Reg. No.									

INTERNATIONAL CENTRE FOR APPLIED SCIENCES

(Manipal University)

I SEMESTER B.S. DEGREE EXAMINATION – NOV. / DEC. 2016

SUBJECT: PHYSICS - I (PH 111)

(OLD SCHEME)

(BRANCH: COMMEN TO ALL)

Saturday, 10 December 2016

Time: 3 Hours **Max. Marks: 100**

- ✓ **Answer ANY FIVE FULL Questions.**
- ✓ **Write the question number clearly on the left side of the margin.**
- ✓ **Any missing data may be suitably assumed**

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: 6.625×10^{-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

1A. i) Distinguish between vibrations of a spring-block system and a string case.

ii) An automobile can be considered to be mounted on four springs as far as vertical oscillations are concerned. The springs of a certain car of mass 1460 kg are adjusted so that the vibrations have a frequency of 2.95 Hz. Find the force constant of each of the four springs (assumed identical).

1B. Derive an expression for the time period of a torsional pendulum. Mention any two characteristics of simple harmonic motion.

1C. i) A 5.13-kg object moves on a horizontal frictionless surface under the influence of a spring with force constant 9.88 N/cm. The object is displaced 53.5 cm and given an initial velocity of 11.2 m/s back toward the equilibrium position. Find (a) the frequency of motion, (b) the initial potential energy of the system, (c) the initial kinetic energy and (d) the amplitude of the motion.

ii) A (hypothetical) large slingshot is stretched 1.53 m to launch a 130 g projectile with speed sufficient to escape from the Earth (11.2 km/s). (a) What is the force constant of the device, if all the potential energy is converted to kinetic energy? (b) Assume that an average person can exert a force of 220 N. How many people are required to stretch the slingshot? **(4+8+8)**

2A. i) Explain the principle of superposition.

ii) Write the equation of a sine wave travelling in the positive x direction and explain the terms

2B. Derive an expression for velocity of transverse waves in a stretched string from Newton's second law. Mention any two characteristics of standing waves.

2C i) A wire of 10.3 m long and having a mass of 97.8 g is stretched under a tension of 248 N. If two pulses, separated in time by 29.6 ms, are generated one at each end of the wire, where will the pulses meet?

ii) The equation of a transverse wave traveling along a string is given by,

$$y = (2.3mm)\sin[(1822\,rad/m)x - (588\,rad/s)t].$$

Find (a) the amplitude, (b) the velocity, (c) the wavelength of the wave, and (d) the maximum transverse speed of a particle in the string.

(4+8+8)

3A. Draw the diagram of the Michelson's interferometer and label its parts. Explain how microscopic length measurements are made in this.

3B. i) Obtain an expression for intensity of light in double-slit interference using phasor diagram.

ii) Discuss qualitatively diffraction at a circular aperture and hence Explain Rayleigh's criterion for resolving images due to a circular aperture.

3C.i) A sheet of glass having an index of refraction of 1.40 is to be coated with a film of material having an index of refraction 1.55 such that green light (λ=500 nm) is preferentially transmitted. What is the minimum thickness of the film that will achieve the result? Which wavelength (>700 nm) is minimally transmitted by this glass, in the infrared region?

ii) In a Newton's rings experiment, the radius of curvature of the lens is 5.0 m and its diameter is 20 mm. a) How many rings are produced? b) How many rings would be seen if the arrangement is immersed in water (n = 1.33) ? (Assume λ = 589 nm)

(4+8+8)

4A. i) Explain with diagram, the polarization of reflected light, incident at Brewster's angle.

ii) Explain the law of Malus with a diagram.

4B. i) Discuss the diffraction due to single-slit. Obtain the locations of the minima and maxima qualitatively. Draw the diagrams wherever necessary.

ii) Obtain an expression for resolving power of a diffraction grating.

4C. i) In a double slit diffraction pattern, the wavelength used is 450 nm, the slit separation is 0.150 mm and the slit width is 25 μm. What is the ratio of the intensity of the third fringe to the side of the center to that of the central fringe?

ii) A diffraction grating has 250 ruling/mm, and a principal maximum is noted at 23°. What are the possible wavelengths of the incident visible light (range is 400-700 nm)?

(4+8+8)

5A. i) Explain the term coherence.

ii) Draw a schematic plot of the intensity of light in a double-slit interference against phase-difference.

5B. With relevant diagrams, explain circular polarization of light by double refraction and optical activity.

5C. i) One slit of a double slit arrangement is covered by a thin glass plate of index of refraction 1.4 and the other by a thin glass plate of index of refraction 1.7. The point on the screen where the central maximum fell before the glass plates were inserted is now occupied by what had been the m = 5 bright fringe before. Assume that λ = 480 nm and the plates have the same thickness. Find the value of plate thickness.

ii) A beam of light is linearly polarized in the vertical direction. The beam falls at normal incidence on a polarizing sheet with its polarizing direction at 58.8^{o} to the vertical. The transmitted beam falls, also at normal incidence, on a second polarizing sheet with its polarizing direction horizontal. The intensity of the original beam is 43.3 W/m^2. Find the intensity of the beam transmitted by the second sheet. **(4+8+8)**

6A. i) State and explain Bragg's law.

ii) Standard optical diffraction grating cannot be used for X-ray diffraction. Justify your answer.

6B. Obtain an expression for the width of the central maximum in diffraction pattern due to multiple slits. Obtain an expression for dispersion by a diffraction grating.

6C. i) In a double-slit experiment, the distance of the screen from the slits is 52 cm, the wavelength is 480 nm, slit separation is 0.12 mm and the slit width is 0.025 mm. (a) What is the spacing between adjacent fringes? (b) What is the distance from the central maximum to the first minimum of the fringe envelope? (c) How many bright fringes are there in the central peak of the diffraction envelope?

ii) A beam of X-rays of wavelength 29.3 pm is incident on a calcite crystal of lattice spacing 0.313 nm. Find the smallest angle between the crystal planes and the beam that will result in constructive reflection of the X-rays.

(4+8+8)

7A. i) Write the assumptions made in Planck's hypothesis of blackbody radiation.

ii) A freely moving quantum particle with mass m and speed u. Its energy is E= K= $mu^2/2$. Determine the phase speed of the quantum wave representing the particle and show that it is different from the speed at which the particle transports mass and energy.

7B. Explain photoelectric effect. What are the observations in the experiment on photoelectric effect? What are the classical predictions about the photoelectric effect?

7C. i) A 0.880 MeV photon is scattered by a free electron initially at rest such that the scattering angle of the scattered electron is equal to that of the scattered photon. Determine the scattering angles

ii) Find the minimum kinetic energy of a proton confined within a nucleus having a diameter of 1.0 x 10^{-15} m. **(4+8+8)**

8A. Give a brief account of tunneling of a particle through a potential energy barrier.

8B. Sketch the potential-well diagram of finite height U and length L for a particle of mass 'm' in it. Write Schrodinger equation for three regions. Write the corresponding wave functions and boundary conditions. Sketch the wave-functions, probability densities for the particle in a potential well of finite height with n = 1, n = 2 and n = 3.

8C. i) A free electron has a wave function $\Psi = A \exp [i (5.00 \times 10^{10}) x]$ where x is in meters. Find (a) its de Broglie wavelength (b) its momentum and (c) its kinetic energy in electron volts.

ii) Calculate the probability of finding the electron in the ground state of an infinite potential well of length L, between x = 0 and x = L /4. **(4+8+8)**