Name _____

Real Time Computing Systems
EE 4770
Final Examination

6 May 1996, 7:30–9:30 CDT

Alias _____

Complete for confidential E-mail grade notification:

E-mail address _____

Final exam index (0-100) _____

Course grade index (0-100) _____

Choose indexes randomly; remember choices.

Problem 1	_____	(25 pts)
Problem 2	_____	(25 pts)
Problem 3	_____	(25 pts)
Problem 4	_____	(25 pts)
Exam Total	_____	(100 pts)

Good Luck!

Problem 1: Design a circuit and interface routine to convert $x \in [0, 200\,\text{kPa}]$, pressure, to a floating-point number $H(x) = \frac{x}{\text{kPa}}$ to be written into variable `pressure`. Pressure is measured using a diaphragm with strain gauges attached at two locations, *location 1* and *location 2*. A pressure x results in strain of $H_{\text{loc1}}(x) = \frac{5\times10^{-8}x}{1+x/(400\,\text{kPa})}\frac{1}{\text{kPa}}$ and $H_{\text{loc2}}(x) = -\frac{5\times10^{-8}x}{1+x/(400\,\text{kPa})}\frac{1}{\text{kPa}}$ where H_{loc1} gives the strain at location 1 and H_{loc2} gives the strain at location 2. The strain gauges each have response $H_{\text{t}}(\epsilon) = R_0(1+2\epsilon)$, where $R_0 = 250\,\Omega$. Use an analog-to-digital converter with response $H_{\text{ADC}(5\,\text{V},8)}$ and make full use of the ADC dynamic range. (25 pts)

- Use both strain gauges.
- Draw a schematic; be sure to identify the strain gauges by location.
- Show all component and supply values.
- Show the interface routine.

Problem 2: Events, their interrupts and handlers are described in the partially filled table below; all events are periodic. Complete the table and show the event sequences used. (25 pts)

Event Name	Str. Pri.	Weak Pri.	Run Time	Period	Load	Load Set	Loaded Duration	Worst Case Latency	Worst Case Duration	Worst Case Resp. Time
A	3	3	5 μs	20 μs						
B	3	2	2 μs	8 μs						
C	3	1	10 μs	200 μs						
D	2	1	11 ms	150 ms						
E	1	1	9 μs	1 s						

Problem 3: Active tasks in a computer using multiround scheduling are described in the table below. The system uses a quantum of 9 ms and is not task-preemptive. The multiround scheduler uses round robin scheduling in the first round, the round robin classes are `alpha`, `beta`, and `gamma`, the class sequence is `(alpha, beta, alpha, gamma)`. Three different policies are used in the second round, a deadline scheduler for tasks in the alpha class, a first come, first served for the beta class, and a priority policy for the gamma class. The table below shows the state of the tasks at $t = 1000$ ms. At $t = 1005$ ms Task B arrives; Task B is in round 1 class alpha, has a deadline of 1075 ms, a run time of 15 ms, and does not perform I/O. Show task states and which tasks are running from $t = 1000$ ms to $t = 1100$ ms. (25 pts)

At $t = 1000$ ms:

Task	Round 1 Class	Round 2 Pr. or Ddln.	Run time remaining.	I/O	State	Time state entered.
A	alpha	1100 ms	20 ms	None	Run	1000 ms
C	beta		50 ms	None	Ready	999 ms
D	beta		200 ms	(90,20)	Wait	985 ms
E	beta		1000 ms	(8,60)	Ready*	995 ms
F	gamma	3	1000 ms	(4,20)	Wait	981 ms
G	gamma	2	200 ms	None	Ready**	1000 ms
H	gamma	1	1000 ms	None	Ready	930 ms

Entry (x, y) in the I/O column indicates that after each x ms of run time the task will perform I/O which takes y ms to complete. (*)Ready state was entered from Wait state (after completing I/O). (**)Ready state was entered from Run state.

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

(a) What is the difference between an executable and a task? (5 pts)

(b) Why can't a task allocate its own resources? How would it be stopped if it tried, for example, from using an I/O port which was not allocated to the task? (5 pts)

(c) What actions does the CPU take when making a system call that are not taken when making an ordinary subroutine call? (5 pts)

More questions on next page.

(*d*) How could the interrupt system described in class be modified so IRQ interrupt requests are chosen by a round-robin policy? Hardware, software, or both may be modified; inexpensive solutions are prefered. (5 pts)

(*e*) Could the system for measuring the concentration of ions also measure the concentration of neutral particles? Explain. (5 pts)