**CHUKA**                                    **UNIVERSITY**

## UNIVERSITY EXAMINATIONS

### FIRST YEAR EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF EDUCATION ARTS

**MATH 123/113: VECTORS AND MECHANICS**

**STREAMS: BED (ARTS)**                    **TIME: 2 HOURS**

**DAY/DATE: WEDNESDAY 25/07/2018**         **5.30 PM – 8.30 PM**

**INSTRUCTIONS:**

- **All Questions are Compulsory**
- **Do not write on the question paper**

**Question One (30 Marks)**

(a)     Define the following terms
(i)     Mechanics
(ii)    Vector
(iii)   Moment                                                    [3 marks]

(b)     Calculate the angle between the vectors

$$\tilde{a} = 4\tilde{i} - 2\tilde{j} + 1\tilde{h}$$
$$\tilde{b} = 2\tilde{i} + 5\tilde{j} - 7\tilde{k}$$

(c)     Given $\tilde{a} \cdot \tilde{b} = \tilde{a} \cdot \tilde{c}$, show that $\tilde{a}$ is perpendicular to $\tilde{b} - \tilde{c}$     [4 marks]

(d)     Given $\overrightarrow{AB} = \tilde{a}$ and $\overrightarrow{AC} = \tilde{b}$, show that the area of triangle ABC is given by Area
$\frac{1}{2}\sqrt{(ab)^2 - (\tilde{a} \cdot \tilde{b})^2}$                                          [4 marks]

(e)    Determine the co-ordinate of the point where the line $\tilde{r}=\begin{pmatrix} 5 \\ 3 \\ -1 \end{pmatrix}+1\begin{pmatrix} 1 \\ -4 \\ 2 \end{pmatrix}$ meets the   plane

$\tilde{r}\cdot\begin{pmatrix} 2 \\ 1 \\ 3 \end{pmatrix}=12$                                                                                     [5 marks]

(f)    Calculate the work done when a force $\vec{F}=-3\tilde{i}+4\tilde{j}-5\tilde{k}$ moves through a displacement
       $\tilde{d}=-\tilde{i}+3\tilde{j}-\tilde{k}$                                                                      [5 marks]

(g)    A projectile is launched at an angle $\theta$ to the horizontal with an initial velocity $v_o$m/s.
       show that its maximum range is given by $R_{max}=\dfrac{vo^2}{g}$                            [5 marks]

## Question Two (20 Marks)

(a)    A force whose point of application is $(1,-2,3)$ is given by $\vec{F}=2\tilde{i}+3\tilde{j}-4\tilde{k}$. Calculate
       the magnitude of the moment of the fore about the point $(1,2,-3)$            [5 marks]

(b)    Given $\vec{F}=\sin 2x\tilde{i}-3\cos y\tilde{j}+\tan z\tilde{k}$, determine D iv F at $\left(\dfrac{\pi}{2},\dfrac{\pi}{3},\dfrac{\pi}{4}\right)$

                                                                                                                   [4 marks]

(c)    Show that the magnitude of vector product of two vectors $\tilde{a}\wedge\tilde{b}$ is equal to the area of
       the parallelogram where $\tilde{a}\wedge\tilde{b}$ form adjacent sides.                    [5 marks]

(d)    If $\tilde{a}\wedge\tilde{b}$ are vectors and $m>0$ is a scalar, show that vector addition is distributive.
                                                                                                                   [5 marks]

## Question Three (20 Marks)

(a)    State Lami's theorem.                                                                            [2 marks]

(b)    A body of weight 50N hang from a string attached to a point on a vertical wall. The string
       will break if its tension exceeds 60N. if the body is pulled away from the wall by a
       horizontal force PN, what angle does the string make with the vertical when it breaks and
       what is the value of P?                                                                          [6 marks]

(c)    A particle moving in a straight line with constant acceleration travels 10m in the first
       second and 15M in the second second. Determine

       (i)     Its initial velocity                                                                     [2 marks]
       (ii)    Its acceleration                                                                         [2 marks]
       (iii)   The distance it travels during the third second.                                        [3 marks]

(d)    Calculate the volume of the parallelepiped defined by vectors

$2\tilde{i}-3\tilde{j}+4\tilde{k}, \tilde{i}-2\tilde{j}+\tilde{k} \wedge 4\tilde{i}+\tilde{j}-3\tilde{k}$                              [5 marks]

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