UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: COMPUTER SYSTEMS* *ENGINEERING: ELECTRICAL*
SUBJECT	:	**ELECTRICAL ENGINEERING 1** **ELECTROTECHNOLOGY I**
CODE	:	**AEI 1221 & ELT 1111**
DATE	:	WINTER EXAMINATION 3 JUNE 2015
DURATION	:	(SESSION 1) 12:30 - 15:30
WEIGHT	:	40 : 60
FULL MARKS	:	100
TOTAL MARKS	:	100

EXAMINER	:	MR A.F. COTTRELL
MODERATOR	:	MR A. SNYMAN
NUMBER OF PAGES	:	7 PAGES (including this page)

INSTRUCTIONS TO STUDENTS (TO BE READ):

1. WORK IN PENCIL WILL NOT BE MARKED;
2. ALL WORK WITH THE EXCEPTION OF THE DIAGRAMS MUST BE IN INK.
3. ALL CALCULATIONS MUST BE SHOWN, NO MARKS FOR ANSWERS ONLY.
4. 1 MARK = 1%
5. QUESTIONS MAY BE ANSWERED IN ANY ORDER.
6. ANY HAND-HELD CALCULATORS ARE PERMITTED
7. **ANSWERS ARE TO BE FILLED IN ON THE ATTACHED SHEET, AND HANDED IN, INSIDE THE ANSWER BOOK.**
8. DO NOT WAIT UNTIL THE END OF THE EXAM BEFORE YOU START FILLING IN YOUR ANSWER SHEET! FILL IT IN AS YOU GO!

QUESTION1

Figure 1 shows an electrical circuit with the known parameters given. Use your knowledge of electric circuits, and calculate the unknown parameters indicated in the answer sheet. (HINT: If a circuit confuses you, redraw it!)

[18]

QUESTION 2

Figure 2 shows an electric circuit with three e.m.f. sources and several resistors. Simplify this circuit and apply Kirchhoff's laws to find the current in each branch of the circuit. Use the currents specified in the figure, and express I_3 in terms of I_1 & I_2. Write down the simultaneous equations in the answer sheet, as well as the final answers.

[12]

QUESTION 3

Due to load shedding, a householder uses a single phase, petrol driven generator to supply some of the domestic loads. He heats up 5 litres of water in an urn, raising the temperature from 21°C to 96°C in 18minute. If the efficiency of the urn is 87% and that of the generator set is 25%, determine:

3.1 The energy in megajoule absorbed by the water if the specific heat capacity of water is 4.19 kJ/kg.K. (2)

3.2 The electrical power input to the urn. (4)

3.3 The resistance of the heating element if the supply voltage is 220 V. (2)

3.3.1 Will this resistance be constant? Explain. (2)

3.4 The volume of petrol consumed in order to heat this water, and its cost, if the calorific value & density of the petrol is 48MJ/kg and 714 kg/m^3, respectively, and the cost of petrol is R11-24 per litre. (10)

[20]

QUESTION 4

The armature of a DC machine shown in Figure 3 has a coil with twelve conductors in each side, each with an effective length of 380mm. The mean diameter of the armature is 260mm. The armature rotates at a speed of 950 revs per minute. Determine:

4.1 The total effective length of the conductor. (2)

4.2 The peripheral speed of the armature in meter per second. (3)

4.3 The e.m.f. generated in the coil if the flux density in the air gap is 0.43 tesla. (2)

4.4 Now, if a current of 22 ampere flows through this coil, find:

4.4.1 The force exerted on the armature. (2)
4.4.2 The Torque. (2)
4.4.3 The power developed in the armature. (2)
4.4.4 Confirm your answer using a different formula. (2)

[15]

QUESTION 5

Figure 4 shows two cores of a simple relay. The dimensions are as given in the table below and are repeated on the illustration, and the B/H curve is given. If the force needed to pull the cores together is 12 newton, find:

5.1 The current that must flow in the coil to achieve this result. (10)
5.2 The new current necessary to maintain the same flux density, when the cores are united (assume the gap to be negligible). (3)
5.3 What is the fractional difference between the reluctance in 5.1 and 5.2? (6)

