M.Sc. 3rd Semester Examination, 2021

PHYSICS

Course Title: Laser Physics and Nonlinear Optics-II

Course Code: 304ME(B)

Course ID: 32454

Time: 2 Hours **Full Marks: 40**

The figures in the right hand side margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

1. Answer *any five* questions: 2x5=10

(a) What is Nominal Hazard Zone?

(b) How sum frequency generation technique can be used to generate a frequency-tunable visible laser?

(c) Define stimulated Raman scattering.

(d) State and explain the physical significance of Miller's rule.

(e) What is the temperature tuning phase matching process? Give an example of a material which is suitable for temperature tuning phase matching process.

(f) Define third-order nonlinear process. Give an example.

(g) Give two examples of birefringent crystal.

2. Answer *any four* questions: 5x4=20

a) Discuss the effect of nonlinear coefficient in third order nonlinear interaction. 5

b) Derive and explain the number of output frequency components when three input waves having frequencies ω_1, ω_2 and ω_3 pass through a third-order nonlinear medium. 5

c) Discuss the Kleinman's symmetry condition? 5

d) Discuss birefringence phase matching. 5

e) What are the positive and negative uniaxial crystals? Discuss the Type I and Type II phase matching conditions for the positive and negative uniaxial crystals. 1+4=5

f) A laser beam of frequency ω carrying 1 W of power is focused to a spot size of 30-μm diameter in a crystal having a refractive index of n = 2 and a second-order susceptibility of $\chi(2) = 4\times10\text{^}11$ m/V. Calculate numerically the amplitude P(2ω) of the component of the nonlinear polarization oscillating at frequency 2ω. 5

3. Answer *any one* question: 10x1=10

a) What is quasi-phase-matching (QPM) technique? Derive the generated field amplitude under QPM for sum-frequency generation in a $\chi^{(2)}$ type medium. Hence calculate the coherent length under third-order QPM. 2+5+3=10

b) Using Maxwell's equation derive the coupled amplitude equations for a three wave-mixing process in a second-order nonlinear media. Hence derive the Manley-Rowe relation. 7+3=10