Exam Review

Test Conditions

Closed Book, Closed Notes

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

Calculator allowed.

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

Test Format and Topics

Duration, 120 minutes, this room, Friday 7 May 1999.

Exam time 10:00-12:00 (noon).

Three problems and one set of short-answer questions.

Comprehensive.

FR-1

How to Allocate Study Time:

10% How an OS works.

15% How interrupts work.

25% Solve timing problems.

25% Working on conditioning problems.

10% How transducers and sensors work.

15% Miscellaneous.

How To Prepare

Study material.

If necessary, re-solve this semester's homework assignments.

Solve past homework and exam problems.

N.B., solving a problem is not the same as memorizing a solution.

FR-2

This Review:

- Overview of Real Time Systems
- Conditioning Problems
- Sensors, Transducers, and Physical Quantities
- Circuits
- Error
- OS Overview
- Task Scheduling
- Interrupt Mechanism
- Interrupt Timing
- Priority Assignment
- Schedulability Tests
- Resource Blocking and Deadlock

FR-3

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.

FR-4

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.

FR-5 FR-5 FR-6 FR-6

FR-7 FR-7

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.

FR-8 FR-8

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

Engineer-friendliness.

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.

FR-9

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.

FR-10

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.

FR-11

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).

FR-12

Chemical

Gas Sensors

- Humidity.
- Oxygen.

Fluid

Reference electrodes.

Ion concentration.

FR-13

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.

FR-14

Error

Know definitions of error.

Remember that error is in the process-variable value, not the transducer output.

FR-15

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.

FR-16

Interrupt Mechanisms

- Hardware needed.
- Steps in interrupt sequence.
- Strong v. weak priority.

Different types of interrupts.

Estimating Latency

One-shot.

Periodic exhaustive.

Periodic statistical.

FR-17

Priority Assignment and Static Scheduling

Cyclic Executive

Rate Monotonic Scheduling

Schedulability Tests

Locking and Blocking and Deadlocking

Use of resources, need for locking.

Locking protocols.

Timing with resource locking.

Deadlock avoidance.

FR-18