SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

19ECT212 – LINEAR CONTROL SYSTEMS

II YEAR/ IV SEMESTER

UNIT I – CONTROL SYSTEM MODELING

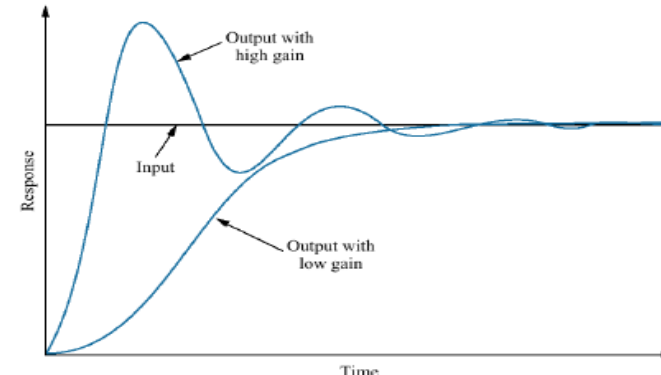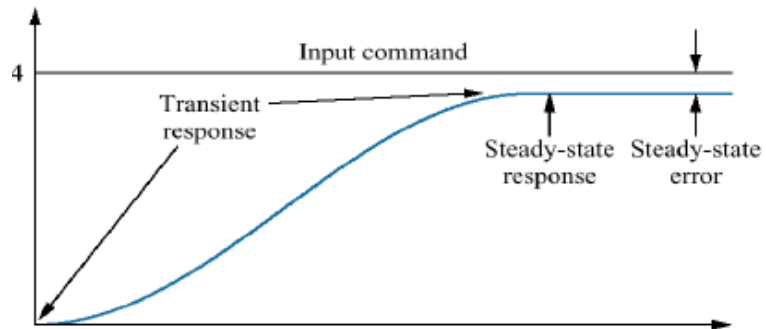### TOPIC 1–BASIC ELEMENTS OF CONTROL SYSTEM

Course Objectives

1. Model common control system components.

2. Select an appropriate control algorithm of PID type or one of its variations.

3. Analyze the performance of a control algorithm using transfer functions, block diagrams, and computer methods, in light of given performance specifications.

4. Using MATLAB and Simulink to analyze and simulate control systems

A control system consists of subsystems and plants for the purpose of obtaining a desired output with desired performance, given a specified input.

A major application of the methods of system dynamics is the design of control systems.

1. Objectives of control (Inputs)

2. Control system components (Controller, plant, actuator, sensor,...)

3. Results (Outputs)

Robot : Sensors (Optical image, displacement, speed, force, torque, pressure voltage, current). Actuators (AC motors, DC motors, step motors, hydraulic actuators)
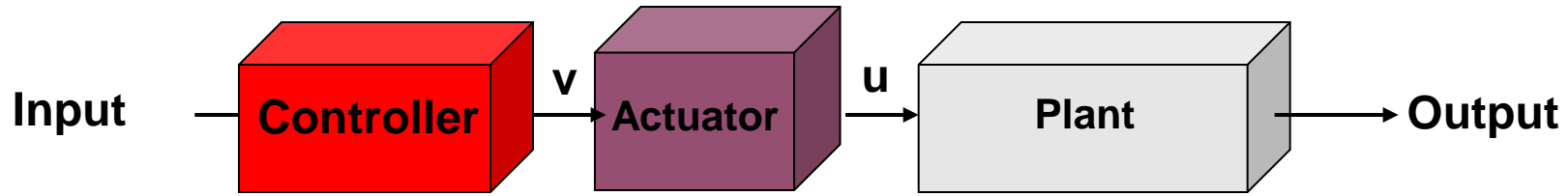
Home Heating System : Sensors (Temperature, pressure, fluid flow). Actuators (Motors, pumps, heat sources)

