Roll No. .....

(05/24)

15433

M.Sc. EXAMINATION

(For Batch 2021 & Onwards)

(Fourth Semester)

PHYSICS

MSc/Phy/4/SEC3(A)

Laser and Spectroscopy-II

Time : Three Hours *Maximum Marks : 70*

Note : Attempt *Five* questions in all, selecting *one* question from each Unit. Q. No. **1** is compulsory.

1. (a) Define efficiency of lasers. Give the various factors affecting efficiency.

   (b) Which pumping source is used for excitation in Dye laser and why ?

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(c) What is the cause of Spiking behaviour in Ruby laser ?

(d) What is meant by birefringence ? Explain.

(e) Give experimental arrangement of intra-cavity laser absorption spectroscopy.

2×5=10

Unit I

2. (a) Discuss gain saturation and amplification in an inhomogeneously broadened system. How single mode oscillations occur in such system ?

(b) What is Lamb dip ? What is its physical significance ? 10+5

3. (a) Write down the rate equations for three level laser systems. Derive the condition for threshold pump rate and pump power with suitable example.

(b) Explain the variation of laser power around threshold. 10+5

Unit II

4. With the help of energy level diagram for He-Ne laser, explain the prominent transitions occurring in the laser system. Also explain the following : 15

(a) The role of He in the laser.

(b) How reverse transfer of energy from Ne to He is controlled ?

(c) The output power is low.

(d) Why tube diameter is small ?

(e) The tube ends are kept at Brewster window

(f) A dispersive element is used in the cavity.

5. With the help of energy level diagram for Nd :YAG laser, explain the prominent transitions occurring in the laser system. Also explain the following : 15

(a) Give physical properties and laser structure of Nd :YAG.

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(b) Which splitting of energy levels is involved in the laser ?

(c) Which optical source is used for pumping the laser and why ?

(d) It can be used in cw and pulsed mode. How ?

(e) What are the important applications of laser ?

(f) How it is advantageous as compared to Ruby laser ?

Unit III

6. (a) Explain Index ellipsoid. How is it employed to achieve phase matching condition ?

(b) Discuss how phase matching condition for interacting waves is considered as momentum matching condition for interacting photons. 10+5

7. (a) Define Q-Switching. What are the necessary conditions for having Q-switching ? Also Deduce expression for the maximum power from a Q-switched pulsed laser.

(b) Explain with the help of experimental set up the methods for obtaining Q-switching using electro-optic and acousto-optic shutter. 10+5

Unit IV

8. (a) Write the Maxwell's equations in a non-linear dispersion-less and dispersive medium. What is the source term for EM radiation in each case ?

(b) Derive the condition for coherence length for observation of second harmonic generation. What are the materials which show SHG ? Give some examples. 8+7

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9. (a) What are the main features of Fluorescence Excitation Spectroscopy ? Give conditions for good relative intensities of different lines using FES. How the excitation spectrum can be recorded ?

(b) What are the various sources of noise affecting the High detection sensitivity ? How can these be overcome ? 10+5

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