ELIZADE UNIVERSITY, ILARA-MOKIN, ONDO STATE

FACULTY OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FIRST SEMESTER EXAMINATION 2020/2021 ACADEMIC SESSION

COURSE TITLE: ELECTRICAL MACHINES I

COURSE CODE: EEE 315/MEE 351

EXAMINATION DATE: 29th MARCH, 2021

COURSE LECTURER: ENGR. OSHIN OLA A

HOD'S SIGNATURE

TIME ALLOWED: 3 HOURS

INSTRUCTIONS:

1. ANSWER QUESTION 1 ANY OTHER FOUR QUESTIONS
2. SEVERE PENALTIES APPLY FOR MISCONDUCT, CHEATING, POSSESSION OF UNAUTHORIZED MATERIALS DURING EXAM.
3. YOU ARE **NOT** ALLOWED TO BORROW ANY WRITING MATERIAL DURING THE EXAMINATION.

QUESTION 1

1a. Explain the principle of operation of an induction generator? (4 marks

b. Explain using suitable diagrams, the no-load saturation characteristics and load characteristics of DC generators. (5 marks)

c. The stator and armature windings of a 4 poles, 48 slots, three phase induction motor is shown in Fig. Q2. It is required that the machine be designed such that it can be either star or delta connected. Show the detail design of the three phase, AC lap winding for the 4 pole machine.

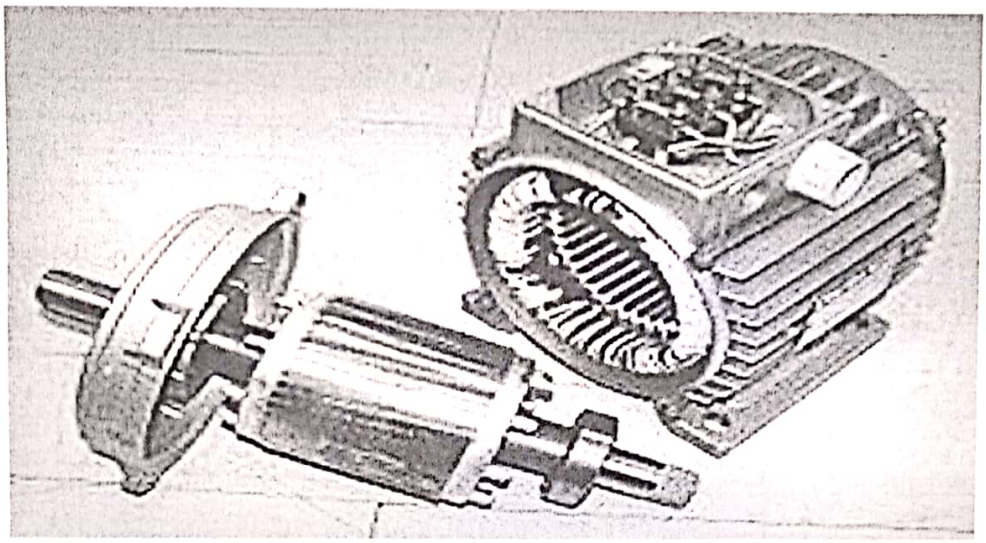

Fig Q2: 4 poles, 36 slots, three phase induction motor (8 marks)

d. A 15 kW shunt generator shown in Fig Q1 has armature circuit resistance of 0.4 Ω and a field resistance of 100 Ω, generates a terminal voltage of 240 V at full load. Determine the efficiency of the generator at full load, assuming the iron, friction and windage losses amount to 1 kW.

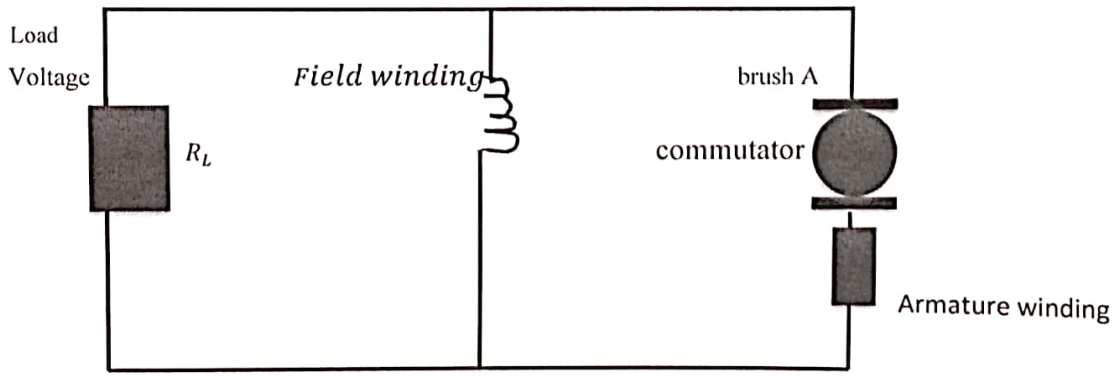

Fig. Q1: Shunt wound D.C generator (7 marks)

