OKLAHOMA STATE UNIVERSITY

SCHOOL OF ELECTRICAL AND COMPUTER ENGINEERING

ECEN 4413
Automatic Control Systems
Spring 2004

Midterm Exam #1

Choose any four out of five.
Please specify below which four you choose to be graded.

_____

Name : _____

Student ID: _____

E-Mail Address:_____

Problem 1:

Consider the *truncation* and *shift* operators defined by

$$y(t) = T_\tau(u(t)) = \begin{cases} u(t) & t \le \tau \\ 0, & t > \tau \end{cases},$$

and

$$y(t) = Q_\tau(u(t)) = u(t-\tau),$$

respectively, where $u(t)$ denotes the input and $y(t)$ the output. If a given system is described by

$$y(t) = Q_\tau\big(T_\tau(u(t))\big),$$

Is this system causal? Is it linear? And is it time-invariant (fixed)? Justify your answers.

Problem 2:

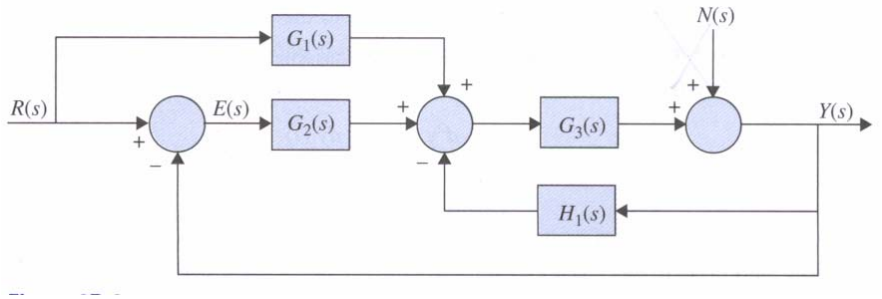
The following differential equation represents linear time-invariant system, where $u(t)$ denotes the input and $y(t)$ the output,

$$\frac{d^2y(t)}{dt^2} + \frac{dy(t)}{dt} + 5y(t) = \dot{u}(t) + 2u(t)$$

Find the transfer function $Y(s)/U(s)$ of the system. In addition, express the system in the state space form of $\dot{x} = Ax + Bu$, $y = Cx + Dy$. Clearly indicate how the state variables are chosen.

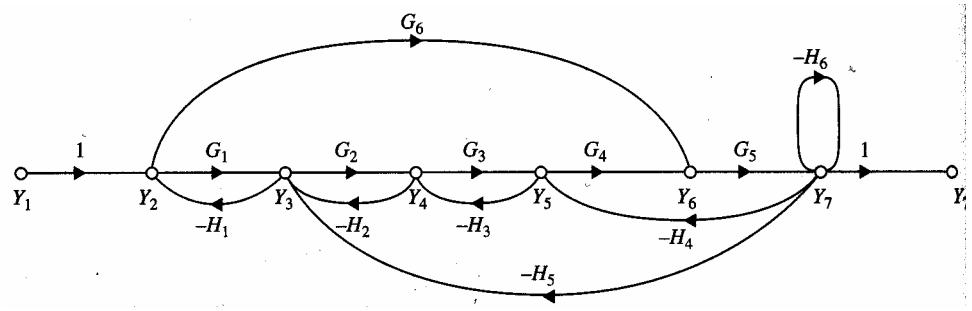
Problem 3:
The block diagram of a control system is shown below. Draw an equivalent SFG (signal flow graph) for the system. Find the following transfer functions by applying the gain formula,

$$\left.\frac{Y(s)}{R(s)}\right|_{N=0}, \quad \left.\frac{Y(s)}{N(s)}\right|_{R=0}, \quad \left.\frac{E(s)}{N(s)}\right|_{R=0}.$$



Problem 4:

Find the transfer functions Y_7 / Y_1 and Y_2 / Y_1 of the SFG shown below.



Problem 5: Let $\bar{y}(t)$ be the unit-step response of a linear time-invariant system. Show that the impulse response of the system equals to $\frac{d\bar{y}(t)}{dt}$.