$, if the time period is 30 sec and the particle has a displacement of 10 cm at $t = 0$,
Find: (i) Epoch, (ii) The phase angle at $t = 5$ sec and
(iii) The phase difference between two positions of the particle 15 seconds apart. **6**

Question 3

a. Explain the interference of light with the help of Young's double slit experiment. **8**

b. Discuss the formation of Newton's ring by reflected light and derive the expressions for the radius of the n^{th} bright and dark ring in case of reflected light. **16**

c. Newton's ring is observed in reflected light of $\lambda = 5.9\times10^{-5}$ cm. The diameter of the 10^{th} dark ring is 0.5 cm. Find the radius of curvature of the lens and the thickness of the air film. **6**

Question 4

a. State Brewster's law and hence prove that reflected rays and refracted rays are perpendicular to each other.

b. What do you mean by resolving power of a microscope? Derive an expression for the resolving power of a microscope.

c. Calculate the specific rotation of the given sample of sugar solution if the plane of polarization is turned through 13.2°. The length of the tube containing 10% sugar solution is 20 cm.

SECTION-B

Question 5 (Compulsory)

a. Distinguish between simple and compound pendulum

b. A body of mass m oscillates back and forth from its mean position obtaining Hooke's law. Show that the displacement equation for the path is sinusoidal.

c. The motion of a particle in simple harmonic motion is given by $y = A \sin\omega t$. If it has a speed u_1 when the displacement is y_1 and speed u_2 when the displacement is y_2, show that the amplitude of the motion is,

$$A = \sqrt{\frac{u_2^2 y_1^2 - u_1^2 y_2^2}{u_2^2 - u_1^2}}.$$

Question 6

a. Define wave motion. Distinguish between transverse and longitudinal wave.

b. Discuss the formation of standing wave hence derive the equation of standing wave to find out the conditions of nodes and antinodes.

c. Show that for a plane progressive wave,

(i) $\frac{d^2y}{dt^2} = v^2 \frac{d^2y}{dx^2}$

(ii) $\frac{dy}{dt} = -v \frac{dy}{dx}$

Question 7

a. What do you understand by length contraction? Establish a relation between total energy and momentum hence find out energy for a photon.

b. Write a short note on Compton effect and derive an expression for the change in wavelength in Compton effect.

c. X-rays of wavelength 15 pm are scattered from a target. Find:
(i) The wavelengths of X-rays through 50° and
(ii) The maximum wavelength present in the scattered X-rays.

Question 8

a. Define: Mass defect. Derive an expression of binding energy from the idea of mass defect.

b. Why mean life of a radioactive element is required to calculate? Show that the mean life of a radioactive element is reciprocal of decay constant.

c. What is nuclear reaction? Discuss the working principle of a nuclear power reactor.