

ELECTRONICS AND INSTRUMENTATION
LABORATORY DEVELOPMENT PROJECT REPORT

AUGUST, 1992 - DECEMBER, 1994

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ABSTRACT

THE TWO-SEMESTER SEQUENCE OF ELECTRONICS COURSES AND LABORATORIES AT GUSTAVUS ADOLPHUS HAS UNDERGONE A REDEVELOPMENT WITH THE ASSISTANCE OF AN NSF-ILI GRANT RECEIVED IN 1992.¹ NEW TEST EQUIPMENT FOR 15 STATIONS HAS PERMITTED MUCH GREATER EFFICIENCY IN HYPOTHESIS TESTING AND QUANTITATIVE ANALYSIS OF CIRCUIT PERFORMANCE. OTHER NEW FEATURES INCLUDE AN INTRODUCTION TO THE PSPICE CIRCUIT SIMULATOR, A PROJECT COMPONENT IN THE SECOND COURSE, AND TOPICS IN ELECTROMAGNETIC INTERFERENCE.

¹NSF GRANT NO. USE-9251608

EQUIPMENT AND SOFTWARE PURCHASED:

	<u>UNIT COST</u>
16 TEKTRONIX 2212 A/D STORAGE O-SCOPES WITH PRINTER AND RS232C INTERFACES	\$2,120
15 CANON BUBBLEJET BJ10ex PRINTERS	\$300
15 LEADER LFG-1300S FUNCTION GENERATORS	\$474
15 FLUKE 45 DUAL-DISPLAY DMM WITH IEEE-488	\$611
15 KENWOOD 18-3 DC POWER SUPPLIES	\$302
2 SENCORE LC-101 DIGITAL LC METERS	\$995
2 GLOBAL SPECIALTIES 4001 PULSE GENERATORS	\$190
4 HEATHKIT ET3700 CIRCUIT TRAINERS	\$150
4 SOUNDBLASTER CARDS	\$95
1 SPECTRA PLUS SOFTWARE PACKAGE	\$250
 TOTAL PROJECT BUDGET	 \$70,516
NSF PORTION	\$23,000
COLLEGE PORTION	\$47,516

ELECTRONICS AND INSTRUMENTATION I
SPRING 1995

TEXT: ANALOG AND DIGITAL ELECTRONICS FOR SCIENTIFIC APPLICATIONS,
DENNIS BARNAAL (WAVELAND PRESS)

CHAPTERS & TOPICS (CLASS MEETS THREE TIMES A WEEK)

A1 PASSIVE COMPONENTS AND NETWORKS, PSPICE

A2 DECIBELS AND CABLES (SELECTED SECTIONS)

A4 DIODES AND POWER SUPPLIES (SUPPLEMENTS)

FIRST HOUR EXAM

A5 AMPLIFIER BEHAVIOR [EXCELLENT COVERAGE]

A6 OPERATIONAL AMPLIFIER AND ELECTRONIC
FUNCTION BLOCKS

SECOND HOUR EXAM

A8 DISCRETE ELECTRONIC DEVICES (OMIT TUBES;
SUPPLEMENTS)

THIRD HOUR EXAM

D1 DIGITAL LOGIC ELEMENTS (OMIT OBSOLETES)

D2 GATE CIRCUITS

INTRODUCTION TO ELECTROMAGNETIC INTERFERENCE
(SUPPLEMENTS AND DEMONSTRATIONS)

COMPREHENSIVE FINAL EXAM

ELECTRONICS AND INSTRUMENTATION II
SPRING 1995

TEXTS: ANALOG AND DIGITAL ELECTRONICS FOR SCIENTIFIC APPLICATIONS,
DENNIS BARNAAL

THE ART OF ELECTRONICS (SECOND ED.), HOROWITZ & HILL

TOPICS AND SOURCES (CLASS MEETS ONCE A WEEK)

FLIP-FLOPS AND DISPLAYS (TEXTS AND OVERHEADS)

COUNTERS AND REGISTERS (TEXTS AND OVERHEADS)

