SAULT COLLEGE OF APPLIED ARTS & TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE:	MICROPROCESSOR CIRCUITS AND APPLICATIONS
CODE NO.:	CET 228 - 5
PROGRAM:	ELECTRICAL/ ELECTRONIC TECHNICIAN / TECHNOLOGIST
SEMESTER:	FOUR
AUTHOR:	PETER SAVICH
DATE:	JANUARY 1990
PREVIOUS OUTLINE DATED:	JUNE 1989 BY TYCHO BLACK

APPROVED: _____ DEAN _____ DATE

90/02/14

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TOTAL CREDIT HOURS: 75

LENGTH OF COURSE: 5 HOURS PER WEEK FOR 15 WEEKS

THREE 1 HOUR THEORY CLASSES
ONE 2 HOUR LAB CLASS

PREREQUISITE(S): CET 205

I. PHILOSOPHY / GOALS

THIS COURSE WILL EXPAND A STUDENT'S UNDERSTANDING OF MICROPROCESSOR CIRCUITS AND APPLICATIONS AND THE PERIPHERAL DEVICES USED TO SUPPORT THEM, AS WELL AS STRENGTHEN HIS/HER KNOWLEDGE OF DIGITAL DEVICES IN GENERAL. MICROCOMPUTER SYSTEM HARDWARE COMPONENTS WILL BE STUDIED AND PRACTICAL LAB EXERCISES WILL REINFORCE THE THEORY.

A COMPARATIVE STUDY OF VARIOUS 8, 16, AND 32 BIT MICROPROCESSORS IS UNDERTAKEN. TYPES OF MEMORY, BUS CONCEPTS, I/O SERVICING, INTERRUPTS, DIRECT MEMORY ACCESS (DMA), SYSTEM TIMING AND FUNCTIONS OF VARIOUS SUPPORT CHIPS WILL BE INCLUDED. THE ESSENTIAL PRINCIPLES OF OPERATION OF COMMON PERIPHERALS FOUND IN MICROCOMPUTER SYSTEMS INCLUDING KEYBOARDS, PARALLEL PORTS, AND FLOPPY DISK DRIVES WILL BE STUDIED. THE 8088 MICROPROCESSOR WILL BE USED AS THE BASIS OF MANY COMPUTER SYSTEM EXAMPLES. THE IBM PC WILL BE STUDIED AS A COMPUTER "SYSTEM" TO ILLUSTRATE THE INTERACTION BETWEEN COMPONENTS AND SUBSYSTEMS.

AN IMPORTANT COMPONENT OF THIS COURSE INVOLVES THE STUDY OF MAINTENANCE AND TROUBLESHOOTING PROCEDURES ON PC'S.

IN THE LAB, PROJECTS IN THE FOLLOWING AREAS WILL DEVELOP PRACTICAL EXPERIENCE TO REINFORCE THE THEORY.

EEPROM PROGRAMMING, 8086 MICROPROCESSOR TRAINER, 8255 PPI PROGRAMMING, PC TROUBLESHOOTING AND AN INTRODUCTION TO IBM PC INTERFACING.

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II THRU IV SPECIFIC COURSE OBJECTIVES

SPECIFIC OBJECTIVES

CET 228-5

STUDENTS WILL DEMONSTRATE SIGNIFICANT UNDERSTANDING OF THE FOLLOWING TOPICS:

BLOCK 1: MICROPROCESSOR SYSTEMS

1. DISCUSS THE EVOLUTION OF MICROPROCESSOR TECHNOLOGY.

2. DESCRIBE THE MAJOR BUILDING BLOCKS OF MICROCOMPUTER SYSTEMS AND THE PRINCIPLES OF OPERATION AN THEIR MAIN PERIPHERAL DEVICES.

