

ENGINEERING FOR SUSTAINABLE DEVELOPMENT

22WSP409

Semester 1 2022

In-Person Exam paper

This examination is to take place in-person at a central University venue under exam conditions. The standard length of time for this paper is **2 hours**.

You will not be able to leave the exam hall for the first 30 or final 15 minutes of your exam. Your invigilator will collect your exam paper when you have finished.

Help during the exam

Invigilators are not able to answer queries about the content of your exam paper. Instead, please make a note of your query in your answer script to be considered during the marking process.

If you feel unwell, please raise your hand so that an invigilator can assist you.

You may use a calculator for this exam. It must comply with the University's Calculator Policy for In-Person exams, in particular that it must not be able to transmit or receive information (e.g. mobile devices and smart watches are **not** allowed).

ENGINEERING FOR SUSTAINABLE DEVELOPMENT (22WSP409)

January 2023

2 Hours

Answer **ALL FOUR** questions.

Questions carry the marks shown.

Any University-approved calculator is permitted.

1. A run-of-the-river hydroelectricity station does not use a damned pool of water from which to harvest kinetic energy as is the case with conventional hydroelectricity stations. Instead, it uses the natural flow of the river (with velocity, v) to drive a submerged turbine. In this respect it can be modelled in similar way to that of a wind turbine, in that a mass of definable volume flows through a swept area, A , over a certain time period, t , as shown in figure.1.

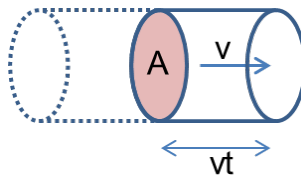


Figure 1. Flow of water through a swept area.

- a) A run-of-the-river hydroelectricity station has one turbine of diameter 1.5 m and is in a constant water flow of 1.3 m s^{-1} . Calculate the expected power generated by this station. Assume the density of the river water to be 1000 kg m^{-3} . Betz law does not apply in this case, but you should use an appropriate efficiency factor for the turbine instead. [10 marks]
- b) Given the obtained expected power output of the turbine, identify a suitable application that may use that harnessed energy giving reasons for your selection. [2 marks]
- c) A run-of-the-river turbine is unlikely to give a consistent output over time. Identify three reasons for this and explain how these inconsistencies could be reduced or mitigated against for your chosen application. [3 marks]

2. Life Cycle Assessment (LCA) is an analytical tool used to improve the environmental sustainability of products.
- a) Describe the four key steps involved in conducting a Life Cycle Assessment according to ISO 14040 [6 marks]
 - b) Define what is meant by 'Functional Unit' and how it is used within a LCA study? [4 marks]
 - c) Using a domestic toaster as an example, discuss how a designer might use LCA tool to make informed decisions about the environmental implications of their choices of materials and/or manufacturing processes. [10 marks]
3. Automotive manufacturers have been forced to consider the adoption of eco-design strategies to reduce the overall environmental impacts of their products. Briefly describe four eco-design strategies that could be implemented in the automotive sector. [10 marks]
4. A particular fast-food company produces meals that customers may either consume on the company's premises or take away to consume elsewhere. The company is considering shifting from providing single use packaging with its meals to returnable, reusable packaging.
- a) Explain how each of the three general approaches for businesses to change consumer behaviour may be applied in this case. For each of the approaches briefly identify two particular socio-economic concerns and describe how each of these might be addressed by the business. [9 marks]
 - b) Assuming that the packaging will be cleaned on-site, draw a diagram to show the additional activities that the company will have to undertake to provide safe food containers for its customers. [3 marks]
 - c) Considering only the food packaging and not the food, what type of product service system would this approach be classed as and what are the implications and benefits for material end-of-life management? [3 marks]

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