**Math 254-1 Exam 1: 9/15/8**

Please read the exam instructions.

Notes, books, papers, calculators and electronic aids are all forbidden for this exam. Please write your answers on **the attached page only** (front and back if necessary). Indicate clearly what work goes with which problem. Cross out work you do not wish graded; incorrect work can lower your grade. You may use this first page as scratch paper; keep it 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 Wednesday 9/17; for details see the syllabus. Each problem is worth 10 points; your total will be scaled to the standard 100 point scale. You have approximately 30 minutes.

1. Carefully state the definition of "spanning". Give two examples for $\mathbb{R}^2$.

2. Let $u = [1\ 2\ 3]$, and $v = [0\ 7\ 15]$. For each of the following, determine what *type* they are (undefined, scalar, matrix/vector). If a matrix/vector, specify the dimensions.
   **DO NOT CALCULATE ANY NUMBERS.**

   Example: $u + v$. This is a $1 \times 3$ matrix (or a row 3-vector).

   (a) $uvu$

   (b) $uv^T u$

   (c) $u^T v u^T$

   (d) $(u \cdot v) \times u$

   (e) $(u \times v) \cdot u$

3. Let $u = (1, 2, 3)$, and $v = (15, -7, 0)$. Are these vectors orthogonal? Be sure to justify your answer.

4. For $A = \begin{bmatrix} 0 & 1 & -1 \\ -1 & 0 & 3 \end{bmatrix}$ and $B = \begin{bmatrix} 2 & 1 \\ 0 & -1 \\ 1 & 5 \end{bmatrix}$, calculate $AB$ and $BA$.

5. For $u = (1, 0, 2)$ and $v = (0, -3, 1)$, calculate $u \times v$ and $v \times u$.

**Please hand in ONLY the second page; keep this first page.**

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Please write all solutions on this page (front and back if necessary).