

Fakulta strojní VŠB – TUO

Katedra automatizační techniky a řízení

Control Instrumentation

doc. Ing. Jaromír Škuta, Ph.D.




1

Fakulta strojní VŠB – TUO

Lectures

1. Basic system concepts, control, regulation, system, element, connection, measurement chain, control types, description of program and software resources.
2. Static and dynamic properties of elements and systems.
3. Standardized signals and types of modulations for information transfer, A/D and D/A converters, serial interface.
4. Division of sensors and examples for measuring quantities in engineering and their evaluation.
5. Electric drives for actuators.
6. PLC, control systems and single chip computers.




2

Fakulta strojní VŠB – TUO

Katedra automatizační techniky a řízení

Lecture no. 1 (Support for notes)

Basic system concepts, control, regulation, system, element, connection, measurement chain, control types, description of program and software resources



3

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

What do you find out?

- Basic system concepts (system, element, connection).
- Measuring chain, procedure for designing a measuring chain.
- Control circuit (quantities, elements, control equation).
- Types of control.
- Description of program and software resources.
- Ways of converting a measured quantity into a measurable one.
-

4

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

Basic system concepts

- System
- Element
- Connection
- System neighborhood
- Information
- Signal
- Resolution level
- ...

System
Element
Connection
System neighborhood
Information
Signal
Resolution level

5

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

Measuring chain, procedure for designing a measuring chain

The diagram shows a measuring chain with three main blocks: **sensor**, **Converter**, and **Evaluation device**. An input signal J_a enters the sensor. The sensor outputs a signal $y_1 = f(y, \theta, U_1)$ to the converter. The converter outputs a signal z_1 to the evaluation device. The evaluation device outputs a final signal y . There are also feedback paths labeled z_i from the converter and evaluation device back to the sensor.

6

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení
Measuring chain - its composition

The diagram illustrates the components of a measuring chain. It includes several sub-diagrams labeled 'Obr. 38', 'Obr. 39', 'Obr. 40', and 'Obr. 41'. The main image shows a mechanical assembly with a spring, a shaft, and a sensor head. To the right, there are gears and a circular component labeled 'a' and 'b'.

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení
Measuring chain, procedure for designing a measuring chain

The flowchart shows the procedure for designing a measuring chain. It starts with 'Input (True Load)' leading to 'Sensing' (Strain, Resistance, Voltage output (displacement), Force/torque) and 'Signal conditioning' (Amplification, Filtering). This leads to 'Signal Processing / Decoding' (Detector, I/V Amplifier, Linepass, A/D Converter, Bridge, Transducer, DMD Controller). The output is 'Output (Displacement, Force/torque)'. Below this, a block diagram shows the flow: Signal Source → Sensor (Transducer) → Signal Conditioning → Analog-to-digital converter → Driver Software → Application Software. At the bottom, there are waveforms for 'Physical phenomena', 'Noisy electrical signal', 'Conditioned signal', and 'Digitized and sampled data'. A table shows 'Raw binary information' and 'Processed data'.

00101001	12.256 N
01001011	43.643 N
01000011	62.379 N
10110101	84.269 N
01000110	96.124 N
00101001	12.256 N
01001011	43.643 N

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení
Measuring chain, procedure for designing a measuring chain
Basic requirements for measurement

- type of measured quantities

Fakulta strojní VŠB – TUO

Katedra automatizační techniky a řízení

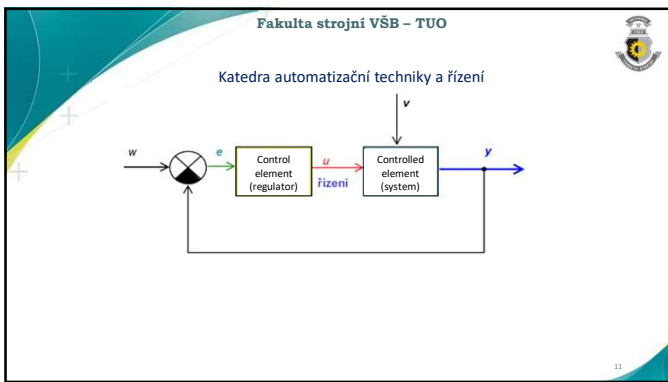
Measuring technology as part of automation technology

