# THE OPEN UNIVERSITY OF SRI LANKA

## DEPARTMENT OF PHYSICS

## B.SC. DEGREE PROGRAMME – 2013/2014

## LEVEL 03

## PHYSICS FOR BIOLOGY STUDENTS – PCU 1271/PSU 1244

## FINAL EXAMINATION

**Time allowed: Three hours (3 hrs.)**

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**Date: 24th November 2014** **Time: 1.30 pm – 4.30pm**

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*Answer SIX (06) questions only.*

1 (a) Write the characteristics of simple harmonic motion.

(b) Drive an expression for the period of oscillation of a simple pendulum.

(c) A 50 g mass vibrates in simple harmonic motion at the end of a light spring. The amplitude of the motion is 12 cm and the period is 1.7 seconds. Find

(i) the frequency
(ii) the spring constant
(iii) the maximum speed of the mass
(iv) the maximum acceleration of the mass
(v) the speed when the displacement x is 6 cm.
(vi) the acceleration when x = 6 cm

(2) (a) State Newton's law of gravitation.

(b) A satellite of mass $m$ is moving in a circular orbit of radius $r$ around the Earth. The radius of the Earth is $R$ and the acceleration due to gravity at the surface of the Earth is $g$. Obtain expressions for the following.

(i) The acceleration due to gravity at a distance $r$ from the centre of Earth.
(ii) The linear speed of the satellite.
(iii) The periodic time of the satellite.

(c) What is the orbital velocity of an artificial satellite revolving round the Earth at a height 100 km from the surface of the Earth? $R = 6400$ km, $g = 9.8\,ms^{-2}$

(3) (a) State Hooke's law.

(b) Draw a labeled graph of tensile stress against tensile strain for a metal wire up to the breaking point. Show on your graph the region in which Hooke's law is obeyed.

(c) A steel wire of length 4.7 *m* and cross-section $3.0\times10^{-5}\text{m}^2$ is stretched by the same amount as a copper wire of length 3.5 *m* and cross-section $4.0\times10^{-5}\text{m}^2$ under a given load. What is the ratio of Young's modulus of steel to that of copper?

(4) (a) State Bernoulli's theorem. State the conditions under which it may be applied.

(b) What is meant by streamline and turbulent flow?.

(c) Water is flowing through a tube having one end at the ground floor and the other end at the first floor which is at a height of 5 *m*. The diameter of the end at the ground floor is 4 mm and that of the end at the first floor is 2 mm. Find the velocity and the pressure at the first floor if the corresponding values at the ground floor are $1.0\text{ms}^{-1}$ and $2\times10^5\text{Nm}^{-2}$ respectively.

(5) (a) (i) Define linear momentum
(ii) State the Principle of Conservation of linear momentum
(iii) How is linear momentum related to force?

(b) A truck of mass 6000 kg travelling at high speed collides with a stationary car of mass 1200 *kg*. The two vehicles lock together on impact and slide a distance of 100 m before coming to rest. Assuming frictional force in the slide is 0.20 × total weight of the vehicles, calculate

(i) the deceleration of the two vehicles after the impact
(ii) the speed of the two vehicles immediately after the impact
(iii) the speed of the 6000 kg truck just before the impact

(6) (a) Draw the circuit symbol and give the truth table for each of the following

(i) a 2 – input AND gate
(ii) a 2 – input NOR gate
(iii) a 2 – input EX-OR gate
(iv) a 3 – input OR gate

(b) Draw a circuit to show how three NAND gates may be connected together to form a 2 – input OR gate. Indicate the logic states at the input and output lines of each NAND gate when one input of the circuit drawn is high and the other input is low.

(c) Write down the truth table for an EX – OR gate and show how an EX – OR gate may be constructed from four NAND gates.

(7) (a) Define the term black body. What is meant by black body radiation?

(b) State Stefan's law with regard to a black body. Sketch graphs showing the distribution of energy in the spectrum of black body radiation at three temperatures and indicate which curve corresponds to the highest temperature.

(c) What is the heat lost from the body of a person per hour whose body temperature is 37°C and the surrounding temperature is 20°C? The emissivity of the skin is 0.92 and the surface area of the skin is 1.6 $m^2$. (Assume that the person is unclothed)

(8) (a) Explain the Doppler effect and two applications of it.

(b) The speed of an ambulance on a highway is 34 $ms^{-1}$. The frequency of the sound emitted by its siren is 500 Hz. Calculate the frequency heard by the driver in a car travelling at 72 km $h^{-1}$ in the opposite direction, when

(i) before passing and
(ii) after passing the ambulance
$\left(V = 340 ms^{-1}\right)$