Module 1 Unit 3

PRINCIPLES OF LASERS – NUMERICAL PROBLEMS

1. The argon laser produces a visible blue-green beam with wavelengths of 488 nm and 514 nm at an optical power output of 160 mW. Find the number of photons emitted per sec by the laser. The optical power share between blue and green spectral radiation is around 3:5.
2. A pulsed laser emits photons of wavelength 780 nm with average power of 20 mW/pulse. Calculate the number of photons in each pulse if the pulse duration is 10 ns.
3. A diode laser operates at 3.6 V and 130 mA current. If its optical power is 10 mW, calculate its efficiency.
4. Find the ratio of population of two energy states of an active medium emitted laser radiation at 694.3 nm at room temperature (27 °C). Comment on the result.
5. Show numerically that spontaneous emission dominates over stimulated emission at room temperature
6. The wavelength of laser emission is 6000 Å and the coefficient of spontaneous emission is 10^6/s. Determine the coefficient for the stimulated emission.
7. At what temperature are the rates of spontaneous and stimulated emission equal? Take λ = 5000 Å.
8. Find the peak emission wavelength at which, rates of spontaneous and stimulated emission are equal at room temperature.
9. The length of a laser tube is 15 cm and the gain factor of the laser material is 0.0005/cm. If one of the cavity mirrors reflects 100% light, what is the required reflectance of the other cavity mirror?
10. Find the limiting value of the overall loss factor in the laser cavity if the mirrors are 100% and 98.9% reflecting and length of the cavity is 10 cm. Overall gain factor is 5.34 x 10^{-4}/cm

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Homework:

1. In He-Ne laser, the transition between 5s to 3p levels of Ne atoms leads to principal laser emission at 632.8 nm. Determine how much eV the 5s state is above the 3p state,
2. Light from a 5 mW laser diode falling on a screen has beam diameter of 5 mm. find the intensity of light on the screen.
3. Waist diameter (beam diameter at the output of a laser source) of a 2 mW laser beam is 1 mm. Determine intensity of laser on a screen held at 80 cm from the source.
4. Find the relative populations of the two states in a Ruby laser that produces a light beam of wavelength 6943 A at 1000 K
5. The energy band gap of the compound semiconductor aluminium gallium arsenide (AlGaAs) is given by the equation $\mathrm{E_g(Al_xGa_{1-x}As)} = 1.422 + 1.2475\mathrm{x}$. Find the wavelength of radiation emitted from AlGaAs laser diode for x = 40%. Will this radiation be visible to eyes? Which colour?

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