PRINT Your Name:_____

There are 17 problems on 10 pages. The exam is worth 200 points. SHOW your work. $\boxed{CIRCLE}$ your answer. **CHECK** your answer whenever possible. **NO CALCULATORS.**

1. (20 points) Let A be an $n \times n$ matrix. List 8 statements that are equivalent to the statement "A is nonsingular".

1) A is nonsingular

2) The only vector X with $AX=0$ is $X=0$

3) The null space of $A = 0$.

4) The dimension of the null space of A is zero.

5) The rank of $A = n$

6) The dimension of the col. space of A is n

7) the cols of A are l.i.

8) the cols of A span R^n

9) the dimension of the row space of A is n

10) the rows of A are lin. indept.

11) the rows of A span the vector space of row vectors with n entries

12) A has an inverse

13) $Ax=b$ has a unique solution for all $b \in R^n$

14) $\det A \neq 0$

15) $\lambda=0$ is **not** an eigenvalue for A

2. (10 points) Define "vector space".

The subset V of R^n is a _vector space_ if it (contains zero and) is closed under addition and scalar multiplication.