SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ON

COURSE OUTLINE

COURSE TITLE: COMMUNICATIONS CIRCUITS AND SYSTEMS

CODE NO.: ELN 237-9 SEMESTER: THIRD

PROGRAM: ELECTRONIC ENGINEERING TECHNICIAN (4024)

AUTHOR: PETER SZILAGYI

DATE: SEPT. 1995 PREVIOUS OUTLINE DATED: SEPT. 1994

APPROVED: _____ 95-08-29
DEAN DATE

COMMUNICATIONS CIRCUITS AND SYSTEMS
Course name

ELN 237
Code No.

TOTAL CREDITS 9

PREREQUISITE: ELN 109 ELECTRONIC CIRCUITS
MTH 143 MATHEMATICS

I. PHILOSOPHY/GOALS: A first course in analog electronic communications, intended for the through-way Electronic Technician/Technologist program. The level of treatment presupposes previous knowledge of basic electric circuits, electronics and mathematics.

II. STUDENT PERFORMANCE OUTCOMES:

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

1) Understand the theoretical fundamentals of the generation, transmission and reception of radio communication signals.

2) Understand the concept of impedance matching, modulation, mixing, demodulation, bandwidth, carrier, sideband, noise, and distortion.

3) Recognise, test and align active and passive radiofrequency communication circuits, such as resonant circuits, LC filters, coupling and impedance matching networks, oscillators, amplifiers, modulators and detectors.

4) Draw up the block diagrams of AM/FM radio transmitters and receivers, and read the schematic diagrams of such equipment.

5) Use sophisticated laboratory and test equipment, such as RF signal generators, sweep oscillators, RF power meters, impedance meters and decibel meters.

6) Test, align and troubleshoot AM/FM radios.

III. TOPICS TO BE COVERED: **Approximate time frames**

BLOCK 1: PASSIVE RF CIRCUITS. 25 hours

1.1 RESONANT CIRCUITS
- series LCR circuits.
- parallel LCR circuits.
- quality factor, impedance, selectivity and bandwidth.

1.2 RF FILTERS
- constant "k" filters.
- "m" derived filters.
- high pass, low pass, band pass and band stop filters.
- Γ, T and π networks
- half section and full section filter networks.

1.3 COUPLING
- introduction to coupling.
- broad band rf coupling.
- narrow band rf coupling.
- tuned rf transformers.

1.4 IMPEDANCE MATCHING
- introduction to impedance matching.
- matching a high impedance generator to a low impedance load.
- matching a low impedance generator to a high impedance load.
- tuned-coupled matching circuits.
- parallel to series transformations.
- matching with rf filters.
- L, T and π matching networks.

BLOCK 2: RF AMPLIFIERS and OSCILLATORS 15 hours

2.1 SMALL SIGNAL CLASS "A" RF AMPLIFIERS
- FET amplifiers.
- BJT amplifiers.
- IC amplifiers.
- coupling and decoupling.
- impedance matching in rf amplifiers.
- gain control and stability.
- narrow band and broad band amplifiers.

2.2 LARGE SIGNAL RF (POWER) AMPLIFIERS
- definition of related terms: Input and output power, dissipated power, load resistance, efficiency
- class "C" biasing and flow angle.
- input and output impedance matching.
- load impedance for a given power.
- push-pull amplifiers.
- frequency multipliers.

2.3 RF OSCILLATORS
- positive feedback.
- Barkhausen conditions.
- ac equivalent circuits.
- interelement capacitance of active components.
- frequency stability of oscillators.
- representative oscillators (Hartley, Colpits, Clapp, Armstrong, Ultra-Audion).
- crystal oscillators (Pierce, Miller, Overtone).

BLOCK 3: AMPLITUDE MODULATION 20 hours

3.1 AM FUNDAMENTALS
- linear addition of sine waves.
- nonlinear mixing.
- AM waveform in time domain.
- AM signal in frequency domain.
- modulation index.
- AM analysis.
- circuits for AM generation (base modulator, collector modulator, linear IC modulator).
- high level and low level modulation.

3.2 AM TRANSMITTER SYSTEMS
- a typical AM transmitter
- transmitter measurements.

3.3 AM RECEPTION
- receiver characteristics (selectivity and sensitivity).
- diode square-law detectors.
- synchronous detectors.

3.4 SUPERHETERODYNE RECEIVERS
- frequency conversion.
- receiver block diagram (rf amp, mixer, local oscillator, IF, detector and audio amp.)
- tuning and alignment.
- automatic gain control (AGC).
- image frequency.
- AM broadcast superheterodyne.
- linear IC AM receiver.

