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

S C H O O L O F E L E C T R I C A L A N D C O M P U T E R E N G I N E E R I N G

ECEN 4413 Controls II
Fall 1997
Midterm Exam #2

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Problem 1:

Find the equivalent *G configuration* of a plant transfer function given as

$G_p(s) = \dfrac{2}{s^3 + 19s^2 + 95s + 77}$ with state feedback control (i.e., $K = 2, k^T = \begin{bmatrix} 1 & 2 & 1 \end{bmatrix}$).

Show the resulting block diagram.

Problem 2:

Apply the state feedback with controller gain ($K = 2$) to an open-loop DC motor with transfer function, $G_p(s) = \dfrac{s^2 + 2s + 1}{s^3 + 2s^2 + 3s + s}$. Find the feedback coefficients (vector *k*) so that the eigenvalues of the closed-loop system matrix are -2, -3 and -5.

Problem 3:

For the state feedback control system described by

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} 0 & 1 \end{bmatrix} x(t) \quad ,$$

$$u(t) = 10(r(t) - \begin{bmatrix} 2 & 3 \end{bmatrix} x(t))$$

find a) $\Phi_k(s)$, b) $G_p(s)$, c) $G_{eq}(s)$, and d) $Y(s)/R(s)$ by matrix method.

Problem 4:

The resolvent matrix, $\Phi(s)$ for a given plant is

$$\Phi(s) = \begin{bmatrix} \frac{1}{s} & \frac{1}{s(s+3)} & \frac{10}{s(s+3)(s+10)} \\ 0 & \frac{1}{s+3} & \frac{10}{(s+3)(s+10)} \\ 0 & 0 & \frac{1}{s+10} \end{bmatrix},$$

and $b = \begin{bmatrix} 0 & 0 & 5 \end{bmatrix}^T$, $c^T = \begin{bmatrix} 1 & 2 & 1 \end{bmatrix}$. Find only $x_2(t)$ for $u(t) = e^{-3t} u_s(t)$ (i.e., $u_s(t)$ is the step function) and $x(0) = \begin{bmatrix} 1 & 2 & 3 \end{bmatrix}^T$.