PENDAHULUAN
SISTEM KENDALI

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PENDAHULUAN

•Rekayasa memberikan perhatian pada pemahaman dan pengendalian material dan kekuatan alam demi kemaslahatan ummat manusia.

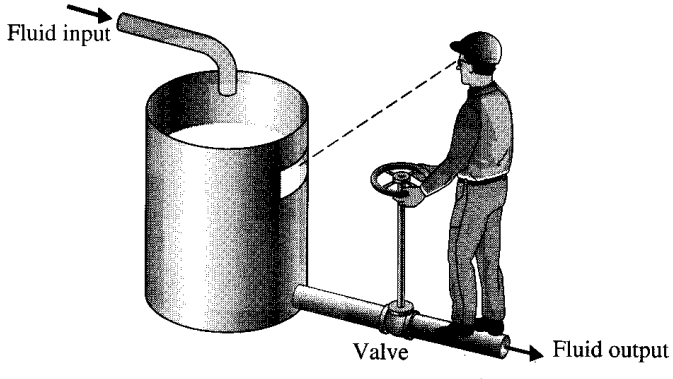
• Sarjana Teknik Kendali dituntut dapat memahami dan mengendalikan bagian kecil lingkungan (sistem) agar menghasilkan produk yang secara ekonomi bermanfaat untuk masyarakat.

•Pemahaman dan pengendalian : komplementer mengingat sistem harus dapat dipahami dan dimodelkan.

•Tantangan saat ini: pemodelan dan pengendalian sistem-sistem yang kompleks, modern, dan terkait satu sama lain: pengendalian lalu lintas, proses-proses kimia, sistem-sistem robot, sistem pesawat angkasa , sistem peluru kendali

•Sebaliknya disiplin ilmu ini memiliki peluang untuk mengendalikan banyak sistem menarik di industri secara otomatis.

•Tiga hal pokok dalam kendali proses: mesin, industri dan ekonomi.



A manual control system for regulating the level of fluid in a tank by adjusting the output valve. The operator views the level of fluid through a port in the side of the tank.

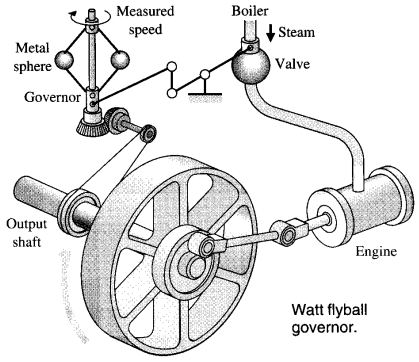
Task Difficulty: Human Versus Automatic Machine

Tasks Difficult for a Machine	Tasks Difficult for a Human
Inspect seedlings in a nursery.	Inspect a system in a hot, toxic environment.
Drive a vehicle through rugged terrain.	Repetitively assemble a clock.
Identify the most expensive jewels on a tray of jewels.	Land an airliner at night, in bad weather.

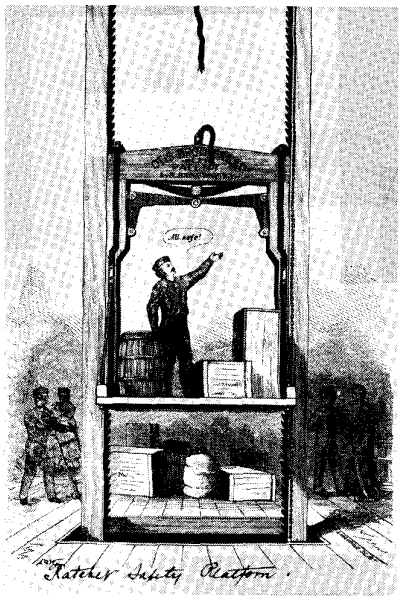
SEJARAH SISTEM KENDALI

TABLE Selected Historical Developments of Control Systems

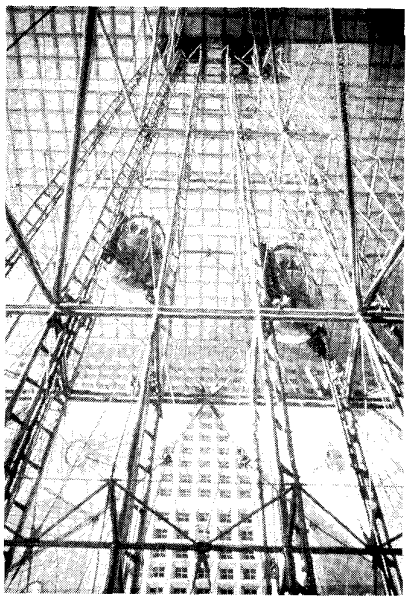
1769	James Watt's steam engine and governor developed. The Watt steam engine is often used to mark the beginning of the Industrial Revolution in Great Britain. During the Industrial Revolution, great strides were made in the development of mechanization, a technology preceding automation.
1800	Eli Whitney's concept of interchangeable parts manufacturing demonstrated in the production of muskets. Whitney's development is often considered as the beginning of mass production.
1868	J. C. Maxwell formulates a mathematical model for a governor control of a steam engine.
1913	Henry Ford's mechanized assembly machine introduced for automobile production.
1927	H. W. Bode analyzes feedback amplifiers.
1932	H. Nyquist develops a method for analyzing the stability of systems.
1952	Numerical control (NC) developed at Massachusetts Institute of Technology for control of machine-tool axes.
1954	George Devol develops "programmed article transfer," considered to be the first industrial robot design.
1960	First Unimate robot introduced, based on Devol's designs. Unimate installed in 1961 for tending die-casting machines.
1970	State variable models and optimal control developed.
1980	Robust control system design widely studied.
1990	Export-oriented manufacturing companies emphasize automation.
1994	Feedback control widely used in automobiles. Reliable, robust systems demanded in manufacturing.



