Millersville University
Department of Applied Engineering, Safety, & Technology

**AENG 262 SEMICONDUCTOR ELECTRONICS**
**3 s.h.**

**CATALOG DESCRIPTION**

This course provides an in-depth study of semiconductor theory. Discrete devices such as diodes, transistors, and silicon-controlled rectifiers among others are introduced. The major component of the course involves integrated circuits (ICs); both digital and linear ICs will be covered, along with the hybrid IC timer. Surface mount technology (SMT) and emerging technologies, such as nanotechnology and biotechnology, will be presented. Practical applications include prototyping circuits, design and problem solving, use of test equipment and troubleshooting. 2 hours lecture, 3 hours laboratory. Prerequisites: ITEC 261 or permission of instructor. Offered fall, spring.

| ***COURSE OBJECTIVES*** *Upon successful course completion, students will be able to:* | ***ASSESSMENTS*** *Students' achievement of course objectives will be assessed based on the following*:* LA | EX | ***PROGRAM OUTCOMES*** *Program learning competencies for the AET(M), ARET, & MFET programs:* |
|---|---|---|---|
| 1. **Utilize** safe procedures in the electronics environment. | x | x | A. Disciplinary Knowledge<br>An ability to **select and apply** the **knowledge**, **techniques**, **skills**, and modern tools of the discipline to broadly defined **applied engineering** activities. |
| 2. **Solve** circuit design problems with discrete devices and integrated devices using circuit simulation software and actual electrical/electronic circuit components. | x | x | |
| 3. Demonstrate satisfactory knowledge of test equipment usage and application including power supplies, digital storage oscilloscope, digital multimeters (DMMs), and related testing devices. | x | | |

| | | | |
|---|---|---|---|
| 4. **Design** circuits and **evaluate** fundamental concepts regarding discrete semiconductor devices such as diodes, transistors, and silicon-controlled rectifiers. | x | x | B. Design<br>An ability to **design systems, components, or processes** for broadly defined **applied engineering problems** appropriate to program educational objectives |
| 5. **Design** circuits and **evaluate** fundamental concepts regarding integrated circuits for both digital and linear electronic circuits. | x | x | |
| 6. **Apply** the systems approach (input, process, output, and feedback) to electronic circuits. | x | x | |
| 7. **Describe** surface mount technology (SMT) devices and construct a basic circuit using these devices. | x | | E. Written Communication<br>An ability to **apply written communication** in both technical and non-technical environments. |
| 8. **Explain** fundamental concepts regarding new and emerging technologies such as biomedical technology and nanotechnology. | x | | |
| 9. **Describe** the impact on various social/environmental concerns related to electronics technology. | x | | |

** LA = Lab Experiment; EX = Exam..*

**CONTENT OUTLINE**

I. Electronics—An Overview
   A. Definitions of terms
   B. Generations of electronics
   C. Review of electrical safety
      1. Precautions for working on a "live" circuit
      2. Capacitor charge storage concerns
      3. Environmental effects
      4. Heating effect of devices
      5. Inspection of interconnecting lines
      6. Based upon specific applications

II. The Electronic Power Supply System
   A. Major function and sections (input, process, output, feedback)
   B. The transformer
   C. Rectifiers
      1. The solid-state diode, theory and construction
      2. Diode ratings and specifications
      3. Rectifier circuits
         a. Halfwave
         b. Fullwave
         c. Bridge
   D. Filters
      1. Capacitor
      2. Capacitor input Pi filter
      3. Ripple percentage and regulation
      4. Inductors vs. resistors in filtering
   E. The voltage regulator
      1. Regulating devices
         a. Resistor-zener diode combination
         b. Transistor regulation
         c. Voltage regulators
   F. Special-purpose power supplies
      1. AC-DC transformerless
      2. Converters and inverters
      3. Voltage doublers

