EDEXCEL NATIONALS
UNIT 5 - ELECTRICAL AND ELECTRONIC PRINCIPLES

ASSIGNMENT No. 3 - ELECTRO MAGNETIC INDUCTION

NAME:

I agree to the assessment as contained in this assignment. I confirm that the work submitted is my own work.

Signature　　　　　　　　　　　　　　　　Date submitted

Learning outcomes

On completion of this unit a learner should:

1 Be able to use circuit theory to determine voltage, current and resistance in direct current (DC) circuits
2 Understand the concepts of capacitance and determine capacitance values in DC circuits
3 Understand the principles and properties of magnetism
4 Understand single-phase alternating current (AC) theory.

FEEDBACK COMMENTS

This assignment assesses P9,M3 and D2.

Grade Awarded:

Assessor Signature__________________________________　　Date:____________________

Internal verifier Signature_____________________________　　Date:____________________

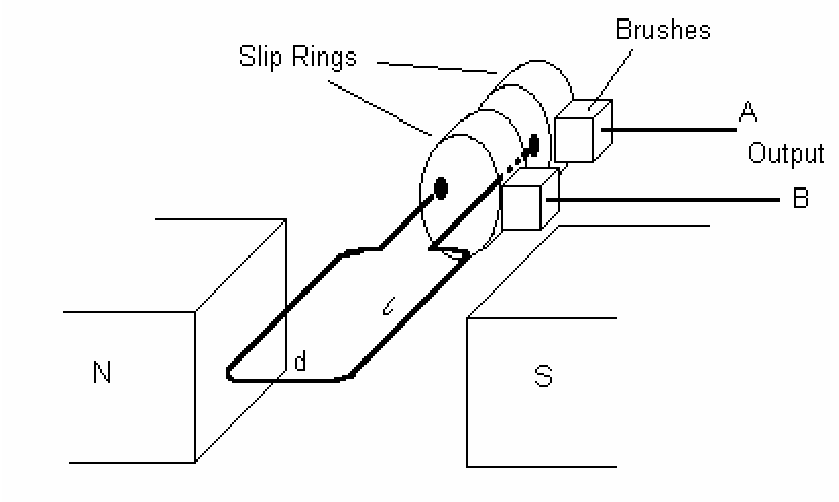
Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describe the level of achievement required to pass this unit.

Grading criteria					
To achieve a pass grade the evidence must show that the learner is able to:	**Achieved**	**To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:**	**Achieved**	**To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:**	**Achieved**
P1 use DC circuit theory to calculate current, voltage and resistance in DC networks		**M1 use Kirchhoff's laws to determine the current in all the branches of a network containing two voltage sources, five nodes and power dissipated in a load resistor**		**D1 analyse the operation and the effects of varying component parameters of a power supply circuit that includes a transformer, diodes and capacitors**	
P2 use a multimeter to carry out circuit measurements in a DC network		**M2 evaluate capacitance, charge, voltage and energy in a network containing a series-parallel combination of three capacitors**		**D2 evaluate the performance of a motor and a generator by reference to electrical theory.**	
P3 compare the forward and reverse characteristics of two different types of semi-conductor diode		**M3 compare the results of adding and subtracting two sinusoidal AC waveforms graphically and by phasor diagram.**			
P4 describe the types and function of capacitors					
P5 carry out an experiment to determine the relationship between the voltage and current for a charging and discharging capacitor					
P6 calculate the charge, voltage and energy values in a DC network that includes a capacitor					
P7 describe the characteristics of a magnetic field and explain the relationship between flux density (B) and field strength (H)					
P8 describe the principles and applications of electromagnetic induction					
P9 use single phase AC circuit theory to explain and determine the characteristics of a sinusoidal AC waveform					
P10 use an oscilloscope to measure and determine the inputs and outputs of a single phase AC circuit.					

