PP1

TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING ELECTRICAL DEPARTMENT

MEDICAL DEPARTMENT

UNIVERSITY EXAMINATION FOR:

Bachelor of Science in Medical Engineering

EEE 4233 ELECTRICAL MACHINES

END OF SEMESTER EXAMINATION

SERIES: APRIL 2025

TIME: 2 HOURS

DATE: April 2025

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.

Do not write on the question paper.

Question ONE (Compulsory 30 marks)

(a)(i) Describe the functions of the following parts of an electrical machines (i) the field system (ii) the commutator **(4mks)**

(ii)State TWO functions of the armature core of a DC generator **(2mks)**

(iii)In a 240V compound generator the resistance of the armature, shunt and series winding are 0.08Ω, 35Ω and 0.05Ω respectively. The load current is 80A at 240V. Calculate the armature current and the induced emf when the machine is connected as (i) Longshunt (ii) Determine the change in ampere turns in (i) when a diverter of 0.3Ω is connected in parallel with series winding. Take total brush drop as 2V. **(6mks)**

(b)(i) State TWO reasons why DC motors are commonly used in the industries **(2mks)**

(ii) Describe giving TWO reasons why back emf is important in the operation of a DC motor **(4mks)**

(iii) A 240V, 4pole shunt motor running at 1000rpm gives 15hp with an armature current of 50A and a field current of 1A. The armature winding is wave connected and has 540 conductors. The armature

resistance is 0.1Ω aqnd drop per brush is 1V. Calculate (i) The useful torque (ii) Total Torque (iii) Iron and frictional losses (iv) Useful flux **(4mks)**

(c)(i) Derive the power equation of a DC motor **(3mks)**

(ii) A 220V Shunt motor runs at 500rpm when armature current is 50A. Calculate the speed if the torque is doubled. The armature resistance of the motor is 0.2Ω **(4mks)**

Question TWO

(a)(i) With aid of sketches describe the following speed control methods for series DC motors (i) Armature resistance (ii) Armature diverter **(4mks)**

(ii) State TWO methods which can be used to control the speed of a shunt motor **(2mks)**

(iii) A 240 DC series motor runs at 1200rpm when taking a line current of 8A. The armature resistance and the series field resistance are 0.8Ω and 0.4Ω. Calculate the speed at which it will run when connected in series with 5Ω resistor taking the same current and voltage **(4mks)**

(b)(i)With aid of a sketch describe the ward Leonard speed control method for shunt motors **(3mks)**

(ii) With aid of a sketch describe the flux speed control method for DC shunt motors **(3mks)**

(iii) A 240V DC shunt motor runs at 800rpm and takes an armature current of 2A. Calculate the resistance required in series with the shunt winding so that the motor may run at 950rpm when taking a current of 28A. Assume flux is proportional to field current. The shunt field resistance is 160Ω and the armature resistance is 0.4Ω **(4mks)**

Question THREE

(a)(i) With aid of a sketch describe the N/Ia characteristics of a series motor and state why it should always be started on load**. (4mks)**

(ii) With reference to motor characteristics state TWO applications of the following motors (i) Shunt motor (ii) Series motor **(4mks)**

(iii) A belt driven 100KW shunt generator running at 300rpm on 220V busbar continues to run as a motor when the belt breaks the taking 10KW. What will be its speed? Given armature resistance=0.025Ω, field resistance=60Ω, contact drop=1V **(4mks)**

(b) (i) State TWO possible cause of the following faults in a motor (i) Overheating (ii) Sparking brushes **(4mks)**

(ii) A shunt motor has a counter emf of 200V, its field resistance is 150Ω and the field current is 1.2A. If the line current is 3I.2A. (i) Calculate its armature resistance (ii) Calculate the armature current when the motor is stationary **(4mks)**

Question FOUR

(a)(i) Describe how single phase AC motors are made self-starting **(2mks)**

(ii) With aid of sketches describe the principal of operation of the following single phase AC motors (i) Capacitor start-capacitor run motor (ii) AC series motor or universal motor **(6mks)**

(iii) A universal motor has a resistance of 30Ω and an inductance of 0.5Ω. When connected to a 250V supply and loaded to take 0.8A, it runs at 2000r.p.m. Calculate the speed and power factor, when connected to 250V, 50Hz supply and loaded to take the same current. **(4mks)**

(b)(i) With aid of a sketch describe the operation of a repulsion induction motor **(3mks)**

(ii) With aid of a sketch describe the construction of a reluctance motor **(3mks)**

Question FIVE

(a)(i) Describe the $\frac{N}{Ta}$ Characteristics of the following DC motors and state ONE application (i) Series motor (ii) shunt motor **(4mks)**

(ii) Describe the possible causes of armature problems in a DC machine **(2mks)**

(iii) A 6pole generator has an induced emf of 300V when driven at a speed of 600rpm. The armature is lap wound and has 800 conductors its resistance being 0.1Ω. The bore of the poleshoe is 60cm. The pole subtends an angle of 45degrees and is 30cm long. Calculate the flux density in the air gap **(4mks)**

(b)(i) State the difference between shaft torque and armature torque of a DC **(2mks)**

(ii) Derive the armature torque equation of a DC motor and show that it can be given by $Ta = 9.55 \times \frac{EbIa}{N}$ N-M **(4mks)**

(iii) An armature of a 4pole machine 95cm in diameter has 900 conductors each having an effective length of 55cm and an armature current of 250A. If 90% of total conductors lie simultaneously in the field of average flux density of$0.65\,wb/m^2$, Calculate (i) The armature torque (ii) Horse power output at 500rpm **(4mks)**