BEN 487 – Bioengineering Capstone Design II
Syllabus (Spring 2024)

Instructor: Douglas Yung
Office Location: Link Hall 361
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Teaching Assistant: Johnson Agyapong
Email: jagyapon@syr.edu
Office Hour: TBD

Class Location and Time:

Studio & Workshop | Wednesday | Link 331 | 9:30 am – 11:30 am
Laboratory | Friday | Link 331 | 12:45 pm – 3:30 pm
Alpha Prototype Demonstration | February 23rd 12:45 pm – 3:30 pm
Beta Prototype Demonstration | March 29th 12:45 pm – 3:30 pm
Final Presentation & Senior Celebration | April 19th | 1:00 pm – 3:00 pm (*tentative*) | Location: National Veterans Resource Center

Friday lab sessions serve the following purposes. You are required to attend certain sessions (e.g., assigned meeting with instruction team and whole-class alpha, beta prototype demonstrations). You are highly encouraged to take advantage of the Friday sessions to spend time with your team member on the project.

- *Additional project time*
- *Open design time*
- *Individual coaching from instruction team*
- *Pitch and presentation practice*

Office Hours:

Please visit Calendly (https://calendly.com/douglasyung) often, as I will be adding additional timeslots each week. I am only a mouse-click away. You can also schedule an appointment at other times if you are unable to meet during my posted office hours. I will do my best to accommodate your availability.

Walk-in Office Hours

Swing by my office at Link 361 without making an appointment. Appointment is also welcome if you want to secure a specific time to meet and beat the crowd.

Monday	09:30 – 11:00
Friday	09:00 – 10:00

By-appointment Office Hours

Set up an appointment at Calendly (https://calendly.com/douglasyung). Calendly is a free, easy-to-use web-based scheduler. You will look at my calendar and choose a time that is convenient for you. Evening office hours are held over Zoom.

Tuesday	11:30 – 12:30
Thursday	09:00 – 11:00

Course Websites:
Blackboard: Blackboard will be playing a minimal role in this semester. You will submit individual assignments through Blackboard. You can check your gradebook and look at course materials.
Microsoft Team: All class announcements, group assignments, project deliverables, and weekly reports will be communicated and submitted via Microsoft Team. Remember to customize the notification setting so that you will get pinged for updates. You are held responsible for all communications in Microsoft Team.
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Link 331 Open Design Time:
Friday: ALL DAY (except for occasional meetings and activities)

Design Space & Safety:
Link 0033 – available 24/7 (combo: 3300).
Link 331 – 24/7 card access granted for all bioengineering students taking BEN 487. You can use this room when there is no scheduled class or other reserved activities.

- Avoid working alone in the lab, especially during off-hours.
- If necessary, inform someone about your schedule and expected duration in the lab.
- Wear appropriate PPE when necessary.
- Keep the lab clean and organized.
- Adhere to all university and lab-specific safety policies. Report any violations or unsafe conditions.

Course Overview:
Bioengineering Capstone Design is intended to give students practical hands-on experience designed a system, device, etc. from concept to fruition. This course will consist of one lecture (on design strategies, engineering ethics, FDA approval, patents, etc.) and one team group work time per week. Strong emphasis will be placed on presentation skills, technical writing proficiency, proper experimental design and execution, and team work.

Workload Calculation:
This is not a heavy lecture-based course. Instead the course hours will be used to guide students in the establishment of their design project. Students are offered adequate time to work on the project. Feedback will be given regularly during the course. You are expected to spend roughly 10 hours per week on this course. This includes 2 hours of lectures per week and 7 hours 'out of class' time spent on background research, progress reports, final report, presentation, prototyping, interaction with instructor/client, experiment, documentation, group discussion, etc.

