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MA110 - MATHEMATICAL METHODS

Time allowed: Two hours (2:00 hours)

Instructions:

1. You must write your **Name**, your **Computer Number and programme of study** on your answer sheet.
2. Calculators are **not** allowed in this paper.
3. There are three (3) questions in this paper, Attempt **All** questions and show **detailed** working for full credit

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QUESTION ONE

a) (i) If $C \subset D$, then simplify if possible $C' \cup D'$ **(2.5 marks)**

(ii) Express 1.171717..... as a fraction $\frac{a}{b}$ in its simplest form where a and b are integers and $b \neq 0$. **(2.5 marks)**

b) Consider the binary operation $a * b = a + b - 2ab$, where a and b are real numbers.

(i) Is * a binary operation on the set of real numbers? Give reason for your answer. **(1) Mark**

(ii) Is the operation * commutative? If not give a counter example. **(1) Mark**

(iii) Find the value of $1*(2*3)$ and $(1*2)*3$ and state whether * is associative **(3) Marks**

c) Given the rational function $f(x) = \frac{x+2}{x-2}$. Sketch its graph indicating its domain and range, all the asymptotes and intercepts. **(5 Marks)**

d) Prove that $\sqrt{2}$ is an irrational number **(5 Marks)**

e) Let $f(x) = \frac{x+1}{x-1}$ and $g(x) = \sqrt{x}$. Find $(g \circ f)(x)$ and determine the domain **(5 Marks)**

QUESTION TWO

a) Using the associative and distributive properties of union and intersection of sets .Show that

$$A \cup B = (A \cap B) \cup (A \cap B') \cup (A' \cap B)$$ (5 Marks)

b) Let α and β be the roots of the quadratic equation $3x^2 + 2x + 5 = 0$. Find a quadratic equation whose roots are $\frac{1}{\alpha^2}$ and $\frac{1}{\beta^2}$ without calculating α and β (5 Marks)

c) Solve the given radical function inequality $\sqrt{2} - \sqrt{x+6} \leq -\sqrt{x}$ (5 Marks)

d) Solve for x and y given that:

$$\frac{x}{1+i} - \frac{y}{2-i} = \frac{1-5i}{3-2i}$$ (5 Marks)

e) Show that the function f defined by $f(x) = \frac{2x}{x-1}$ $x \in R$, is a bijection on R on to $\{y \in R : y \neq 2\}$ (5 Marks)

QUESTION THREE

a) Use the Rational root theorem to solve $x^3 - 4x^2 + 8 = 0$ (5 Marks)

b) Rationalize the denominator $\frac{1}{(\sqrt{2}+1)(\sqrt{3}-1)}$ (5 Marks)

c) (i) Determine whether the function $f(x) = x^4 + x^2 + 1$ even, odd or neither. (2.5 marks)

(ii) Let $A = \{x \in \mathbb{R} : -4 \leq x < 2\}$ and $B = \{x \in \mathbb{R} : x \geq -1\}$.
Find a) $A \cap B$ b) A' (2.5 marks)

d) What are the dimensions of the largest rectangular field which can be enclosed by 1200 m of fencing? (5 Marks)

e) Sketch the graph of $f(x) = |2x + 1|$. On the same diagram sketch also the graph of $g(x) = \sqrt{1 - 2x}$ and , hence, find the values such that $\sqrt{1 - 2x} > |2x + 1|$ (5 Marks)

MA110 - MATHEMATICAL METHODS TEST 2

Time allowed: Two hours thirty minutes (2:30)

Instructions:

1. You must write your **Name**, your **Computer Number and programme of study** on your answer sheet.
2. Calculators are **not** allowed in this paper.
3. There are four (4) questions in this paper, Attempt **All** questions and show **detailed** working for full credit

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QUESTION ONE

a) Express $\frac{2x+1}{x^3-1}$ in partial fractions (5marks)

b) Find the centre and length of a radius of the given circle and graph it $x^2 + y^2 - 10x = 0$. (5marks)

c) Prove the result by induction. $1 \times 3 + 2 \times 4 + \cdots + n(n+2) = \frac{1}{6}n(n+1)(2n+7)$ (5marks)

d) Find the 4^{th} term in the binomial expansion $\left(2 - \frac{x}{2}\right)^9$ (5marks)

e) If $xy = 64$ and $log_x y + log_y x = \frac{5}{2}$, Find x and y. (5marks)

QUESTION TWO

a) A is the point $(-1, 2)$, B is the point $(2, 3)$ and C is the point $(3, 5)$. P is a point which divides BC in the ratio 3 : 4 and Q lies on AB such that $AQ = \frac{2}{5}AB$.

