Instrumentasi Industri

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Referensi Kuliah

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BAB I

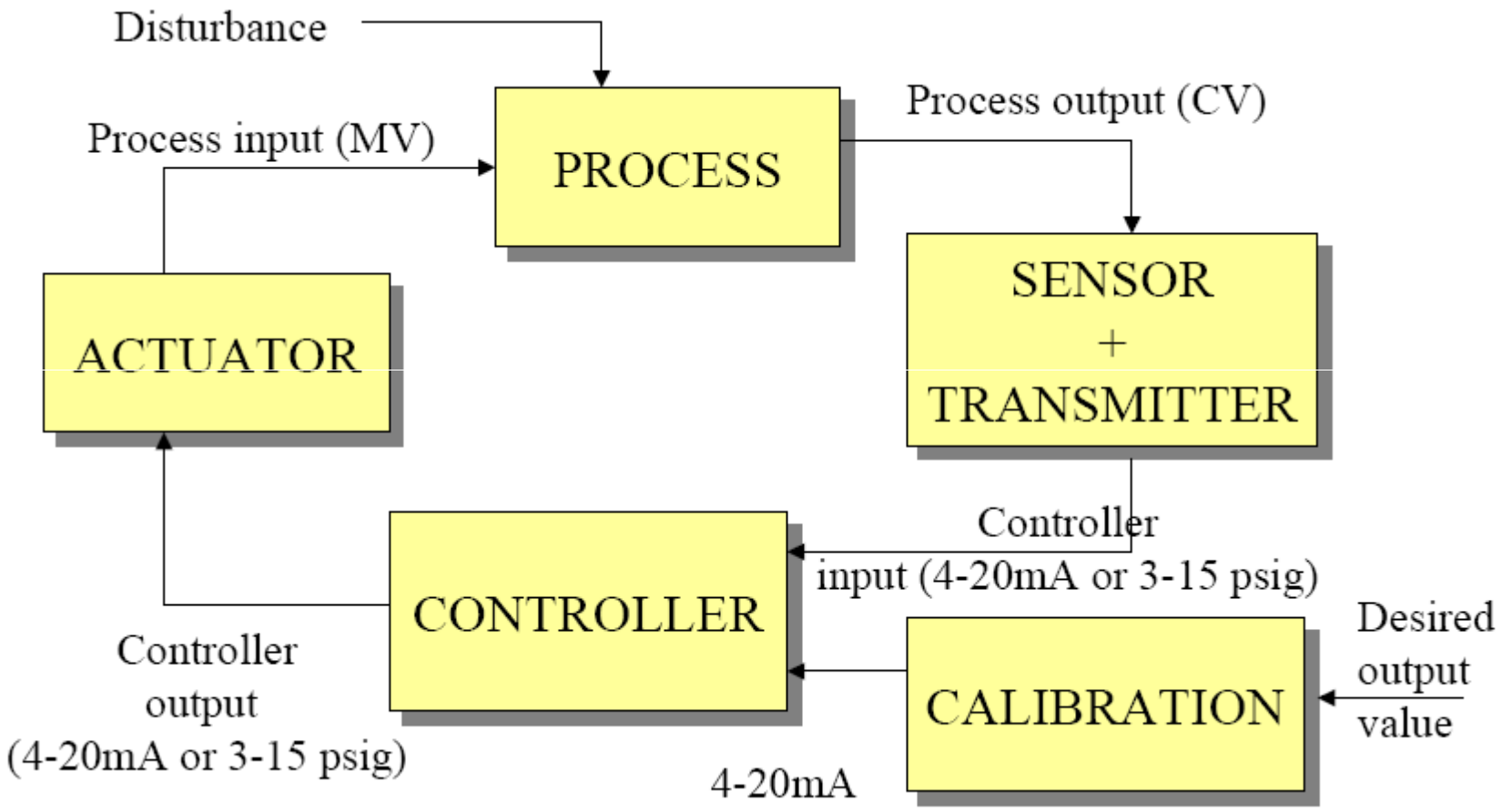
Pengenalan Teknologi Instrumentasi & Diagram Instrumen

