Choose any four out of five problems,

*Please specify*

1)_____; 2)_____; 3)_____; 4)_____; 

Name: ______________________________

Student ID: ______________________________

E-Mail Address: ______________________________
Problem 1:
Consider the truncation and shift operators defined by,
\[ T_t(u(t)) = \begin{cases} 
  u(t) & t \leq \tau \\
  0 & t > \tau
\end{cases} \]
and
\[ Q_t(u(t)) = u(t - \tau) , \]
respectively. For a given system described by
\[ y(t) = T_t(Q_t(u(t))) , \]
is it causal? is it linear? is it time-invariant (fixed)? Justify your answers.
**Problem 2:**

Apply the gain formula to the SFGs shown below to find the transfer functions $\frac{Y_2}{Y_1}$.
**Problem 3:**
The block diagram of a feedback control system is shown below.

a) Derive the transfer functions of \( \frac{Y(s)}{R(s)} \bigg|_{N=0} \) and \( \frac{Y(s)}{N(s)} \bigg|_{R=0} \).

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:**

Draw the state diagram for the state space system given

\[
\dot{x} = Ax + Bu = \begin{bmatrix} -3 & 2 & 0 \\ -1 & 0 & 1 \\ -2 & -3 & -4 \end{bmatrix} \begin{bmatrix} x \\ 1 \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} u.
\]
Problem 5:
Find an minimal controllable canonical form realization in state space for the following system described by transfer function matrix,

$$H(s) = \begin{bmatrix} 
\frac{2s}{s^3 + 6s^2 + 11s + 6} \\
\frac{s^2 + 2}{s^2 + 2s + 2} \\
\frac{s^4 + 6s^3 + 9s^2 + 4s}{s^4 + 6s^3 + 9s^2 + 4s} 
\end{bmatrix}. $$

Note $A$ is a $6 \times 6$ matrix.