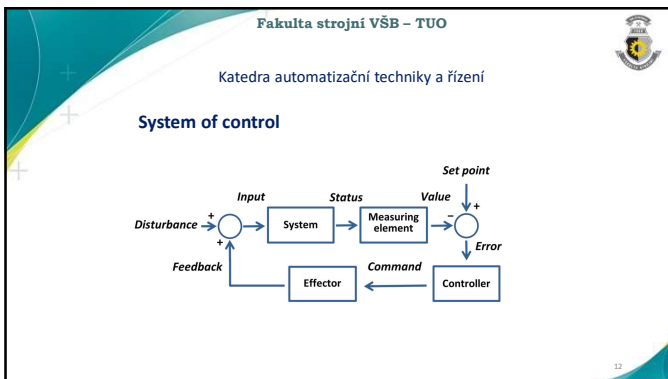
measurement is a source of information:

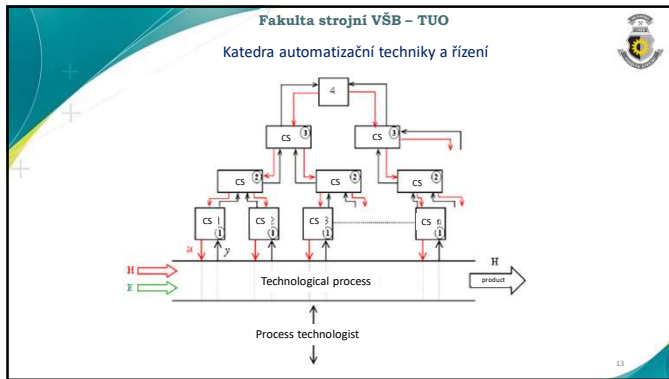
- about the state of the technological
- about the safety parameters

