MECHATRONICS FINAL EXAM FOR MECHATRONICS ENGINEERING BSC:

- *Electrotechnics and electronics I-II.*
- *Basics of Mechatronics*
- *Mechatronics I-II.*
- *Measurements and automatics I.-II.*
- *Programming and Digital technics I.-II.*
- *Programmable logic controllers I.*

Programmable logic controllers

1. Construct a program, which controls various (maximum 3 pcs) pneumatic cylinders, in a single plane, crossing each other, by sensing the position of the piston.

2. Create a PLC program to control a hydraulic cylinder, (the hydraulic pump has been started by the PLC as well) where the work phase of the cylinder is 5 sec, and the overall cycle time is 15 sec (try to consider the pistons as a real world device).

3. Consider a machine, which input axle is driven by an induction motor (controlled by an inverter) and a hydraulic motor parallel. Make a program, which can handle the different driving speeds of the individual devices by inhibiting (synchronizing) the parallel driving.

Electrotechnics and electronics I-II.

1. In case of building a high-performance power supply, how could you realize a circuit of a given rectifier?

2. There is given an electrical machine with its loss parameters (transformer, synchronous motor, asynchronous motor). Draw the equivalent circuit of the electrical machine and write the equations of a known circuit analysis method (Kirchoff's laws, mesh analysis, nodal analysis)!

3. Describe a taught electrical circuit that is able to revers the rotation of an electric motor! Explain further application opportunities of the circuit in case of electrical drives.

4. In case of a given logic network, write down the circuit's truth table! Simplify the logic function applying the Karnaugh table and design a logic network for the simplified logic function with AND, OR, NAND, NOR!

5. How can you realize control elements with operational amplifiers? (adding, subtracting, proportional, integrator, differential). Write an application example, where you would apply control engineering basic element.

Programming and Digital Technics I.-II.

1. Describe the von Neumann and Harward architecture of microcomputers and the internal structure of FPGA-s! Show practical applications, where application of microcontroller (MCU) provides better (flexible) solution than application of FPGA.

2. Describe (with schematic) the (1) FPGA and (2) microcontroller based, time-multiplexed control of 4 digit, 7-segment display. Describe the FPGA control by block diagram and VHDL code.

3. Describe multiplexers! How to build MUX 4x4, using MUX 2x1, and develop the VHDL code?

4. Describe the full adder structure, using half adders! Describe the truth tables and VHDL codes. How to make parallel implementation of adders?

5. Describe the conversion of binary numbers to BCD! Introduce the ShiftAdd3 algorithm with flow chart and block diagram!

6. Show the software implementation of switch debouncing using microcontroller (MCU) and FPGA! Prepare flow chart for MCU and block diagram for FPGA!
How to make code, what is able to could switch press?

7. Describe the UART, SPI and I2C communication interfaces. How the UART can be implemented on FPGA (with HVDL)? Show the state machine for UART communication! Describe the UART functions can be used used in MCU-s!

Mechatronics I-II.

- A 2500 kg car jack assuming compare what would be the advantages and disadvantages of electro and electro-hydraulic solution!

- What kind of practical solutions would implement an electro-pneumatic and electro-hydraulic circuit, four each in different positions to move 800 mm long stroke cylinder!

- A new industrial process to achieve the expansion of the existing pneumatic system is needed. In the selection of air preparation units, what aspects should be taken into the production of high-quality air!

- What are the influencing factors that lead to a hydraulic actuator broken / not perfect functioning. Make a chart and describe the appearance of errors.
- How and what tools need to realize a forest ripping machine? Explain your answer!

Measurements and automatics I-II.

- What kind of sensors uses for measure the liquid level in industrial processes? Describe the operating principle of the sensor type selected.
- What aspects would you choose an industrial measurement system? What are the principles which should be considered in the Metrology?
- Describe the with practical examples of the control and feedback control! Please make an effects sketch of the processes, explain the differences.
- What are the principles, methods that a control system status can be determined, be describe?
- Why do we need in an industrial process control as simple as possible to implement the logical connections? Show us Min terms and Max terms form of solution through an example.

Basics of Mechatronics

- Four-bar linkage. (The simplest movable closed chain linkage.) Planar four-bar linkages are constructed from four links connected in a loop by four one degree of freedom joints. A joint may be either a revolute that is a hinged joint, denoted by R, or a prismatic, as sliding joint, denoted by P.
  To be determined: displacement, velocity, acceleration.
- Bond graph (is a graphical representation of a physical dynamic system.) A simple mechanical, pneumatic, hydraulic, electrical system describing and system equation with standard elements.
- Basic concepts, mathematical description of physical phenomena: real physical system, definition of signal, group the systems by the number of inputs and outputs, definitions of linear and non-linear systems, definition of parameter and variable, theory of distributed and concentrated parametric description, description of deterministic and stochastic systems, concept of causality, the concept of static systems and dynamic systems.