

Math 8062 Homework 9

Due Thursday, 4/7/22

1. Consider the following commutative diagram of abelian groups:

$$\begin{array}{ccccccc} & & 0 & & 0 & & 0 \\ & & \downarrow & & \downarrow & & \downarrow \\ 0 & \longrightarrow & A & \longrightarrow & D & \longrightarrow & G \longrightarrow 0 \\ & & \downarrow & & \downarrow & & \downarrow \\ 0 & \longrightarrow & B & \longrightarrow & E & \longrightarrow & H \longrightarrow 0 \\ & & \downarrow & & \downarrow & & \downarrow \\ 0 & \longrightarrow & C & \longrightarrow & F & \longrightarrow & I \longrightarrow 0 \\ & & \downarrow & & \downarrow & & \downarrow \\ & & 0 & & 0 & & 0 \end{array}$$

Prove that if all the rows are exact, and the second and third columns are exact, then the first column is also exact. *Note:* When describing a diagram chase, it is helpful to give “walking directions.” For instance: given an element $e \in E$, chase down, then to the right, then up...

2. Problem 9 on page 53 of Hatcher. (*Hint:* use homology!)
3. Problem 29 on page 133 of Hatcher.
4. Problem 29 on page 158 of Hatcher.