(30) Question 1. Multiply numerator and denominator by 20.

y(n) = (14x(n) -13x(n-1) +3x(n-2) -10y(n-1) +5y(n-2))/20

```
#define CONSTANT 8000      // 1ms = 125ns*8000
  y[2] = y[1]; y[1] = y[0]; // shift MACQs
  x[2] = x[1]; x[1] = x[0];
  x[0] = A2D(0);        // new 8-bit data, 0 to 255
  y[0] = (14*x[0]-13*x[1]+3*x[2]-10*y[1]+5*y[2])/20; // 16-bit will work
```

(30) Question 2.

1) add ground gain so sum of all gains is one

$V_{out} = 4\ V_1 - 10\ V_2 + V_{ref} + 6\ V_g$

2) The gains will be

$4 = R_f/R_1$

$10 = R_f/R_2$

$1 = R_f/R_{ref}$

$6 = R_f/R_g$

3) The least common multiple of 4,10,1,6 is 60. Build the circuit so that the smallest resistor (R_2) larger than 10 kΩ. Let the feedback resistor 300 kΩ. Thus,

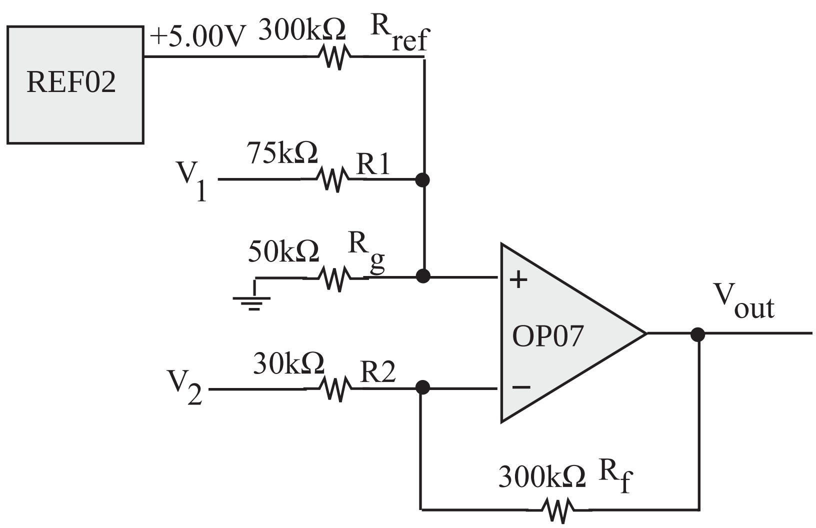
$R_1 = R_f/4 = 300k\Omega/4 = 75k\Omega$

$R_2 = R_f/10 = 300k\Omega/10 = 30k\Omega$

$R_{ref} = R_f = 300k\Omega$

$R_g = R_f/6 = 300k\Omega/6 = 50k\Omega$

4) build



(40) Question 3. An instrument to measure weight

(10) Part a) Complete the following table.

W	ΔR	R1	R2	R3	R4	V1	V2	V1-V2	V3	Data
0	0	100	100	100	100	2.500	2.500	0.000	0.00	0
200	1	99	101	101	99	2.525	2.475	0.050	1.25	2048
400	2	98	102	102	98	2.550	2.450	0.100	2.50	4095
lbs	Ω	Ω	Ω	Ω	Ω	V	V	V	V	

(5) Part b) The sampling rate should be greater than 2Hz, because of the Nyquist Theorem.

(5) Part c) The desired gain is 25. Notice that V3=25*(V1-V2)

(5) Part d) $\mathbf{R_f}$ is 49.4kΩ/(gain-1) = 2058Ω

(5) Part e) The maximum allowable noise is range/4096, which is 0.100/4096 = 24 μV.

(5) Part f) The measurement resolution is range/4096 = 400/4096 = 0.1 lbs.

(5) Part g) Unsigned binary fixed point with a resolution of 1/16.