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**B.TECH**  
**(SEM IV) THEORY EXAMINATION 2017-18**  
**LASER SYSTEMS & APPLICATIONS**

**Time: 3 Hours****Total Marks: 100****Note:** Attempt all Sections. If require any missing data; then choose suitably.**SECTION A**

- 1. Attempt all questions in brief. 2 x 10 = 20**
- a. What are the conditions fulfilled by wave function  $\psi$ ?
  - b. Write the hypothesis of Planck quantum theory of radiation?
  - c. What are the differences between spontaneous emission and induced emission of radiation?
  - d. With the help of suitable diagram prove that in a two level laser lasing is not possible.
  - e. Describe the essential characteristics of host material and dopants in the active medium of a solid state laser.
  - f. What is the role of axial magnetic field and return tube in an ionic laser?
  - g. What are the differences between CW and Pulsed lasers?
  - h. What is the reason of low efficiency of ionic lasers?
  - i. What is the role of laser in general surgery? Give examples of two lasers used in medical applications.
  - j. What are the differences between LIDAR and RADAR?

**SECTION B**

- 2. Attempt any three of the following: 10 x 3 = 30**
- a. Describe temporal and spatial coherence in detail. Derive an expression between coherence length and line width. The coherence length of light source is  $2.5 \times 10^{-20}$  m and its wavelength is  $5500\text{\AA}$ . Calculate i) Frequency ii) Coherence time.
  - b. Write laser rate equations for a three level laser and derive the condition of population inversion for it and explain its physical significance. Give an example of a practical three level laser.
  - c. Derive Einstein's relation between Einstein's coefficients and explain its physical significance. An atom has two atomic levels separated by 2.26 eV energy. At what temperature would the ratio  $(N_2/N_1)$  is half?
  - d. What are atomic, ionic and molecular laser systems? Describe how the medium is excited in ionic lasers. Explain the operation of Argon ion laser with suitable energy level diagram.
  - e. Write short note on a) Laser in material processing, b) Laser in optical fibre communication.

**SECTION C**

- 3. Attempt any one part of the following: 10 x 1 = 10**
- (a) Derive Schrodinger's time dependent wave equation and explain physical significance of wave function

- (b) What do you mean by population inversion? Describe various methods to achieve it. Prove that population inversion state is a negative temperature state.

**4. Attempt any *one* part of the following: 10 x 1 = 10**

- (a) Explain Heisenberg's uncertainty principle. Calculate the uncertainty in the position of a dust particle with mass equal to 1mg if uncertainty in its velocity is  $5.5 \times 10^{-20}$  m/s.
- (b) Describe the various configurations of optical cavities. What is the criteria of stability and draw the stability diagram.

**5. Attempt any *one* part of the following: 10 x 1 = 10**

- (a) Explain construction, working, energy level diagram and applications of Ruby laser. What is the reason of spiking in Ruby laser?
- (b) What do you mean by Q-switching and mode-locking in laser systems? Describe in detail various methods of Q-switching and mode-locking.

**6. Attempt any *one* part of the following: 10 x 1 = 10**

- (a) What are liquid lasers? Explain the working and principle of liquid lasers. How is tuning achieved in dye lasers?
- (b) What is excimer? Explain the excitation mechanism of excimer laser with suitable energy level diagram. Why this laser is known as self-illuminating laser?

**7. Attempt any *one* part of the following: 10 x 1 = 10**

- (a) Explain the principle of holography and discuss its applications. Describe construction and reconstruction of holograms.
- (b) Write short note on applications of laser in ophthalmology and dentistry.

**Physical Constants:**

Mass of electron :  $m_0 = 9.1 \times 10^{-31} \text{ kg}$

Speed of light :  $c = 3 \times 10^8 \text{ m/s}$

Planck's constant :  $h = 6.62 \times 10^{-34} \text{ J-s}$

Boltzmann's constant:  $k = 8.6 \times 10^{-5} \text{ eV/K}$