PART	Length (mm)	Cross sectional area (mm^2)
A	90	180
B	60	180
Air gap	2 x 5mm	180

[19]

QUESTION 6

A two-plate capacitor shown in Figure 5 is immersed in insulating oil having a relative permittivity of 4.5. The dimensions and other information are given in the figure. If 600 volt D.C. is applied across the plates, determine:

6.1	The capacitance. (ε_o =8.85 x 10^{-12} (F/m)	(2)
6.2	The charge stored (when fully charged).	(2)
6.3	The electric field strength.	(2)
6.4	The electric flux density.	(2)
6.5	The time constant.	(2)
6.6	The initial charging current.	(2)
6.7	Sketch the voltage and current charging curves, showing important values.	(4)
		[16]

TOTAL MARKS: 100

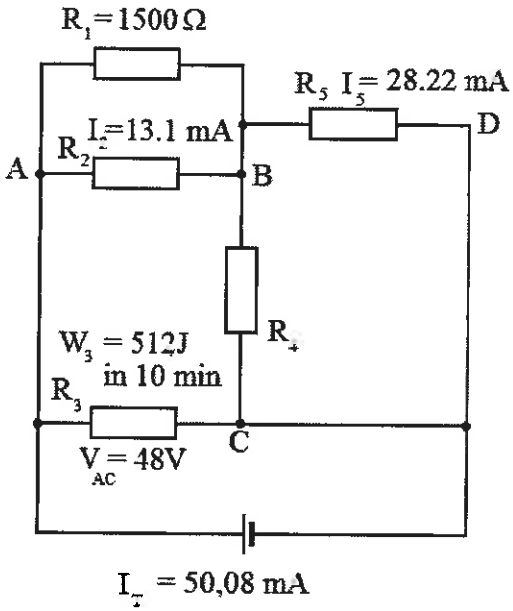


Figure 1

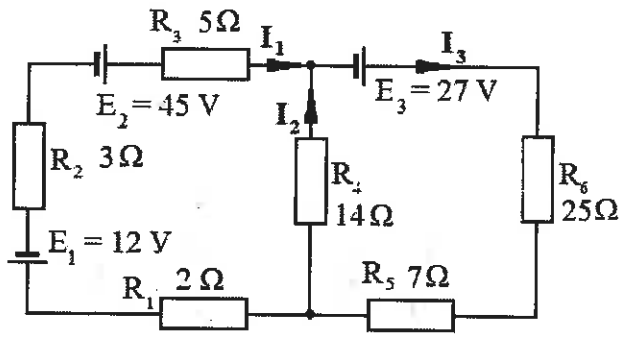


Figure 2

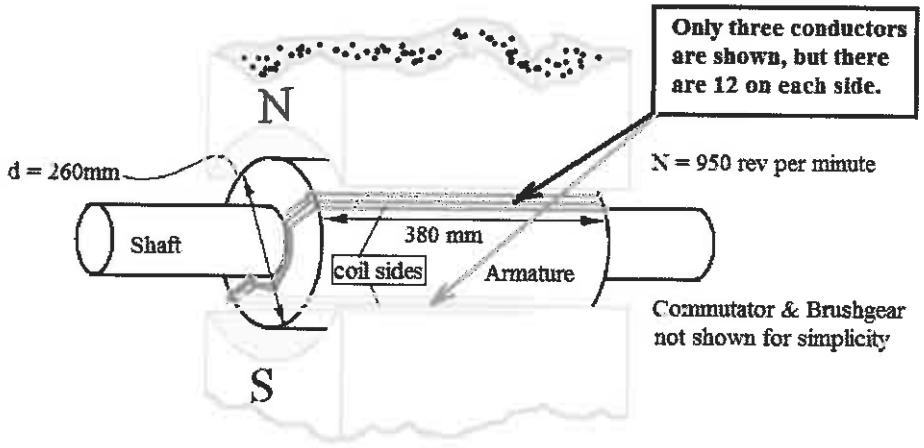


Figure 3

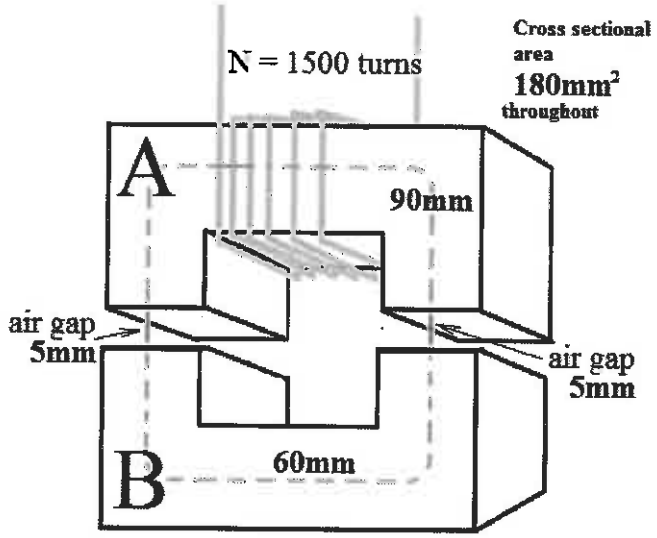
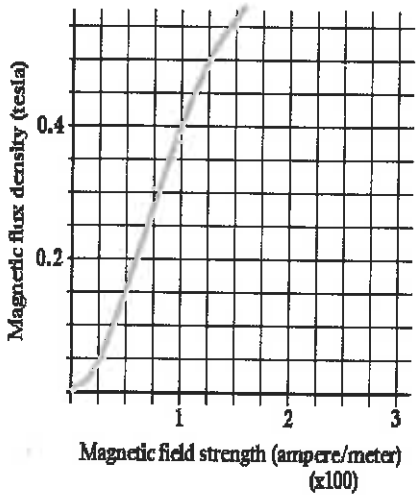


Figure 4



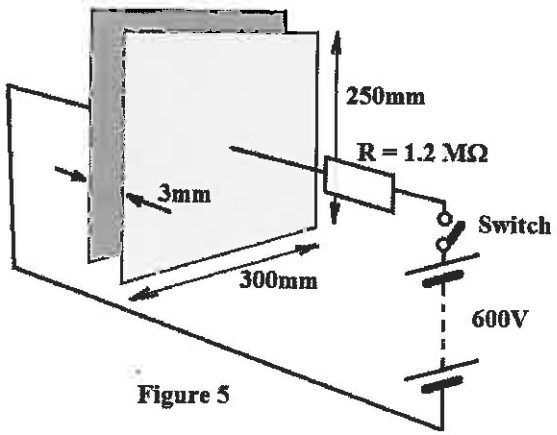


Figure 5

