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, Wednesday 17 March 1999.
Exam starts 8:40.
One or two problems and one set of short-answer questions.
Material up to and including operating systems overview.

How to Allocate Study Time:
50% Working on conditioning problems.
25% How transducers and sensors work and OS basics.
25% Miscellaneous. (Units, parts of RTS, etc.)

This Review:
• Overview of Real Time Systems
• Conditioning Problems
• Sensors, Transducers, and Physical Quantities
• Circuits
• OS Overview Overview

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.

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

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.

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).

Chemical
- Gas Sensors
- Humidity.
- Oxygen.

Fluid
- Reference electrodes.
- Ion concentration.

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 formulae.