Problem 1. Back-substitution

Consider an $n \times n$ upper triangular matrix. How many operations are carried out in back-substitution?

- (A) Independent of $n$
- (B) Proportional to $n$
- (C) Proportional to $n^2$
- (D) Proportional to $n^3$

Problem 2. Rank and Nullspace

A matrix of size $10 \times 7$ has a row space of dimension 5. What is the dimension of its nullspace?

- (A) 2
- (B) 7
- (C) 10
- (D) 0
- (E) 5

Problem 3. Elimination matrices

Consider the elimination matrices

\[
A = \begin{pmatrix} 1 & 1 & 1 \\ 2 & 1 & 1 \\ -4 & 1 & 1 \end{pmatrix}, \quad B = \begin{pmatrix} 1 & 1 \\ -2 & 1 \\ 4 & 1 \end{pmatrix}, \quad C = \begin{pmatrix} 1 & 1 \\ 1 & 1 \\ 5 & 1 \end{pmatrix}.
\]

What is $ABC$?
Problem 4. Invariants of LU

Suppose you have an LU factorization $PA = LU$.

Is rowspace($U$) = rowspace($PA$)?

(A) Yes
(B) No

Problem 5. Invariants of LU

Suppose you have an LU factorization $PA = LU$.

Is $N(U) = N(PA)$?

(The original version of this question specified got the answer wrong.)

(A) Yes
(B) No