SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: NETWORK ANALYSIS

Code No.: ELR 319-6

Program: ELECTRICAL/ELECTRONIC TECHNOLOGY

Semester: FIVE

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New: ________ Revision: X

APPROVED: L.P. Crozzitto
Chairperson

Date

NETWORK ANALYSIS — Course Name

ELR 319-6 — Course Number

PHILOSOPHY/GOALS:

To present the general methods of circuit and network analysis by employing differential and integral calculus and transform methods with a strong emphasis on application.

METHOD OF ASSESSMENT (GRADING METHOD):

Approximately four (4) 1 hour tests will be given during the semester. Students will be advised at least one week in advance of a test. Quizzes may be given without notice.

A 80--100%
B 66-- 79%
C 55-- 65%

The grading will be distributed as follows: 80% for theory, 20% for computer assignments. To achieve an overall grade, a passing grade in theory and assignments must be achieved.

Students with a final grade between 50 and 55% may at the discretion of the instructor sit a final three (3) hour examination covering the whole course, the maximum mark that can be achieved is 55%.

Students with a grade less than 50% will be assigned an R.

TEXTBOOK:

Network analysis with Applications - William D. Stanley

COURSE OBJECTIVES:

LECTURE	TOPIC
5	Basic Circuit Laws Ohm's Law Kirchhoff's Laws Voltage and Current Dividers Units and Definitions Equivalent resistance Controlled sources

10 <u>Circuit Analysis Methods</u>
Mesh current analysis
Node voltage analysis
Thevenin's Theorem
Nortons's Theorem
Superposition Theorem

5 <u>Capacitive and Inductive Transients</u>
Graphical differentiation and integration
Voltage-current relationships in capacitive and inductive circuits
Mutual inductances and transformers

10 <u>Initial, Final and First Order Circuits</u>
Initial and final conditions with dc excitation
Mathematical properties
Mathematical relationships for voltage and current responses of first order circuits

5 <u>Laplace Transforms</u>
Properties of Laplace transforms
Laplace transform operations
Inverse transforms

10 <u>Circuit Analysis with Laplace Transforms</u>
Transform impedance and admittance
Initial value conditions
s - domain models
Analysis of s - domain models
Natural and forced responses
Apply Laplace transform methods to completely solve first and second order circuits

5 <u>Transfer Functions</u>
Linear, lumped, and time-invariant systems
Transfer function of a given circuit
S-plane pole-zero diagrams
Stability
Block diagram algebra

5 <u>Sinusoidal Steady - State Analysis</u>
Phasor representation
Phasor algebra
Steady state impedance and admittance
Sinusordal steady - state circuit analysis

10 **<u>Frequency Response Analysis and Bode Plots</u>**
Relationship between Laplace and phasor domains
Steady-state transfer functions
Bode plot concepts
Bode plot forms
Bode plots

10 **<u>Wave Form Analysis</u>**
dc and rms values of periodic signals
Form factor
Step and ramp functions
Shifted functions
Complex wave form synthesis
Superposition
Impulse function
Fourier analysis
Sine - cosine form
Amplitude - phase form
Fourier series, symmetrical conditions

SPECIFIC OBJECTIVES:

Block 1 - Basic Circuit Laws

The student shall be able to:

1. Define the basic circuit quantities and state the symbols and units used to represent them.
2. Define the basic active and passive models and sketch their schematic forms.
3. Explain power conventions and determine when power is absorbed or delivered.
4. State and apply Ohm's Law.
5. State and apply Kirchhoff's voltage and current laws.
6. Determine the equivalent resistance of complex resistive networks.
7. State and apply the voltage and current divider rules to complex resistive networks.
8. Define the form types of controlled (or dependent) sources and discuss their significance in circuit modelling.

Block 2 - Circuit Analysis Methods

1. Determine the current, voltages and power in a single loop circuit.
2. Determine the voltage, currents and power in a single node-pair circuit.
3. Apply source transformations to simplify source models.
4. Determine appropriate models for realistic voltage and/or current sources.
5. Apply mesh current analysis to determine all voltages, currents and power in a circuit containing several meshes.
6. Apply node voltage analysis to determine all voltages, currents and power in a circuit containing several nodes.
7. Determine the Thevenin and Norton equivalent circuits for a given circuit.
8. Apply various circuit analysis methods to circuits containing dependent (or controlled) sources.
9. Apply the principle of superposition in the analysis of linear circuits.

