

**Tutorial Sheet-6**  
**[Laser Technology and Applications, 16BINPH533, Odd Semester 2020]**

1. [CO 4] Consider a typical cavity of He-Ne laser with the following specifications:  
 $L = 20\text{cm}, n_0 = 1, R_1 = 1, R_2 = 0.98, \alpha_{\text{eff}} \approx 0$ . For such a cavity, calculate cavity lifetime, FWHM of the spectrum and the frequency separation between adjacent longitudinal modes. [Ans: 66.7 ns, 2.4 MHz & 750 MHz]
2. [CO 4] For a cavity of GaAs semiconductor laser with the following values of various parameters:  
 $L = 500\mu\text{m}, n_0 = 3.5, R_1 = 0.3, R_2 = 0.3, \alpha_{\text{eff}} \approx 0$ , calculate cavity lifetime and FWHM of the spectrum. [Ans: 4.86 ps &  $3.3 \times 10^{10}$  Hz]
3. [CO 4] The half-width of the gain profile of a He-Ne laser material is about 0.002 nm. What should be the maximum length of the cavity in order to have a single longitudinal mode oscillation? [Ans: 10 cm]
4. [CO 4] The half-width of the gain profile of a He-Ne laser material is about  $2 \times 10^{-3}$  nm. If the length of the cavity is 30 cm, how many longitudinal modes can be excited? The emission wavelength of He-Ne laser is 632.8 nm. [Ans: 3]
5. [CO 3] Determine whether or not the following mirror arrangements lead to stability:
  - (a) Two mirrors with radii of curvature of 1.8 m, separated by a distance of 2 m.
  - (b) One mirror with radius of curvature of 2 m and the other with radius 3 m, separated by a distance of 2.3 m.
  - (c) One mirror with radius of curvature 5 m and the other with radius 3 m, separated by a distance of 4 m.
  - (d) Two mirrors with radius of curvature of 0.5 m, separated by a distance of 0.5 m.
6. [CO 4] A laser cavity consists of two mirrors separated by a distance of 10 cm in air. The laser beam has a central frequency of  $6 \times 10^{14}$  Hz and two frequencies on either side of the central frequency. Calculate the frequency spacing between the longitudinal modes and the corresponding mode numbers. [Ans: 1500 MHz]
7. [CO 1] Explain (a) line broadening, (b) natural broadening and (c) collision broadening of a spectral line.