



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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University Examinations 2023/2024

SECOND YEAR FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING, BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING AND BACHELOR OF TECHNOLOGY IN ELECTRICAL AND ELECTRONIC ENGINEERING

SME 3200: MATHEMATICS III/GEOMETRY

DATE: DECEMBER 2023

TIME: 2 HOURS

INSTRUCTIONS: Answer question *one* and any other *two* questions

QUESTION ONE (30 MARKS)

- a) Determine the directed distance from the line $L : 4x - y + 2 = 0$ to the point $p(3,2)$ (4 marks)
- b) Find the centre and the radius of a circle whose equation is given as $x^2 + y^2 - 16x + 24y + 127 = 0$ (4 marks)
- c) Calculate the angle between the lines $3x + y = 4$ and $x - y = 2$ (3 marks)
- d) A parabola has an equation $y = -3x^2 - 12x - 9$. Rewrite the equation in the form $y = a(x - h)^2 + k$ and hence determine the vertex, x-intercepts and the line of symmetry of the parabola (5 marks)
- e) A line whose equation is $y = mx + 8$ makes an angle of 75.97° with the x-axis. Find the coordinates of the point where the line cuts the x-axis (4 marks)

- f) Three constant forces $f_1 = 12i - 15j + 6k$, $f_2 = i + 2j - 2k$ and $f_3 = 2i + 8j + k$ act on a point P displacing it from $2i - 3j + k$ to $4i + 2j + k$. Determine the work done
(4 marks)
- g) Given that $\sinh x = \frac{3}{4}$, find the value of x expressing the answer as natural logarithm
(3 marks)
- h) A force $R = 2\hat{i} + 3\hat{j} + \hat{k}$ Newtons is applied at a point O, with position vector $3\hat{j}$. Calculate moment about O and hence its magnitude
(3 marks)

QUESTION TWO (20 MARKS)

- a) Find the area of a triangle whose vertices are $P(3, -1, 2)$, $Q(1, -1, -3)$ and $R(1, -3, 1)$
(6 marks)
- b) The equation of an ellipse is given by $16x^2 + 25y^2 - 64x - 100y - 236 = 0$. Find
- The centre, foci and eccentricity of the ellipse (6 marks)
 - The co-ordinates of its vertices and hence sketch the ellipse (4 marks)
- c) Given that $\cosh x = \frac{17}{15}$, calculate $\sinh x$ and $\tanh x$ (4 marks)

QUESTION THREE (20 MARKS)

- a) The equation of hyperbola is given by $16x^2 - 9y^2 - 32x - 54y - 641 = 0$. Determine the centre, vertices and asymptotes of the hyperbola
(8 marks)
- b) Solve for x in the equation $3 \cosh 2x + 5 \sinh 2x = 22$ (6 marks)
- c) Prove the following hyperbolic identities
- $\sinh 2x = 2 \sinh x \cosh x$ (3 marks)
 - $\sinh(x + y) = \sinh x \cosh y + \cosh x \sinh y$ (3 marks)

QUESTION FOUR (20 MARKS)

- a) Find the angle between $\alpha = -5\hat{i} + \hat{j} + 7\hat{k}$ and $B = -2i - 6j + k$ (4 marks)
- b) A line passing through $P(4,5)$ and $Q(h,2)$ is perpendicular to another line whose equation is $3y + x + 3 = 0$
- Find the value of h (2 marks)
 - Determine the equation of PQ in the form $y = mx + c$ (2 marks)
 - Find the x-intercept and y-intercept of PQ (2 marks)
- c) The parametric equations of a functions are given by $x = 2 \sin t$ and $y = 3 \cos 2t$.
- Determine dy/dx and d^2y/dx^2 (6 marks)
- d) Given that $\phi = x^2 yz^3 + xy^2 z^2$, $\frac{\partial \phi}{\partial x}$, $\frac{\partial \phi}{\partial y}$ and $\frac{\partial \phi}{\partial z}$ at $p(1,3,2)$ (4 marks)

QUESTION FIVE (20 MARKS)

- a) A circle whose equation is $x^2 - 8x + y^2 - 6y + 15 = 0$ has a tangent at the point $(7,2)$.
Determine the equation of the tangent (6 marks)
- b) Solve the equation $2 \cosh 2x + 10 \sinh 2x - 5 = 0$ (4 marks)
- c) An ellipse has an equation $4x^2 + 25y^2 - 100 = 0$. Determine the length of its major and minor axis (4 marks)
- d) An object moves on space such that at a time t , its position is given by
 $x = 2t + 3$, $y = t^2 + 3t$ and $z = t^3 + 2t^2$. Given that $r = x(t)i + y(t)j + z(t)k$, find at $t = 2$
- dr/dt (3 marks)
 - d^2r/dt^2 (3 marks)