

Solutions to Abstract Algebra (Dummit and Foote 3e)

Chapter 2 : Subgroups

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This work was done as an undergraduate student: if you really don't understand something in one of these proofs, it is very possible that it doesn't make sense because it's wrong. Any questions or corrections can be directed to jason.rosendale@gmail.com.

Exercise 2.1.1a

$0 + 0i$ is the identity element of G , and $a + ai, b + bi \in G$ implies $-b + (-b)i \in G$ with $(a + ai) + (-b + (-b)i) = (a - b) + (a - b)i \in G$.

Exercise 2.1.1b

1 is the identity element of G , and $a, b \in G$ implies $|ab^{-1}| = |a||b^{-1}| = |1||1| = 1$ so that $ab \in G$.

Exercise 2.1.1c

$\frac{n}{q}$ is the identity element of G , and $a/b, p/q \in G$ implies $b|n$ and $q|n$ so that $b = n/x$ and $q = n/y$ for some $x, y \in \mathbb{Z}$. Thus:

$$\frac{a}{b} - \frac{p}{q} = \frac{ax}{n} - \frac{py}{n} = \frac{ax - py}{n}$$

which, when reduced, becomes

$$= \frac{(ax - py) / \gcd(ax - py, n)}{n / \gcd(ax - py, n)}$$

The denominator of this fraction clearly divides n , and thus the fraction is $\in G$.

Exercise 2.1.1d

$\frac{n}{q}$ is the identity element of G , and $a/b, p/q \in G$ implies

$$\frac{a}{b} - \frac{p}{q} = \frac{aq - bp}{bq}$$

And if b, q are relatively prime to n then bq is also relatively prime to n so the fraction is $\in G$.

Exercise 2.1.1e

1 is the identity element of G , and $a, b \in G$ implies

$$(ab)^2 = a^2b^2$$

which is a product of elements of \mathbb{Q} and is thus an element of \mathbb{Q} .

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Shaun V. Ault



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