JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

UNIVERSITY EXAMIMATION FOR THE DEGREE IN SCIENCE IN RENEWABLE ENERGY TECHNOLOGY AND MANAGEMENT

3RD YEAR 2ND SEMESTER 2023/2024 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1312

COURSE TITLE: WIND ENERGY TECHNOLOGY II

EXAM VENUE: **STREAM: BSc. REN ENGY TEC & MGT**

DATE: /04/2024 **EXAM SESSION:**

DURATION: 2 HOURS

Instructions

1. **Answer question 1 (Compulsory) and ANY other two questions**
2. **Candidates are advised not to write on question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Question One (Compulsory) (30 Marks)

(a) Explain giving reasons why wind turbine control is necessary. **[5 Marks]**

(b) What are the two key areas that must be continuously be controlled in wind turbine operation regime for power optimization and limitation. **[2 Marks]**

(c) Different control methods are used to either optimize or limit the power out from the wind turbine. Wind turbines can be either be controlled by one the listed below methods. Discuss the purpose and operation of each the listed control methods.

(i) Blade angle adjustment (Pitch control) **[6 Marks]**

(ii) Rotation of the entire wind turbine (Yaw control) **[4 Marks]**

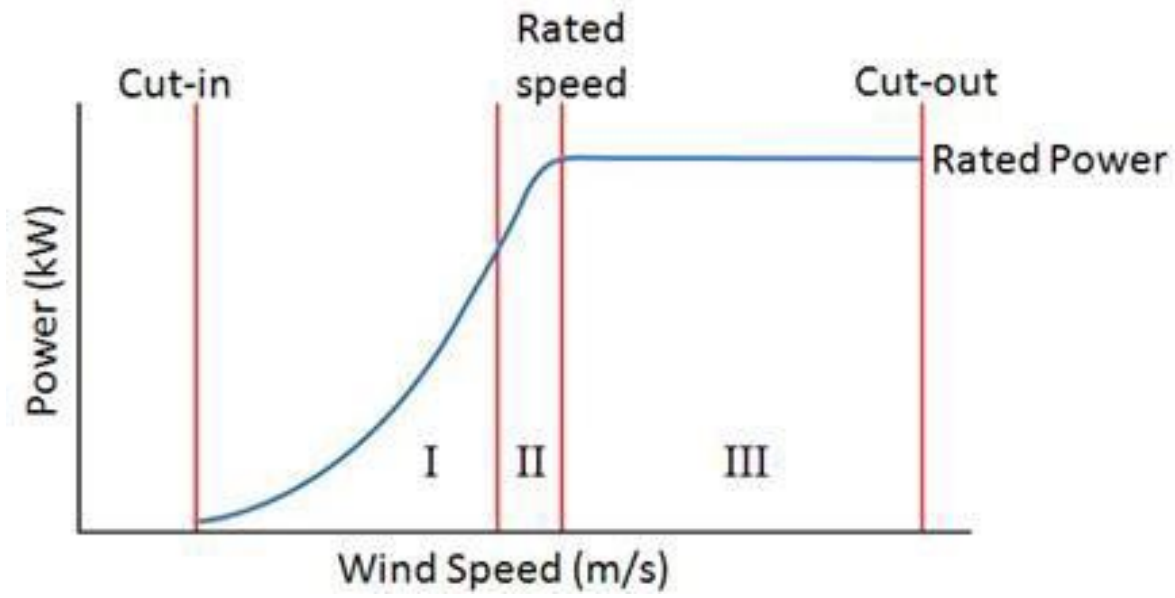
(iii) Generator speed control **[5 Marks]**

(d) Draw a well leaked diagram showing a system layout of a wind energy conversion system and the signal used. **[8 Marks]**

Question Two (20 Marks)

(a) The critical measure for a wind turbine is the electrical power output for a given wind speed. Explain giving reasons why and how it is important to understand the power curve i.e. relationship between the output power and wind speed. **[4 Marks]**

(b)



The power curve of a wind turbine indicates power output as a function of wind velocity at a hub height as shown in figure above. The curve shows the steady idealized characteristic.

Explain briefly the following limiting wind speeds, giving where applicable speed values.
(i) Cut-out wind speed (V_{in}) **[3 Marks]**

(ii) Rated wind speed (V_{full}) **[3 Marks]**

(iii) Cut-out wind speed (V_{out}) **[2 Marks]**

(c) Explain what occurs as the wind speed reaches these positions on the curve: **[4 Marks]**

(i) as the cut-in (V_{in}) wind speed reached

(ii) as the cut-out (V_{out}) wind speed is reached

(d) The power curve is split into three regions, explain briefly what is achieved in each region in terms of power output and turbine controls. **[4 Marks]**

Question Three (20 Marks)

(a) List two important curves characterising the performance of a wind turbine. **[2 Marks]**

(b) A wind turbine will be designed for a specific rated power output, delivered at rated wind speed. What is one of the major factors that influence wind machine design? **[1 Mark]**

(c) Controls falls in the two categories, list them and and explain briefly each of these two wind turbine control methods. Discuss how each control method is achieved. **[10 Marks]**

(d) Explain is yaw control and under which circumstances is it used? **[3 marks]**

(e) Distinguish between Fixed-speed wind turbine (FSWT) systems and variable-speed wind turbine (VSWT) systems giving the advantages and disadvantages for each **[4 Marks]**

Question Four (20 Marks)

(a) With aid of diagrams where applicable explain the planning phases/stages, outlining the requirements for each phases/stage of installing wind power projects. **[15 Marks]**

(b) Evaluate the selection of optimum wind energy generation (WEG). **[5 Marks]**

Question Five (20 Marks)

(a) What is grid integration? With help of a diagrams explain how electrical connection of a wind farm can be made to the distribution electrical power grid. **[5 Marks]**

(b) Discuss interconnection of wind farms to the distribution electrical power grid. **[15 Marks]**