3. DISCUSS MICROCOMPUTER INPUT/OUTPUT (I/O) FUNDAMENTALS IN THE FOLLOWING CATEGORIES:
   - A) COMPUTER BUSES
   - B) THREE STATE LOGIC, MULTIPLEXED BUSES AND BUS "CONTENTION"
   - C) BUS HANDSHAKING
   - D) POLLED I/O VS INTERRUPT DRIVEN I/O
   - E) DEDICATED (OR ISOLATED) I/O VERSUS MEMORY MAPPED I/O
   - F) DIRECT MEMORY ACCESS (DMA)

4. DESCRIBE AND COMPARE THE ARCHITECTURE FOR THE FOLLOWING MICROPROCESSORS: 6800, 8085, 8088, 8086, 80286, 68000

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BLOCK 2: 8088 CPU OPERATION AND SYSTEM ORGANIZATION

1. DESCRIBE THE 8088 CPU, ITS INTERNAL ORGANIZATION, TIMING, PIN DEFINITIONS AND OPERATING MODES.

2. DESCRIBE THE WAY BUS MULTIPLEXING IS ACCOMPLISHED IN 8088 BASED SYSTEMS WITH (AND WITHOUT) THE 8288 BUS CONTROLLER.

3. DISCUSS THE OPERATION OF THE 8284 CLOCK GENERATOR.

4. DESCRIBE BASIC MEMORY AND I/O OPERATIONS IN 8088 SYSTEMS.

5. DESCRIBE THE SYSTEM LEVEL ORGANIZATION OF AN IBM PC AND THE FUNCTION OF ALL MAJOR COMPONENTS.

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BLOCK 3: MEMORY DEVICES AND MEMORY INTERFACING

1. IDENTIFY THE PRINCIPAL TYPES OF STATIC AND DYNAMIC READ/WRITE MEMORY (RWM OR RAM) AND DESCRIBE THEIR FEATURES, THEIR ADVANTAGES AND DISADVANTAGES AND THEIR IMPLEMENTATION IN MEMORY SYSTEMS.

2. DESCRIBE THE CHARACTERISTICS OF ROM (READ ONLY MEMORY) DEVICES, PROM, EPROM, EEPROM, EAROM, PLA, FPLA AND BUBBLE MEMORY AND BE ABLE TO DISCUSS THEIR ADVANTAGES AND DISADVANTAGES FOR VARIOUS APPLICATIONS.

3. BE ABLE TO ANALYZE AND DESIGN THE ADDRESS DECODING FOR SIMPLE MEMORY SYSTEMS.

4. DESCRIBE THE MEMORY ORGANIZATION IN AN IBM PC AND AT.

BLOCK 4: 8088 I/O INTERFACE FUNDAMENTALS

1. UNDERSTAND THE OPERATION AND FUNCTION OF VARIOUS BUFFERS, LATCHES AND REGISTER CIRCUITS INCLUDING THE 74244, 74245, 74151, 74155, 74138, 74374, AND 8282.

2. DESCRIBE ADDRESS DECODING TECHNIQUE FOR I/O PORTS.

3. DISCUSS THE USE OF INTERRUPTS IN THE 8088 AND UNDERSTAND THE OPERATION OF THE INTEL 8259 PROGRAMMABLE INTERRUPT CONTROLLER (PIC).

4. DESCRIBE THE ARCHITECTURE OF THE INTEL 8255 PROGRAMMABLE PERIPHERAL INTERFACE (PPI) AND BE ABLE TO PROGRAM IT IN A VARIETY OF MODES.

5. BE ABLE TO DESCRIBE THE NATURE OF ASYNCHRONOUS SERIAL DATA TRANSMISSION.

6. DESCRIBE THE NATURE OF A CENTRONICS PARALLEL INTERFACE.

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BLOCK 5: A/D AND D/A CONVERSION

1. DISCUSS THE PRINCIPLES AND OPERATION OF VARIOUS DIGITAL TO ANALOG (D/A OR DAC) CONVERTERS.

2. DISCUSS THE CONCEPTS OF ANALOG TO DIGITAL (A/D OR ADC) CONVERSION FROM THE POINTS OF VIEW OF SAMPLE RATES, STEP SIZE, AND ERROR CHARACTERISTICS.

