SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

Course Title: MEASUREMENTS

Code No.: ELR 101

Program: ELECTRICAL/ELECTRONIC TECHNOLOGY

Semester: TWO

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New: XX Revision: ______

APPROVED: Chairperson ______ Date Dec. 17/85

MEASUREMENTS
Course Name

ELR 101-3
Course Number

PHILOSOPHY/GOALS:

1. To provide a sound understanding of the operating principles, characteristics and limitations of electrical/electronic measuring devices.

2. To provide hands-on use of all commonly used electrical/electronic measuring instruments.

3. To familiarize the student with the manufacturers manuals.

METHOD OF ASSESSMENT (GRADING METHOD):

1. Written tests will be held at the end of one or more blocks of work, usually at least one week's notice will be given. Test questions may cover work from previous blocks

2. Short quizzes may be given without notice.

3. Laboratory log books are to be maintained and must be ready for assessment one week after completion of the laboratory session.

4. Each student will be subject to continuous evaluation in the laboratory, with emphasis on skill in the use of tools, test equipment, work habits, effort, participation and attitude.

5. Students are reminded that all laboratory sessions are compulsory.

Course weighting:

Theory 60%
Practical 40%

assigned grades are:

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

In the case of final marks less than 55% and greater than 50%, consideration will be given to a supplemental examination covering the whole course. The maximum mark that can be obtained on the supplemental is 55%

In the case of final marks less than 50%, there will not be an opportunity to write a supplemental examination and an R grade will be assigned.

TEXTBOOK(S):

COURSE OBJECTIVES

LECTURE	LAB	TOPIC
3	0	**INTRODUCTION** Historical development Measurement and error: accuracy, precision, significant figures and types of errors Units of measurement: fundamental and derived, SI units. Measurement standards: National Research Council, National Bureau of Standards
3	0	**BASIC DEFLECTION INSTRUMENTS** Controlling, deflecting and damping forces. Permanent Magnet Moving Coil (PMMC) instruments Moving iron instruments Electrodynamic or dynamometer instruments Sources of errors and limitations
3	6	**VOLTMETERS, AMMETERS AND OHMMETERS** Correct usage Multiplers Shunts Current and potential transformers Series and shunt ohmmeters VOM (Simpson 260) Loading effect Digital multimeters Component testing
2	6	**OSCILLOSCOPE** Block diagram Deflection system Internal and external triggering Delayed triggering Oscilloscope specifications Storage oscilloscopes Calibration, adjustments and use of probes, component testing Curve tracing
1	2	**DIGITAL INSTRUMENTS** Multimeters (Block diagram) Frequency counters Tachometers

2	4	<u>SIGNAL GENERATORS</u>
		Audio Function Pulse R.F.
2	4	<u>LABORATORY POWER SUPPLIES</u>
		Basic power supply Filtering Voltage regulation Series-pass regulations Feedback regulators Switching regulators Current limiting Overvoltage protection
2	4	<u>RL AND C MEASUREMENT</u>
		Volt-ammeter method Wheatstone bridge Kelvin bridge Universal bridge Sencore Z meter
1	4	<u>POWER MEASUREMENT</u>
		Wattmeters 3 phase and 1 phase power measurement Tong-test ammeters and voltimeters Bridge megger Wee megger Industrial analyzer

BLOCK 1 - INTRODUCTION TO MEASUREMENTS

SPECIFIC OBJECTIVES

1. Student shall be familiar with the historical development of the science of measurement and the development of general units and standards.

2. To become familiar with the six basic units of measurements as outlined by the International System of Units (SI):
   a) length - meter (m)
   b) time - second (s)
   c) mass - kilogram (kg)
   d) temperature - kelvin (k)
   e) Electric current - ampere (A)
   f) Liminous intensity - candela (cd)

3. Recall that the above basic units of measurements are a modernized version of the metric system and that all other SI units are derived from these six basic units.

4. Recall that the National Bureau of Standards (NBS) in the USA and the National Research Council (NRC) in Canada are responsible for the establishment and maintenance of the SI standards in the USA and Canada respectively.

5. Recall the characteristics of good measurement.

6. Recall that in measurements, precision is a necessary prerequisite to accuracy, but precision does not guarantee accuracy.

7. Become familiar with the 3 main types of errors and how these errors may be reduced.

BLOCKS 2 & 3 - BASIC DEFLECTION INSTRUMENTS

The student shall become thoroughly familiar with the operation of the instruments in this block. He shall be able to use manufacturer's manuals for the various instruments and be able to determine their applications, ranges, accuracy, specifications, limitations, precautions and operating procedures and any other pertinent data.

