

BME 241: Introductory Biomedical Engineering Laboratory

Instructors:

Cynthia Chestek, Ph.D.
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GSI:

Amy Blatt
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IAs:

Hannah Gannon
hgannon@umich.edu

Franklin Qiu
fsqiu@umich.edu

Graders:

Simona Krifman skrifman@umich.edu
Saumya Khurana ksaumya@umich.edu

Office hours:

Chestek: Mon 2:30-3:30 pm (2220 LBME)
Blatt: Wed 2:30-4:30pm (1105/1220 LBME)

Lecture: Mon, Wed 1:30 - 2:30pm 1123 LBME
(First day Sept 9, finals Dec 20)

Lab: Fri Section 1 8:30am – 12:30pm (1105/1220 LBME)
Fri Section 2 1:00pm – 5:00pm (1105/1220 LBME)

Course Materials

Required:

- Laboratory notebook (purchase scientific lab notebook, 192 pg version)
- Course notes, lab handouts, associated documents (CTools Resources)

Suggested:

- Statistics text – Miller and Freund's Probability and Statistics for Engineers (8th Edition) by Richard Johnson, Irwin Miller, John Freund

Grading

Problem Sets	15%
Quizzes	20%
Lab notebooks	15%
Pre-lab assignments	10%
Post-lab reports	30%
Research Project	10%

Lab Projects

Circuits, Op-Amps Introduction to lab instrumentation, simple circuits, op-amps
EMG(+LabVIEW) Acquire and analyze electromyograms
Material Properties Investigate and compare mechanical properties of biological materials

<i>Cell Culture</i>	Attachment rates and live-dead assays using cultured mammalian cells
<i>Research Project</i>	Develop hypothesis, the design and conduct experiments. Project deliverables: proposal, lab notebook, poster presentation

Lab Safety

All students are expected to work safely in the lab. Safety glasses must be worn at all times in the Wet Lab. Students must wear long pants, shirts with sleeves (or a lab coat, buttoned up), and close-toed shoes. No eating, drinking, or gum chewing are allowed in the lab.

Biohazardous materials, glass material, solvents, raw chicken, etc. must be disposed of properly. Details for proper disposal will be discussed in lab. Please do not touch any materials or equipment not relevant to your lab. Take care when using fast-moving, sharp, or other dangerous parts of lab equipment and be familiar with safety features of the devices.

Lab Notebook Maintenance

Student performance is evaluated in part on the maintenance of a lab notebook (15% of course grade). Please consult lecture notes and lab notebook grading rubric (CTools) for detailed instructions on how to maintain your lab notebook.

Attendance Policy

Students are expected to attend *all* sessions of the laboratory. A student choosing to miss a lab session to attend another commitment (e.g. job interviews, graduate school interviews) must inform the GSI in advance and then make up the session at a time convenient to one of the instructors and possibly his/her lab partners – subject to the availability of equipment. If a convenient time cannot be established or the student choose not to make up the session, no points will be given for the assignments relating to that session. Illness and family emergencies will be handled on an individual basis. Contact the GSI as soon as possible if an emergency arises.

Honor Code Policy

Much of the learning in this lab will be from coaching and interaction with other students, the instructors, and the GSI. It is important that a collegial environment is maintained. For most experiments, you and your partner(s) will collect only one set of data. You may discuss strategies for data preparation and interpretation with your partner(s) and other students, but you must do all data calculations, graphing, tabulating, etc. yourself. Likewise, all homework sets and quizzes are to be completed individually. Finally, you must do all of the writing yourself, unless specified otherwise (an exception being the final 2 lab reports, which are group efforts). You may consult the lab protocols, course notes, other textbooks, review articles, and published research papers. Information taken from journals, books, and websites must be adequately referenced.

