(Knowledge for Development)

# KIBABII UNIVERSITY

## UNIVERSITY EXAMINATIONS

## 2017/2018 ACADEMIC YEAR

## FIRST YEAR FIRST SEMESTER

## MAIN EXAMINATION

## FOR THE DEGREE OF BACHELOR OF SCIENCE

**COURSE CODE:** **MAT 106**

**COURSE TITLE:** APPLIED MATHEMATICS

**DATE:** 10/01/18 **TIME:** 2 PM -4 PM

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## INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

## QUESTION ONE COMPULSORY (30MARKS)

a) Define the following terms. **(4mks)**

i) Moment of a force.

ii)Force couple.

b) A ball travelling horizontally at 9m/s rolls over the edge of a cliff. Determine the velocity of the ball after two seconds. **(3mks)**

c) Two particles A and B travelling in the opposite direction collide head-on. A has a mass of 2kg and was travelling at 5m/s while B has a mass of 3kg and a velocity of V m/s.After the collision they both move with a velocity of 3m/s. Determine the initial velocity of B. **(3**mks)

d) A block of weight 1000N resting on a smooth horizontal surface is pulled by a force $P = 500N$ inclined at an angle of $30^0$ to the horizontal as shown below:-


Determine:-

i) Normal reaction force on the block from the ground. **(3mks)**

ii) Horizontal frictional force from the ground which is needed to prevent the block from sliding. **(2mks)**

e)An object undergoes SHM in the y-direction at an amplitude of 120mm and a period of 36 seconds. You observe that after the start of your clock the object first crosses the y-axis going in the negative y direction at 15seconds.

i) Sketch the y-motion of the particle. **(2mks)**

ii)Calculate the phase angle. **(4mks)**

f) Given two forces $F_1$ and $F_2$ acting at a point Owith an angle $\alpha$ between them,using the parallelogram law of forces, show that:-

i) $R^2 = F_1^2 + F_2^2 + 2F_1F_2\cos\alpha$ **(4mks)**

ii)If $\alpha = 180^0$ ,show that $R = F_1 - F_2$ **(2mks)**

g) Show that for a body negotiating a corner on a balanced road.

$\tan\theta = \frac{v^2}{Rg}$ **(3mks)**

**QUESTION TWO. (20mks).**

a) A body of mass 2kg swings in a horizontal circle at the end of a cord of length 20m.Determine:-

i)The constant speed of the body if the rope makes an angle of $30^0$ with the vertical. **(4mks)**

ii) The tension in the string. **(3mks)**

iii) The centripetal force. **(3mks)**

b)A car of mass M travelling at 20m/s negotiates a bend which has a radius ofcurvature of 250m.. Given that the road is banked at an angle $\alpha$ so that the car is able to negotiate the corner.

i)By resolving forces vertically, find an equation relating N, the normal reaction, angle $\alpha$ and the mass M of the car. **(4mks)**

ii)Resolving forces horizontally,determine the inward force responsible for producing the centripetal acceleration if the mass of the car is 800kg. **(3mks)**

iii)Determine the value of angle $\alpha$ for which the car can not slide. **(3mks)**

**QUESTION THREE. (20mks).**

a)A load of mass 300g stretches a spring by 10cm.The spring is then stretched by 5.0cm and released. Determine:-

(i) The spring constant. **(3mks)**

ii)The maximum acceleration. **(4mks)**

iii)Velocity through equilibrium positions. **(4mks)**

iv)The equation of motion. **(4mks)**

b)For a simple pendulum oscillating at an angle $\theta$, show that $T_{string} = 2\pi\sqrt{\frac{L}{g}}$ where L is the length of the string. **(5mks)**

**QUESTION FOUR (20 MKS)**

a) Define **(2mks)**

i) Periodic motion

ii) Simple harmonic motion

b) 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 **(3mks)**

iii) Maximum velocity **(2mks)**

c) A particle of mass M is projected with a speed $v$ up a rough slope which is inclined at an angle $\theta$ to the horizontal. The coefficient of friction between the particle and the slope is $\mu$. Show that the maximum distance x travelled up the slope by the particle before it starts to slide down again is given by $x = \dfrac{v^2}{2g(\sin\theta + \mu\cos\theta)}$ **(6mks)**

d) i) Define moment of inertia **(1mk)**

ii) Show that the radius of gyration for a uniform rod of length L rotating about its end is 0.577L from that end. **(4mks)**

**QUESTION FIVE. (20mks).**

a)i) Define power. **(2mks)**

ii)Show that the power output of an engine which delivers W joules of work in a time T is given by $p = F \times v$ where $v$ is the speed **(6mks)**

b)A car of mass 800kg has an engine with a maximum power output of 50kw. Calculate the fastest speed the car can attain. **(12 mks)**

i) On a flatsurface,working against a constant resistance force of 1,000N. ii)With no resistance, but up a slope of $10^0$ iii)Up a slope inclined at $10^0$and with a resistance of 500N.
iv) Going down a slope inclined at $2^0$ and against a resistance of 1500N.