

Math 320 Worksheets

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This is a collection of worksheets for use in Math 320.

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Chapter 1

Systems of Linear Equations

1.1 Introduction to Systems of Linear Equations

In this section we convert systems of linear equations into augmented matrices and use row operations to help solve the systems of linear equations.

1.1.1 Solving Systems of Linear Equations

A system of linear equations has

- no solution, or
- exactly one solution, or
- infinitely many solutions.

We solve linear systems of equations by putting them into augmented matrix form and then simplifying them using one or more of the following **elementary row operations**:

Replacement: Replace one row by the sum of itself and a multiple of another row.

Interchange: Interchange two rows.

Scaling: Multiply all entries of a row by a nonzero constant.

1.1.2 Exercises

1. Write the augmented matrix of the linear system of equations below.

$$\begin{aligned}x_1 + 5x_2 &= 7 \\ -2x_1 - 7x_2 &= -5\end{aligned}$$

2. Write the linear system of equations corresponding to the augmented matrix below.

$$\left[\begin{array}{ccc|c} 2 & -3 & -5 & \\ -4 & 6 & 10 & \end{array} \right]$$

3. Write the augmented matrix of the linear system of equations below.

$$\begin{aligned}x_2 + 4x_3 &= -5 \\ x_1 + 3x_2 + 5x_3 &= -2 \\ 3x_1 + 7x_2 + 7x_3 &= 0\end{aligned}$$

4. Write the linear system of equations corresponding to the augmented matrix below.

$$\begin{bmatrix} 1 & -3 & 7 & -3 \\ 0 & 1 & -2 & 2 \\ 0 & 3 & -6 & 6 \end{bmatrix}$$

1.1.3 Using Row Operations in Sage

Let's investigate how to use Sage to "simplify" augmented matrices using the three row operations.

```
A=matrix(QQ, [[5,3,1], [1,4,-2]]); A
```

To use the Interchange row operation, we use the `swap_rows` method. Note that Sage starts counting at 0, so the first row is row 0.

```
A.swap_rows(0,1); A
```

```
[1 4 -2]
[5 3 1]
```

We now use a Replacement row operation; since this operation adds a multiple of one row to another row, the method name is `add_multiple_of_row`.

```
A.add_multiple_of_row(1,0,-5); A
```

To understand the syntax of the method `add_multiple_of_row`, read it right to left. In the above example, we added $-5 \cdot$ Row 0 to Row 1 (where Row 0 is the first row).

A Scaling operation will make that second row look nicer. We use the `rescale_row` method.

```
A.rescale_row(1, -1/17); A
```

You should see a 4 as the top middle entry. use a Replacement operation in the Sage cell below to change the top middle entry to a 0.