

EEN-E1040 Measurement and Control of Energy Systems
Final exam, Feb 17th 2017, 9.00–12.00

Please answer questions 1-3 and either the DRYER or ENGINE part of question 4.

1. TEMPERATURE

What kinds of installation possibilities are available to measure the temperature of flowing liquid in a pipe? What kinds of advantages do these installations have compared to each others?

2. FLOW

Explain the operational principle of the pitot tube. Draw a schematic diagram of the pitot tube and explain the different parts and their role in the measurement. Describe the use of pitot tube in flow rate measurement. What kind of errors would be specific to the pitot tube measurement? In what kind of situations do you think the pitot tube would be a good method or a poor method for flow measurement?

3. CONTROL

- a. Describe the demonstration setup used in the control exercise.
- b. What could be done to improve the controllability of the demonstration setup?
- c. When tuning the system, quantities called *dead time* and *response time* were used. Describe what they mean.

4. DRYER (give short answers, not an essay)

- a. What are the main ways to decrease drying time in the lab-scale fixed bed dryer?
- b. Mention the two ways, how biomass moisture content was measured during the experiments?
- c. In which conditions (time and temperature) can it be assumed that biomass sample is fully dried?

OR

4. ENGINE

Your measurement task is to measure the pressure of a pneumatic circuit which is supposed to be at below 15 bar. You are using a thin film pressure sensor with the following characteristics:

Range 0-20 Bar gauge
Out 2-10 V
Supply 24 V

Draw a graph of the sensor output as a function of pressure, the output can be considered linear. Your measurement result from the circuit in question is 6.0 V. What is the pressure of the circuit? The atmospheric pressure at the time of measurement is 1026 mBar. What will be the sensor reading when the measurement port is disconnected (i.e. in ambient air)?