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UNIVERSITY EXAMINATIONS 2023/2024

SECOND YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING

SME 3200: ENGINEERING MATHEMATICS III /GEOMETRY

DATE: APRIL 2024 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

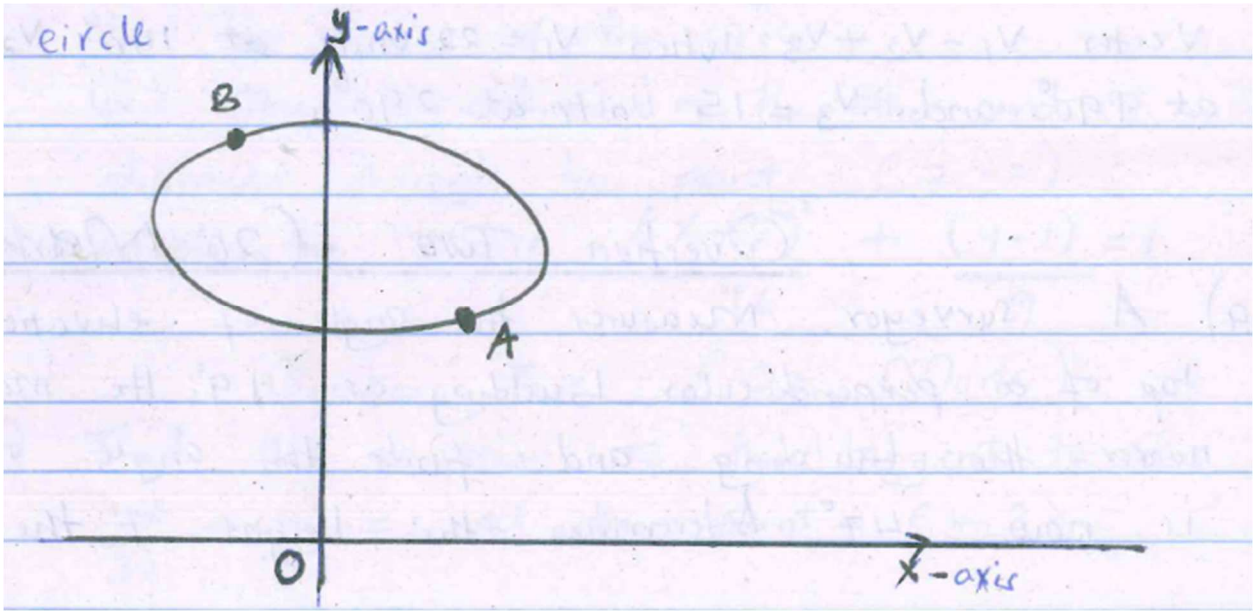
a) The line L_1 is perpendicular to the line L_2 and the equation of the line L_2 is given as $4y + 5x = 6$. The points A (4,2) and B (8,6) lies on the line L_2. If the line L_1 cuts the line L_2 at m, where m is the midpoint of AB:

i. Find the gradient of line L_1. (2 Marks)

ii. Find the equation of the line L_1. (4 Marks)

iii. Find the angle θ the line L_1 makes with the x-axis. (3 Marks)

b) The figure below shows the point A (4,6) and B (-2,14), which both lie on the circumference of a circle:



Given that AB is a diameter of a circle, determine an equation for the circle. (3 Marks)

c) Find the distance from point P(-2,-3) to the line $8x + 15y - 24 = 0$. (2 Marks)

d) Find the tangent to the circle at the point P (7,12) if the equation has centre c (4,8). (3 Marks)

e) Find the equation of the parabola whose focus if F (2,0) and the directrix is $x = -2$ (2 Marks)

f) Determine the eccentricity, the foci and the length of the latus rectum of the hyperbola $\frac{x^2}{25} - \frac{y^2}{9} = -1$. (3 Marks)

g) Find the polar equation of the ellipse $x^2 + 9y^2 = 9$. (2 Marks)

h) An electricity pylon stands on horizontal ground. At a point 80m from the base of the pylon, the angle of elevation of the top of the pylon is 23^0. Calculate the height of the pylon to the nearest metre. (3 Marks)

i) Calculate the magnitude and the resultant of the vector $v_1 - v_2 + v_3$ when $v_1 = 22$ units at 140^0, $v_2 = 40$ units at 190^0 and $v_3 = 15$ units at 290^0. (3 Marks)

QUESTION TWO (20 MARKS)

a) A surveyor measures the angle of elevation of the top of perpendicular building as 19^0. He moves 120m nearer the building and finds the angle of elevation is now 47^0. Determine the height of the building. (7 Marks)

b) A force of 5N is inclined at an angle of 45^0 to a second force of 8 N, both forces acting at a point. Calculate the magnitude of the resultant of these two forces and the direction of the resultant with respect to the 8 N force. (8 Marks)

c) Rewrite the equation $^1/_3\,x + {}^2/_5\,y + {}^1/_6 = 0$ in the form $\frac{x}{a} + \frac{y}{b} = 1$, hence determine the x-intercept and the y-intercept. (5 Marks)

QUESTION THREE (20 MARKS)

a) The line $Ax + 2y = B$ passes through the point (-3,5) and is perpendicular to the line $2x - y = 4$. Determine the values of A and B. (5 Marks)

b) Find the equation of the tangent to a circle whose equation is $x^2 - 8x + y^2 - 6y + 15 = 0$ at the point (7,2). (6 Marks)

c) A triangle ABC has sides a = 9.0 cm, b = 7.5 cm and c = 6.5m. determine its three angles and its area. (9 Marks)

QUESTION FOUR (20 MARKS)

a) The circle given by the equation $x^2 + y^2 - 6x + 4y + k = 0$ passes through the point (2,2). Determine:

i. The value of K. (2 Marks)

ii. The co-ordinates of the centre of the circle. (3 Marks)

iii. The radius of the circle. (3 Marks)

iv. The co-ordinates of the other end of the diameter through the point (2,-2) (4 Marks)

b) Graph the ellipse $\frac{(x+2)^2}{16} + \frac{(y-1)^2}{9} = 1$. (8 Marks)

QUESTION FIVE (20 MARKS)

a) Find the equation of the tangent to the ellipse $\frac{x^2}{32} + \frac{y^2}{8} = 1$ at the point (4,3). (5 Marks)

b) The equation of a parabola is given by $x = 2y^2 - 4y + 6$. Locate the vertex, the y-intercepts and the line of symmetry. (8 Marks)

c) Graph the hyperbola $\frac{(x-3)^2}{25} - \frac{(y+4)^2}{36} = 1$. (7 Marks)