

Name _____

Real Time Computing Systems
EE 4770
Final Examination
13 May 1995, 10:00–12:00 CDT

Problem 1 _____ (25 pts)

Problem 2 _____ (25 pts)

Problem 3 _____ (25 pts)

Problem 4 _____ (25 pts)

Alias _____

Exam Total _____ (100 pts)

Good Luck!

Problem 1: Design a circuit and interface routine to convert process variable $x \in [0, 2000 \text{ N}]$, a force, into a floating-point number $H(x) = 3 \ln(1 + (x/N))$ to be written into variable `lnF`, where `ln` is the natural logarithm. A transducer with response $H_t(x) = \frac{a_2}{1+a_1 x^2} x$, where $a_1 = \frac{1}{4 \times 10^6 (\text{N}^2)}$ and $a_2 = 0.3175 \frac{\mu\text{A}}{\text{N}}$, is to be used. The transducer must have a bias of at least 12 V. Use an ADC with response $H_{\text{ADC}(7\text{V},16)}$. (25 pts)

- Draw a schematic, show all component and source values.
- Make full use of the ADC's dynamic range.
- Show the interface routine.

Problem 2: A RTS must react to six event types. The names of the event types, their occurrence times, the priorities of their respective interrupts, and the run time of their handlers is listed in the table below. For each event type find the latency, actual duration, loading factor and response time. Describe how the latency, actual duration, and response times are computed. (*E.g.*, $X + 2Y$). (20 pts)

What is the maximum rate of response to event F ? (5 pts)

Event Name	Strong Priority	Weak Priority	Handler Run Time	Period
A	3	3	$5 \mu s$	See below.
B	3	2	$4 \mu s$	$10 \mu s$
C	3	1	$3 \mu s$	$14 \mu s$
D	2	2	11 ms	150 ms
E	2	1	8 ms	70 ms
F	1	1	9 ms	See below.

Event A will occur no more than 2 times in any $50 \mu s$ interval and no more than 12 times in any $500 \mu s$ interval. Event F can occur any time when there have been no previous instances of event F and it can occur any time after the last instance of F had been responded to.

Problem 3: A shortcoming of deadline scheduling is that a task might be scheduled to run that would miss its deadline. (That is, the task became ready too late; it could not possibly finish on time.) The deadline scheduler might nevertheless choose such a doomed task to run, possibly resulting in other tasks missing deadlines. If the doomed task were not run, some of the other tasks might have finished on time.

(a) Give an example of such a situation. Indicate task states, arrival times, deadlines, and run times. (12 pts)

(b) Develop a scheduling algorithm which reduces the number of missed deadlines. (The algorithm does not have to be optimal.) Show an example (the one above, if appropriate) where your algorithm would result in fewer missed deadlines than deadline scheduling. (13 pts)

Problem 4: Briefly answer all questions below. Overly long answers may not receive full credit.

(a) Explain how strain results in a change in electrical characteristics of a strain gauge. What are the important properties of a material in an ideal strain gauge. (7 pts)

(b) Explain how a photomultiplier works. (7 pts)

(c) When interrupts occur while a task is running the task does not get to execute during part of its quantum. If there are many or lengthy interrupts then the task may only get a small part of its quantum. Explain how the OS could be modified so that a task gets its full quantum while the interrupt handlers still get to run. (11 pts)