CORE COURSES OF MECHATRONICS COMPREHENSIVE EXAM

1. ROBOTS AND ROBOTICS TECHNOLOGY
2. BASICS OF MECHATRONICS AND MODELLING AND SIMULATION PROTOTYPE TECHNOLOGIES I.
3A: ELECTRONICS I.
3B: MEASUREMENT AND DATA ACQUISITION
4A: ELECTROPNEUMATICS AND ELECTROHYDRAULICS
4B: MECHATRONIC DEVICES (SENSORS, ACTUATORS, MOTORS)
5. APPLIED AUTOMATIZATION I I.-II.
6. ELECTRICAL MACHINES AND DRIVES

Oral topics for flash Q-A oral comprehensive exam:

1. ROBOTS AND ROBOTICS TECHNOLOGY

1. Robot coordinate systems and their geometric coordinate relations.

2. Denavit-Hartemberg parameters, Jacoby matrix, correlations.

3. Options of measuring Tools and Bases (KUKA), the procedure of measuring.

4. Ambiguities and singularity Positions on 6 DOF robots. What is the mathematical definition of singularity? How does the robot controller behave near singularity?

5. Robot architectures, Bond graph modelling of joints (P and R join with servo motor).

2. BASICS OF MECHATRONICS AND MODELLING AND SIMULATION PROTOTYPE TECHNOLOGIES I

1. When to use the Zero junction and when to use the One junction? What is the mathematical definitions of Type 0 and Type 1 junctions? What is the difference between the I element and the C element?

2. Why Bond Graph modeling is good for Mechatronics Systems modeling? Explain the Causality! What kind of mathematical models are existed to describe the dynamical behavior of a system?

3. If you have a simple electronic series RC circuit what to use Zero or One Junction? Please explain your decision! What is the flow variable in the case of Electrical, Mechanical Translation, Hydraulic systems? What are the SI units of them?

4. What is the effort in the case of Electrical, Mechanical Translation, Hydraulic systems? What are the SI units of them? What is the Causality represent?

5. How to decide the direction of the (integral or differential) causality in case of R, Se, C elements? how to decide the direction of the (integral or differential) causality in case of TF, GY, I elements?

3A: ELECTRONICS I.

1. What kind of studied Electronics components feasible voltage amplifier circuits? Describe in detail how these components do work, advantages and disadvantages of them? How many approximately amplifying values can be reach with each components?

2. What passive filter circuits do you know? What components do the filter circuit include? How can calculate the cut off frequency? What is the definition of cut-off frequency? Which methods can be analyzed the filter working parameters?

3. What kind of Electronics components feasible galvanic isolation in case of AC and DC voltage? Describe in detail how these components do work?

4. You would like to measure 0-24 V analog voltage and 4-20mA analog current as a sensor's output signal. Your measured system maximum input range is 0-10V. How can this problem be solved?

5. How many the standard voltage values of 3 phases power (electricity) grid/network? Which connection types are known in 3 phases topic? What are the advantages and disadvantages of these connection types? What are the 3 phases typical applications? What does higher harmonics means?

3B: MEASUREMENT AND DATA ACQUISITION

1. Describe the static characteristics of sensors. Define the properties and ranges. Why important to use these parameters? What is sensor calibration?

2. What kind of protection of sensors against external influences do you know, and what kind of levels do they have? Describe, what kind of safety range devices would you use in different rooms of house?

3. What kind of parameters the date sheet does include in case of passive and active component/equipment? List and describe these parameters!

4. Describe the related properties (with units) of the following electrical sensors: (1) thermocouple; (2) differential pressure switch; (3) optical incremental encoder.

5. Describe the related properties (with units) of the following actuators: (1) mechanical relay with NO/NC switches; (2) 5/3 both side electrical actuated pneumatic valve; (3) electric heating element;

4A: ELECTROPNEUMATICS AND ELECTROHYDRAULICS

1. A 2500 kg car jack assuming compare what would be the advantages and disadvantages of pneumatic and hydraulic solution!

2. What kind of practical solutions would implement an electro-pneumatic and electro-hydraulic circuit, five in different positions to move 1200 mm long stroke cylinder!

3. A new industrial process to achieve the expansion of the existing hydraulics system is needed. In the selection of hydraulic pump unit, what aspects should be taken into the production of high pressure oil! Describe the related properties of hydraulic oil.

4. What are the influencing factors that lead to a pneumatic actuator broken / not perfect functioning. Make a chart and describe the appearance of errors. Describe the related properties of the working material.

5. How and what tools need to realize a forest wood splitter machine? Explain your answer! What would be the risk of injury and how to avoid?

4B: MECHATRONIC DEVICES (SENSORS, ACTUATORS, MOTORS)

1. What kind of sensors use for measure the liquid level in industrial processes? Describe the operating principle of the sensor type selected.

2. What aspects would you choose an industrial measurement system? What are the principles which should be considered in the Metrology?

3. Describe the with practical examples of the open loop and feedback control! Please make an effects sketch of the processes, explain the differences. Describe different excitation signals!

4. What are the principles, methods that a control system status can be determined, be describe? Describe the properties of control performance measurement properties. What is the definition of stability?

5. Why do we need in an industrial process control as simple as possible to implement the logical connections. Describe the Minterm and Maxterm solution methods.

5. APPLIED AUTOMATIZATION I I.-II.

1, Describe the structure of a PLC with a compact and modular architecture! List what modules the modular controller can be expanded with! Compare their applications! List internal functional units that can be operands of the control program. List the types of variables you know and describe the rules for working with them.

2. What technical requirements do we set for the PLC? (Housing, power supply, inputs, outputs, program memories, communication capabilities). Describe the standard installation solutions of PLCs! What techniques can be used to implement the visualization of the control program? (Design, operation, hardware components).

3. Describe the function and connection of the internal registers of the PLC. What parameters are relevant in the development of a PLC program? What requirements would you place on an integrated program development environment? (Functional components, services).

4. Describe the steps of developing a PLC program. What program types and design methods do you know? Describe the structure of a PLC program project, the function of its components!

5. Describe the technique of software management of an analog signal in an integrated development environment. What is a POU? Describe how to create and manage it! Why a user-definable function block? What is the process of creating and using it?

6. ELECTRICAL MACHINES AND DRIVES

1. Describe the shunt (parallel) type and series type Direct Current machine operational theory. How does the electrical machines behave on low and high angular speed? How can be change the angular speed amplitude and direction? What are the important characteristics, with units?

2. Describe the stepper motor operational theory. How does the electrical machines behave on low and high angular speed? How can be change the angular speed amplitude and direction? What are the important characteristics, with units?

3. Describe the 3-phase induction machine operational theory. How does the electrical machines behave on low and high angular speed? How can be change the angular speed amplitude and direction? What are the important characteristics, with units?

4. Describe the operational theory of inverter (DC-AC converter) driven AC machine: theory of operation and schematic: AC-DC converter, DC line filter, DC-AC converter. How the angular speed and torque can be change?

5. Servo drives: theory of operation and schematic: electrical machine, revolution sensor, power drive electronics, control electronics. How the speed and torque control can be realized? What are the important characteristics, with units?

Closed: 2021.04.14

Reviewer: Dr. Szemes Péter Tamás