Block 3 - Capacitive and Inductive Transients and Equivalent Circuits

1. Apply graphical differentiation to piecewise linear continuous functions.
2. Apply graphical integration to piecewise linear functions.
3. State and apply the instantaneous voltage-current relationships for a capacitance.
4. State and apply the instantaneous voltage-current relationships for an inductance.
5. Obtain the equivalent capacitance of a complex capacitor network.

6. Obtain the equivalent inductance of a complex inductor network.
7. State and apply the voltage-current relationships for mutual inductance.
8. State and apply the relationships for ideal transformers.

Block 4 - Initial, Final and First Order Circuits

1. Determine equivalent circuits and predict the voltages and currents in a circuit immediately after an excitation is first applied.
2. Determine equivalent circuits and predict the voltages and currents in a circuit after dc steady-state conditions have been reached.
3. State the mathematical properties for and sketch the exponential function.
4. Recognize the form of a first-order circuit with dc excitation.
5. Determine the time required for an exponential response to reach any value.

Block 5 - Laplace Transforms

1. Define and explain the purposes of the Laplace transforms as applied to circuit analysis.
2. State the Laplace transforms for the most common functions encountered in circuit analysis.
3. State the forms of the most common Laplace transform operations.
4. Determine the Laplace transform of a given time function.
5. Determine the inverse transform of a given s-domain function.

Block 6 - Circuit Analysis with Laplace Transforms

1. Define transform impedance and admittance and determine these quantities for any given circuit element.
2. Represent initial conditions for capacitors and inductors in terms of s-domain Thevenin and Norton models.
3. Determine the complete s-domain model for a given circuit.
4. Apply various circuit analysis methods to s-domain circuit models.
5. Identify the natural and forced responses and determine when these represent transient and steady-state responses.
6. Apply Laplace transform methods to obtain complete solutions for first-order circuits with arbitrary excitations.
7. Apply Laplace transform methods to obtain complete solutions for second-order circuits.

Block 7 - Transfer Functions

1. State the conditions for a system to be linear, lumped and time-invariant.
2. Define the transfer function and the input-output relationship for a linear system.
3. Determine the transfer function for a given circuit.
4. Determine the output of a given system from a knowledge of the transfer function and the input.
5. Determine the poles and zeros from a given transfer function.
6. Construct an s-plane pole-zero diagram and show its relationship to the transfer function.
7. Define a stable, a marginally stable, and an unstable system; and discuss the relationship to the poles and zeros of the transfer function.
8. Apply block diagram algebra to simplify interconnections of transfer functions.
9. Discuss the form of the step response of a second-order system.

Block 8 - Sinusoidal Steady-State Analysis

1. Represent a sinusoidal voltage or current as a complex phasor.
2. Obtain a single sinsoid equivalent to the sum of several sinusoids of the same frequency using phasor analysis.
3. Define the following terms based on the sinusoidal steady-state: impedance, resistance, reactance, admittance, conductance, and susceptance.
4. Determine inductive reactance and susceptance for a given inductance.
5. Determine capacitive reactance and susceptance for a given capacitance.
6. Transform a complete circuit to the steady-state phasor form.
7. Apply basic circuit analysis methods to phasor circuit models to determine complete solutions.
8. Compute average power in a sinusoidal steady-state circuit.

Block 9 - Frequency Response Analysis and Bode Plots

1. Discuss and show the mathematical relationship between the s-domain and the phasor domain.
2. Define the steady-state transfer function, and show how it relates to the s-domain transfer function.
3. Determine the steady-state transfer function for a given circuit.

4. Define the linear amplitude response, the decibel amplitude response, and the phase response, and determine these functions from the steady-state transfer function.
5. Discuss the form of a Bode plot, and explain its significance.
6. Construct a Bode plot decibel amplitude response from a given transfer function or circuit.
7. Same as (6) for a Bode plot phase response.

Block 10 - Waveform Analysis

1. Determine the dc value of a periodic waveform and explain its significance.
2. Determine the rms value of a periodic waveform and explain its significance.
3. Determine the average power dissipated in a resistor by a periodic waveform or current.
4. Define and sketch the step and ramp functions.
5. Express the mathematical equation for and sketch the form of a delayed function.
6. Express various piecewise linear waveforms in terms of step and ramp functions starting at appropriate times.
7. Apply superposition to determine the response of a circuit excited by a waveform composed of various step and ramp components as in (6).
8. Define the unit impulse function and explain its relationship to the unit step function.
9. Define the form of a Fourier series and discuss the practical significance in spectral analysis.
10. Determine the Fourier series for certain "standard" waveforms.
11. Apply symmetrical conditions to simplify the computation in (10).