Watt flyball governor.

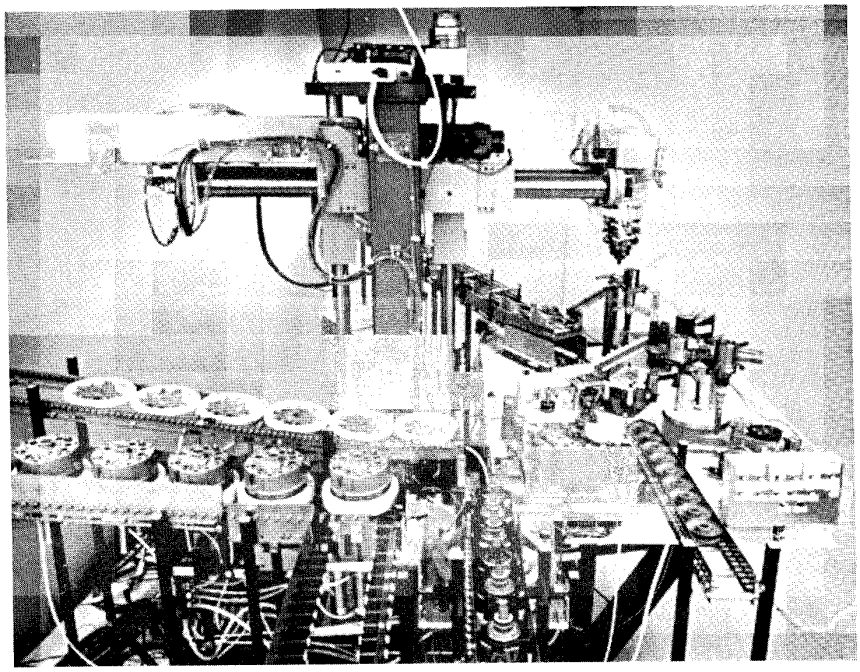


(a)



(b)

a. Early elevators were controlled by hand ropes or an elevator operator. Here, a rope is cut to demonstrate the safety brake, an innovation in early elevators; **b.** modern Duo-lift elevators make their way up the Grande Arche in Paris, driven by one motor, with each car counterbalancing the other. Today, elevators are fully automatic, using control systems to regulate position and velocity.



A programmable robot assembly station can assemble the 17 parts of a commercial automobile alternator in 2 minutes, 42 seconds. At the far right is a control box through which the robot can be taught a sequence of moves that are recorded in the memory of a minicomputer. (Courtesy of *Scientific American.* Photo by Ben Rose.)

KARAKTERISTIK TANGGAPAN

Beberapa Definisi:

- Sistem : kombinasi beberapa komponen yang bekerja secara bersama-sama dan membentuk suatu tujuan tertentu.
- Proses (alamiah) : suatu urutan operasi yang kontinyu atau suatu perkembangan yang dicirikan oleh urutan perubahan secara perlahan yang terjadi tahap demi tahap dengan cara yang relatif tetap dan memberikan suatu hasil atau akhir.
- Proses (artifisial) : operasi yang dilakukan secara berkesinambungan yang terdiri dari beberapa aksi yang dikendalikan atau pergerakan yang secara sistematik diarahkan pada suatu hasil atau akhir.
- Operasi : proses yang dikendalikan: proses kimia, biologi, ekonomi.

- Plant : dapat berupa bagian suatu peralatan yang berfungsi secara bersama-sama untuk membentuk suatu operasi tertentu. (Setiap obyek fisik harus dikendalikan: reaktor kimia, heating furnace, spacecraft)

- Gangguan : suatu sinyal yang cenderung mempengaruhi (secara acak) nilai output suatu sistem: gangguan internal dan eksternal.

- Kendali umpan-balik: suatu operasi yang dengan munculnya gangguan akan cenderung akan memperkecil perbedaan antara output suatu sistem dengan beberapa input dan selanjutnya bertindak sesuai bertitik tolak dari perbedaan tsb.

