NAMIBIA UNIVERSITY
OF SCIENCE AND TECHNOLOGY

FACULTY OF HEALTH, NATURAL RESOURCES AND APPLIED SCIENCES

SCHOOL OF AGRICULTURE AND NATURAL RESOURCES SCIENCES

DEPARTMENT OF AGRICULTURAL SCIENCES AND AGRIBUSINESS

QUALIFICATION: BACHELOR OF SCIENCE IN AGRICULTURE	
QUALIFICATION CODE: 07BAGA	LEVEL: 7
COURSE CODE: MTA611S	COURSE NAME: MATHEMATICS FOR AGRIBUSINESS
SESSION: JULY 2025	PAPER: 2
DURATION: 3 HOURS	MARKS: 100

SECOND OPPORTUNITY EXAMINATION QUESTION PAPER	
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MODERATOR:	DR TEOFILUS SHIIMI

INSTRUCTIONS
1. Attempt all questions. 2. Write clearly and neatly. 3. Number the answers clearly & correctly.

PERMISSIBLE MATERIALS

1. All written work MUST be done in blue or black ink
2. Calculators allowed
3. The LAST PAGE have FORMULAS

This question paper consists of 6 pages including the front page

QUESTION ONE

a. Give concise definitions of the following concepts related to functions:
   i. Domain **(2)**
   ii. Range **(2)**

b. Consider a function $f(x) = \log_e(x^2 - 2x - 8)$, compute $f(10)$, and use interval or set notation to express the domain of a function. **(6)**

c. Use interval notation to express the domain and the range of the function:

$$h(x) = \frac{2x-3}{x^2-16}$$ **(5)**

d. A vendor's total monthly revenue is from the sale of x bags potatoes is represented by a function:

$$r = 150x$$

Furthermore, the vendor's total month costs are given by $c = 100x + 3500$.

Compute, how many bags of potatoes must the vendor sale to break even? **(5)**

(Hint: break even means revenue is equal to cost).

TOTAL MARKS **[20]**

QUESTION TWO

a. Use mathematical expressions to concisely define the following concepts:
   i. Regular limit. **(2)**
   ii. Newton's Difference Quotient. **(2)**

b. Briefly describe at least two algebraic approaches you would use to find the limit of a function at a given point, $x = a$. **(4)**

c. Find the limits of the following functions:

   i. $\lim_{x \to a}(x^3 + 4x^2 - 3)$ **(2)**

   ii. $\lim_{x \to l} \frac{x^4+x^2-1}{x^2+5}$ **(3)**

   iii. $\lim_{x \to 18} \frac{\sqrt{x-2}-2}{x-18}$ **(5)**

d. Find the equation of a straight-line that is tangent to the curve:

$$y = 2m^2 - 4m - 48$$

$$at\ m = 4$$ **(7)**

TOTAL MARKS **[25]**

QUESTION THREE

a. Define the following concepts:
   i. Cross derivative (2)
   ii. Partial derivative (2)

b. Find the second derivatives of the following functions:
   i. $f(m) = (3m^4 - 10)^8$ (5)
   ii. $g(x) = x^2\sqrt{625 - x^2}$ (5)

c. Given a function:

$$m(x, y) = 4e^{8-2x}y^{\frac{8}{3}} + x^3y^4$$

Find m_x, m_y *and* m_{yx}. (8)

d. Optimize the following function by (i) finding the critical value(s) at which the function is optimized and (ii) testing the second-order condition to distinguish between a relative maximum or minimum.

$$q(x) = x^3 - 6x^2 - 135x + 4 \quad (8)$$

TOTAL MARKS [30]

QUESTION FOUR

a. Solve the following indefinite integral:

i. $\int 3m^3(m^4 + 2m)^2\, dm$ (6)

ii. $\int_3^5 2m + 9m^2\, dm$ (4)

iii. $\int_0^1 (3x^3 - x + 1)\, dx$ (4)

b. To produce 70 tons of wheat, an agribusiness wishes to distribute production between its two farms, farm 1 and farm 2. The total cost of wheat production, c, is given by the function:

$$c = 4{q_1}^2 + 2q_1q_2 + 5{q^2}_2 + 1000$$ (11)

where q_1 and q_2 are tons of wheat produced at farm 1 and farm 2, respectively. How should the agribusiness have distributed to production between the two farms to minimize costs? Furthermore, compute (λ).

