ENGR 200 FALL, 2017

**A8: ELECTRICAL POWER CALCULATIONS**

**(using one-dimensional matrices in MATLAB)**

DUE: November 21, 2017 at 11:59 p.m., CST POINTS: 30

**INTRODUCTION:**

Wind power depends on the volume of the air, the speed of the air, and the mass of the air. Electrical power production from a wind powered generator depends on the size of the turbine, the speed of the air, and the efficiency of the turbine and generator.

The wind power equation is:

P = ½ρAv3

Where:

P = power in watts

ρ = air density (1.225 kg/m3 at sea level and 15° C)

A = swept area of rotating turbine blades in square meters

v = wind speed in meters per second

**Betz Limit and Power Coefficient:**

In 1919, the German physicist Albert Betz concluded that no wind turbine could convert more than 59.3% of the kinetic energy of the wind into mechanical energy. This is known as the Betz Limit or Betz’s Law. Thus, the theoretical power efficiency of any wind turbine design is about 0.59 (59%). When the power coefficient of 59% is applied to the above equation we get:

P = .59(½ρAv3)

However, the real world power coefficient limit is generally considered well below the Betz Limit. The values of 35% to 45% are common even in the best designed wind powered turbines.

Other factors such as the gearbox, bearings, generator, and so on, reduce the power coefficient to 10-30% of the wind power that is actually converted to usable electrical energy.

**ASSIGNMENT:**

Write a MATLAB program that will load the blade radii in centimeters from the input file **blade\_radii.txt**, and the wind speeds in mph from the input file **wind\_speeds.txt**. The blade radii will be in a one-dimensional matrix and the wind speeds will be in a separate one-dimensional matrix.

The program will use the one-dimensional matrices to generate a report as shown on page two. You will be computing four separate power columns; one for 10%, one for 20%, one for 40%, and one for 59% (ideal power). Notice that the power equation requires wind speeds in meters per second, and the swept area in square meters. When computing and printing the power table, if a wind speed is zero mph then print the message **NO ELECTRIAL OUTPUT**, else print the wind speed, 10% power, 20% power, 40% power, and 59% power calculations. Position the message as shown in the output format given on page two.

The report will be printed in MATLAB’s **Command Window** and to the output file **power\_results.txt**. Before running your Matlab program, do the following setup:

1. Set the **Command Window** screen format by selecting:

**Preferences, Command Window**

Numeric Format: **short g**

Numeric Display: **loose**

Tab Size: **0**

**Apply, OK**

2. If needed, expand the **Command Window** to full screen before executing your

program.

**OUTPUT FORMAT:**

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ELECTRICAL POWER CALCULATIONS IN WATTS

Wind(m/h) 10pct 20pct 40pct 59pct

Blade radius #1 = xxx centimeters

xx xxx.x xxx.x xxx.x xxx.x

. . . . .

. . . . .

NO ELECTRICAL OUTPUT

. . . . .

. . . . .

xx xxx.x xxx.x xxx.x xxx.x

==================================================

Blade radius #2 = xxx centimeters

xx xxx.x xxx.x xxx.x xxx.x

. . . . .

. . . . .

NO ELECTRICAL OUTPUT

. . . . .

. . . . .

xx xxx.x xxx.x xxx.x xxx.x

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**FILE NAME:**

The naming convention that was used for C programs **cannot** be used in Matlab. Before submitting to Blackboard, name your Matlab program file **A8\_firstname\_lastname**.

2 for loops

First for loop controls blade radii

Inside for loop controls wind speeds (calculations and printing coluns)

If structure inside this loop that will determine went to print electrical output and column of numbers so if/else operation. Else part will print columns.

Equals signs need if structure to print them