

## A. Definitions

1. **system:** collection of matter contained within a real or imaginary boundary.
2. **Inputs:** variables prescribed by the environment or another system to the system of interest.
3. **Outputs:** Variables of interests produced by the system.
4. **State Variables:** the minimum set of variables required to define the state of the system  
(order of system = number of state variables = n) state variables are non-unique: i.e.v and p=mv.
5. **Plant:** system to be controlled.
6. **Controller:** system that generates control action on the plant.

## B. General closed loop system configuration

### 1. Nonlinear plant

$$\dot{\underline{x}} = \underline{f}(\underline{x}, \underline{u})$$

$$\underline{y} = \underline{g}(\underline{x}, \underline{u})$$

### 2. Linear plant

$$\dot{\underline{x}} = \underline{A}\underline{x} + \underline{B}\underline{u}$$

$$\underline{y} = \underline{C}\underline{x} + \underline{D}\underline{u}$$

3. **Open loop:** Control not influenced by system outputs.
4. **Closed loop:** Control is a direct function of the system outputs.

## C. Control task

1. **Formulate plant model**
  - a. State equations
  - b. Transfer functions
  - c. Block diagrams
2. **Specify steady state and transient performance measures**
  - a. Time domain
  - b. Frequency domain
3. **Synthesize a controller design to satisfy the performance measures**

**D. Features of closed loop control (compared to open loop)**

1. Reduces sensitivity to disturbances
2. Reduces sensitivity to changes in plant parameters
3. Alters dynamic behavior of the closed loop system
4. Affects overall gain of the closed loop system
5. Affects stability

**E. Types of feedback control systems**

1. Linear versus nonlinear
2. Time invariant versus time varying
3. Continuous versus discrete time

