Industrial Measurement Systems for Control (IMS)

Rehearsal Question Catalogue

The following questions are examples that could be picked from a written exam. Answering these will give you a good base knowledge for your own written exam. It is also possible that some of the questions at the exam will be taken from this catalogue.

Allowed material at the exam: pocket calculator, TEFYMA (or similar) and PIC16F84 instruction list.

OP-amp technique

OP1 Design a circuit that will generate a constant current of 1 mA through a transducer with a resistance between 1 kohm and 5 kohm.

OP2 Modify the circuit in the previous task so that the transducer is ground referenced at one terminal.

OP3 What problem occurs when a small resistance should be measured over a large distance? How can it be solved?

OP4 What parameters are important if an OP-amplifier should be used for low voltage measurements?

OP5 What advantages does a chopper stabilized OP-amplifier has?

Electrical measurements ***(no lecture 2014)***

EM1. You view a digital square wave on your oscilloscope but suspect that there is a glitch hidden somewhere in the signal since your frequency counter shows the double frequency. What would you do to be able to detect the glitch on the oscilloscope?

EM2. In a repeated digital sequence it can be difficult to get a stable view on an oscilloscope. What can you do to stabilize the view?

EM3. Can you think of any measurement situation where an analog oscilloscope is superior to a digital one?

EM4. (Written exam 2003-12-04) A PIC microcontroller uses a 6.000 MHz integrated crystal oscillator as clock generator. A measurement at the output of this device will give the three different results, shown below, depending on the method used. (The output of the circuit is a buffered Schmittrigger.) All measurements are made using the same 100MHz oscilloscope but with these three connection methods:

Method X: Single separate wires with 4mm lab-connectors and hooks.

Method Y: Passive oscilloscope-probe with the switch in the 1X position.

Method Z: Passive oscilloscope-probe with the switch in the 10X position.

All pictures are in the scale 2V per division. (Each 8 divisions high.) The supply voltage for the circuit is 5V. The digit 1 at the left edge of each figure indicates the ground level.

