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

- 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 formulae.
- 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.