

MUGA



UNIVERSITY OF NAIROBI

SECOND SEMESTER EXAMINATIONS 2009/2010

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

FEB 114: ENVIRONMENTAL AND BIOSYSTEMS ENGINEERING

FEE 112: ELECTRICAL AND ELECTRONIC ENGINEERING

FME 174: MECHANICAL ENGINEERING

FGE 174: GEOSPATIAL ENGINEERING

FCE 164: CIVIL ENGINEERING

APPLIED MATHEMATICS II

DATE: JULY 27, 2010

TIME: 8.30 A.M. – 10.30. A.M.

Instructions

- Answer QUESTION 1 and any other TWO QUESTIONS
- Use acceleration due to gravity as 10m/s^2

QUESTION 1

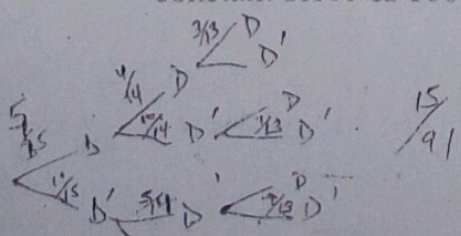
- (i) Define the terms:
- (i) Angular velocity (2 marks)
- (ii) Angular acceleration (1 mark)
- (ii) A particle of mass 0.32kg revolves uniformly in a circle on a horizontal frictionless surface. It is attached by a chord 0.5m long to a pin set in the surface. If the particle makes two complete revolutions in every 3 seconds, then find the force exerted on the particle by the chord. (5 marks)

$$P(3) = {}^{15}C_3 \left(\frac{1}{3}\right)^3 \left(\frac{2}{3}\right)^{12} \quad P(x) = {}^nC_r p^r q^{n-r}$$

- (iii) Water is pumped from a reservoir to a height of 5m, where it is ejected from a pipe with a cross-sectional area of 10cm^2 , at a rate of 120 litres per minute. Calculate the power needed. **(4 marks)**
- (iv) A particle P is performing Simple Harmonic motion about a fixed point, O . The amplitude of the motion is 0.2m and the maximum speed is 0.05m/s. Find the period of the motion. Write down, in terms of t , an expression for the displacement from O , t seconds after the particles passes O . **(5 marks)**
- (v) A bullet of mass 30g is fired with a velocity of 350m/s into a plastic block of mass 2.8kg which is lying on a smooth table. Find the velocity with which the block and bullet move after the bullet has become embedded in the block. **(5 marks)**
- (vi) Three light bulbs are chosen at random from 15 bulbs of which 5 are defective. Find the probability that:
- (i) None are defective 5C_3
 - (ii) Exactly one is defective
- (4 marks)**
- (vii) Grading system for a public university considers only the fourth and fifth year units registered for. For a student to get upper-second class honours, the mean mark for the 24 units a student registers for must be between 60 and 69, inclusive. The mean mark for the last 8 units a student registered for was 75 yet he was awarded an upper-second class degree. Determine the minimum and maximum arithmetic means for the other 16 units he had registered for earlier. **(4 marks)**

QUESTION 2

- (a) A particle is projected from a point O at time $t = 0$ and performs Simple Harmonic Motion with O as the centre of oscillation. The motion is of amplitude 20 cm and time period 4 seconds. Find:
- (i) The speed of projection.
 - (ii) The speed of the particle when $t = 1.5$ seconds.
- (6 marks)**
- (b) A ball of mass 500 grams is moving in a straight line with a speed of 3m/s, when it is struck a blow by a bat in the direction of motion. Assuming that the bat and the ball are in contact for 0.001 seconds, and that during this time, the bat exerts a constant force of 1000N on the ball, find:



$$v = \sqrt{u^2 - a^2}$$

- (i) The speed of the ball immediately after it has been struck. (8 marks)
- (ii) The distance moved by the ball while the bat was in contact with it. (6 marks)
- (c) One end of an elastic string of length 40cm is fixed and to the other end a mass of 8kg is attached which when in equilibrium stretches 10cm. The mass is pulled down a distance of 4cm below its equilibrium position and then released. Find the period of oscillation and the maximum kinetic energy. (6 marks)

QUESTION 3

- (a) What do you understand by the term "Energy"? Explain the various forms of mechanical energies. (4 marks)
- (b) An engine of mass 50 tonnes pulls a train of mass 250 tonnes up a gradient of 1 in 125 with a uniform speed of 36km/h.

Find the power transmitted by the engine, if the tractive resistance is 60 Newtons per tonne. Also find the power transmitted by the engine, if the acceleration of the engine is 0.2m/s^2 up the gradient. (10 marks)

- (c) A particle is set moving with kinetic energy F straight up an inclined plane inclination ϕ and coefficient of friction β .

Prove that the work done against friction before the particle comes to rest is

$$\frac{F\beta \cos \phi}{\sin \phi + \beta \cos \phi} \quad (6 \text{ marks})$$

9

QUESTION 4 (20 marks)

- (a) State the principle of conservation of linear momentum. Prove that the torque about the origin of a coordinate system is equal to the time rate change of angular momentum. (6 marks)

- (b) A particle of mass 3 units moves in a force field depending on time t given by:

$$\vec{F} = 30t^2\hat{i} + (36t - 15)\hat{j} - 21t\hat{k}$$

Given that at time $t=0$, the particle has the velocity $\vec{V}_0 = 2\hat{i} + 7\hat{j} - 4\hat{k}$,

- (i) Find the velocity of the particle at any time t .
(ii) Find the impulse in moving the particle from $t = 1$ to $t = 2$ and verify that the impulse is equal to the change in momentum. (8 marks)

- (c) An object of mass m strikes an obstruction and gets deviated by an angle 45° from its original direction. If the speed of the object has changed from u to v , then find the magnitude of the impulse acting on the object. (6 marks)

QUESTION 5

(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

- (i) Determine the lowest and highest marks obtained by the middle 50% of the students.
- (ii) The lecturer later discovered that there were some students who got marks between 50-60 but were left out. If these marks were considered the median of the data changed to 22. Determine the number of students whose marks were left out.

(10 marks)

(b) A manufacturer of a consumer electronics product expects 2% of units to fail during the warranty period. A sample of 500 independent units is tracked for warranty performance.

$$P(X) = {}^nC_x p^x q^{n-x}$$

- (i) What is the probability that none fails during the warranty period? $29 = q$
- (ii) What is the expected number of failures during the warranty period? $98 = \bar{x}$
- (iii) What is the probability that more than 2 units fail during the warranty period? $x = 500$

$$\bar{x} = nq$$

(5 marks)

(c) The number of surface flaws in plastic panels used in the interior of automobiles has a Poisson distribution with a mean of 0.05 flaws per square foot of plastic panel. An automobile interior contains 10 square feet of plastic panel.

- (i) What is the probability that there are no surface flaws in an automobiles interior?
- (ii) If 10 cars are sold to a rental company; what is the probability that at most 1 car has any surface flaws?

11