Jonathan W. Valvano

(25) Question 1. Design an analog amplifier with the following relationship

$V_{out} = 100 \bullet (V_1 - V_2) + 2.5$

Step one, rewrite with reference chip voltage shown as a third input.

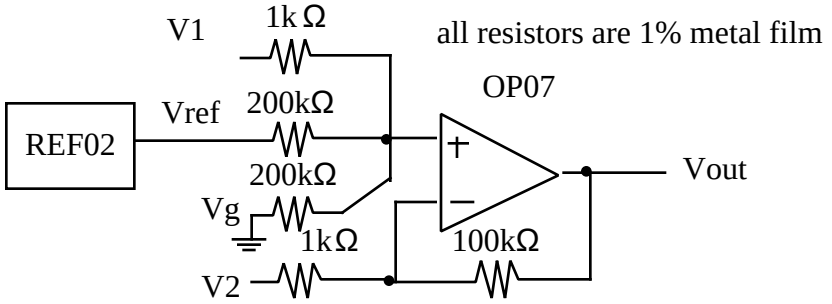
$V_{out} = 100 \bullet V_1 - 100 \bullet V_2 + 0.5 \bullet V_{ref}$

Step two, add a ground as a third input, with a gain such that the sum of the gains is 1.

$V_{out} = 100 \bullet V_1 - 100 \bullet V_2 + 0.5 \bullet V_{ref} + 0.5 \bullet V_g$

Step three, choose a feedback resistor which is the least common multiple of 100,0.5. $R_f = 100k\Omega$.

Step four, select four input resistors to get the desired gains.



(25) Question 2.

```
Sema4Type InValid;  // 1 means In1, In2 are valid, 0 means not valid
Sema4Type OutValid; // 1 means Out is valid, 0 means not valid
```

```
void client(void){
  OS_InitSemaphore(&InValid,0);
  OS_InitSemaphore(&OutValid,0);
  DDRA=DDRB=0; // Ports A, B are input
  DDRC=0xFF;   // Port C is an output
  while(1){
    In1=PORTA; // read first input
    In2=PORTB; // read second input
    OS_Signal(&InValid);
    OS_Wait(&OutValid);
    PORTC=Out; // output the result
  }
}
```

```
void server(void){
  while(1){
    OS_Wait(&InValid);
    if(In1>=In2){
      Out = In1; // In1 is larger
    }
    else{
      Out = In2; // In2 is larger
    }
    OS_Signal(&OutValid);
  }
}
```

(25) Question 3. The error due to the finite time between outputs is 100V/s*0.001s = 0.1V
The error due to the finite DAC precision is 5V/1024 =0.005 V.
Combined the error is 0.105V.

(25) Question 4. Convert constants to integers

$T = (83*R*R)/10000 - (12465*R)/1000 + 6632$

Use signed long math because 83*R*R will exceed 16 bits. Must be signed because 83*R*R<124650*R

```
short Convert(short R){ long bigT,bigR;
  bigR = (long)R;      // promote to 32-bits
  bigT = (83L*bigR*bigR-124650L*bigR)/10000+6632;
  return (short) bigT; // demote
}
```

You could use unsigned long math if you rearrange the terms to keep the intermediate calculations positive

```
unsigned short Convert(unsigned short R){ unsigned long bigT,bigR;
  bigR = (unsigned long)R;      // promote to 32-bits
  bigT = (66320000L+83L*bigR*bigR-124650L*bigR)/10000;
  return (unsigned short) bigT; // demote
}
```