

### Math 254 Exam 1: 9/12/6

Please read the exam instructions.

Notes, books, papers, calculators and electronic aids are all forbidden for this exam. Please write your answers on **separate paper**, indicate clearly what work goes with which problem, and put your name on every sheet. Cross out work you do not wish graded; incorrect work can lower your grade, even compared with no work at all. Keep this list of problems for your records. Show all necessary work in your solutions; if you are unsure, show it. Extra credit may be earned by handing in revised work in class on Thursday 9/14; for details see the syllabus. Each problem is worth 10 points. You have approximately 30 minutes.

1. Carefully state the definition of “basis”. Give two examples for the vector space  $\mathbb{R}^2$ .

2. Let  $u = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}$ , and  $v = \begin{bmatrix} -1 & 5 & 2 \end{bmatrix}$ . For each of the following expressions, determine what type they are (undefined, scalar, matrix/vector). If a matrix, specify the dimensions of the matrix. **DO NOT CALCULATE ANYTHING**, just determine the types of objects involved.

Example:  $7u$ . This is a  $3 \times 1$  matrix (or, a column 3-vector).

- (a)  $uvu$
- (b)  $uvv$
- (c)  $(u \cdot v) \cdot v$
- (d)  $(u \times v) \cdot u$
- (e)  $(u \times v) \times u$

3. For  $u = \begin{bmatrix} -3 & 5 & 2 \end{bmatrix}$  and  $v = \begin{bmatrix} 4 & 2 & 1 \end{bmatrix}$ , determine whether  $u, v$  are orthogonal. Justify your answer.

4. For  $A = \begin{bmatrix} 1 & 0 & -2 \\ 0 & 2 & 3 \end{bmatrix}$ , and  $B = \begin{bmatrix} 2 & 1 \\ 0 & -1 \\ 1 & 6 \end{bmatrix}$ , calculate  $AB$  and  $BA$ .

5. For  $\vec{u} = (1, 2, 1)$  and  $\vec{v} = (-3, -1, 0)$ , find  $\vec{u} \times \vec{v}$  and  $\vec{v} \times \vec{u}$ .