COURSE NUMBER: MP2140

COURSE TITLE: Circuit Analysis I

COURSE DESCRIPTION:

This course covers advanced topics in A.C. and D.C. circuit analysis as well as an introduction to Two-Port Networks. It will provide the necessary background for learners to enter second year Electrical and Electronics programs.

PREREQUISITES: ET1101 – Electrotechnology
MA1101 – Mathematics

CO-REQUISITES: None

CREDIT VALUE: Four (4)

COURSE HOURS PER WEEK: Three (3)

LAB HOURS PER WEEK: Two (2)

SUGGESTED TEXT:

Jackson, H.W., Temple, D., & Kelly, B. (2012). *Introduction to electric circuits* (9th ed.). Oxford University Press. ISBN-13: 978-0-19-5438130

LEARNING RESOURCES: To be determined by instructor

MAJOR TOPICS:

1.0 Network Theory
2.0 Transients in D.C. Circuits
3.0 Complex Algebra Analysis of A.C. Circuits
4.0 Two-Port Network Parameters

LEARNING OBJECTIVES:

The expected learning outcomes are that the learner will be able to:

1.0 Network Theory

1.1 Introduction to Network Theory

- 1.1.1 Restatement of Ohm's Law and Kirchhoff's Laws
  - 1.1.1.1 State a generalized version of Ohm's Law and the Power Law and all variations of them
  - 1.1.1.2 State a generalized version of Kirchhoff's Circuit Laws

- 1.1.2 Network Equations from Kirchhoff's Laws
  - 1.1.2.1 Write and solve network equations using Kirchhoff's Laws

- 1.1.3 Types and Characteristics of Power Sources
  - 1.1.3.1 List types of power sources
  - 1.1.3.2 Discuss the characteristics of these power sources

- 1.1.4 Voltage and Current Sources
  - 1.1.4.1 Describe the characteristics of voltage and current sources
  - 1.1.4.2 Identify Independent & Dependent sources
  - 1.1.4.3 Transform Voltage sources to Current sources

- 1.1.5 Mesh Analysis
  - 1.1.5.1 Write network equations using mesh analysis technique
  - 1.1.5.2 Solve equations for unknown currents
  - 1.1.5.3 Solve equations for circuits with dependent sources

- 1.1.6 Nodal Analysis
  - 1.1.6.1 Write network equations using nodal analysis technique
  - 1.1.6.2 Solve equations for unknown voltages
  - 1.1.6.3 Solve equations for circuits with dependent sources

- 1.1.7 The Superposition Theorem
  - 1.1.7.1 State the superposition theorem
  - 1.1.7.2 Solve multiple source networks by superposition
  - 1.1.7.3 Solve equations for circuits with dependent sources

1.2 Equivalent Circuit Theorems

- 1.2.1 Thevenin's Theorem
  - 1.2.1.1 Describe the "black box" representation of a network
  - 1.2.1.2 State Thevenin's Theorem
  - 1.2.1.3 Calculate Thevenin resistance
  - 1.2.1.4 Calculate Thevenin resistance for circuits involving dependent sources
  - 1.2.1.5 Calculate Thevenin voltage
  - 1.2.1.6 Calculate load current using Thevenin equivalent circuit
  - 1.2.1.7 Calculate load current for circuits involving dependent sources

- 1.2.2 Norton's Theorem
  - 1.2.2.1 State Norton's Theorem

1.2.2.2 Calculate Thevenin current
1.2.2.3 Calculate load current using Norton's equivalent circuit

2.0 Transients in D.C. Circuits

2.1 Inductor Current / Voltage Relationships
2.1.1 Rise of Current in a Pure Inductor
2.1.1.1 Sketch the graph of I vs. t for pure inductor

2.1.2 Rise of Current in Inductor with Resistance
2.1.2.1 Sketch the graph of I vs. T for R-L circuit
2.1.2.2 Describe the relationship between I and t as an exponential function

2.1.3 Decay of Current
2.1.3.1 Sketch the I vs. t graph for a decaying circuit
2.1.3.2 Write the formula for I vs. t

2.1.4 Time Constant
2.1.4.1 Define time constant for an inductive circuit
2.1.4.2 Rewrite the current equations in terms of x
2.1.4.3 Relate circuit charging and discharging in terms of time constant

