



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

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University Examinations 2022/2023

SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN CIVIL ENGINEERING

SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

SPECIAL/SUPPLEMENTARY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN ELECTRICAL ENGINEERING

SME 3100: CALCULUS/MATHEMATICS 1

DATE: AUGUST 2023

TIME: 2 HOURS

INSTRUCTIONS: Answer question one and any other two questions

QUESTION ONE (30 MARKS)

- State the fundamental theorem of calculus (2 marks)
 - Find the derivative of $f(x) = 4\sqrt{x}$ using the delta method; hence find $f'(2)$ (6 marks)
 - Use the quotient rule to find the first derivative of $f(x) = 2 \tan x$ with respect to x (3 marks)
 - Compute $\frac{dy}{dx}$ given that $xy^5 - y^3 + 2x + 3 = 0$ (4 marks)
 - Find the velocity of a body moving in a straight line with a displacement given in meters by the function $S = t^3 - 2t + 4$ at time $t = 5$ seconds (2 marks)
 - Find:
 - $\int (x - 2)(x + 3) dx$ (2 marks)
 - $\int e^{3x+1} dx$ (2 marks)
 - Find $\frac{dy}{dx}$ and $\frac{dy^2}{dx^2}$ given that $x = t^3 - t, y = 4 - t^2$ (5 marks)
 - Find the stationary points of the function $f(x) = x^3 - 3x^2 + 2$ (4 marks)
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QUESTION TWO (20 MARKS)

- a) Differentiate the function $f(x) = x^x$ with respect to x for $x > 0$ (4 marks)
- b) Find $\frac{d}{dx}$ of $f(x)$ given that
- (i) $f(x) = \log_{10}(4x^2 - 3x - 5)$ (3 marks)
- (ii) $g(x) = \frac{4^x}{\cos x}$ (3 marks)
- c) Differentiate the function $y = \tan^{-1}x$ with respect to x (4 marks)
- d) The function of $y = ax^2 + bx + c$ has a gradient function $g(x) = 6x + 2$ and a stationary value of 1. Find the value of the constants a , b and c (6 marks)

QUESTION THREE (20 MARKS)

- a) Use the gradient method to classify the turning points of the function $f(x) = \frac{1}{4}(x^4 - 4x^3)$ (10 marks)
- b) A rectangular cardboard measuring 15cm by 24 cm is used to make a box (open top) by cutting equal squares out of the corners and folding up the flaps. Find the dimensions for which the box will have greatest volume (6 marks)
- c) Find $d/dx \left[\int_0^{x^2} 2/t \, dt \right]$ (4 marks)

QUESTION FOUR (20 MARKS)

- a) Find y^0 given that:
- (i) $y = 2e^x - 3\ln x$ (3 marks)
- (ii) $y = 8^x - \frac{1x^4}{4} + 9$ (3 marks)
- b) Use logarithmic differentiation to find dy/dx given that $y = x^{2x} + 1$ (6 marks)
- c) Find the equation of the tangent line and Normal line to the curve $y = 2x^3 + 4x^2 + 18$ at the point $x = 2$ (5 marks)
- d) An object moves along a straight line with velocity $v(t) = t^2$ for $t > 0$. How far does the object travel between the times $t = 1$ and $t = 2$? (3 marks)

QUESTION FIVE (20 MARKS)

a) Evaluate the integrals:

(i) $\int_0^1 (5x^3 - 3x^2) dx$ (2 marks)

(ii) $\int_0^\pi \sec^2 x dx$ (3 marks)

(iii) $\int_0^{\frac{\pi}{2}} \sec(2x) dx$ (2 marks)

b) Use the method of derivatives to classify the turning points of the function (13 marks)

$$h(x) = \frac{x^4}{4} - x^3$$