(Knowledge for Development)

KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS

2016/2017 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER

SPECIAL/ SUPPLEMENTARY EXAMINATION

FOR THE DEGREE OF BACHELOR OF SCIENCE

MATHEMATICS

COURSE CODE: MAT 106

COURSE TITLE: APPLIED MATHEMATICS

DATE: 12/09/17 **TIME:** 3 PM -5 PM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 6 Printed Pages. Please Turn Over.

QUESTION ONE (30 MARKS)

a) Define the following (2mks)

i) Composition of force

ii) Resolution of force

b) A brick rests on an inclined board with the coefficient of friction between the brick and the board being $\mu = 0.5$. One end of the board is lifted until the brick starts to slide. Determine the angle of inclination of the plank to the horizontal. (4mks)

c) A particle of mass 20kg is at limiting equilibrium on a rough plane which is inclined at an angle of 30^0 to the horizontal. Determine the coefficient of friction between the particle and the plane. (4mks)

d) Determine the acceleration of a 900kg car moving at 10m/s around a circle with a radius of 25.0m. (3mks)

e) Particle A of mass 10kg travelling at 15 m/s collides head-on with particle B of mass 20kg which is at rest. After collision B moves away at 5m/s. Determine the velocity of A after collision (3mks)

f) A load of mass 100g stretches a spring by 10.0 cm. The spring is then stretched by 5.0cm and released. Determine:

i) The spring constant (2mks)

ii) Maximum acceleration (2mks)

g) A car negotiates a turn of radius 80m at a speed of 12m/s. Determine the optimum banking angle for this curve. (3mks)

h) A block of mass 5kg attached to a spring undergoes simple harmonic motion with a period of T=0.5 sec. The total energy of the system is E=5.0 J Find (4mks)

a) Force constant of the spring.

b) Amplitude of motion.

i) calculate the power used when a force of 2kN pulls a crate along a level floor a distance of 10m in 50 seconds. (3mks)

QUESTION TWO (20 MARKS)

a) Define the following (2mks)

i) Uniform circular motion

ii) Centripetal force

b) i) For a body negotiating a corner on a banked road. Show that

$$\tan\theta = \frac{v^2}{Rg}$$ (5mks)

ii) A car of mass 800kg negotiates a turn of radius 80m at a speed of 12m/s. Find the centripetal force (3mks)

c) A 900kg car moving at 10m/s takes a turn around a circle with a radius of 25.0m. Determine: (5mks)

i) The acceleration of the car.

ii) The net force acting upon the car.

d) A 2 kg mass swings in a horizontal circle at the end of a cord of length 10m making an angle of 30^0 with the vertical. Find: (5mks)

i) The constant speed of the mass.

ii) The tension in the spring

QUESTION THREE (20 MARKS)

a) Find the kinetic energy of a wheel rotating at 4 rads/s given the mass is 3kg and the radius of gyration is 0.2m. (3mks)

b) A stone of mass m falls from rest through a distance h, hitting the ground with speed v. Show how the principal of the conservation of mechanical energy applies. (4mks)

c. i) A 3 kg rock swings in a circle of radius 5m. If its constant speed is 8m/s. Determine ; (4mks)

I) Centripetal acceleration

II) Centripetal force

ii) A skater moves with 15m/s in a circle of radius 30m.The ice exerts a central force of 450 N. What is the mass of the skater? (3mks)

d) A load of mass 500g stretches a spring by 10.0 cm. The spring is then stretched by 5.0cm and released. Determine:

i)The spring constant (2mks)

ii) Maximum acceleration (2mks)

iii)Velocity through equilibrium position. (2mks)

QUESTION FOUR (20 MARKS)

a) Define the terms (2mks)

i)Force

ii)Resultant Force

b)Given two forces F_1 and F_2 acting at a point O. Use parallelogram law of forces to show that

$R = \sqrt{F_1^2 + F_2^2 + F_1^2 F_2^2 COS\alpha}$ Where R is the resultant force (5mks)

c) Given that $\vec{r} = \vec{i} + 3\vec{j} - 2\vec{k}$ and $\vec{F} = \vec{i} + 5\vec{j} - \vec{k}$. Find the momentum ($M_O$) using vector cross product (4mks)

d) Particle A of mass 1kg travelling at 5 m/s collides head-on with particle B of mass 2kg travelling at 2m/s. After collision B moves away at 3m/s. At what velocity will A move.

(4mks)

a) Two students are playing by pulling on ropes connected to a hook in a rafter.The bigger one pulls on the rope with a force of 270N at an angle of 55^0 from the horizontal.The smaller student pulls with a force of 180N at an angle of 110^0 from the horizontal.

i) Which student is exerting the greatest vertical(downward) force on the hook (3mks)

ii) What is the resultant force (2mks)

QUESTION FIVE (20 MARKS)

a) Define the following terms (2mks)

i) Couple

ii) Force couple

b) A uniform plank 3 metres long is supported at a point under its mid-length. A lord of mass 10kg is placed at a distance of 0.5 metres from one end and a second load of mass 30kg placed at a distance of one metre from the other end. Find the resultant moment from the middle of the plank. (4mks)

c) A particle of mass 10kg is at limiting equilibrium on a rough plane which is inclined at an angle of 60^0 to the horizontal. Determine the coefficient of friction between the particle and the plane. (4mks)

d) A student throws a block of metal on a spring scales which oscillates about the equilibrium position with a period of T=0.5 seconds. The amplitude of vibration A=2.0 cm and path length is 4.0cm. Find:

i) Frequency (2mks)

ii) Maximum acceleration (2mks)

iii) Maximum velocity (2mks)

e) A hoist operated by an electric motor has a mass of 500kg. it raises a load of 300kg vertically at a steady speed of 0.2 m/s. Frictional resistance is at 1200N.Find the required power. (4mks)