UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES III**
CODE	:	**ELM3221**
DATE	:	MAIN EXAMINATION / NOVEMBER 2014 12/NOV/2014 ; 08 :30
DURATION	:	3 HOURS
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 **[18 Marks]**

1.1 A 2-MVA, 33/6.6-kV, delta-star, three-phase, 50 Hz transformer gave the following test results:

Short-Circuit (HV)	400 V	175 A	17 kW
Open-Circuit (LV)	6600 V	150 A	15 kW

1.1.1 Calculate the percentage resistance and reactance drops. **(6)**
1.1.2 Calculate the percentage full-load voltage regulation at a power factor of 0.8 lagging. **(2)**
1.1.3 Calculate the percentage full-load efficiency at a power factor of 0.8 lagging. **(2)**
1.1.4 Calculate the load at which the maximum efficiency occurs. **(2)**

1.2 Two 33/11-kV, delta-star, 3-phase transformers of 400-kVA and 600-kVA are connected in parallel to supply a load of 800 kW at a lagging power factor of 0.8. The percentage impedance of the transformers is (2+j4) and (1+j5) respectively. Calculate how the load will be shared between the two transformers. Take the base of 600-kVA. **(6)**

QUESTION 2 **[12 Marks]**

A Scott-connected transformer with similar secondary windings supplies two electric furnaces. The primary voltage is 11 kV. The load on the teaser is 600 kW at unity power factor, and on the main is 900 kW at a lagging power factor of 0.8. Calculate the current in the primary lines.

[30 Marks]

SECTION B

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

QUESTION 1 **[28 Marks]**

1.1 The following headings are some of the external causes of abnormal conditions of three-phase machines. Discuss the most important consequence that will result from these causes.

1.1.1 Mechanical overload **(2)**

1.1.2 Line voltage changes **(2)**

1.1.3 Single-phasing. **(2)**

1.1.4 Frequency variation. **(2)**

1.2 A 10-kW, 400-V, 4-pole, 50-Hz, delta-connected, three-phase induction motor. At full-load, the line current taken from the supply was 18 A and the power input was 11.2 kW. The stator resistance is 1.2 Ω/phase. Stator core loss is 228 W, and friction and wind losses (rotational losses) are 420 W. If the full-load slip is 5%, calculate;

1.2.1 The total rotor copper loss at full-load **(4)**

1.2.2 The full-load speed. **(2)**

1.2.3 The electromagnetic torque. **(3)**

1.2.4 The shaft torque. **(3)**

1.2.5 The full-load efficiency. **(2)**

1.3 Draw a typical diagram that illustrate soft-starting squirrel cage induction motor **(6)**

QUESTION 2 **[6 marks]**

We wish to use a 40 hp, 1440 r/min, 415 V, 3-phase squirrel-cage induction motor as an asynchronous generator for wind turbine application. The rated current of the motor is 41 A and the full-load power factor is 0.87 lagging. Calculate;

2.1 The capacitance required per phase if the capacitors are connected in delta. **(4)**

2.2 At which speed should be the driving wind turbine run to generate a frequency of 50 Hz? **(2)**

[34 Marks]

SECTION C:

SPECIAL MACHINES AND INTRODUCTION TO SYNCHRONOUS MACHINES

QUESTION 1 **[22 Mark]**

1.1 A 50-Hz, single-phase, capacitor-start, induction motor has winding impedances of Z_m= (4.3 + j3.5) Ω and Z_A = (9.6 + j3.2) Ω. Calculate the capacitance of the capacitor to be connected in series with the auxiliary winding to give 90° phase-shift between the currents of the two windings. **(8)**

1.2 A 220 V, 50 Hz, 250-W universal motor runs at 1600 RPM and takes a current of 0.8 A when connected to a DC source. Determine the speed, torque, power factor and efficiency 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. **(14)**

QUESTION 2 **[14 Marks]**

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.

[36 Marks]

END