ANSWER SHEET – THIS SHEET MUST BE PLACED INSIDE YOUR ANSWER SCRIPT AND HANDED IN.

STUDENT NAME & INITIALS _____

STUDENT NUMBER _____

QUESTION 1 (NOTE: YOU MUST FILL IN UNITS!)

R_1	1500 Ω	I_1		V_{BC}	19.19V
R_2		I_2	13.1mA	V_{AC}	48V
R_3		I_3		P_1	
R_4		I_4			
R_5		I_5	28.22mA		
W_3	512J (in 10 min)	I_T	50.08mA		

QUESTION 2

Equations(below)	I_1 =	
1	I_2 =	
2	I_3 =	

Answers to QUESTION 3

3.1 Energy in boiled water		Volume of petrol	
3.2 Input power (electrical)		Cost of fuel	
3.3 Resistance (Element)			
R constant? Explain.			

QUESTION 4

4.1 Total effective length		4.4.2 Torque	
4.2 Peripheral speed.		4.4.3 Power developed	
4.3 e.m.f.		4.4.4 Power developed	Examiner will look at working.
4.4.1 Force			

QUESTION 5

B_{gap} =		**New mmf =**	
H_{gap} =		**New current =**	
H_{iron} =		**Total flux =**	
mmf_{Total} =		**$S_{initial}$ =**	
I =		**S_{final} =**	

QUESTION 6

6.1 C =		**6.3 $\mathscr{E}$ =**		**6.5 T =**	
6.2 Q =		**6.4 $\mathscr{D}$ =**		**6.6 $I_{initial}$ =**	