III. Solid-state Discrete Devices and Circuit Applications
   A. The bipolar transistor (input, process, output, feedback)
      1. Operating principles
      2. Applications in circuits
      3. Switching circuits
   B. The silicon-controlled rectifier, triac and diac
      1. Operating principles
      2. Applications in circuits
   C. Transducers
      1. Thermistors
      2. Pressure sensors
      3. Photoelectric sensors
      4. Hall effect devices

5. LEDs and LCDs

D. Impacts: Vacuum tube – solid-state

IV. Amplifier Systems

A. Amplifying devices (input, process, output, feedback)
   1. The bipolar transistor
   2. The field-effect transistor

B. Classifications of amplifiers
   1. According to use
   2. The common emitter
   3. Frequencies utilized

C. Audio amplifiers
   1. The voltage amplifier
   2. The power amplifier
   3. Speakers
   4. Microphones
   5. Control circuitry

D. Impacts: Amplifier systems

V. Integrated Circuit (IC) Devices

A. Characteristics of linear devices (input, process, output, feedback)
   1. Operational amplifiers
   2. Voltage regulators

B. Characteristics of digital devices (input, process, output, feedback)
   1. Digital number system
   2. Basic logic gates
      a. AND gate
      b. OR gate
      c. NOT gate (inverter)
      d. NAND gate
      e. NOR gate
   3. Combinational logic

C. Characteristics of timers (input, process, output, feedback)
   1. The 555
   2. Monostable operation
   3. Astable operation
   4. Cascading 555s

VI. Surface Mount Technology (SMT)

A. Characteristics of SMT (input, process, output, feedback)
   1. Insertion mount technology (IMT) vs. surface mount technology
   2. Characteristics of SMT components (resistor, capacitor, diode, LEDs, and integrated circuits)
   3. An introduction to vision systems such as magnifiers and microscopes
   4. Soldering SMT devices

VII. Testing, Evaluation, and Troubleshooting

A. Characteristics (input, process, output, feedback)

B. Equipment
   1. Power supplies
   2. Multimeters
   3. Digital oscilloscope

4. Other
C. Analyze circuit
D. Typical faults
E. Divide-in-half method of fault detection
F. Signal injection fault detection

VIII. The Design of Electronic Circuit
A. Define the problem
B. Develop circuit design solutions
C. Select circuit design
D. Build and test circuit design
E. Troubleshoot the circuit as necessary
F. Redesign circuit solution

IX. New and Emerging Technologies in Electronics
A. Biomedical technology
1. Biomedical transducers
2. Temperature measurement
3. Galvanic skin resistance
4. Pulse rate digital meters
5. Electromyograms (EMG) [electrical muscle potential]
6. Electroencephalograms (EEG) [electrical brain potential]
B. Nanotechnology
1. Safety issues and concerns
2. Size and measurements
3. Top-down fabrication
4. Bottom-up fabrication
5. Applications
6. Visionaries
a. Richard Feynman
b. K. Eric Drexler

**TEXT AND REQUIRED MATERIALS**

Rockis, G. (2012). *Solid state devices and systems* (4th ed.). Homewood, IL: American Technical Publishers, Inc.

Skelly, W. H., De Lucca, K. P., & Wright, J. R., Jr. (2012, 2008, 2007, 2005, 2002, 2001). *Student activities/experiments manual (6th ed).* ITEC 262 Semiconductor Electronics. Department of Applied Engineering, Safety & Technology, Millersville University of Pennsylvania Campus Bookstore. Millersville, Pennsylvania. ISBN: 9660202018879

Test leads (clip leads)
Safety glasses (ANSI approved)
A calculator (with scientific notation and trigonometric functions). Note: cell phones, PCs, PDAs, and any type data storage devices are **not** allowed for use on examinations.

