KISII UNIVERSITY
UNIVERSITY EXAMINATIONS

FIRST YEAR EXAMINATION FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE IN RENEWABLE ENERGY
SECOND SEMESTER 2021/2022
(FEBRUARY-JUNE, 2022)

PHRE 125: ENERGY CONVERSION SYSTEMS

STREAM: Y1 S2 **TIME: 2 HOURS**

DAY: MONDAY, 9.00 AM – 11.00 AM **DATE: 30/05/2022**

INSTRUCTIONS

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

QUESTION ONE (30 MARKS)

a) Outline four important properties that magnetic lines of force possess (4 marks)

b) Explain the following terms as applied in electromagnetism
i. Magnetic flux density (2 marks)
ii. Permeability (2 marks)
iii. Reluctance (2 marks)

c) Explain any two similarities between magnetic and electric circuits. (4 marks)

d) An iron ring of 400 cm mean circumference is made from round iron of cross-section 20 cm2. Its permeability is 500. If it is wound with 400 turns, what current would be required to produce a flux of 0·001 Wb? (4 marks)

e) State the first and second Faraday's laws of electromagnetic induction.

(4 marks)

f) Distinguish between statically induced and dynamically induced emf.

(4 marks)

g) Define the term eddy current loss and explain two ways in which the magnitude of eddy current loss can be reduced.

(4 marks)

QUESTION TWO (20 MARKS)

a) Armature windings can be divided into lap or wave winding depending on how the wires are joined to the commutator. Explain.

(4 marks)

b) A 4-pole generator has a lap-wound armature with 50 slots with 16 conductors per slot. The useful flux per pole is 30mWb. Determine the speed at which the machine must be driven to generate an e.m.f. of 240V.

(4 marks)

c) i) A separately excited generator develops a no load e.m.f. of 150V at an armature speed of 20 rev/s and a flux per pole of 0.10Wb. Determine the generated e.m.f. when;

(a) the speed increases to 25rev/s and the pole flux remains unchanged,

(b) the speed remains at 20 rev/s and the pole flux is decreased to 0.08Wb, and

(c) the speed increases to 24 rev/s and the pole flux is decreased to 0.07Wb.

(6 marks)

ii) Using an appropriate diagram, explain the typical separately-excited generator open-circuit characteristic.

(4 marks)

iii. Determine the terminal voltage of a generator which develops an e.m.f. of 200V and has an armature current of 30A on load. Assume the armature resistance is 0.30 ohms

(2 marks)

QUESTION THREE (20 MARKS)

a) The armature of a d.c. machine has a resistance of 0.25Ω and is connected to a 300V supply. Calculate the e.m.f. generated when it is running

(i) as a generator giving 100A, and

(ii) as a motor taking 80A.

(6 marks)

b) i) Explain how to control the speed of a shunt wound motor

(2 marks)

ii) A 5kVA single-phase transformer has a turns ratio of 10:1 and is fed from a 2.5kV supply. Neglecting losses, determine;

(a) the full-load secondary current,

(b) the minimum load resistance which can be connected across the secondary winding to give full load kVA,

(c) the primary current at full load kVA.

(6 marks)

c) A 100kVA, 4000V/200V, 50Hz single-phase transformer has 100 secondary turns. Determine;

(i) the primary and secondary current,

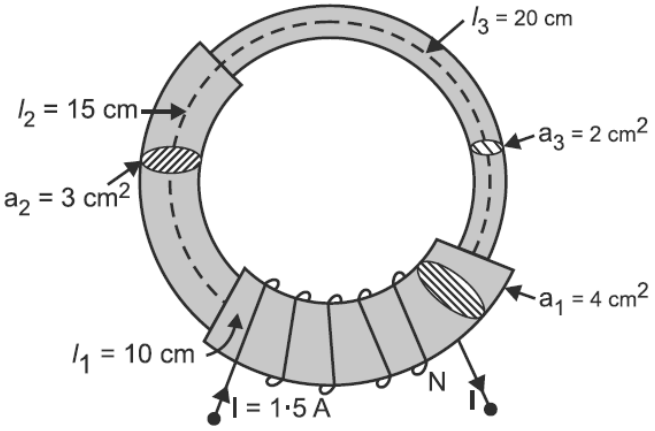
(ii) the number of primary turns, and

(iii) the maximum value of the flux.

(6 marks)

QUESTION FOUR (20 MARKS)

a) The ring shaped core shown in Fig. 1.16 is made of a material having a relative permeability of 1000. The flux density in the smallest area of cross-section is 2 T. If the current through the coil is not to exceed 1·5 A, compute the number of turns of the coil.



(6 marks)

b) Using an appropriate graph, explain the B-H curve for sheet steel, cast steel and cast iron.

(4 marks)

c) i. Explain the concept magnetic hysteresis

(2 marks)

ii. Using an appropriate diagram, explain the hysteresis loop.

(6 marks)

iii. Explain why hard steel is never used for the construction of machine parts

(2 marks)

QUESTION FIVE (20 MARKS)

a) i. Distinguish between self inductance and mutual inductance.

(4 marks)

ii. Two coils of self inductance 120 mH and 250 mH and mutual inductance of 100 mH are connected in parallel. Determine the equivalent inductance of combination if;

(i) mutual flux helps the individual fluxes and

(ii) mutual flux opposes the individual fluxes.

(6 marks)

b) A shunt generator supplies a 20kW load at 200V through cables of resistance, R =100 mΩ. If the field winding resistance, Rf = 50Ω and the armature resistance, Ra = 40mΩ, determine

(a) the terminal voltage, and

(b) the e.m.f. generated in the armature.

(6 marks)

c) A 240V shunt motor takes a total current of 30A. If the field winding resistance Rf = 150Ω and the armature resistance Ra = 0.4Ω determine;

(a) the current in the armature, and

(b) the back e.m.f.

(4 marks)