Reg.No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

I SEMESTER B.S. DEGREE EXAMINATION – NOV. 2017

SUBJECT: PHYSICS I (PH 111)

Wednesday, 15 November 2017

Duration: 3 Hrs. **Max. Marks: 100**

Physical Constants

Elementary charge	1.6×10^{-19} C	Mass of electron	9.1×10^{-31} kg
Boltzmann constant	1.38×10^{-23} J/K	Planck's constant	6.63×10^{-34} J.s
Stefan-Boltzmann constant	5.67×10^{-8} W/m^{2}K^4	Speed of light in vacuum	3.0×10^{8} m/s

- ✓ **Answer Any FIVE FULL questions.**
- ✓ **Answer all the sub questions of a main question in a continuous sequence.**
- ✓ **Any missing data may suitably be assumed.**
- ✓ **Write question number on the left side of the margin. Draw neat sketches wherever necessary**.

1A. What is interference phenomenon in light? What are the conditions to be met to observe sustained, good contrast interference fringes ?

1B. Illustrate the phasor method of determining intensity distribution due to double slit interference pattern. Plot the intensity profile.

1C. i) A plano-convex glass lens(n=1.52) of diameter 10cm is used in Newton ring setup. When a 650nm light is incident normally, a total of 55 bright rings are observed with the last one right on the edge of the lens. What is the radius of curvature of the convex surface of the lens?

ii) White light reflected at perpendicular incidence from a soap film in air has, in the visible spectrum, an interference maximum at 600nm and a minimum at 450nm with no minimum in between. If n=1.33 for the film, what is the film thickness assumed to be uniform? **(4+8+8)**

2A. i) Light cannot bend around larger obstacles on its path. State whether this statement is **True** or **False**. Justify your answer.

ii) Distinguish between Fraunhofer and Fresnel classes of diffraction.

2B. i) Derive an expression for the width of principal maxima in multiple slit diffraction pattern.

ii) Discuss pattern of double slit interference and diffraction taking place simultaneously.

2C. i) What requirements must be met for the central maximum of the envelope of the double slit interference pattern to contain exactly 11 fringes?

ii) The two head lights of an approaching automobile are 1.42m apart. At what a) angular separation and b)maximum distance will the eye resolve them? Assume pupil diameter of 5.00mm and wavelength of 562nm.

(4+8+8)

3A. i) Explain how stimulated emission produce amplification of light?
ii) Explain the graded index optical fiber and light propagation through it.

3B. i) Explain the components of any laser.
ii) Obtain an expression for the numerical aperture of an optical fiber.

3C. i) A He-Ne laser emits light at a wavelength of 632.8nm and has an output power of 2.3mW. How many photons are emitted each minute by this laser when operating?
ii) A glass optical fiber of core refractive index 1.450 is to be clad with another to ensure total internal reflection that will contain light travelling within 5° of the fiber axis. What minimum index of refraction is allowed for cladding?

(4+8+8)

4A. i) What are the assumptions of Planck, in his explanation of black body radiation?
ii) Wien's displacement law relates the total energy radiated by a black body to its temperature. Say whether the statement is **true** or **false**. If false, give the correct statement.

4B. i) Deduce the Einstein photo-electric equation.
ii) Derive the relation between a) group speed and phase speed b) group speed and particle speed.

4C. i) A black body at 7500 K consist of an opening of diameter 0.050mm. Find the number photons in the wavelength range of 500- 501 nm escaping per second through the hole.
ii) The speed of an electron is measured to be 5.00×10^3 m/s to an accuracy of 0.0030 %. Find the minimum uncertainty in determining the position of this electron .

(4+8+8)

5A. i) What is ultraviolet catastrophe?
ii) What is a quantum particle?

5B. i) What are the classical predictions of photo electric effect?
ii) Derive Compton shift equation.

5C. i) The stopping potential for photoelectrons released from a metal is 1.48V larger compared that in another metal. If the threshold frequency for the first metal is 40% smaller than for the second metal, determine the work function of each metal.
ii) An electron has a kinetic energy of 3.0eV. Compare its wavelength with that of a photon of same energy. **(4+8+8)**

6A. i) What is a wave function?
ii) What is meant by normalization of a wave function?

6B. Solve Schrodinger equation for a particle in an infinite potential well of one dimension.

6C. i) A 30 eV electron is incident on a square barrier of height 40eV, width 0.1nm. What is the probability that the electron will tunnel through the barrier?

ii) Calculate the probability that the electron in the ground state of hydrogen will be found outside the first Bohr radius. Given : Radial probability density.

$$P_{1s} = \left(\frac{4r^2}{a_o^3}\right) exp\left(-\frac{2r}{a_o}\right)$$ **(4+8+8)**

7A. i) What is tunneling in quantum mechanics?

ii) The electron of an hydrogen atom is in a one dimensional infinite potential well. Say whether the statement is **true** or **false**. If false, give the correct statement.

7B. i) Compare the eigen functions and eigen values of particles of same mass in infinite and finite potential wells.

ii) Explain the quantum numbers associated with the solution of Schrodinger equation of an hydrogen atom.

7C. i) A particle wave function is given by the equation $\psi(x) = A \exp(-ax^2)$. What is the expected value $\langle x \rangle$ for this particle?

ii) A 0.50 kg baseball is confined to two rigid walls of a stadium that can be modeled as a box of infinite height and of length 100m.Calculate the minimum speed of the baseball.

(4+8+8)

8A. i) Define Fermi energy.

ii) Draw a plot of resistance verses temperature curve for metals and superconductors.

8B. i) Explain the formation of energy bands in solids.

ii) Explain Meissner effect.

8C. i) Each atom of gold (Au) contributes one free-electron to the metal. The concentration of free-electron in gold is $5.90 \times 10^{28}/m^3$. Compute the Fermi Energy of gold.

ii) Show that the average kinetic energy of a conduction electron in a metal at zero K is $(3/5)\, E_F$ **(4+8+8)**