# BMEn 2151 "Introductory Medical Device Prototyping"

Department of Biomedical Engineering, University of Minnesota

Syllabus – Tentative Spring 2017

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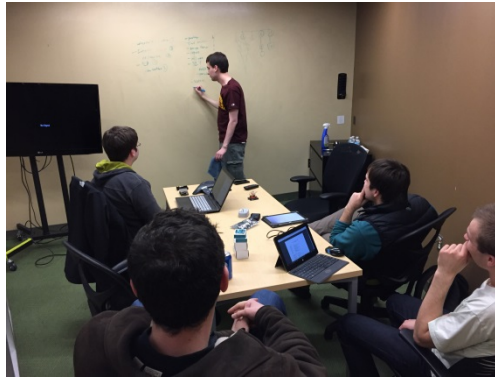
Lectures:
Lectures are on Monday & Wednesday 3:35 to 4:30 pm, and Friday 2:30 to 3:25 pm in the Medical Device Center (MDC). Fridays are a mix of discussion and exercise time.

Lab: Short discussions and workshop time for exercises are in the MDC, new CSE Student Workshops, and Mechanical Engineering Student Shop. These occur on Friday and independently.

Credits: 2

Prerequisites: The class size is initially limited to 20 students, and priority will go to CSE lower-division students who have completed BMEn 2401 (Programming/MATLAB). If seats remain available, others may add the class with permission from the instructor.

Course Goals and Objectives
Students will become acquainted with the following topics:

- o Engineering drawing with SolidWorks
- o CAM and 3D FDM printing
- o Lathe, mill, and other shop instruction
- o Biomaterials & biocompatibility
- o Digital and analog electronics, SPICE
- o Programming in C
- o Microcontrollers, sensors and actuators
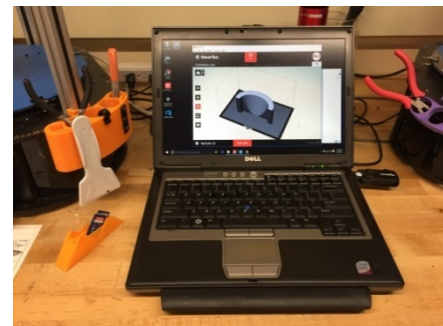
Required Books:
Scherz, P. and S. Monk, *Practical Electronics for Inventors*, 4th ed., McGraw Hill, NY (2016).
Cost is $22.78.

Required Software:
Arduino (free download)
SolidWorks (free from the University)
Multisim and Ultiboard (free student evaluation period, then $39.95 to purchase)

Optional Software (all can be downloaded for free):
Fritzing
MPLAB IDE
Integrated Programming Environment (IPE)
MPLAB C Compiler
MPLAB Code Configurator

Reference Books (all are available on reserve from Prof. Saliterman in the MDC):
Electronics:
Baker, B. A., *Baker's Dozen: Real Analog Solutions for Digital Designers*, Elsevier – Newnes, Burlington, MA (2005).
Belin, H.M. *Design of Op Amp Circuits*, Blacksburg, H.W. Sams Indianapolis, IN (1977).
Carr, J.C. *IC Timers*, H.W. Sams, Indianapolis, IN, (1997)
Jung, W., *Op Amp Applications Handbook*, Elsevier Newnes, Analog Devices, Burlington, MA (2006) Free on the web.
Jung, W.G., *IC Op Amp Cookbook* 3rd ed. H.W. Sams, Indianapolis, IN (1991).
Kochan, S.G., *Programming in C*, 3rd ed. H.W. Sams, Indianapolis, IN, (2005).
Lancaster, D. and H.M. Berlin, CMOS Cookbook, H.W. Sams Indianapolis, IN (1988).
Monk, S. *Fritzing for Inventors*, Tab – McGraw Hill Education, New York, NY (2016).
Monk, S. *Hacking Electronics*, Tab – McGraw Hill Education, New York, NY (2013).
Platt, C, *Encyclopedia of Electronic Components: Power Sources and Conversion*, Vol. 1, MakerMedia, Sebastopol, CA (2013)
Platt, C, *Encyclopedia of Electronic Components: Signal Processing*, Vol. 2, MakerMedia, Sebastopol, CA (2014).
Platt, C, *Encyclopedia of Electronic Components: Sensors*, Vol. 3, MakerMedia, Sebastopol, CA (2016).
Platt, C, *Electronics*, 2nd ed., MakerMedia, Sebastopol, CA (2015)
Platt, C, *More Electronics*, MakerMedia, Sebastopol, CA (2014)

Engineering Drawing & CADD/CAM:
Cogorno, G.R., Geometric Dimensioning and Tolerancing for Mechanical Design, McGraw Hill, 2nd ed., New York, NY (2011)
Lombard, M. SolidWorks 2011 Parts (or later), Wiley, Indianpolis, IN (2011)
Madsen, D. A. and D. P. Madsen, *Engineering Drawing and Design*, 5th ed., Delmar Cengage Learning, Clifton Park, NY, (2012)

Machining:
Fitzpatrick, M., *Machining and CNC Technology*, McGraw Hill, New York, NY (2014).

