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$1 b 1 0 1! 1 b 2 0 1! = 1 b 1 + b 2 0 1! 1 b 1 0 1! 1$
 $= 1 b 1 0 1! 2H. So H G: Moreover H \checkmark = R+ \prime: H !$

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$R = \mathbb{Z} \oplus \mathbb{Z}$. Define $f: R \rightarrow R$ by $f(1, 0) = (1, 0)$ and $f(0, 1) = (0, 1)$. Then f is one-to-one. Then for all $b \in R$, there exists $h \in R$ such that $f(h) = b$, where $h = (b_1, b_2)$.

GROUP THEORY EXERCISES AND SOLUTIONS

Solution: 1) The groups

$\mathbb{Z}/6\mathbb{Z}$ and

S_3 are not isomorphic because one is commutative and not the other. 2) When n and m are not coprime (relatively prime), the

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groups $\mathbb{Z}/(nm)\mathbb{Z}$ and $\left(\mathbb{Z}/n\mathbb{Z}\right) \times \left(\mathbb{Z}/m\mathbb{Z}\right)$ are not isomorph.

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every group of order 77 is cyclic. 2) Show that $GL(3; \mathbb{Z}_5)$ has a normal subgroup of index 4.

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1*: Discuss the Exercises in the sections 1.1-1.3 in Chapter I of the notes. Exercise 2: Show that an infinite group G has to contain a non-trivial subgroup, i.e. a subgroup $H \neq G$; Exercise 3: Suppose that $a^2b^2 = (ab)^2$ for all a, b in the group G : Show that G is abelian. Exercise 4*: Show that $(1\ 2\ 3\ 4)(1\ 2) = S$

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GROUP THEORY (MATH 33300) 3 1. BASICS 1.1.

Definition. Let G be a non-empty set and fix a map $\cdot : G \times G \rightarrow G$. The pair $(G; \cdot)$ is called a group if (1) for all

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$a; b; c \in G: (a b) c = a (b c)$ (associativity axiom). (2) there is $e \in G$ such that $e a = a$ for all $a \in G$ (identity axiom). (3) for every $a \in G$ there is a $0 \in G$ such that $a 0 = e$ (inverse axiom) .

GROUP THEORY (MATH 33300)

GROUP THEORY EXERCISES AND SOLUTIONS 7

2.9. Let G be a finite group and (G) the intersection of all maximal subgroups of G . Let N be an abelian minimal normal subgroup of G . Then N has a complement in G if and only if $N \leq (G)$ Solution

Assume that N has a complement H in G . Then $G =$

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group. 1-group.) = A =A) = S =

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4 SOLUTIONS FOR FINITE GROUP THEORY BY I.

MARTIN ISAACS 10. a) Let be the set of right cosets of H. H acts on by right multiplication.

Denoting the set of fixed points by 0, we have: 0 =

fHa: Hah = Ha for all $h \in H$ $g = Ha: aha^{-1} \in H$ for all

$h \in H = Ha: aHa^{-1} \in H = fHa: Ha = Hg = fHa: a \in N$

$G(H)g$ Therefore $j \in 0j = j \in N G(H) : Hj$, as desired. b)

Note that $j \in jG: Hj$.

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SOLUTIONS FOR FINITE GROUP THEORY BY I. MARTIN ISAACS

Chapter 1 Introduction 1.1 What is a group? Definition 1.1: If G is a nonempty set, a binary operation on G is a function $\cdot : G \times G \rightarrow G$. For example $+$ is a binary operation defined on the integers \mathbb{Z} .

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in the definition of a group. There are many examples of groups which are not abelian. The smallest of these is the group of symmetries of an

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equilateral triangle. As an exercise, convince yourself of the following: † Let f_i and f_l denote the reflections in two of the axes of symmetry of an equilateral triangle. Then $f_i \circ f_l \neq f_l \circ f_i$.

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GROUP THEORY EXERCISES AND SOLUTIONS 3

$1 b 1 0 1! 1 b 2 0 1! = 1 b 1 + b 2 0 1! 1 b 1 0 1! 1$

$= 1 b 1 0 1! 2H$. So $H G$: Moreover $H \checkmark = R+ \prime : H !$

$R+ 1 b 1 0 1!! b 1 \prime [1 b 1 0 1! 1 b 2 0 1!]= b 1 + b$

$2 = \prime 1 b 1 0 1! \prime 1 b 2 0 1! Ker \prime = f 1 b 1 0 1! j \prime 1 b$

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$1 \ 0 \ 1! = 0 = b \ 1g = Id$. So ϕ is one-to-one. Then for all $b \in R$, there exists $h \in H$ such that $\phi(h) = b$, where $h = 1 \ b \ 0 \ 1!$

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GROUP THEORY (MATH 33300) 3 1. BASICS 1.1.

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axiom). (3) for every $a \in G$ there is a $a^{-1} \in G$ such that $aa^{-1} = e$ (inverse axiom) .

GROUP THEORY (MATH 33300)

GROUP THEORY EXERCISES AND SOLUTIONS 7

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Assume that N has a complement H in G . Then G/H is a 1-group. $(G/H) = A/H = S/H =$

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