O K L A H O M A   S T A T E   U N I V E R S I T Y

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING
SCHOOL OF MECHANICAL AND AEROSPACE ENGINEERING

ECEN/MAE 5713 Linear Systems
Spring 2012
Midterm Exam #2

DO ALL FOUR PROBLEMS

Name : ______________________________

E-Mail Address:_______________________________________

<u>Problem 1</u>:

Find a minimal *observable* canonical form realization (i.e., its simulation diagram and state space representation) for the following MISO system described by

$$H(s)=\left[\frac{2s+3}{s^3+4s^2+5s+2} \quad \frac{s^2+2s+2}{s^4+3s^3+3s^2+s}\right].$$

Problem 2:

A vector space, V, is spanned by v_1, v_2, v_3 given as

$$v_1 = \begin{bmatrix} 1 \\ 1 \\ 1 \\ -1 \end{bmatrix}, \quad v_2 = \begin{bmatrix} -5 \\ 1 \\ 1 \\ 5 \end{bmatrix}, \quad v_3 = \begin{bmatrix} -1 \\ 2 \\ 2 \\ 1 \end{bmatrix}.$$

Determine the orthogonal complement space of V, $V^{\perp}$, and find a basis and dimension of $V^{\perp}$.

For $x = \begin{bmatrix} 0 & 3 & 3 & 0 \end{bmatrix}^T$, find its direct sum representation of $x = x_1 \oplus x_2$, such that $x_1 \in V, x_2 \in V^{\perp}$.

Problem 3:
Consider the linear operator

$$A = \begin{bmatrix} 1 & 2 & -1 & 0 \\ 2 & 4 & -2 & 0 \\ 1 & 2 & -1 & 0 \end{bmatrix},$$

determine its rank and nullity, then find a basis for the range space and the null space of the linear operator, A, respectively ?

<u>Problem 4</u>:

Show if the following two sets

$$\begin{bmatrix} 3 & -2 \\ 1 & 1 \end{bmatrix}, \begin{bmatrix} 1 & -1 \\ 1 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 \\ -1 & -1 \end{bmatrix} \text{ and } \begin{bmatrix} 2 & -1 \\ 0 & 0 \end{bmatrix}, \begin{bmatrix} 3 & -2 \\ 1 & 1 \end{bmatrix}, \begin{bmatrix} 2 & -2 \\ 2 & 2 \end{bmatrix}$$

span the same subspace V of $\left(\Re^{2\times 2}, \Re\right)$. If so, to form a basis for the set with all 2×2 matrices with real coefficients.