Materials:
Hill, D., *Design Engineering of Biomaterials for Medical Devices*, Wiley, New York, NY (1998).
John, V. *Introduction to Engineering Materials 3rd ed.*, Industrial Press Inc., New York, NY (1992)
Modjarrad, K. and S. Ebnesajjad, *Handbook of Polymer Applications in Medicine and Medical Devices*, 1st ed., Elsevier, William Andrew (2014)
Ratner, B.D., A.S. Hoffman, F.J. Schoen, J.E. Lemons, *Biomaterials Science* 3rd ed. Society for Biomaterials, Academic Press, New York (2013).

Microcontrollers and Mechatronics:
Boxall, *Arduino Workshop*, No Starch Press, San Francisco, (2013).
Lynch, K.M., N. Marchuk, E.L. Matthew, *Embedded Computing and Mechatronics with the PIC32 Microcontroller*, Newnes-Elsevier, Waltham, MA (2016).
Scarpino, M. *Motors for Makers*, Que, Indianapolis, IN, (2016).

Programming:
Kochan, S.G. *Programming in C*, 3rd ed. Developers library, Sams Publishing, Indianapolis, IN (2005).
Monk, S., *Programming Arduino: Getting Started with Sketches*, Tab – McGraw Hill Education, New York, NY (2012).
Monk, S., *Programming Arduino: Next Steps*, Tab – McGraw Hill Education, New York, NY (2012).
Reas, C and B. Fry, *Processing: A Programming Handbook for Visual Designers and Artists*, 2nd ed. MIT (2014).

Examinations: See Class Schedule spreadsheet.

Homework: Reading assignments (25 pages/week) and exercises (some of which will be done during Lab time, others independently.)

Class Time: About 60% lecture, 30% exercises, and 10% discussion.

Exercises
You will be required to complete assigned exercises in engineering drawings, 3D FDM part fabrication, machining parts, breadboarding analog and digital circuits, C programming, and interfacing an Arduino to various sensors and actuators.

Grading
Midterm exam   25%
Exercises: 25%
Project and participation: 15% Presentation
                        10% Participation
Final exam: 25%

If you are having difficulties with the material please let Prof. Saliterman or the TA know. We will meet with you and set up whatever is necessary for you to improve. If you perform poorly on a test, it is possible to study again and retake an examination. The examinations are short essay style, and not open book. Do no bring study materials or calculators into the examination room unless instructed to do so.

Course Conflicts: Please notify the instructor if you have a course or final examination conflict.

University Policies

Administrative Policy for Legitimate Absences
Students may be absent absence during the semester due to unavoidable or legitimate circumstances. Such circumstances include illness of the student or his or her dependent, participation in intercollegiate athletic events. For other University of Minnesota policies regarding absences and makeup work, please see:
http://policy.umn.edu/Policies/Education/Education/MAKEUPWORK.html

Board of Regents Policy on Academic Freedom
Please read this important information on the University of Minnesota's Board of Regents Policy on Academic Freedom and Responsibility
http://regents.umn.edu/sites/default/files/policies/Academic_Freedom.pdf

Board of Regents and Administrative Policy on Conduct, Teaching, and Learning
Please familiarize yourself with the Student Conduct Code and Administrative Policy on Teaching and Learning:
http://policy.umn.edu/Policies/Education/Education/STUDENTRESP.html
http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf

Board of Regents Policy on Equity, Diversity, Equal Employment Opportunity, and Affirmative Action
Please see this important information on the University of Minnesota's Board of Regents Policy on Equity, Diversity, Equal Employment Opportunity, and Affirmative Action:
http://regents.umn.edu/sites/default/files/policies/Equity_Diversity_EO_AA.pdf

Board of Regents Policy on Sexual Harassment
Please see this important information on the University of Minnesota's Policy on Sexual Harassment:
http://regents.umn.edu/sites/default/files/policies/SexHarassment.pdf

Disability
The University of Minnesota is committed to providing equitable access to learning opportunities for all students. Disability Services (DS) is the campus office that collaborates with students who have disabilities to provide and/or arrange reasonable accommodations.
If you have, or think you may have, a disability (e.g., mental health, attentional, learning, chronic health, sensory, or physical), please contact DS at 612-626-1333 to arrange a confidential discussion regarding equitable access and reasonable accommodations. If you are registered with DS and have a current letter requesting reasonable accommodations, I encourage you to contact me early in the semester to review how the accommodations will be applied in the course.

Grade Definitions
The University of Minnesota's "Grading and Transcripts" policy can be reviewed here:
http://policy.umn.edu/Policies/Education/Education/GRADINGTRANSCRIPTS.html

Mental Health and Stress Management Services
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating, and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce your ability to participate in daily activities. University of Minnesota services are available to assist you with addressing these and other concerns you may be experiencing. You can learn more about the broad range of confidential mental health services available on campus via www.mentalhealth.umn.edu. Please visit http://mentalhealth.umn.edu/ for several resources for students, their parents, faculty, and staff.