WAVEFORM SHAPING AND ONE-SHOTS (TEXTS & OH)

TIMERS AND WAVEFORM GENERATORS (TEXTS & OH)

HOURLY EXAM OVER FIRST 5 CLASSES

DIGITAL TO ANALOG CONVERSION (TEXTS)

ANALOG TO DIGITAL CONVERSION (TEXTS & OH)

NOISE COUPLING MECHANISMS (REFERENCES)

NOISE MITIGATION TECHNIQUES (REFS)

FILTERS (H&H TEXT)

LOCK-IN TECHNIQUES (H&H TEXT, REFS)

PROJECT REPORTS AND DEMONSTRATIONS

FINAL EXAM (CLOSED-BOOK/OPEN-BOOK)

ELECTRONICS AND INSTRUMENTATION I EXPERIMENTS

RLC BLACK BOXES (TWO WEEKS)

DIODE CHARACTERISTICS AND CIRCUITS

RECTIFICATION, FILTERING, AND REGULATION (TWO)

OP AMP CHARACTERISTICS AND APPLICATIONS (TWO)

TRANSISTOR CHARACTERISTICS AND AMPLIFIERS (TWO)

TTL LOGIC CHARACTERISTICS AND CIRCUITS (TWO)

ELECTRONICS AND INSTRUMENTATION II EXPERIMENTS

FLIP-FLOPS

COUNTERS AND SHIFT REGISTERS

WAVESHAPING AND MULTIVIBRATORS

COUNTER APPLICATIONS & INTERFACING

TRACKING A/D CONVERSION

VCO AND PHASE-LOCKED LOOPS

PROJECTS (SIX WEEKS)

TYPICAL ELECTRONICS AND INSTRUMENTATION II PROJECTS:
[TWO JANUARY TERMS AND ONE SPRING SEMESTER]

CONSTRUCTION AND TESTING OF A REFLEX TIMER (*ELECTRONICS NOW*)

FREEZE FRAME STROBE (*ELECTRONICS NOW*)

AUDIO PERFORMANCE OF MESSAGING CHIP ISD-1016

ELECTRONIC THERMOSTAT (*ELECTRONICS NOW*)

MODEL LOCK-IN AMP DEMONSTRATION & CHARACTERIZATION (*AJP*)

IR PULSE WIDTH ENCODED REMOTE RELAY BANK (ORIGINAL)

MANUAL/COMPUTER-CONTROLLED STEPPER MOTOR DRIVER WITH LIMIT SWITCH
(ORIGINAL)

CODE-PROTECTED COUNT-DOWN EVENT INITIATOR (ORIG.)

ANALYSIS OF LNS TECHNOLOGIES DIGITAL SPEECH CHANGER (*ELECTRONICS
NOW*)

CONSTRUCTION OF A CCD CAMERA (*CCD CAMERA COOKBOOK*)

PHASE MEASUREMENT WITH LEAD-LAG DETECTION (*AJP*)

CONVERSION OF A DYNAMIC HYSTERESIS MEASUREMENT SYSTEM FROM APPLE
II TO IBM COMPATIBLE (ORIGINAL)

SET UP AND ALIGNMENT OF FM TRANSCEIVER BOARDS (ORIGINAL)

ELECTROMAGNETIC COMPATIBILITY TOPICS

EXAMPLES OF OPENING DEMONSTRATIONS:

INTERFERENCE OF FM TUNERS (LOCAL OSC. RADIATION)
COMPUTER, OSCILLOSCOPE EMI WITH FM/AM RADIOS
CRT DISTORTION DUE TO LOCAL AC SOURCES

EXAMPLES AND CASE STUDIES AS MOTIVATION:

HITTING OF BRITISH WARSHIP IN FALKLANDS BY EXOCET MISSILE WHILE
JAMMING COUNTERMEASURES WERE OFF DURING RADIO COMMUNICATIONS
WITH LONDON.

VIDEO CAMERA NOISE FOOLS RADIO ASTRONOMERS INTO "DISCOVERING" 2
kHz PULSAR (SCIENCE, NOV. 4, 1994).