**COURSE REQUIREMENTS**

Students are expected to participate in or complete the following activities:

1. Obtain the specified text.
2. Participate in class discussions.
3. Complete and submit all required exams, experiments and assignments
4. Participate in all assigned clean-up activities at the end of each class session and the close of the semester.
5. Regularly attend all lecture and laboratory sessions in their entirety. An attendance record will be maintained by the instructor during both lecture and laboratory segments. The attendance policy adopted by the Department of Applied Engineering, Safety & Technology will be in effect; unauthorized absences exceeding the number permitted in the departmental policy (3) will result in removal from the course, and a grade of "F" will be assigned. A copy of the departmental policy concerning attendance is posted on the bulletin boards in both the laboratory and the lecture room. Attendance will be a factor in "letters of recommendation" requested by the student from the course instructor.

**EVALUATION**

| | |
|---|---|
| Written Examinations (2 @ 20% each) | 40% |
| Manipulative Exams (2 @ 12.5% each) | 25% |
| Lab Experiments (7 @ 5% each) | 35% |
| | 100% |

Scale:

| | | | | | |
|---|---|---|---|---|---|
| 93 - 100 | A | 80 – 82.9 | B- | 67 – 69.9 | D+ |
| 90 – 92.9 | A- | 77 – 79.9 | C+ | 63 – 66.9 | D |
| 87 – 89.9 | B+ | 73 – 76.9 | C | 60 – 62.9 | D- |
| 83 – 86.9 | B | 70 – 72.9 | C- | below 60 | F |

Should the end-of-semester mean score for the class fall below 75%, each student will receive a curve to fit the mean of 75%.

Grades will not be based upon criteria such as need, appearance, race, age, sex, or social status. Once determined, grades will not be changed except in the case of clerical errors that cause the student's true level of ability to be underestimated.

**NOTES:**

ANSI-approved safety glasses are to be worn at all times in the lab.

The instructor reserves the right to alter this syllabus as required.

Late work (less than 1 week) will be subject to a 25% reduction in the student's earned grade. All work submitted more than 1 week late will not be accepted and will result in a zero for the assignment.

**ASSESSMENT OF COURSE OBJECTIVES** *(identified in italics following the objective)*
After a series of planned experiences, the student will be able to:

1. Apply the systems approach (input, process, output, and feedback) to electronic circuits. *(Examinations and Laboratory Activities)*
2. Solve circuit design problems with discrete devices and integrated devices using circuit simulation software and actual electrical/electronic circuit components. *(Laboratory Activities)*
3. Utilize safe procedures in the electronics environment. *(Examinations and Laboratory Activities)*
4. Demonstrate satisfactory knowledge of test equipment usage and application including power supplies, digital storage oscilloscope, digital multimeters (DMMs), and related testing devices. *(Examinations and Laboratory Activities)*
5. Build and evaluate fundamental concepts regarding discrete semiconductor devices such as diodes, transistors, and silicon-controlled rectifiers. *(Examinations and Laboratory Activities)*
6. Build and evaluate fundamental concepts regarding integrated circuits for both digital and linear electronic circuits. *(Examinations and Laboratory Activities)*
7. Describe surface mount technology (SMT) devices and construct a basic circuit using these devices. *(Examinations and Laboratory Activities)*
8. Explain fundamental concepts regarding new and emerging technologies such as biomedical technology and nanotechnology. *(Examinations)*
9. Describe the impact on various social/environmental concerns related to electronics technology. *(Examinations)*

**SAFETY PROCEDURES**

A. OSHA approved eye protection shall be worn by all individuals in the laboratory whenever activity is in progress.
B. Smoking is not permitted during classroom activities (within the laboratory or outdoor sessions).
C. Individuals shall not operate equipment unless they have been authorized by the instructor to do so.
D. Tools and equipment shall not be removed from the laboratory.
E. Be familiar with the location of all fire extinguishers, power disconnect buttons, and other safety equipment contained within the laboratory.
F. Individuals should wash their hands with provided soap (laboratory sink) after handling solder.
G. ALL accidents must be reported to the instructor immediately.

