MILLERSVILLE UNIVERSITY
Department of Applied Engineering, Safety & Technology

AENG 467 MOBILE ROBOTICS
3 s.h.

CATALOG DESCRIPTION
This course is a study of the development of mobile robotic solutions. Emphasis is placed on the programming and interfacing of microcontrollers to control autonomous mobile robots in known environments. A research and development activity is required. 2 hours lecture, 3 hours laboratory. Prerequisite: AENG 262 or permission of the instructor.

COURSE OBJECTIVES *Upon successful course completion, students will be able to:*	*ASSESSMENTS* *Students' achievement of course objectives will be assessed based on the following*:*				*PROGRAM OUTCOMES* *Program learning competencies for the AET(M), ARET, & MFET programs:*
	LA	QU	EX	HW	
1. **Explain** the origins of the personal computer and the microcontroller.		x			A. Disciplinary Knowledge An ability to **select and apply** the **knowledge**, **techniques**, **skills**, and modern tools of the discipline to broadly defined **applied engineering** activities.
2. **Interface** microcontrollers to sensors and dc motor control circuitry to develop and control mobile robotic motion.	x				
3. **Assess** platform construction and design needs for given mobile robotic applications.	x				B. Design An ability to **design systems, components, or processes** for broadly defined **applied engineering problems** appropriate to program educational objectives.
4. **Assess** and deduce sensing needs for a mobile robot and its environment.	x				
5. **Design** algorithms and **develop** programming techniques for various mobile robotic control issues.	x		x		
6. **Design** algorithms and **develop** a complex control program for an autonomous mobile robot.	x		x		

7. **Design** and **develop** a physical chassis solution (including sensor location) for an autonomous mobile robot.	x		
8. **Critique** current literature published on mobile robotics.		x	E. Written Communication An ability to **apply written communication** in both technical and non-technical environments.
9. **Organize** and **develop** complete documentation for an autonomous mobile robot research and development project from conception to completion.	x		

* LA = Lab Experiment/Design Challenge; QU = Quiz; EX = Exam; HW = Homework/Papers.

CONTENT OUTLINE
      I.   Historical Development and Applications
          A. Microprocessors/Personal Computer
          B. Microcontrollers
          C. Mobile Robots

      II. Programming Techniques
          A. Digital Input/Output Control
          B. Analog Input/Output Control
          C. Timing Delays
          D. Recursion
          E. Loops
          F. Subroutines
          G. Arithmetic
          H. Pulse Width Modulation
          I. Logic
          J. Multitasking
          K. Commenting
          L. Real time data acquisition and control

      III. Data Types
          A. Boolean
          B. Byte
          C. Integer
          D. Long
          E. Floating Point
          F. String

      IV. Platform Selection/Construction for Mobile Robots
          A. Mechanics/Locomotion
             1. Tracks
             2. Wheels
             3. Legs
          B. Platform Size/Shape

      C. Motor Selection
      D. Power Sources
      E. Speed
      F. Feedback
         1. Closed Loop
         2. Open Loop
      G. Steering Control
         1. Holonomic
         2. Non-holonomic

  V. Sensor Selection for Mobile Robots
      A. Contact
         1. Limit (Normal Open and Normal Closed)
      B. Non-Contact
         1. Infrared (IR)
         2. LASER
         3. Hall Effect
         4. Pyroelectric
         5. Ultra Violet (UV)
         6. Sonar

  VI. Interfacing Techniques for Mobile Robots
      A. Sensors
      B. Servo Motors
      C. H-bridge DC Motor Control Boards
      D. LEDs
      E. Computers
      F. LCD Displays
      G. Actuators

REQUIRED MATERIALS
Odom, C. D. (2020). Physical Computing & Robotics with the Arduino IDE, Volume One.

    http://www.lulu.com/spotlight/ChrisOdom

Odom, C. D. (2017). Physical Computing & Robotics with the Arduino IDE, Volume Two.
    http://www.lulu.com/spotlight/ChrisOdom

ANSI-approved safety glasses

GENERAL COURSE REQUIREMENTS
Students are expected to participate in or complete the following:

1. Obtain the required text.
2. Participate in class discussions.
3. Complete and submit all required experiments.
4. Complete a research and design experience.
5. Satisfactorily complete all tests and quizzes.
6. Participate in all assigned clean-up activities at the end of each class session and the close of the semester.
7. Attendance is the responsibility of each student—assignments, experiments or other class activities carried on during any absence rests with the student. An excessive number of absences will almost certainly be detrimental to your grade. Attendance will be taken for the record. A student's class attendance will be a factor in "letters of recommendation" requested by the student from the course instructor. Attendance guidelines, as set forth by the Department of Industry and Technology, shall be followed. This policy is included in this syllabus.