Course Outcomes:
Successful course completion should result in the following student outcomes

- An ability to design a system, component or process to meet a desired need, to demonstrate historical solutions to design problems, identify potential use cases and failure modes, identify and apply constraints to design problems, manages design project development, utilize computational design tools, use engineering principles and judgment to design a component of a system [program outcomes 1, 2, 4]
- An ability to function on multidisciplinary teams in a simulated "start-up" environment, research and gather information, fulfill team role's duties, share in work of team, and listen to other teammates (program outcome 5)
- An ability to validate medical needs, understand market assessment and the competitive evaluation of existing technologies, hone techniques for analyzing and valuing intellectual property, gain an

appreciation of the process for taking a medical device from invention 1 to market, and learn the essentials of writing a business plan. (program outcomes 2, 6, 7)

- An understanding of professional and ethical responsibility (program outcome 4)
- An ability to communicate effectively, prepare effective slides or demonstrations, deliver oral presentations effectively, convey complete, logically organized written reports, utilize correct grammar, punctuation, spelling and format, utilize computer software relevant to written reports data presentation, and oral presentation (program outcome 3)
- The broad education necessary to understand the impact of engineering in a global or societal context, build critical thinking skills, relate engineering practice to sustainability and environment, understand the role of economics in engineering practices, understand the impact of government, law, and public policy on engineering practice (program outcome 2)
- A knowledge of contemporary issues with the ability to list and explain current issues of societal importance to bioengineers, demonstrate engagement in a contemporary issue related to bioengineering (program outcome 7)
- An ability to use the techniques, skills, and modern engineering tools for engineering practice, implement engineering fundamentals to tackle real world problems, utilize relevant software and or instrumentation, recognize the role of constraints in engineering practice (program outcomes 1, 2, 6, 8)

Program Outcomes: ABET-accredited engineering programs must demonstrate that their graduates have:

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics;
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors;
3. an ability to communicate effectively with a range of audiences;
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts;
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives;
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions;
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies;
8. an understanding of biology and physiology, and the capability to make measurements on living system and solve associated bioengineering problems.

Course Tags:

BEN 487 fosters three Shared Competencies, Syracuse University's university-wide learning goals for undergraduate students:

- Critical and Creative Thinking
- Scientific Inquiry and Research Skills
- Civic and Global Responsibility

Course Calendar

Use this URL to access the course calendar from a web browser. You can also find this calendar in Blackboard. Please note that the calendar is subject to change. Any changes will be communicated to students via email.

January 2024

14	15	16 First Day of Spring Semester	17 9:30am Class 1	18	19 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	20
21	22	23 12pm Progress Report 1, 12p-12	24 9:30am Class 2	25	26 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	27
28	29	30 12pm Progress Report 2, 12p-12	31 9:30am Class 3	Feb 1	2 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	3

