UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES III**
CODE	:	**ELM3221**
DATE	:	SUMMER SSA EXAMINATION 2014 5 DECEMBER 2014
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40: 60
TOTAL MARKS	:	**100**
FULL MARKS	:	**100**

ASSESSOR	:	MR. M.C MUTEBA
MODERATOR	:	Dr. C. RICHARDS
NUMBER OF PAGES	:	4 PAGES

REQUIREMENTS

- STANDARD STATIONARY.
- NO-PROGRAMMABLE CALCULATOR MAY BE USED

INSTRUCTIONS

- READ INSTRUCTIONS CAREFULLY.
- ALL CALCULATIONS AND ANSWERS MUST BE DONE WITH A MINIMUM OF 3 DECIMALS.
- WRITING MUST BE IN BLUE OR BLACK INK PEN ONLY- NO PENCIL WRITING WILL BE MARKED
- WORK NEATLY, UNTIDY WORK MAY BE PENALIZED.
- ALL UNITS MUST BE SHOWN-MARKS WILL BE DEDUCTED FOR NO OR WRONG UNITS
- ALL CALCULATIONS MUST BE DONE IN COMPLEX NOTATION AND ANSWERS MUST BE WRITTEN IN POLAR FORM, WHERE APPLICABLE.

SECTION A:

THREE-PHASE TRANSFORMERS

QUESTION 1 **[25 Marks]**

1.1 A short-circuit test is carried out on a 50-kVA, 7200/208-V, delta-star, three-phase, 50 Hz transformer. With instruments placed at HV side, the following results were obtained:

P_{sc}= 600 W, I_{sc}= 4.01 A, V_{sc}= 370 V

For an iron loss of 500 W calculate;

1.1.1 The approximate equivalent circuit parameters referred to LV side. **(8)**
1.1.2 The percentage resistance and reactance drops. **(6)**
1.1.3 The p.u. full-load voltage regulation at a power factor of 0.8 lagging. **(3)**
1.1.4 The % full-load efficiency at a power factor of 0.8 lagging. **(2)**

1.2 A 800-kVA transformer with impedance of (1+j5) % is connected in parallel with a 500-kVA transformer of impedance of (1.5+j4) %. Calculate how the load of 1000-kVA at a lagging power factor of 0.9 will be shared. **(6)**

QUESTION 2 **[12 Marks]**

A Scott-connected transformer with similar secondary windings supplies two electric furnaces. The primary voltage is 11 kV and the secondary voltage is 80 V. When the load on the teaser is 500 kW at unity power factor, and that of the main is 800 kW at unity power factor. Calculate the current in the primary lines.

[37 Marks]

SECTION B

APPLICATION, PERFORMANCE OF THREE-PHASE INDUCTION MACHINES AND BASICS OF INDUCTION MOTOR CONTROL

QUESTION 1

[18 Marks]

1.1. The following headings are related to Three-phase induction machines operations. Discuss;

1.1.1 Plugging **(2)**

1.1.2 Dynamic braking **(3)**

1.1.3 Regenerative braking **(3)**

1.2. A 440 V, delta-connected, double-cage, 50-Hz, three-phase induction motor has the following equivalent circuit parameters, all of which are phase values referred to the stator:

$Z_1 =$ (1+j3) Ω, $Z_{outer} =$ (3+j1) Ω and $Z_{inner} =$ (0.6+j5) Ω

1.2.1 The starting torque in Synchronous-Watt **(5)**

1.2.2 The torque for a slip of 4 % (Synchronous-Watt) **(5)**

QUESTION 2

[11 marks]

An overhead crane in a factory is driven horizontally by means of two linear induction motors whose rotor are the two steel I-beams upon which the crane rolls. The three-phase, 4-pole linear stators have a pole pitch of 8 cm and are driven by a variable frequency electronic source. During the test on one of the motors the following results were obtained.

Stator frequency: 15 Hz
Power to stator: 5-kW
Copper and iron loss in stator: 1-kW
Crane speed: 1.8 m/s

2.1 Calculate the synchronous speed and slip. **(3)**

2.2 Calculate the power input to the rotor. **(2)**

2.3 Calculate the copper loss in the rotor. **(2)**

2.4 Calculate the mechanical power. **(2)**

2.5 Calculate the thrust. **(2)**

[29 Marks]

SECTION C:

SPECIAL MACHINES AND INTRODUCTION TO SYNCHRONOUS MACHINES

QUESTION 1

[12 Mark]

A 120-V, 60-Hz, 186.5-W universal motor runs at 2000 RPM and takes a current of 0.6 A when connected to a DC source. Determine the speed, torque and power factor when it is connected to the above AC supply. The resistance and inductance measured at the motor terminals are 20 Ω and 0.25 H respectively.

QUESTION 2

[22 Marks]

2.1. A 16-pole, 144-slots, three-phase, star-connected, synchronous generator has 10 conductors per slot in two layers. The rotor is driven at a speed of 375 rpm. The flux per pole has a fundamental component of 25 mWb. Coils are short-pitched by 1 slot. Compute the RMS value of the induced (line) e.m.f. **(14)**

2.2. A three-phase, 600 MVA alternator has a rated terminal voltage of 22 kV (line). The stator winding is star-connected and has a resistance of 0.014Ω/phase. The same excitation current that produced the rated current on short-circuit has produced the open-circuit voltage of 4351V (line). Calculate the % voltage regulation for a load having a power factor of 0.8 lagging. **(8)**

[34 Marks]

END