3. DISCUSS THE PRINCIPLES OF OPERATION OF VARIOUS TYPES OF ANALOG TO DIGITAL CONVERTERS, THEIR ADVANTAGES AND DISADVANTAGES.

4. UNDERSTAND THE OPERATION OF THE A/D AND D/A CIRCUITRY IN THE MICROCOMPUTER APPLICATION TRAINERS (MAT) TRAINERS AND BE ABLE TO INTERFACE THEM AND CONTROL THEM WITH ASSEMBLER PROGRAMS.

BLOCK 6: MICROCOMPUTER SYSTEM PERIPHERALS

1. DISCUSS THE PRINCIPLE OF OPERATION OF VARIOUS KEYBOARDS.

2. BE ABLE TO DESCRIBE THE NATURE OF FLOPPY DISKS, VARIOUS FORMATTING STANDARDS AND DIGITAL ENCODING TECHNIQUES USED IN MAGNETIC MEDIA.

3. DESCRIBE THE ORGANIZATION AND OPERATION OF THE INTEL 8272 FLOPPY DISK CONTROLLER.

4. DESCRIBE THE PRINCIPLES OF OPERATION OF A TYPICAL DISK DRIVE.

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BLOCK 7: TROUBLESHOOTING PROCEDURES

THIS BLOCK INCLUDES PRACTICAL INFORMATION AND PROCEDURES WHICH WILL BE PARTLY TAUGHT AND TESTED IN THE LAB. ITS CONTENT IS BASED ON THE "TROUBLESHOOTING PC'S" LAB MANUAL AND INCLUDES THE FOLLOWING TOPICS:

1. PC/XT/AT MODEL CHARACTERISTICS INCLUDING BUSSES, MEMORY ORGANIZATION, CLOCK, POWER SUPPLY AND SYSTEM COMPONENTS.

2. PREVENTATIVE MAINTENANCE IN PC'S.

3. GENERAL TROUBLESHOOTING PROCEDURES:
   - A) POWER ON SELF TEST (POST) AND THE SEQUENCE OF EVENTS WHEN A SYSTEM IS "BOOTED".
   - B) BOARD IDENTIFICATION
   - C) DMA, IRQ, I/O PORTS AND DIP SWITCHES IN COMMON SYSTEMS
   - D) FINDING AND REPLACING BAD BOARDS
   - E) CHIP LEVEL TROUBLESHOOTING
   - F) SYSTEM BOARD TROUBLESHOOTING
   - G) MEMORY ERRORS

4. POWER SUPPLY TROUBLESHOOTING

5. HARD DISK DRIVE CHARACTERISTICS INSTALLATION AND TROUBLESHOOTING. BACKUP AND LOW LEVEL FORMATTING OF HARD DISKS.

6. FLOPPY DISK DRIVE CHARACTERISTICS AND TROUBLESHOOTING.

7. PRINTER AND SERIAL PORT PROBLEMS.

8. KEYBOARD AND DISPLAY PROBLEMS.

9. DESCRIBE THE MODES OF OPERATION AND CAPABILITIES OF SYNCHRONOUS AND ASYNCHRONOUS LOGIC ANALYZERS AND BE ABLE TO APPLY THEM TO TROUBLESHOOTING MICROPROCESSOR BASED CIRCUITS.

10. DESCRIBE THE APPLICATION OF SIGNATURE ANALYSIS TO TROUBLESHOOTING.

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V. METHOD(S) OF EVALUATION

1.

THE STUDENT WILL BE ASSESSED THROUGH A SERIES OF THREE (3) WRITTEN TESTS. THESE TESTS WILL EACH BE WEIGHTED TO 20% OF THE FINAL MARK.

THE TENTATIVE DATES ARE: MAR 5 /90
APR 3 /90
MAY 19/90

THESE TEST DATES WILL BE RE-ANNOUNCED APPROXIMATELY ONE WEEK IN ADVANCE.

2.

