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## MA 26500 Quiz 5

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1. Consider the matrix

$$A = \begin{bmatrix} 1 & 1 & 2 \\ 1 & 2 & 1 \\ 2 & 3 & 3 \\ 0 & -1 & -1 \end{bmatrix}. \quad (\star)$$

- (a) (12 points) Recall that the **nullspace** of an  $m \times n$  matrix  $A$  is the set of vectors  $\mathbf{x}$  in  $\mathbb{R}^n$  such that  $A\mathbf{x} = \mathbf{0}$ . This subset spans a subspace of  $\mathbb{R}^n$ . Give a description of the nullspace of the matrix  $(\star)$  by writing down basis for the nullspace.

[HINT: You should begin by putting the matrix in rref.]

- (b) (8 points) The **range** or **columnspace** of an  $m \times n$  matrix  $A$  is the set of vectors  $\mathbf{y}$  in  $\mathbb{R}^m$  that are, in some sense, “hit” by vectors  $\mathbf{x}$  in  $\mathbb{R}^n$  by the matrix  $A$ , i.e.,  $\mathbf{y} = A\mathbf{x}$  for some  $\mathbf{x}$ . Using your calculations from above (the hint), write down a basis for the range of  $(\star)$ .