2.1.5 Calculation of Instantaneous Current from Exponential Graph
2.1.5.1 Solve charging and decaying inductive circuits using the universal time constant graph

2.1.6 Calculation of Algebraic Formula
2.1.6.1 Calculate current from exponential equation
2.1.6.2 Calculate time from exponential equation

2.1.7 Energy Stores in Inductance
2.1.7.1 Derive the formula for energy stored in an inductance

2.2 Transients in D.C. Capacitive Circuits
2.2.1 Kirchhoff's Laws Applied to Charging Capacitors
2.2.1.1 Describe the voltage relationships in a series R-C circuit

2.2.2 Time Constant
2.2.2.1 Define the time constant of a capacitive circuit

2.2.3 Charging and Discharging Capacitors
2.2.3.1 Sketch the graphs of v versus t for charging and discharging circuits
2.2.3.2 Write the equations of v versus t for charging and discharging

circuits

2.2.4 Graphic Solution for Charge and Discharge of Capacitors
2.2.4.1 Solve capacitive circuits using the time constant curve

2.2.5 Algebraic Solution for Charge and Discharge of Capacitors
2.2.5.1 Calculate voltage from exponential equation
2.2.5.2 Calculate charging current
2.2.5.3 Calculate time
2.2.5.4 Calculate charge on capacitor

2.2.6 Energy Stored in Capacitors
2.2.6.1 Derive the equation for energy stored in a capacitor

3.0 Complex Algebra Analysis of A.C. Circuits

3.1 Phasors
3.1.1 Representing a Sine Wave by a Phasor Diagram
3.1.1.1 Define phasor
3.1.1.2 Represent a sinusoidal waveform by a phasor diagram

3.1.2 Phasor Representation of Phase Difference
3.1.2.1 Draw phasor diagrams to represent the phase angle difference between two or more sinusoids

3.1.3 Phasor Diagrams of Simple A.C. Circuits
3.1.3.1 Employ phasor diagrams to represent the magnitude and phase relationship between all voltages in any simple A.C. circuit
3.1.3.2 Employ phasor diagrams to represent the magnitude and phase relationship between all currents in any simple A.C. circuit

3.2 Complex Algebra Solution of A.C. Circuits
3.2.1 Representation of Reactance using J. Operator
3.2.1.1 Represent inductive and capacitive reactance in complex form

3.2.2 Series A.C. Circuits
3.2.2.1 Calculate voltages and currents in series A.C. circuits using complex algebra techniques
3.2.2.2 Calculate the total impedance of a series A.C. circuit

3.2.3 Parallel A.C. Circuits
3.2.3.1 Calculate voltages and currents in parallel A.C. circuits using complex algebra techniques

3.2.4 Admittance and Susceptance

3.2.4.1 Define susceptance and admittance
3.2.4.2 Calculate the total admittance of a parallel A.C. circuit

3.2.5 Series-Parallel A.C. Networks
3.2.5.1 Analyze series-parallel A.C. Networks using complex algebra techniques

4.0 Two-Port Network Parameters

4.1 Admittance Parameters
4.1.1 Determine the admittance parameters of a two-port network
4.1.2 Determine the response to a load on the two-port network using the admittance parameters

4.2 Impedance Parameters
4.2.1 Determine the importance parameters of a two-port network
4.2.2 Determine the response to a load on the two-port network using the impedance parameters

4.3 Hybrid Parameters
4.3.1 Determine the hybrid parameters of a two-port network
4.3.2 Determine the response to a load on the two-port network using the hybrid parameters

LABORATORY EXPERIMENTS:

1.0 Network Analysis
2.0 Transients in Capacitive Circuits
3.0 A.C. Circuits and Phasors

EVALUATION:

Laboratories:	10%
Assignments:	10%
Mid Term Examination:	30%
Final Examination:	50%

DATE DEVELOPED: **DATE REVIEWED:**

REVISION NUMBER: 3 **DATE REVISED:** March 2014

Note to instructor: Check PIRS to ensure this outline is the most current version.