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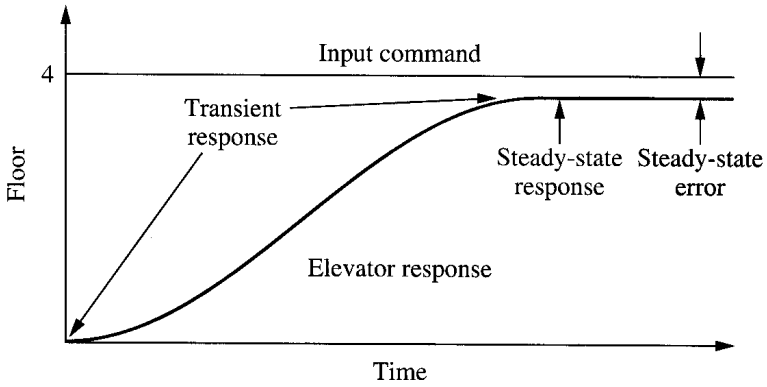
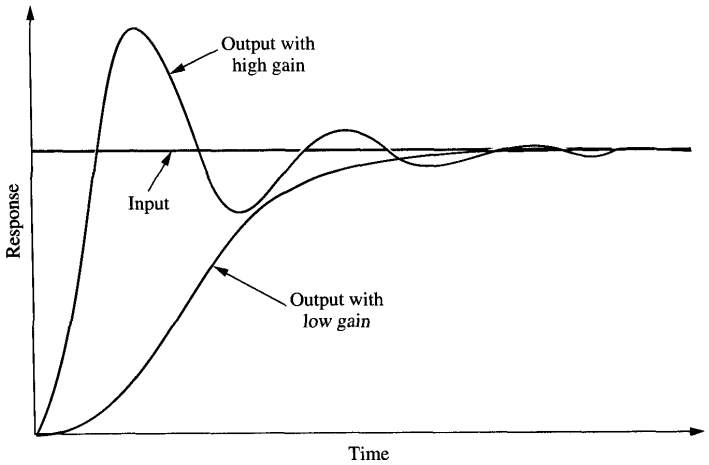
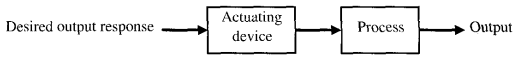
Input: stimulus
Desired response
Control system
response
Actual response

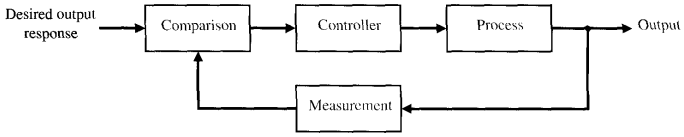

Input command
4
Transient response
Steady-state response
Steady-state error
Floor
Elevator response
Time


Output with high gain
Input
Response
Output with low gain
Time

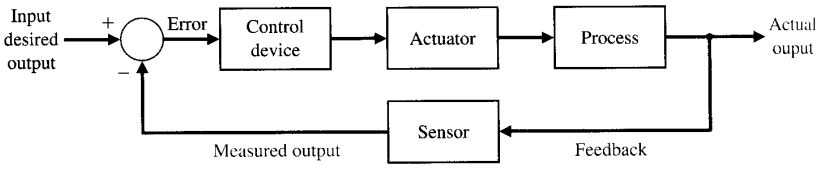
SISTEM LOOP TERBUKA VS LOOP TERTUTUP



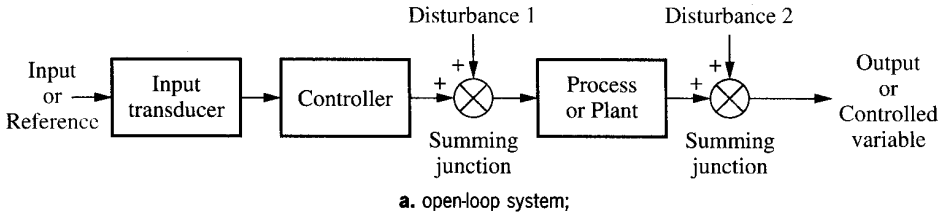
An open-loop control system utilizes an actuating device to control the process directly without using feedback



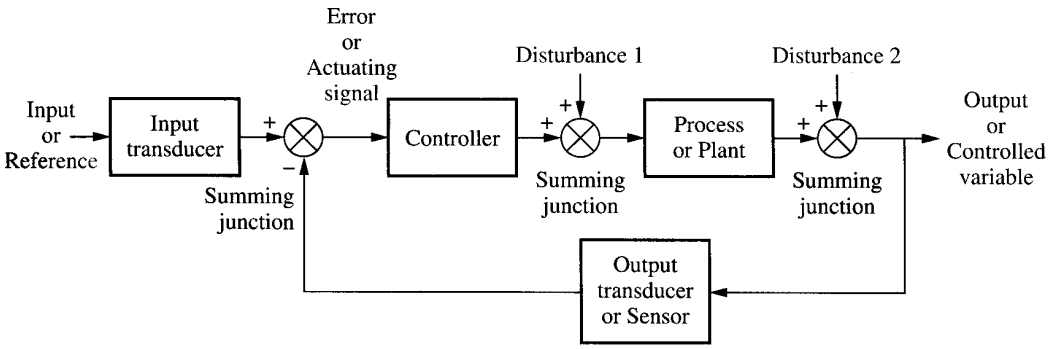
A closed-loop control system uses a measurement of the output and feedback of this signal to compare it with the desired input (reference or command).



A negative feedback system block diagram depicting a basic closed-loop control system. The control device is often called a "controller."

