



MACHAKOS UNIVERSITY

ISO 9001:2008 Certified 

SCHOOL OF PURE AND APPLIED SCIENCES FOR THE BACHELOR'S DEGREE

DEPARTMENT OF CIVIL, ELECTRICAL AND MECHANICAL ENGINEERING

UNIVERSITY SUPPLEMENTARY EXAMINATION

ECU 104: ENGINEERING MATHEMATICS 1

INSTRUCTIONS:

- 1) Answer Question ONE and any other TWO questions.
- 2) Mobile phones and any written material are prohibited in the examination room.
- 3) No writing should be done on this question paper. Any rough work should be done at the back of the answer booklet and canceled.
- 4) All answer booklets should be handed in at the end of the exam whether used or not.
- 5) Programmable calculators are prohibited

QUESTION ONE (30 MARKS)

- (a) The angle between two lines is 45° . If the slope m_1 of l_1 is $\frac{2}{3}$. Determine the slope of l_2 . (3mks)
- (b) Find the equation of the circle which has the points $(0, -1)$ and $(2, 3)$ as ends of a diameter. (5mks)
- (c) Find the equation of the tangent at the point of contact $(8, -3)$ of the circle whose equation is $x^2 + y^2 - 6x + 4y - 12 = 0$. (5mks)
- (d) Prove that the circles $x^2 + y^2 - 16x - 12y + 75 = 0$ and $5x^2 + 5y^2 - 32x - 24y + 75 = 0$ touch each other. (5mks)
- (e) Determine the length of the tangent drawn from the point $(5, 7)$ to the circle $x^2 + y^2 - 4x - 6y + 9 = 0$. (5mks)
- (f) Derive the equation of the parabola with its vertex at $(3, 2)$ and its focus at $(5, 2)$. (4mks)
- (g) Convert the polar equation $r = 4 \sin \theta$ to rectangular form. (3mks)

QUESTION TWO (20 MARKS)

- (a) Show that the point $(1, 1)$ is equidistant from the lines $3x + 4y = 12$, $5x - 12y + 20 = 0$ and $4x - 3y = 6$. (6mks)
- (b) Find the equations of the tangent to the curve $xy = 6$ which are parallel to the curve $3y + 2x = 0$ (6mks)
- (c) A circle passes through the points $A(-5, 2)$, $B(-3, -4)$ and $C(1, 8)$. Find the point of intersection of the perpendicular bisectors of AB and BC. What is the equation of the circle? (8mks)

QUESTION THREE (20 MARKS)

- (a) Find the equations to the tangents and normal to the parabola $y^2 = 16x$ at points $(16, 16)$ and $(1, -4)$. The tangents intersect at the point T and normal intersect at R. Prove that the line TR is parallel to the axis of the parabola. (10mks)
- (b) Find the vertex, focus, equation of the directrix and the length of latus rectum if the equation of the parabola is $3x^2 - 9x - 5y - 2 = 0$. Hence sketch the curve. (10mks)

QUESTION FOUR (20 MARKS)

- (a) (i) For the vectors $a = i + 4j - 2k$ and $b = 2i - j + 3k$ find $a \times b$. (3mks)

(ii) Determine the angle between the vectors a and b when $a = i + 2j - 3k$ and

$$b = 2i - j + 4k. \quad (4\text{mks})$$

(b) A force $F = 10i + 2j - k$ newtons displaces an object from $A = i + j + k$ to $B = 2i - j + 3k$ (in metres). Find the work done. (5mks)

(c) Find the moment and magnitude of the moment of force of $(i + 2j - 3k)$ newtons about point b having coordinates $(0,1,1)$ when the forces acts on a line through A whose coordinates are $(1,3,4)$. (8mks)

QUESTION FIVE (20 MARKS)

(a) Find the coordinates of the centre, vertices and foci, the equations of the diretrices, the equations of the asymptotes and sketch the graph of the hyperbola whose equation is $9x^2 - 16y^2 - 18x - 64y - 199 = 0$. (10mks)

(b) Find the equations of the tangent and normal to the ellipse $5x^2 + 3y^2 = 137$, at the point in the first quadrant whose y coordinate is 2. (6mks)

(c) Derive the equation of the ellipse having its centre at the origin, one focus at $(0,3)$ and the length of semi-major axis 5. (4mks)