Exam Review

Test Conditions

Closed Book, Closed Notes

May use 216 mm × 280 mm note sheet, *eyes only.*

Calculator allowed.

No electronic organizers, computers, or other devices ...
... that can store significant amounts of text.

Test Format and Topics

Duration, 50 minutes, this room, 70 minutes before class time.

Exam starts **7:30**.

Two problems and one set of short-answer questions.

Material up to and including displacement.

How to Allocate Study Time:

50% Working on conditioning problems.

25% How transducers and sensors work.

25% Miscellaneous. (Units, parts of RTS, etc.)

This Review:

- Overview of Real Time Systems
- Conditioning Problems
- Sensors, Transducers, and Physical Quantities
- Circuits

Overview of Real Time Systems

Parts of RTS

Sensor, Actuator, Process, Computer

Know how each part fits into whole system.

Know how RT computer hardware and software ...
... are different than general purpose computer and software.

Challenges in Building a RTS

Specification, testing, evaluating reliability.

Typical Problem

Purpose: convert a process variable value ...
... into an electrical or information quantity.

Solution to Typical Problem:

- Identify what *is given* and what output *is needed.*

  Be sure to identify **what form** output is needed in: ...
  ... voltage, current, number written in a computer memory, etc.

- Choose transducer (or use one specified) ...
  ... to convert process variable to a raw electrical quantity.

- Choose analog-to-digital converter, if necessary.

- Design conditioning circuit ...
  ... to convert raw electrical quantity ...
  ... to a form suitable for an analog-to-digital converter ...
  ... or to the form requested in the problem statement ...
  ... or to whatever form is specified in the problem.

- Design interface routine.

  Interface routine must account for:
  Transducer Response
  Conditioning Circuit Response
  Analog to Digital Conversion
  ... and ...
  The Desired Output

Each problem has its own constraints ...
... those constraints must be identified ...
... and the circuit designed accordingly.

Transducers and Sensors

For every sensor and transducer:

- Be able to explain how it works.
- Know its strengths and weaknesses ...
  ... relative to other sensors measuring same physical quantity.
- Understand the units in which the process variable is measured.

If a model function was presented in class:

- Know which conditioning circuit(s) to use.

MR-5

Temperature Transducers

- Temperature Definition
  - Know definition of thermodynamic and practical scales.
- Thermistor
  - Know how to derive linear model from model function.
  - Know how to use linearization circuit (shunt resistor).
- RTD
  - Know how to use three-wire bridge connection.
- Thermocouple
  - Know how to use tables.
  - Know how to use isothermal block.
- Integrated Temperature Sensor

MR-6

- Light Sensors
  - Units
    - Definition of different quantities, *e.g.*, irradiance.
    - Radiometric v. photometric units.
    - Know how to convert between quantities under simple situations.
  - Photodiode, phototransistor.
  - Vacuum-tube photocell, photomultiplier.
- Displacement and Proximity Sensors
  - Potentiometer
  - LVDT
  - Capacitive
  - Coded
    - Relative v. absolute types.
    - Know gray/binary conversion.
  - Reed Switch
  - Hall Effect
  - Magnetic Reluctance
  - Cross-correlation speed sensor.

MR-7

Circuits

- Amplifiers
  - Non-Inverting Amplifier
  - The Versatile Inverting Amplifier
    - "Plain" inverting amplifier.
    - Summing amplifier.
    - Gain/offset amplifier.
    - Current-to-voltage converter.
  - Instrumentation Amplifier
- Other Circuits
  - Wheatstone bridge.
    - Know how to place complementary pairs in bridge.
    - Know exact and approximate formulæ.

MR-8

- Strain, Force, and Pressure
  - Units
    - Definition of strain, force, and pressure.
    - Different measures of pressure.
  - Strain Gauge.
    - Derivation of gauge factor.
    - Use in bridge.
  - Force
    - Construction of large- and small-displacement sensors.
  - Pressure
    - Construction of large-displacement sensors.
    - Construction of diaphragm sensors.

Flow

- Units, etc.
  - Measures of flow: volumetric, mass, velocity.
  - Open v. closed conduit.
  - Fluid v. slurry.
- Sensors
  - Rotation.
  - Obstruction.
  - Hot-wire anemometer.
  - Weir. (Water drop.)
  - Cross-correlation.
  - Doppler (sonar).