CASH DRAWERS AT MCDONALDS ACTIVATED BY POLICE MOBILE RADIO.

COMMON LABORATORY RF SOURCES: SPUTTERING CHAMBERS, INDUCTION
FURNACES, LASERS.

NEW CAMPUS FM STATION TVI EXAMPLES.

MALFUNCTIONING CABLE TV AMPLIFIERS RADIATED TVI.

ELECTRIC UTILITY LINES RADIATE AT HARMONICS OF 60 HZ (ESPECIALLY ODD-
TRIPLES), AFFECT RR SIGNALS.

FAILURES DUE TO ELECTROSTATIC DISCHARGE.

"ASK ANY GRADUATE STUDENT IN EXPERIMENTAL WORK".

ISSUES AND MECHANISMS

EMISSIONS AND SUSCEPTIBILITY

RADIATED AND CONDUCTED PATHS

REVIEW OF NEAR E & B FIELDS & FAR-FIELD (EM WAVES)

INDUSTRY AND FEDERAL STANDARDS (BRIEF)

SURVEY OF MITIGATION TECHNIQUES

GOOD DESIGN BEFORE IS BETTER THAN FIXES AFTER

FILTERS & FERRITES

CABLES, SHIELDING, & "GROUNDING"

ELECTROMAGNETIC COMPATIBILITY RESOURCES

TEXTBOOKS:

NOISE REDUCTION TECHNIQUES IN ELECTRONIC SYSTEMS (2ND ED.), HENRY W. OTT (WILEY, 1988). EXCELLENT TEXT AND REFERENCE, AT A GOOD LEVEL FOR UNDERGRADUATES.

INTRODUCTION TO ELECTROMAGNETIC COMPATIBILITY, CLAYTON R. PAUL (WILEY SERIES IN MICROWAVE AND OPTICAL ENGINEERING, 1992). THE MOST COMPREHENSIVE BOOK IN THE FIELD, HIGHER LEVEL THAN OTT.

PRINCIPLES OF ELECTROMAGNETIC COMPATIBILITY (3RD ED.), BERNARD KEISER (ARTECH HOUSE, 1987). ANOTHER GOOD TEXT, ROUGHLY EQUIVALENT IN LEVEL TO OTT.

HOW TO CONTROL ELECTRONIC NOISE (2ND ED.), MICHAEL MARDIGUIAN (INTERFERENCE CONTROL TECHNOLOGIES, INC., 1983). A PRACTICAL BOOK OF THE TYPE USED IN SHORT COURSES IN INDUSTRY. PART OF A LARGE SERIES.

ORGANIZATIONS AND PERIODICALS:

ELECTROMAGNETIC COMPATIBILITY SOCIETY OF THE INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERS (IEEE). PUBLISHES THE QUARTERLY *TRANSACTIONS ON EMC*, NEWSLETTER, HOLDS MEETINGS, SYMPOSIA, ETC. ABOUT ONE THIRD OF MEMBERS HAVE DEGREES IN PHYSICS.

EMC TECHNOLOGY AND INTERFERENCE CONTROL NEWS, A FREE TRADE JOURNAL, AND *THE EMC ITEM*, A YEARLY DIRECTORY-CATALOG-HANDBOOK, PRODUCED BY INTERFERENCE CONTROL TECHNOLOGIES, INC. _____
(CALLED THE "DON WHITE OUTFIT" BY PRACTITIONERS OF THE ART.)

CONCLUDE TALK WITH SAMPLE PROBLEM FROM:
INTRODUCTION TO PSPICE (FOURTH ED.) BY
NILLSON AND RIEDEL. (ADDISON-WESLEY, 1993)

ORDER FORM FOR COURSE MATERIALS

NAME _____

MAIL TO:

DEPARTMENT _____

DR. DENNIS C. HENRY
PHYSICS DEPARTMENT
GUSTAVUS ADOLPHUS COLLEGE
800 WEST COLLEGE
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MAKE CHECKS PAYABLE TO:
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