Tutorial Sheet-7, Physics-2 (15B11PH211), Even Semester 2019-20

1. Explain the following terms: (i) spontaneous emission, (ii) stimulated emission, (iii) meta-stable state, (iv) population inversion, and (v) optical pumping. **[CO1]**

2. **(a)** A certain ruby laser emits 1.00-J pulses of light whose wavelength is 694 nm. What is the minimum number of Cr^{3+} ions present in ruby laser? **(b)** In a Ruby laser, total number of Cr^{3+} ions is 2.8×10^{19}. If the laser emits radiation of wavelength 7000 Å. Calculate the energy of the laser pulse. **[Ans: (a) 3.5×10^{18} ions, (b) 7.94 J]** **[CO2]**

3. Find the ratio of populations of two states in a laser that produces light of wavelength 6328 Å at 27°C. **[Ans: 1.1×10^{-33}]** **[CO2]**

4. Find the ratio of spontaneous emission to stimulated emission for a cavity of temperature 50 K and wavelength is 10^{-5} m. **[Ans: 3.16×10^{12}]** **[CO2]**

5. A 10 *mW* laser has efficiency of 1%. Suppose all input energy is utilized in pumping atoms from the ground state to the excited state, which is 20 *eV* above the ground state. Find how many atoms are promoted to the excited state in one second. **[Ans: 3.12×10^{17}]** **[CO3]**

6. The coherence length of sodium light is 2.945×10^{-2} m and its wavelength is 5890 Å. Calculate **(i)** the frequency, **(ii)** the number of oscillations corresponding to the coherence length, and **(iii)** the coherence time. **[Ans: (i) 5.09×10^{14} Hz, (ii) 5×10^{4}, and (iii) 9.82×10^{-11} sec**.] **[CO3]**

7. The ruby laser has two states at 27°C and 227°C. If it emits radiation of wavelength 7000 Å, then calculate the ratio of relative population. **[Ans: 1.25×10^{-12}]** **[CO3]**

Constants: $h = 6.62\times10^{-34}$ J-s, $k = 1.38\times10^{-23}$ J/K = 8.61×10^{-5} eV/K.