Automobile : Sensors (Displacement, speed,force,pressure,temperature, fluid flow, fluid level voltage, current). Actuators (DC motors, step motors, pumps, heat sources)
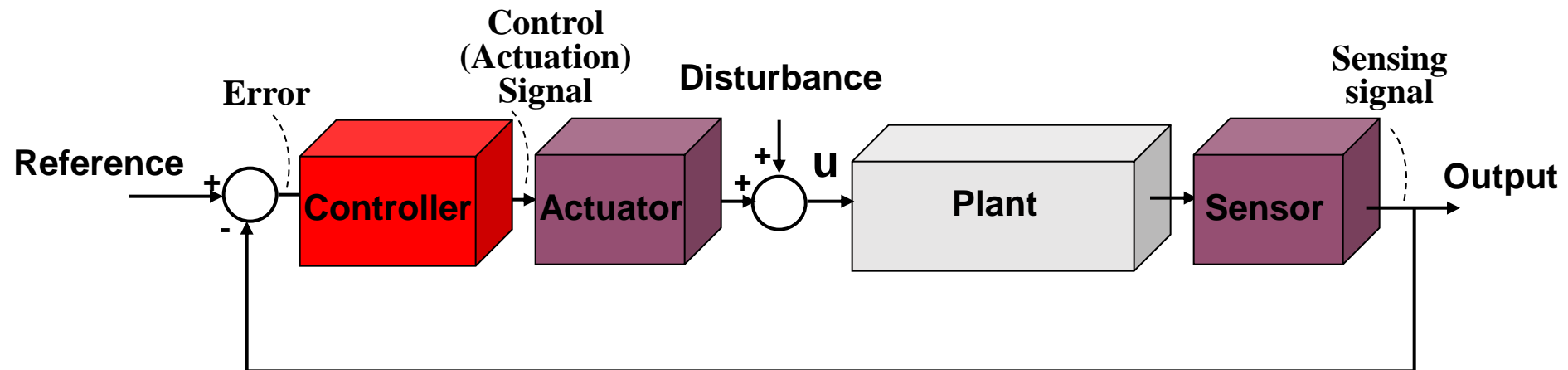
Control systems

→ Open-loop control sytems

→ Closed-loop control sytems
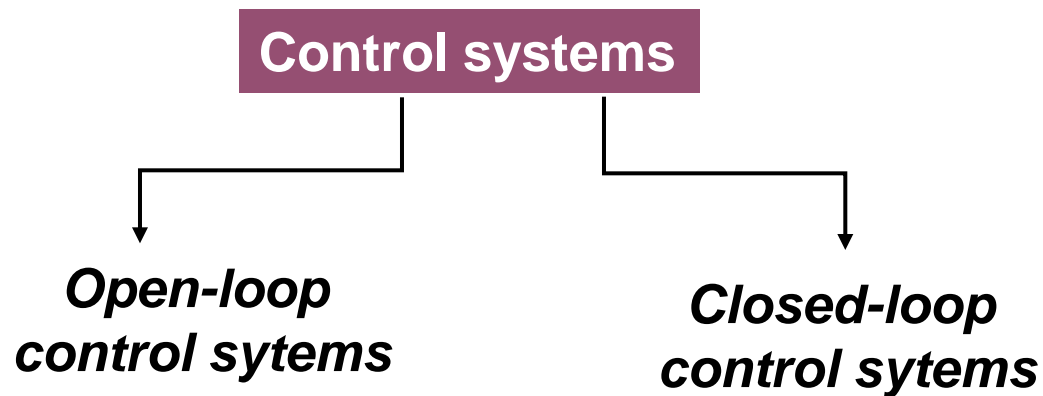
Open Loop Control Systems

Sensitive to changing in parameters and disturbance.

Closed Loop Control Systems: (Feedback Systems)
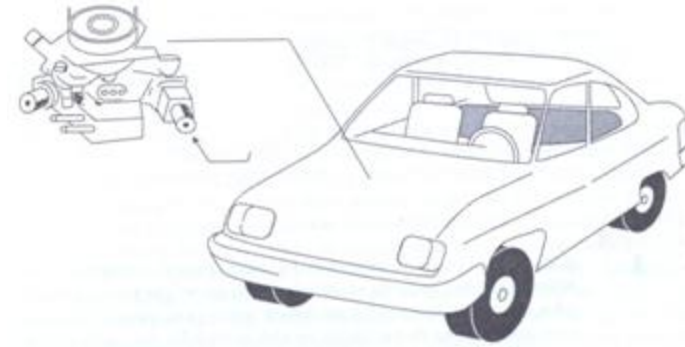

