BCIT®

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Course Outline

School of Manufacturing, Electronics and Industrial Processes
Program: Robotics
Option:

ELEX 2220
Digital and Electronic Circuits

Start Date:	January					**End Date:**	May				
Total Hours:	120	**Total Weeks:**	20			**Term/Level:**	2	**Course Credits:**	8		
Hours/Week:	6	**Lecture:**	3	**Lab:**	2	**Shop:**		**Seminar:**		**Other:**	1

Prerequisites

Course No.	Course Name
ELEX 1205	DC Circuit Analysis for Robotics
ELEX 1215	Digital Techniques 1 for Robotics
MATH 1342	Technical Math for Robotics 1

ELEX 2220 is a Prerequisite for:

Course No.	Course Name
ELEX 3321	Electronic Circuits 2 (Robotics)
ROBT 3351	Automation Equipment
ROBT 3356	Controller Systems

■ Course Description

The first half of this course covers: sequential logic devices such as D, J-K, and T flip-flops, counters, shift registers; electrical specifications; noise margins; propagation delay and loading considerations; interfacing to discrete devices; data multiplexing; bus structures; memory devices. The second half is an introductory electronics circuits course that provides the foundation for subsequent electronics courses in the Robotics program. The course covers: diodes and bipolar junction transistors; common emitter and common collector circuits and transistor switching; transistor biassing; field effect transistors; CMOS; frequency response of amplifiers; and power amplifiers. Lab work emphasizes logical circuit layout and wiring and the use of common test equipment to analyze and troubleshoot electronic circuits.

■ Course Goals

1. Apply the basic principles of digital electronics (from ELEX 1215) to subsequent courses, with emphasis on practical hands-on experience including troubleshooting skills.
2. Analyze, design and modify electronic circuits.
3. Build, test and troubleshoot electronic circuits using common laboratory test equipment.

■ Evaluation

Lab work	30%
Term work	40%
Final exam	30%
TOTAL	100%
Minimum passing grade	**50%**

Comments: Satisfactory completion of both the lab component and the theory component of this course is a requirement for a passing grade. BCIT policy states that where:

- either the lab or the theory component is failed,

and

- the average mark is above the pass mark; a grade of U (unsatisfactory) will be assigned.

Course Learning Outcomes/Competencies

Upon successful completion, the student will be able to:

TERM A: DIGITAL TECHNIQUES

1. LATCHES AND FLIP-FLOPS

Analyze and implement latches and flip-flops.

1.1 Define setup and hold time, rise and fall time, propagation delay, pulse width.
1.2 Implement a T flip-flop using J-K or D flip-flops.
1.3 Generate timing diagrams, state tables and state diagrams for latches and flip-flops.

2. MEASUREMENTS

Use the voltmeter, oscilloscope and frequency counter.

2.1 Use DVM, VOM, DC supply, to test/measure/troubleshoot logic circuits.
2.2 Use oscilloscope to display repetitive, non-repetitive digital waveforms.

3. COUNTERS

Analyze, design and use various counters such as decade, up/down, modulo N. Use IC monostable multivibrators.

3.1 Analyze, design and implement, asynchronous binary counters (up or down).
3.2 Analyze, design and implement modulo N counters.
3.3 Analyze design and implement logic circuits using monostable multivibrators.
3.4 Calculate propagation delay in sequential circuits.
3.5 Analyze and implement synchronous as well as presetable up/down counters.
3.6 Cascade counters.
3.7 Analyze, design and implement counter state decoders and 7 segment displays.
3.8 Show sequential logic timing relationships on the oscilloscope.
3.9 Generate timing diagrams, state tables and state diagrams for counters.
3.10 Analyze, design and implement basic storage register (PIPO).

4. SHIFT REGISTERS

Analyze, design and use various shift registers such as SIPO, PISO and L/R.

4.1 Analyze, design and implement, N bit shift register circuits such as SISO, SIPO and PISO using discrete flip-flops.
4.2 Analyze and implement SISO, SIPO, and PISO IC shift registers.
4.3 Analyze L/R shift register and show binary arithmetic application.
4.4 Cascade shift registers.
4.5 Generating timing diagrams, state tables and state diagrams for shift registers.
4.6 Analyze and design ring counter, Johnson counter.
4.7 Analyze parity error detection circuits.

5. ELECTRONIC CHARACTERISTICS AND SPECIFICATIONS OF TTL FAMILY

Use detailed specifications for digital ICs from the logic component data book.

