MANIPAL
ACADEMY of HIGHER EDUCATION
(Deemed to be University under Section 3 of the UGC Act, 1956)

Reg. No.										

DEPARTMENT OF SCIENCES, III SEMESTER M.Sc (Physics)
END SEMESTER EXAMINATIONS, JANUARY 2021

SUBJECT: LASERS AND OPTICAL FIBERS [PHY 5002]
(REVISED CREDIT SYSTEM-2017)

Time: 3 Hours MAX. MARKS: 50

Note: (i) Answer **ALL** questions
(ii) Missing data may be assumed suitably

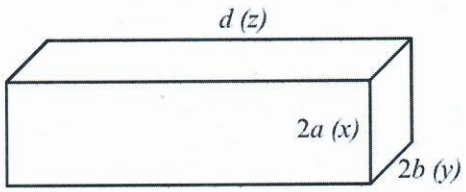
1A. Obtain the expressions for Einstein coefficients and hence obtain the ratio of the number of spontaneous to stimulated emission under thermal equilibrium. [5]

1B. Define passive cavity lifetime and obtain an expression for it. [3]

1C. Estimate the wavelength at which stimulated emission rate becomes $1/5^{th}$ of spontaneous emission rate at room temperature (300 K). [2]

2A. What is Q switching? Write the importance of Q-switching and explain any two techniques for Q-switching. [5]

2B. Given: $a = b = 1$ cm, $d = 6$ cm. Estimate θ_x, θ_y and θ_z for the mode defined by $m = 0$, $n = 1$, $q = 10^6$. [3]



2C. Consider a typical cavity of a He – Ne laser (λ_0 = 632.8 nm) with following specifications. Cavity length d = 20 cm, n_0 = 1, reflectivity R_1 = 1 and R_2 = 0.98, α_1 = 0. Estimate the quality factor. [2]

3A. What is the significance of mode selection in lasing systems? Explain any two of the mode selection techniques. [5]

3B. Write a short note on laser safety. [3]

3C. For a near normal incidence, the free spectral range of the etalon must be greater than 8GHz. Estimate the upper limit for the thickness of the etalon by assuming fused quartz (n = 1.462) as the etalon medium. [2]

4A. Do the modal analysis of TE modes of a symmetric step index planar wave guide. [5]

4B. An optical fiber has n_1 = 1.45 with core diameter 2.5 μm. Estimate the range of r.i allowed for cladding if it has to support 3 modes (λ_0 = 0.85 μm) [3]

4C. Define quality factor for a laser system. [2]

5A. Explain the fabrication of Fiber Bragg Grating (FBG). How an FBG can be used as strain sensor? [5]

5B. What is the maximum rate (frequency) at which the information can be sent along a 20 km fiber of core r. i. 1.46 and $(n_1 - n_2)/n_1 = 0.01$. [3]

5C. Explain the working of Erbium Doped Fiber Amplifier (EDFA). [2]

****