UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES II**
CODE	:	**ELM2221**
DATE	:	MAIN EXAMINATION / JUNE 2016 28 MAY 2016 ; 12 :30-15 :30
DURATION	:	3 HOURS
WEIGHT	:	40: 60
TOTAL MARKS	:	**100**
FULL MARKS	:	**100**

ASSESSOR	:	MR. M.C MUTEBA
MODERATOR	:	Mr. 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.

SECTION A:
DC MACHINES

QUESTION 1 [17 Marks]

1.1 A 4-pole DC machine has an armature with 72 slots and 10 conductors per slot and runs at 1500 r.p.m, the flux per pole is 0.05 Wb. Determine the induced e.m.f if armature winding is:

1.1.1 lap connected **(2)**

1.1.2 wave connected **(2)**

1.2 Name at least three methods of improving commutation in DC machines. **(3)**

1.3 Discuss the effects of armature reaction in DC machines **(2)**

1.4 A 500 V, 250 kW, long shunt compound generator induces an e.m.f of 480 V when running at 1000 r.p.m on no-load. On full-load the speed of the machine drops to 975 r.p.m, the flux increases by 15 % and the terminal voltage rises to 500 V. If the series and shunt field resistances are 0.02 Ω and 100 Ω respectively, calculate the armature resistance. Assume a voltage drop of 1 V per brush. **(8)**

QUESTION 2 [14 Marks]

2.1 A DC series motor runs at 500 r.p.m drawing 40 A from 600 V supply. Determine the value of the external resistance to be added in series with the armature for the motor to run at 450 r.p.m. The load torque varies as the square of the speed. Assume linear magnetization and take armature resistance as 0.3 Ω and series field resistance 0.2 Ω. Neglect brush contact voltage drop. **(7)**

2.2 A 250 V, 25 kW DC shunt motor has an efficiency of 85 % when running at 1000 r.p.m on full load. The armature resistance is 0.1 Ω and field resistance is 125 Ω. Find the starting resistance required to limit the starting current to 150 % of rated current. **(7)**

[31 Marks]

SECTION B
SINGLE-PHASE TRANSFORMERS

QUESTION 1 [20 Marks]

1.1 A single-phase ideal transformer with a ratio of 440/110 V takes a no-load current of 5 A at 0.2 power factor lagging. If the secondary supplies a current of 120 A at a power factor 0.8 lagging. Calculate the current taken by the primary. **(6)**

1.2 A 50 kVA, single phase transformer has a turn ratio $N_2/N_1=0.2$ and $R_1= 0.25$ Ω, $X_1=1.05$ Ω, $R_2=0.01$ Ω, $X_2=0.03$ Ω. The applied voltage is 1100 V. Calculate;

1.2.1 The equivalent resistance, reactance and impedance as referred to primary. **(6)**

1.2.2 The % resistance and reactance drops. **(4)**
1.2.3 The output voltage at 0.8 power factor lagging at full load. **(2)**
1.2.4 The % full-load voltage regulation at 0.8 power factor lagging. **(2)**

QUESTION 2 **[13 Marks]**

A 10-kVA, 500/250 V, and 50 Hz single phase transformer gave the following test results:

Short-circuit test (HV): 60 V; 20 A; 150 W

2.1 Determine the approximate equivalent parameters referred to LV side. **(6)**
2.2 Determine the % full-load voltage regulation for a lagging power factor of 0.8. **(2)**
2.3 For a core loss of 130 W, determine the efficiency at half-load for a 0.8 power factor lagging **(2)**
2.4 If the maximum efficiency occurs at 125 % of the full-load, determine the maximum efficiency at unity power factor. **(3)**

[33 Marks]

SECTION C
THREE-PHASE INDUCTION MOTORS

QUESTION 1 **[9 Marks]**

A 1.5 kW, 400 V, 4-pole, 50 Hz, three-phase slip ring induction motor operates at 1440 r.p.m on full-load, has at standstill a rotor voltage of 80 V between slip rings when open circuited. The impedance of the rotor referred to the stator is (0.01 +j0.03) Ω. The ratio of rotor to stator winding is 0.5.

1.1 Calculate the rotor current and rotor power factor at standstill. **(3)**
1.2 Calculate rotor current and rotor power factor when running at full-load. **(4)**
1.3 Calculate the input power if the efficiency at full-load is 0.9 **(2)**

QUSTION 2 **[8 Marks]**

2.1 Determine the suitable auto-transformer ratio for the starting of a three-phase induction motor with line current not exceeding 2 times the full-load current. The short-circuit current is 6 times the full-load current and the full-load slip is 4.5 %. **(3)**

2.2 Referring to the above question, determine the torque in terms of the full-load torque. **(5)**

QUESTION 3 **[9 Marks]**

Draw and discuss the power flow diagram of an induction motor.

[26 Marks]

SECTION D
FAULTS AND FAILURES IN ELECTRICAL MACHINES

QUESTION 1 **[10 Marks]**

Name at least ten causes of sparking between commutator and brushes in DC machines.

[10 Marks]

END