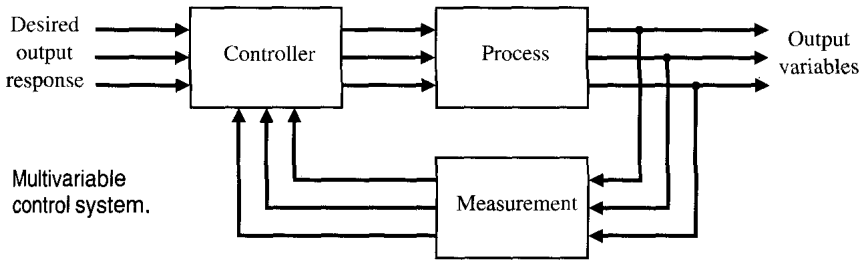


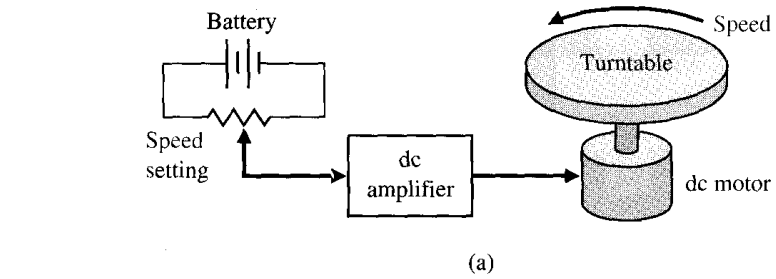
a. open-loop system;



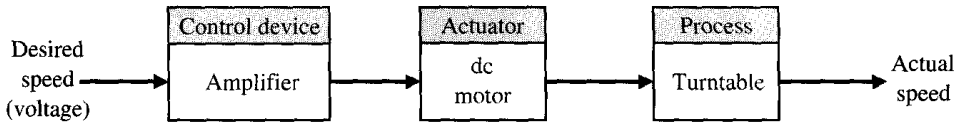
b. closed-loop system

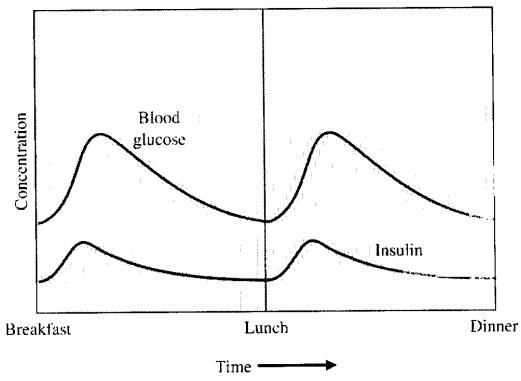
Sistem Multi-Input Multi-Output





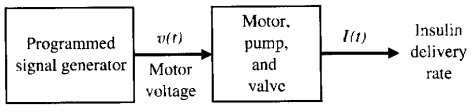
(a) Open-loop (without feedback) control of the speed of a turntable. (b) Block diagram model.

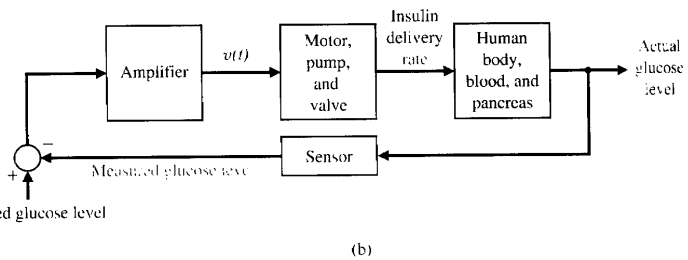




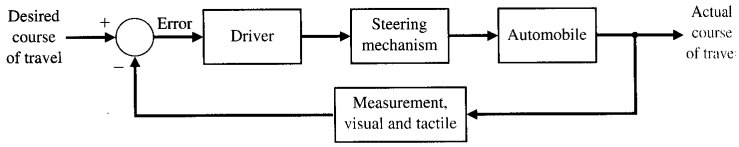
The blood glucose and insulin levels for a healthy person.

(a) Open-loop (without feedback) control and (b) closed-loop control of blood glucose.

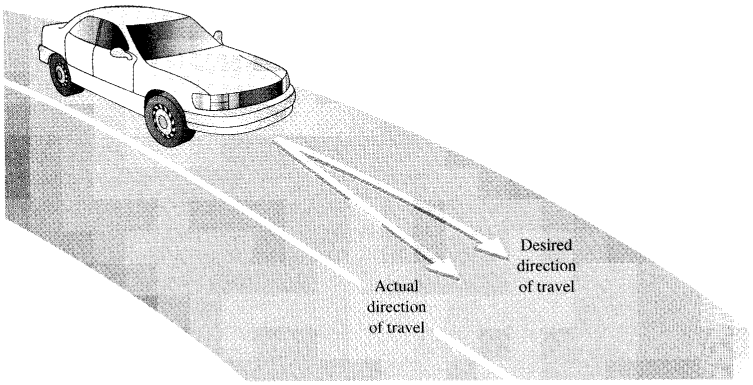




CONTOH-CONTOH SISTEM KENDALI

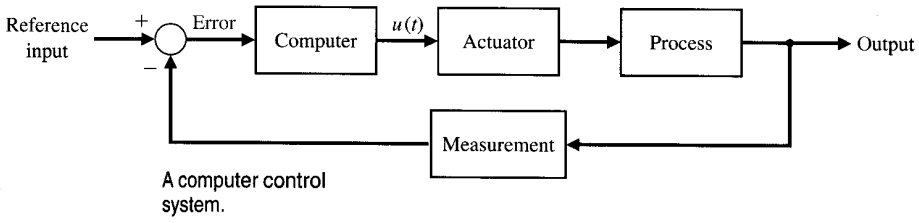


(a)



