SUNAME	FIRST NAME	STUDENT NO.

ELECTRICAL MACHINES 4 – MAIN EXAM

DURATION OF EXAM: 2 HOURS

TOTAL MARKS ON PAPER: 75

NUMBER OF MARKS TO OBTAIN 100%: 75

DATE AND TIME: FRIDAY 14 OCTOBER 2016 9AM-11AM

INSTRUCTIONS

- ONLY NON-POGAMMABLE CALCULATORS MAY BE USED
- THIS IS CLOSED BOOK EXAM SO NO ADDITIONAL INFORMATION MAY BE TAKEN INTO THE EXAM ROOM
- ATTEMPT ALL QUESTIONS – 75 MARKS WILL SCORE 100 % WHICH IS THE MAXIMUM SCORE
- MARKS WILL BE LOST FOR ILLEGIBLE WRITING AND LACK OF CORRECT EXPLANATION
- ANSWER IN THE SPACE PROVIDED. IF YOU NEED ADDITIONAL SPACE USE THE BACK OF THE EXAM SHEETS OR REQUEST ADDITIONAL PAPER

QUESTION	EXAMINER	MODERATOR
1		
2		
3		
TOTAL MARKS		

Internal Examiner: Professor D G Dorrell

Internal Moderator: Dr R Pillay Carpanen

External Examiner: Prof Willie Cronje

Question 1

a) From the 4 coil model in Fig. Q1 derive the matrix equation that defines the D-Q components of a 3-phase induction motor. In this derivation you should state any assumptions that you have made, including any transforms. [16]

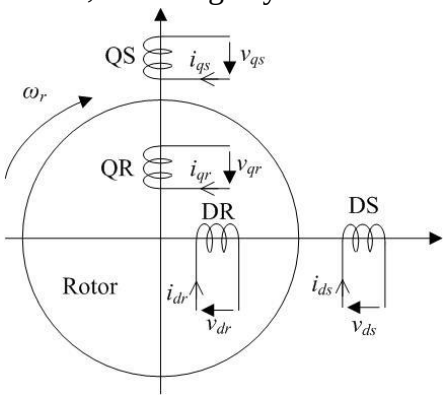

Fig. Q1

b) Discuss methods that can be used to start a squirrel cage induction motor in terms of design of the rotor. [9]

Question 2

a) Show how a 3-phase sinusoidally-distributed winding with p pole-pairs can produce a flux wave rotating at the synchronous speed when excited from a balanced 3-phase supply. [7]

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b) Discuss how torque is produced in an induction motor. Explain why no torque is generated at the synchronous speed and derive what the power is that crosses the airgap and what is rotor loss and what is electro-mechanical energy conversion. [5]

c) A 4-pole 50-Hz star-connected squirrel-cage induction motor has the equivalent circuit shown in Fig. Q.2.

(i) Estimate the rotor and stator resistances and total leakage reactance X_L if the locked-rotor test produces a total input power of 486 W with phase current of 9 A and phase voltage of 40.2 V. The line-to-line resistance when disconnected is 2 Ω. [6]

(ii) If the rated slip is 0.04 calculate the rated output torque and power, the rated speed, the rated current and the locked-rotor current. [7]

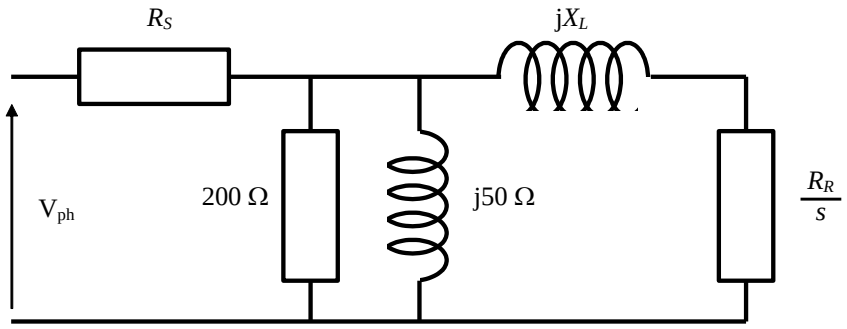

Fig. Q2

Question 3

a) The equivalent circuits for the transformer and induction motor are similar. Why is this so? Compare the equivalent circuits of the two devices and comment on the differences and relate them to actual operation and design. [12]

b) A wye-connected 3-phase 50 Hz 2-pole induction motor operates at 220 V (line-line) and draws a current of 5A at p.f. of 0.65 lagging. The efficiency is 78 % and the speed is 2750 rpm. The windage and friction is 20 W. Calculate

(i) The input power and output power. [4]

(ii) The slip. [2]

(iii) The torque. [3]

(iv) The rotor losses assuming no friction and windage. [2]

(v) Estimate the stator resistance if the iron losses are 20 W [2]

END OF PAPER