TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Applied & Health Sciences

DEPARTMENT OF MATHEMATICS & PHYSICS

UNIVERSITY EXAMINATION FOR THE
BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

SPH 2173: PHYSICS FOR ENGINEERS I

SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: OCTOBER 2013
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer Booklet*

This paper consist of **FIVE** questions in **TWO** sections **A** & **B**
Answer question **ONE (COMPULSORY)** and any other **TWO** questions
Maximum marks for each part of a question are as shown
This paper consists of **FOUR** printed pages

SECTION A (COMPULSORY)

Question One

a) Determine the dimensions of the following constants.
- **(i)** Acceleration **(1 mark)**
- **(ii)** Density **(1 mark)**
- **(iii)** Work **(1 mark)**

b) If the units of length, mass and force are chosen as fundamental units, what will be the dimensions of time in terms of these units. **(2 marks)**

c) State Kepler's laws of planetary motion **(3 marks)**

d) Show that for a circular track of radius r and angle of banking θ :

$$\theta = \tan -1\left(\frac{v^2}{vg}\right)$$

where v is the maximum velocity for negotiating the track and of is acceleration due to gravity. **(4 marks)**

e) (i) Define simple harmonic motion **(1 mark)**
(ii) A mass vibrates through an amplitude of 2cm in simple harmonic motion with a period IS. What is the distance moved from the centre of oscillation in 0.4s **(3 marks)**

f) Define the following terms:
(i) Stress **(1 mark)**
(ii) Strain **(1 mark)**
(iii) Elasticity **(1 mark)**

g) While at 0°C, a square steel plate of side 20cm is fixed at both ends so that it cannot expand. If its temperature is raised to 20°C, what force would be excited on the support at the ends. Young's modulus Y = 2 x 1012Nm2 and coefficient of expansion of steel = 10-5°C^{-1} **(5 marks)**

h) State the following laws:
(i) Boyle's law **(1 mark)**
(ii) Charles's law **(1 mark)**

i) A standard resistance coil marked 30 Ω is found to have a true resistance of 3.114 Ω at 300K. Calculate the temperature at which the making is correct. (The temperature coefficient of the material of the coil is 4.2 x 10^{-3}°C^{-1}) **(4 marks)**

SECTION B (Answer any TWO questions from this section)

Question Two

a) Define the following terms:
(i) Kinetics **(1 mark)**
(ii) Kinematics **(1 mark)**

b) The position coordinate of a particle which is confined to move a long a straight line is given by:

$$S = 24t^3 - 12t + 3$$

Where S is measured in meters from the origin and t is the seconds. Determine:

(i) The time required for the particle to reach a velocity of 72ms^{-1} from its initial condition at t = 0 **(3 marks)**
(ii) The acceleration of the particle when v = 30ms^{-1} **(3 marks)**

(iii) The net displacement of the particle during the interval from t = 35 to t = 45 **(3 marks)**

c) Show that the relationship between the linear velocity v of the particle moving with angular velocity in a circular path of radius r is given by v = rw **(4 marks)**

d) A stone of mass 0.6kg attached to a string of length 0.5m is whirled in a horizontal circle at a constant speed. If the tension in string is 30N before its breaks, calculate:

(i) The maximum angular speed of the stone **(3 marks)**

(ii) The maximum number of revolutions it can make **(2 marks)**

Question Three

a) Define hence derive the formula for radius of gyration **(5 marks)**

b) Derive the moment of inertia of a thin uniform rod.

(i) About an axis passing through its centre and perpendicular to its length. **(5 marks)**

(ii) A long an axis passing through one of its ends. **(4 marks)**

c) A 1kg stone attached to the end of a 60cm chain is revolving at a rate of 3 rev s^{-1}

(i) What is its angular momentum **(3 marks)**

(ii) If after 30s it is making only 1 rev s^{-1} find the mean torque. **(3 marks)**

Question Four

a) State Hooke's law **(1 mark)**

b) Differentiate between the three types of elastic modulus **(3 marks)**

c) Show that the modulus of torsion of a cylinder is given by:

$$\frac{\pi n a^4}{2L}$$

Where the symbols have their usual meaning **(8 marks)**

d) What force is required to stretch a steel wire to double its length when its area of cross-section is $1cm^2$ and Young's modulus = $2 \times 10^{-11} Nm^{-2}$ **(4 marks)**

e) Find the maximum load which may be placed on a steel wire of diameter 1mm if the permitted strain must not exceed 1/1000 and the Young's modulus of steel is 2×10^{11} Pa. **(4 marks)**

Question Five

a) What is:

(i) Coefficient of viscosity **(1 mark)**

(ii) Terminal velocity **(1 mark)**

b) Show that the terminal velocity of a sphere falling through a viscous fluid is given by:

$$v_t = \frac{2r^2(Ts - Tf)g}{an}$$

State what the symbols stand for. **(6 marks)**

c) Define the following terms:

(i) Specific heat capacity **(2 marks)**

(ii) Latent heat of fusion **(2 marks)**

d) A carolimeter with heat capacity of $80J0C^{-1}$ contains 50g of water at 40°C. What mass of ice at 0°C needs to be added in order to reduce the temperature to 10°C? Assume no heat is lost to the surroundings. (Specific heat capacity of water = 4.2×10^3 $Jkg^{-1o}C$, specific latent heat of ice = $3.4 \times 105Jkg^{-1}$. **(5 marks)**

e) An ideal gas has a volume of $100cm^2$ at 2 x 105 Pa and 27°C. What is its volume of $100cm^2$ at 2×10^5 Pa and 27°C. What is its volume at 5 x 105 Pa and 60°C. **(3 marks)**