UNIVERSITY OF JOHANNESBURG

PROGRAM	:	National Diploma *ENGINEERING: MECHANICAL*
SUBJECT	:	**ELECTROTECHNOLOGY 3**
CODE	:	**ELT 312**
DATE	:	MAIN EXAMINATION / November 2019 November 2019
DURATION	:	3 HOURS
WEIGHT	:	40: 60
TOTAL MARKS	:	**100**
FULL MARKS	:	**100**

ASSESSOR	:	Ms EF Swana
MODERATOR	:	Prof AA Yusuff
NUMBER OF PAGES	:	4

REQUIREMENTS

- STANDARD STATIONARY.
- NO-PROGRAMMABLE CALCULATOR MAY BE USED

INSTRUCTIONS

- READ INSTRUCTIONS CAREFULLY.
- ALL CALCULATIONS AND ANSWERS MUST BE DONE WITH A MINIMUM OF 2 AND 1 DECIMAL IN NUMBERS AND ANGLE, RESPECTIVELY.
- 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.

Question 1 Electromagnetism [14 Marks]

1.1 State Faraday's laws of electromagnetic induction and Lenz's law. **(4)**

1.2 A flux of 30 mWb links with a 1200 turn coil when a current of 5 A is passing through the coil. Calculate:

1.2.1 The inductance of the coil. **(2)**

1.2.2 The energy stored in the magnetic field. **(2)**

1.2.3 The average e.m.f. induced if the current is reduced to zero in 0.20 s. **(2)**

1.3 A coil of 2500 turns has a flux of 10 mWb linking with it when carrying a current of 2 A. Calculate the coil inductance and the e.m.f. induced in the coil when the current collapses to zero in 20 ms. **(4)**

Question 2 DC Machines [22 Marks]

2.1 The armature of a dc machine has a resistance of 0.5 Ω and is connected to a 200 V supply. Calculate the e.m.f. generated when it is running:

2.1.1 As a motor drawing 50 A. **(2)**

2.1.2 As a generator supplying 70 A. **(2)**

2.2 A 6-pole generator has a lap-wound armature with 40 slots with 20 conductors per slot. The flux per pole is 25 mWb. Calculate the speed at which the machine must be driven to generate an e.m.f. of 300 V. **(4)**

2.3 A dc generator has a generated e.m.f. of 210 V when running at 700 rpm and the flux per pole is 120 mWb. Determine the generated e.m.f.:

a) At 1050 rpm, assuming the flux remains constant. **(2)**

b) If the flux is reduced by one-sixth at constant speed. **(2)**

c) At a speed of 1155 rpm and a flux of 132 mWb. **(2)**

2.4 A dc motor draws an armature current of 110 A at 480 V. The armature resistance of 0.2 Ω. The machine has 6-poles and the armature is lap connected with 864 conductors. The flux per pole is 0.05 Wb. Calculate:

2.4.1 The motor speed. **(4)**

2.4.2 Torque developed by the armature. **(4)**

Question 3 Transformers [16 Marks]

3.1 A 10 kVA, single-phase transformer has a turns ratio of 12:1 and is supplied from a 2.4 kV supply. Neglecting losses, determine:

3.1.1 The full load secondary current. **(4)**

3.1.2 The minimum value of load resistance which can be connected across the secondary winding without exceeding the kVA rating. **(2)**

3.1.3 The primary current of the transformer. **(2)**

3.2 A single-phase 800 V/100 V, 50 Hz transformer has a maximum core flux density of 1.294 T and an effective core cross-sectional area of 60 cm^2. Determine the number of primary and secondary turns. **(6)**

3.3 A 6 kVA, 100 V/500 V, single-phase transformer has a secondary terminal voltage of 475 V when loaded. Determine the regulation of the transformer. **(2)**

Question 4 Three Phase Systems [28 Marks]

4.1 A balanced three-phase load consists of three coils, each of resistance 4 Ω and inductance 0.02 H connected in series. When the coils are connected to a 400 V, three phase, 50 Hz supply. Determine the total active power for:

4.1.1 Star-connected load. **(8)**

4.1.2 Delta-connected load **(6)**

4.2 The input power to a three-phase motor was measured by the two wattmeter method. The readings were 7.2 kW and 2.7 kW, the reverse switch being operated on the meter indicating the 2.7 kW reading and the line voltage was 425 V. Calculate:

4.2.1 The total active power. **(2)**

4.2.2 The power factor. **(4)**

4.2.3 The line current. **(2)**

4.3 Two wattmeters are connected to measure the input power to a balanced three-phase load. If the wattmeter readings are 9.3 kW and 5.4 kW determine:

4.3.1 The total output power. **(2)**

4.3.2 The load power factor. **(4)**

Question 5 **Three Phase Induction Machines** **[20 marks]**

5.1 A three-phase induction motor is wound for 4 poles and is supplied from a 50 Hz system. Calculate:

5.1.1 The synchronous speed. **(2)**

5.1.2 The speed of the rotor when the slip is 4 per cent. **(2)**

5.1.3 The rotor frequency. **(2)**

5.2 A 480-V, 50 Hz, 50-hp, three phase induction motor is drawing 40 A at 0.88 PF lagging. The stator copper losses are 2.2 kW, and the rotor copper losses are 400 W. The friction and windage losses are 350 W, the core losses are 600 W, and the stray losses are negligible. Find the following quantities:

5.2.1 The air-gap power PAG. **(4)**

5.2.2 The power converted Pconv. **(2)**

5.2.3 The output power Pout. **(2)**

5.2.4 The efficiency of the motor. **(2)**

5.3 Name 4 methods of starting a three phase induction motor. **(4)**

The End