

Qui3 1, EE640, Multi variable Control 26th Aug 2015

Note: Attempt all questions. Marks distribution at the end.

Some questions do not have sought answers: in that case explain why sought answer is not possible.

(Each question carries 10 marks.)

Q-1. Consider $A \in \mathbb{R}^{n \times n}$ and $B \in \mathbb{R}^{n \times m}$. Consider following equivalent statements.

(a) $[B \ AB \ \dots \ A^{n-1}B]$ is full row rank.

(b) $\eta e^{At} B = 0$ for all $t \in [0, T] \Rightarrow \eta = 0$
 $\eta \in \mathbb{R}^{1 \times n}$ $T > 0$

(c) $[A - \lambda I \ B]$ is full row rank for every $\lambda \in \mathbb{C}$.

Choose any two and show they are both equivalent.

Q-2: Show that if (A, B) is uncontrollable, then

$\bigcap_{F \in \mathbb{R}^{m \times n}} \sigma(A + BF)$ is not empty. $\sigma(\cdot) \equiv$ set of eigenvalues.
 $A \in \mathbb{R}^{n \times n}, B \in \mathbb{R}^{n \times m}$.

Q-3: (a) Find S_1 such that $S_1^{-1} A S_1$ is in (any one) companion form

for $A = \begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}$.

(b) Find S_2 such that $S_2^{-1} A S_2$ is in (any one) companion form

for $A = \begin{bmatrix} 2 & & \\ & 4 & \\ & & 4 \end{bmatrix}$ (diagonal A).

Q-4: Suggest a cyclic 3×3 matrix A and a vector b such that (A, b) is uncontrollable. ($b \neq 0$)

Q-5: For each (A, b) find $f \in \mathbb{R}^{1 \times 2}$ such that the desired closed loop polynomial is achieved.

(a) $A = \begin{bmatrix} 2 & 0 \\ 0 & 3 \end{bmatrix}, b = \begin{bmatrix} 1 \\ -1 \end{bmatrix}, d(s) = (s+1)^2$.

(b) $A = \begin{bmatrix} 2 & 0 \\ 0 & 2 \end{bmatrix}, b = \begin{bmatrix} 1 \\ -1 \end{bmatrix}, d(s) = (s+1)^2$.