North Shore Community College
Telecommunications Technology A.A.S. Degree

Course Number: IEL104 Section: MAL
Course Name: Electrical Circuits
Semester: Spring 2004
Credit: 4
Hours: 3 Hours Lecture, 2 Hours Laboratory per week
Fridays 8am-11am Lecture 11am-12:30pm Lab
Room: LW207 Lecture, LE201 Lab

Instructor: George H. Walsh Jr.
Office: Lynn Campus LW228
Phone: 978-762-4000 Extension 6260
email: gwalsh@northshore.edu

Office Hours: Text: Principles of Electric Circuits, 7th Ed. by Floyd/Prentice Hall
Experiments in Basic Circuits Theory and Application, 5th Ed
by David Buchla, Prentice Hall

Supplemental:

Software: Circuit Maker or Multisim

Additional
Lap-top Computer with analysis and simulation software
TI 68 Calculator

Materials:

Prerequisite: Technical Math I, Computer Applications

Co-requisite: (Composition1) NextStep Program

Course Description: This course will develop student skills in the application of
Ohm’s law, Kirchhoff’s laws, Thevenin’s theorem, and Superposition to the analysis of DC and AC circuits, including R-L-C circuits, impedances, phase angles, resonance, and Transformers.
**Procedures:** There are five hours of lecture and laboratory per week. The student is introduced to topic material in the lecture followed by a demonstration pertaining to the topic as solved by the use of a computer, a calculator and by connecting components on a breadboard for the purpose of testing and troubleshooting actual circuits

**Course Rationale:** This course will introduce the student to electrical circuits and devices as used in the Telecommunications Industry. This course is recommended by the Bell Atlantic Next Step Program for the Telecommunications Technology Degree.

**Course Objectives:** Instructors shall make every effort to incorporate the following umbrella competencies into the course: Problem solving, teamwork, project leadership, quality, contextual learning, technology and service delivery and customer focus.  

The following list of course goals will be addressed in the course.

Students will use skills and knowledge gained from lectures, readings, demonstrations and exercises to perform tasks in preparation for employment in local businesses and industry. Those tasks directly relate to these goals. Students shall demonstrate the following competencies:

1. Identify the characteristics of DC and AC sources, and calculate their effect on voltage, current, and power in passive networks.

2. Describe the V-I characteristics of resistors, capacitors, inductors, and utilize these circuit elements with DC and AC excitation. AC circuit analysis shall be based on the use of complex numbers.

3. Given a series, parallel, or series-parallel circuit consisting of any combination of R-L-C components, choose and follow through on one or more of the following methods of circuit analysis.
   (a) Ohm’s Law, Kirchhoff’s Voltage Law, Kirchhoff’s Current Law
   (b) Voltage Divider Rule, Current Divider Rule
   (c) Thevenin’s Theorem
   (d) Superposition Theorem
   (e) Internal Resistance and the Maximum Power Transfer Theorem

4. Use the computer as an analytical tool. Use computer simulation to solve AC and DC circuit problems and save or print solutions and graphs.

5. Given an R-C or R-L series circuit (or a more complicated R-C or R-L circuit that can be reduced to a simple series circuit by Thevenizing and/or combining C’s or L’s as required), driven by a switched DC source, calculate the time constant and any current or voltage at any time as required, using the universal time constant curve.

6. Given a series or parallel R-L-C circuit driven by a sinusoidal source, calculate:
   (a) the resonant frequency ($f_r$)
   (b) all currents and voltages
   (c) circuit Q, coil Q
   (d) the bandwidth
(e) the corner frequencies, \(f_1\) and \(f_2\)
(f) the value of resistance needed to increase the BW to a specified value.

7. Explain conventional transformer action in terms of flux linkages and, given an ideal transformer, calculate:
   (a) primary and secondary voltages, currents, and power.
   (b) currents and voltages with multiple secondaries
   (c) currents and voltages for an ideal autotransformer.
   (d) impedance transformations.

8. Follow and summarize prescribed lab test procedures, set up equipment, take measurements, interpret results, and run computer simulations. Interpret schematic diagrams and construct breadboard circuits. Troubleshoot circuits.

