Lab 4:
Generator

Objectives:
Study a generator powered by a falling mass.
Find the efficiency of the generator by examining how the potential energy stored in the hanging mass is converted to electrical energy and kinetic energy.

Introduction:

Diagram:

Procedure:
In Capstone connect a voltage probe to the same virtual terminal to which your real voltage probe is connected on the Pasco interface.
Set the sample rate to 1000 Hz and attach a graph to your voltage measurement.
On your generator, plug in the 100 Ω resistor and connect your voltage probe leads across the resistor.
Hang a mass, not exceeding 30 grams including the mass hanger, on the thread. Attach the thread to the generator pulley and wind it up to the top. The thread should be loosely connected to the shaft of the pulley so the pulley can continue to turn after the mass stops falling.
Record the diameter of the pulley you used.
Start Capstone and release the mass.
Record the distance through which the mass fell.
After performing the analysis for your first run, repeat all steps, changing either the hanging mass, the pulley size, or the fall distance.

Measurements:
Record the height h through which the mass fell and attach a graph of $V(t)$ versus t here.

Analysis:

After collecting data for two runs, do all the following analysis steps for both.
Enter the formula for calculating the instantaneous power delivered to the resistor by the generator [$P= V^2/R$]. Note: R=100Ω.

The area of the graph from t_i to t_f is equal to the energy the generator delivered to the resistor. Why? *Hint:* Think about the relationship between power and energy.

Plot the instantaneous power versus time. Calculate the area under the curve. Include this plot in your report.

How much did the gravitational potential energy of the hanging mass decrease when it fell?

So far, you have accounted for the change in the gravitational potential energy of the falling mass and the electrical energy delivered by the generator to the resistor. Now we need to account for the change in the kinetic energy of the falling mass. This means we need to know the speed of the falling mass immediately prior to impacting the foam pad.
To do this we can find the time between the maximum on the $V(t)$ versus t graph and its preceding peak. This time corresponds to the time that the pulley takes to make one revolution just before the mass impacts the pad. Thus, we know the distance the mass fell during this time period, and therefore can calculate its speed.

Find t for the maximum value of $V(t)$. Record this time here: $t_2 =$
Repeat for the previous peak: $t_1 =$
Use this information to find the speed of the mass just prior to impact: $v_{impact} =$
What is the kinetic energy of the hanging mass just prior to impact (show your calculation)?
$K_{impact} =$
What is the initial kinetic energy of the falling mass? $K_i =$
What is the change in gravitational potential energy for the falling mass (show your calculation)?
$\Delta U =$

Find the total change in mechanical energy for the falling mass.

Find the total electrical energy delivered to the resistor by the generator $U_{ELEC} =$

For a perfect system, the change in potential energy of the mass would be converted entirely into electrical energy and kinetic energy. Calculate the difference between the change in potential energy and the sum of the electrical energy and kinetic energy. This is the unaccounted for energy $E_{lost} =$

Note that a nonzero E_{lost} means energy has been "lost" in the process (some of the potential energy was not converted to either kinetic or electrical energy). Where did this energy go?

What percent of the initial total energy is missing?

Calculate the efficiency of the generator in converting gravitational potential energy to electrical energy delivered to the 100 Ω resistor.

Did the efficiency change between runs? Why or why not?

Conclusions:
Brief summary of the procedure and analysis:

Summary of sources of error:

If there are multiple sources of error, which is most important?

Which are less important?