BIRLA INSTITUTE OF TECHNOLGY AND SCIENCE, PILANI (RAJASTHAN)
First Semester 2017-2018

Mid Semester Test (Closed Book)

PHY F213	**OPTICS**	**Weightage: 30%**
Date: 09/10/17	**Duration: 90 min.**	**Full Marks: 90**

PART A (30 Marks)

Each question carries three marks. Answer all the ten questions in the first two or three pages of the *answer sheet.*

1. Using two lenses of focal length ***f*** and ***2f***, an achromatic doublet separated by a distance *l* is constructed. Estimate the value of separation *l* assuming both the lenses were made of same material.

2. Estimate the spectral purity of a laser of 600nm with $\tau_c = 25$ns.

3. Write down the expression for system matrix for a thin lens.

4. The refractive index of a certain dispersive medium is described by $n(\lambda)= A - B\lambda + C\lambda/(\lambda^2-l)^2$. Find out the group index n_g of this medium.

5. Consider the beating phenomenon due to 603 nm and 607.4 nm lines of Neon, what should be the minimum resolution of response time of the optical detector to observe this beating?

6. An electromagnetic wave in a medium has refractive index $n= (1-\Omega^2/\omega^2)^{1/2}$. Find out the product of group velocity and phase velocity.

7. With a proper sketch, explain the working principle of Michelson stellar interferometer.

8. An optical communication system is fabricated using LEDs with a wavelength 850nm and spectral width of 25 nm. Estimate he material dispersion coefficient D_m of this system.

9. For a homogeneous medium the refractive index n(x) is constant, using the ray equation obtain the expression for ray path x(z).

10. Estimate the area of the first Fresnel half period zone of a plane wavefront (λ=590 nm) at a distance of one meter from the screen.

PART B (60 Marks)

Answer any 4 questions from the first five questions [48 Marks].

Q1. A hollow glass sphere of radius 10 cm is filled with water. Refraction due to thin glass walls is negligible for paraxial rays. Determine the system matrix and unit planes. Estimate the position and magnification of a small object 20 cm from the sphere. **[12]**

Q2. Consider a plane surface of a material of refractive index n, placed in air. By simple application of Snell's law, obtain an expression for the spherical aberration of the plane surface. **[12]**

Q3. Estimate the transit time i.e. time taken by a ray to traverse a certain length through a parabolic index waveguide with a refractive index variation: $n^2(x) = n_1^2 - \alpha^2 x^2$. **[12]**

Q4. Using which of these two models given below one can arrive at the correct expression for Snell's law of refraction. Justify your answer by deriving the expression for Snell's law of refraction using both Newton's corpuscular model and a model based on Huygen's principle. **[12]**

Q5. Find the width of the anomalous dispersion region for the case of single resonance at frequency ω_0. Assume the damping coefficient $\gamma << \omega_0$. Show that the index of refraction assumes its maximum and minimum values at points where the absorption coefficient is at half maximum. **[12]**

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Q6. A distant source of sodium light (589.3nm) illuminates a circular aperture whose diameter can be varied. As the diameter of the aperture increases, irradiance at an axial point of 1.5m from the circular aperture passes alternately through maxima and minima. Calculate the diameters of the aperture that produce (a) the first two maxima and (b) the first two minima. **[12]**

or

Using Fresnel half period zone construction method for a cylindrical wavefront, estimate the amplitude at an axial point due to the entire wavefront. **[12]**

_____All the best_____