ASEN 1320 Fall 2020
Homework Assignment 2 - DC Motor
Due: 11:59pm on September 13 (Sunday)

Problem: When a NASA aircraft is being prepared for a major research project, the Sheet Metal Shop of the Armstrong Flight Research Center's Experimental Fabrication Branch is likely to be involved. The Sheet Metal Shop is the organization at Armstrong that carries out all modification and repair work on the aircraft, ranging from the creation of something as small as an aluminum bracket, to which electrical wires will be attached, all the way up to replacing or modifying wing spars, fuselage ribs, control surfaces, and large areas of exterior skin. As an intern at the Armstrong Flight Research Center, you are tasked to write software for monitoring the efficiency of a DC motor machine that feeds sheet metal into a punch press. A motor is a machine for converting electrical energy into mechanical energy. When such conversions take place, certain losses occur which are dissipated in the form of heat. The efficiency of a DC machine $\boldsymbol{\eta}$ is the ratio of the output power to the input power and is usually expressed as a percentage (%):

$$\begin{aligned} \boldsymbol{\eta} &= \frac{\text{outputpower}}{\text{inputpower}} \times 100 \\ &= \frac{\mathbf{VI} - \mathbf{I}^2\mathbf{R} - \mathbf{C}}{\mathbf{VI}} \times 100 \ , \end{aligned}$$

where $\mathbf{V}$ is the voltage (in Volts), $\mathbf{I}$ is the current in circuit (in Amperes), $\mathbf{R}$ the total resistance of the motor (in Ohms), and $\mathbf{C}$ is the sum of the iron, friction and windage losses (in Watts). The efficiency of a given motor is said to be maximum when the load is balanced such that

$$\mathbf{I}^2 = \mathbf{C}/\mathbf{R} \ . \tag{1}$$

The maximum efficiency of the motor is therefore expressed as

$$\boldsymbol{\eta}_{max} = \frac{\mathbf{VI} - 2\mathbf{I}^2\mathbf{R}}{\mathbf{VI}} \times 100 \ . \tag{2}$$

Tasks: Write a C++ program that (i) takes user-defined input values of $\mathbf{R}$, $\mathbf{I}$, and $\mathbf{V}$, (ii) informs the user whether the maximum efficiency condition $\mathbf{I}^2 = \mathbf{C}/\mathbf{R}$ (Equation (1)) is satisfied for given user-defined input values of $\mathbf{R}$ and $\mathbf{I}$ and a pre-defined value of $\mathbf{C} = 320.0$. If the maximum efficiency condition is satisfied, the maximum efficiency of the motor $\boldsymbol{\eta}_{max}$ should be computed using Equation (2), and output to the console.

Here are some details.

- Submit a C++ program source file named **motor.cpp** to Gradescope

- All the computation should be done just in `main ()` using the iostream and string libraries, console I/O, elementary arithmetic operations, branching statements, boolean expressions, and type casting.
- Prompt the user for input values for **R**, **I**, and **V** with the following messages "Enter a resistance value: ", "Enter a current value: ", and "Enter a voltage value: " in this order. Each message should start on a new line.
- Verify the user's input values so that they are not zero before proceeding. If any input for **R**, **I**, and **V** values is zero, the program should output the following error message "Error: resistance, current and voltage values cannot be zero!", and stop execution by returning control to the operating system. A new line needs to be added at the end of this error message.
- Use floating point numbers (`double`) for **I**, **V**, **R**, and **C**.
- Inform the user whether the maximum efficiency condition $\mathbf{I}^2 = \mathbf{C}/\mathbf{R}$ is satisfied, or the load (the amount of current **I**) is too large/small in comparison to $\mathbf{C}/\mathbf{R}$ by printing the following messages: "The maximum efficiency condition is met" when $\mathbf{I}^2 = \mathbf{C}/\mathbf{R}$,"The load is too high" when $\mathbf{I}^2 > \mathbf{C}/\mathbf{R}$,"The load is too low" when $\mathbf{I}^2 < \mathbf{C}/\mathbf{R}$.
- The console output of the DC machine's maximum efficiency η_{max} needs to be rounded up or down to the nearest integer number , and accompanied with the message "The efficiency is XXX %". (Round up if over 0.5 and round down otherwise. This rounding operation can be achieved by adding 0.50 first and then using a C++ type casting operation.)
- Sample example console output:

```
ASEN1320CanvasRole:~/environment/hw2 $ ./motor
Enter a resistance value: 0.2
Enter a current value: 0
Enter a voltage value: 250
Error: resistance, current and voltage values cannot be zero!
ASEN1320CanvasRole:~/environment/hw2 $ ./motor
Enter a resistance value: 0.2
Enter a current value: 40
Enter a voltage value: 250
The maximum efficiency condition is met
The efficiency is 94%
ASEN1320CanvasRole:~/environment/hw2 $ ./motor
Enter a resistance value: 0.2
Enter a current value: 20
Enter a voltage value: 250
The load is too low
ASEN1320CanvasRole:~/environment/hw2 $ ./motor
Enter a resistance value: 0.2
Enter a current value: 45
Enter a voltage value: 250
The load is too high
```

Here are some common mistakes from Homework Assignment 1.

- The final upload file name has to be motor.cpp. Not motor-01.cpp, motor(2).cpp, motor_01.cpp, motor.zip.
- Upload only a source file named motor.cpp file to Gradescope. Do not upload a folder or a zipped file
- Gradescope will not give you a full score until the output matches exactly.
- Check spelling, letter cases and extra spaces of the output.
- Check if type casting is used properly to round a decimal number to the nearest integer yield for the output.
- The output should end with a new line. Make sure to add \n or `endl`.
- Read and follow the instructions given in Homework pdf document and Canvas/Piazza completely.