(i) Find the coordinates of P (2.5 marks)

(ii) Find the coordinates of Q. (2.5 marks)

b) Find λ for which the matrix $\lambda I - A$ is a singular matrix if where I is an identity Matrix given that $A = \begin{pmatrix} 1 & 0 & 2 \\ 0 & -1 & -2 \\ 2 & -2 & 0 \end{pmatrix}$ (5 marks)

c) Show that the sum of the integers from 1 to n is $\frac{1}{2}n(n+1)$ (5marks)

d) Solve the logarithmic equation : $\log(x-4)+\log(x-1)=1$ (5marks)

e) In the expansion of $(1+ax)^n$, the first three terms in ascending power of x are $1-\frac{5}{2}x+\frac{75}{8}x^2$, Find the values of n and a, and state the range of values of x for which the expansion is valid. (5marks)

QUESTION THREE

a) Find the radius of the circle with center at $C(-2,5)$ if the line $x+3y=9$ is a tangent line. (5marks)

b) Using geometrical progression, change $0.2\overline{14}$ to $\frac{a}{b}$ form , where a and b are integers and $b \neq 0$. (5marks)

c) Use mathematical induction to prove that the statement is true for all positive integers n given that 4^n-1 is divisible by 3 (5marks)

d) Graph $f(x)=log_{\frac{1}{2}}x$ by reflecting the graph of $g(x)=\left(\frac{1}{2}\right)^x$ a cross the line $y=x$ (5marks)

e) (i) Find the inverse of the matrix $A=\begin{pmatrix}3 & -1 & 2\\ 1 & 1 & 1\\ 2 & 2 & -1\end{pmatrix}$ (5marks)

(ii) Use your inverse to solve the system of linear equations

$$\begin{aligned}3x-y+2z&=4\\ x+y+z&=2\\ 2x+2y-z&=3\end{aligned}$$ (3marks)

QUESTION FOUR

a) Write the following in sigma notation

(i) $1-\frac{2}{3}+\frac{4}{9}-\frac{8}{27}+\cdots$ (3marks)

(ii) $1^4+2^4+3^4+\cdots+n^4+(n+1)^4$ (2marks)

b) The number of grams of a certain radioactive substance present after t hours is given by the equation $Q=Q_0e^{-0.45t}$, where Q_0 represents the initial number of grams. How long will it take 2500 grams to be reduced to 1250 given $ln\left(\frac{1}{2}\right)=-0.693$ (5marks)

c) (i) Expand $(1+2x)^4$ and $(1-2x)^4$ in ascending powers of x. (5marks)
(ii) Hence reduce $(1+2x)^4-(1-2x)^4$ to its simplest form. (3marks)
(iii) Using the results in (ii) evaluate $(1.002)^4-(0.998)^4$ (5marks)

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THE COPPERBELT UNIVERSITY

SCHOOL OF MATHEMATICS AND NATURAL SCIENCES

Department of Mathematics

2022/2023 ACADEMIC YEAR

SESSIONAL EXAMINATION

MA110-MATHEMATICAL METHODS I

TIME ALLOWED: Three (3) hours

INSTRUCTIONS:

1. You must write your **COMPUTER NUMBER**, **PROGRAM** and **YOUR GROUP** on each answer booklet you have used.
2. There are **seven (7)** questions in this paper, Attempt any **five (5)** questions, Each question consists of **a, b, c, d, e**. All questions carry equal marks
3. Calculators are **NOT** allowed in this paper.
4. Should you have any problem or if you need more answer booklet, put up your hand an invigilator will come to attend to you.

