EE-80J: Renewable Energy Sources

Hydroelectric Laboratory PRE Questionnaire

Student's name_____ Student ID_____

1. What is the mass of 5 liters of water?
    a. 1 kg
    b. 2.5 kg
    c. 5 kg
    d. 7.5 kg
    e. 25 kg
2. What are the units of gravitational potential energy?
    a. Watts
    b. Newton
    c. Joules
    d. Volts
    e. Amps
3. What are the units of power?
    a. Watts
    b. Newton
    c. Joules
    d. Volts
    e. Amps

4. If 3 liters of water were dropped from a 5 story building (approximately 25 meters). What is the gravitational potential energy?
    a. 10 Joules
    b. 100 Joules
    c. 150 Joules
    d. 300 Joules
    e. 750 Joules

5. How much power does an electric device generate when it supplies 6 Joules of energy for 1 minute?
    a. 1/6 Watts
    b. 1/10 Watts
    c. 1 Watt
    d. 6 Watts
    e. 36 Watts

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EE-80J: Renewable Energy Sources

Hydroelectric Laboratory Experiment

Oxana Pantchenko and Prof. Ali Shakouri

Student's name_____ Student ID_____ Grade _____ / _____

ABSTRACT

In this laboratory experiment, students will become familiar with calculating gravitational potential energy using a hydroelectric turbine. They will also calculate efficiency of such systems and compare it to systems built in previous lab experiments. Students will learn how to plot graphs showing Power vs. Time.

INTRODUCTION

Hydroelectric power plants convert kinetic energy of moving water into electrical energy. A typical scenario is a hydroelectric power plant installed in combination with a river dam. The dam raises the water level in the reservoir.

As water from the reservoir is allowed to fall through the pipes, its potential energy is converted into kinetic energy which in turn is used to power a turbine. The turbine converts the kinetic energy into mechanical energy. A generated finally converts the mechanical into electrical energy.

Hydroelectric power plants reach efficiencies of up to 80-90%.

LIST OF MATERIALS

- ET-Generator (1)
- Impeller Housing (1)
- Impeller (1)
- Plastic tubing (3 feet)
- Plastic nozzle (1)
- Tube clamp (1)
- Screwdriver (Phillips) (1)
- Water reservoir (1)
- Resistor plus 100Ω (1)
- Alligator clamps (2)
- Beaker (1)
- Rod stand (1)
- Finger clamp (2)
- LabView Software (1)
- Ruler

Figure 1 These are the supplies needed for this lab. Make sure you box has all listed components. If something is missing, inform your TA .

PROCEDURE

1. Attach the ET-Hydro Accessory housing to the shaft of the ET-Generator using that two captured screws and the screwdriver.
2. Slide the housing with turbine (impeller) over the long shaft screw molded to the Generator. Hold the shaft to prevent it from spinning.
3. Slide the stand-off nut over the shaft screw and tighten.
4. Insert the pointed end of the plastic nozzle into the spring clip underneath the housing.
5. Connect the nozzle to 3-ft plastic tubing
6. Connect the other end of the plastic tubing to water reservoir
7. Use the finger clamp to attach reservoir to the highest point on the rod stand
8. Place beaker under impeller housing
9. Insert **100Ω** resistor plug into ET Generator
10. Connect the alligator clamps to computer interface
11. Open EE80J/Hydroelectric Lab
12. Clamp the tube
13. Add water to the reservoir
14. Measure the mass of the water

Figure 2 This is ET-generator with the impeller housing and impeller attached. Right, this is what the ET-generator should look like under the housing after step 4.

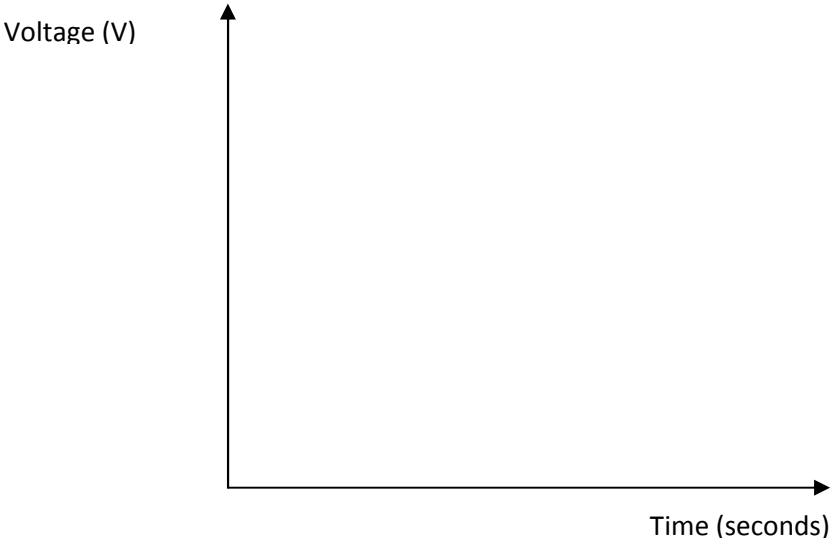
($mass_{beaker+water}$-$mass_{beaker}$=$mass_{water}$)