Student Conduct Code
The University of Minnesota's Student Conduct Code: can be reviewed here:
http://regents.umn.edu/sites/default/files/policies/Student_Conduct_Code.pdf

BMEn 2151 - *Introductory Medical Device Prototyping* Class Schedule
Spring 2017, M and W - 3:35-4:30 and F - 2:30-3:25, Two Credits
Prof. Steven S. Saliterman

Week	Day	Date	Topic	Reading Assignment *	Weekly Labwork
1	Wednesday	1/18/2017	Introduction to Medical Device Prototyping		Short week
	Friday	1/20/2017	Fundamentals of Engineering Drawing	Madson & Madson selections	
2	Monday	1/23/2017	Demo: SolidWorks Part 1	Madson & Madson selections	Lab 1 - Drawing exercises & 3D FDM printing.
	Wednesday	1/25/2014	3D FDM Printing	SolidWorks tutorial (TBD)	
	Friday	1/27/2017	Discussion: Machine Shop Part 1		
3	Monday	1/302017	Demo: SolidWorks Parts 2 and 3	Madson & Madson selections	Lab 2 - Drawing exercises & 3D FDM printing.
	Wednesday	2/1/2017	Machine Shop Part 2 and 3	SolidWorks tutorial	.
	Friday	2/3/2017	Discussion: Machine Shop Parts 4 & 5		
4	Monday	2/6/2017	Demo: SolidWorks Parts 3 and 4	Madson & Madson selections	Lab 3- ME safety videos and mill/lathe training.
	Wednesday	2/8/2017	Demo: SolidWorks Parts 5 and 6	SolidWorks tutorial	
	Friday	2/10/2018	Discussion: Machine Shop Part 6		
5	Monday	2/13/2017	Computer Aided Manufacturing Parts 1 & 2	Fitzpatrick selections	Lab 4 - Continuation of mill/lathe training schedule.
	Wednesday	2/15/2017	Biomaterials Part 1 - Overview	Ratner et. al. selections	
	Friday	2/17/2017	Workshop Time (lab exercises)		
6	Monday	2/20/2017	Biomaterials Part 2 - Polymers	Modjarrad selections	Lab 5 - Fabricate part on mill or lathe.
	Wednesday	2/22/2017	Biomaterials Part 3 - Biocompatiblity	Saliterman selections	
	Friday	2/24/2017	Workshop Time		
7	Monday	2/272017	Analog Circuits Part 1 - Circuit Theory	Scherz and Monk selections	Lab 6 - Breadboard analog circuit
	Wednesday	3/1/2017	Analog Circuits Part 2 - Amplifiers	Berlin selections	
	Friday	3/3/2017	Discussion: Test Equipment		
8	Monday	3/6/2017	Midterm Exam Part 1 - Drawing	Scherz and Monk selections	Lab 7 - Characterize circuit
	Wednesday	3/8/2017	Midterm Exam Part 2 - Questions	Scherz and Monk selections	
	Friday	3/10/2017	Workshop Time		
Spring Break 3/13/2017-3/17/2017					
9	Monday	3/20/2017	Digital Circuits Part 1 - Logic Gates	Lancaster selections	Lab 8 - Breadboard digital circuit
	Wednesday	3/22/2017	Digital Circuits Part 2 - Communication	Scherz and Monk selections	
	Friday	3/24/2017	Workshop Time		
10	Monday	3/27/2017	Fabricating Electronic Circuits	Scherz and Monk selections	Lab 9 - Design a circuit board
	Wednesday	3/29/2017	Programming in C Part 1	Kochran selections	
	Friday	3/31/2017	Project Assignment and Workshop Time		
11	Monday	4/3/2017	Programming in C Part 2	Kochrank selections	Lab 10 - C programming exercise
	Wednesday	4/5/2017	Arduino Microcontroller Part 1	Monk	
	Friday	4/7/2017	Team Time		
12	Monday	4/10/2017	Arduino Microcontroller Part 2	Monk, Boxall selections	Lab 11 - Arduino programming exercise
	Wednesday	4/12/2017	Microchip PIC Microcontrollers		
	Friday	4/14/2017	Team Time		
13	Monday	4/17/2017	Sensor Principles	Scherz and Monk selections	Lab 12 - Interfacing a sensor and actuator to Arduino
	Wednesday	4/19/2017	Actuators and Control Circuits	Scherz and Monk selections	
	Friday	4/21/2017	Workshop Time		
14	Monday	4/24/2017	Team 1 and 2 presentations		
	Wednesday	4/26/2017	Team 3 and 4 presentations		
	Friday	4/28/2017	Team 5 and 6 presentaions		
15	Monday	5/1/2017	Team 7 and 8 presentations		
	Wednesday	5/3/2017	Team 9 and 10 presentations		
	Friday	5/5/2017	Course Review		
16			Final Exam - 2 hr. Closed Book Exam		
*All reference books listed on the Syllabus are on reserve in the Medical Device Center.					
Reading also includes information contained in the Workshop exercises.					