KISII UNIVERSITY

UNIVERSITY EXAMINATIONS

SPECIAL EXAMINATION

FOURTH YEAR EXAMINATION FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE RENEWABLE ENERGY

FIRST SEMESTER 2021/2022

(JULY, 2022)

PHRE 411: WIND ENERGY II

STREAM: Y4 S1 **TIME: 2 HOURS**

DAY: MONDAY, 11:30 AM – 1:30 PM **DATE:25/07/2022**

INSTRUCTIONS:

1. ***Do not write anything on this question paper.***
2. ***Answer Question ONE (Compulsory) and any other TWO questions.***

QUESTION ONE

a) What is the difference between data screening and data validation [2Marks]

b) State three reasons as to why the armature voltage $E_A$is not equals to the output voltage V_ϕ in synchronous machine. [3marks]

c) In an experiment to find how wind picks from one height to another, the following data was obtained.

Height (m)	Speed (m/s) Hour 1	Speed (m/s) Hour 2
10	4.8	7.2
30	5.4	8.2

Using the information and by applying an appropriate extrapolation method, determine;

i. The wind shear exponent [2marks]

ii. Surface roughness parameter. [2marks]

iii. Calculate the WPD using the combined two-hour average (n=1) and then with the two distinct hourly average values (n=2) for the two

hub heights. Comment on the results. (*Assume standard temperature and pressure (101,325 Pa and 288 °K) andthe specific gas constant for air (287 J/kg·K)*) [10marks]

iv. Wind speeds of the site at 50m above the ground [2marks]

d) If you wish to closely examine wind data from selected stations, several attributes about the data should be determined. Name any four of them; [4Marks]

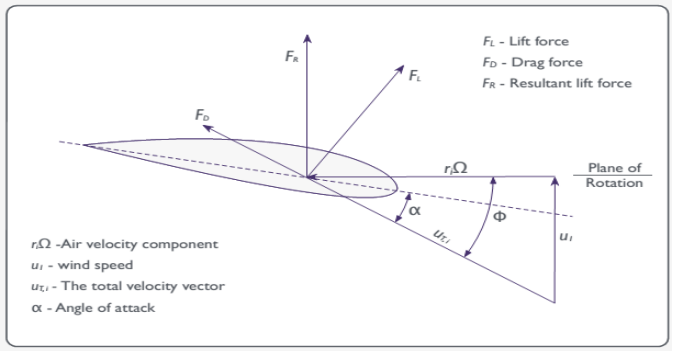
e) State three quantities that must be determined in order to describe the generator model. [3marks]

f) Briefly discuss the Open circuit Test under Measuring parameters of synchronous generator model. [2marks]

QUESTION TWO

a) d)By aid of a diagram figure 1, show that for Betz condition to be satisfied, the width at radius r is equal to; $W = \frac{8\pi R sin\Phi}{3\lambda n C_L}$ [8marks]

Fig 1



b) A three bladed wind turbine operates in a mean wind speed of 6m.s^{-1}. The turbine rotates at 15 rpm, each blade is 40m long and has an angle of attack, $\alpha$of 5.4^o. Determine;

i. The speed of the trip. [2marks]

ii. The tip speed ratio, comment on this result. [3marks]

iii. The width and the angle the blade make with the plane of rotation for r=10, r=R/2 and r=R. Assume$C_L \approx 1$. [6marks]

c) What is the significance of introducing a twist into wind turbine blade design? [1mark]

QUESTION THREE

a) Wind turbines are classified into two general types. State and explain these types. [2marks]

b) State and explain any three parts of a wind turbine. [3marks]

c) A 200KV, 480V, 50HZ, Y-connected synchronous generator with a rated field current of 5A was tested and the following data was obtained;

i. $V_{T,OC} = 540V$ at the rated I_F

ii. $V_{L,SC} = 300A \; at \; the \; rated \; I_F$

When a DC voltage of 10V was applied to two of the terminals, a current of 25A was measured. Find the generator's model at the rated conditions. (i.e, the armature resistance and the approximate synchronous reactance) [8marks]

d) "The wind power system design must optimize the annual energy capture at a given site". Stating two advantages for each, briefly discuss the fixed and variable-speed system designs. [6amrks]

e) State one factor that affect wind. [1mark]

QUESTION FOUR

a) The Suzlon S.66/1250, 1.25MW rated power at 12m/s rated wind speed turbine design has a rotor diameter of 66 meters & a rotational speed of 13.9-20.8rpm. Determine its angular speed, rotor's tip speed range and tip speed ratio range [6marks]

b) With the aid of a diagrams, discuss the following techniques as used in wind power systems energy capture maximization; [9marks]

I. The Hill climbing MPPT technique
II. Peak-Power-Tracking technique.
III. Constant TSR technique

c) State four present and future energy storage technologies that may be considered for stand-alone wind energy systems. [4marks]

d) What do you understand by the word 'rated speed?' [1marks]

QUESTION FIVE

Discuss the following wind energy conversion systems; [20marks]

i. Single speed WECS
ii. Wound-Rotor Inductor Generator (WRIG) with external Rotor Resistances.
iii. Doubly Fed Induction Generator WECS with reduced capacity power converter
iv. Configuration with full-capacity Back-to-Back power converters