



# MACHAKOS UNIVERSITY

University Examinations for 2022/2023 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF MATHEMATICS AND STATISTICS

FIRST YEAR FIRST SEMESTER EXAMINATIONS FOR

BACHELOR OF SCIENCE (ELECTRICAL AND ELECTRONICS ENGINEERING)

BACHELOR OF SCIENCE (CIVIL ENGINEERING)

BACHELOR OF SCIENCE (MECHANICAL ENGINEERING)

ECU 101: ENGINEERING MATHEMATICS I

DATE:

TIME:

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## INSTRUCTIONS TO CANDIDATES.

Answer question ONE and any other TWO questions.

### QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Find the coordinate of the Foci of the vertices and length of major axis, the minor axis, the eccentricity and the latus rectum 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 4mks

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

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

$$y = x^2 - 2x - 3 \quad (4 \text{ marks})$$

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

- 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  
 $f(x) = 5x^3 + 12x^2 - 7x$  at  $x = -1$  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
- (6.18, 2.35) (3 marks)
- (-2.4, 3.6) (3 marks)
- Sketch the curve  $x = \sqrt{1 - \left(\frac{y}{6}\right)^2}$  (5 marks)
- b) Determine the angle in degrees and minutes subtended at the centre of a circle of diameter 42 mm by an arc of length 36m. calculate also that of the minor sector. (5 marks)
- c) 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 2mks  
given by the equation  $x^2 + y^2 + 8x + -2y + 8 = 0$
- c) Resolve the acceleration vector of  $17\text{m/s}^2$  at an angle of  $120^\circ$  to the horizontal in to the horizontal and a vertical component (4 marks)
- d) A ship heads on a course due south at  $12\text{km/h}$ . it is moved off course by a current flowing in a north-easterly direction at  $8\text{ km/h}$ . 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  
 $f(x) = \sin 2x$  at  $x = 0$  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)

$2r_1 - 3r_2 - 5r_3$  (3 marks)

b) Find a unit vector parallel to the resultant of vectors  $r_1 = 2i + 4j - 5k$ ,  
 $r_2 = i + 2j + 3k$  4mks

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)

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 (6 marks)

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

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