Error signal= Reference – Sensing signal
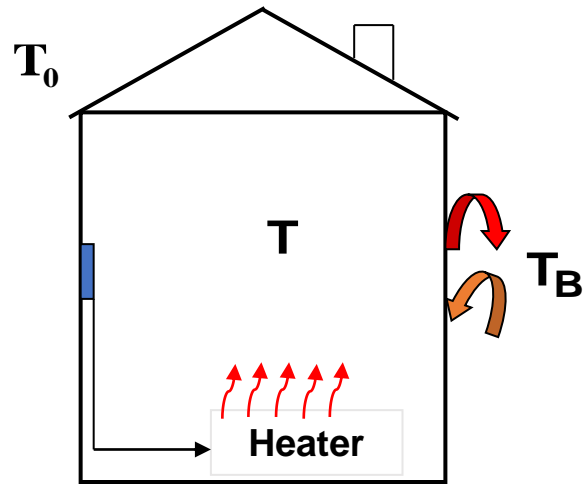
Examples of Control System Applications

Washing machine

Step motors
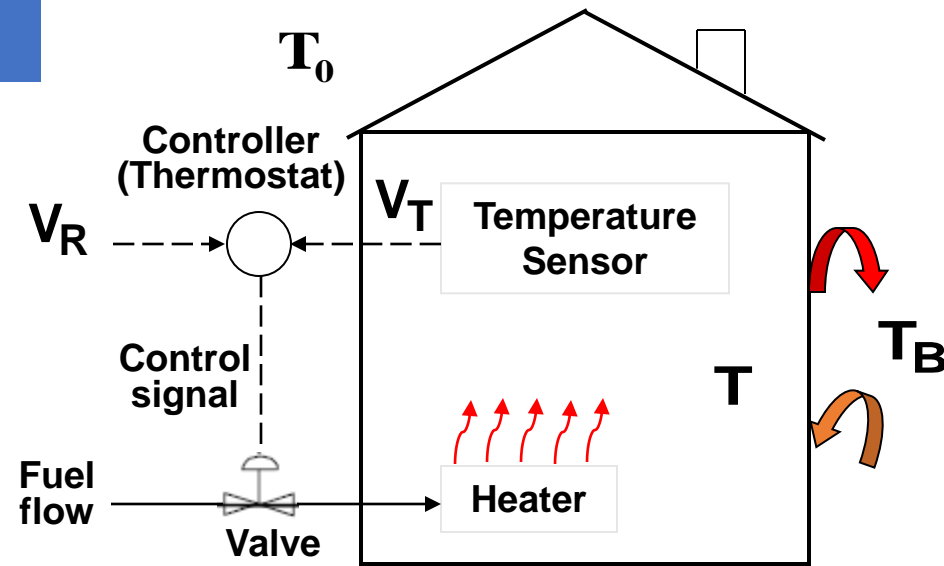
Idle-speed control

Home heating system

Cruise control

Robots

V_R : Reference temp.

V_T : Measured temp.

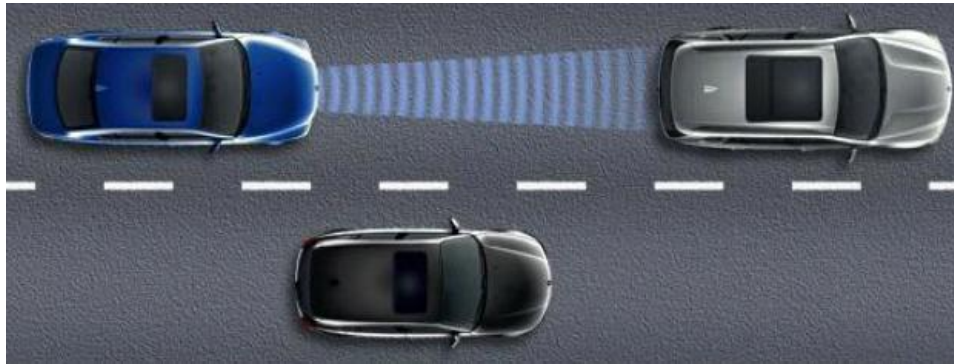T_B : Disturbance
(heat transfer: door,
window, wall, etc.)

