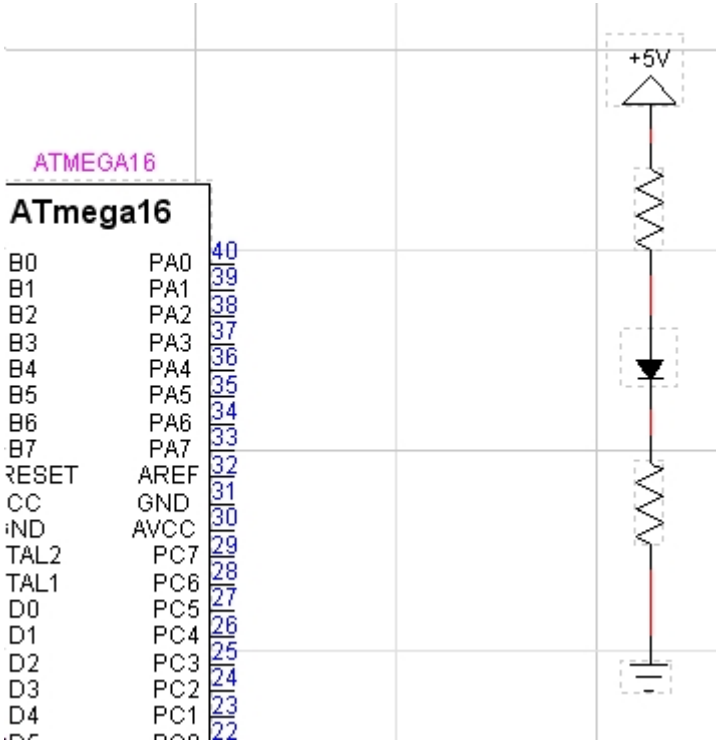
PLEASE DO NOT COLLABORATE – THIS IS MEANT AS AN INDIVIDUAL ASSIGNMENT

Question 1: A temperature monitor is being designed around a germanium diode. The diode's forward voltage drop is a strong function of temperature. Therefore, a direct voltage measurement across the diode must be made to determine the temperature. Design an ADC interface using the AVR that will accomplish this, subject to the requirements below:

-Only port A I/O pins may be used.
-The reference voltage will be Vdd for the chip (AREF).
-No additional parts may be used.
-AVR CPU clock 8MHz
-Convert as fast as possible
-LSB of result will be in bit 0 of ADCL.
-The ADC configuration must maximize the sensitivity to the diode's voltage variations.
-The forward voltage drop of the diode ranges from 0.28V to 0.38V over the temperature of interest.

a. Finish the schematic below:



b. Show the values for the following registers. Bits that do not affect ADC operation may be left blank:

ADMUX

7	6	5	4	3	2	1	0

ADCSRA

7	6	5	4	3	2	1	0

Question 2: A particular motor operates at 10 revolutions per second when its controlling input is 3.7volts. Assume you are using a microcontroller with a PWM whose output port can be set high (5V) or low (0V).

Compute the duty cycle to obtain 10 revolutions per second. Write code for a counter-timer from the AVRmega16 to achieve this. Assume an 8 MHz processor clock.

Question 3: To generate a PWM we want to use a scale of 0 to X, where X is the highest value equaling a 100% duty cycle. For example we could use 0 to 255, 0 to 64, 0 to 100, where the value of 255, 64, and 100 should equate to a duty cycle of 100%. For all the parts assume you are using Timer0.

A) Determine the value for OCR if you want to generate a PWM with a scale of 0 to 255 so that the period is approximately 15ms. Use a prescaler of clk/8 assuming the crystal on your prototyping board. Hint: You will need to use a counter value to keep track of the number of output compare interrupts.

B) Derive a formula to determine the time between output compare interrupts (defined as IT) in terms of the OCR0 value. Assume a prescaler of clk/8 and use the crystal value from your prototyping board.

C) Derive a formula to determine the PWM period in terms of IT (time between output compare interrupts) and X.

D) Derive a formula in terms of X to determine the Output Compare Value for Timer0 so that the period of <15ms is maintained. Use a prescaler of clk/8 assuming the crystal on your prototyping board. NOTE: that because of the 8-bit limit on the OCR, X must be greater than 54. To fix this limitation you can change the prescaler (which is NOT required for this question).

Question 4: Create a program that uses a single timer (use Timer0) to generate three separate PWMs. Use three variables ‘R’, ‘G’, and ‘B’ to determine the value of the duty cycle for each PWM signal. Assume the ‘R’ PWM is being generated on Pin 1, ‘G’ on Pin2, and ‘B’ on Pin 3. ‘R’, ‘G’, and ‘B’ have a scale of 0 to 255. Turn in code that initializes Timer 0 and implements the interrupt service routine for generating 3 separate PWMs.