90 =
95 =

QUESTION ONE

a) Given that A and B are sets, simplify the following if possible $[(A \cap B)' \cap (A' \cup B)]'$.

b) Solve the logarithmic equation :

$$\log(x-4) + \log(x-1) = 1.$$

c) Use De Moivre's theorem to find the indicated power of $(1+i)^{20}$ and express results in $a + bi$.

d) Find the limit of the quotients as

$$h \to 0 \ \frac{\sqrt{x+h} - \sqrt{x}}{h}.$$

e) Evaluate the definite integral of

$$\int_0^{\pi^2} \frac{cos\sqrt{x}}{\sqrt{x}}\, dx.$$

QUESTION TWO

a) Use the rational root theorem to solve $x^3 - 4x^2 + 8 = 0$.

b) Use mathematical induction to prove that the statement is true for all positive integers n given that $4^n - 1$ is divisible by 3.

c) Find the period, amplitude , phase shift and sketch the curve of

$$f(x) = 1 + \frac{1}{3} sin\left(2x + \frac{\pi}{4}\right).$$

d) Let $f(x) = \frac{|x|}{x}$. Determine giving reasons whether or not the function is continuous at $x = 0$.

e) Show that $\frac{d}{dx}(tan^{-1}x) = \frac{1}{1+x^2}$.

QUESTION THREE

a) Define an operation $*$ on the set of real numbers by

$$a * b = a^b$$

i). Is $*$ a binary operation on the set of real numbers?

ii). Is the operation commutative?

iii). Evaluate $(3 * 2) * -2$.

b) Find λ for which the matrix $\lambda \mathrm{I} - \mathrm{A}$ is a singular matrix where I is an identity Matrix given that $A = \begin{pmatrix} 1 & 0 & 2 \\ 0 & -1 & -2 \\ 2 & -2 & 0 \end{pmatrix}$.

c) Solve for real values of x, given that $sinh^2 x - 3coshx = 3$.

d) Differentiate the function $f(x) = sinx$ using the first principle

e) Evaluate the indefinite integral of

$$\int \frac{2x^2 - 5x + 2}{x(x^2 + 1)} dx.$$

QUESTION FOUR

a) Let $f(x) = 1 - x^2$ and $g(x) = \sqrt{x}$, Find $(g\ o\ f)(x)$ and determine the domain.

b) Write the following in sigma notation

(i) $1 - \frac{2}{3} + \frac{4}{9} - \frac{8}{27} + \cdots$ (ii) $1^4 + 2^4 + 3^4 + \cdots + n^4 + (n+1)^4$

c) Find all the critical points of the function

$f(x) = 1 + \sin^2 x + \sin x$ defined on the interval

$0 < x < 2\pi$.

d) Find the equation of the tangent to the graph of the function $f(x) = 1 + \sin^2 x + \sin x$ at a point where $x = \pi$.

e) Evaluate the indefinite integral of $\int \ln x \, dx$.

QUESTION FIVE

a) Let α and β be the roots of the quadratic equation $3x^2 + 2x + 5 = 0$. Find a quadratic equation whose roots are $\frac{1}{\alpha^2}$ and $\frac{1}{\beta^2}$ without calculating α and β.

b) The number of grams of a certain radioactive substance present after t hours is given by the equation $Q = Q_0 e^{-0.45t}$, where Q_0 represents the initial number of grams. How long will it take 2500 grams to be reduced to 1250 given $\ln\left(\frac{1}{2}\right) = -0.693$.

c) Sketch the graph of the polar equation $r^2 = sin2\theta$.

d) Find the cube root of $8i$.

e) Find the derivative of $xe^y - 3ysinx = 1$.

QUESTION SIX

a) Prove that $\sqrt{2}$ is an irrational number.

b) Find the centre and length of a radius of the given circle and graph it

$$x^2 + y^2 - 10x = 0.$$

c) Solve the trigonometric equation $sinx + cosx = \sqrt{2}$ if $0 \leq x \leq 2\pi$.

d) Use the Second derivative Test to find the local extrema of

$$f(x) = x^4 - 8x^2 + 10.$$

e) Evaluate the indefinite integral of

$$\int e^x sinxdx.$$

QUESTION SEVEN

a) Show that the function f defined by $f(x) = \frac{2x}{x-1}$ $x \in R$, is a bijection on R on to $\{y \in R: y \neq 2\}$.

