-SQA- SCOTTISH QUALIFICATIONS AUTHORITY

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NATIONAL CERTIFICATE MODULE DESCRIPTOR

-Module Number- **2160050** **-Session-1990-91**
-Superclass- **RC**

-Title- **ELECTROMAGNETICS**

-DESCRIPTION-

Purpose

This module is designed to extend the student's knowledge of electromagnetic relationships, characteristics and circuits.

Preferred Entry Level

2160020 Circuit Elements (x 1/2) and 81057 Mathematics Grade 3 or
2160040 Transformation and Rectification (X $^{1}/_{2}$).

Outcomes

The student should:

1. apply the relationships between electromagnetic properties;

2. determine, by the application of electromagnetic circuit laws, quantities in a series magnetic circuit;

3. apply B/H characteristics to magnetic materials;

4. apply the relationship between magnetically coupled inductances L_1 and L_2 and their mutual inductance M.

Assessment Procedures

Acceptable performance in the module will be satisfactory achievement of all the Performance Criteria specified for each Outcome.

The following abbreviations are used below:

PC Performance Criteria
IA Instrument of Assessment

OUTCOME 1 **APPLY THE RELATIONSHIPS BETWEEN ELECTROMAGNETIC PROPERTIES**

PCs

(a) The relationships between magneto-motive force, the magnetising force, the magnetic flux density, the magnetic flux and the reluctance are correctly stated.
(b) The above relationships are applied appropriately to a given magnetic circuit.

IA Structured Question

Given a torrid of known dimensions, relative permeability, turns and drawing a current from a d.c. supply, the student will be required to state appropriate relationships and use them to calculate:

(a) the magneto-motive force;
(b) the magnetising force;
(c) the reluctance;
(d) the magnetic flux density;
(e) the magnetic flux.

Satisfactory achievement of the Outcome is based on all parts of the question being answered correctly. An incorrect response is one which shows a lack of understanding and is not caused by trivial arithmetic error.

OUTCOME 2 **DETERMINE, BY THE APPLICATION OF ELECTROMAGNETIC CIRCUIT LAWS, QUANTITIES IN A SERIES MAGNETIC CIRCUIT**

PCs

(a) The application of magnetic relationships is appropriate to a series magnetic circuit.
(b) The determination of the required magnetic quantities is correct.

IA Structured Question

The student will be presented with a uniform magnetic circuit of known dimensions comprising of a magnetic material of known permeability and a series air gap.

Given a value of magneto-motive force the student will apply the appropriate relationships to determine:

(a) the reluctance of magnetic core;
(b) the reluctance of the air gap;
(c) the resultant reluctance;
(d) the flux in the magnetic core;
(e) the flux density in the air gap;
(f) the air gap mmf;
(g) the material mmf.

Satisfactory achievement of the Outcome is based on all parts of the question being answered correctly. An incorrect response is one which shows a lack of understanding and is not caused by trivial arithmetic error.

OUTCOME 3 **APPLY B/H CHARACTERISTICS TO MAGNETIC MATERIALS**

PCs

(a) The sketching of B/H loops for magnetically hard and soft materials is correct.
(b) The identification of salient points is clearly shown.
(c) The identification of relationship between area of loop and hysteresis loss per cycle per unit volume is correct.
(d) The statement of eddy current reduction achieved by lamination of magnetic material is correct.

IA Structured Question

Given scaled common axis of B and H the student will be required to draw the characteristics for hard and soft magnetic materials.

The student should then identify:

(a) the characteristic for the hard material;
(b) the characteristic for the soft material;
(c) a saturation point;
(d) a coercive force (coercivity);
(e) a remnant flux density (remanence);
(f) the material with the highest hysteresis loss;
(g) another energy loss and a method of reducing it.

Satisfactory achievement of the Outcome is based on all parts of the question being answered correctly. An incorrect response is one which shows a lack of understanding and is not caused by trivial arithmetic error.

OUTCOME 4 **APPLY THE RELATIONSHIP BETWEEN MAGNETICALLY COUPLED INDUCTANCES L_1 and L_2 AND THEIR MUTUAL INDUCTANCE M**

PCs

(a) The relationship between mutual inductance M and self-inductances L_1 and L_2 and coupling coefficient is stated correctly.
(b) The statement of the concept of ideal coupling is correct.

(c) The application of the equation
$M = k\sqrt{L_1 L_2}$ for various values of coupling coefficient is correct.

IA Structured Question

Given two magnetically coupled coils of self inductances L_1 and L_2 and a coupling coefficient k, the student:

(a) states the mutual inductance expression
$M = k\sqrt{L_1 L_2}$;
(b) states what is meant by ideal coupling in terms of flux linkage;
(c) calculates the mutual inductance if the coils are mounted on a common magnetic core to give ideal coupling;
(d) states the effect on the coupling coefficient with the removal of the core;
(e) calculates the mutual inductance for a coupling coefficient of less than 1.

Satisfactory achievement of the Outcome is based on all parts of the question being answered correctly. An incorrect response is one which shows a lack of understanding and is not caused by trivial arithmetic error.

The following sections of the descriptor are offered as guidance.
They are not mandatory.

CONTENT/CONTEXT

Appropriate units, symbols and unit-symbols should be used throughout.

Corresponding to Outcomes 1-4:

1. For coil having N turns, magnetic core length 1 and core csa A and core material absolute permeability of u.

   Magnetic Motive Force NI = F
   Magnetising Force F/l = H
   Average Core Flux Density $H\mu = H\mu_o\mu_r = B$

   Flux in Core $BA = \Phi$

   $\Phi = BA = H\mu_o\mu_r A = NI/l\ \mu_o\mu_r A = NI/S$

2. $\Phi S = NI$ = mmf for magnetic circuit or part thereof.

   For a magnetic circuit containing a magnetic core and an air gap in series.

   ΦS (total) = ΦS (core) + ΦS (air gap)
   For common flux levels ΦS (total) = Φ(S core + S air gap)
   Hence total mmf = mmf for core + mmf for air gap.

3. Relationship of B/H for both soft and hard materials between extremes of saturation.

   Reference to saturation, remnant flux density and coercive force (remanence, coercivity).

   B/H Loop is indicative of energy dissipation per cycle per unit volume of core;
   hysterises loss.
   Induction of core voltage resulting in Eddy current losses; methods of reducing these losses.

4. M for inductance L_1 and L_2= the associated mutual inductance $M = k\sqrt{L}$, L_2 Coefficient of coupling k; methods by which k is modified. Special case of k = 1.

SUGGESTED LEARNING AND TEACHING APPROACHES

The student should be introduced to electromagnetism by use of simple illustrative experiments: the various electro-magnetic relationships should be introduced by the written example. Statements indicating these relationships are expected, as opposed to a rigorous development. Their application is important and can be introduced by exposition lessons followed by discussion and the written exercise.

09/02/98 JH/AV