THE STUDENT WILL BE ASSESSED THROUGH A SERIES OF UNANNOUNCED QUIZZES. THE TOTAL WEIGHT OF THESE QUIZZES ARE NOT TO EXCEED 10% OF THE FINAL MARK.

3.

THE STUDENT WILL BE ASSESSED THROUGH A SERIES OF LAB ASSIGNMENTS. COLLECTIVELY THESE ASSIGNMENTS WILL BE WEIGHTED TO 25% OF THE FINAL MARK.

4.

THE STUDENT WILL BE ASSESSED ON HIS/HER ABILITY TO ANSWER QUESTIONS ABOUT THE LAB ASSIGNMENT ONCE SUBMITTED. THE STUDENT'S RESPONSE TO THESE LAB DEMONSTRATION QUESTIONS WILL BECOME PART OF HER/HIS "PRACTICAL DEMONSTRATION" MARK. THIS MARK WILL BE WEIGHTED TO 5% OF THE FINAL MARK.

5.

THE STUDENT ATTENDING MORE THAN 80% OF THE TIME WILL RECEIVE A BONUS OF 2%.

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SUMMARY OF FINAL MARK

1.	TESTS	60%
2.	QUIZZES	10%
3.	ASSIGNMENTS	25%
4.	DEMOS	5%
		100%
5.	ATTENDANCE	2% BONUS ONLY

COURSE GRADING SCHEME

A+	90+	OUTSTANDING ACHIEVEMENT
A	80 - 89	ABOVE AVERAGE ACHIEVEMENT
B	70 - 79	AVERAGE ACHIEVEMENT
C	55 - 69	SATISFACTORY ACHIEVEMENT
U		UNSATISFACTORY GIVEN AT MIDTERM ONLY
S		SATISFACTORY GIVEN AT MIDTERM ONLY
R		REPEAT
X		A TEMPORARY GRADE THAT IS LIMITED TO INSTANCES WHERE SPECIAL CIRCUMSTANCES HAVE PREVENTED THE STUDENT FROM COMPLETING OBJECTIVES BY THE END OF THE SEMESTER. AN "X" GRADE MUST HAVE THE DEAN'S APPROVAL AND HAS A MAXIMUM TIME LIMIT OF 120 DAYS.

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3. UPGRADING OF INCOMPLETES

WHEN A STUDENT'S COURSE WORK IS INCOMPLETE OR FINAL GRADE IS BELOW 55%, THERE IS THE POSSIBILITY OF UPGRADING TO A PASS WHEN THE STUDENT'S PERFORMANCE WARRANTS IT. ATTENDANCE AND ASSIGNMENT COMPLETION WILL HAVE A BEARING ON WHETHER UPGRADING WILL BE ALLOWED. A "REPEAT" GRADE ON ALL TESTS WILL REMOVE THE OPTION OF ANY UPGRADING AND AN "R" GRADE WILL RESULT. THE HIGHEST ON A RE-WRITTEN TEST OR ASSIGNMENT WILL BE 56%.

THE METHOD OF UPGRADING IS AT THE DISCRETION OF THE TEACHER AND MAY CONSIST OF ONE OR MORE OF THE FOLLOWING OPTIONS:

ASSIGNED MAKE-UP WORK
RE-DOING PROJECTS
RE-DOING OF TESTS
WRITING OF COMPREHENSIVE SUPPLEMENTAL EXAMINATION

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VI. REQUIRED STUDENT RESOURCES

THE TEXT REQUIRED TO BE PURCHASED BY STUDENTS IS:

1.

SMALL COMPUTER THEORY AND APPLICATIONS
BY DENTON DAILEY
PUBLISHER MCGRAW-HILL

2.

COURSE NOTES PROVIDED BY THE INSTRUCTOR (NOT TO BE PURCHASED)

3.

THE STUDENTS WILL ALSO BE EXPECTED TO PURCHASE APPROXIMATELY 10 FLOPPY DISKS 5 AND ONE QUARTER INCH, DOUBLE SIDED, DOUBLE DENSITY.

