



KIBABII UNIVERSITY

2020/2021 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

SPECIAL/SUPPLEMENTARY EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY AND  
BIOFUELS TECHNOLOGY

COURSE CODE: REN 323

COURSE TITLE: Wind Energy 1

DATE:18/1/2022

TIME:2-4PM

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 4 printed pages. Please Turn over

### Question One

(a)	If you were taking wind speed measurements at a site for a year, how often would you need to take measurements? Give your reasoning.	[5 marks]
(b)	A wind farm development company is only able to measure the wind speed at a height of 20m above ground level. They measure a mean value of 6.6m/s. The site is in a field with long grass and it is decided to take a value for the surface roughness length of $z_0$ of 0.07 to use in the calculation. There are two types of wind turbine under consideration. The first has a hub height of 30m and the other of 45m. Estimate the mean wind speed at these two heights using the log law.	[6 marks]
(c)	The attached picture shows the variation of wind speed with height for different ground roughness. Describe the change in the shape of the graph as the ground roughness increases.	[6 marks]
(d)	The attached picture shows 4 different landscapes where a wind farm may be situated. Considering the wind resource only, discuss factors affecting siting of a wind turbine in each location.	[6 marks]
(e)	(i) What are the advantages of using a cup anemometer for wind speed measurements?	[3 marks]
	(ii) What are the alternative instruments that can be used?	[4 marks]



## Question Two

- (a) Outline the key requirements to be considered during the site selection process for a wind farm project [ 15 Marks]
- (b) State and describe the functions of the main components of a commercial horizontal axis wind turbine [5 Marks]

## Question Three

- (a) A particular form of the log law for wind shear in the lower atmospheric boundary layer can be written as:

$$U(z) = \frac{U^*}{k} [\ln(z/z_0)]$$

- (i) Describe carefully all the terms which appear in this equation and the conditions under which it applies
- (ii) Explain why this form of the log law is not normally applied directly
- (iii) State the form of the log law usually applied explaining any new variables you have introduced. State the height to which this relation can be considered accurate. [10 Marks]
- (b) (i) A site has an annual mean wind speed of 7.5m/s at a measurement height of 50m. If the annual wind speed at the same location, but at a height of 10m, is 6m/s, estimate the effective surface roughness for the site.
- (ii) Name the terrain that characterizes the site [10 Marks]

## Question Four

- (a) Sketch a typical power curve of Horizontal axis wind turbine indicating on the graph the cut-in, rated, and cut-out wind speeds [10 Marks]
- (b) Explain the reasons why the cut-in and cut-out wind speeds are imposed [10 Marks]

## Question Five

A wind farm developer wishes to make an estimate of the long-term (10 year) mean wind speed at a potential wind farm site, at a wind turbine hub height of 60m. There is a Met Station at a distance of approximately 50km from the site. The developer has erected a single mast at the potential wind farm site to make measurements of hourly averaged wind speed and wind direction at 10m above ground level. The measurement campaign lasts for six months. The developer is to perform an MCP analysis using concurrent data at the Met Station and the mast in conjunction with long term wind speed statistics at the Met Station.

- (a) Describe three variants of the MCP method s/he might use, and indicate the conditions under which each method is appropriate. **[7 Marks]**
- (b) (i) Discuss what further step the developer must make to produce an estimate of the long-term mean wind speed at the wind turbine hub height. **[7 Marks]**
- (ii) Name additional data the developer will require regarding the site to do this accurately
- (c) Describe two improvements to the data available to the developer that would improve the estimate of the long-term mean wind speed at the site. **[6 Marks]**