EVALUATION
Course activities will be divided into the following categories:

A. Design Challenges (Robot Navigation & Control)   20%
    a. Navigation w/sonar (5%)
    b. Navigation w/IR (5%)
    c. UV Light Detection + LCD (5%)
    d. Color Detection Interface (OpenMV CAM w/Teensy) + LCD (5%)

B. Quizzes (2)   10%
    a. History of the Personal Computer (5%)
    b. IGVC Rules (5%)

C. R&D Project   45%
    a. Team Build/Performance (20%)
    b. Teamwork/Participation/Initiative/Contribution/Timeliness (12.5%)
    c. Professional Documentation (See sample **and add schematics**) (12.5%)

C. Final Code Exam*   20%

   *Each student is allowed to use a single page (8.5"x11") hand written command/code reference sheet. Proper flowcharting technique is also expected to be part of the exam.

E. Bonus Article Review (2nd Review – use bonus form)   3%
                                                                         103%

The letter grade for the course will be determined as follows:

93.0 - 100	A	80.0 – 82.9	B-	67.0 – 69.9	D+
90.0 - 92.9	A-	77.0 – 79.9	C+	63.0 – 66.9	D
87.0 – 89.9	B+	73.0 – 76.9	C	60.0 – 62.9	D-
83.0 – 86.9	B	70.0 – 72.9	C-	0 – 59.9	F

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.

Should the mean of the final grades for the class drop below a 75% (Average Grade = C), a curve to this value may be implemented at the discretion of the instructor.

TITLE IX STATEMENT
Millersville University and its faculty are committed to assuring a safe and productive educational environment for all students. In order to comply with the requirements of Title IX of the Education Amendments of 1972 and the University's commitment to offering supportive measures in accordance with the new regulations issued under Title

IX, 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](#) 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 set forth at: www.millersville.edu/titleix

<u>ATTENDANCE POLICY</u>

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

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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.

<u>University approved guidelines:</u>
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.

<u>Appeals:</u>
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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AEST DEPARTMENT ATTENDANCE POLICY
Adopted May 4, 1998

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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:
   <u>Fall and spring semesters</u>
   - three per semester for a course scheduled three days per week
   - two per semester for a course scheduled one or two days per week
   <u>Winter and summer sessions</u>
   - 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.

BIBLIOGRAPHY
Bignell, J. W., & Donovan, R. (2007). *Digital electronics* (5th ed.). Clifton Park, NY: Thomson Delmar Learning.
Dixon, A. C., & Antonakos, J. L. (2000). *A practical approach to digital electronics*. Upper Saddle River, NJ: Prentice Hall.
Floyd, T. L. (2008). *Digital fundamentals* (8th ed.). Upper Saddle River, NJ: Prentice Hall.
Jones, J. L., Seiger, B. A., & Flynn, A. M. (1999). *Mobile robots: Inspiration to implementation* (2nd ed.). Natick, MA: A K Peters.
Lindsay, A. (2003-04). *Robotics with the Boe-Bot student guide v. 2.2*. Rocklin, CA: Parallax, Inc. www.stampsinclass.com
Lindsay, A. (2003). *What's a microcontroller? Student guide v. 2.0*. Rocklin, CA: Parallax, Inc. www.stampsinclass.com
Susneau, I., & Mitescu, M. (2005). *Microcontrollers in practice*. Berlin, Germany: Springer.
Tokheim, R. L. (2008). *Digital electronics: Principles and applications* (7th ed.). Columbus, OH: Glencoe/McGraw-Hill.