UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES III**
CODE	:	**ELM3221**
DATE	:	SUMMER SSA EXAMINATION 2017 13 JANUARY 2017
DURATION	:	(SESSION 1) 08:00 - 11:00
WEIGHT	:	40: 60
~~**TOTAL MARKS**~~	:	~~**100**~~
FULL MARKS	:	**100**

ASSESSOR	:	Dr. W. DOORSAMY
MODERATOR	:	Prof. O.D. DINTCHEV
NUMBER OF PAGES	:	4 PAGES

REQUIREMENTS

- STANDARD STATIONARY.
- NON-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.
- ALL SECTIONS ARE COMPULSORY.

SECTION A:

THREE-PHASE TRANSFORMERS

QUESTION 1 **[25 Marks]**

1.1 A delta-star connected, three-phase, 500 kVA, 33/11 kV, 50 Hz transformer has core losses = 3050 W, primary winding resistance/phase $R_1 = 35\ \Omega$, and secondary winding resistance $R_2 = 1.5\ \Omega$. Calculate the efficiency of the transformer at:

1.1.1 Full-load at unity p.f. **(10)**
1.1.2 Full-load at 0.8 lagging p.f. **(3)**
1.1.3 Half-load at unity p.f. **(3)**
1.1.4 Half-load at 0.8 lagging p.f. **(3)**

1.2 A 100 kVA transformer is connected in parallel with a 200 kVA transformer across the same load. Their secondary induced voltages are 500 V and 450 V respectively. The percentage impedances of the transformers are 5% and 8% respectively. Calculate the circulating current. Use 100 kVA as the base. **(6)**

QUESTION 2 **[12 Marks]**

Two single phase electric furnaces A and B are supplied at 220 V from a 3-phase 1100 V supply by means of Scott-connected transformer combination. If the total output is 600 kW at 0.6 power factor lagging. Calculate the currents in the windings and transformer ratio of the main and teaser transformers.

[37 Marks]

SECTION B

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

QUESTION 3 **[19 Marks]**

3.1. The following terms refer to starting methods for squirrel-cage induction motors. Explain briefly:

3.1.1 Direct-on-line starting **(2)**

3.1.2 Auto-transformer starting **(2)**

3.1.3 Star-delta starting **(2)**

3.2. The power supplied to a three-phase induction motor is 50 kW and the stator losses are 2 kW. If the slip is 4%, calculate the:

3.2.1 Rotor copper losses **(4)**

3.2.2 Mechanical power developed by the rotor **(3)**

3.2.3 Output power if the friction and windage losses are 1 kW **(3)**

3.2.4 Percentage efficiency of the motor, neglecting the rotor iron losses **(3)**

QUESTION 4 **[10 marks]**

A linear induction motor propelled train moves at a speed of 120 km/h when the supply frequency is 50 Hz. Calculate the,

4.1 Synchronous speed, in m/s **(2)**

4.2 Length of the pole-pitch, in cm **(4)**

4.3 Speed of the train at a slip of 25%, in km/h **(4)**

[29 Marks]

SECTION C:

SPECIAL MACHINES AND INTRODUCTION TO SYNCHRONOUS MACHINES

QUESTION 5 **[6 marks]**

5.1 What is a universal motor? **(2)**

5.2 List two roles of damper windings in synchronous machines. **(4)**

QUESTION 6 **[12 Marks]**

A 250 W, single-phase, 50 Hz, 220-V universal motor runs at 2000 rpm and takes 1.0 A when supplied from 220 V dc. If the motor is connected to 220 V ac supply and takes 1.0 A (rms), calculate the speed, torque and power factor. Assume R_a=20 Ω and L_a= 0.4 H.

QUESTION 7 **[16 Marks]**

A three-phase, 50 Hz, 4-pole, Y-connected alternator has 6 slots per pole per phase. The armature has double layer windings. The windings are arranged as 5 conductors per layer. The coil pitch is 5/6 of the full pitch and the value of the flux is 0.05 Wb. Calculate the voltage per phase.

[34 Marks]

END