MACHAKOS UNIVERSITY

University Examinations for 2024/2025 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FIRST YEAR FIRST SEMESTER EXAMINATION FOR DEGREE IN

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING

BACHELOR OF SCIENCE IN CIVIL ENGINEERING

ECU 104/110: ENGINEERING MATHEMATICS 1

DATE: 16TH JANUARY, 2025 **TIME: 8.30 AM – 10.30 AM**

INSTRUCTIONS:

*Answer question **ONE (Compulsory)** and **any other TWO** questions*

QUESTION ONE (30 MARKS)

a) Find the coordinate of the Foci of the vertices and length of major axis, the minor axis, the eccentricity and the lactus of the ellipse. (5 Marks)

$$\frac{x^2}{25}+\frac{y^2}{9}=1$$

b) A tunnel has a shape of semi-ellipse that is 15 feet high from the centre and 36 ft across the base. At most how high should a passing truck be if it is 12 ft wide for it to be able to fit through the tunnel? (5 Marks)

c) Find the Centre and radius of the circle

$$4x^2+4y^2-4x+8y-1=0$$ (4 Marks)

d) Graph the parabola, label its vertex, axis and intercept

$$y = x^2 - 2x - 3$$ (4 Marks)

$$y = \frac{-1}{4}x^2 - 2x + 3$$ (4 Marks)

e) State which of the following are scalar and which are vectors. (5 Marks)

i) Weight

ii) Magnetic field intensity

iii) Volume

iv) Energy

v) Speed

f) Determine the equation of the tangent at the point indicated

$f(x) = 5x^3 + 12x^2 - 7x \quad at \quad x = -1 \; and \; 1$ (3 Marks)

QUESTION TWO (20 MARKS)

a) Express the given cartesian coordinate as polar coordinate correct to 2dp both in degree and radians

i) (6.18, 2.35) (3 Marks)

ii) (-2.4,3.6) (3 Marks)

b) Sketch the curve $x = \sqrt{1 - \left(\frac{y}{6}\right)^2}$ (5 Marks)

c) Determine the angle in degrees and minutes subtended at the center of a circle of diameter 42 mm by an arc of length 36m. calculate also that of the minor sector. (5 Marks)

d) Line A passes through the point (-3,-1) and (-1,9) line B passes through the points (-2,1) and (K,4). Line A and line B are perpendicular. Find the value of K. (4 Marks)

QUESTION THREE (20 MARKS)

a) Express (4.5, 5.16 rad) in cartesian coordinate (3 Marks)

b) Determine

i) The radius (2 Marks)

ii) The coordinate of the circle (2 Marks)

given by the equation $x^2 + y^2 + 8x + -2y + 8 = 0$

c) Resolve the acceleration vector of 17m/s^2 at an angle of 120^0 to the horizontal in to the horizontal and a vertical component. (4 Marks)

d) A ship heads on a course due south at 12km/h. it is moved off course by a current flowing in a north-easterly direction at 8 km/h. determine the resultant velocity. (3 Marks)

e) Find the equation of the line parallel to 2x +5y =10 (3 Marks)

f) Determine the equation of the tangent at the point indicated

$$f(x) = sin\ 2x \qquad at \quad x = 0\ and\ {}^{\pi}/_{6}$$ (3 Marks)

QUESTION FOUR (20 MARKS)

a) Given r_1 =3i-2j+k, r_2 =2i-4j-3k, r_3 =-i+2j+2k find the magnitude of

$r_1 + r_2 + r_3$ (3 Marks)

$2r_1 - 3\ r_2 - 5\ r_3$ (3 Marks)

b) Find a unit vector parallel to the resultant of vectors

r_1 =2i+4j-5k,

r_2 =i+2j+3k (4 Marks)

c) find the equation of the tangent and the equation of the normal to the curve

$y = x + \frac{1}{x}$ at the point where x =2 (4 Marks)

d) Find the equation of the hyperbola with foci (5,2) and (-1,2) whose transverse axis is 4 units long. (6 Marks)

QUESTION FIVE (20 MARKS)

a) Find the coordinates of the center, foci and vertices and the equations of the asymptotes of

$$\frac{(y-2)^2}{64} - \frac{(x+1)^2}{36}$$ (7 Marks)

b) Find a vector of magnitude 11 in the direction opposite to that of $\overrightarrow{PQ}$, where P and Q are the points (1,3,2) and t (-1,0,8), respectively. (7 Marks)

c) Find the unit vector in the direction of the sum of the vectors

$$\vec{a} = 2\hat{i} - \hat{j} + 2\hat{k}$$

$$\vec{b} = -\hat{i} + \hat{j} + 3\hat{k}$$ (6 Marks