Name ______________________

Real Time Computing Systems

EE 4770

Final Examination

7 May 1997, 7:30-9:30 CDT

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

Alias ______________________

Good Luck!

Problem 1: Design a circuit to convert process variable $x \in [10\,\frac{\mathrm{W}}{\mathrm{sr}}, 20\,\frac{\mathrm{W}}{\mathrm{sr}}]$, the radiant intensity of a light source, to $H(x) = x/\frac{\mathrm{W}}{\mathrm{sr}}$, a floating-point number to be written into variable `rad_int`. The precision should be $\pm 1\,\frac{\mathrm{mW}}{\mathrm{sr}}$. Use a photodiode with response $H_{\mathrm{t}}(E) = 2.12E\,\frac{\mu\mathrm{A\,cm}^2}{\mathrm{mW}}$ mounted 718 mm from the light source. Make full use of the ADC dynamic range. The light source radiates uniformly in all directions. Draw a schematic of the circuit, indicating all component and source values. Show the interface routine. (25 pts)

Problem 2: Events and their interrupts and handlers in a real time system are described in the partially filled table below. Item "1 Time" in the table indicates that the respective event will occur just once, "3 Times" indicates that the event will occur three times. Complete the table. To be eligible for partial credit show the event sequences used. (25 pts)

Event	Str.	Weak	Run	Period or	Worst Case	
Name	Pri.	Pri.	Time	Num. Occur.	Latency	Response Time
A	3	1	$1\,\mu$s	$10\,\mu$s		
B	2	4	$2\,\mu$s	1 Time		
C	2	3	$3\,\mu$s	$200\,\mu$s		
D	2	2	$10\,\mu$s	1 s		
E	2	1	$5\,\mu$s	1 Time		
F	1	1	$7\,\mu$s	3 Times		

Problem 3: Flow is to be measured using a turbine flow meter. The turbine consists of twelve blades; as described in class, a sensor detects the passing of each blade. When functioning properly, its k factor is 200/l (200 pulses per liter). However, these turbine blades can break off. If they do, the turbine will continue to rotate and its rotation rate will be the same as it would with all blades attached.

Each time a turbine blade passes the sensor the routine below is called with insignificant latency. Complete the routine so that variable `flow_rate` is assigned the flow rate in liters per minute. The variable need not be updated on every call. State any reasonable assumptions made. Solve the problem in *one* of the following ways:

- For full credit, complete the routine so that it determines the correct flow rate with any five or fewer blades missing. (The number and position of missing blades is *not* available.) (25 pts)
- For partial credit, complete the routine using variable `blades`, which gives the number of blades currently on the turbine. (That is, `blades` is provided for your use.) ($<$ 25 pts)
- For reduced partial credit, complete the routine assuming that all twelve blades are attached. ($<$ 20 pts)

```
void blade_handler()
{
 /* Seconds since midnight 1 January 1970, microsecond precision. */
 double now = precision_time();

 /* Static variables hold values from call to call. */
 /* On first call, -1; thereafter, time of previous call. (See below.)  */
 static double previous = -1;
 static int count=0;  /* Number of times this routine has been called. */
 count++;











 flow_rate = ???;
 previous = now;
}
```

Problem 4: Answer each question below and on the next page. Be brief.

(a) Show a situation where round robin runs tasks differently than first-come, first-served would. In both cases a fixed quantum should be used. *(Hint: consider three tasks, one performs I/O, the other two don't.)* (5 pts)

(b) Consider the following displacement transducers: a potentiometer, a capacitive displacement transducer, and a linear variable differential transformer (LVDT). For each, describe (and justify) a measurement situation where it is the obvious choice over the other two. (5 pts)

(c) Design (or remember a design used previously) a circuit to measure clockwise rotation using a two-way coded displacement transducer. The amount of clockwise rotation should be converted to an integer. (Do not be concerned with units or overflow.) Counterclockwise rotation should have no effect, that is, the counter *should not* count up or down. (5 pts)

(d) How does a photodiode work? Why are photodiodes reverse-biased? (5 pts)

(e) What property of thermocouple junctions makes the type of metal in the conditioning circuit leads connecting to an isothermal block irrelevant? Illustrate mathematically. (5 pts)