OKLAHOMA STATE UNIVERSITY

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

ECEN 4413/MAE 4053
Automatic Control Systems
Spring 2008
Final Exam

Choose any four out of five problems.
Please specify which four listed below to be graded:
1)_____; 2)_____; 3)_____; 4)_____;

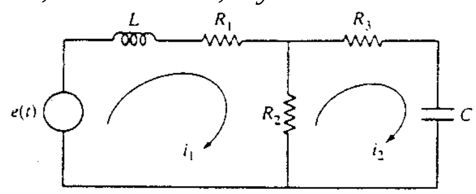
Name : ______________________________

E-Mail Address:_______________________________________

Problem 1:

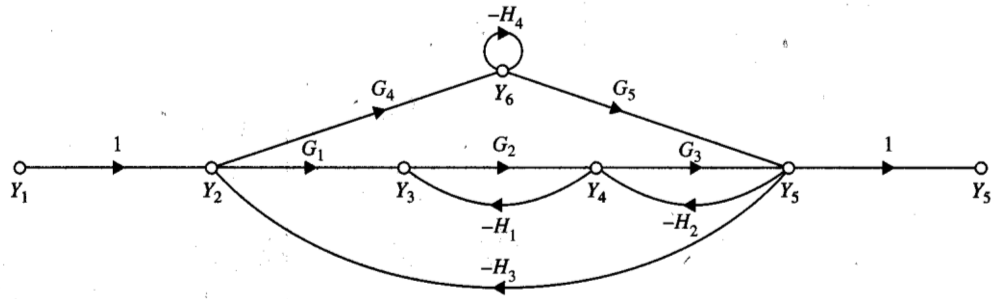
For the RLC circuit shown below, consider voltage source $e(t)$ is the input (u) and voltage across capacitor C is the output (y) and then find the following system representations:

a) input-output representation (described by ordinary differential equations)
b) transfer function, $H(s) = Y(s)/U(s)$
c) state space representation, $\dot{x} = Ax + Bu, \quad y = Cx + Du$.



Problem 2:

Apply the gain formula to the SFG shown below to find the transfer functions of $\frac{Y_5}{Y_1}$ and $\frac{Y_5}{Y_2}$.

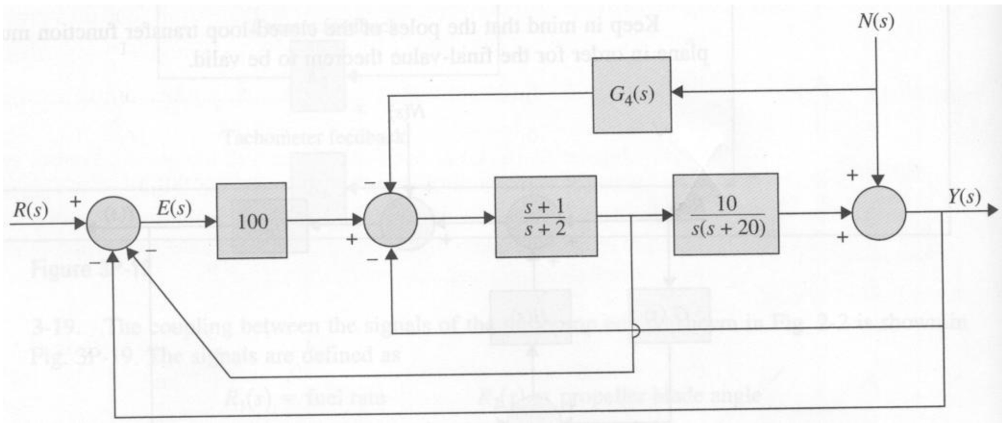


<u>Problem 3</u>:

The block diagram of a feedback control system is shown below.

a) Derive the transfer functions of $\left.\dfrac{Y(s)}{R(s)}\right|_{N=0}$, $\left.\dfrac{Y(s)}{N(s)}\right|_{R=0}$.

b) The controller with the transfer function $G_4(s)$ is for the reduction of the effect of the noise $N(s)$. Find $G_4(s)$ so that the output $Y(s)$ is totally independent of $N(s)$.



Problem 4:

The state equation of a linear time-invariant system can be represented by

$$\dot{x}(t) = Ax(t) + Bu(t).$$

Find the state-transition matrix $\Phi(t)$, the characteristic equation and the eigenvalues of A for

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

Problem 5:

Figure below shows the block diagram of a control system with conditional feedback. The transfer function $G_p(s)$ denotes the controlled process, and $G_c(s)$ and $H(s)$ are the controller transfer functions.

a) Derive the transfer function $Y(s)/R(s)\big|_{N=0}$ and $Y(s)/N(s)\big|_{R=0}$.

b) Let

$$G_p(s) = G_c(s) = \frac{100}{(s+1)(s+5)},$$

find the output response $y(t)$ when $N(s)=0$ and $r(t)=u_s(t)$ (i.e., unit step function).

c) With $G_p(s)$ and $G_c(s)$ as given in part b), select $H(s)$ among the following four choices such that when $n(t)=u_s(t)$ and $r(t)=0$, the steady state value of $y(t)$ is equal to zero.

$$H(s) = \frac{10}{s(s+1)} \qquad H(s) = \frac{10}{(s+1)(s+2)}$$

$$H(s) = \frac{10(s+1)}{s+2} \qquad H(s) = \frac{K}{s}.$$

Keep in mind that the pole of the closed-loop transfer function must all be in the left-half *s*-plane in order for the final-value theorem, to be valid.