KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
Electrical Engineering Department

EE380 **081** **Problem Session I**

Problem 1:

Represent the electrical network shown in Figure 1 in state space, where $i_R(t)$ is the output.

Problem 2:

A position servo for a large microwave antenna is shown in Figure 2. The antenna is modeled as a mass having a large moment of inertia, J. An output potentiometer measures the output shaft position, converting the position to the proportional voltage according to $v_0 = K_p\theta$. The motor is coupled to the antenna with a gear train, of ratio $\theta = \frac{N_1}{N_2}\theta_m$. Assume the motor has negligible armature inductance and negligible internal damping.

- Write the dynamic model equations.
- Draw the block diagram and signal flow graph.
- Find the transfer function C(s)/R(s).

Problem 3:

Reduce the block diagram shown in Figure 3 to obtain the system transfer function Y(s)/R(s).

Problem 4:

A system with several feedback loops and feed forward paths is shown in Figure 4. Using Mason's rules find the transfer function of the system.

Problem 5:

The state equations of a linear time-invariant system are represented by $x(t) = Ax(t) + B(u(t)$

(a) Find the state-transition matrix Φ(t), the characteristic equation, and the eigenvalues of A for the case:

$$A = \begin{bmatrix} -5 & 1 & 0 \\ -6 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix} \quad , \quad B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

(b) Find Φ(t), and the characteristic equation using matlab.

Problem 6: For the transfer function given, determine the signal flow model and the matrix differential equation using:

(a) The phase variable format, and
a) The canonical (diagonal) variable format, and
b) The input feed forward format

$$\frac{Y(s)}{U(s)} = \frac{5(s+6)}{s^3 + 10s \;\; + 31s + 30}$$

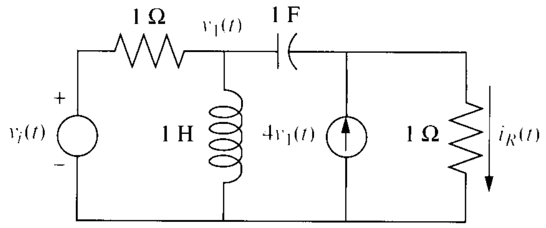

Figure 1

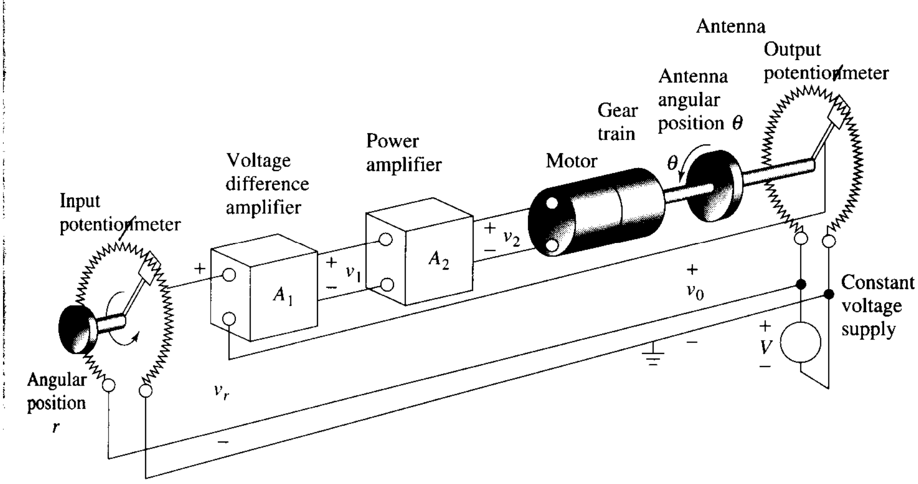

Figure 2

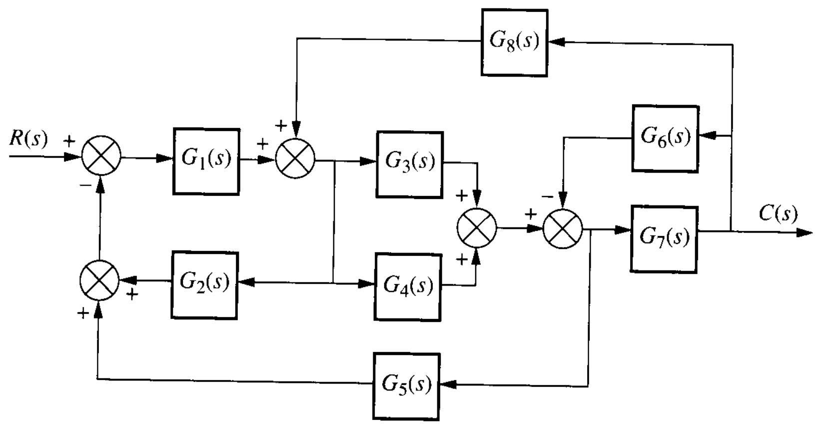

Figure 3

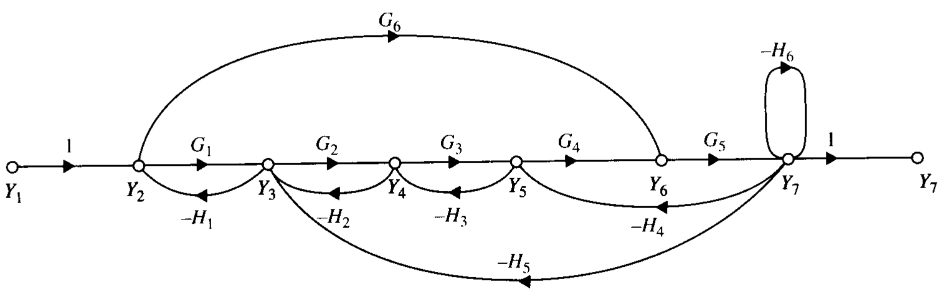

Figure 4