9. Given a supplemental assignment or an activity assignment, develop a formal laboratory report including objectives, theory, procedures, equipment list, schematics, calculated and measured data, and conclusion. Quality of the report shall meet industrial standards.

10. Given the specifications for a hardware project, i.e. constructing a V-O-M, Flasher, Strobe Light, Speaker Crossover network, or other:
   
   (a) select and work productively with other students as partners.
   (b) determine the project scope and sequencing of critical events.
   (c) obtain materials needed for the project and construct the unit using schematics, assembly drawings, and appropriate soldering or wiring techniques
   (d) test unit to project specifications, and create necessary documentation, i.e. theory of operation, schematics, assembly drawings, test procedure(s) and instructions on how to use the completed project.
   (e) develop and deliver to his/her colleagues a 10-minute oral presentation.

11. Listen and think critically and analytically.

**Attendance:** All students are expected to attend every session of each course for which they are registered. Students are responsible for all that transpires in class whether or not they are in attendance. The College defines excessive absence or lateness as more than the equivalent of one week (four hours) of class meetings during the semester. Excessive absence or lateness may lead to failure in a course or removal from the class roster. Students must notify the instructor of any anticipated absences.

**Homework:** Reading assignments are the responsibility of the student. Most topics are covered by the book or supplemental material and should be read before class. Other readings are suggested during the course. Since topics are fragmented throughout the text and supplemental materials, the student should utilize indices to locate readings pertinent to each topic.
Examinations:  
1. Three tests on material to date (60 min)  30%  
2. Comprehensive final exam (120 min)  15%  
3. Lab work  30%  
4. Homework  10%  
5. Project  15%  

Laboratory: This course requires extensive laboratory work. All assignments must be turned in one week from the date of issue, unless otherwise indicated. All assignments are graded for timeliness, accuracy, completeness and neatness. A final project is required for all students, however, students are encouraged to work in teams in order to accomplish project objectives within the time frame.

Accommodation Statement: If a student feels that due to a disability you have the need for special assistance and/or adaptations to accomplish the goals of this course, please see the instructor within the first week of classes.
IEL104
Electrical Circuits

Topical Outline

1. FOUNDATIONS [1 week]
   • Careers in electronics
   • History of the electronics field
   • Electrical and magnetic quantities and their units
   • Scientific notation
   • Engineering notation
   • Conversions
   • Using a calculator

2. VOLTAGE, CURRENT AND RESISTANCE [1 2/3 weeks]
   • Definitions
   • Charge
   • Voltage
   • Current
   • Resistance
   • Color code
   • Protective and control devices
   • Wire
   • Using meters
   • Applications

3. OHM'S LAW, ENERGY AND POWER [1 week]
   • Ohm’s Law
   • Solving problems using Ohm’s Law
   • Energy and power
   • Power ratings for resistors
   • Voltage drop
   • Ampere-hour rating
   • Applications

4. SERIES CIRCUITS [1 1/3 week]
   • Total resistance
   • Applying Ohm’s Law to series circuits
   • Voltage sources in series
   • Kirchhoff’s Voltage Law
   • Voltage divider rule
   • Potentiometers and rheostats
   • Grounds (positive and negative)
   • Troubleshooting
   • Signal-tracing
   • Opens and shorts
   • Applications
5. **PARALLEL CIRCUITS**  [1 2/3 weeks]
   - Nodes and branches
   - Kirchhoff’s Current Law
   - Total current
   - Total resistance
   - Conductance
   - Applying Ohm’s Law in solving parallel circuits problems
   - Signal tracing
   - Current divider rule
   - Power
   - Troubleshooting
   - **Applications**

6. **SERIES-PARALLEL**  [2 1/3 week]
   - Loops and Meshes
   - Signal-tracing a PC board
   - Redrawing the circuit
   - Total resistance
   - Calculating currents, voltages and power
   - Voltage dividers with resistive loads
   - Bipolar voltage dividers
   - Voltmeter loading
   - Wheatstone bridge
   - Superposition theorem
   - Thevenin’s theorem
   - Troubleshooting
   - Applications