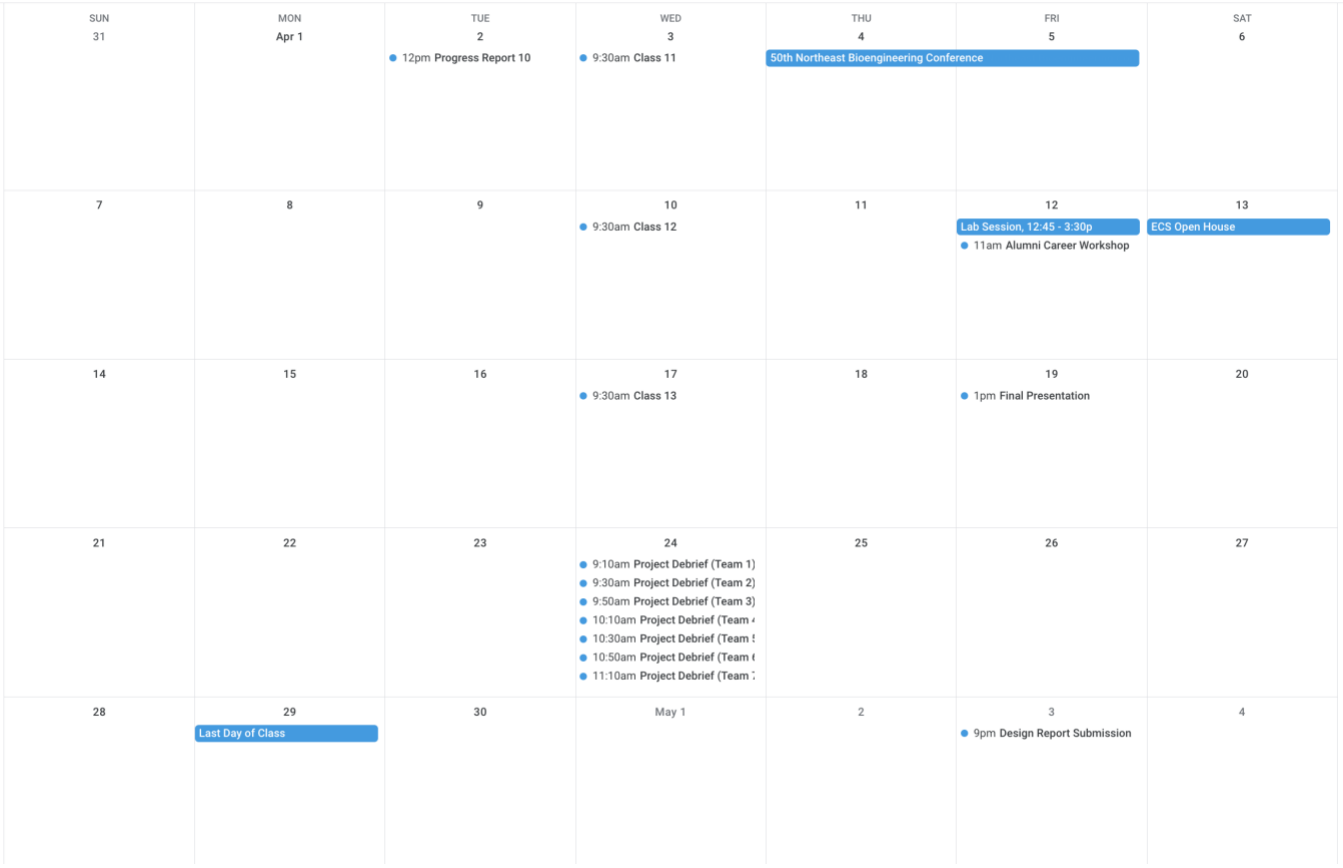
February 2024

SUN	MON	TUE	WED	THU	FRI	SAT
28	29	30 12pm Progress Report 2, 12p-12	31 9:30am Class 3	Feb 1	2 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	3
4	5	6 12pm Progress Report 3	7 9:30am Class 4	8	9 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	10
11	12	13 12pm Progress Report 4	14 9:30am Class 5	15	16 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	17
18	19	20 12pm Progress Report 5	21 9:30am Class 6	22	23 11am Alumni Career Workshop 12:45pm Alpha Prototype Demo	24
25	26 Start of Simulated Internship	27 12pm Progress Report 6	28 9:30am Class 7	29	Mar 1 Design Notebook Submission #1 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	2

March 2024

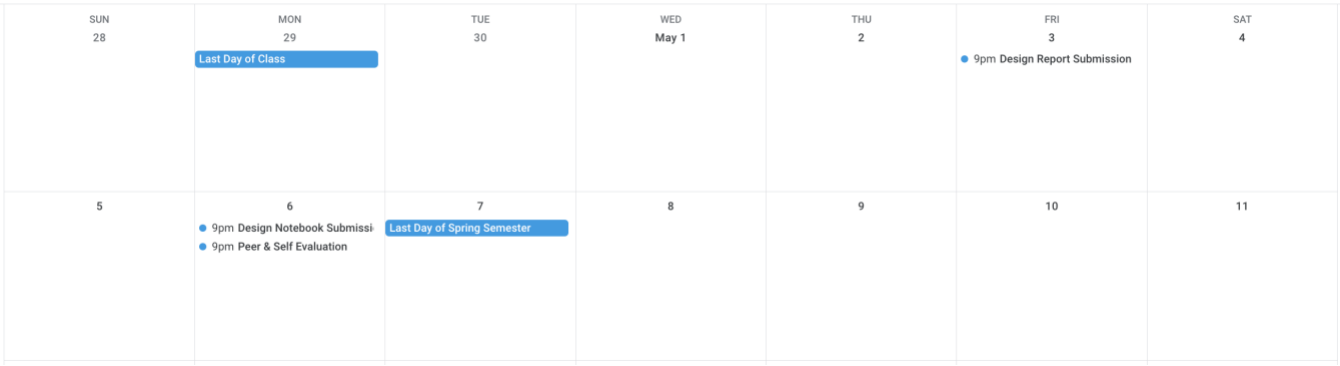
SUN	MON	TUE	WED	THU	FRI	SAT
25	26 Start of Simulated Internship	27 12pm Progress Report 6	28 9:30am Class 7	29	Mar 1 Design Notebook Submission #1 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	2
3	4	5 12pm Progress Report 7	6 9:30am Class 8	7	8 Lab Session, 12:45 - 3:30p	9
10 Spring Break	11	12	13	14	15	16
17 Spring Break	18	19 12pm Progress Report 8	20 9:30am Class 9	21	22 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	23
24	25	26 12pm Progress Report 9	27 9:30am Class 10	28	29 11am Alumni Career Workshop 12:45pm Beta Prototype Demon	30
31	Apr 1	2 12pm Progress Report 10	3 9:30am Class 11	4 50th Northeast Bioengineering Conference	5	6

