



**KENYATTA UNIVERSITY**  
**UNIVERSITY EXAMINATIONS 2011/2012**  
**INSTITUTIONAL BASED PROGRAMME (IBP) (DECEMBER SESSION)**  
**EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE**  
**SMA 431: DIFFERENTIAL GEOMETRY**

**DATE:** Wednesday 2<sup>nd</sup> May 2012

**TIME:** 8.00a.m – 10.00a.m

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**INSTRUCTIONS:**

Answer question ONE and any TWO of the remaining questions. Show all the necessary working

**QUESTION ONE (30 MARKS)**

- a) Define direction *cosine* of a vector  $\vec{a}$  show that

$$\cos \theta_i = \frac{a_i}{|\vec{a}|}, \quad i = 1, 2, 3 \quad [4\text{marks}]$$

- b) The graph of the equation  $r = 2 \cos \theta - 1$ ,  $0 \leq \theta \leq 2\pi$  in polar coordinates represents a curve. Show that this representation is regular. [4marks]

- c) Find the equation of the tangent line and normal plane to the curve  $x_1 = (1+t)$ ,  $x_2 = -t^2$ ,  $x_3 = (1+t^2)$  [5marks]

- d) Define curvature vector of a curve.

Find the curvature vector  $\vec{k}$  and curvature  $k$  on the curve

$$\vec{x} = t \vec{e}_1 + \frac{1}{2} t^2 \vec{e}_2 + \frac{1}{3} t^3 \vec{e}_3 \quad [7\text{marks}]$$

- e) Show that a curve of class  $\geq 3$  along which  $\vec{n}$  is of class  $C^1$  is a plane curve if and only if its torsion vanishes identically. [5marks]

- f) Find the equation of the tangent plane and normal line to the surface represented by

$$\vec{x} = u \vec{e}_1 + v \vec{e}_2 + (u^2 - v^2) \vec{e}_3$$

at the point corresponding to  $u = 1$ ,  $v = 1$ .

[5marks]

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