5.1 Analyze totem pole, open collector, and tristate outputs listing differences, advantages and application.
5.2 Determine TTL I/O characteristics from TTL data book.
5.3 Calculate TTL noise margins, propagation delays, power dissipation.
5.4 Determine I/O characteristics of other TTL logic families using data book.

6. LOGIC CIRCUIT INTERFACE

Interface TTL logic to such devices as LEDs, transistors and relays.

6.1 Analyze and implement the transistor as a switch.
6.2 Interface TTL to LED, opto isolator, small signal power transistor as well as standard relays.
6.3 Describe the operation of standard and reed relays.

7. MULTIPLEXING

Analyze, design and implement a bus structure using multiplexing/de-multiplexing, decoding, and tri-state techniques.

7.1 Define the terms multiplexing and de-multiplexing.
7.2 Analyze and design digital multiplexor using TTL ICs and discrete gates.
7.3 Analyze common bus techniques using tristate and open collector devices.

8. MEMORY

Analyze RAM and ROM memory, and address decoding.

8.1 Define RAM and ROM memory, and their main features.
8.2 Analyze and design address decoding for memory clips.

TERM B: ELECTRONIC CIRCUITS

9. BASIC PRINCIPLES

Identify the symbols, terminology and characteristics of diodes and the bipolar junction transistor.

9.1 Explain depletion region formation and the effects of forward and reverse bias on a P-N junction.
9.2 Draw and interpret the I-V characteristic of a diode and a zener diode.
9.3 Specify the require bias polarities and explain the basic operation of a BJT.
9.4 Identify and use correct symbology and terminology for diodes and BJTs.
9.5 Demonstrate the use of basic laboratory test equipment.
9.6 Demonstrate the use of relevant electrical circuit concepts.

10. COMMON EMITTER CIRCUITS/THE TRANSISTOR SWITCH

Design and test a common emitter amplifier.

10.1 Describe and interpret the graphical characteristics of a BJT in the common emitter configuration.
10.2 Analyze and design a fixed base current DC bias circuit for a transistor connected as a CE amplifier.
10.3 Describe the connection of an AC input signal to a CE circuit and the resulting DC and AC equivalent circuits.
10.4 Analyze, design and test a small signal CE AC amplifier.
10.5 Explain the effects of transistor parameter variations on amplifier characteristics.
10.6 Describe the operation of a transistor switch.
10.7 Explain power dissipation considerations/worst case design.
10.8 Analyze, design and test single-transistor switch circuits.

11. THE COMMON COLLECTOR (EMITTER FOLLOWER) AMPLIFIER

Design and test a common collector amplifier.

11.1 Analyze, design and test a small signal emitter follower AC amplifier.
11.2 Use a transistor tester to measure transistor AC current gain.
11.3 Evaluate the comparative characteristics of the CE and CC configurations.

12. IMPROVED BIAS CIRCUITS

Design and test improved bias circuits using negative feedback.

12.1 Explain DC bias stability and the use of negative feedback to obtain the same.
12.2 Perform exact and approximate analysis to design voltage divider bias circuits.
12.3 Construct and evaluate a CE amplifier using voltage divider biasing.

13. FIELD EFFECT TRANSISTORS

Design and test field effect transistor circuits.

13.1 Explain the bias requirements and internal operation of a junction field effect transistor (JFET).
13.2 Draw and interpret the graphical characteristics of a JFET.
13.3 Identify and use correct JFET symbols and terminology.

13.4 Describe the use of a JFET as a constant current source and as a voltage variable resistor.
13.5 Analyze, design and test a common source JFET AC amplifier.
13.6 Use a transistor curve tracer to observe and match JFET characteristics.
13.7 Construct and evaluate a high input resistance JFET DC amplifier.
13.8 Describe the biasing, operation and transfer characteristics of MOSFETs (including VMOS).
13.9 Measure and plot the transfer characteristic of a power MOSFET.
13.10 Describe the operation of CMOS digital logic.

14. AMPLIFIER FREQUENCY RESPONSE

Analyze the frequency response of amplifiers.

14.1 Express amplifier voltage and power gain in decibels.
14.2 Define and identify on a gain-frequency plot: f1, f2, and bandwidth.
14.3 Analyze a typical amplifier circuit for low and high frequency rolloff in terms of the AC model.
14.4 Construct an AC equivalent circuit and predict, measure and plot the effects of coupling, bypass and shunt capacitances on the amplitude and phase response of the circuit.

15. POWER AMPLIFIERS

Design and test power amplifiers.

