# UNIVERSITY OF NAIROBI

## SECOND SEMESTER EXAMINATIONS – 1012/2013

### FIRST YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF SCIENCE IN ENGINEERING

FEB 114:     ENVIRONMENTAL & BIOSYSEMS ENGINEERING
FGE 174:     GEOSPATIAL ENGINEERING
FCE 164:     CIVIL ENGINEERING

### APPLIED MATHEMATICS 1B

DATE: MAY 14, 2013                              TIME: 8.30 A.M. – 10.30 A.M.

---

**INSTRUCTIONS:**

- Answer Question 1 and TWO other questions
- Use $g = 9.81$ m/s$^2$

---

## Question 1 (30 Marks)

(a)   A machine gun fires 35g bullets at a speed of 750 m/s. If the gun can fire 200 bullets per minute, what is the average force the shooter must exert to keep the gun from moving?                                         [5 marks]

(b)   A body moves with simple harmonic motion and completes 20 oscillations per second. Its speed at a distance of 2.5 cm from the centre of oscillation is one-half the maximum speed. Find the amplitude and the maximum acceleration of the body.                                         [5 marks]

(c)   Define the following terms:

    (i)     Elastic Collision
    (ii)    Hooke's Law                                         [4 marks]

(d)   Box A contains 8 items of which 3 are defective, and box B contains 5 items of which 2 are defective. An item is drawn at random from each box.

    (i)     What is the probability that both items are non-defective?

    (ii)    What is the probability that one item is defective and one not?

    (iii)   If one item is defective and one is not, what is the probability that the defective time came form box A?                                         [5 marks]

(e)     A tank, of cross-sectional area 8m², contains water at a depth of 5m. The water is pumped out in 1.5 hours at 4 m/s to a similar sized tank whose base is 20m higher than the base of the first tank. Taking the density of water as 1000 kg/m³, find the average power of the pump. [6 marks]

(f)     A set of 20 observations was found to have a mean, $\bar{x} = 40$ and standard deviation, $S = 5$. Subsequent verification revealed that 2 observations, 30 and 45 were found to be wrong while the correct observations were 54 and 42. Determine the correct value of the mean and standard deviation if the wrong values were replaced with the correct ones. [5 marks]

## Question 2 (20 marks)

(a)     Define angular momentum of a rigid body. [2 marks]

(b)     A stationary horizontal hoop of mass 0.04 kg and radius 0.15m is dropped from a small height centrally and symmetrically onto a gramophone turntable which is freely rotating at 3.0 rad/s. Eventually the combined turntable and hoop rotate together with angular velocity 2.0 rad/s.

Calculate:

(i)     the moment of inertia of the turntable about the axis of rotation.

(ii)    the original and eventual kinetic energies of the turntable/hoop system and account for any change in kinetic energy.
(Note:  moment of inertia of hoop = $mr^2$) [5 marks]

(c)     Two particles A and B, whose masses are m and 2m, are moving along a straight line and in the same direction with speeds 3u and u respectively. The particles collide and continue to move in the same line and direction with B now having the greater speed. Find the velocities of the particles after the collision, assuming that it is perfectly elastic. [7 marks]

(d)     An object of mass m strikes an obstruction and gets deviated at an angle 30° from its original direction. If the speed of the object has change from $v_0$ to $v$, then find the magnitude of the impulse acting on the object. [6 marks]

## Question 3 (20 marks)

(a)     A lecturer prepared a frequency distribution for the marks obtained by his students as follows:

| Marks     | 0-10 | 10-20 | 20-30 | 30-40 | 40-50 |
|-----------|------|-------|-------|-------|-------|
| Frequency | 5    | 22    | 20    | 8     | 5     |

(b)    The region under the curve $y = e^{-x}$ and above [1,2] is revolved about the x-axis. Find the volume of the resulting solid of revolution.    [5 marks]

(c)    The region bounded below by the first quadrant of the curve $x^2 + y^2 = v^2$ is revolved about the x-axis. Find the area of the resulting surface of revolution.    [5 marks]

## QUESTION FIVE: (20 MARKS)

(a)    Find the area of the paraboloid which is obtained by revolving the parabolic arc $y = x^2$ $0 \leq x \leq \sqrt{2}$ around the y-axis.    [5 marks]

(b)    Find the length of the circle $x^2 + y^2 = v^2$.    [5 marks]

(c)    Consider the region R bounded above by $y = x^2$ below by the x-axis and lying between $x = 0$ and $x = 1$. Find the volume of the solid obtained by revolving R about

    (i)     the line y = -1
    (ii)    the line x = -2    [10 marks]

$$S = \sqrt{\frac{\Sigma x^2 - (\bar{x})^2}{(\Sigma f)}}$$

$$25 = \frac{\Sigma x^2}{20} - (40)^2$$

$$32500 - (30^2 + 45^2) + (54 -$$