KIMATHI UNIVERSITY COLLEGE OF TECHNOLOGY

University Examinations 2010/2011

FIRST YEAR SUPPLEMENTARY EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHATRONIC ENGINEERING, TELECOMMUNICATIONS AND INFORMATION ENGINEERING, GEOMATIC ENGINEERING AND GEOSPATIAL INFORMATION SYSTEMS AND GEOSPATIAL INFORMATION SCIENCE, CIVIL ENGINEERING, ELECTRICAL AND ELECTRONIC ENGINEERING

SPH 2170: PHYSICS I

DATE: 27th February 2012 TIME: 2.00 pm – 4.00 pm

Please, answer the first question and any two other questions

1. (a) State in words and mathematically formulate three Newton's laws of motion **(6 marks)**

(b) Define and differentiate kinetic energy and work. Mathematically prove the relationship between them. Prove that their dimensions are the same **(6 marks)**

(c) State in words and mathematically formulate the principle of conservation of linear momentum for an isolated system of particles **(6 marks)**

(d) State in words and mathematically formulate the three Newton's laws of rotational motion **(6 marks)**

(e) Define the term "simple harmonic motion, SHM". Deduce Newton's law of motion of SHM. Prove the law of conservation of total mechanical energy for SHM **(6 marks)**

2. (a) An auto's velocity increases uniformly from $6.0\frac{m}{s}$ to $20\frac{m}{s}$ while covering $70m$ .Find the acceleration and the time taken **(6 marks)**

(b) A horizontal cable pulls a $200-kg$ cart along a horizontal track. The tension in the cable is $500N$. Starting from rest

(i) How long it will take the cart to reach a speed of $8\frac{m}{s}$?

(ii) How long far will it have gone? **(7 marks)**

(c) A $6.0-kg$ block rests on horizontal surface. Its coefficient of kinetic friction is 0.22. The block is connected by a string passing over a pulley to a $3.0-kg$ mass as in Fig.1.

(i) What is the acceleration a? (ii) What is the tension T in the string? **(7 marks)**

3. (a) A block falls from a table $0.6m$ high. It lands on an ideal, massless, vertical spring with a force constant of $2.4k\frac{N}{m}$. The spring is initially $25cm$, but it is compressed to a minimum height of $10cm$ before the block stops. Find the mass of the block **(6 marks)**

(b) What power must a man spend on a $100-kg$ log that he is dragging down a hillside at a speed of $0.50\frac{m}{s}$? The hillside makes an angle of 20^0 with the horizontal and the coefficient of friction of 0.9 **(7 marks)**

(c) Using the "ray tracing" technique, describe the image formed by a concave mirror when a real object is situated between the focal point and the mirror. Check your results using the equation for thin spherical mirrors by taking: Focal length: $f=+20cm$, object distance: $d_0=+15cm$ and size of object: $\ell_0=+5cm$ **(7 marks)**

4. (a) A block of mass $2kg$ hangs from a spring of force constant $k=800\frac{N}{m}$. The block is pulled $20cm$ from equilibrium and released

(i) What are the amplitude, angular frequency, and period of the motion?
(ii) What are the velocity and acceleration of the block when it is $12cm$ from equilibrium? **(8 marks)**

(b) A $0.2kg$ mass suspended from a spring describes a simple harmonic motion with a period T of $3s$ and amplitude R of $10cm$. At $t=0$ the mass passes upward through the equilibrium position.
(i) Find the force constant k of the spring.
(ii) Find the displacement, velocity, and acceleration of the mass when $t=1s$ **(8 marks)**

(c) An electric heater supplies $1.8kW$ of power in the form of heat to a tank of water. How long will take to heat $200kg$ of water in the tank from 10 to 70^0C? Assume heat losses to the surroundings to be negligible **(4 marks)**

5. (a) For the wave $y=5\sin 30®\left[t-\left(\frac{x}{240}\right)\right]$, where x and y are in centimetres and t in seconds, find the (i) displacement when $t=0$ and $x=2cm$; (ii) wavelength; (iii) velocity of the wave and (iv) frequency of the wave **(6marks)**

(b) A body falls from rest. Find (i) its acceleration, (ii) the distance it falls in $3s$ (iii) its speed after falling $70m$ (iv) the time required to reach a speed of $25\frac{m}{s}$ (v) the time taken to fall $300m$. **(8 marks)**

(c) A projectile is fired with initial velocity $v_0=95\frac{m}{s}$ at an angle $^-=50^0$. After $5s$, it strikes the top of a hill. What is the elevation of the hill above the point of firing? At what horizontal distance from the gun does the projectile land? **(6 marks)**