

**ECE 170A Midterm Exam**

Name: [REDACTED]

UID: [REDACTED]

1. **Diverging laser beam** Consider a H<sub>2</sub>-Ne laser beam at 633 nm with a spot size of 1 mm. Assuming a Gaussian beam, what is the divergence of the beam? What are Rayleigh range and the beam width at 25 m?

[REDACTED]

2. **Refractive index** Using the Sellmeire coefficient for diamond, calculate its refractive index at 610 nm (red light)

[REDACTED]

3. **Complex refractive index** Measurements on a germanium crystal at a photon energy of 1.5 eV show that the real and imaginary parts of the complex refractive permittivity are 21.56 and 2.772 respectively. Find the complex refractive index. What is the reflectance and absorption coefficient at this wavelength? How do your calculations match with the experimental values of  $n = 4.653$  and  $K = 0.298$ ,  $R = 0.419$  and  $\alpha = 4.53 \times 10^{-6} \text{ m}^{-1}$

[REDACTED]

4. **Fabry-Perot optical cavity from a ruby crystal** Consider a ruby crystal of diameter 2 cm and length 10 cm. The refractive index is 1. The ends have been silvered and intensity reflectance is 0.95. What is the wavelength of the mode closest to 694.3 nm? What is the mode separation in frequency and wavelength? What are the finesse  $F$  and  $Q$ -factors for the cavity?

[REDACTED]

5. **A multimode fiber** Consider a multimode fiber with a core diameter of 100  $\mu\text{m}$ , core refractive index of 1.4750, and a cladding refractive index of 1.4550 both at 850 nm. Consider operating this fiber at  $\lambda = 850 \text{ nm}$ .

- (a) Calculate the V-number for the fiber and estimate the number of modes.
  - (b) Calculate the wavelength beyond which the fiber becomes single mode
  - (c) Calculate the numerical aperture
  - (d) Calculate the maximum acceptance angle
- [REDACTED]