PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL MACHINES II**
CODE	:	**ELM2221**
DATE	:	MAIN EXAMINATION / JUNE 2019 01 JUNE 2019 ; 12 :30
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 **[11 Marks]**

1.1. An 8-pole, wave-connected armature of a dc machine has 600 conductors and is driven at 625 rpm. If the flux per pole is 20 mWb, determine the generated e.m.f. **(3)**

1.2. A 500-V, 250-kW, long-shunt compound dc generator induces an e.m.f of 480-V when running at 1000 rpm on no-load. On full-load the speed of the machine drops to 975 rpm, 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 **[19 Marks]**

2.1 A series dc motor runs at 500 rpm 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 rpm. 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 350-V shunt dc motor runs at its normal speed of 1200 rpm when the armature current is 90 A. The resistance of the armature is 0.3 Ω

2.2.1. Find the speed when the armature current is 45A and a resistance of 0.4 Ω is connected in series with the armature, the shunt field remaining constant. **(6)**
2.2.2. Find the speed when the armature current is 45A and the shunt field is reduced to 75% of its normal value by increasing resistance in the field circuit. **(6)**

QUSTION 3 **[4 Marks]**

A series dc motor drives a load at 1800 rpm and takes a current of 10 A when the supply voltage is 400-V. If the total resistance of the motor is 2 Ω and the iron, friction and windage losses amount to 300-W, determine the efficiency of the motor.

[34 MARKS]

SECTION B
SINGLE-PHASE TRANSFORMERS

QUESTION 4 **[20 Marks]**

4.1. A single-phase ideal transformer with a ratio of 440-V/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)**

4.2. 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;

4.2.1. The equivalent resistance, reactance and impedance as referred to primary**.** **(6)**
4.2.2. The % resistance and reactance drops. **(4)**
4.2.3. The output voltage at 0.8 power factor lagging at full load. **(2)**
4.2.4. The % full-load voltage regulation at 0.8 power factor lagging. **(2)**

QUESTION 5 **[13 Marks]**

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

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

5.1. Determine the approximate series equivalent parameters referred to LV side. **(6)**
5.2. Determine the % full-load voltage regulation for a lagging power factor of 0.8. **(2)**
5.3. For a core loss of 130-W, determine the efficiency at half-load for a 0.8 power factor lagging **(2)**
5.4. 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 6 **[10 Marks]**

A 1.5-kW, 400-V, 4-pole, 50 Hz, three-phase, star-connected, slip ring induction motor operates at 1440 rpm 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. Calculate:

6.1. The rotor current and rotor power factor at standstill. **(4)**
6.2. The rotor current and rotor power factor when running at full-load. **(4)**
6.3. The input power if the efficiency at full-load is 0.9 **(2)**

QUESTION 7 **[15 Marks]**

A 4-pole, 50-Hz, 400-V, 58 A, star-connected, three-phase squirrel cage induction motor has a on full-load a power factor 0.8 lagging and a full-load slip of 5%. If the stator winding phase resistance and the stator iron loss are to be 0.125 Ω and 800-W respectively, determine;

7.1. The rotor copper loss **(5)**
7.2. The total mechanical power developed by the rotor, **(3)**
7.3. The output power and torque of the motor if friction and windage losses are 750-W **(5)**
7.4. The efficiency of the motor, neglecting rotor iron loss**.** **(2)**

QUESTION 8 **[8 Marks]**

Draw a typical torque speed characteristic of a 4-pole, 50-Hz, 1450 rpm, three-phase, squirrel cage induction motor and clearly indicate the locked rotor torque, breakdown torque and nominal torque points of operations.

[33 MARKS]

END