UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: MECHANICAL*
SUBJECT	:	**ELECTROTECHNOLOGY III**
CODE	:	**ELT312**
DATE	:	MAIN EXAMINATION / NOVEMBER 2014 05/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	:	5 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 **[16 Marks]**

1.1 The following terms are related to dc machines, define;

1.1.1 Armature reaction **(2)**

1.1.2 Commutation **(2)**

1.2 A 4-pole dc generator has a lap-wound armature with 50 slots with 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. **(4)**

1.3 A short-shunt compound generator supplies 80 A at 200 V. If the shunt, series and armature resistances are 40 Ω, 0.02 Ω and 0.04 Ω respectively, determine the e.m.f generated. **(8)**

QUESTION 2 **[8 Marks]**

A 200-V dc shunt-wound motor has an armature resistance of 0.4 Ω and at a certain load has an armature current of 30 A and runs at 1350 RPM. If the load on the shaft of the motor is increased so that the armature current increases to 45 A, determine the speed of the motor, assuming the flux remain constant.

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SECTION B

TRANSFORMERS

QUESTION 1 [15 Marks]

The no-load current of a transformer is 5 A at 0.2 lagging power factor when supplied at 250 V, 50 Hz. The number of turns on the primary is 2000 and secondary is 800 turns. Calculate;

1.1 The maximum value of the flux in the core **(2)**

1.2 The core loss components (current and resistance) **(4)**

1.3 The magnetising components (current and reactance) **(4)**

1.4 The primary current and primary power factor when secondary current is 100 A at a power factor of 0.85 lagging. **(5)**

QUESTION 2 [13 Marks]

A 5 kVA, 200/400 V single-phase transformer has R_1= 0.25 Ω, R_2= 0.01 Ω, X_1=1 Ω and X_2=0.04 Ω. Calculate for the transformer;

2.1 The % resistance and reactance drops. **(8)**

2.2 The % voltage regulation at full-load of 0.8 lagging power factor. **(2)**

2.3 The % efficiency at full-load of 0.8 lagging power factor if the core loss is 160 W. **(3)**

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SECTION C:

THREE-PHASE INDUCTION MOTORS

QUESTION 1 [10 Marks]

A 415-V, 50-Hz, 4-pole, star-connected, three-phase slip ring induction motor runs at 1440 RPM on full-load. The voltage at standstill between two slip rings is 415-V, the rotor resistance per phase is 1.8 Ω and rotor reactance at standstill is 3.5 Ω. Calculate;

1.1 The p.u full-load slip **(2)**

1.2 The speed that corresponds to maximum torque **(2)**

1.3 The torque developed at standstill. **(3)**

1.4 The torque developed when the motor runs at its rated speed. **(3)**

QUESTION 2 [13 Marks]

A 400-V, 50-Hz, 6-pole, star-connected, 3-phase squirrel cage induction motor absorbs 75-kW with a line current of 75 A at full-load and runs at a slip of 0.025 p.u. If the stator iron loss is 2-kW, windage and friction loss is 1.2-kW and stator resistance per phase is 0.16 Ω. Calculate;

2.1 The full-load power supplied to the rotor **(3)**

2.2 The full-load rotor copper loss **(2)**

2.3 The full-load mechanical power on the shaft **(3)**

2.4 The full-load shaft torque **(3)**

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

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SECTION D

SPECIAL MACHINES AND SYNCHRONOUS MACHINES

QUESTION 1 **[7 Marks]**

A three-phase, 600 MVA alternator has a rated terminal voltage of 22 kV (line). The stator winding is star-connected and has a resistance of 0.014Ω/phase. The same excitation current that produced the rated current on short-circuit has produced the open-circuit voltage of 4351V (line). Calculate the % voltage regulation for a load having a power factor of 0.8 lagging.

QUESTION 2 **[8 Marks]**

A universal series motor has a resistance of 30 Ω and inductance of 0.5 H. When connected to 250 V dc supply and loaded takes 0.8 A, it runs at 2000 RPM. Estimate its speed and power factor, when connected to 250-V, 50 Hz AC supply and loaded the same current.

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SECTION E

INTRODUCTION TO ELECTRONICS

QUESTION 1 **[10 Marks]**

1.1 Define;

1.1.1 Doping **(2)**

1.1.2 Intrinsic semiconductors **(2)**

1.2. Sketch a typical full-bridge single-phase diode rectifier with resistive load and clearly label all components and parameters. **(6)**

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[10]

END