4.

THE CET 205 - 5 COURSE TEXTBOOK IS ALSO USEFUL AND PROVIDE THE STUDENT WITH ANOTHER AVENUE OF SELF STUDY.

VII. ADDITIONAL RESOURCE MATERIALS (AVAILABLE IN COLLEGE LIBRARY)

THERE ARE MANY OTHER BOOKS ON 8088 PROGRAMMING, OTHER MICROPROCESSORS, ETC.

VIDEO TAPES: TROUBLESHOOTING THE IBM PC

PERIODICALS: THERE ARE PC MAG, BYTE MAG, COMPUTING CANADA

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VIII. SPECIAL NOTES

SAFETY GUIDELINES TO USE WHILE WORKING WITH ELECTRONICS AND COMPUTER SYSTEMS

ALWAYS WORK IN A SAFE WORKING ENVIRONMENT. THIS SAFE ENVIRONMENT SHOULD BECOME A HABIT. THIS HABIT WILL ALLOW YOU TO LIVE, ENJOY LIFE LONGER.

ELECTRONIC EQUIPMENT IS FILLED WITH OPPORTUNITIES FOR ACCIDENTS. ELECTRIC SHOCK, BURNS FROM HOT METALS, CHIPS, ETC. ARE POSSIBLE IF NOT PRACTISING SAFE WORK HABITS.

LETHAL CURRENT CHART

AMPERES	EXPECTED OUTCOME
1.00	
0.80	
0.60	SEVERE BURNS
0.40	
0.20	DEATH
0.10	DEATH
0.09	EXTREME BREATHING DIFFICULTIES
0.08	BREATHING UPSET
0.07	LABOURED BREATHING
0.06	SEVERE SHOCK
0.05	MUSCULAR PARALYSIS
0.04	CAN NOT LET GO
0.03	VERY PAINFUL
0.02	PAINFUL
0.01	MILD SENSATION
0.001	THRESHOLD OF SENSATION

NOT PAYING ATTENTION TO DESIGN DRAWINGS, OR INCORRECTLY WIRING COMPONENTS MAY ACTUALLY CAUSE A DEVICE, CHIP TO EXPLODE. YOU MUST PROTECT YOURSELF FROM POSSIBLE EYE INJURY OR OTHER PHYSICAL HARM.

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THE FOLLOWING STEPS ARE A PART OF SAFE WORK HABITS, FOLLOWING THEM WILL REDUCE THE RISK OF ACCIDENT AND INJURY TO AN ACCEPTABLE LEVEL. THE PRECAUTIONS INVOLVED WILL MINIMIZE THE DAMAGE IF AN ACCIDENT DOES OCCUR. YOU MUST CONSTANTLY BE AWARE OF THE POTENTIAL HAZARDS AND PERIODICALLY CHECK YOUR SAFETY PRECAUTIONS.

1.
AVOID WORKING ON ENERGIZED EQUIPMENT IF AT ALL POSSIBLE. IN MANY CASES YOU CAN CONNECT TEST LEADS WITH THE POWER OFF AND THEN TURN ON THE POWER.

2.
JEWELRY SUCH AS RINGS, WATCHES, AND BRACELETS SHOULD NEVER BE WORN IN THE WORKPLACE. NOT ONLY ARE MOST OF THESE OBJECTS CONDUCTIVE, WHICH WILL CAUSE A SHOCK IF THEY CONTACT BOTH YOU AND THE ENERGIZED CIRCUIT, BUT THERE IS ALSO THE DANGER OF THEM CATCHING ON COMPONENTS OR ANY MOVING ELECTROMECHANICAL DEVICES.

3.
MAKE A PRACTICE OF ALWAYS STANDING ON A RUBBER MAT WHILE WORKING WITH ELECTRICITY. RUBBER MATS INSULATE YOU FROM THE FLOOR, WHICH IS USUALLY AT GROUND POTENTIAL. THIS REDUCES THE CHANCE OF AN ELECTRICAL PATH THROUGH YOUR BODY.