BME 241 Lab and Lecture Schedule, F-2016

Wk	Lecture				Lab
	Monday		Wednesday		
	Date 2016	Topic	Date 2016	Topic	
1	9/05	No class	9/07	Intro, Lab Notebooks, Circuits	Lab 1: Introductory Circuits 9/09
2	9/12	Lab Reports, Group Project, LabVIEW	9/14	Bode Plots, Fourier Analysis	Lab 2: LabView "take home" 9/16
3	9/19	RC Filters, Operational Amplifiers	9/21	Op-Amps, Active Filters, Instrumentation Amplifiers	Lab 3: Op-Amps 9/23
4	9/26	EMG, Materials Testing Introduction	9/28	Definitions, Probability, Descriptive Statistics	Lab 4: EMG 9/30
5	10/03	Discrete Random Variables and Distributions	10/05	Materials Testing, Stress, Strain, Young's Modulus, Tensile Testing, Viscoelasticity	Lab 5: Tensile Testing 10/07
6	10/10	Continuous Random Variables and Distributions	10/12	Materials Testing, Compression, Beam Theory, Flexure Tests, Research Project Introduction	Lab 6: Biological Tensile Testing 10/14
7	10/17	No class (Fall Break)	10/19	Sampling Statistics, t distribution	Lab 7: Compression Testing 10/21
8	10/24	Central Limit Theorem, Point Estimation, Confidence Intervals	10/26	Quiz 1	Lab 8: Flexure Testing 10/28
11	10/31	Cell Culture	11/02	Hypothesis Testing	Lab 9: Cell Viability, Counting 11/04
12	11/07	Research Project Proposal Due, Project mini-pitches	11/09	Design of Experiments, Power Analysis, Sample Size	Lab 10: Cell Adhesion 11/11
13	11/14	Regression	11/16	Quiz 2	Lab 11: Research Project 11/18 (1 of 3)
14	11/21	Multiple Regression	11/23	No class - Thanksgiving	No Lab – Thanksgiving 11/25
15	11/28	Categorical Data	11/30	ANOVA	Lab 11: Research Project 12/02 (2 of 3)
16	12/05	Non-Parametric Tests	12/07	Special Topics, Quiz 3 Review	Lab 11: Research Project 12/09 (3 of 3)
17	12/12	Quiz 3	Poster Presentations 12/21 1:30pm – 3:30pm (Due in pdf form 12/20 at midnight, upload to Canvas)		

BME 241 Lab Assignment Due Dates, F-2016

Wk	Lab	What's due?		
		Pre-lab (collected at beginning of lab)	Lab report (collected at beginning of lab)	Lab Notebook (collected at end of lab)
1	Lab 1: Introductory Circuits 9/09	Lab 1 – Intro Circuits Pre-lab		
2	Lab 2: LabView “take home” 9/16			Yes (Lab 1)
3	Lab 3: Op-Amps 9/23	Lab 3 – Op amps Pre-lab		
4	Lab 4: EMG 9/30	Lab 4 – EMG Pre-lab	Op-Amps (5 page limit, individual)	Yes (Labs 2 & 3)
5	Lab 5: Tensile Testing 10/07	Lab 5 – Tensile Testing Pre-lab		
6	Lab 6: Biological Tensile Testing 10/14		EMG (5 page limit, individual)	Yes (Labs 4 & 5)
7	Lab 7: Compression Testing 10/21	Lab 7 – Compression Testing Pre-lab		
8	Lab 8: Flexure Testing 10/28	Lab 8 – Flexure Testing Pre-lab		
11	Lab 9: Cell Viability, Counting 11/04		Tensile and Compression (10- page limit, group)	Yes (Labs 6 & 7)
12	Lab 10: Cell Adhesion 11/11			
13	Lab 11: Research Project 11/18 (1 of 3)		Cell Adhesion (5 page limit, group)	Yes (Labs 8 & 10)
14	Thanksgiving – No Lab 11/25			
15	Lab 11: Research Project 12/02 (2 of 3)			Yes (Lab 9)
16	Lab 11: Research Project 12/09 (3 of 3)			
17	Poster Presentation 12/21 1:30-3:30pm (Due in pdf format 12/20 at midnight, upload to Canvas)			

BME 241: Introductory Biomedical Engineering Laboratory

Instructors:	GSI ^s :	IA ^s :
Dennis Claflin , Ph.D. claflin@umich.edu	Amos Cao (Sec 2) amoscao@umich.edu	Nusayba Tabbah (Sec 2) ntabbah@umich.edu
Scott Lempka , Ph.D. lempka@umich.edu	Amos Cao (Sec 3) amoscao@umich.edu	Tess Bradley (Sec 3) bradlete@umich.edu
	Hengky Chandralim , Ph.D. (Sec 4) hengky@umich.edu	Phillip Yang (Sec 4) philyang@umich.edu