T_0

Controller
(Thermostat)

V_R

V_T Temperature
Sensor

Control
signal

T_B

T

Fuel
flow

Heater

Valve

Error	Status	Control action
$V_R - V_T > 0$ ·····>	Cold ·····>	Open valve
$V_R - V_T < 0$ ·····>	Hot ·····>	Close valve

T_B

V_R +

Controller
(Thermostat)

Valve

+
+

Plant

Temp.
Sensor

V_T

-
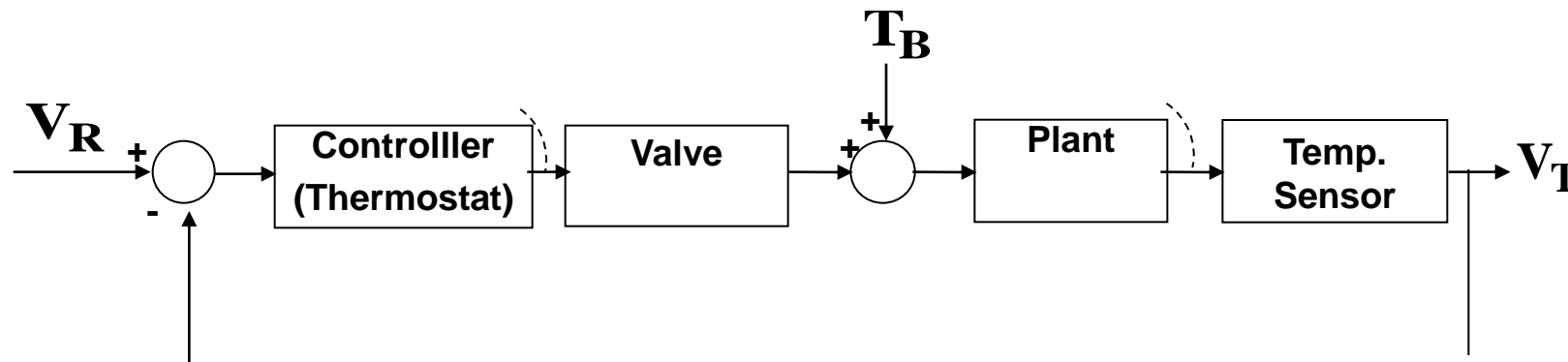
Usage in 1990's

Driver comfort

Save fuel

Block diagram:

Reference → (+/−) → Error signal → **Controller** → Control signal → **Actuator (Valf)** → Fuel flow → (+) [Road conditions (+)] → **Motor and Powertrain system** → Vehicle speed → **Speed Sensor** → Measured speed signal → **Speed**

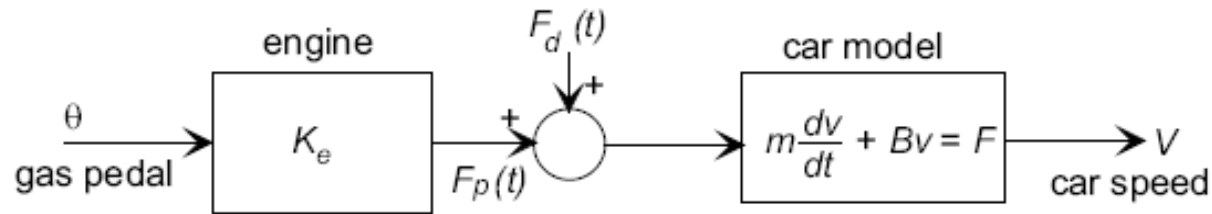Feedback loop from Speed Sensor back to summing junction (−)
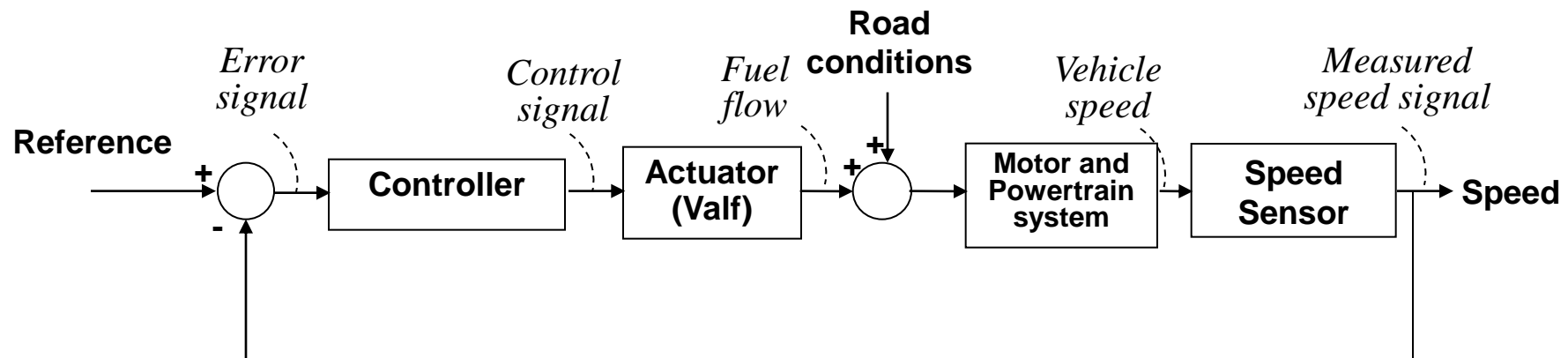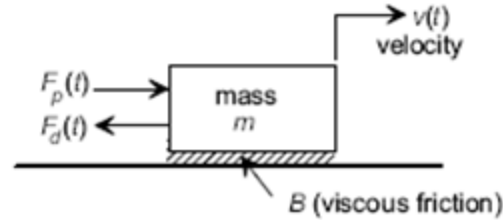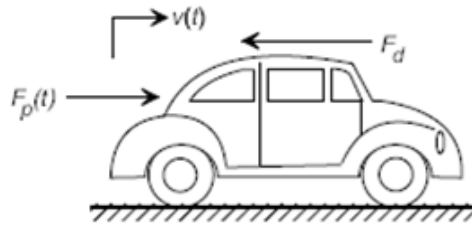
F_p: Pushing force (from engine)

