(c)			(b)		(a)	QUE	Febru	Matri	Ν̈́	
[5 marks] Let S be the set of integers that are congruent to 2 modulo 4. Is S closed under multiplication? Justify your answer.		$\exists x \in \{0, 1, \dots, 4\}$ s Fill in the following table accordingly.	[5 marks] For each a		[5 marks] For each element $x \in \{0, \dots, 4\}$ find which to x^2 modulo 5. Fill in the following table accordingly.	QUESTION 1.	February 2023	Matric. no.:	Name:	1
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et of i		$\{0,1\}$ ble acc	$\{0, 1, \dots \}$	x (: x^2 ($ \begin{array}{c} \text{nent } x \\ \text{the fc} \end{array} $					
be the set of integers Justify your answer.	$\frac{a}{T/F}$	$\exists x \in \{0, 1, \dots, 4\}$ such that $2x - 1$ g table accordingly.	$\{0,1,\ldots,4\}$ evaluate the truth	$ \pmod{5} $ $ \pmod{5} $	$e \in \{0$		CA1			
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5 close			ıg stai		} is cc	(15 1	D: 50			
ed unc			value of the following statement		$\{0,\ldots,4\}$ find which element of $\{0,\ldots,4\}$ is congruent wing table accordingly.	(15 marks)	50 minutes			
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For graders only:			
Marks	Question		
	1(a)		
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QUESTION 2. (15 marks)

Let $\mathbb Q$ denote the set of rational numbers and S denote the set of odd integers. Determine the truth value of the following statements. Justify your answers.

(a) [5 marks] $\forall x \in \mathbb Q$, $\exists y \in \mathbb Q$, $\exists z \in S$, xyz = 2023;

(b) [5 marks] $\exists x \in S$, $\exists y \in \mathbb{Q}$, $\forall z \in S$, x + yz = 2023;

(c)			
(c) [5 marks] $\neg (\forall x \in S, \forall y \in \mathbb{Q}, \exists z \in S, xy + z = 2023).$			
rks] ¬			
$(\forall x \in A)$			
$S, \ \forall y$			
⊕			
$\exists z \in S$			
, xy +			
z=2			
023).			

(a) [5 marks] Wr $\neg (q \land p) \lor q.$	QUESTION 3.
[5 marks] Write out the truth table for the co $\neg (q \land p) \lor q$. Is $(\neg p \to q) \lor \neg q \equiv \neg (q \land p) \lor q$?	
e for the compound property $(q \wedge p) \vee q$?	
(a) [5 marks] Write out the truth table for the compound propositions $(\neg p \to q) \lor \neg q$ and $\neg (q \land p) \lor q$. Is $(\neg p \to q) \lor \neg q \equiv \neg (q \land p) \lor q$?	(20 marks)
q and	rks)

(b) [5 marks] Identify all the critical rows for the argument below. Write out the truth values for p, q, r, and s for each critical row that you find.

$$\begin{array}{c}
\neg p \to q; \\
r \to q; \\
s \to \neg p; \\
\neg s;
\end{array}$$

 $\vdots \neg s;$

(c) For each of the following arguments, decide whether or not it is valid. If it is invalid give a counterexample, if it is valid then demonstrate how the conclusion follows from the premises, pointing out which inference rule you are using at each step. You may need the following inference rules: modus ponens, modus tollens, and disjunctive syllogism.

(i) [5 marks]

$$p \land q;$$

$$\neg r \rightarrow s;$$

$$q \lor r;$$

$$p \lor s;$$

$$\vdots r.$$

(ii) [5 marks]

s.