PH201	OPTICS AND LASERS	
Date: 29/04/2017	Time: 2PM TO 5PM (AN)	Maximum marks: 50

ANSWER ALL THE QUESTIONS

SI No		Marks
1	A thin lens as shown in figure has radius of curvatures R_1 and R_2 in its surfaces, given "n" is the refractive index of the lens. The ray transfer matrix for this configuration will be (ray is propagating from left to right in figure)	2

a. $\begin{bmatrix} 1 & 0 \\ -(n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) & 1 \end{bmatrix}$

b. $\begin{bmatrix} 1 & 0 \\ (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) & 1 \end{bmatrix}$

c. $\begin{bmatrix} 1 & 0 \\ 1 & -(n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \end{bmatrix}$

d. $\begin{bmatrix} 1 & 0 \\ 1 & (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) \end{bmatrix}$

(figure: R_1 with $n=1$; lens with index n; R_2 with $n=1$)
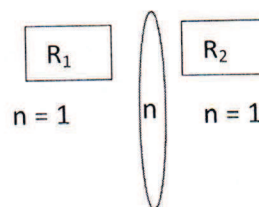
| 2 | According to the classical theory, non-linear optical properties originate when | 1 |

    a. electrons dissociate from the nucleus
    b. dipoles oscillates anharmonically
    c. dipole oscillations are damped
    d. critical damping of dipole oscillations occur

| 3 | Inside the laser gain medium the photon flux grows _____ as a function of distance travelled inside the gain medium | 1 |

    a. Linearly
    b. exponentially
    c. quadratically
    d. logarithmically

| 4 | Multimode's from a laser is observed due to | 1 |

    a. Gain medium
    b. Incoherent pump source (eg. Flash lamp)
    c. frequency instability
    d. Laser cavity

| 5 | Host crystal used in the gain medium for Ruby Laser is | 1 |

    a. Yttrium Aluminium Garnet (YAG = $Y_3Al_5O_{12}$)
    b. Sapphire crystal (Al_2O_3)

PLEASE TURN OVER (PTO)

	c. ZrO_2 d. $LiYF_4$	
6	A two-mirror cavity is formed by a convex mirror of radius $R_1 = -1m$ and a concave mirror of radius $R_2 = 1.5m$. What is the maximum possible mirror separation if this is to remain a stable resonator?	4
7	Using the Lorentz oscillator model, derive the expression for dipole moment (for low intensity case)	4
8	Explain the working principle of a Distributed Feedback Laser?	4
9	Describe wavelength division multiplexing in the context of optical communication?	4
10	a. Explain the working principle of Tunable external cavity diode laser (grating based) for single mode operation? b. How to perform absorption spectroscopy using Tunable external cavity diode laser for an atomic alkali gas (eg Rubidium atomic gas) ?	8
11	Describe the states of polarization of the following waves: (a) $\vec{E} = \hat{i} E_0 \cos(kz - \omega t) \mp \hat{j} E_0 \sin(kz - \omega t \mp \pi/4)$ (b) $\vec{E} = \hat{i} E_0 \cos(kz - \omega t + \pi/8) \pm \hat{j} E_0 \sin(kz - \omega t \mp \pi/8)$	4
12	Derive the expression for intensity obtained due to Fresnel diffraction of a plane wave incident normally on a circular aperture.	4
13	Explain how the use of holograms can help prevent counterfeiting of currency notes.	2
14	A GaAs laser has a 400 micrometer long cavity with a refractive index of 3.6. The material gain function is guassian with its peak at 800nm and its σ as 2nm. The maximum gain at 800nm is 50 cm^{-1}. If the loss in the cavity is 30 cm^{-1} and is independent of the wavelength. Find the number of modes which will exist in the laser when gain and loss are equal?	3
15	If the half width of the He-Ne 632.8nm transition is 1500MHz, what must be the length of the laser cavity to ensure only one longitudinal mode of oscillation?	3
16	a. Explain the principle of Q-switching for generating pulsed laser? b. Explain the working principle of fiber amplifier?	4