TOTAL MARKS **[25]**

THE END

FORMULA

Basic Derivative Rules

Constant Rule: $\frac{d}{dx}(c) = 0$

Constant Multiple Rule: $\frac{d}{dx}[cf(x)] = cf'(x)$

Power Rule: $\frac{d}{dx}(x^n) = nx^{n-1}$

Sum Rule: $\frac{d}{dx}[f(x) + g(x)] = f'(x) + g'(x)$

Difference Rule: $\frac{d}{dx}[f(x) - g(x)] = f'(x) - g'(x)$

Product Rule: $\frac{d}{dx}[f(x)g(x)] = f(x)g'(x) + g(x)f'(x)$

Quotient Rule: $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)f'(x) - f(x)g'(x)}{[g(x)]^2}$

Chain Rule: $\frac{d}{dx}f(g(x)) = f'(g(x))g'(x)$

Derivative Rules for Exponential Functions

$$\frac{d}{dx}(e^x) = e^x$$
$$\frac{d}{dx}(a^x) = a^x \ln a$$
$$\frac{d}{dx}(e^{g(x)}) = e^{g(x)}g'(x)$$
$$\frac{d}{dx}(a^{g(x)}) = \ln(a)\, a^{g(x)}\, g'(x)$$

Derivative Rules for Logarithmic Functions

$$\frac{d}{dx}(\ln x) = \frac{1}{x}, x > 0$$
$$\frac{d}{dx}\ln(g(x)) = \frac{g'(x)}{g(x)}$$
$$\frac{d}{dx}(\log_a x) = \frac{1}{x \ln a}, x > 0$$
$$\frac{d}{dx}(\log_a g(x)) = \frac{g'(x)}{g(x)\ln a}$$

Basic Integration Rules

1. $\int a\,dx = ax + C$
2. $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C, \quad n \neq -1$
3. $\int \frac{1}{x}dx = \ln|x| + C$
4. $\int e^x\,dx = e^x + C$
5. $\int a^x dx = \frac{a^x}{\ln a} + C$
6. $\int \ln x\,dx = x\ln x - x + C$

Integration by Parts

The formula for the method of integration by parts is:

$$\int u dv = u \cdot v - \int v du$$

There are three steps how to use this formula:

- Step 1: identify *u* and *dv*
- Step 2: compute *u* and *du*
- Step 3: Use the integration by parts formula

Integration by Substitution

The following are the 5 steps for using the integration by substitution metthod:

- Step 1: Choose a new variable *u*
- Step 2: Determine the value *dx*
- Step 3: Make the substitution
- Step 4: Integrate resulting integral
- Step 5: Return to the initial variable *x*

Unconstrained optimization: Univariate functions

The following are the steps for finding a solution to an unconstrained optimization problem:

- Step 1: Find the critical value(s), such that:

  $$f'(a) = 0$$

- Step 2: Evaluate for relative maxima or minima
  - If $f''(a) > 0 \rightarrow$ minima
  - If $f''(a) > 0 \rightarrow$ maxima

Unconstrained optimization: Multivariate functions

The following are the steps for finding a solution to an unconstrained optimization problem:

$f'(a) = 0$	$f''(a) > 0$:	relative minimum at $x = a$
$f'(a) = 0$	$f''(a) < 0$:	relative maximum at $x = a$

Condition	*Minimum*	*Maximum*
FOCs or necessary conditions	$f_1 = f_2 = 0$	$f_1 = f_2 = 0$
SOCs or sufficient conditions	$f_{11} > 0$, $f_{22} > 0$, and $f_{11} \cdot f_{22} > (f_{12})^2$	$f_{11} < 0$, $f_{22} < 0$, and $f_{11} \cdot f_{22} > (f_{12})^2$
	Inflection point	
	$f_{11} < 0$, $f_{22} < 0$, and $f_{11} \cdot f_{22} < (f_{12})^2$ or $f_{11} < 0$, $f_{22} < 0$, and $f_{11} \cdot f_{22} < (f_{12})^2$	
	Saddle point	
	$f_{11} > 0$, $f_{22} < 0$, and $f_{11} \cdot f_{22} < (f_{12})^2$, or $f_{11} < 0$, $f_{22} > 0$, and $f_{11} \cdot f_{22} < (f_{12})^2$	
	Inconclusive	
	$f_{11} \cdot f_{22} = (f_{12})^2$	

Constrained Optimization

The following are the steps for finding a solution to a constrained optimization problem using the Langrage technique:

- Step 1: Set up the Langrage equation
- Step 2: Derive the First Order Equations
- Step 3: Solve the First Order Equations
- Step 4: Estimate the Langrage Multiplier