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No.					



Department of Sciences

(A constituent Unit of Manipal University, Manipal-576104) III M.Sc End Semester Examination -DEC 2015 SUBJECT: OPTO ELECTRONICS- I (PHY 707.3)

Time: 3 Hrs.

Max. Marks: 50

Answer any FIVE FULL questions. Each question carries 10 marks Answer all the sub questions of a main question in a continuous sequence. Write specific and precise answers.

Write question number within the margin. Draw neat sketches wherever necessary

- **1A.** Write down the laser rate equations for a two, three and four two level laser systems and mention the advantages of four level system when compared to three and two level systems. **6 Marks**
- 1B. Explain collision broadening mechanism. 4 Marks
- 2A. Discuss the longitudinal mode selection in an in homogeneously broadened laser. 5 Marks
- 2B. Explain briefly the principle of Q-switching. 5 Marks
- 3A. Discuss briefly the amplification of optical signals in Erbium-doped fiber amplifier. 6 Marks
- 3B. What is skip distance in an optical fiber? With neat diagram, derive an expression for it. 4 Marks
- 4A. A three level laser emits light of wavelength 550 nm. (a) What is the ratio of population of the upper level (E2) to that of the lower level (E1) in laser transition, at 300 K? (b) At what temperature the ratio of the population of E2 to that of E1 becomes half? (c) At what negative temperature the population of the upper level exceeds that of the lower by 10%? 4 Marks
- **4B.** Calculate the optimum reflectivity of one of the mirrors of the resonator (assuming the other mirror to be 100% reflecting) for $R = 2R_t$. Assume the length of the resonator to be 100 cm, $n_o=1$ and the intrinsic loss per unit length to be 3 X 10⁻⁵/cm. If the power output at the optimum coupling is 10mW. What is the corresponding energy inside the cavity? **3 Marks**
- **4C.**The transition to the ground state from two closely spaced upper and lower states in a ruby laser results in the emission of photons of wavelengths 692.8nm and 694.3nm respectively. Calculate the energy values of the two levels and also the ratio their populations. **3 Marks**
- 5A. A ruby laser delivers a 20.0-ns pulse of 0.1MW average power/pulse. If the number of photons emitted per pulse is 6.98×10¹⁵. Calculate wavelength of the photons. 4 Marks.

- **5B.** A much shorter resonator with $d = 3\mu m$ has $u_F = 50$ THz. How many modes are there in the optical band 700nm-900nm and also calculate the frequency range?. **4 Marks**
- 5C. A 30 cm long resonator with air between the mirrors (n=1). Calculate the frequency spacing between the modes. 2 Marks
- **6A.** Calculate the number of modes that an optical fiber would support for propagation given the following data $n_{core}=1.50$, $n_{clad}=1.48$, core radius=50µm, wavelength of light=1µm. **4 Marks**
- **6B**. The numerical aperture of an optical fibre is 0.2 when surrounded by air. Determine the refractive index of its core. The refractive index of the cladding is 1.59. Also find the acceptance cone half-angle when the fibre is in water. Refractive index of water is 1.33. **3 Marks**
- **6C.** The angle of acceptance of an optical fibre is 30° when kept in air. Find the angle of acceptance when it is in a medium of refractive index 1.33. **3 Marks**

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