15.1 Explain the significance of the AC vs DC loadlines for an amplifier.
15.2 Explain the development of the "Totem Pole" emitter follower output stage.
15.3 Identify and explain the characteristics of the Darlington and complimentary Darlington transistor configuration.
15.4 Identify a complementary and quasi-complementary output stage.
15.5 Explain the function of each stage and analyze the DC and AC characteristics of several multi-stage power amplifiers.
15.6 Analyze and test a discrete component power amplifier and an integrated circuit power amplifier.
15.7 Describe the need for heatsinking of electronic components and perform the associated analysis and design.

Verification

I verify that the content of this course outline is current.

Norman WM Cassis

Authoring Instructor

Dec 23 2005.

Date

I verify that this course outline has been reviewed.

David Lewis

Program Head/Chief Instructor

DEC. 23, 2005

Date

I verify that this course outline complies with BCIT policy.

Dean/Associate Dean

Date

Note: Should changes be required to the content of this course outline, students will be given reasonable notice.

Instructor(s)

Norman Cousins	Office Location:	SW3-2905		Office Phone:	604-412-7588
	Office Hrs.:	As posted		E-mail Address:	norman_cousins@bcit.ca

Learning Resources

Required:

Digital Systems – Principles and Applications (Canadian Edition) by Tocci, Widmer, Moss, Jenness, Temple
Circuit Analysis with Devices by Robbins & Miller
ELEX 2220 Lab Manual
Lab Notebook
2 – reliable prototype breadboard (minimum 64 holes along length)
2 – Grayhill #76STC04 (4 SPDT) DIP switch (or equivalent)
2 – Augat machine wire wrap socket (or equivalent) for the DIP switches
2 – Switchcraft #903 (SPDT) pushbutton (or equivalent)
1 – Set of tools (small needlenose pliers, wire cutter, wire stripper, small screwdriver)
1 – Set of wires to power the breadboard
2 – 47 nF, 10 nF, 1 nF ceramic disc capacitors
8 – 100 nF ceramic disc capacitors
10 – LEDs or LED strip
1 – MAN 72 7-segment display or equivalent
1 – 74LSXX TTL ICs: 04, 06, 10, 27, 47, 74A, 75, 76A, 83A, 86, 90, 92, 93, 123, 139, 193, 273
2 – 74LSXX: 00, 02, 14, 244
2 – diodes IN914 or equivalent
1 – 2N3904 NPN transistor
1 – 2N3906 PNP transistor
6. –Alligator clips

Reference:

Electronic Devices and Circuit Theory (Canadian Edition) by Boylestad and Nashelsky
TTL Data book (by Texas Instruments)
The XYZs of Using a Scope from Tektronix

Information for Students

Assignments: Late assignments, lab reports or projects will **not** be accepted for marking. Assignments must be done on an individual basis unless otherwise specified by the instructor.

Makeup Tests, Exams or Quizzes: There will be **no** makeup tests, exams or quizzes. If you miss a test, exam or quiz, you will receive zero marks. Exceptions may be made for **documented** medical reasons or extenuating circumstances. In such a case, it is the responsibility of the student to inform the instructor **immediately**.

Ethics: BCIT assumes that all students attending the Institute will follow a high standard of ethics. Incidents of cheating or plagiarism may, therefore, result in a grade of zero for the assignment, quiz, test, exam, or project for all parties involved and/or expulsion from the course.

Attendance: BCIT policy states that students who are absent for any cause other than substantiated illness, for more than 10% of the time prescribed for the course/program may be prohibited from completing their program or courses.

Illness: A doctor's note is required for any illness causing you to miss assignments, quizzes, tests, projects, or exam. At the discretion of the instructor, you may complete the work missed or have the work prorated.

Attempts: Students must successfully complete a course within a maximum of three attempts at the course. Students with two attempts in a single course will be allowed to repeat the course only upon special written permission from the Associate Dean. Students who have not successfully completed a course within three attempts will not be eligible to graduate from the appropriate program.

Course Outline Changes: The material or schedule specified in this course outline may be changed by the instructor. If changes are required, they will be announced in class.

■ Assignment Details

TERM A: DIGITAL TECHNIQUES

Labs:

1. Basic trouble-shooting techniques
2. Measurements in digital electronics (using the oscilloscope)
3. Flip-flops and the oscilloscope
4. Binary counters and the oscilloscope
5. Mod N counters and associated waveforms
6. Monostables and programmable counters
7. Decade counting assembly
8. Interfacing TTL
9. The data bus

TERM B: ELECTRONIC CIRCUITS

Labs:

1. Test equipment
2. Diode and transistor characteristics
3. Transistor output characteristics
4. The common emitter amplifier
5. The emitter follower amplifier
6. The JFET amplifier
7. Power MOSFET
8. Amplifier Frequency Response
9. Power amplifiers