4.
ALWAYS BE AWARE OF POSSIBLE ELECTRICAL PATHS THROUGH YOUR BODY. IN MANY INSTANCES IT IS DESIRABLE TO REST PART OF YOUR HAND ON THE CHASSIS WHILE SUPPORTING A TEST PROBE. THIS WAY IF THERE IS A SHOCK, IT WILL GO THROUGH YOUR HAND, AND NOT THROUGH YOUR HEART.

5.

IF YOU MUST WORK ON ENERGIZED EQUIPMENT, USE ONLY ONE HAND AT A TIME. THIS PREVENTS A CURRENT FROM PASSING FROM ONE HAND, THROUGH YOUR BODY TO THE OTHER HAND.

6.
COMPONENTS SUCH AS TRANSISTORS OR RESISTORS MAY BECOME VERY HOT. THEY SHOULD NOT BE TOUCHED WITH BARE HANDS EVEN AFTER THE POWER HAS BEEN TURNED OFF.

7.
NEVER ROUTE CONNECTING WIRES OR TEST LEADS OVER TRANSISTORS OR LARGE RESISTORS. BECAUSE THEY GET HOT, THESE COMPONENTS CAN MELT THE WIRE COATING AND POSSIBLY SHORT CIRCUIT.

8.
NEVER ASSUME THAT JUST BECAUSE THE EQUIPMENT IS UNPLUGGED, IT IS SAFE. CAPACITORS CAN STORE EXTREMELY HIGH VOLTAGES. FOR EXAMPLE, THE CRT SCREEN FLYBACK TRANSFORMER. TO PROTECT YOURSELF, USE A GROUND STRAP TO SHORT THE COMPONENT'S LEADS TO GROUND BEFORE YOU PUT YOUR HAND CLOSE TO THEM, OR ATTACH A TEST LEAD. YOU MAY EVEN WANT TO LEAVE THE GROUND LEAD IN PLACE UNTIL YOU ARE THROUGH WORKING IN THAT AREA. THIS WILL PREVENT SHOCK EVEN IF YOU DO ACCIDENTLY TOUCH THE COMPONENT'S LEADS. BUT REMEMBER, USE A GROUNDED STRAP ONLY IF THE EQUIPMENT IS UNPLUGGED. REMOVE THE GROUND STRAP WHEN TESTING IS COMPLETED.

9.

TEST EQUIPMENT SHOULD ALWAYS BE PLUGGED INTO THE SAME OUTLET AS THE COMPUTER AND PERIPHERALS BEING USED. IF NOT, THERE IS A DANGER OF CONNECTING TO OPPOSITE PHASES OF THE POWER LINE. THIS WOULD RESULT IN A 220 VOLT DIFFERENCE IN THEIR POWER CONNECTIONS. ALTHOUGH THIS IS NOT NORMALLY A PROBLEM, THIS VOLTAGE COULD SHOW UP IF THERE IS ANOTHER FAILURE.

10.
NEVER WORK ON HIGH VOLTAGE EQUIPMENT ALONE. PRACTICE THE BUDDY SYSTEM. IF YOU SHOULD BECOME DISABLED YOUR BUDDY CAN TURN OFF THE POWER AND PROVIDE AID. A SEVERE SHOCK COULD MAKE YOU INCAPABLE OF DISENGAGING YOURSELF FROM THE EQUIPMENT. ALWAYS USE INSULATED TOOLS TO REDUCE THE POSSIBILITY OF SHOCK WHEN ADJUSTING A LIVE CIRCUIT.

11.
IT IS ALSO GOOD PRACTICE TO ALWAYS WEAR SAFETY GLASSES WHEN WORKING ON ELECTRONIC EQUIPMENT OR OPERATING POWER TOOLS OF ANY TYPE.

IX. SPECIAL NOTES

INSTRUCTORS (PROFESSORS) RESERVE THE RIGHT TO MAKE CHANGES TO THE COURSE OUTLINES WHERE NECESSARY