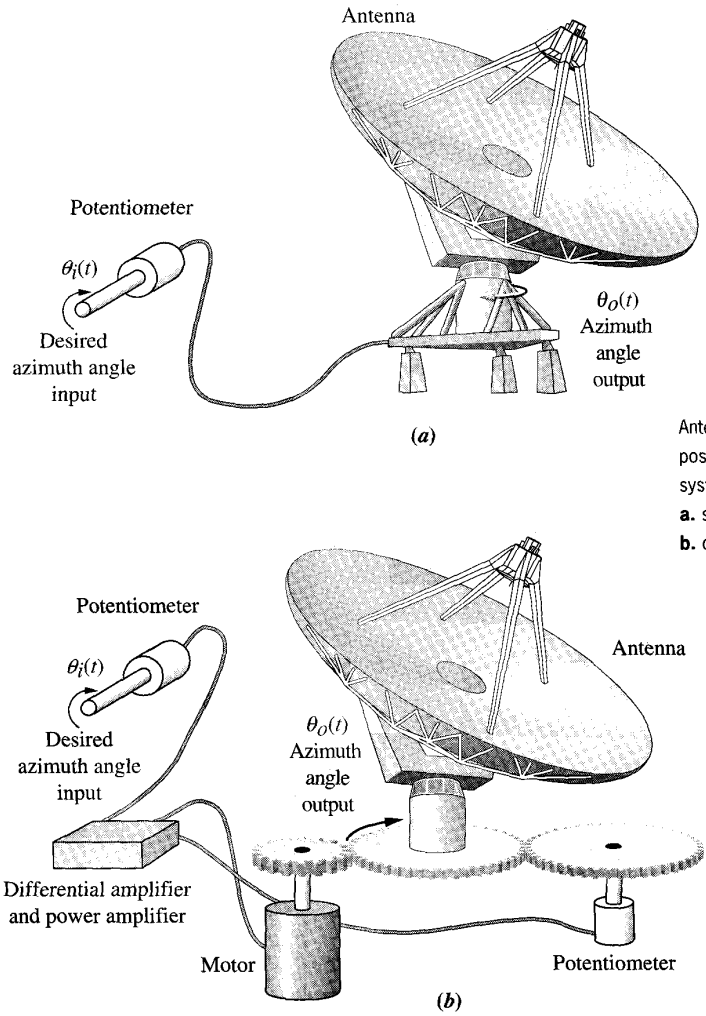
(b)

(a) Automobile steering control system. (b) The driver uses the difference between the actual and desired direction of travel to generate a controlled adjustment of the steering wheel.

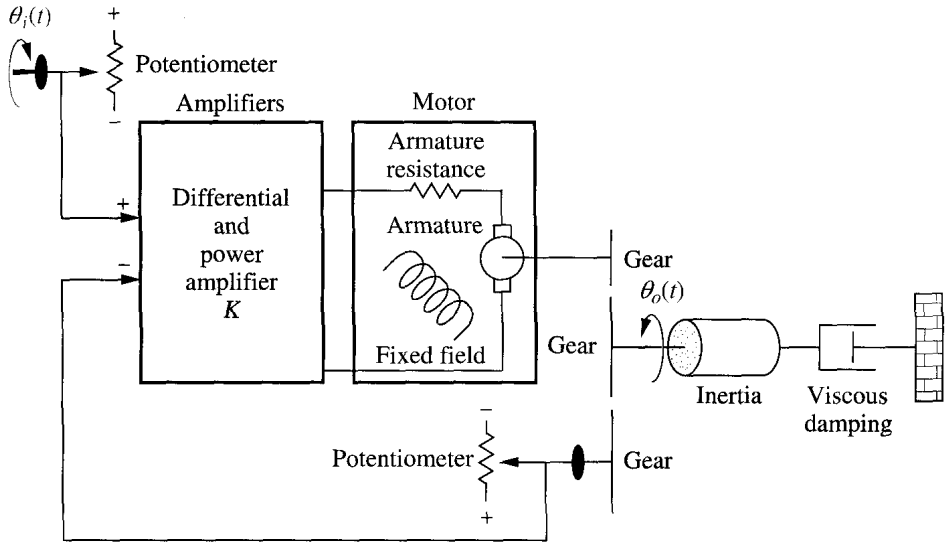


A computer control system.

