SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: ELECTRONIC CIRCUIT ANALYSIS and DESIGN

CODE NO.: ELN 320-7 SEMESTER: FIFTH

PROGRAM: ELECTRONIC ENGINEERING TECHNOLOGY (4023)

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APPROVED: _____ 94-08-29
DEAN DATE

ELECTRONIC CIRCUIT ANALYSIS and DESIGN — Course name

ELN 320 — Code No.

TOTAL CREDITS 7

PREREQUISITE: ELN 311 NETWORK ANALYSIS

ELN 245 COMMUNICATIONS SYSTEMS

I. PHILOSOPHY/GOALS: This project oriented course is intended to develop the students ability to apply design and analysis techniques and reporting skills to project oriented tasks.

II. STUDENT PERFORMANCE OUTCOMES:

Upon successful completion of the course, participants will be able to:

1) Design printed circuit board layout for testability and manufacturability.

2) Import Smartwork PCB layout into HIWIRE, and print size 1-to-1 PCB artwork on a laser printer.

3) Import schematic diagrams, PCB layout and MathCad files into a Word Perfect text document.

4) Plot graphics files, such as schematics, PCB and curves on a pen plotter.

5) Design heat-sinks for power electronic components.

6) Analyze and design electronic circuits; such as linear and pulse amplifiers, linear and switched mode power converters and pulse generators.

7) Complete all phases of an electronic circuit project, including design, manufacturing and documentation.

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III. TOPICS TO BE COVERED: — **Approximate time frame** Theory/Laboratory hours

Block 1: Schematic capture and PCB design. 2/3

Block 2: Heatsink design. 3/6

Block 3: Two port parameters. 3/0

Block 4: Linear Voltage and Current Regulator design. 9/9

Block 5: Switched Mode Power Supply design. 15/9

Block 6: Pulse and clock generator design. 3/3

Project1 Design and build a Step-down Switched Mode Power Supply. 1/9

Project 2 Design and build a Flyback Transformer. . . . 1/3

Testing 6/3

IV. LEARNING ACTIVITIES/REQUIRED RESOURCES

Block 1: Schematic capture and PCB design.

Topic description:

- Load the Equation Keyboard in Word Perfect and assign mathematical and scientific characters to keys on your keyboard.
- Generate ASCII characters from 1 to 255 and include them in your document.
- Use ctrV to generate Math/Scientific characters in Word Perfect.
- Set up a pen plotter and a laser printer for printing from Hiwire, Smartwork and MathCad.
- Create HPGL graphic plot files and import them into Word Perfect. Edit a graphic file in Word Perfect.
- Generate a HIWIRE symbols library for MOSFETs, PWMs and other analog and digital ICs.
- Printed circuit board layout concepts, for testability and manufacturability.

Learning activities:

Follow a demonstration on the procedures of graphics file import, editing, printing and plotting. Use the principles learned in editing your project reports.

Listen to a lecture on printed circuit board design.

Required resources:

Hiwire, Smartwork, MathCad and Word Perfect software available in the laboratory.

IBM compatible PC, mouse, dot matrix printers, laser printer, pen plotter also available in the laboratory.

Handouts will be provided.

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Block 2: Heat-sink design.

Topic description:

- Dissipated power in a semiconductor junction.
- The definition of the thermal resistance.
- Junction to case, case to heatsink and heatsink to air thermal resistance.
- Heat flow and the electrical equivalent to heat flow equations.
- Temperature rise versus dissipated power characteristics.
- Design examples.

Learning activities:

Listen to lectures on heat-sink design. Solve assigned homework problems. Perform a heat-sink related laboratory experiment.

Required resources:

Overheads, handouts, laboratory equipment.

Block 3: Two port parameters applied to BJTs.

Topic description:

- Black box theory.
- The hybrid defining equations.
- Two port, hybrid equivalent network.
- The definition of the short circuit output and the open circuit input hybrid parameters.
- Two port device connected to source and load.
- Hybrid parameters applied to BJT's.
- The meaning of h_{11} , h_{12} , h_{21} and h_{22} .
- CE, CB, and CC hybrid equivalent circuits.
- Input and output impedance, voltage gain and current gain of a transistor amplifier, based on hybrid parameters.
- How to read h parameters from the data book.

Learning activities:

Manufacturers data books specify the hybrid transistor parameters. Participants will learn how to interpret and use hybrid parameters in amplifier design.

Required resources:

Overheads, handouts, MathCad software and access to the computers available in the laboratory.

