Name ______________________________

Real Time Systems

EE 4770

Final Examination

10 May 1994, 15:00-17:00

Problem 1	________	(20 pts)
Problem 2	________	(20 pts)
Problem 3	________	(20 pts)
Problem 4	________	(40 pts)
Exam Total	________	(100 pts)

Alias ______________________________

Good Luck!

Problem 1: (20 pts) Open conduit fluid flow is to be measured using a weir flow meter. The notch is cut such that the flow rate is $Q = Kx^{2.5}$, where $K = 1.1 \frac{\mathrm{cm}^{0.5}}{\mathrm{s}}$ and x is the water level. The water level will range from 0 to 0.2 m.

The flow rate is to be converted to a floating point number, $H(Q) = \frac{Q}{\mathrm{lm/\min}}$, the flow rate in liters per minute. A 10-bit analog-to-digital converter (ADC) is to be used with response $H_{\mathrm{ADC}(10,5\,\mathrm{V})}$.

- Choose a sensor to measure the fluid level. Show the sensor in a diagram illustrating the flow meter.
- Design the circuit, showing all component and supply values.
- Write an algorithm to convert the ADC output to the proper value.

Problem 2: (20 pts) A RTS uses 5 events, A, B, C, D, and E. Event A occurs at a frequency of 25 kHz; its handler has an unloaded duration of 5 μs. Event B has a period of 30 μs, its handler has an unloaded duration of 7 μs. The time between occurrences of event C will be no less than 30 seconds; its handler has an unloaded duration of 22 μs. Event D occurs at a frequency of 20 Hz; its handler has an unloaded duration of 20 ms. Event E has a period of 100 s; its handler has an unloaded duration of 10 s.

The interrupts for A and B are at strong-priority-level 4, A is at weak-priority-level 2 and B is at weak-priority-level 1. The interrupts for C, D, and E, are at strong-priority-levels 3, 2, and 1, respectively.

For each interrupt find the latency, loading factor, and actual duration. Show how (*e.g.* $D + E$) each latency and duration is computed.

Problem 3: (20 pts) A system using round-robin, first come first served scheduling has a quantum of 20 ms. At $t = 0$ three tasks are in the ready list, A, B, and C; none of these tasks have yet been in the run state. Task A arrived in the ready list at $t = -10$, task B arrived at $t = -5$, and task C arrived at $t = -1$. No other tasks are active, however there is an event which causes an interrupt every $50\,\mu$s. The handler for this event has an unloaded duration of $20\,\mu$s. Task A will need to perform a disk read after computing for 15 ms; it will take 30 ms for this disk read to complete. The other tasks will not perform any action that would cause them to go into the wait state. The total computation time for each task is 30 ms. Show the state of each task and the CPU, from $t = 0$ to when the last task finishes. Show the time at which each state change occurs. Show an example of when the handler runs, it is not necessary to illustrate each run of the handler.

Problem 4: Answer each question below and on the next page. Correct but excessively long answers will not receive full credit.

(a) (6 pts) Describe a situation in which a two level handler would be needed. Show two timelines, one with a two level handler and the other with a conventional handler handling the same event. Illustrate a problem caused by the conventional handler that is avoided with the two level handler.

(b) (6 pts) Explain how the weak priority interrupt hardware and software would have to be modified to implement deadline scheduling.

(c) (7 pts) What role does the membrane play in the system for measuring ion concentration using reference electrodes?

(d) (7 pts) What is the difference between a lumen and a (light) Watt? (Qualitatively, not the conversion factor.) Describe a situation in which a lumen would be the more appropriate unit and a situation in which a Watt would be the more appropriate unit.

(e) (7 pts) Draw the pattern of marks used in the incremental displacement sensor that measures linear displacement.

(f) (7 pts) Draw the schematic of a linear differential variable transformer (LDVT), showing how the coils are connected. Explain how it works.