F_d: Distrubance (wind, gravity, enviromental factors, etc.)

$$F_p(t) = K_e\theta(t) \qquad F_B = Bv$$
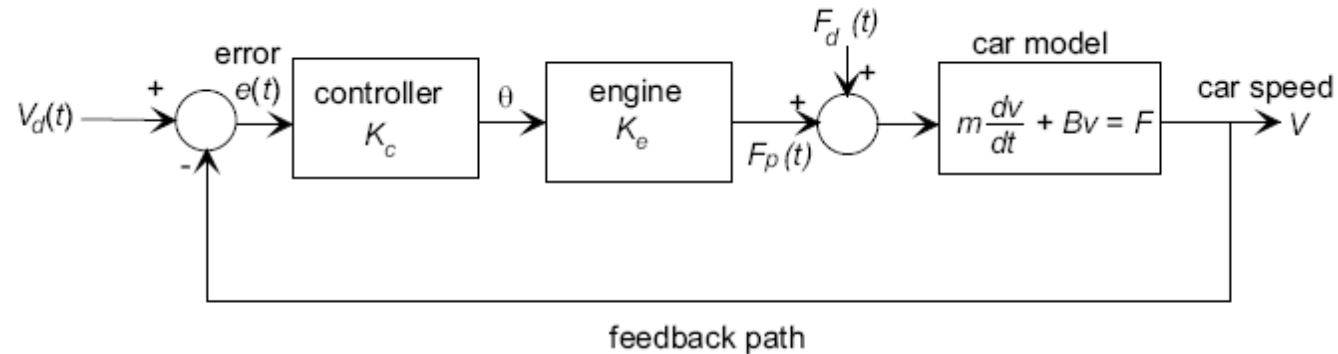
$$m\frac{dv}{dt} + Bv = F_p(t) + F_d(t) \qquad \boxed{m\frac{dv}{dt} + Bv = K_e\theta(t) + F_d(t)}$$

b) Closed loop control:

