

B.TECH
(SEM IV) THEORY EXAMINATION 2018-19
LASER SYSTEMS AND APPLICATIONS

Time: 3 Hours

Total Marks: 70

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1. Attempt all questions in brief. 2 x 7 = 14

- a. What was Planck's revolutionary idea to explain black body radiation spectrum.
- b. What do you mean by quantum mechanical tunneling? Give example.
- c. Laser beam has a band width of 2500Hz. What are the values of coherence length and coherence time?
- d. Why population inversion state is known as a negative temperature state?
- e. What are metastable states? Explain their role to get laser action.
- f. Explain the role of nitrogen and helium gas in carbon dioxide laser.
- g. List the difference between holography and ordinary photography.

SECTION B

2. Attempt any three of the following: 7 x 3 = 21

- a. A particle is confined to move in a one dimensional infinite potential box of width 'a'. Write down Schrodinger's wave equation and solve it to find energy eigen values and eigen functions.
- b. Explain Einstein's A and B coefficients. Derive a relation between them and explain the significance of this equation.
- c. What do you mean by Q-switching? Describe various methods to achieve this.
- d. What are Neodymium lasers? Explain construction, working, energy level diagram and applications of Nd-YAG lasers.
- e. What is the difference between LIDAR and RADAR? Discuss its components and their role. Explain the principle of operation of LIDAR.

SECTION C

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

- (a) Explain spectral series of hydrogen atom with a suitable diagram. Calculate the series limit of all the series.
- (b) An electron is bound by a potential which closely approaches square well of width $2.5 \times 10^{-10} \text{m}$. Calculate the lowest three permissible quantum energies the electron can have.

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

- (a) What do you mean by coherence? Explain temporal and spatial coherence. Derive an expression for temporal and spatial coherence length.
- (b) Ruby laser has two states at 27°C . If it emits radiation of wavelength 7000\AA , then calculate relative population (N_2/N_1).

5. Attempt any *one* part of the following: 7 x 1 = 7
- Describe the essential components of a laser system with the help of suitable diagram. Describe various pumping mechanism used in different laser systems.
 - What do you mean by loop gain in a laser system? Derive an expression for loop gain. Describe the threshold condition for laser oscillation.
6. Attempt any *one* part of the following: 7 x 1 = 7
- Why excimer laser is known as self-illuminating laser? Explain the excitation mechanism of excimer laser with suitable energy level diagram. Give some output wavelengths of excimer laser.
 - Discuss the excitation mechanism of semiconductor diode laser. What is the difference between LED and LASER?
7. Attempt any *one* part of the following: 7 x 1 = 7
- Explain the principle of holography and discuss its applications. Describe construction and reconstruction of holograms.
 - Discuss the applications of lasers in material processing. What advantages are there in processing materials using lasers?

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

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

Rydberg's constant: $R_H = 1.0973 \times 10^7 \text{ m}^{-1}$

Wein's constant: $b = 0.2896 \times 10^{-2} \text{ mK}$