



UNIVERSITY OF NAIROBI

SPECIAL/SUPPLEMENTARY EXAMINATIONS - 2013/2014

FIRST YEAR EXAMINATIONS FOR THE DEGREES OF BACHELOR OF SCIENCE
IN ENGINEERING

FCE 131 : CIVIL ENGINEERING

FEB 103 : ENVIRONMENTAL AND BIOSYSTEMS ENGINEERING

FEE 101 : ELECTRICAL AND ELECTRONIC ENGINEERING

FGE 175 : GEOSPATIAL ENGINEERING

FME 111 : MECHANICAL ENGINEERING

ENGINEERING PHYSICS 1 A

DATE: AUGUST 12, 2014

TIME: 11.30AM – 1.30PM

INSTRUCTIONS:

The paper consists **THREE** Sections:

Sections A, B and C. Answer **THREE** questions with at least **ONE** question from each Section

Constants:

Acceleration due to gravity $g = 9.8 \text{ m/s}^2$

Velocity of sound : $v = 340 \text{ m/s}$

Specific heat capacity of water $c_w = 4184 \text{ J/kg.K}$

Stefan Boltzmann Constant $\sigma = 5.6 \times 10^{-8} \text{ W/m}^2 \text{ K}^4$

SECTION A

- 1) a) Distinguish between a vector and a scalar giving an example in each case. (4 marks)
- b) Define the following quantities and stating their SI units
(i) Displacement (2 marks)
(ii) Work (2 marks)
(iii) Linear momentum (2 marks)
- c) A stone is thrown from the top of a building upward at an angle of 30° to the horizontal and with an initial speed of 20 m/s. The height of the building is 45 m.
(i) How long is the stone "in flight"? (5 marks)
(ii) What is the speed of the stone just before it strikes the ground? (5 marks)

2. a) (i) State Newton's first law of motion. (1 mark)
(ii) Show that the ratio of change in linear momentum is equal to the net force acting on the body. (4 marks)
- b) (i) State the two conditions for equilibrium. (4 marks)
(ii) A traffic light weighing 100N hangs from a cable tied to two other cables fastened to support. One of the two cables makes an angle of 37° and the other makes an angle of 53° with the horizontal. Find the tension in the three cables. (11 marks)

SECTION B

3. a) (i) Define a rigid body. (1 mark)
(ii) State the two conditions necessary for the conservation of angular momentum. (2 marks)
- b) Show that the ratio of change of total angular momentum is proportional to the cross product between position vector (V_2) and force (F_1) acting on each individual particle. (4 marks)
- c) (i) Define the following physical quantities
I. Angular velocity
II. Angular speed
III. Angular acceleration (3 marks)
- ii) Show that the kinetic energy in rotational dynamics is given by $KE = \frac{1}{2} I\omega^2$ and further derive the rotational analogs to the following linear equations
 $v = u + at$
 $s = ut + \frac{1}{2} at^2$
 $v^2 = u^2 + 2as$
- d) Show that the moment of inertia for a rigid body consisting of N small mass elements above an axis through the centre of mass is given by

$$I = \sum_{i=1}^N \Delta M_i r_i^2 \quad (4 \text{ marks})$$

4. a) (i) What is a restoring force? State and explain one factor which such a force depends on. (3 marks)
- (ii) Define the following physical quantities
I. Period
II. Frequency
III. Amplitude of vibration (3 marks)

- b) Find the velocity and acceleration of a system described by the following equation

$$X = X_0 \cos \omega t$$

where ω and X_0 are the angular velocity and amplitude respectively. (8 marks)

- c) A pigeon flaps its wings at the rate of 70 wing flaps per second. Find the frequency and wavelength of the wave produced and hence the equation of the wave if the amplitude is $\frac{1}{2}$ cm. (6 marks)

SECTION C

- 5 a) (i) State the three Keplers Laws of planetary motion. (3 marks)
(ii) What is escape velocity (1 mark)
(iii) Assuming the orbit of the earth about the sun to be circular with a radius of 1.5×10^{11} m. Find the mass of the sun. (2 marks)
- b) Write brief notes on the following:
i. Stress
ii. Strain
iii. Young's modulus
iv. Stoke's law (8 marks)
- c) (i) State the Archimedes Principle. (1 mark)
(ii) A chunk of copper suspended from a balance weighs 196.8g in air, when in water at 20°C , the reading on the balance is 148.3g. Calculate the specific gravity of copper. (2 marks)
- d) From the Bernoullis principle, show that the sum of pressure and total energy per unit volume of a given fluid is always constant (use relevant diagrams) (4 marks)
6. a) Briefly explain the following terms as used in thermal physics
(i) Objects in thermal contact. (1 mark)
(ii) Objects in thermal equilibrium (1 mark)
(iii) Internal energy (1 mark)
(iv) Zeroth law of thermodynamics (1 mark)
(v) Tripple point of water (1 mark)
- b) The emissivity of tungsten is 0.35. A tungsten sphere of radius 1.5 cm is suspended within a large evacuated enclosure whose walls are at 290K. What power input is required to maintain the sphere at a temperature of 300K if heat conduction along the support is negligible. (5 marks)

- c) Nitrogen is kept in a closed container at a temperature of 27°C and a pressure of $1.0 \times 10^5 \text{ pa}$. The density of nitrogen is 1.25 kg/m^3 . Calculate:
- (i) The root mean square of the molecules. (2.5 marks)
 - (ii) The temperature at which the molecules travel twice. (2.5 marks)
- d) Show that for an ideal gas undergoing an adiabatic process
- $$TV^{\gamma-1} = \text{Constant.} \quad (5 \text{ marks})$$

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