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, NOVEMBER 2018

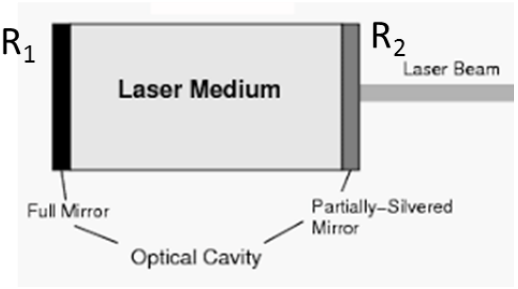
SUBJECT: LASERS AND OPTICAL FIBERS [PHY 5002]
(REVISED CREDIT SYSTEM-2017)

Time: 3 Hours Date: MAX. MARKS: 50

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

1A. Derive expressions for Einstein's coefficients and hence show that for $\omega > k_BT/\hbar$, the number of spontaneous emissions far exceeds the number of stimulated emissions. [5]

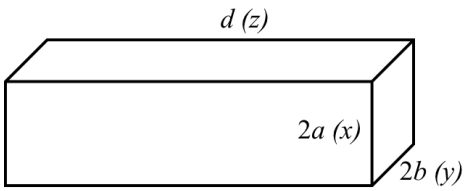
1B. Given: $n_o = 1.5$, $d = 10$ cm, $\alpha_1 = 0$, $t_c = 8$ ns. Estimate the reflectivity of the mirrors that can sustain lasing action if $R_2 = 0.98\ R_1$. [3]



1C. Explain Doppler line broadening mechanism in laser. [2]

2A. By assuming the propagation along z-axis, obtain the expressions for E_x, E_y and E_z for a closed rectangular cavity. [5]

2B. Given: $a = b = 1$ cm, $d = 20$ cm. Estimate θ_x, θ_y and θ_z for the mode defined by $m = 0$, $n = 1$, $q = 10^6$ [Ref. the figure in pg. no. 2]. [3]



2C. With reference to laser, define quality factor and cavity life time. [2]

3A. Analyze propagation of leaky mode in optical waveguides. [5]

3B. With necessary diagrams, explain the working of He – Ne laser. [3]

3C. The multimode fiber with core r.i. 1.500, relative r.i. difference 3% is operated at 0.82 μm. Estimate the critical radius of curvature at which large bending loss occurs. [2]

4A. Do the analysis of TE modes of a symmetric step index planar wave guide and define the condition for single mode operation. [5]

4B. Compute the largest thickness that will guarantee single TE mode operation at 900 nm in a wave guide with $n_1 = 1.5$ and $n_2 = 1.48$. [3]

4C. Write a note on radiation mode in optical fiber. [2]

5A. Obtain the expression for pulse dispersion in step index fibers and hence define the maximum bit transfer rate. [5]

5B. 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]

5C. Give the structure of optical data storage system. [2]

****