QUESTION 2

a. i. What is meant by armature reaction in a d.c machine? (2 marks)

ii. State two effects of armature Reaction in a D.C Machine (2 marks)

iii. State two remedies to the effects of armature Reaction in a D.C Machine(2marks)

iv. Describe the importance of using Chamfered pole in the design of an electrical machine (3 marks each)

b. Prove that the Torque, T, of a DC machine is given as $T = \frac{P\emptyset ZI_a}{2\pi C}$ (4 marks)

c. A series motor having a series field resistance of 0.25 Ω and an armature resistance of 0.15 Ω is connected to a 220 V supply and at a particular load runs at 20 rev/s when drawing 20 A from the supply. Calculate the e.m.f. generated at this load. Determine also the speed of the motor when the load is changed such that the current increases to 25 A. Assume the flux increases by 25%. (6 marks)

QUESTION3

a. State three advantages of slip ring induction motor or wound rotor induction motor **(3 marks)**

b. State two advantages of Squirrel cage induction motor (2 **marks)**

c. A 415V, three-phase, 50Hz, 4-pole, star-connected induction motor runs at 23 rev/s on full load. The rotor resistance and reactance per phase are 0.3 Ω and 3.4 Ω respectively, and the effective rotor-stator turns ratio is 0.78:1

Calculate

a. the synchronous speed
b. the slip
c. the full load torque
d. the power output if mechanical losses amount to 700W
e. the maximum torque
f. the speed at which maximum torque occurs, and
g. the starting torque (14 marks)

Question 4

a. State three methods of speed control in DC motors (3 marks)

b. State three categories of faults associated with electrical machines? Using a Star-connected stator winding diagram, state and identify the different types of stator winding faults (5 marks)

c. A 250 V, series-wound motor is running at 500 rev/min and its shaft torque is 130 Nm. If its efficiency at this load is 88%, find the current taken from the supply. (5 marks)

d. In a test on a d.c. motor, the following data was obtained. Supply voltage: 500 V, Current taken from the supply: 42.4 A , Speed: 850 rev/min, Shaft torque: 187 Nm. Determine the efficiency of the motor (6 marks)

Question 5

a. State the D.C motor suitable for (i) electric locomotive (ii) reciprocating pump (iii) elevators

(3 marks)

b. Prove that the torque of an induction motor is given by the expression

$$T = \frac{1}{2\pi n_s} \frac{s^2 \cdot \frac{N_2^2}{N_1^2} XE_1^2}{R_2^2 + (SX_2)^2} \frac{R_2}{s}$$ (8 marks)

c A 340 V series motor takes 90 A and runs at 1200 rev/min at full-load. The armature resistance is 0.102Ω and the series winding resistance is 60 mΩ. Assume that the flux is proportional to the field current, calculate the speed when developing full load torque but with a 0.24Ω diverter in parallel with the field winding. (8 marks)

QUESTION 6

a. State one application of each of the following motors: Servomotors, Stepper Motor, Precision Motors and Linear Induction Motor, (4 marks)

b. Mention four reasons why a running generator will not produce output power. In each case, briefly describe how you will carry out the necessary repair? (6 marks)

c. The power supplied to a three-phase induction motor is 52 kW and the stator losses are 1800W. If the slip is 6%, Determine

i. The rotor copper loss

ii. The total mechanical power developed by the rotor

iii. The output power of the motor if friction and windage losses amount to 800

iv. The efficiency of the motor, neglecting rotor iron loss (9 marks)

QUESTION 7

7a. . Using suitable diagram describe the constructional feature of a DC machine (6 marks)

b. Explain using suitable diagram, the advantage of using field pole lamination with some rectangular holes punched in them in a D.C machine. (6 marks)

c. A series motor runs at 1080 rev/minute when the voltage is 415V and the current is 42 A. The armature resistance is 0.28Ω and the series field resistance is 0.22Ω. Calculate the resistance of the field regulator to be connected in series with the armature winding to reduce the speed to 720 rev/min with the same current. (7 marks)