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**UNIVERSITY EXAMINATIONS  
2022/2023 ACADEMIC YEAR**

**THIRD YEAR SECOND SEMESTER  
MAIN EXAMINATIONS**

**FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND BIO  
FUELS TECHNOLOGY**

**COURSE CODE: REN 423**

**COURSE TITLE: WIND FARM DEVELOPMENT**

**DURATION: 2 HOURS**

**DATE: 2/8/2023**

**2:00-4:00PM**

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**INSTRUCTIONS TO CANDIDATES**

- Answer **QUESTION ONE** (Compulsory) and any other **TWO (2)** Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

### Question One

- (a) Explain why an environmental impact assessment (EIA) is always necessary before a major project is carried out. [ 4 marks]
- (b) An EIA should include an assessment of effects and a review of mitigating measures. Briefly detail a likely approach to these two areas relating to
- (i) Visual and landscape assessment [ 4 marks]
  - (ii) Ecological assessment [ 4 marks]
- (c) (i) Suggest reasons why a programme of public consultations may be beneficial prior to submitting an application [ 4 marks]
- (ii) With reference to two case studies in Kenya, explain why local opposition to development of wind farms occur [ 4 marks]
- (d) A wind farm containing 2 identical turbines has the following characteristics: [ 5 marks]
- |   |                |
|---|----------------|
| Gross annual yield (after density, array & topographical corrections) | 47,655,250 kWh |
| Availability  | 98%            |
| Electrical losses   | 2%             |
| Control losses  | 4%             |
- No other losses are incurred
- The wind farm achieves a load factor of 0.38. What is the installed capacity of each turbine
- (e) Using a discounting method with a discount of 12% determine the Present Value stream of £200 per annum over a 5-year period [ 5 marks]

### Question Two

- (a) A wind farm developer wishes to measure the wind energy resource available at a site.
- (i) Explain what measurements would be required [ 6 marks]
  - (ii) What length of time would be suitable for measurement campaign? [ 2 marks]
- Explain the reasoning behind this
- (iii) Briefly describe how you would predict the long-term wind resource at the site for the expected wind farm life tie (e.g., 20 years) [ 6 marks]
- (b) Until recently, installation of offshore wind farms had been considered to be uneconomic because of anticipated high costs. What cost savings have been made in recent years to improve economic viability of offshore wind energy? [ 6 marks]

In what areas are there potential further cost savings?

### Question Three

- (a) The figure below shows 2 wind farm layouts (Layout 1 and Layout 2). Describe the wind rose that would lead to each of these layout designs. [ 4 marks]



Layout 1

Layout 2

- (b) How does the thrust curve of a wind turbine affect the energy yield of a wind farm? [ 3 marks]
- (c) A wind farm developer wishes to calculate the energy yield of a wind farm on a hilltop site. The long-term (i.e., 15 years) wind speed prediction at 50m is 9.00m/s. What extra information is needed to calculate the energy yield of the wind farm? [ 5 marks]
- (d) The wind farm generates 15Gwh of electricity each year. The purchase price for the electricity produced from the wind farm is £0.05/kWh (constant price for all years). Calculate the income from the wind farm in year 1. [ 2 marks]
- (e) The discount rate for this project is 10%. Calculate the present value of the energy. [ 3 marks]
- (f) As an investor, describe what extra information you would need and calculations you would carry out to assess the project value. [ 3 marks]

### Question Four

- (a) Define the following accounting terms
- (i) Net Present Value (NPV) [ 2 marks]
  - (ii) Internal Rate of Return [ 2 marks]
  - (iii) Discount Rate [ 2 marks]
- (b) Explain the importance of the terms above in relation to development of energy projects [ 6 marks]



- (c) A long-term frequency distribution at hub height has been combined with a power curve of a 1.5MW turbine to obtain an annual base yield of 3.9GWh. The proposed project has a layout of 5 turbines and the energy yield has been calculated to wake losses of 8% and topographical increases of 5%. What additional loss factors are required to calculate the annual net yield of the wind farm? [ 4 marks]
- (d) A wind farm has an annual net yield of 61.2GWh. The agreed price for the electricity produced from the wind farm is £0.05/kWh (constant for all years of the project life). If the discount rate is 8% what is the Present Value of the project income in its first and tenth years of operation? [ 4 marks]

#### Question Five

You are in charge of an Investment Fund that has £100 million that is to be invested in a wind power project. You are in talks with 2 wind developers: the first has a proposal for a 60W offshore project; and the second for a 90W onshore project. You can only invest in one project. Describe the issues on which you would seek clarification from developers in order to come to a decision about which project would provide the best investment.

Your list should cover:

- (a) Site assessment [ 5 marks]
- (b) Permitting [ 6 marks]
- (c) Construction [ 6 marks]
- (d) Operation & Maintenance [ 3 marks]