BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE PILANI, PILANI (RAJ)

Semester I 2022-2023

Electricity Magnetism and Optics Lab (PHY F214)

Comprehensive Examination

Date: 10th December 2022 Max. Marks: **60** Max. duration: **90 min**

Name: ID:

Attempt all the questions. Each question has a weightage of 2 Marks. Write your answers in the box provided on the last page. Overwriting is strongly discouraged, marks will not be awarded in such cases.

Q1. In the Michelson Interferometer experiment while using a He-Ne laser (λ = 640 nm), a fringe of certain order is found at an angle θ = 16.2°. The given order fringe is found at the center when the movable mirror is further displaced from its last position by 0.02 mm closer to the beam splitter. What is the order of that ring?

Q2. In the Michelson interferometer experiment, a shift of 85 bright fringes is observed upon inserting a thin film of refractive index n=1.5 perpendicular to the path of the beam in one of the arms of the interferometer. What is the thickness of the film if you are using the He-Ne laser (λ = 640 nm) as your light source?

Q3. What do we observe on the screen in the Michelson Interferometer experiment when the distance of the movable mirror from the beam splitter is the same as the distance of the fixed mirror from the beam splitter?

Q4. What is the Brewster angle for light incident on a glass of refractive index n=1.66? What is the Brewster angle for the light emerging from the same glass?

Q5. When red light in vacuum is incident at the Brewster angle on a certain glass slab, the angle of refraction is 38°. What is the index of refraction of the glass?

Q6. An unpolarized light of wavelength 640 nm and intensity I_0 is incident on a stack of three polarizer sheets. The first and the third polarizer pass axis are parallel to each other whereas the second polarizer is rotated by an angle 45°. What will be the transmitted intensity by the stack of polarizers?

Q7. A student recorded the following data in the Gaussian nature of the laser beam experiment. While performing this experiment, the student maintained the y-scale at maxima throughout and the z-scale at 2.2 mm. Calculate the beam spot size using this data.

x (mm)	Intensity (μA)	x (mm)	Intensity (μA)
1.5	9	2.7	170
1.65	24	2.85	140
1.85	38	3.0	110
2.0	60	3.15	80
2.1	90	3.2	70
2.2	108	3.3	55
2.35	139	3.45	30
2.5	171	3.6	23
2.6	178	3.7	8

Q8. If the divergence angle for the laser used for the above table was 9.2°, what would be its beam spot size when the z-scale was increased to 5.0 mm?

Q9. Consider an optical fiber kept in air with refractive index of core 1.45 and of cladding 1.40. What is the acceptance angle of the fiber?

Q10. The difference in the refractive indices of the core and the cladding is 0.08 and their summation is 2.78. Calculate the numerical aperture of the optical fiber.

Q11. An optical fiber has a numerical aperture of 0.20 and the refractive index of the cladding is 1.59. Determine the core refractive index and the acceptance angle for fiber when immersed in water of refractive index 1.33.

Q12. In the Ultrasonic Diffraction experiment, the grating element is found to be 0.187 mm. If the wavelength of the sodium light is 5893 A° and the frequency of the oscillator is set to 9.0 MHz, what is the angle of diffraction for the first order maxima?

Q13. In the Ultrasonic Diffraction experiment, what is the diffraction angle (in degree) of the 2^{nd} order maxima if the speed of the ultrasound wave is 1500 m/s, the frequency of the oscillator is 3 MHz, and the wavelength of the monochromatic light used is 600 nm.

Q14. If the first order diffraction angle in an Ultrasonic Diffraction experiment is 0.137^0 for the monochromatic light of 600 nm, find the wavelength of the standing waves produced in a container of liquid.

Q15. In the Fresnel bi-prism experiment, the separation between two virtual sources is 3.5 mm and the distance between the slit and the eyepiece is 1.1 m. If the distance between two fringes is observed 0.18 mm, find the wavelength of the light used in the experiment.

Q16. If the whole Fresnel bi-prism experimental setup is immersed in water, what will happen to the width of the fringe pattern? Justify your answer in one sentence only.

Q17. In a Fresnel bi-prism experiment, the fringe width is 0.4 mm when the eyepiece is at a distance of 1 m from the slit. If now only the eyepiece is moved 25 cm towards the bi-prism, find the change in fringe width.

Q18. For designing a permanent magnet, the material should possess _____ retentivity and _____ coercivity. Write the two words for each blank.

Q19. An electron (1.6×10^{-19} *C*) is rotating in a circular path within an atom of radius *10 nm* with an angular velocity of 10^6 rev/sec. Calculate the corresponding magnetic moment.

Q20. In a charging capacitor experiment, a 20 μF capacitor is fully charged to 10V, using a DC battery. If the capacitor is now discharged within a RC loop through a resistor of 100 kilo-ohm, find the capacitor voltage after 4 seconds.

Q21. If a capacitor is charged to a voltage of 12 V and has a resistance of 50 Ohm. Find out the initial value of the discharge current.

Q22. During charging a capacitor with a loop current is I_R, what will be the conduction current I_c and displacement current I_D between two capacitor plates?

Q23. Find out the value of dielectric constant of a material. Given data: the value of standard capacitance is 50 pf, the voltage across the dielectric cell is 0.35 V, the voltage across the standard capacitor is 1.25 V. If the parallel plates of the capacitor are circular with a diameter of 0.8 cm and the thickness of the dielectric slab is 0.3 mm.

Q24. In a parallel plate capacitor, the electrical susceptibility of the dielectric material is 9, and the ratio of the area to thickness of the dielectric slab is *10 cm*. What is the capacitance of the dielectric material in terms of ε_0.

Q25. An extremely long straight wire carries a current of *5 A* and makes a circular loop of radius *5 cm* at the middle, as shown below. What will be the magnetic field ***B*** ($\mu = 4\pi \times 10^{-7}$) at the *center* of the loop?

Q26. In the current-balance experiment, the force measured on a conducting loop of length *55 mm* carrying a current of *3 A* was found to be *26.4 mN*. Due to a disturbance, the loop got tilted w.r.t. its initial horizontal position during the experiment and the force measured for the same current was decreased to a value of *15.14 mN*. What was the angle of the tilt during the second measurement?

Q27. What is the force per unit length ***F*** of two conducting wires carrying parallel currents of *5 A* separated by a distance of 20 cm?

Q28. In the magnetoresistance experiment, the value of magnetoresistance is found to be *0.1* for a magnetic field of *3 kG* and a probe current of *10 mA*. If the probe voltage is found to be *200 mV* for zero magnetic field, what would be the probe voltage for magnetoresistance measurement?

Q29. Why is the four probe technique used in magnetoresistance measurement instead of the usual two probe I-V measurement?

Q30. A square (side *l*) plate capacitor and a circular (radius *r*) plate capacitor are connected in series which are filled with materials of dielectric constants *K* and 2*K*, respectively. If both dielectric cells are having the same plate separation *d* and show a similar potential drop of *V* across them during the dielectric constant measurement. Find the value of *l* / *r*.

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Q1		Q16	
Q2		Q17	
Q3		Q18	
Q4		Q19	
Q5		Q20	
Q6		Q21	
Q7		Q22	
Q8		Q23	
Q9		Q24	
Q10		Q25	
Q11		Q26	
Q12		Q27	
Q13		Q28	
Q14		Q29	
Q15		Q30	