## Final Exam Review

When, Where

Wednesday, 7 May 1997, 7:30–9:30 CDT.

This Room

Duration, 120 minutes.

Test Conditions

Closed Book, Closed Notes

Can bring one 216 mm × 280 mm sheet.

Cannot bring a special viewer, such as a microfiche viewer.

Calculator allowed.

No electronic organizers, computers, or other devices which allow for the storage of significant amounts of text.

No communication devices.

Format

Four questions:

- Interrupt and/or task timing problem.
- Sensor/conditioning problem.
- Short-answer questions.
- ???





How to Allocate Study Time:

10% How an OS works.

15% How interrupts work.

20% Solve timing problems.

30% Working on conditioning problems.

10% How transducers and sensors work.

15% Miscellaneous. (Error, threshold circuit, etc.)

This Review:

- Overview of Real Time Systems
- Conditioning Problems
- Sensors, Transducers, and Physical Quantities
- Circuits
- Error
- OS Overview
- Task Scheduling
- Interrupt Mechanism
- Interrupt Timing





## 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 either a form suitable for an analog to digital converter, to the form requested in the problem statement, or to some other form which is needed.
- 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.

To solve the problem 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 the 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





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 formulæ.
  - Comparators and threshold detectors.
    - Know how to use a comparator.
    - Know how to set two thresholds in threshold detector.





- Logic
  - Know how to generate logic levels.
- Error
  - Know definitions of error.
  - Remember that error is in the process-variable value, not the transducer output.

- Operating Systems
  - Function: resource allocation.
  - Tasks
    - Difference between task, program, and executable.
  - Task Management
    - Task states.
    - Context switching.
  - Scheduling
    - Scheduling events.
    - Quantum and preemption.
    - Scheduling methods.
  - Performance Measures.





- Interrupts
  - Mechanism.
    - Hardware needed.
    - Steps in interrupt sequence.
    - Strong v. weak priority.
  - Different types of interrupts.
  - Estimating Latency
    - One-shot.
    - Periodic exhaustive.
    - Periodic statistical.