M.Sc. PHYSICS
THIRD SEMESTER
NONLINEAR & FIBER OPTICS-I
MSP - 303C
[USE OMR FOR OBJECTIVE PART]

SET
A

Duration: 1:30 hrs.

Full Marks: 35

(**Objective**)

Time: 15 mins.

Marks: 10

Choose the correct answer from the following:

1×10=10

1. Which effect is observed when a material's refractive index changes with light intensity?
   a. Kerr effect
   b. Faraday effect
   c. Photoelectric effect
   d. Doppler effect

2. In the first experiment on nonlinear optics, what was produced by the application of a Ruby laser?
   a. Frequency modulation
   b. Second harmonic generation
   c. Raman scattering
   d. Soliton waves

3. Which of the following processes is NOT a typical nonlinear optical phenomenon?
   a. Second harmonic generation (SHG)
   b. Sum frequency generation (SFG)
   c. Fluorescence
   d. Four-wave mixing (FWM)

4. The electric field strength of conventional light sources can go up to
   a. $E \sim 10^3 \, V/cm$
   b. $E \sim 10^7 \, V/cm$
   c. $E \sim 10^{11} \, V/cm$
   d. $E \sim 10^{15} \, V/cm$

5. For efficient frequency doubling, the necessary phase matching condition is
   a. $\Delta k_1 = 0$
   b. $\Delta k_2 = 0$
   c. $k_2 - 2k_1 = 0$
   d. $k_1 - 2k_2 = 0$

6. In pre-laser era, what is considered for the energy of a photon proportional to?
   a. Its frequency
   b. Its voltage
   c. Its speed
   d. Its amplitude

7. In a nonlinear medium, self-focusing occurs due to
   a. Dispersion dominating over nonlinearity
   b. Decrease in intensity of the laser beam
   c. Light-induced change in the medium's refractive index
   d. Uniform propagation of light without any change

1

8. Which among the following material is preferred for making the core of optical fiber?
   a. Air
   b. Diamond
   c. Glass
   d. Quartz

9. Which of the following loss occurs inside the fibre?
   a. Radiative loss
   b. Scattering
   c. Absorption
   d. Attenuation

10. Which among the following is described by the concept of numerical aperture in an optical fibre?
    a. Light collection
    b. Light scattering
    c. Light dispersion
    d. Light polarization

-- --- --

(__Descriptive__)

[Answer question no.1 & any two (2) from the rest]

1. Explain the concept of a multi-photon process. Demonstrate mathematically how the threshold frequency is reduced in the case of the multi-quantum photoelectric effect by a factor corresponding to the number of photons involved.
   1+4=5

2. Describe the processes of sum frequency generation (SFG) and difference frequency generation (DFG). Highlight the key applications of SFG and DFG.
   5+5=10

3. Discuss the phenomenon of self-focusing of light. Derive the expression that relates the nonlinear refractive index of a medium to the intensity of the incident light.
   2+8=10

4. Discuss briefly the three-photon process. Establish the 'wave synchronism' condition in terms of refractive indices η, for efficient transfer of light in second harmonic generation (SHG).
   10

5. Explain the principle of light transmission in optical fibers. Discuss the differences between single-mode and multi-mode fibers, and provide examples of their typical applications.
   2+4+4 =10

$$= = *** = =$$