INDUSTRIAL MEASUREMENTS AND PROCESS CONTROL
general subject (final exam topics, Automation and Industrial Process Control specialization)

1. Functional units, system structure of PLCs, PLC architectures (generations), CPU parts, memories.

2. Classification, brief description, main parameters of PLC IO units. Structure, operation principles of digital input and output modules.

3. Differences between PLCs and computers. PLC program execution modes. Cycle time.

4. PLC selection viewpoints: hardware selection, problems of system performance, environmental conditions, PLC manufacturers' requirements.

5. Operational safety of PLCs: basic concepts, reliability, redundancy, failure coefficient, useful lifetime, tests, system engineering of safety PLCs.

6. PLC project structure specifications according IEC 61131-3 standard.

7. PLC programming languages and their peculiarities according IEC 61131-3 standard. Standard data types, operations, functions, function blocks.

8. Industrial control engineering networks. Ethernet network. PLC field bus systems.

9. Sample and hold circuitry of computer based measurement systems.

10. Analogue to digital conversion. Type of converters, summary and comparing of converters.

11. Functions and specification of multifunctional data acquisition equipment.

12. Application characteristic and functionality of analogue input of multifunctional data acquisition equipment.

13. Application characteristic and functionality of analogue output of multifunctional data acquisition equipment.

14. Describe the general features of sensors and their selection points of views.

15. Describe the methods and devices of temperature measurements.

16. Describe the measuring principle of the strain gauge.

17. Describe the devices of inductive displacement measurement (principle, types). Describe the devices of optical displacement measurement (types, operational principle).

18. Describe the devices of pressure measurement.

19. Describe the sensors of voltage- and current measurement.

20. Describe the types of flow sensors.

21. Describe the types of humidity and gas sensors.

The examination subject consists of the curriculums of the following subjects:

- **Automation** specialization:
    - TFBE1714 Programmable Logic Controllers (PLC),
    - TFBE1712 Computer Controlled Measurement and Process Control,
    - TFBE1716 Sensors and Actuators.

- **Industrial Process Control** specialization:
    - TTFBE1321 Industrial Process Control,
    - TTFBE1322 Smart Sensor and Measure Systems.

ACTUATORS OF INDUSTRIAL AUTOMATION
specialized subject (final exam topics, Automation specialization)

ELECTROTECHNOLOGY
specialized subject (final exam topics, Industrial Process Control specialization)

1. Transformer: principle of operation, construction, equivalent circuit, losses in the transformer, concept of drop, conditions of parallel connection. Construction and configurations of three phase transformers.
2. Commutator (DC) machines: principle of operation, construction, expressions of torque and armature (induced) voltage, equivalent circuit, torque-angular velocity curve of constant pole flux motor, DC series (universal) motor.
3. Synchronous machines: principle of operation, construction, AC windings, generation of rotary magnetic field, equivalent circuit, expressions of torque and mechanical power, load angle, circle diagram of simplified machine, reactive power compensation by synchronous machines.
4. Asynchronous machines: principle of operation, AC windings, generation of rotary magnetic field, construction, rotor types, concept of slip, equivalent circuit, torque-angular velocity curve, methods for revolution control, single phase asynchronous motors.
5. Power semiconductor devices. Thyristor, Triac, Light Activated SCR, Gate Turn Off Thyristor, MCT, IGBT, ...
6. AC-DC converters, rectifiers. Half-wave controlled rectifier, phase control type. Controlled half-wave rectifier with R-L-E load. Full-wave controlled converter with center-tapped transformer.
7. AC-DC converters, rectifiers. 3-phase bridge rectifier. Control of three phase, half-wave, 3 pulse controlled rectifier from rectifier operation to inverter operation. Three-phase full-wave 6-pulse uncontrolled rectifier or three-phase bridge rectifier.
8. AC voltage controllers. Cycloconverter. Illumination control circuit and its operation.
9. AC voltage controllers. Phase-control type. Phase half-wave control type. On-off control type. Three-phase ACVCs.
10. DC-DC converters. Step-down chopper (buck-converter) connected to resistive load and RLE load. Step-up chopper (boost-converter). Four quadrant, full bridge DC-choppers, circuit diagram and operation.
11. DC-AC converters, inverters. Half-bridge inverter. Bridge inverter. Three phase inverters and their conduction strategies.
12. Relays: function, parameters, classification, applications, structure of electromagnetic relays.
13. Fuses: function, parameters. Low-voltage fuses: classification, their structure, characteristics curves. General points of views of fuse selection.
14. Low-voltage circuit breakers: parameters, requirements, classification, their structure and operational principles.
15. Contactors: parameters, classification, function, structure, operational, arc quenching units, contacts, utilization categories, life span curves, selection.
16. Motor-protective devices, their selection.
17. Overvoltage protective devices: classification, their brief characterization.
18. Disconnectors: function, placement, parameters, structure, their drives, dielectric strength and operational current-load requirements, requirements implied fault current thermic and dynamic effects.

The examination subject consists of the curriculums of the following subjects:

- **Automation** specialization:
  - TFBE1711 Electrical Machines and Drives,
  - TFBE1705 Power Electronics,
  - TFBE1707 Electrical Switchgears.

- **Industrial Process Automation** specialization:
  - TTFBE1324 Electrical Machines and Drives,
  - TTFBE1325 Power Electronics,
  - TTFBE1323 Electrical Switchgears.