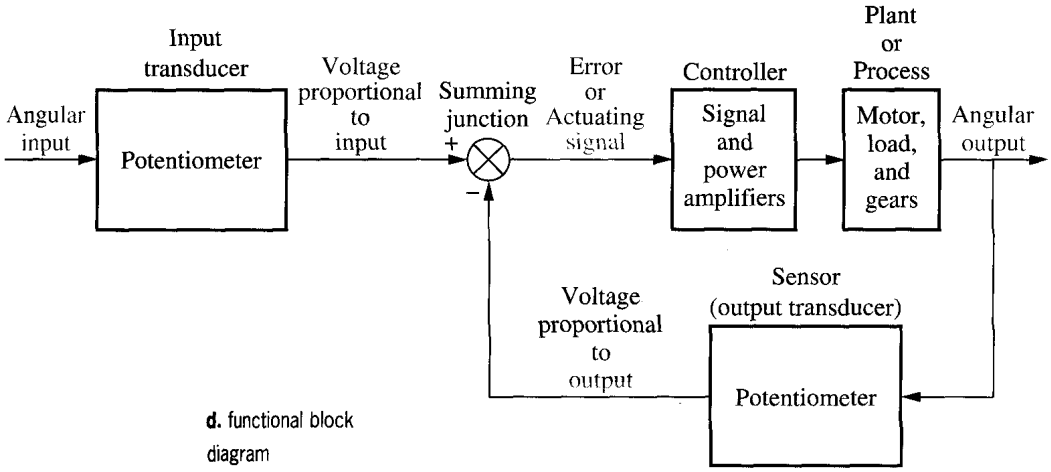
Sistem Kendali Posisi (Azimuth)



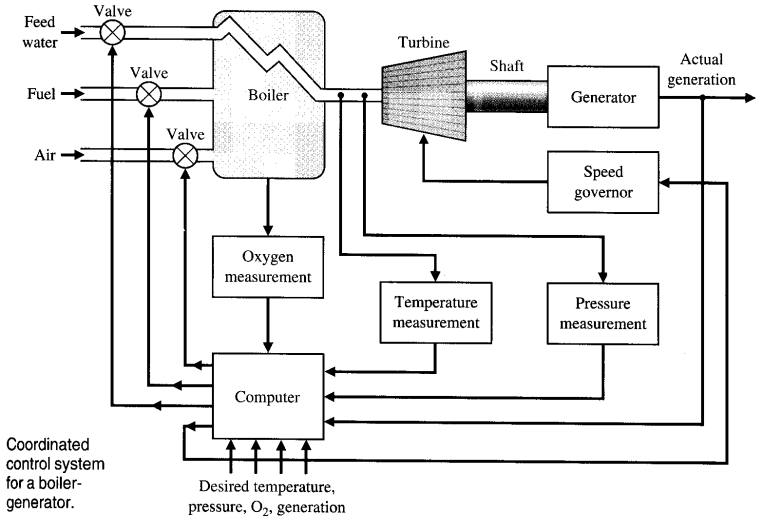
Antenna azimuth position control system:
a. system concept;
b. detailed layout;

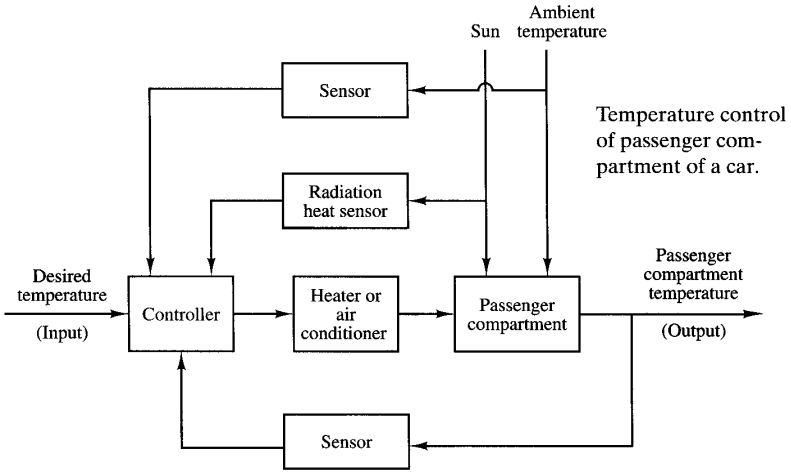


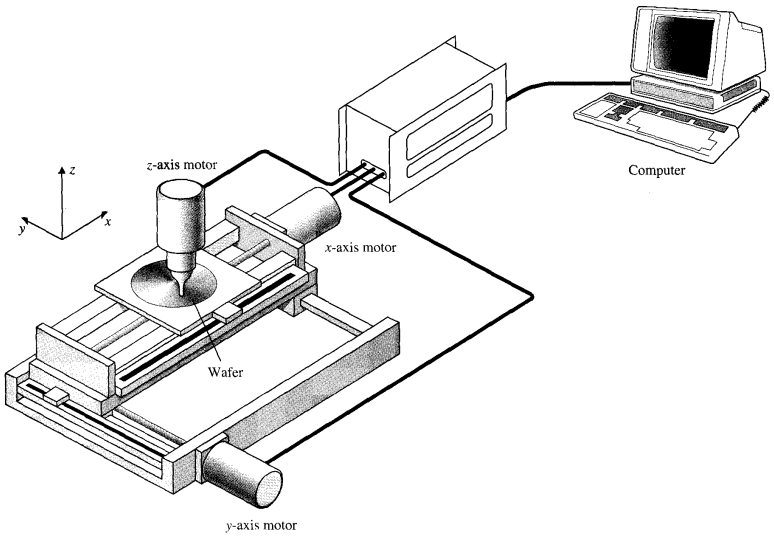
c. schematic;



