UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES III**
CODE	:	**ELM3221**
DATE	:	MAIN EXAMINATION / NOVEMBER 2016 25/NOV/2016 ; 08:30
DURATION	:	3 HOURS
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:

TRANSFORMERS

QUESTION 1 **[18 Marks]**

A 200 kVA transformer is in circuit continuously. During the day, the transformer is loaded as follows:

No. of Hours	*Load (kW)*	*Power factor*
8	160	0.8 lagging
6	80	Unity

The transformer operates under no-load for the remaining hours of the day. Full load copper losses are 3.02 kW and the iron losses are 1.6 kW. Calculate the all-day efficiency of the transformer.

QUESTION 2 **[12 Marks]**

Three single-phase transformers, connected in Δ-Δ, supply a balanced 3-phase load of 1200 kW at 4400 V at 0.8 power factor lagging. The transformers are supplied from 3-phase mains at 11000 V.

2.1 Find the currents in the windings of each transformer. **(6)**

2.2 If one transformer is found faulty and the other two are connected in V-V, determine the currents in the windings of each transformer and transformer p.f. **(6)**

[30 Marks]

SECTION B

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

QUESTION 3 **[28 Marks]**

3.1. The following refer to the operation of three-phase induction machines. Briefly discuss:

3.1.1 Plugging **(2)**

3.1.2 Dynamic braking **(3)**

3.1.3 Regenerative braking **(3)**

3.2 A 400 V, three-phase, 50 Hz, 2-pole, star-connected induction motor runs at 48.5 rev/s on full load. The rotor resistance and reactance per phase are 0.4 Ω and 4.0 Ω respectively, and the effective rotor-stator turns ration is 0.8:1. Calculate the

3.2.1 Synchronous speed **(2)**

3.2.2 Percentage slip **(2)**

3.2.3 Full-load torque **(4)**

3.2.4 Power output, if mechanical losses amount to 500 W **(4)**

3.2.5 Maximum torque **(3)**

3.2.6 Speed at which maximum torque occurs **(2)**

3.2.7 Starting torque **(3)**

QUESTION 4 **[6 marks]**

A single-sided linear induction motor has 98 poles with a pole pitch of 50 cm. The motor is used for propelling an electric vehicle. If the supply frequency is 50 Hz and the slip is 0.25, calculate:

4.1 The linear synchronous speed in km/h **(4)**

4.2 The speed of the vehicle in km/h **(2)**

[34 Marks]

SECTION C:

SPECIAL MACHINES AND INTRODUCTION TO SYNCHRONOUS MACHINES

QUESTION 5 **[22 Mark]**

5.1 The main winding and starting winding impedances of a 220 V, 50 Hz capacitor-start motor are $Z_m = (4 + j3.5)\ \Omega$ and $Z_A = (5 + j3)\ \Omega$ respectively. Calculate the value of the starting capacitance for getting maximum torque. **(8)**

5.2 A universal series motor has resistance of 30 Ω and an inductance of 0.5 H. When connected to a 250 V-dc supply and loaded to take 0.8 A it runs at 2000 rpm. Calculate its speed and power factor, when connected to a 250 V, 50 Hz AC supply and loaded to take the same current. **(14)**

QUESTION 6 **[14 Marks]**

The number of slots of a three-phase, 12-pole, Y-connected synchronous generator is 180. The number of conductor per slot is 12 and the conductors are connected in series. The coil is in full pitch winding and the flux per pole is 0.05 Wb. If the machine runs at a speed of 600rpm, calculate the line voltage.

[36 Marks]

END