ECE 376 - Final: Name ________________

Calculators Permitted.

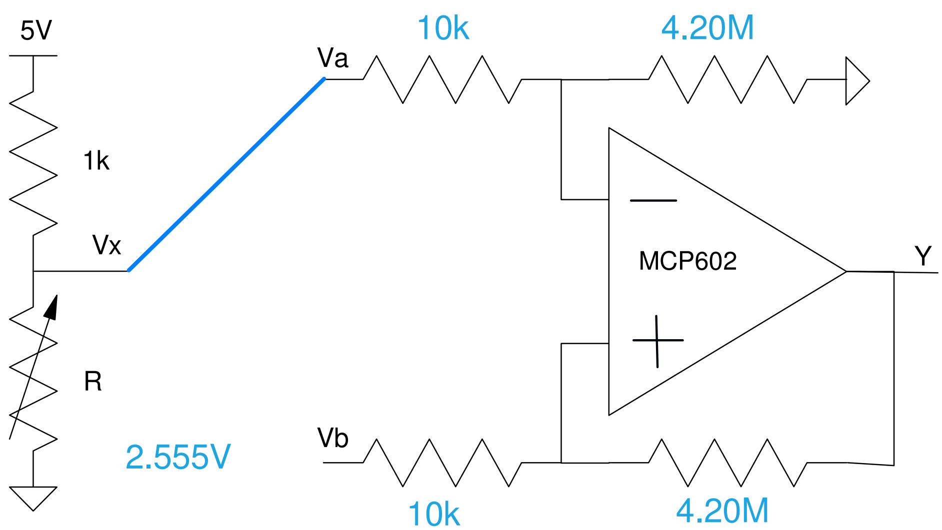
1) Binary Input: Schmitt Trigger.   Design a circuit which outputs

- 0V when the magnetic field is > 0.55 Gauss
- 5V when the magnetic field is < 0.45 Gauss

Assume you have a thermistor where

$$R = 1000 \cdot (1 + 0.1G)\ \Omega$$

and G is the magnetic field strength in Gauss



G = +0.55: (Y=0)

$$R = 1055\Omega$$

$$V_x = \left(\frac{R}{R+1000}\right)5V = 2.567V$$

G =0.45 (Y = 5V)

$$R = 1045\Omega$$

$$V_x = \left(\frac{R}{R+1000}\right)5V = 2.555V$$

Connect to the minus input (Von < Voff)

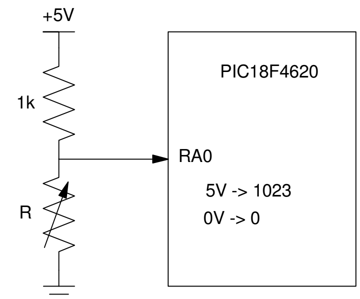
Offset = 2.555V (where Y goes high)

$$gain = \left(\frac{5V-0V}{2.567V-2.555V}\right) = 420.2$$

2) Analog Input: A magentic field sensor has the following resistance vs. magnetic field relationship

$$R = 1000 \cdot (1 + 0.1G)\ \Omega$$

where G is the magnetic field strength in Gauss.



2a) Determine the A/D reading for the following circuit at -1 Gauss / 0 Gauss / +1 Gauss

-1 Gauss	0 Gauss	+1 Gauss
485	**512**	**536**

-1 Gauss

$$R = 900$$

$$V = \left(\frac{900}{900+1000}\right) 5V = 2.368V$$

$$A/D = \left(\frac{2.368V}{5.000V}\right) 1023 = 484.6$$

0 Gauss

$$R = 1000$$

$$V = \left(\frac{1000}{1000+1000}\right) 5V = 2.500V$$

$$A/D = 511.5$$

+1 Gauss

$$R = 1100$$

$$V = \left(\frac{1100}{1100+1000}\right) 5V = 2.619V$$

$$A/D = 535.9$$

2b) Give a calibration function to compute the field strength in Gauss based upon the A/D reading

$$G = \left(\frac{536-485}{2}\right)(A/D - 512) = 0.03922(A/D - 512)$$

2c) What is the smallest change in magetic field you can detect with your code (i.e. the resolution of this sensor)?