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Block 4: Power MOSFET transistors.

Topic description:

- MOSFET structure, operation and physics.
- Advantages of power MOSFETs.
- Basic characteristics of power MOSFETs.
- Safe operating areas.
- Gate drive requirements.
- Gate drivers for power MOSFETs.

Learning activities:

Listen to lectures on MOSFET theory and applications. Learn how to test a MOSFET in the laboratory.

Required resources:

Overheads and handouts. A relevant book by Motorola is available in the college library. (Power MOSFET transistor data.)

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Block 5: Linear Voltage and Current Regulators.

Topic description:

- Line and load regulation.
- Classes of voltage regulators.
- Linear shunt regulators.
- Linear series regulators.
- Overvoltage and short circuit protection.
- Monolithic integrated circuit voltage regulators.
- Programmable voltage regulators.
- Current source and current sink regulators.
- Design examples.

Learning activities:

Listen to lectures on linear voltage and current regulators. Perform laboratory experiments with linear regulator chips.

Required resources:

Overheads, handouts. Relevant text: Motorola, Linear/Switchmode Voltage Regulator handbook, available in the college library.

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Topic description:

- Classes of Switched Mode voltage regulators.
- Buck, Boost, and Buck-Boost Converters.
- BJT and MOSFET switches.
- Continuous Current Mode (CCM) and Discontinuous Current Mode (DCM) of operation.
- Voltage Mode and Current Mode topologies.
- Switched mode voltage regulators in a closed loop.
- Hysteretic control, variable frequency, variable pulse width, constant on-time, constant off-time controls.
- Isolated switched mode power supplies.
- The DC to DC transformer concept.
- The Forward Converter.
- The Flyback Converter.
- Switched mode constant current source.

Learning activities:

Lectures will cover the classification, functioning and design of switched mode power supplies. Different model switchers will be built in the laboratory.

Required resources:

Theory class and laboratory handouts will be supplied. A number of relevant reference books are available in the college library:

1. Rudolf P. Severns and Gordon Bloom, Modern DC-to-DC Switchmode Power Converter Circuits.

2. Eugene R. Hnatek, Design of Solid State Power Supplies.

3. Keith H. Billings, Switchmode Power Supply Handbook.

4. Abraham I. Pressman, Switching Power Supply Design.

5. George Chryssis, High Frequency Switching Power Supplies: Theory and design.

6. Motorola, Practical Switched Mode Power Supply design.

Block 7: Pulse and Clock Generator design.

Topic description:

- The exponential equation of a charging capacitor.
- Generators based on TTL and CMOS gates.
- Generators based on Schmitt triggers.
- Generators with integrated monostable multivibrators.
- Monolithic integrated circuit pulse generators.
- Crystal clock oscillators.
- Logic controlled run-stop oscillators.
- Pulse triggered pulse burst generators.
- The generation of a predetermined number of pulses.
- Design examples.

Learning activities:

Listen to lectures on pulse generators. Complete relevant laboratory experiments.

Required resources:

Handouts and overheads. Components and test instruments for the experiments available in the laboratory.

V. EVALUATION METHODS:

Four written tests will be conducted. Quizzes may be given without prior notice. Design assignments and hardware projects will carry the same weight as theory tests.

Grading:

Grading is done using the following definitions:

- Consistently outstanding performance.....A+ (90-100)%
- Outstanding performance.....A (80- 90)%
- Above average performance.....B (70- 80)%
- Satisfactory performance.....C (55- 70)%
- Unsatisfactory performance.....R (< 55)%

Upgrading:

a) If a test is missed for reasons whatsoever, the grade for that test is 0 unless a very good and credible reason can be given for the absence.

b) The method of upgrading is at the teachers discretion. It may consist of the rewriting of block tests, the writing of comprehensive examination, repeating laboratory experiments or repeating the course.

c) No upgrading tests will take place during the semester. All rewrites will be scheduled during the last week of the semester.

d) In the case of final marks less than 55% and greater than 50%, provided an 80% or better attendance record, consideration will be given to a supplemental examination covering the whole course. The grades that can be obtained on the supplemental are either a "pass" or a "fail".

Attendance:

a) Attendance for laboratory classes is compulsory. Laboratory activities missed for reasons whatsoever must be completed during the students own time.

b) Attendance for all theory classes is highly recommended and recorded, but not mandatory.

c) Anyone with an accumulated attendance record of less then 80% at the end of the semester, and who is also in a failing condition, can expect to have to repeat the course, with no rights to write a make-up test.