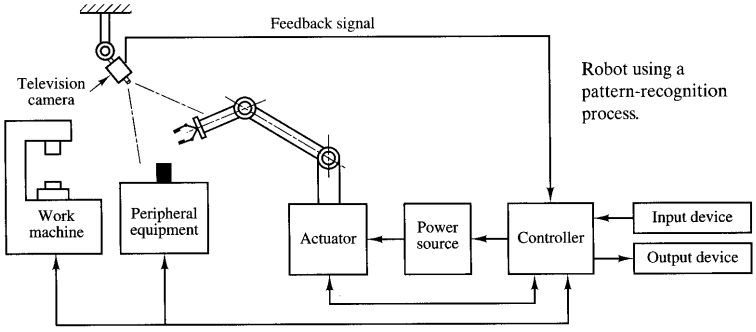
d. functional block diagram

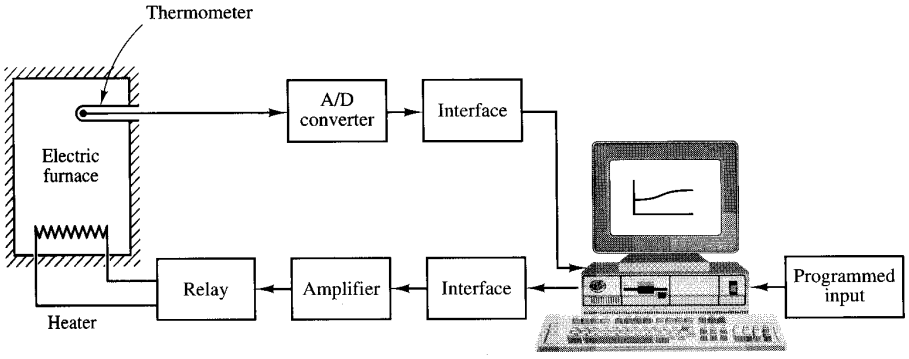

Feed water
Valve
Fuel
Valve
Air
Valve
Boiler
Turbine
Shaft
Generator
Actual generation
Speed governor
Oxygen measurement
Temperature measurement
Pressure measurement
Computer
Coordinated control system for a boiler-generator.
Desired temperature, pressure, O_2, generation


Ambient temperature
Sun
Sensor
Radiation heat sensor
Temperature control of passenger compartment of a car.
Desired temperature
(Input)
Controller
Heater or air conditioner
Passenger compartment
Passenger compartment temperature
(Output)
Sensor

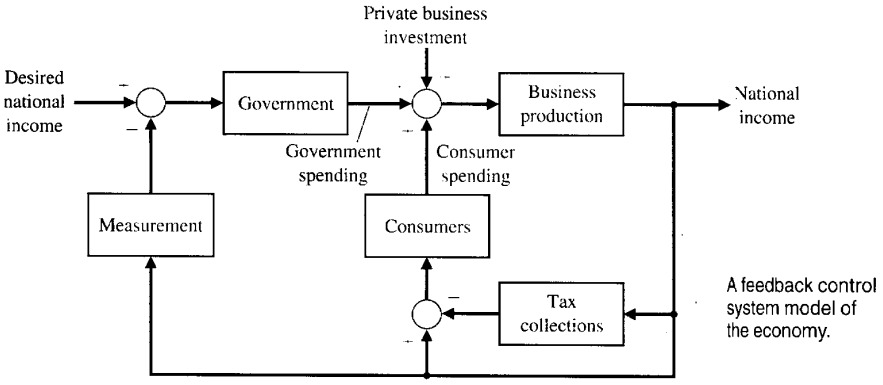


A three-axis control system for inspecting individual semiconductor wafers with a highly sensitive cam era.