The student shall be able to:

1. Recall 5 requirements of a good meter.
2. Recall that a moving coil meter movement responds to DC current only.
3. Explain the operation of a basic moving coil meter movement with the aid of a fully labeled diagram.
4. Recall that the sensitivity of a meter movement is the amount of current (Im) required to produce full-scale deflection (fsd).
5. Recall that the internal resistance (Rm) of a meter movement is the DC resistance of the coil.
6. Recall that the ohms-per-volt rating is related to meter sensitivity.
7. Determine experimentally the sensitivity (Im) of a meter movement.
8. Determine experimentally the internal resistance (Rm) of a meter movement.
9. Determine the amount of error in reading any instrument when the accuracy is known.
10. Design a voltmeter using a meter movement and multiplier resistors.
11. To determine the percent error between the calculated (true) and measured (apparent) readings.
12. Recall the precautions that must be observed in using voltmeters.
13. To determine the ohms-per-volt rating of a voltmeter.
14. Explain how the loading effect of a voltmeter causes errors in meter readings.
15. Recall the precautions to be observed when measuring current with an ammeter.
16. Calculate the percent error between measured and calculated current readings.
17. Design an ammeter using a basic meter movement and a shunt resistor.
18. Design a multi-range ammeter using an Ayrton shunt.

19. Verify experimentally the value of the shunt required to convert a meter movement into a milliameter of a specified range.

20. To determine the insertion effects of an ammeter in an actual circuit.

21. Recall the precautions that must be observed when using an ohmmeter.

22. Design a series type ohmmeter from a basic meter movement.

23. To calibrate an ohms scale for the series-type ohmmeter.

24. To design a shunt ohmmeter circuit.

25. To design a multirange ohmmeter.

26. Using the schematic diagram of a Simpson 260 VOM to draw out the circuit applicable to the DC voltage ranges, DC current ranges, AC voltage

BLOCK 4 - OSCILLOSCOPE

The student shall be able to:

1. Explain with the aid of a block diagram, the operation of an oscilloscope.
2. Set up and calibrate an oscilloscope and probe.
3. Measure frequency, phase angle, time delay, voltage, dc components of pulsating waveforms.
4. Dynamically test diodes, zener diodes, curve tracing.
5. Measure rise time, fall time, time delay, storage time, pulse width, tilt and overshoot of pulses.
6. Use an oscilloscope for frequency-domain display.
7. Use an oscilloscope with intensity modulation.
8. Correctly use an oscilloscope with common ground and floating ground.
9. Display envelopes using external triggering.

BLOCK 5 - DIGITAL INSTRUMENTS

The student shall be able to:

1. Explain with the aid of a block diagram the basic operation of digital multimeter and discuss its advantages as compared to a VOM, eg: Simpson Model 260.

2. Correctly use a digital multimeter to measure resistance, voltage, and current.

3. Correctly use a frequency counter to measure frequency.

4. Correctly use contacting and non-contacting tachometers.

BLOCK 6 - SIGNAL GENERATORS

The student shall be able to:

1. Explain with the aid of a schematic diagram the operation of a sine wave generator.

2. Correctly use a sine-wave generator.

3. Explain with the aid of a diagram the operation of pulse and square wave generators.

4. correctly use pulse and square wave generators.

5. Explain with the aid of a block diagram the operation of a function generator.

6. Correctly use function generators.

7. Explain with the aid of a schematic the operation of an RF signal generator.

8. Correctly use an RR signal generator.

BLOCK 7 - LABATORY POWER SUPPLIES

The student shall be able to:

1. Explain with the aid of achematic the operation of a simple full-wave power supply including capacitor and pi filters.

2. To determine the source impedance and the voltage regulation of a power supply.

3. Explain with the aid of schematics the following types of voltage regulators:

    1. Zener diode
    2. Series pass
    3. Feedback
    4. A switching regulator

4. Correctly connect a voltage supply to provide

    1. a positive potential with respect to common
    2. a negative potential with respect to common
    3. a dual polarity output

5. Recall the need for and the methods of providing overvoltage and output

cu:

BLOCK 8 - MEASUREMENT OF RESISTANCE

using the methods and test equipment listed below:

a. Volt-ammeter method
b. Wheatstone bridge
c. Kelvin bridge
d. Marconi Universal Bridge TF 2700
e. General Radio Impedance Bridge 1650
f. AVO Universal Measuring Bridge
g. Sencore Z Meter

The student shall be able to:

1. Describe the procedure for measuring resistance using the above instrumens and methods.

2. Solve problems using th circuits listed in (a) and (g).

4. To become familiar with the proper handling and application of the above instruments.

BLOCK 9 - POWER MEASUREMENT

The student shall be able to:

1. Recall and explain the operation of a wattmeter, and be able to correctly connect and measure dc and single-phase ac power.

2. Correctly connect wattmeters, with or without current transformers, to measure three-phase power using the two-wattmeter method.

3. Correctly use tong-test ammeters and voltmeters.

4. Explain with the aid of a sketch the principle of a Wee Megger.

5. Measure evaluation resistance and continuity using a Wee-Megger.

6. Measure resistance and insulation resistance using a bridge megger.

7. Measure power, voltage, current and phase sequence using an industrial analyzer.

8. Explain the operation of an RF power meter and its use.