Question Paper

Exam Date & Time: 15-Nov-2019 (02:00 PM - 05:00 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

INTERNATIONAL CENTRE FOR APPLIED SCIENCES
END SEMESTER THEORY EXAMINATIONS
NOVEMBER-2019
I SEMESTER (B.S Engg)
Physics - I [PH 111]

Marks: 100 **Duration: 180 mins.**

Answer 5 out of 8 questions.

Useful constants
Planck's constant h = 6.63 x 10^{-34} Js,Velocity of light c = 3x 10^{8} ms-1. Charge on electron e = 1.6x10^{-19} C. Mass of electron= 9.1 x 10^{-31} kg.Mass of proton = 1.67 x 10^{27} kg.
Missing data, if any, may be suitably assumed.

1) A) Write the conditions for constructive and destructive interferences. How path difference and phase differences are related? (4)

B) Explain - i) Reflection phase shifts ii) Optical path iii) Coherent waves (6)

C) A double-slit arrangement produces interference fringes for sodium light (wavelength = 600 nm) that are 0.25° apart. For what wavelength would the angular separation be 10% greater ? Assume, the angle θ is small. (5)

D) When the movable mirror is moved through a distance of 0.230 mm, 800 fringes swept across the field of view. What is the wavelength of the light used? (5)

2) A) Obtain an expression for the intensity distribution in diffraction pattern due to a narrow single slit using phasor method. (6)

B) Draw phasor diagrams representing central maxima and first minima assuming the slit is divided into eight equal parts. (4)

C) A single slit is illuminated by light whose wavelengths areλa and λb, so chosen that the first diffraction minimum of λa component coincides with the second minimum of the λb component. i) What is the relationship between the two wavelengths? ii) Do any other minima in the two patterns coincide? (6)

D) A diffraction grating 3 cm wide produces a deviation of 33.2° in the second order with a light of wavelength 589 nm. Find the total number of rulings on the grating. (4)

3) Derive an expression for the radius of bright rings produced in Newton's rings set up. Why the fringes are circular in shape? (6)

A)

B) What is a grating? Deduce grating equation. (4)

C) In a Newton's rings experiment, the radius of curvature R of the lens is 5.0m and its diameter is 22 mm,wavelength of the light used = 600 nm. i) How many rings are produced? ii) How many rings would be seen if the arrangement is immersed in water(n = 1.3)? (6)

D) A grating has 6000 rulings/cm, how many orders of the entire visible spectrum (400-700nm) can be produced? (4)

4) Draw the refractive index profile of step index and graded index fiber. (4)

A)

B) Obtain an expression for the numerical aperture of an optical fiber. (6)

C) The numerical aperture of an optical fiber is 0.39. If the difference in refractive indices is 0.05 calculate the refractive index of the material of the core. (6)

D) An FM radio transmitter has a power output of 150 kW and operates at a frequency of 99.7 MHz. How many photons per second does the transmitter emit? (4)

5) Draw I vs. λ graph of a black body radiation for three different temperatures. (5)

A) What is ultra-violet catastrophe?

B) What is Compton effect? What are classical predictions and experimental observations? (6)

C) Electrons are ejected from a metallic surface with speeds up to 4.60 x 10^5 m/s when a light of wavelength of 625 nm is used. (a) What is the work function of the surface? (b) What is the cut-off frequency for this surface? (5)

D) An electron and a bullet (m= 20gm) each have a velocity of 500m/s accurate to within 0.010%. Within what limits could we determine the positions of the objects along the direction of the velocity? (4)

6) What is a simple harmonic oscillator? Deduce Schrodinger equation for a quantum oscillator. (5)

A)

B) What is Radial probability density? Obtain an expression for the same in case electron of a hydrogen atom. (5)

C) Calculate the most probable value and average value of r for an electron in the ground state of the hydrogen atom. Given : (6)

$$\psi_{1S}(r) = \frac{1}{\sqrt{\pi a_o^3}} \exp\left(-\frac{r}{a_o}\right)$$

D) Calculate the angular momentum L, allowed values of L_z and its corresponding angles θ, that L makes with the Z-axis for l = 1. (4)

7)		Explain briefly the components of a laser.	(6)
	A)		
	B)	Explain i) stimulated emission ii) Population inversion and iii) Pumping	(6)
	C)	A pulsed laser emits light at a wavelength of 650 nm. If the energy release per pulse is 150 mJ, how many photons are there in each pulse ?	(4)
	D)	A quantum oscillator consists of an electron bound by a restoring force constant 9 N/m. What is the longest wavelength of light that can excite the oscillator?	(4)
8)		Draw a representative graph of Resistance Vs Temperature for a superconductor and a normal conductor and hence explain critical temperature.	(4)
	A)		
	B)	Explain i) Meissner effect ii) Doping of semiconductors	(6)
	C)	Most solar radiation has awavelength of 0.750 μm or less. What energy gap should the material in solar cell have in order to absorb this radiation ? Is silicon (E_g= 1.14 eV) appropriate?	(5)
	D)	Calculate the energy of a conduction electron in silver at 800 K, assuming the probability of finding an electron in that state is 0.950. The Fermi energy is 5.48 eV at this temperature.	(5)

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