$$e(t) = v_d(t) - v(t) \qquad \theta(t) = K_c e(t) = K_c(v_d(t) - v(t)),$$
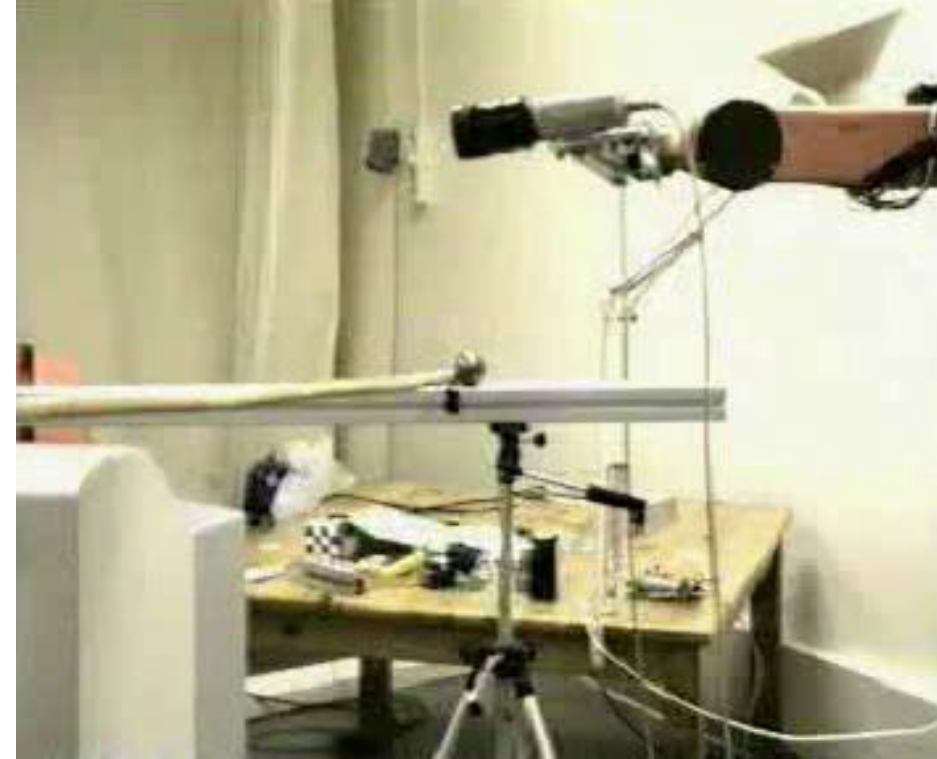
$$F_p(t) = K_e K_p e(t) = K_e K_c(v_d(t) - v(t))$$

feedback path
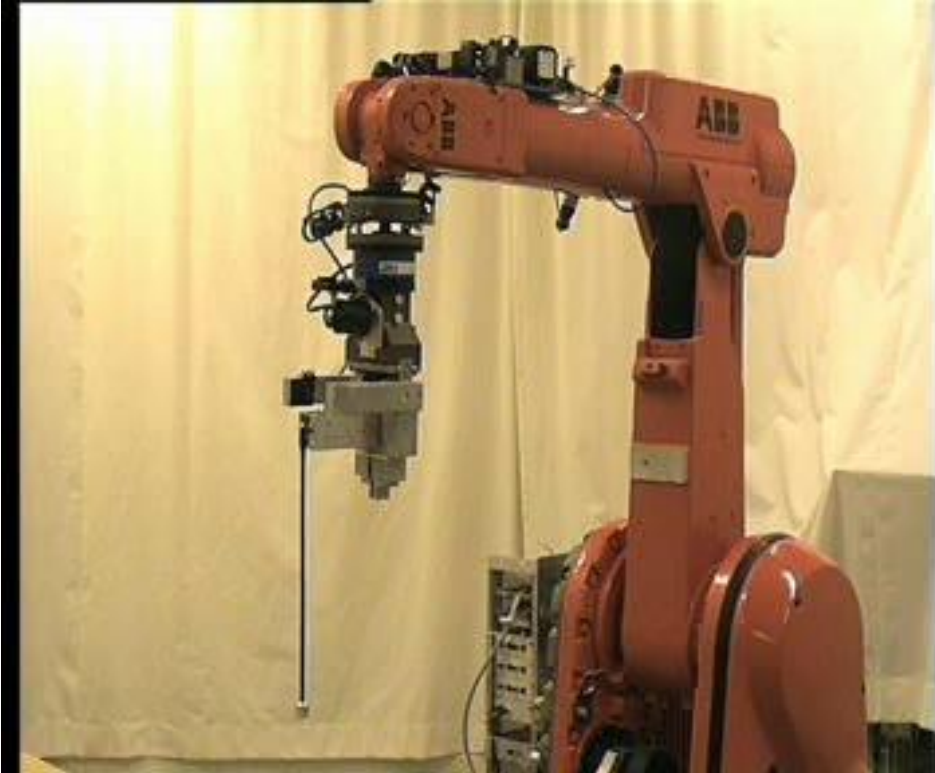
Inverted pendulum control

Ball grabber

SUMMARY

19ECT212/Linear Control Systems/Unit 1/Dr.Swamynathan.S.M/AP/ECE