$Mass_{beaker}$=_____kg

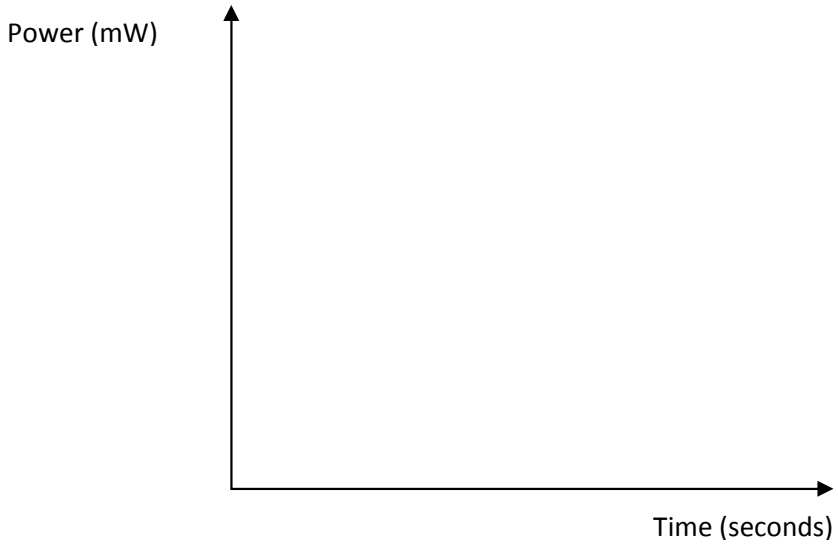
$Mass_{beaker+water}$ =_____kg

$Mass_{water}$= _____kg

15. In LabView, click start button
16. Open the clamp and allow water to run through turbine
    Note: make sure the impeller is rotating
17. Draw your Voltage vs. Time graph



18. If Power = (Voltage)^2 / Resistance, estimate and draw your Power vs. Time plot.



19. Record the value of electrical energy generated _____ J.

20. Determine the average height that the water falls.
    a. Measure the distance from the table to the highest point of the water in the water reservoir,

       h_{top}=_____m

    b. Measure the distance from the table to bottom of the water reservoir:

       h_{bottom}=_____m

    c. Measure the distance from the table to the nozzle,

    d. h_{nozzle}=_____m

    e. Calculate $h_{avg.}$= $\frac{h_{top}+h_{bottom}}{2} - h_{nozzle}$

       $h_{avg.}$= _____m

21. Calculate the change in gravitation potential energy, where PE=mgh.

PE=_____Joules

22. Calculate the efficiency (Percent of energy transferred),
where efficiency = (energy generated/mgh) x 100

Efficiency=_____ %

23. Where does the rest of the energy go?

24. Why is the efficiency here so much less than for the flywheel generator?

25. Empty beaker
26. Lower the position of the water reservoir to half of the original height.
Note: be careful not to change the nozzle angle.
27. Repeats steps 12-19
28. Add water to the reservoir
29. Measure the mass of the water

$mass_{beaker+water}$-$mass_{beaker}$=$mass_{water}$

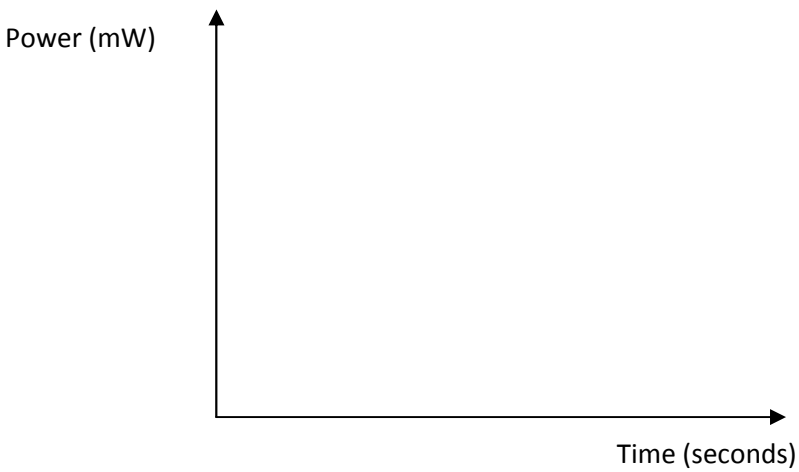
$Mass_{beaker}$=_____kg

$Mass_{beaker+water}$ =_____kg

$Mass_{water}$= _____kg

30. In LabView, click start button
31. Open the clamp and allow water to run through turbine
Note: make sure the impeller is rotating
30. In LabView, click stop button
32. Make a Power vs. Time graph from Voltage vs. Time plot on the screen. Remember,

$$Power = V^2 / R$$



33. Record the value of the generated electrical energy: _____ J.
34. Determine the average height that the water falls.
    a. Measure the distance from the table to the highest point of the water in the water reservoir,

       h_{top}=_____m

    b. Measure the distance from the table to bottom of the water reservoir,

    c. h_{bottom}=_____m

    d. Measure the distance from the table to the nozzle,

    e. h_{nozzle}=_____m

    f. Calculate $h_{avg.}= \frac{h_{top}+h_{bottom}}{2} - h_{nozzle}$

       $h_{avg.}$= _____m

35. Calculate the change in gravitation potential energy, where PE=mgh.

    PE=_____J

36. Calculate the efficiency (Percent of energy transferred), where efficiency = energy generated/mgh x 100.

    Efficiency=_____%

37. Compare the efficiency for the two heights, steps 22 and 36.

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