Aalto University
Department of Mechanical Engineering

**EEN-E1040 Measurement and Control of Energy Systems**
**Final exam, Dec 19th 2016, 09.00–12.00**

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

1. TEMPERATURE

   Explain advantages and challenges of thermocouples, PT-100 sensors and infrared thermometers. Give examples in which case each performs better than the other two.

2. FLOW

   Consider two different flow rate measurement methods of your own choice. Describe the underlying scientific principles and the technical implementation. What are the strong and weak points of the methods? What kind of accuracy could be expected? In what kind of applications do you think the methods would be appropriate or inappropriate?

3. CONTROL
   a. Present a PID tuning method and shortly describe how to tune a controller with it.
   b. Consider an ideal process and the process in the laboratory experiment of this course. What are the main differences? How do these differences affect the controllability of the system?
   c. In the final part of the laboratory experiment you investigated how the controller performance changes when certain aspects of the system are changed. Describe your findings in a few sentences.

4. DRYER (give short answers, not an essay)
   a. What are the main ways to improve drying time (make it faster) in the lab-scale fixed bed dryer?
   b. How was the initial moisture content measured?
   c. Why is it important to monitor the air temperature going into the dryer bed?
   d. Discuss why and when it is important to reach a specific final moisture content in drying of biomass.

OR

4. ENGINE (give short answers, not an essay)
   a. What is the common use of a piezo-capacitive pressure sensor?
   b. How does a piezo-capasitive pressure sensor work?
   c. Describe the properties of a piezo-capacitive pressure sensor.