MACHAKOS UNIVERSITY

University Examinations for 2021/2022 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (APPLIED PHYSICS AND TECHNOLOGY)

SPH339: WIND ENERGY TECHNOLOGY

DATE: TIME:

INSTRUCTIONS:
Answer **QUESTION ONE** and **ANY OTHER TWO** questions.

Question 1 carries **30** (marks) and the others carry **20** (marks) each

QUESTION ONE (COMPULSORY) (30 MARKS)

a) Identify any four properties of an actuator disk   (4 marks)

b) Describe the two types of aerofoils   (4 marks)

c) Describe the principle of equal transit-time   (3 marks)

d) Define the terms;

      i) Aerofoil   (2 marks)

      ii) Relative velocity   (2 marks)

e) Identify the advantages of wind energy over other conventional technologies. (3 marks)

f) Name any three types of wind turbines   (3 marks)

g) Using a sketch, identify the different parts of a wind turbine generator system. (5 marks)

h) Based on axis, classify the types of wind turbines   (2 marks)

i) Define the power coefficient of a wind turbine and explain the Betz limit   (2 marks)

QUESTION TWO (20 MARKS)

a) Using a sketch, describe the different parts of an aerofoil (10 marks)

b) Discuss the forces involved in the aerodynamics of a turbine (4 marks)

c) Describe the working principle of a wind turbine (6 marks)

QUESTION THREE (20 MARKS)

a) Discuss the following models;

    i) Normal wind profile model (NWP) (5 marks)

    ii) Extreme wind speed model (EWM) (5 marks)

    iii) WAsP model in rugged terrain (5 marks)

b) Discuss the environmental impacts of wind energy (5 marks)

QUESTION FOUR (20 MARKS)

a) Describe the wind harvesting, mounting and installation processes. (10 marks)

b) Considering the actuator disk model with exit plane velocity u_1, the wind speed outside the streamtube v_0 and the mass flow m^*, show that the rotor power is given by;

$$P = \frac{1}{2}m^*.(v_0{}^2 - u_1{}^2)$$ (10 marks)

QUESTION FIVE (20 MARKS)

a) Show that the power of a wind turbine is given by;

$$P = \frac{1}{2}\rho A v^3$$ (10 marks)

Where ρ is the density, A is the sweep area and v is the speed of wind.

b) Discuss the effects of Reynold's number on

    i) Lift coefficient (5 marks)

    ii) Drag coefficient (5 marks)