TECHNICAL UNIVERSITY OF MOMBASA

SCHOOL OF ENGINEERING AND TECHNOLOGY

MECHANICAL DEPARTMENT

UNIVERSITY EXAMINATION FOR:

Bachelors of Science in Electrical Engineering

TEE 4342 ELECTRICAL MACHINES (PP2)

END OF SEMESTER EXAMINATION

SERIES: NOVEMER 2024

TIME: 2HOURS

DATE: NOVEMBER 2024

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 20 marks)

(a)(i) State the difference between AC and DC machines **(2mks)**

(ii) Describe the construction and application of the following parts of a DC machine (i) The armature core (ii) The commutator **(4mks)**

(iii) A separately excited generator is run at 1800rpm supplies a load of constant resistance with 240V and a current of 250A. Determine the load current when the speed is dropped to 900rpm if the field remain constant. The armature resistant is 0.08Ω, $R_L = 0.895\,\Omega$and the total brush drop is 1.5V **(4mks)**

(b) (i) Explain the effect when the speed of rotating magnetic field becomes equal to the motor speed of a three phase induction motor **(3mks)**

(ii) Derive the torque equation for a three phase induction motor under running conditions **(3mks)**

(iii)A 6pole, 3phase,50Hz induction motor has star connected rotor. The rotor has a resistance of 0.2Ω per phase and a standstill reactance of 5Ω per phase. The induced emf between the slip rings is 150V. If the full load speed is 800rpm, Calculate (i)Slip (ii)The induced emf in the rotor in each phase (iii) Rotor reactance per phase (v) Rotor power factor (**4mks)**

Question TWO

(b)(i) Describe the shaft torque of a DC motor **(3mks)**

(ii) Derive the armature torque equation of a DC motor and show that it can also be given by $T_a = 9.55\frac{EbIa}{N}$ **(3mks)**

(iii) A 150hp 415V shunt motor has 6 poles and a 2 wave winding with 600conductors. The flux is 30mwb per pole and full load efficiency of 84%. The armature and commutating field have a total resistance of 0.5Ω. The shunt field resistance is 300Ω. Calculate for full load (i) The speed (ii) The useful torque **(4mks)**

(b)(i) State why the wound rotor type 3phase induction motor has a higher starting torque than the squirrel cage rotor type**. (2mks)**

(ii) With aid of a sketch describe the torque-slip characteristics of a three phase induction motor **(4mks)**

(iii) A 1200hp, 3phase 415V, 50Hz induction motor runs at a speed of 750rpm on full load. The machine has 4poles (i) Calculate the full load slip (ii) Determine the number of cycles the rotor voltage will make per minute**.(4mks)**

Question THREE

(a)(i) Describe TWO causes of problems in the (i) commutator (ii) Brushes of an electrical machine **(4mks)**

(ii) With aid of a sketch describe the N/Ia Characteristics of a shunt motor **(2mks)**

(iii) A shunt motor has a counter emf of 220V, a field resistance of 200Ω and a field current of 2A. If the line current is 55A, (i) determine the armature resistance (ii) determine the armature current when the motor is stationary (**4mks)**

(b)(i) Describe what happens when a load is applied on 3phae induction motor **(3mks)**

(ii) Show that at maximum torque $S = \frac{R_2}{X_2}$**(3mks)**

(iii) A 4pole, 50Hz, 3phase induction motor has rotor resistance and reactance per phase of $0.05\Omega \wedge o.2\Omega$ respectively. (i) Determine the speed at which the torque is maximum (ii)Calculate the value of external resistance per phase to produce a quarter of the maximum torque at starting

(4mks)

Question FOUR

(a)(i) State TWO applications of three phase transformers **(2mks)**

(ii) With aid of a sketch describe the construction of a three phase transformer from a common magnetic **circuit (4mks)**

(iii) A 3phase step down transformer is connected to 11000V on the primary side. The ratio of turns per phase is 9 and the line current drawn from the mains is 60A. Calculate the secondary line voltage and the secondary currents if the transformer is connected in star-star configuration **(4mks)**

(b)(i) State why construction of transformer from a common magnetic core is preferred to a bank of three single phase transformers **(2mks)**

(ii) With aid of a sketch illustrate the current and voltage relationship for star-delta configuration **(4mks)**

(iii) A 3phase step down transformer is connected to 33000V on the primary side. The ratio of turns per phase is 16 and the line current drawn from the mains is 50A. Determine secondary line voltage and secondary line current when the transformer is connected in star delta configuration.**(4mks)**

Question FIVE

(a)(i) State TWO applications of single phase motors **(2mks)**

(ii) Describe why single phase induction motor is not self-starting **(3mks)**

(iii) At starting the windings of a 230V, 50Hz, split-phase induction motor have the following parameters: main winding$R=4\,\Omega, X_L=7.5\,\Omega$, $Starting\ Winding: R=7.5\,\Omega; X_L=4\,\Omega$Determine (i)Current I_m in the main winding (ii) Current I_S in starting winding (iii) phase angle between $I_S$and I_M(v) Power factor of the motor **(4mks)**

(b) (i) Describe how single phase induction motor can be made self-starting **(2mks)**

(ii) With aid of sketches describe the construction of the following types of single phase motors (i) AC universal motor (ii) Capacitor start capacitor run motor **(5mks)**

(iii) A 4 pole, 250W,115V,60Hz capacitor start induction motor takes a full load line current of 5.3 A, while running at 1760rpm. If the full load efficiency of the motor is 64%, Calculate (i) Motor slip(ii) Power factor (iii) full load torque**(4mks)**