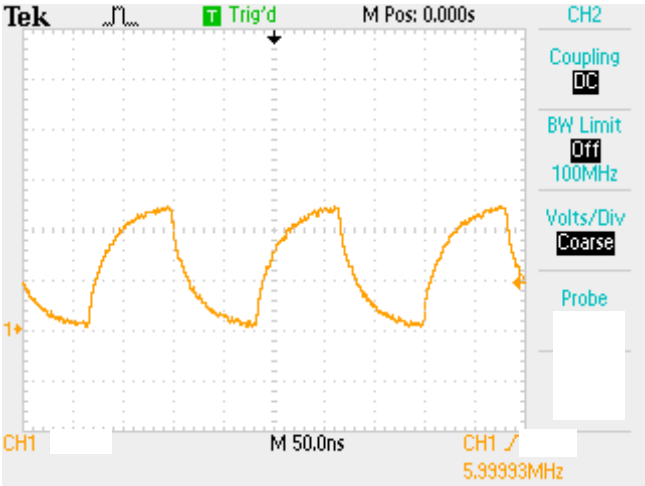

fig A

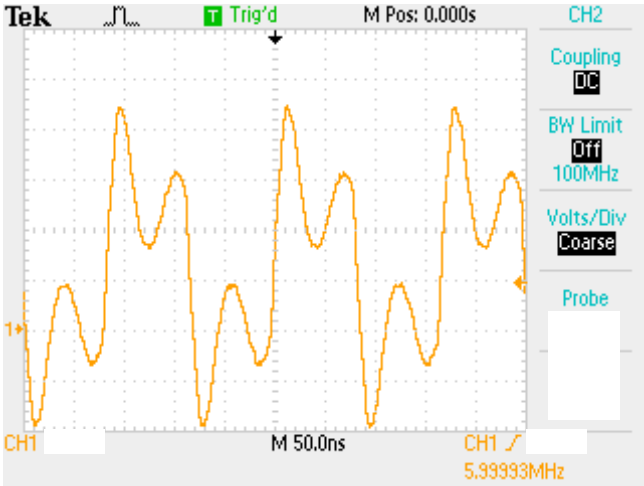

fig B

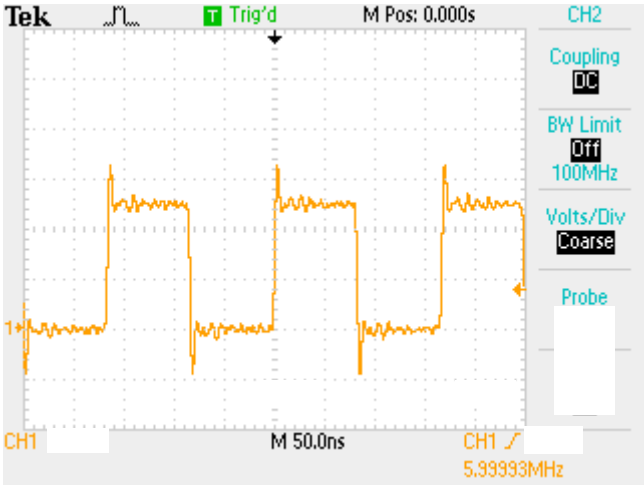

fig C

a) Associate the correct figure with each method.

b) Select the method that gives the best correspondence between the real voltage and the voltage in the figure. Draw the electric circuit for this case and explain why this gives the best result.

c) In two of the cases we can observe voltages outside of the voltage range. Why?

Transducers (Measurement of Non-Electric Entities)

G1. Give examples of at least two measurement principles for each of the following magnitudes. The principles should also be explained briefly.
1. Presence of object (position)
2. Temperature
3. Rotational speed (rpm)
4. Torque

G2. Explain the difference between precision and accuracy.

G3. A transducer output gives a voltage between 1,000 and 1,025 V over the operating range. This signal should be connected to an A/D-converter with an input range of 0 to 5V. Design, using operational amplifiers, an interface circuit that adjusts the signal so that the entire A/D-range is utilized. The values for the components should be specified.

G4. Give a brief description of the operational principle for an inductive transducer.

G5. Explain how the Seebeck effect (i.e. the physical principle behind the thermocouple measurement) can affect a low voltage measurement.

Digital Circuits

In this section is ”*” or identifier concatenation (A*B=AB) used for logical AND. Boolean OR is expressed as ”+” and inverting is expressed using ” ’ ”. $\oplus$ denotes the Boolean exclusive or.

D1. Explain the difference between a combinatorial network and a sequential network.

D2. An unknown combinatorial network is embedded in a ”black box” and only input- and output-signals can be observed. Is it possible to design an equivalent network and in such a case what has to be done?

D3. An unknown state machine is embedded in a ”black box” and only input- and output-signals can be observed. Is it possible to design an equivalent network and in such a case what has to be done?

D4. The truth table for the output signal Y as a function of the input signals A, B, C and D is:

A\BCD	000	001	010	011	100	101	110	111
0	1	0	1	0	1	0	1	0
1	1	0	1	0	0	0	0	0

a) Give an expression for Y in disjunctive normal form.
b) Simplify the expression from a) using Karnaugh diagrams.
c) Implement Y using only NAND-gates.

D5. Simplify the expression: A + A'B + B + A'C + C

D6. Design a modulus-4 counter with 2 D-type flip-flops and logic gates. The counter should repeatedly count from 0 to 3.

D7. Design a 4-bit BCD-counter using D-type flip-flops and gates. The D-input expressions should be simplified using e.g. Karnaugh diagrams.

D8. Most PLD-circuits have got a structure with one AND- and one OR-plane. Explain how this corresponds to the form of the logical expression that is to be implemented.

D9. Why is open collector technique sometimes used?

D10. What is the difference between a tri-state- and an open collector-output?

Microcomputers/Microcontrollers

M1. Give some examples on operations that can be performed by the ALU in a microprocessor.

