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:

$1 \times 10 = 10$

1. Linear refractive index of a medium relates to its linear susceptibility via

   a. $n = 1 + \chi$
   b. $n^2 = 1 - \chi$
   c. $n = \sqrt{1 + \chi}$
   d. $n^2 = \sqrt{1 - \chi}$

2. In the first experiment on nonlinear optics, _____ was produced by the application of a Ruby laser.

   a. an UV light
   b. an X-ray
   c. an IR light
   d. a γ-ray

3. 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. $E \sim 10^{15} \, V/cm$

4. 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. $k_1 - 2k_2 = 0$

5. 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

6. Parametric amplification can be used to convert a ___ frequency to a ___ frequency optical pulse.

   a. low, low
   b. high, high
   c. low, high
   d. high, low

7. If a two-photon process leads to second-harmonic generation (SHG) the refracting indices of the pumping and the secondary waves will be related by

   a. $n_p(\omega) = 2n_s(2\omega)$
   b. $n_p(\omega) = n_s(2\omega)$
   c. $n_p(\omega) = \frac{n_s}{2}(2\omega)$
   d. $n_p(\omega) = n_s^2(2\omega)$

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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

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(**Descriptive**)

Time : 1 hr. 15 mins.   Marks : 25

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

1. What do you mean by multi-photon process? Show that in   1+4=5
   multi-quantum photoelectric effect the threshold frequency
   lowers by a factor of number of photons.

2. Discuss the sum frequency generation (SFG) and different   5+5=10
   frequency generation (DFG) processes. Give applications of the
   SFG and DFG process.

3. Explain self focusing of light and derive the relation how   2+8=10
   nonlinear refractive index of a medium is related to intensity of
   light.

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

5. a. What is the basic principle of optical fiber in the transmission   1+4+1+4
      of optical signals?   =10
   b. Show schematically the construction of optical fiber and
      discuss the parts.
   c. What do you understand by Fiber Loss? A fiber of 100 m
      length has P_{in}= 10 μW and P_{out} = 9 μW. Find the loss in
      dB/km.

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