Control objective :

1) Safety
2) Environmental protection
3) Operational constraints
   a) Equipment protection
   b) Smooth operation
4) Product quality
5) Profit
6) Monitoring and diagnosis

Process dynamic:

Refers to the time-varying behavior of controlled or uncontrolled process behavior when there are subject to disturbances.

Process control:

Controlling the unsteady state behavior and bring the system back to the steady – state.

Classes of variables:

1) Un controllable variables: ambient condition ,catalyst activity.
2) Controllable variables: temperature ,pressure ,flow ,level ,pH.
3) Product variables: color ,viscosity, composition.

Laplace transformation:

Laplace transform is useful for providing qualitative analysis of dynamic processes. Laplace transform is an operator that transforms the independent variable of a function from the time domain to the s-domain. In this case, it facilitates the solution of linear differential equation as Laplace transform converts the ODE into algebraic variables.

Definition of the Laplace transformation:

$$\mathcal{L}(t) = f(s) = \int_{0}^{-\infty} f(t)e^{-st}d(t)$$

s is variable defined in the complex plane (i.e. ,s=a+jb)

<u>Transformation of simple functions:</u>

1) Exponential function

$f(t) = e^{-at}$ for t ≥0

Then

$$\mathcal{L}[e^{-at}] = \frac{1}{s+a}$$

2) The step function

$$f(t) = \begin{Bmatrix} 0 & t < 0 \\ A & t > 0 \end{Bmatrix}$$

3) Ramp function

$f(t) = at$ *for t≥0 with a is constant*

Then $\mathcal{L}[at] = \frac{a}{s^2}$

4) Trigonometric function

$$f(t) = \sin \omega t$$

$$\mathcal{L}[\sin \omega t] = \frac{\omega}{s^2 + \omega^2}$$

$$f(t) = \cos \omega t$$

$$\mathcal{L}[\cos \omega t] = \frac{s}{s^2 + \omega^2}$$

5) Derivatives

$$\left[\frac{d^n f(t)}{dt^2}\right] = s^n f(s) - s^{n-1} f(0) - s^{n-2} f'(0) .... - sf^{n-2}(0) - f(0)$$

$$\mathcal{L}\left[\frac{df(t)}{dt}\right] = sf(s) - f(0)$$

$$\mathcal{L}\left[\frac{d^2 f(t)}{dt^2}\right] = s^2 f(s) - sf(0) - f'(0)$$

6) Integrals

$$\mathcal{L}\left[\int_0^t f(t)dt\right] = \frac{1}{s}f(s)$$

Final –value theorem:

$$\lim_{t\to\infty} f(t) = \lim_{s\to 0}[sf(s)]$$

Initial-value theorem

$$\lim_{t\to 0} f(t) = \lim_{s\to\infty}[sf(s)]$$