7. **THE SINE WAVE**  [to be done in 3 lab periods]
   - Cycle, period, frequency
   - Radians, degrees
   - Peak, peak-peak, rms, effective, average_{360}, average_{180}, phase
   - Applying Ohm’s Law
   - Applying KCL and KVL
   - Dc and ac superimposed
   - Oscilloscope measurements
   - Function generator
   - Applications

8. **CAPACITORS**  [2 weeks]
   - Structure and characteristics
   - Energy storage
   - Coulomb’s Law
   - Voltage rating, temperature coefficient, leakage
   - Physical characteristics and capacitance
   - Types
   - Labeling
9. **INDUCTORS**  [1 week]
   - Structure and characteristics
   - Energy storage
   - Faraday’s Law
   - Lenz’s Law
   - Physical characteristics and inductance
   - Winding resistance and winding capacitance
   - Types
   - In series
   - In parallel
   - Induced voltage
   - Time constant
   - Inductor in dc circuits
   - Reactance and complex number representation
   - Phase shift
   - Power
   - Testing inductors
   - LC meter
   - Applications

10. **RESONANCE**  [1/2 week]
    - Series Resonance: $Q_{\text{CKT}}$, $Q_{\text{COIL}}$, and bandwidth
    - Parallel Resonance: $Q_{\text{CKT}}$, $Q_{\text{COIL}}$, and bandwidth

11. **TRANSFORMERS**  [1/2 Week]
    - The Basic Transformer
    - Step-Up Transformers
    - Step-Down Transformers
    - Loaded Secondary
    - Reflected Load
    - Matching Load and Source Resistances
    - The Transformer as an Isolation Device
# IEL104

## Electrical Circuits

### Activity Outline

<table>
<thead>
<tr>
<th>Week</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Metric Prefixes, Scientific Notation and Graphing (Buchla Lab 1)</td>
</tr>
<tr>
<td>2</td>
<td>Laboratory Meters and Power Supply (Buchla Lab 2)</td>
</tr>
<tr>
<td>3</td>
<td>Measurement of Resistance (Buchla Lab 3)</td>
</tr>
<tr>
<td>4</td>
<td>Voltage Measurement and Circuit Ground (Buchla Lab 4)</td>
</tr>
<tr>
<td>5</td>
<td>Ohm’s Law (Buchla Lab 5)</td>
</tr>
<tr>
<td>6</td>
<td>Power in DC Circuits (Buchla Lab 6)</td>
</tr>
<tr>
<td>7</td>
<td>Series Circuits (Buchla Lab 7)</td>
</tr>
<tr>
<td>8</td>
<td>The Voltage Divider (Buchla Lab 8)</td>
</tr>
<tr>
<td>9</td>
<td>Parallel Circuits (Buchla Lab 9)</td>
</tr>
<tr>
<td>10</td>
<td>Series-Parallel Combination Circuits (Buchla Lab 10)</td>
</tr>
<tr>
<td>11</td>
<td>The Superposition Theorem (Buchla Lab 11)</td>
</tr>
<tr>
<td>12</td>
<td>Thevenin’s Theorem (Buchla Lab 12)</td>
</tr>
<tr>
<td>13</td>
<td>The Sine Wave and AC Circuits I (Handout Lab Sheet 1)</td>
</tr>
<tr>
<td>14</td>
<td>The Sine Wave and AC Circuits II (Handout Lab Sheet 2)</td>
</tr>
<tr>
<td>15</td>
<td>The Sine Wave and AC Circuits III (Handout Lab Sheet 3)</td>
</tr>
<tr>
<td>16</td>
<td>Lab Practical Exam (if time permits)</td>
</tr>
</tbody>
</table>

This Course Outline was adapted from the Knowledge Depot of the Verizon Next Step Program and was developed by Stanley F. Smith, in concert with other Faculty of the Next Step Program.

Stanley F. Smith ● Onondaga Community College ● Rt. 173 ● Syracuse, NY 13104
Ph (315) 469-2456  Office  Fax (315)-469-2593  smiths@aurora.sunyocc.edu