CICS 290M (F19) Homework 7

For any question involving calculation, you MUST write down at least one line of derivation (i.e. how you derived the answer). If you write down a number without any derivation, you will receive 0. [2+2+2+3+3+8=20pts]

1. What is a reed sensor for? Name two applications of reed sensor. [2pts]

   Reed sensor is built using a reed switch for additional functionality.

2. What is an H-bridge used for? How many transistors do you need to make an H-bridge? [2pts]

   H-Bridge is used to change the polarity of voltage applied to a load. You need for transistors to make an H-bridge.

3. What is a servo motor? What component does the servo use to tell its current angular position? [2pts]

   It is a motor with a built-in encoder and feedback circuit for working with angular positions. The encoder(potentiometer) provides the current angular position.

4. [*This problem has nothing to do with electronics, nonetheless, it's a classic problem to practice equation solving skills*]. Some chickens and rabbits got mixed into a cage. An advanced computer sensor detected that there are **35 heads and 94 legs**. How many chicken and rabbits are there respectively? [Hint: obviously a chicken has 2 legs and a rabbit has 4 legs]. [3pts]

   Let x be chickens and y be rabbits
   x+y = 35
   2x+4y = 94
   => x + 2y = 47
   =>y = 12 and x = 35-12 = 23

5. We have two resistors of unknown values, but we do know that their **series resistance** (i.e. total resistance when they are connected in series) **is 20 ohm** and the **parallel resistance is 3.2 ohm**. What are the two resistor values respectively? [3pts]

   a+b = 20 = series resistance, where a and b are the resistors
   1/a + 1/b = 1/(3.2)
   => a+b/ab = 1/(3.2)
   =>ab/20 = 3.2
   => ab = 64.
   $(a+b)^2 = 20^2 = 400$
   $(a+b)^2 - 4ab = (a-b)^2$
   =>400 - 4*64 = $(a-b)^2$ = 144
   -> a-b = 12
   a + b = 20,
   a - b = 12
   2a = 32,
   a = 16ohms,
   b = 4ohms

[Continue to the next page]

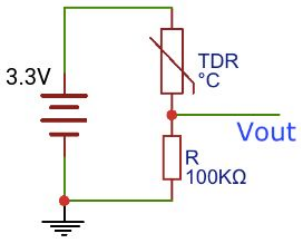
CICS 290M (F19) Homework 7

6. A typical thermistor (TDR) has a nominal value of 100KΩ. Its datasheet can be found here. Using the datasheet, answer the following questions: [8pts]

a) If at some room, the resistance of the TDR is **161KΩ**. What's the room temperature at this moment in Celsius (°C)? [Hint: just use the closest number in the table, no need to interpolate, 1pt]

15.00

b) To use ESP32 to measure temperature with this TDR, we adopt a voltage divider circuit shown on the right. The **power supply voltage is 3.3V**, and the **fixed resistor R=100KΩ**. Write down the expression for Vout in terms of TDR. [2pts]



$V_{out} = V_{PS} * TDR/(TDR+R)$

c) We use ESP32's analog pin to measure Vout. If the **analog reading is ADC**, write down the expression for TDR in terms of ADC. [Recall that the analog reading ADC is 0 when the measured voltage is 0.0V, and 4096 when measured voltage is 3.3V, and everything in between scales linearly]. [1pt]

$ADC = V_{out} * 4096/3.3$ $V_{out} = V_{ps} * TDR/(TDR+R)$ $= 3.3 * TDR/(TDR+100K)$ => $ADC = 3.3*(4096/3.3)*TDR/(TDR+100K)$ $= 4096*TDR/(TDR+100K)$

d) If we put the circuit in a room, and ESP measured **ADC=2048**, 1) what's the value of TDR at the moment? 2) using the datasheet again, find out the temperature in Celsius (°C). [2pts]

1) ADC = 4096*TDR/(TDR+100K) = 2048 => TDR/(TDR+100K) = ½ =>(TDR+100K)/TDR = 2 =>1+100K/TDR = 2 =>100K/TDR = 1 =>TDR = 100K 2) 25 degrees C

e) We put the circuit in a freezer, and Arduino measured **ADC=585**, 1) what's the value of TDR at the moment? 2) using the datasheet again, find out the temperature in Celsius (°C). [2pts]

1) ADC = 4096*TDR/(TDR+100K) = 585 => TDR/(TDR+100K) = 585/4096 =>(TDR+100K)/TDR = 4096/585 =>1+100K/TDR = 4096/585 =>100K/TDR = 4096/585-1 =>TDR = 100K/6.00170940171 => TDR = 16.66K 2) 69.44 degrees C