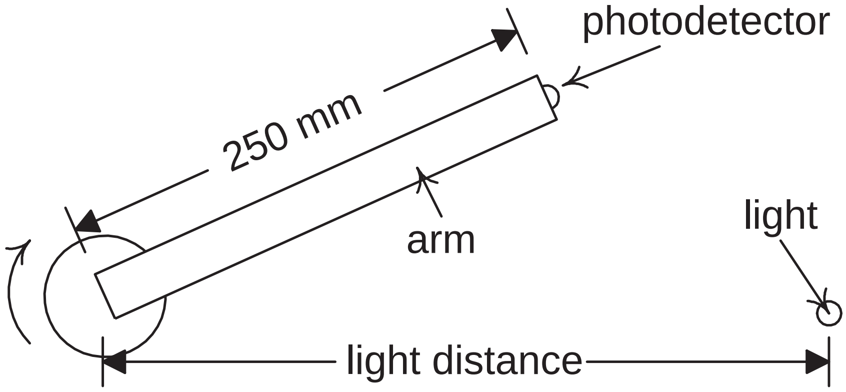
EE 4770 **Homework 3** **Due: 8 March 1999**

Problem 1: The distance from a light source of unknown but steady brightness is to be determined using a photodetector mounted on one end of a 250 mm rotating arm (with the rotation around the other end) as illustrated below.



The light source radiates uniformly in all directions; the photodetector is sensitive to irradiance and is equally sensitive to light in all directions and is sensitive to no other light sources. The light source will be outside the circle traced by the rotating photodetector. The photodetector is connected to a conditioning circuit (already designed) which feeds an 18-bit ADC. The ADC output is interfaced to a computer. The photodetector and conditioning circuit are linear; the ADC saturates at $10\,\frac{\mathrm{mW}}{\mathrm{cm}^2}$. The ADC is noisy, so its output randomly varies by ± 1.

The arm makes one complete rotation in exactly 10 seconds. A proximity sensor detects when the arm is at its 0° angle, at which point a 16-bit counter is reset. The counter is clocked at 6.5536 kHz and is interfaced to the computer.

An interface routine is to sample the ADC and counter values and determine the direction of the light source in degrees (with respect to the arm's zero position), the radiant flux of the light source in milliwatts, and its distance from the axis of rotation in centimeters. To do this the interface routine will have to sample the sensors multiple times (and so will not be able to produce values the first time called).

The light source can move, the distance and radiant flux values need not be correct while it is moving or for a short time after it stops.

A shell of the interface routine appears below. Complete the shell.

```
extern double light_direction, light_distance, light_radiant_flux;
void interface_routine()
{
  double next_sample_time = get_current_time(); /* Time in seconds since 1970 */
  /* Insert additional declarations and initializations below. */

  /* Main Loop */
  while(1){
    int photo_raw = readInterace(PHOTODETECTOR);
    int angle_raw = readInterace(BEAMCOUNTER);

    /* Insert code below. */




    light_direction = /* Insert code */ ;
    light_distance = /* Insert code */ ;
    light_radiant_flux = /* Insert code */ ;
    next_sample_time = /* Insert code */ ;
    sleep_until(next_sample_time);
  }
}
```

Problem 2: Write equations that can be solved to determine the minimum and maximum distances that the system above can determine in terms of the radiant flux of the light. The equations do not have to be solved.

Problem 3: Add code to the program to write the precision of the distance computed for a particular measurement to variable `light_distance_precision`. The precision is the magnitude of the maximum possible difference between the value of `light_distance` and the actual distance assuming everything works perfectly except the photodetector ADC, which may be off ± 1.