**ATTENDANCE**

**MILLERSVILLE UNIVERSITY ATTENDANCE POLICY**
*EFFECTIVE SPRING 2003*
*Approved by Faculty Senate 12/4/02; Administrative approval 1/10/03*

The University supports departmental and faculty class attendance policies that are reflective of and consistent with University approved guidelines. Faculty will include their class attendance policy in their syllabi given to all students in their classes at the start of the semester.

**University approved guidelines:**

1. **Students are expected to attend all classes.** It is the student's responsibility to complete all course requirements even if a class is missed. If a student misses class for an officially excused reason, then he/she is entitled to make up the missed work but only at the convenience of the faculty member. Responsibility for materials presented in, assignments made for, and tests/quizzes given in regularly scheduled classes lies solely with the student.

2. **The University policy is that faculty will excuse absences for the following reasons:**
   a. personal illness,
   b. death or critical illness in the family,
   c. participation in a university-sponsored activity,
   d. jury duty,
   e. military duties, or
   f. religious holidays

3. **Faculty judge the validity of student absences from class within the University's approved guidelines and may require documentation for excused absences.** Faculty will evaluate any reason, other than those listed above, for a student missing class and determine whether the absence is justified. In these circumstances, a student may make up missed work at the discretion of the instructor.

4. **In the case of foreseeable absences, students are encouraged to notify the faculty member in advance.** A student who will miss class due to participation in an official University activity must notify the instructor well in advance of the activity to assure that the absence is excused.

**Appeals:**
As with any academic issue, students may exercise their right to appeal adverse attendance decisions. Please refer to the current undergraduate catalog for the complete Academic Appeal procedure.

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**DEPARTMENT OF APPLIED ENGINEERING, SAFETY, & TECHNOLOGY ATTENDANCE POLICY**
**Adopted May 4, 1998**

Students are expected to attend all scheduled classes in accordance with the above policy. To the extent that this does not happen, the following shall apply:

1. The limit of unauthorized absences depends upon the number of scheduled days per week as follows:
   Fall and spring semesters
   - three per semester for a course scheduled three days per week
   - two per semester for a course scheduled one or two days per week

   Winter and summer sessions
   - two per session

2. Each late arrival and early departure will count as one-half of an unauthorized absence.

3. Participation in outside-of-the-classroom educational activities and intercollegiate contests shall be communicated to the instructor prior to the absence. Failure to do so will convert these authorized absences to "unauthorized absences."

4. Students whose "unauthorized" absences exceed the policy stated in item #1 are liable to dismissal from the course with a grade of 'F' or 'Z.'

**STUDENTS WITH SPECIAL NEEDS**
The instructor will provide reasonable accommodations to any student with special needs. The student is encouraged to inform the instructor of any condition that requires such accommodations. Also, it is the student's responsibility to contact the Office of Learning Services, Room 348, Lyle Hall (Phone 872-3178) to request an official approval for providing any special accommodations and present a copy of this official document to the instructor.

**TITLE IX**

Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to meet this commitment, comply with Title IX of the Education Amendments of 1972, 20 U.S.C. §1681, et seq., and act in accordance with guidance from the Office for Civil Rights, the University requires faculty members to report to the University's Title IX Coordinator incidents of sexual violence shared by students. The only exceptions to the faculty member's reporting obligation are when incidents of sexual violence are communicated by a student during a classroom discussion, in a writing assignment for a class, or as part of a University-approved research project. Faculty members are obligated to report to the person designated in the University Protection of Minors policy incidents of sexual violence or any other abuse of a student who was, or is, a child (a person under 18 years of age) when the abuse allegedly occurred.

Information regarding the reporting of sexual violence, and the resources that are available to victims of sexual violence, is available at http://www.millersville.edu/socialeq/title-ix-sexual-misconduct/index.php.

**BIBLIOGRAPHY**


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