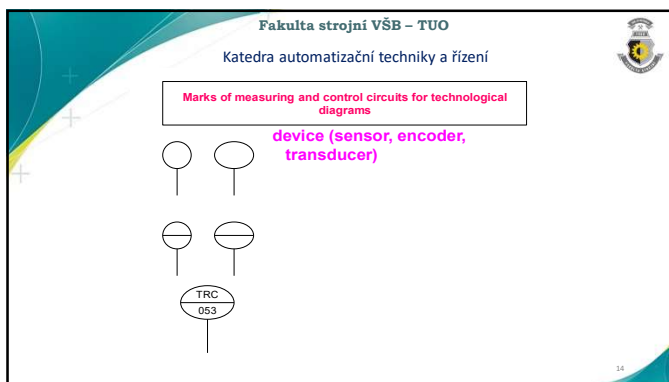
elements of measuring technology

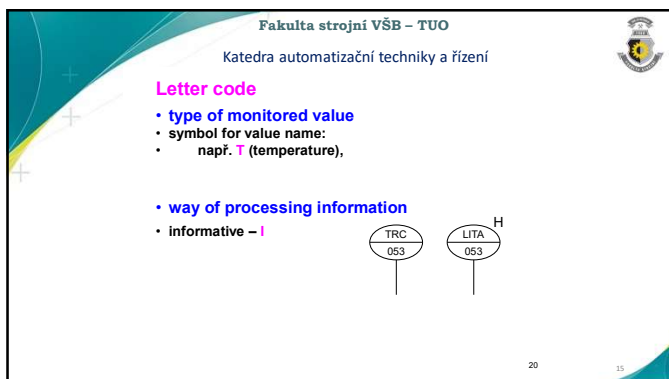
10

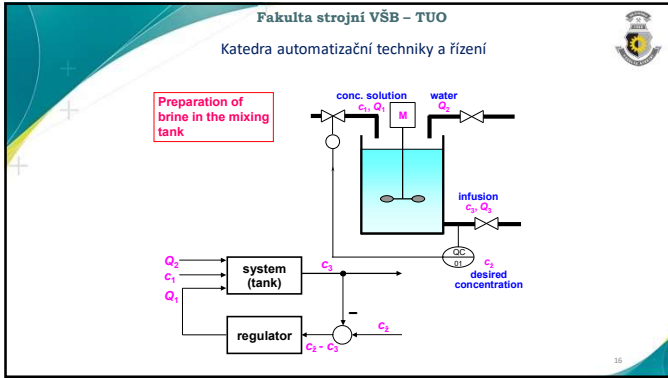


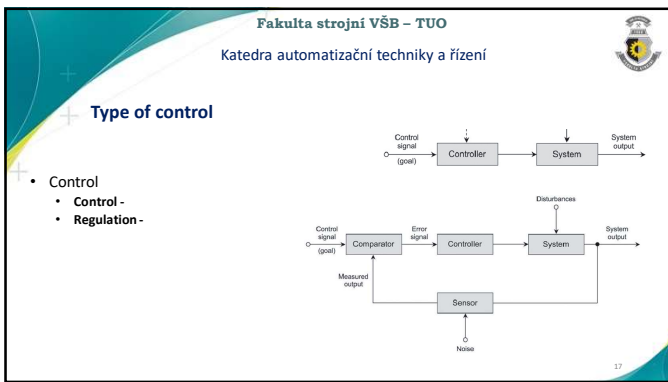


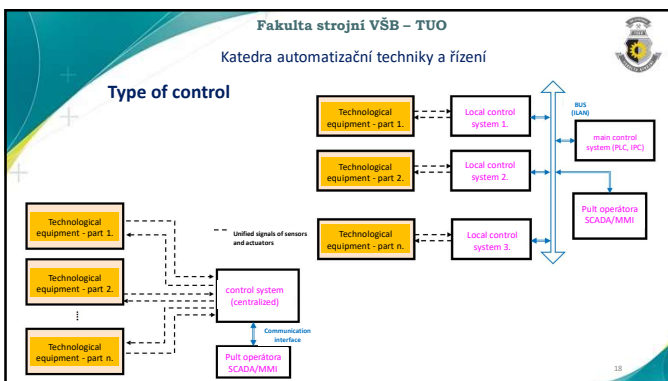












Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

Type of control

The diagram illustrates a multi-level control architecture. At the bottom is the 'Field Level' (Level 0) with 'Plant' units. Above it is 'Level 1: Direct Control' with 'Supervisory Computers'. 'Level 2: Production Control' includes 'Supervisory Computers' and 'Executive Processors'. The top level is 'Level 3: Production Scheduling' with 'Executive Processors'. A 'Control System' box encompasses Levels 1 and 2. Below, 'Input/output' shows 'Program Storage', 'Executive Processor', and 'Computational Processor' connected to 'Joint 1' through 'Joint 6'. A legend indicates 'DC Power Flow' (black arrow) and 'Information Flow (Communications)' (grey arrow).

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

Program and software resources

Two pyramids represent software resource layers. The left pyramid has layers: 'Management/Optimization', 'Supervisory Control', 'Regulatory Control', and 'Field'. The right pyramid has layers: 'Production operation and integration (RIO)', 'Advanced Control (MPC)', and 'Basic Control and Instrumentation'. Both pyramids point to a 'Process plant' at the base.

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

Examples - measurements on gearboxes

The slide shows a photograph of a gearbox on the left. On the right, two graphs are displayed. The top graph is a 'Time History (20000Samples)' plot of 'Residual[1]' vs 'Residual[1]', showing a noisy signal oscillating between -0.01 and 0.01. The bottom graph is a 'Tooth Pitch Fluctuation' plot of 'Pitch Error' vs 'Pitch Error', showing three curves: 'Pitch 217' (blue), 'Pitch 447' (red), and 'T.E.' (black).

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

Examples - measuring the uniformity of revoluti

The diagram illustrates the measurement of flywheel uniformity. On the left, a flywheel with teeth is shown with a transducer measuring the gap between teeth. Below it, a segment with a 180-degree gap is shown. On the right, a timing diagram shows the relationship between the crankshaft, camshaft, and ignition points for a 4-cylinder engine. The tachometer output (tacho PIC output) is shown as a series of pulses corresponding to the teeth on the flywheel. The diagram also shows the 1st and 2nd revolutions of the crankshaft and a complete revolution of the camshaft.

22

Fakulta strojní VŠB – TUO
Katedra automatizační techniky a řízení

What was the content of the lecture

- Basic system concepts (system, element, connection).
- Measuring chain, procedure for designing a measuring chain.
- Control circuit (quantities, elements, control equation).
- Types of control.
- Description of program and software resources.
- Ways of converting a measured quantity into a measurable one.
-

23