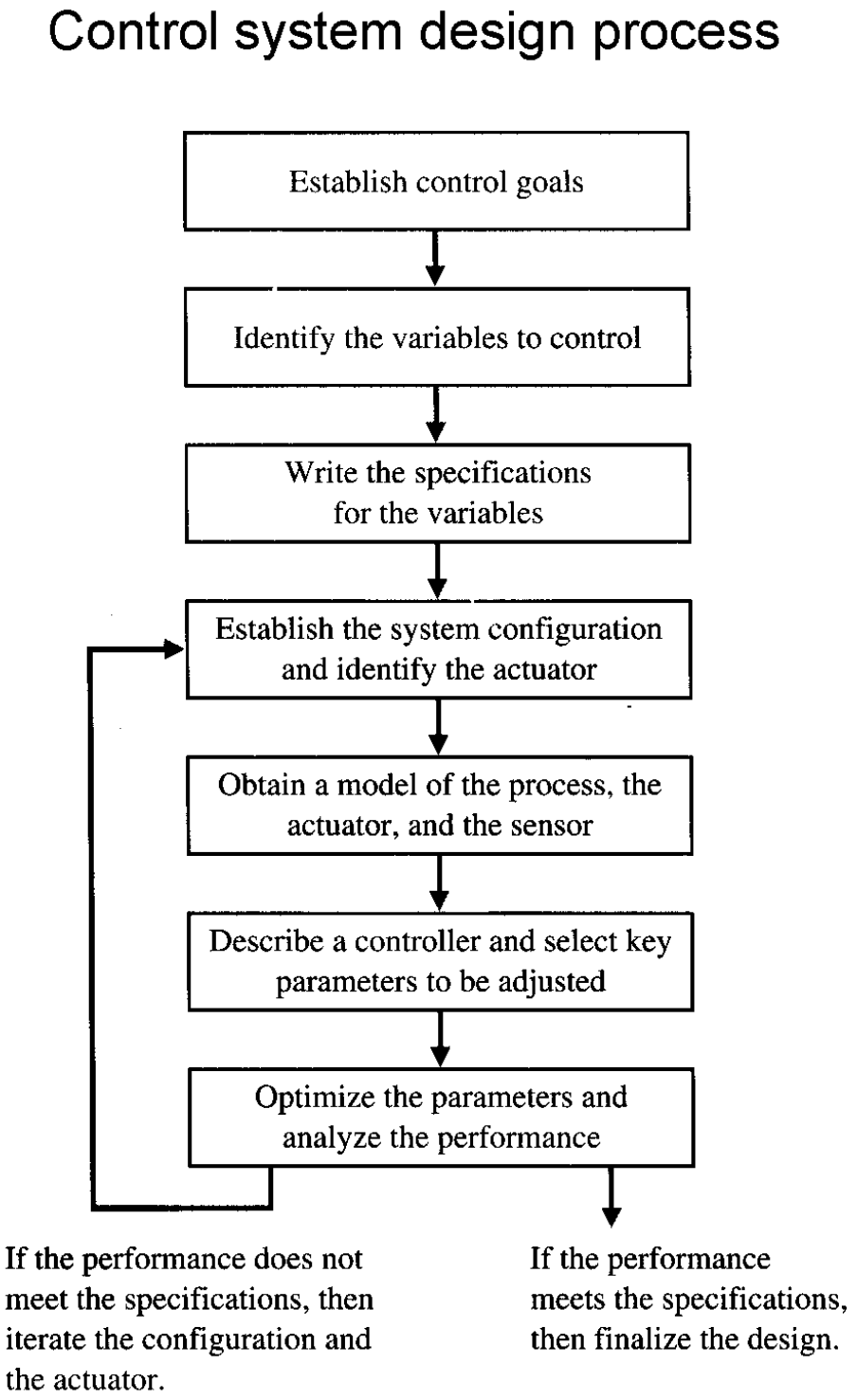


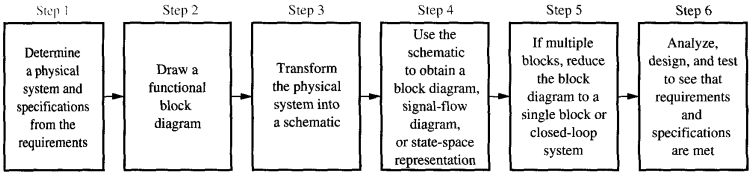
Temperature control system.



A feedback control system model of the economy.

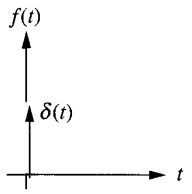
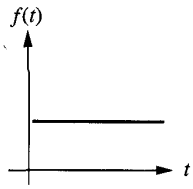
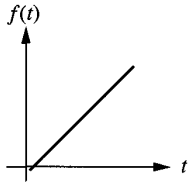
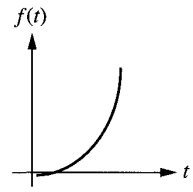
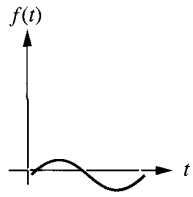
PROSES PERANCANGAN





The control system design process

Table Test waveforms used in control systems

Input	Function	Description	Sketch	Use
Impulse	$\delta(t)$	$\delta(t) = \infty$ for $0- < t < 0+$ $= 0$ elsewhere $\int_{0-}^{0+} \delta(t)\,dt = 1$		Transient response Modeling
Step	$u(t)$	$u(t) = 1$ for $t > 0$ $= 0$ for $t < 0$		Transient response Steady-state error
Ramp	$tu(t)$	$tu(t) = t$ for $t \geq 0$ $= 0$ elsewhere		Steady-state error
Parabola	$\frac{1}{2}t^2u(t)$	$\frac{1}{2}t^2u(t) = \frac{1}{2}t^2$ for $t \geq 0$ $= 0$ elsewhere		Steady-state error
Sinusoid	$\sin \omega t$			Transient response Modeling Steady-state error

ARAH EVOLUSI SISTEM KENDALI