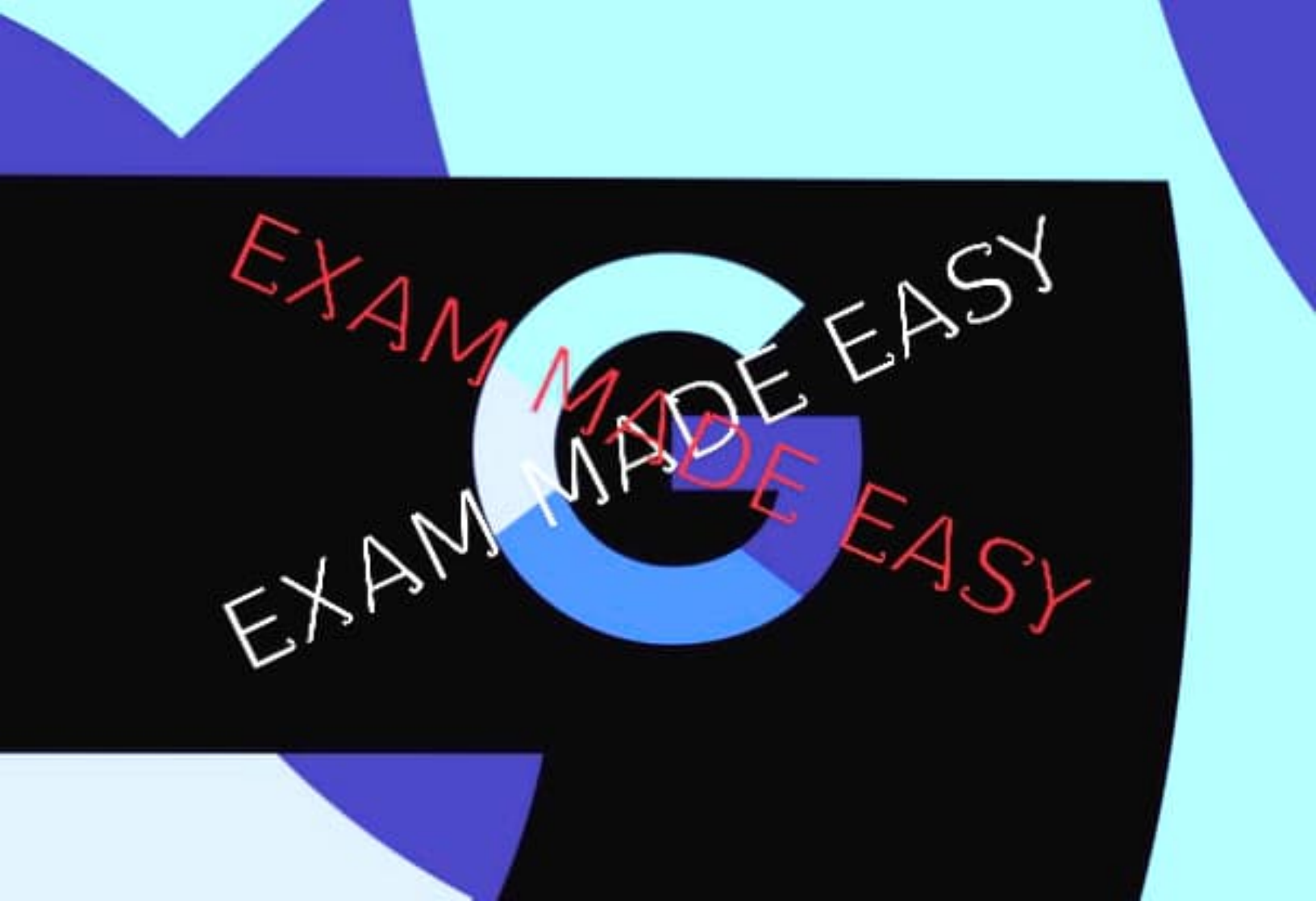
b) Use binomial theorem to find the value of $(1.01)^{10}$ up to the third term.

c) Find the exact value of $\tan 67.5°$

d) Determine the interval for which $f(x)$ is continuous.

$$f(x) = \sqrt{4 - x^2}.$$

e) Two numbers x and y are connected by the relation $x + y = 6$. Find the values of x and y which give a stationary point of the function $T = 2x^2 + 3y^2$ and determine whether they make T a maximum or minimum.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