-SQA- SCOTTISH QUALIFICATIONS AUTHORITY

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NATIONAL CERTIFICATE MODULE DESCRIPTOR

-Module Number- **2160090** **-Session-1990-91**
-Superclass- **XJ**

-Title- **DC AND AC CIRCUIT RESPONSES ($x^1/_2$)**

-DESCRIPTION-

Purpose

This module is designed to extend the student's knowledge of ac and dc circuit theory in relation to energy storage and responses.

Preferred Entry Level

2160040 Transformation and Rectification (x 1/2)

Outcomes

The student should:

1. interpret the factors relating to the energy stored in magnetic and electrostatic fields;

2. interpret the effects of voltage and current responses in CR and LR series circuits to a sudden change in dc;

3. interpret the responses of RLC series and parallel circuits to ac supplies at resonant frequency.

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

Note: The Outcomes and PCs are mandatory and cannot be altered. The IA may be altered by arrangement with SQA. (Where a range of performance is indicated, this should be regarded as an extension of the PCs and is therefore mandatory.)

OUTCOME 1 **INTERPRET THE FACTORS RELATING TO THE ENERGY STORED IN MAGNETIC AND ELECTROSTATIC FIELDS**

PCs

(a) The statement that energy is stored in magnetic and electrostatic fields is correct.
(b) The statement of the equation for energy stored in a magnetic field is correct.
(c) The statement of the equation for energy stored in an electrostatic field is correct.
(d) The solution of problems, using the energy equations, is correct.

IA Short Answer Questions

The student will be presented with questions to test understanding of the factors relating to energy storage in magnetic and electrostatic fields.

The test will consist of 8 short answer questions to be allocated as follows:

(i)	statement of magnetic and electrostatic field as energy stores;	2 questions
(ii)	equations for energy stored in magnetic and electrostatic fields;	2 questions
(iii)	calculation of energy stored in magnetic field;	2 questions
(iv)	calculation of energy stored in electrostatic field.	2 questions

Satisfactory achievement of the Outcome will be based on all questions of (i) and (ii), one question of (iii) and one question of (iv) being answered correctly. An incorrect response is one which shows a lack of understanding and is not caused by trivial arithmetic error.

OUTCOME 2 **INTERPRET THE EFFECTS OF VOLTAGE AND CURRENT RESPONSES IN CR AND LR SERIES CIRCUITS TO A SUDDEN CHANGE IN DC**

PCs

(a) The sketching of the current and voltage curves for LR and CR circuits is correct.
(b) The matching of response curves to the curve equations is appropriate.
(c) The definition of the time constant for LR and CR circuits is correct.

IA Structured Question

The student will be set a question to test ability to interpret voltage and current responses in a CR and LR series circuit when a dc source is suddenly changed.

The student will be presented with two diagrams, one with L and R in series and the other with C and R in series and appropriate instantaneous current and voltage equations, ie.

$i = I(1 - e^{-t/T})$, $i = Ie^{-t/T}$,

$v_c = Ve^{-t/T}$, $v_c = V(1 - e^{-t/T})$.

Where T = time constant.

For the sudden application of a direct voltage and its subsequent sudden removal after steady state conditions are reached, the student should:

(i) sketch the current response curves for the LR circuit;
(ii) sketch the voltage response curves for the CR circuit;
(iii) match the response curves to the appropriate equations;
(iv) state the equations for the time constant for LR and CR circuits;
(v) define the term time constant for LR and CR circuits.

Satisfactory achievement of the Outcome will be 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 **INTERPRET THE RESPONSES OF RLC SERIES AND PARALLEL CIRCUITS TO AC SUPPLIES AT RESONANT FREQUENCY**

PCs

(a) The sketching of current/frequency response curve for RLC series and parallel circuits is correct.
(b) The matching of a given equation for resonant frequency to a circuit is appropriate.
(c) The phase relationship and impedance values at resonance are stated correctly.
(d) The solution of problems on series and parallel resonant frequency and impedance is accurate.

IA Structured Question

The student will be set a question to test ability to interpret current/frequency response for (i) an RLC series circuit and (ii) RL series circuit with C in parallel when a variable frequency ac supply is applied.

The student will be given two circuit diagrams, one for series and one for parallel with appropriate resonant frequency equations and will be required for each case to:

(i) sketch current frequency response curve;
(ii) match resonant frequency equation to appropriate circuit;
(iii) state the impedance expression at resonance;
(iv) state the phase relationship between current and voltage at resonance;
(v) calculate the resonant frequency;
(vi) calculate the circuit impedance at resonance.

Satisfactory achievement of the Outcome will be based on all parts of the question being answered correctly.

An incorrect response should be considered as a response which demonstrates 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 1-3:

1. Concept of magnetic field surrounding a current carrying coil.

   The magnetic field as an energy store.
   Statement of energy stored in the magnetic field of a coil having inductance L Henry, when its current changes at a uniform rate of I/t Ampere per second, as $W = 1/2\ LI^2$ Joules. Evaluation of energy stored in magnetic field.

   Concept of electrostatic field between the plates of a charged capacitor.

   The electrostatic field as an energy store. Statement of energy stored in the electrostatic field of a capacitor of C Farads, charged at a constant current of I Ampere for t seconds, as $W = 1/2\ CV^2$ Joules. Evaluation of energy stored in electrostatic field.

2. The sudden application of a dc source to:

   (i) an LR series circuit; transient response
   $i = I(1 - e^{-t/T})$
   (ii) a CR series circuit; transient response
   $v_c = V(1-e^{-t/T})$

   The sudden removal of a dc source from:

   (i) an LR series circuit; transient response $i = Ie^{-t/T}$
   (ii) a CR series circuit; transient response $v_c = Ve^{-t/T}$

   Relating the equation to the curve shape.

   Definition of the time constant T.

   The time constant T expressed in terms of the circuit elements:
   L/R for LR in series, CR for CR in series.

3. Sketching of X_L, X_c and R against frequency. Sketching of current against frequency for:

   (i) RLC series circuit;
   (ii) RL series circuit in parallel with C.

Statements that $f_r = 1/2 \pi \sqrt{LC}$ for series case and that

$fr = 1/2 \pi \sqrt{1/LC - R^2/L^2}$ for parallel case.

Calculation of the circuit impedance at resonant frequency for each case.

Calculation of the resonant frequency for a given circuit arrangement involving R, L and C. Production of phasor diagrams indicating current and voltage relationship at resonance.

SUGGESTED LEARNING AND TEACHING APPROACHES

This module could be taught by exposition lesson followed by laboratory work to form a practical exercise to illustrate that both L and C are energy storage devices and that, by virtue of their combined connection, the energy from a voltage source of a definite frequency energy will oscillate from one field to the other ie: resonance conditions.

Application of each circuit could be discussed.

09/02/98 EmacD/AV