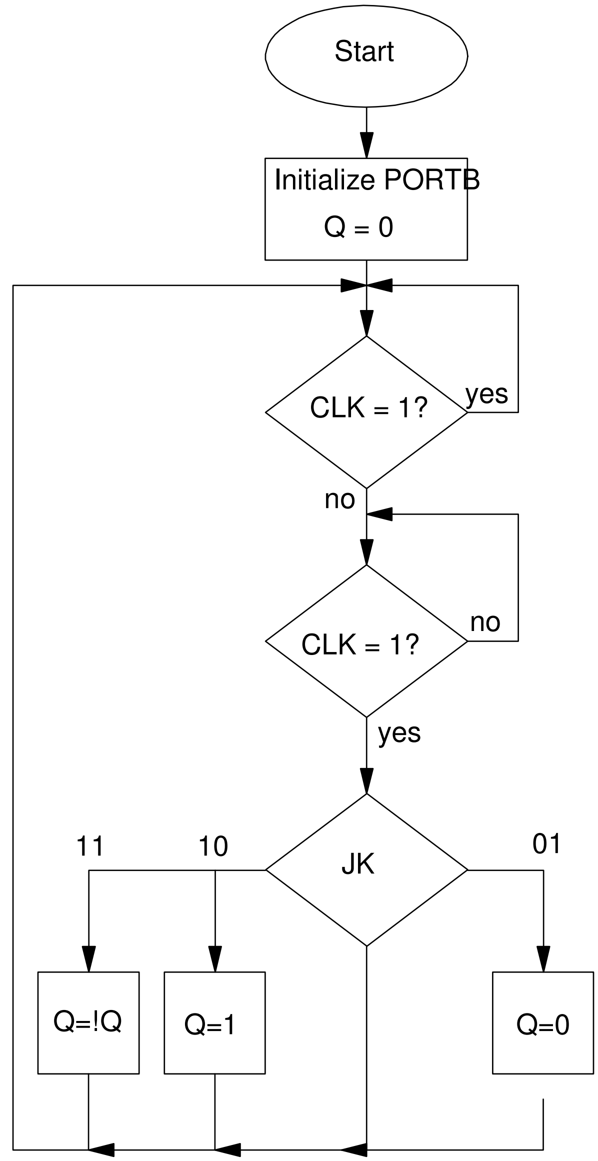
smallest change a PIC can detect is 1 count on the A/D

smallest change a PIC can detect is 0.03922 Gauss

3) C Coding: The following flow chart is for a JK flip flop. Write the corresponding C code.

RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
-	-	-	-	Q output	J input	K input	CLK input

```
TRISB = 0x07;
RB3 = 0;

while(1) {

   while(RB0);

   while(!RB0);

   if(RB2)

      if(RB1) RB3 = !RB3;
      else  RB3 = 1;

   else

      if(RB1) RB3 = 0;

   }
```



4) C Programming: Write subroutine which

- Is passes a number from 0 to 5 (N), and
- Lights up that many lights on PORTC as a bar graph

N	0	1	2	3	4	5
PORTC	0000 0000	0000 0001	0000 0011	0000 0111	0000 1111	0001 1111

```
void Problem4(unsigned char N)
{

   if(N == 0) PORTC =0x00;

   if(N == 1) PORTC =0x01;

   if(N == 2) PORTC =0x03;

   if(N == 3) PORTC =0x07;

   if(N == 4) PORTC =0x0F;

   if(N == 5) PORTC =0x1F;

   }
```

not stylish, but you can do pretty much anything with if-statements.

5) A square wave with a frequency between 1Hz and 5Hz is applied to the PIC. Write a program which can measure the period of the square wave using Timer 0 with a resolution of 1ms or better.

a) Hardware: What I/O pin do you connect the signal to and what interrupt are you using?

I/O Pin on PIC	Interrupt Used
RB0	INT0 interrupt (rising edge) Timer0 interrupt\

b) Interrupt Initialization (i.e. pre-scalar you are using for Timer 0/1/3 or ABC tor Timer2)

INT0:

rising edge

Timer0

PS = 1

c) Interrupt Service Routine: Measure the period and compute the frequency in Hz

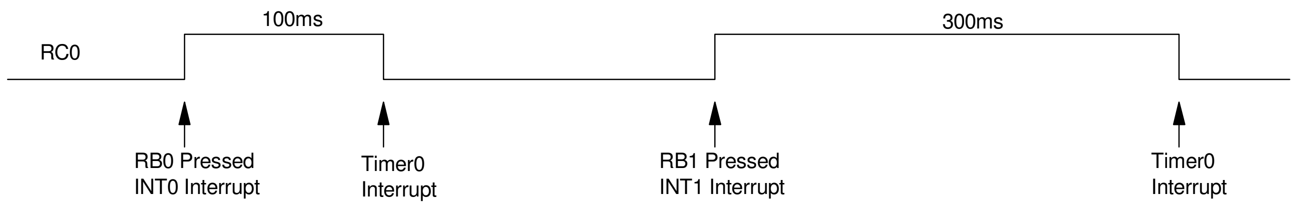
```
void interrupt IntServe(void) {
   if(INT0IF) {
      T0 = T1;
      T1 = TIME + TMR0;
      Period = T1 - T0;
      Hz = 10000000.0 / Period;
      INT0IF = 0;
      }
   if(TMR0IF) {
      TIME = TIME + 0x10000;
      TMR0IF = 0;
      }
   }
```

note:

- floating point operations OK to use since you have 2,000,000+ clocks between rising edges
- the period is measured with a resolution of 100ns

6) Interrupts Changing Interrupts: Using interrupts, generate

- A 100ms pulse on RC0 when you press RB0
- A 300ms pulse on RC0 when you press RB1



6a) Interrupt Set-Up: Specify the initialization for INT0 and Timer2 interrupts

INT0 Setup (rising edge)	INT1 Setup (rising edge)	Timer0 Setup (PS)
INTEDG0 = 1;	INTEDG1 = 1;	PS = 64;

6b) Interrupt Service Routine:

INT0	INT1	Timer0

`if(INT0IF) {`
`RC0 = 1;`
`//100ms @ PS=64`
`TMR0 = -15625;`
`INT0IF = 0;`
`}`
	`if (INT1IF) {`
	`RC0 = 1;`
	`// 300ms @ PS=64`
	`TMR0 = -46875;`
	`INT1IF = 0;`
	`}`
		`if (TMR0IF) {`
		`RC0 = 0;`
		`TMR0IF = 0;`