Lecture: Mon & Wed, 12:30pm – 1:30pm, G906 Cooley

Lab: Sec 2: Mon, 3:30 – 7:30pm, 1105/1220 LBME (Amos, Nusayba)
Sec 3: Tue, 3:30 – 7:30pm, 1105/1220 LBME (Amos, Tess)
Sec 4: Wed, 3:30 – 7:30pm, 1105/1220 LBME (Hengky, Phillip)

Office hours:

Clafin:	Wed, 1:30 – 2:30pm	(2232 LBME)
Lempka:	Wed, (TBD)	(TBD)
Amos:	Tue, 1:30 – 3:30pm	(1105/1220 LBME)
Hengky:	Wed, 2:30 – 3:30pm	(1105/1220 LBME)

Course Materials

Required:

- Laboratory notebook (purchase scientific lab notebook – 192-page version)
- Lab instructions, equipment manuals, etc. ([Canvas](#), “Pages”)

Suggested:

- Statistics text – Miller & Freund's Probability and Statistics for Engineers (8th Edition) by Richard Johnson, Irwin Miller, John Freund

Grading

Lab Notebook	15%
Pre-lab Homework	10%
Post-lab Reports	30%
Research Project	10%
Statistics Homework	15%
Statistics Quizzes	20%

Lab Modules

Circuits, Op-Amps.....Introduction to lab instrumentation, simple circuits, op-amp circuits
EMG (+LabVIEW).....Instrumentation amps, acquire and analyze electromyograms (EMG)
Material PropertiesInvestigate and compare mechanical properties of biological materials
Cell CultureAttachment rates and live-dead assays using cultured cells
Research Project.....Develop hypothesis, then design and conduct experiments.
Project deliverables: proposal, lab notebook, poster presentation

Lab Safety

All students are expected to work safely in the lab. Safety glasses must be worn at all times in the Wet Lab. Students must wear long pants, shirts with sleeves (or a lab coat, buttoned up), and close-toed shoes. No eating or drinking is allowed in the lab.

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BME 241 Lab and Lecture Schedule, W-2017

Week	Lab	Lecture			
		Monday		Wednesday	
		Date (2017)	Topic	Date (2017)	Topic
1	No Lab Mon 1-02, Tue 1-03, Wed 1-04	02-Jan	No Lecture	04-Jan	Intro, Circuits
2	Lab 1: Introductory Circuits Mon 1-09, Tue 1-10, Wed 1-11	09-Jan	Lab Notebooks, Lab Reports, Breadboards	11-Jan	Bode Plots, Fourier Analysis, LabVIEW
3	Lab 2 - LabVIEW "take home" To complete Part 4: Lab open Wednesday and Friday (1/18 & 1/20) from 9AM to 5PM	16-Jan	No Lecture (MLK Holiday)	18-Jan	R-C Filters, Operational Amplifiers
4	Lab 3: Op-Amps Mon 1-23, Tue 1-24, Wed 1-25	23-Jan	Op-Amps, Active Filters, Instrumentation Amplifiers	25-Jan	Electromyogram (EMG), Origin & Acquisition
5	Lab 4: EMG Mon 1-30, Tue 1-31, Wed 2-01	30-Jan	Definitions, Descriptive Statistics	01-Feb	Materials Testing: Stress, Strain, Young's Modulus, Tensile Testing, Viscoelasticity
6	Lab 5: Tensile Testing Mon 2-06, Tue 2-07, Wed 2-08	06-Feb	Probability, Discrete Random Variables and Distributions	08-Feb	Continuous Random Variables and Distributions
7	Lab 6: Tensile Testing - Biological Mon 2-13, Tue 2-14, Wed 2-15	13-Feb	Materials Testing: Compression, Beam Theory, Flexure Tests, Research Project introduction	15-Feb	Sampling Distributions, t-distribution
8	Lab 7: Compression Testing Mon 2-20, Tue 2-21, Wed 2-22	20-Feb	Hypothesis Testing I	22-Feb	Quiz 1 (G906 Cooley)
9	No Lab (Spring Break) Mon 2-27, Tue 2-28, Wed 3-01	27-Feb	Spring Break	01-Mar	Spring Break
10	Lab 8: Flexure Testing Mon 3-06, Tue 3-07, Wed 3-08	06-Mar	Cell Culture, Research Project	08-Mar	Hypothesis Testing II
11	Lab 9: Cell Adhesion Mon 3-13, Tue 3-14, Wed 3-15	13-Mar	Hypothesis Testing III, Power	15-Mar	Project Micro-Pitches (Research Project proposal due)
12	Lab 10: Cell Viability Mon 3-20, Tue 3-21, Wed 3-22	20-Mar	Point Estimation, Confidence Intervals	22-Mar	Quiz 2 (G906 Cooley)
13	Lab 11: Research Project (1 of 3) Mon 3-27, Tue 3-28, Wed 3-29	27-Mar	Linear Regression	29-Mar	Multiple Regression
14	Lab 11: Research Project (2 of 3) Mon 4-03, Tue 4-04, Wed 4-05	03-Apr	ANOVA	05-Apr	Two-Way ANOVA
15	Lab 11: Research Project (3 of 3) Mon 4-10, Tue 4-11, Wed 4-12	10-Apr	Summary	12-Apr	Quiz 3 (G906 Cooley)
16	No Lab (and no Lecture) Mon 4-17, Tue 4-18, Wed 4-19	Research Project Poster Presentations: Thursday, April 20, 1:30PM - 3:30PM [Due 4-19, 11:59PM: Poster in PDF format - upload via Canvas "Submit Assignment" button] [Due 4-20, 1:30PM: Poster hard-copy, Lab Notebooks]			