3.5 SINGLE-SIDE-BAND COMMUNICATIONS
- basic SSB concepts, advantages and disadvantages.
- time domain, frequency domain and phasor representation of SSB signals.
- balanced modulators (push-pull, ring, LIC).
- SSB filters (LC, crystal, ceramic and mechanical).
- filter method and phase method of SSB generation.
- SSB demodulation: second mixer and BFO.
- SSB receivers.

BLOCK 4: FREQUENCY MODULATION 20 hours

4.1 FM PRINCIPLES
- angle modulation.
- the amount and rate of deviation.
- FM mathematical analysis.
- side frequencies from Bessel functions.
- broadcast and narrow-band FM standards.
- FM noise analysis and capture effect.
- preemphasis and deemphasis. (Dolby system).

4.2 FM GENERATION
- direct method (capacitance microphone, varactor diode, reactance modulator, VCO, Crosby modulator).
- indirect method (Armstrong modulator).
- PLL FM transmitter.

4.3 FM RECEIVERS
- composite modulating signals.
- block diagram of FM receivers.
- limiting and sensitivity.
- rf amplifiers and limiters.
- discriminators (slope detector, Foster-Seely, ratio detector, quadrature detector, coincidence detector, PLL).

4.4 STEREOPHONIC BROADCASTING
- block diagram of transmitter.
- block diagram of receiver.
- composite modulating signals.
- stereo demodulation (decoding) and LIC stereo decoders.
- SCA signal and SCA PLL decoder.

COMMUNICATIONS CIRCUITS AND SYSTEMS — ELN 237
Course name — Code No.

IV. LEARNING ACTIVITIES/REQUIRED RESOURCES

Block 1: Passive RF Circuits

Learning activities:

Listen to lectures on series and parallel resonant circuits, LC filters, coupling and impedance matching circuits. Relevant equations will be developed from first principles. Numerical examples and laboratory experiments will support all aspects of circuit theory. Homework will be assigned at the end of each theory class.

Resources:

Communications Circuits, Study material, chapters 1, and 2, overheads, handouts, laboratory equipment.

****

Block 2: RF amplifiers and oscillators.

Learning activities:

Listen to lectures on RF voltage and power amplifiers, LC and crystal oscillators. Complete relevant laboratory experiments. Work out all assigned homework problems.

Resources:

Communications circuits, Study material, chapters 3, 4 and 5, overheads, handouts, laboratory equipment.

****

Block 3: Amplitude modulation.

Learning activities:

Lectures on AM and SSB modulation, transmitters and receivers will cover all topics of Block 3. Students will complete AM and SSB related laboratory experiments and will solve homework assignments.

Resources:

Miller: Modern Electronic Communications, chapters 1, 2 3, and 4, overheads, handouts, laboratory equipment.

Block 4: Frequency modulation.

Learning activities:

Lectures will cover FM principles, methods of FM generation and reception and stereophonic broadcasting. FM related laboratory experiments will be conducted. Homework will be assigned.

Resources:

Miller: Modern Electronic Communications, chapters 5 and 6, overheads, handouts, laboratory equipment.

V. EVALUATION METHODS:

Testing:

a) Written tests based upon theory objectives will occur following the completion of each theory block and with about a week of advance notice. Short written quizzes may occur at any time without advance notice.

b) Testing of laboratory objectives will occur concurrent with the specific laboratory activity.

Grading:

a) 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)%

b) The grading of laboratory type objectives will be in two parts: The demonstrated ability to perform a skill function, e.g. use an instrument in a specified role or trouble shoot a circuit, will be graded "C". Failure to demonstrate the skill function will be graded "R". Subjective evaluation of lab reports, supporting theory, deportment, housekeeping etc., will be used to modify the skill function grade upward, where applicable.

c) Laboratory reports are due one week after the scheduled date of completion for a given laboratory experiment. Late reports are penalized 5% per day.

d) The grading weight will be 30% for the laboratory and 70% for the theory.

e) A final overall accumulated mark of 55% is the minimum requirement for course credit with the added restriction that neither the theory or the lab part of the course can be less then 55%.

f) A failing grade on more then half the classroom theory tests during the semester leads directly to an "R" grade.

g) Failing one third of the semesters theory tests excludes a final "A" grade, regardless the theory average.

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 "C" grade or an "R" grade.

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.