NAVAL POSTGRADUATE SCHOOL
Monterey, California

EC 3210 FINAL EXAM 12/99 Prof. Powers

- This exam is open book and notes.
- There are four problems; each is equally weighted.
- Partial credit will be given; be sure to do some work on each problem.
- Be sure to include units in your answers.
- Please circle or underline your answers.
- Do *NOT* do any work on this sheet.
- Show *ALL* work.
- Enter your name in the space provided.
- Exams and course grades *should* be available outside the Optical Electronics Laboratory (Bu 224) on **Friday afternoon, 17 December**.
- Have a good holiday season and enjoy your break!

Course grade: _____

| | | | |
|---|---|---|---|
| 1 | | 2 | |
| 3 | | 4 | |
| **TOTAL** | | | |

Name: _____

1. An experiment is performed with a Michelson interferometer and a HeNe laser operating at 632.8 nm. It is observed that there are 10 fringes per millimeter in the fringe pattern. When one of the mirrors is displaced (i.e., moved) the fringe pattern is observed to move 2.68 fringes.

   (a) Find the angle of misalignment between the beams at the observation screen (in degrees).

   (b) Calculate the displacement of the mirror.

   (c) If the displacement experiment is repeated using an argon laser ($\lambda = 488.4$ nm), what is the expected fringe shift?

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2. Consider a Gaussian beam traveling from left to right at a wavelength of 1.064 $\mu$m. At a given location the beam spot size is 1.563 mm and the radius of curvature of the phase is 6.0 m.

   Find the beam's spot size *and* radius of curvature of the phase at a location that is 7.08 meters to the left of the given location.

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3. Consider a waveplate made of quartz that is 0.05 mm thick. The fast axis is aligned horizontally along the x-axis. A unit-amplitude, right-circular-polarized wave at a wavelength of 800 nm is incident on the waveplate. Using phasor notation, write phasors to represent the x- and y-components at the output face of the waveplate. (Note: All phase angles in your answer *must* be in degrees and lie in the range between $-180°$ and $+180°$.)

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4. Consider an erbium fiber laser operating at 1550 nm. (The laser is a piece of optical fiber with a central region that has been doped with erbium ions, which are the lasing material.) The energy levels for erbium (a 3-level laser material) are shown below. The laser medium is 15 meters long and the radius of the cylindrical lasing region is 3 $\mu$m. The mirror reflectivities are 100% and 92%. The index of refraction of the active material is 1.456. The lasing transition is lifetime broadened. The internal loss coefficient is 0.01 $\text{m}^{-1}$.

   Calculate the threshold population inversion.

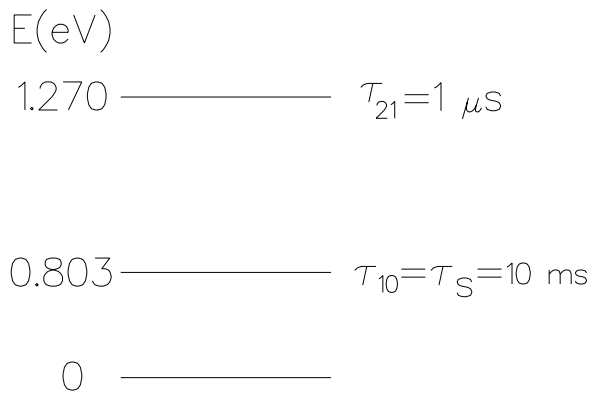


Figure 1: Erbium energy levels

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