UNIVERSITY OF OSLO

Faculty of Mathematics and Natural Sciences

Exam in : FYS 3240/4240
Day of exam: : 11. June 2015
Exam hours: : 14.30 – 17.30
This examination paper consists of 2 pages.

Permitted materials: **: Calculator**

Make sure that your copy of this examination paper is complete before answering.

Problem 1

a) Assume that you have to connect DAQ-equipment to the analog output of a grounded signal source. Make a simplified circuit diagram of the signal source and the DAQ-equipment front-end electronics, and explain the considerations and the connection options.
b) Why is DMA preferred for DAQ systems instead of using interrupts?
c) Explain RAID-5.
d) Explain why "unbuffered File I/O" can be useful in DAQ systems, and how data are written to and read from a hard drive when using this option.

Problem 2

a) One possible implementation of a level shifter is shown in Figure 1. Find the equation for the output voltage V_{out} as a function of the input voltage V_{in}, given that V_{ref} = 2.5 V, R1 = 30 kΩ, R2 = 10 kΩ and R3 = 7.5 kΩ.

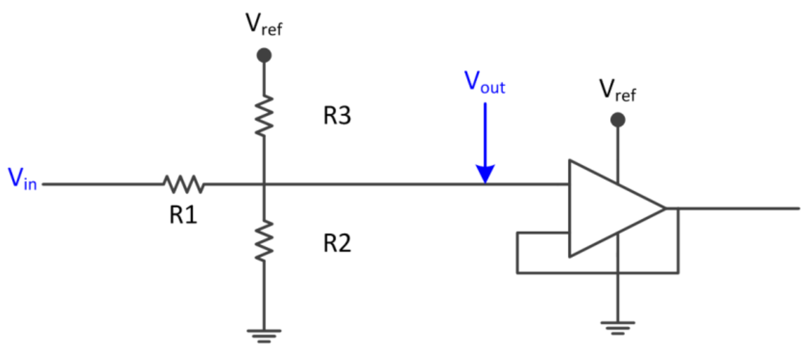

Figure 1 **Level shifter**

b) Why is a level shifter often needed in battery powered embedded systems?
c) Explain the impact of clock frequency and supply voltage on an embedded system power consumption.
d) What are the advantages of using I2C instead of SPI?
e) Explain why a minimum of four satellites are need to calculate a position in a satellite navigation system such as GALILEO.
f) Explain what IRIG-B is.
g) How do you configure all pins in PORTB in an ATMEL XMEGA microcontroller to be output pins? Explain, and write the C-code.

Problem 3

a) Assuming that you have two sensors that take a measurement z of a constant but unknown parameter x, in the presence of noise v with standard deviations σ_1 and σ_2. This gives the measurement equations $z_1 = x + v_1$ and $z_2 = x + v_2$. Implement an estimator by writing the equation(s) to fuse the data from the two sensors.
b) Explain how the complimentary filter works.
c) Explain the state update measurement equation in the Kalman filter:

$$\hat{x} = \bar{x} + K(z - H\bar{x})$$

d) What happens if you tell the Kalman filter that the uncertainty in the sensor measurements is low?