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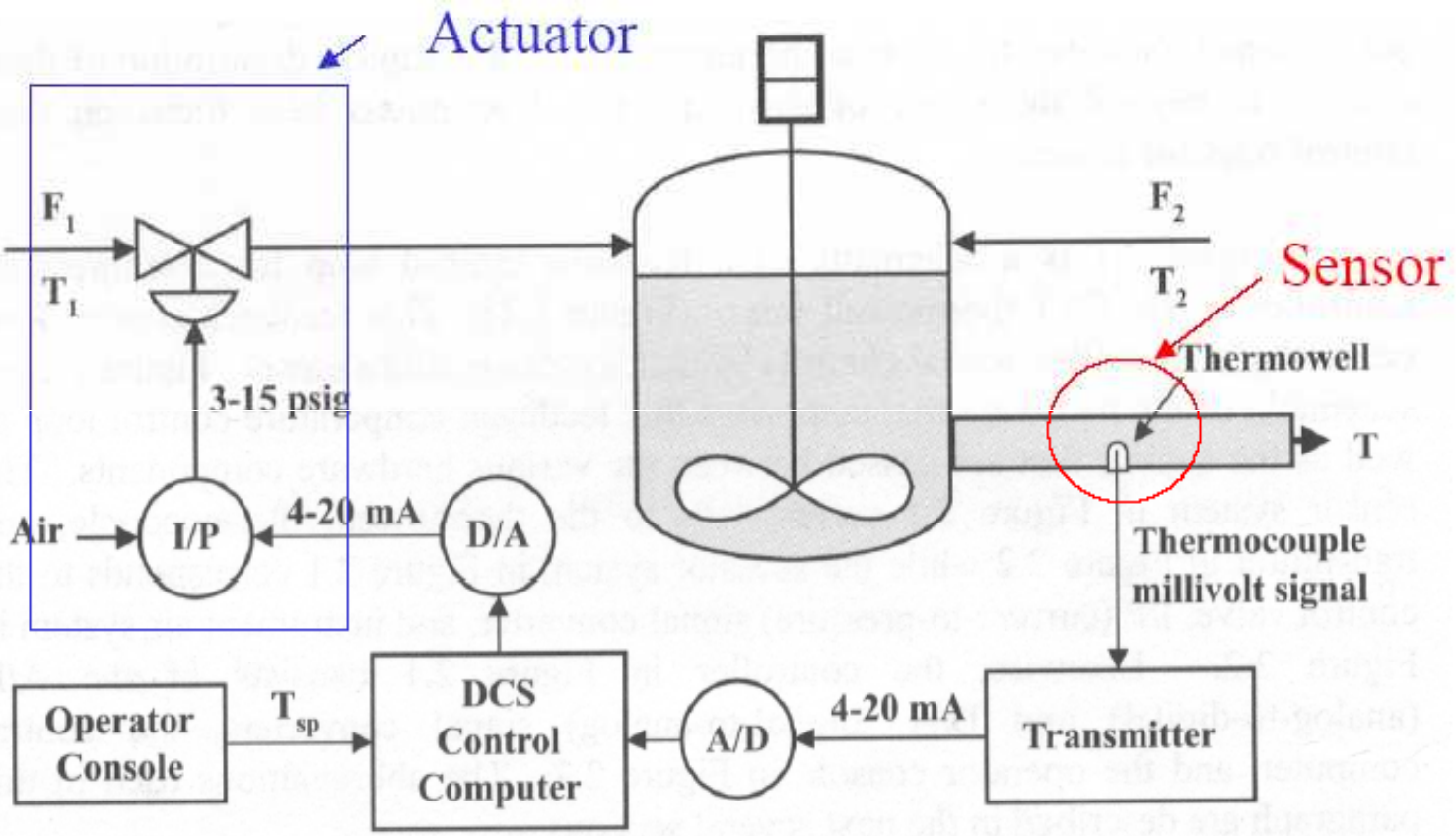
Components of Process Control Instrumentation

- Sensors (orifice, thermocouple, dP cell)
- Transmitters (signal converter, amplifier, conditioner)
- Transmission line (electronic/electrical, air tube/pneumatic, data line)
- Controllers (Computer, PLC, DCS)
- Actuators (Control Valve)

Typical Configuration



Example of Control Loop



Standard Instrumentation Signal Level

- Before 1960, instrumentation in the process industries utilized pneumatic (air pressure) signals to transmit measurement and control information almost exclusively.
- These devices make use of mechanical force-balance elements to generate signals in the range of 3 to 15 psig, an industry standard.
- Since about 1960, electronic instrumentation has come into widespread use.

Process Transmitter

- A transmitter usually converts the sensor output to a signal level appropriate for input to a controller, such as 4 to 20 mA.
- Transmitters are generally designed to be *direct acting*.
- In addition, most commercial transmitters have an adjustable input range (or span).
- For example, a temperature transmitter might be adjusted so that the input range of a platinum resistance element (the sensor) is 50 to 150 °C.

Process Transmitter

- In this case, the following correspondence is obtained:

Input	Output
50 °C	4 mA
150 °C	20 mA

- This instrument (transducer) has a lower limit or *zero* of 50 °C and a range or *span* of 100 °C.

Process Transmitter

- For the temperature transmitter discussed above, the relation between transducer output and input is

$$T_m(\text{mA}) = \left(\frac{20\ \text{mA} - 4\ \text{mA}}{150\ ^\circ\text{C} - 50\ ^\circ\text{C}}\right)\left(T - 50\ ^\circ\text{C}\right) + 4\ \text{mA}$$

$$= \left(0.16\frac{\text{mA}}{^\circ\text{C}}\right)T\left(^\circ\text{C}\right) - 4\ \text{mA}$$

Instrument Gain

The gain of the measurement element K_m is 0.16 mA/°C. For any linear instrument:

$$K_m = \frac{\text{range of instrument output}}{\text{range of instrument input}}$$

Implementation Mode

- Pneumatic
  - Transmission: Pressure signals (3-15 psig)
  - Control Calculation: Mechanical device (e.g., tubes, bellows)
  - Only very basic calculation can be performed
  - **Safe** in general
- Electronic Analog
  - Transmission: Analog electric signal (4-20 mA)
  - Control Calculation: Analog circuit
  - More advanced calculation but still not very flexible
  - Susceptible to contamination
  - Cannot be used in safety-sensitive processes

Implementation Mode

- Digital
  - Transmission: either analog signal (which gets converted to digital signal just before entering the controller) or digital signal (sequence of 0-1 binary pulses)
  - A/D: converts analog signal to digital signal
  - D/A: converts digital signal to analog signal
  - Controller: digital computer (can be complex).
  - High flexibility and easy reconfiguration.
  - Easy access of remote data and past data.

Advantages of Digital Implementation

- Increased flexibility – much easier to manipulate data (on computers) than analog signals (through analog devices)
  - Signal conditioning (e.g., noise filtering)
  - Control calculation ("algorithm")
- Easy storage and display
- More precision
  - Little signal degradation
- Opportunity for improved control
  - Smart actuators and sensors
  - More sophisticated control algorithms
  - Easily reconfigurable