M2. Why are busses in various shapes important in microprocessors? What are the requirements for a unit that should be possible to connect to a bus?

M3. Explain the terms:
- instruction-wordlength,
- data-wordlength and
- address-wordlength.

M4. Explain how a jump instruction is executed by a microprocessor. Explain what registers are affected. What data is fetched where and where is it written?

M5. How should "random" be interpreted in the term "Random Access Memory"?

M6. What do the abbreviations mean? Also give a brief description of the characteristics of each type of memory.
- RAM
- ROM
- PROM
- EPROM
- EEPROM
- DRAM

M7. The structure of a memory is almost always a matrix. Why?

M8. What does it mean that a program is relocateable? Will this call for special requirements for the instructions? If yes – why?

M9. Why is there usually a stack in a microprocessor? Give two examples on when it can be used.

M10. What is the difference between a subroutine call and an ordinary jump? Describe the sequence executed by the CPU when a subroutine call is executed.

M11. What is characteristic for a RISC-processor?

M12. What is characteristic for a microcontroller?

M13. A microprocessor has got a RD (read), a WR (write) and an IORQ (input/output request) -signal. Furthermore, it has got 8 addressbits, A7..A0, for I/O-addressing. Connect an 8-bit in port consisting of tri-state-buffers at address 0x31 and an 8-bit out-port consisting of D-type flip-flops at address 0x33. The data-transfer takes place at the databits D7..D0.

M14. Give two examples on how to connect a parallel output port to the environment without any galvanic connection.

M15. Describe how a successive approximation A/D-converter works.

M16. A 14-bit ideal D/A-converter has got a reference voltage of 10V giving a full scale of 10V. How much is the output changed for each unit step in the digital input value?

M17. How can an A/D-measurement be made without any galvanic connection between the host computer and the environment? Give at least two examples.

Real time programming

RT1 Describe the advantages of using interrupts instead of polling.

RT2. Explain the following terms in real time programming:
- Process
- Context
- Context switch
- Concurrent execution

RT3. What is required to implement a system with several independent real time processes in a computer system?

RT4. Describe the actions of a real time system scheduler when a clock tic occurs and a task switch should occur.

RT5. How is an interrupt processed by a microcontroller? Describe in terms of stack, program counter…

RT6. In an interrupt handling routine some special steps have to be executed. Describe them.

Digital communication

DK1. There is an increased use of busses like I2C, Microwire and SPI in modern digital design. What advantages are gained compared to more traditional design principles?

DK2. What is the difference between asynchronous and synchronous serial communication?

DK3. Why is a startbit used in asynchronous serial communication?

DK4. Why is the balanced transfer line in RS485 superior to e.g. RS232 from a disturbance point of view?

DK5. When are fieldbusses used? What are their characteristics?

Electronic system design

EK1. Explain the term "through plated hole" in PCB manufacturing.

EK2. The allowed current density (A/mm^2) on a PCB is very often much higher than in a cable. Why is this?

EK3. Describe the design steps from idea to CAM-files for a printed circuit board.

EMC

S1. Describe 3 precautions to avoid disturbances through inductive connection.

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S3. When high frequency EMC-shielding is done it is common to use shielding material with holes to allow cooling air to pass. Give a simple rule of thumb for the size of the holes compared to the disturbance. If the hole is unsymmetrical – what dimension is used?

S4. The main rule of grounding tells us that all subsystems should be grounded in one common ground junction. For practical reasons this is not always possible. What alternative options may be used?

Power supply

PS1 What advantages will you get when replacing a linear power supply with a switched one?

PS2 Draw a schematic for an ordinary linear power supply with a transformer, a Greatz bridge and a filtering capacitor.

PS3 Draw a schematic for a switching circuit that will reduce the input voltage and explain the function.

PS4 Draw a schematic switching circuit that will increase the input voltage and explain the function.

PS5. Describe at least two situations when a DC/DC-converter can solve a power supply problem.