(University of Choice)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

UNIVERSITY EXAMINATIONS 2023/2024 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATIONS ENGINEERING

COURSE CODE: ECE 225

COURSE TITLE: ELECTRICAL MACHINES I

DATE: TUESDAY, APRIL 23RD 2024 **TIME:** 8:00 AM - 10:00 AM

INSTRUCTIONS TO CANDIDATES

ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS.
QUESTION ONE CARRIES 30 MARKS AND ALL OTHERS 20 MARKS EACH.
Constants; $\mu_o = 4\pi \times 10{-}7$ Wb/A-t-m,

This Paper Consists of 4 Printed Pages. Please Turn Over.

QUESTION ONE (Compulsory)

(a) Compare the electric and magnetic circuits by their similarities and dissimilarities. [2 Mks]

(b) Explain the following armature winding Terminologies;

i. Pole pitch

ii. Coil span. [2 Mks]

(c) A circular iron ring, having a cross–sectional area of 10 cm^2 and a length of 4 cm in iron, has an air gap of 0.4 mm made by a saw-cut. The relative permeability, μ_r is 1000 and the permeability of free space, μ_o is 4×10^{-7} H/m. The ring is wound with a coil of 2000 turns and carries a 2 mA current. Determine the air gap flux neglecting leakage and fringing. [4 Mks]

(d) Explain Armature reaction phenomena and state two effects on the distribution of the main magnetic field. [3 Mks]

(e) A coil for a solenoid is 20 cm long and made up of 200 turns of wire. This wire has a dc resistance of 2.25Ω. The solenoid is connected to a 100 V dc source. Find the MMF the coil produces and the magnetic field intensity. [3 Mks]

(f) With neat diagram, explain main parts of DC machine. Mention the functions of each part. [4 Mks]

(g) Enumerate four reasons for paralleling operation of D.C. generators. [2 Mks]

(h) A separately excited generator with Armature resistance of 0.04 Ω, running at 1000 r.p.m. supplies a current of 200 A at 120 V to a circuit of constant resistance. Find the current when the speed drops to 800 r.p.m if the field current remains constant, total voltage drop at the brushes is 2 V and armature reaction effect is negligible. [3 Mks]

(i) 240 V shunt motor has the following parameters: R_a = 0.6 Ω, R_f = 100 Ω and rotational (core, mechanical and stray) losses are 20 watts. On full load, the line current is 20 A and the motor runs at 1000 rpm, find:

i. The developed power. [2 Mks]

ii. The output power. [2 Mks]

iii. The output torque. [3 Mks]

QUESTION TWO

(a) State two comparisons of lap and wave-type windings. [1 Mks]

(b) Derive an expression for the e.m.f generated in a DC generator. [4 Marks]

(c) A shunt machine, connected to a 240V main has an armature resistance of 0.15 Ω and field resistance is 100 Ω. Find the ratio of its speed as a generator to its speed as a motor, line current in each case being 75 A. [4 Marks]

(d) Find the ampere-turns required to produce a flux of 0.4 milliweber in the airgap of a circular magnetic circuit which has an airgap of 0.5 mm. The iron ring has 4 cm^2 cross section and 63 cm mean length. The relative permeability of iron is 1800 and the leakage coefficient is 1.15. [4 Marks]

(e) A magnetic core made of cast steel must carry a flux density of 1.0 T. It has a total length of 1.56 M and a cross-sectional area of 0.37 m^2. Find the permeability, the relative permeability and reluctance of the core. Given; B=1.0 T and H = 800 A-t/m. [2 Marks]

QUESTION THREE

(a) Using a well-labeled schematic diagram, explain the working principle of a Separately Excited D.C. Generator. [4 Mks]

(b) The core loss (*Hysteresis loss +eddy current loss*) for a given specimen of magnetic material is found to be 2000w at 50 Hz Keeping the flux density constant, the frequency of the supply is raised to 75 hz resulting in a core loss of 3200W. Compute separately hysteresis and eddy current losses at both frequencies. [6 Mks]

(c) A lap wound DC shunt generator having 80 slots with 10 conductors per slot generates at no load emf of 400 V, when running at 1000 r. p.m., at what speed should be rotated to generate a voltage of 220 volt on open circuit. [5 Mks]

QUESTION FOUR

(a) Derive the Torque Equation of DC Motor. [6 Mks]

(b) A 230 V dc shunt motor draws 5A from the line on no load and runs at 1000 r.p.m. the armature resistance and shunt field resistance are 0.2 Ω and 250 Ω respectively. What will be the speed of the motor when it is loaded and take current of 50A. (Armature reaction weakness the field by 3%). [4 Mks]