BME 241 Assignment Due Dates, W-2017

Week	Lab	What's Due?			
		Pre-lab (collected at start of lab)	Lab Report (Hardcopy + PDF upload)	Lab Notebook (collected at end of lab)	Other (Stats HW, Project Proposal) (PDF uploads)
1	No Lab Mon 1-02, Tue 1-03, Wed 1-04				
2	Lab 1: Introductory Circuits Mon 1-09, Tue 1-10, Wed 1-11	Intro Circuits (Lab 1)			
3	Lab 2: LabVIEW "take home"	LabVIEW (Lab 2) (upload 6 VI's by 5PM Fri, 1-20)		yes (Lab 1) (turn in by 5PM Fri, 1-20)	
4	Lab 3: Op-Amps Mon 1-23, Tue 1-24, Wed 1-25	Op-Amps (Lab 3)			
5	Lab 4: EMG Mon 1-30, Tue 1-31, Wed 2-01	EMG (Lab 4)	Op-Amps (5-page limit, individual)	yes (Labs 2 & 3)	
6	Lab 5: Tensile Testing Mon 2-06, Tue 2-07, Wed 2-08	Tensile Testing (Lab 5)			Stats HW 1 (due Fri, 2-10, 11PM)
7	Lab 6: Tensile Testing - Biological Mon 2-13, Tue 2-14, Wed 2-15		EMG (5-page limit, individual)	yes (Labs 4 & 5)	Stats HW 2 (due Fri, 2-17, 11PM)
8	Lab 7: Compression Testing Mon 2-20, Tue 2-21, Wed 2-22	Compression Testing (Lab 7)			
9	No Lab (Spring Break) Mon 2-27, Tue 2-28, Wed 3-01				
10	Lab 8: Flexure Testing Mon 3-06, Tue 3-07, Wed 3-08	Flexure Testing (Lab 8)			Stats HW 3 (due Fri, 3-10, 11PM)
11	Lab 9: Cell Adhesion Mon 3-13, Tue 3-14, Wed 3-15		Tensile & Compression (10-page limit, group)	yes (Labs 6 & 7)	Project Proposal (due Wed, 3-15, 11:59AM)
12	Lab 10: Cell Viability Mon 3-20, Tue 3-21, Wed 3-22				Stats HW 4 (due Mon, 3-20, 11PM)
13	Lab 11: Research Project (1 of 3) Mon 3-27, Tue 3-28, Wed 3-29		Cell Adhesion (5-page limit, group)	yes (Labs 8 & 9)	
14	Lab 11: Research Project (2 of 3) Mon 4-03, Tue 4-04, Wed 4-05				Stats HW 5 (due Wed, 4-05, 11PM)
15	Lab 11: Research Project (3 of 3) Mon 4-10, Tue 4-11, Wed 4-12			yes (Lab 10)	
16	No Lab (and no Lecture) Mon 4-17, Tue 4-18, Wed 4-19	Research Project Poster Presentations: Thursday, April 20, 1:30PM - 3:30PM [Due 4-19, 11:59PM: Poster in PDF format - upload via Canvas "Submit Assignment" button] [Due 4-20, 1:30PM: Poster hard-copy, Lab Notebooks]			