UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES II**
CODE	:	**ELM2221**
DATE	:	SUPPLEMENTARY EXAMINATION /JULY 2019
DURATION	:	3 HOURS
WEIGHT	:	40: 60
TOTAL MARKS	:	**100**
FULL MARKS	:	**100**

ASSESSOR	:	Dr. M MUTEBA
MODERATOR	:	Dr. P BOKORO
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.
- THE END OF A SECTION SHOULD BE MARKED WITH A SOLID LINE

SECTION A
DC MACHINES

QUESTION 1 **[10 Marks]**

1.1. A 4-pole dc generator has a lap-wound armature with 50 slots. There are 16 conductors per slot. The useful flux per pole is 30 mWb. Determine the speed at which the machine must be driven to generate an e.m.f. of 240-V. **(3)**

1.2.A 500-V, 250-kW, long-shunt compound dc generator has the series, shunt and armature resistances of 0.04 Ω, 100 Ω and 0.01 Ω respectively. Neglect the contact brush voltage drop, calculate the generated e.m.f. **(7)**

QUESTION 2 **[14 Marks]**

2.1.A 500-V shunt dc motor takes a total current of 100 A and runs at 1200 rpm. If the shunt field resistance is 50 Ω, the armature resistance is 0.25 Ω and the iron, friction and windage losses amount to 2-kW, determine the overall efficiency of the motor. **(6)**

2.1 A series dc motor runs at 1000 rpm when taking 35 A from a 240-V supply. The total resistance of the armature and field circuits is 0.8 Ω. Calculate the value of the additional resistance required in series with the machine to drop the speed to 600 rpm if the gross torque is: Assume unsaturated.

2.1.1 Constant, **(3)**
2.1.2 Proportional to the speed and **(3)**
2.1.3 Proportional to the cube of the speed **(2)**

QUESTION 3 **[10 Marks]**

A 500-V shunt motor runs at its normal speed of 600 rpm when the armature current is 120 A. The armature resistance is 0.2 Ω. Determine:

3.1. The speed when the current is 60A and a resistance of 0.5 Ω is connected in series with the armature, the shunt field remaining constant. **(5)**

3.2. The speed when the current is 60A and the shunt field is reduced to 80% of its normal value by increasing resistance in the field circuit. **(5)**

[34 MARKS]

SECTION B
SINGLE-PHASE TRANSFORMERS

QUESTION 4 **[13 Marks]**

4.1. The no-load current of a single-phase transformer is 5 A at 0.25 power factor lagging when supplied from 235-V, 50-Hz source. The number of turns on the primary winding is 200. Calculate:

4.1.1. The maximum flux in the core **(3)**
4.1.2. The core loss current **(2)**
4.1.3. The magnetizing current **(2)**

4.2.A single-phase transformer with a ratio of 230/115 V is supplying a load current of 5 A, at 0.8 power factor lagging. The no-load current is 0.2 A at a power factor of 0.20 lagging. Calculate the primary current and power factor. **(6)**

QUESTION 5 **[18 Marks]**

The following readings were obtained from OC and SC tests on 8 kVA, 400/100 V transformer.

Open-Circuit (LV side): 60 W, 4 A, 100 V
Short-Circuit (HV side): 100 W, 20 A, 10 V

Compute:

5.1. The components of the no-load current (**4)**
5.2. The equivalents circuits parameters as referred to LV and HV sides **(6)**
5.3. Voltage regulation at full-load at 0.8 power factor lagging. **(2)**
5.4. The load at which the maximum efficiency occurs **(2)**
5.5. The efficiency at full-load for a 0.8 power factor lagging **(2)**
5.6. The efficiency at half-load for a 0.8 power factor lagging. **(2)**

[31MARKS]

SECTION C
THREE-PHASE INDUCTION MOTORS

QUESTION 6 **[8 Marks]**

A three-phase induction motor, at standstill, has a rotor voltage of 100-V between slip rings when open circuited. The rotor winding is star-connected and has a leakage reactance of 1 Ω/phase at standstill and a rotor resistance of 0.2 Ω/phase. Calculate;

6.1. The rotor current for a slip of 4 %, slip rings shorted. **(3)**
6.2. The slip and rotor current for a maximum torque. **(5)**

QUESTION 7 **[12 Marks]**

A 14.92-kW, 400-V, 950 rpm, three-phase, star-connected, 50-Hz, 6-pole, induction motor takes a full-load current of 30 A with a power factor of 0.81 lagging. Compute;

7.1. The rotor copper loss if the total stator losses are estimated to 875-W **(4)**
7.2. The mechanical power developed by the rotor **(2)**
7.3. The windage and friction losses, assume that the rotor iron losses are neglected **(2)**
7.4. The full-load efficiency **(2)**
7.5. The shaft torque **(2)**

QUESTION 8 **[15 Marks]**

The following terms are related to some of the methods used for the starting of three-phase induction motors. Discuss:

8.1. Star-delta **(5)**
8.2. Auto-transformers **(5)**
8.3. Rotor resistances **(5)**

Hint: Support your answer with the aid of a power diagram

[35 MARKS]

END