PART 1 GENERATOR PRINCIPLE

The diagram shows a simple single loop generator. The loop has a length l mm and diameter d mm. The flux density is B Tesla and the loop rotates at N rev/s. Calculate the velocity of the conductors and determine the output voltage at the position shown. Determine which terminal is positive and which is negative. The loop rotates clockwise viewed from the front. Explain fully with a suitable diagram how you determined this.



Student	d	l	B	N
1	20	40	0.8	50
2	25	30	0.5	20
3	30	30	0.2	60
4	22	50	1.1	40
5	50	75	0.9	25
6	45	100	0.7	35
7	60	150	0.5	25
8	35	75	0.4	120
9	32	64	1.2	40
10	46	110	0.5	35

PART 2 - APPLICATIONS OF D.C. MOTORS

Explain with the aid of a diagram the construction of a D.C. Motor with series windings and shunt windings.

Explain the operating characteristics of both and explain the advantages and disadvantages of both.

List examples where each may be used.

PART 3 - SMALL D.C. MOTORS AS PRESENTED IN MANUFACTURERS DATA SHEETS.

Using the manufacturers data sheet determine the voltage and current needed to run the motor GR16C at 3000 rev/min with a load torque of 40 N cm.

Guide Notes - You will not have come across examples of this motor in your tutorial notes. All the information required to solve the problem is given here.

Many smaller d.c. motors use permanent magnets and so current is only supplied to the armature. Manufacturers of such motors present the performance data in tables such as that shown below. Here is a brief description of the terms used and the meaning.

The motor must deliver a useful torque at the output shaft called the load torque $\mathbf{T_L}$. However, some of the electric power is lost in overcoming losses. The data sheet states the torque in N cm which is not a preferred SI unit and the shaft speeds are stated in 1000 rev/min.

First, there is a permanent loss of torque due to friction and a current is needed to overcome friction torque before any useful torque is produced. This is expressed as T_f and the figure is given in the data sheet.

There is also a loss of torque due to damping which is directly proportional to the speed of the motor. This torque is denoted T_d and is found by the equation

$$\mathbf{T_d = k_d N} \quad \text{where N is in 1000 rev/min.}$$

k_d is a constant that is given in the data sheet.

The other important constants given in the data sheet are the Torque constant $\mathbf{k_t}$ and the e.m.f. constant $\mathbf{k_e}$ which is explained next.

The current required to operate the motor is given by the equation

$$\mathbf{I = (T_L + T_f + T_d)/k_t}$$

The useful torque from the motor is hence: $\mathbf{T_L = k_t I - T_f - T_d}$

The voltage required at the terminals is $\mathbf{V = (N\,k_e/1000) + (I_a R_a)}$

MANUFACTURER'S DATA TABLES FOR MOTORS

Motor Constants ↓	**Model →**	**GR12C**	**GR12CH**	**GR16C**	**GR16CH**	**GR19CH**
Torque K_t Ncm/Amp		10.8	17.0	23.7	37.3	24.0
EMF K_e V/krpm		11.3	17.8	24.8	39.0	25.0
Damping K_d Ncm/krpm		1.16	1.95	3.57	6.44	7.76
Friction Torque T_f Ncm		4.2	4.2	7.7	7.7	9.8
Terminal Resistance @ 5A R_m Ohm		0.95	0.95	0.95	0.95	0.65
Rotor Moment of Inertia J kg.cm^2		1.2	1.2	5.93	5.93	12.71

PART 4 PHASORS

The graph shows two sinusoidal voltages A and B plotted against angle.

1. Write down the equation for both voltages.
2. Draw a graph C that represents A + B by adding the two graphs and write the equation for the result.
3. Draw a graph D that represents A - B by subtracting the two graphs and write the equation for the result.
4. Draw the phasors for A and B on the polar graph below.

Do the following on a separate sheet of graph paper.

5. Show how to add A and B and show that the result agrees with (2).
6. Show how to subtract B from A and show that the result agrees with (3).