April 2024



SUN	MON	TUE	WED	THU	FRI	SAT
31	Apr 1	2 12pm Progress Report 10	3 9:30am Class 11	4 50th Northeast Bioengineering Conference	5 50th Northeast Bioengineering Conference	6 50th Northeast Bioengineering Conference
7	8	9	10 9:30am Class 12	11	12 Lab Session, 12:45 - 3:30p 11am Alumni Career Workshop	13 ECS Open House
14	15	16	17 9:30am Class 13	18	19 1pm Final Presentation	20
21	22	23	24 9:10am Project Debrief (Team 1) 9:30am Project Debrief (Team 2) 9:50am Project Debrief (Team 3) 10:10am Project Debrief (Team 4 10:30am Project Debrief (Team 5 10:50am Project Debrief (Team 6 11:10am Project Debrief (Team 7	25	26	27
28	29 Last Day of Class	30	May 1	2	3 9pm Design Report Submission	4

May 2024



SUN	MON	TUE	WED	THU	FRI	SAT
28	29 Last Day of Class	30	May 1	2	3 9pm Design Report Submission	4
5	6 9pm Design Notebook Submissi 9pm Peer & Self Evaluation	7 Last Day of Spring Semester	8	9	10	11

Workshop Topics

- **Project Management**: Principles of planning, organizing, and managing resources to achieve specific goals within a project's scope, time, and budget constraints.
- **Engineering Ethics**: Understanding professional and ethical responsibilities, including case studies on ethical dilemmas and decision-making in engineering practice.
- **Lean Six Sigma**: Introduction to lean manufacturing and Six Sigma methodologies for improving efficiency, reducing waste, and enhancing quality in engineering processes.
- **Technical Writing**: Skills for effectively communicating technical information through reports, manuals, and documentation, adhering to clarity, accuracy, and professionalism.
- **Engineering Standards and Regulations**: Familiarity with relevant industry standards, codes, and regulatory requirements impacting design and implementation.
- **Risk Management**: Identifying, analyzing, and mitigating risks in engineering projects, including safety considerations and contingency planning.
- **Sustainability and Green Engineering**: Principles of sustainable design and environmental considerations in engineering projects.
- **Intellectual Property and Patenting**: Basics of intellectual property rights, patent laws, and the process of patenting engineering innovations.
- **Quality Control and Assurance**: Understanding the importance of quality in engineering, including methods for quality control and assurance in design and manufacturing.
- **Systems Engineering**: Approaches to the design, integration, and management of complex systems over their life cycles.
- **Justice, Equity, Diversity, and Inclusion (JEDI) in Engineering**: Exploring the importance of creating inclusive and equitable engineering solutions, understanding diverse user needs, and promoting diversity within engineering teams.
- **Medical Reimbursement**: Understanding the complexities of medical reimbursement processes, including insurance, Medicare, and Medicaid, and how they influence the design and development of medical devices and technologies.
- **Healthcare Information Systems**: An overview of information systems used in healthcare settings, focusing on data management, patient privacy, and the integration of technology in healthcare delivery.
- **Electronic Health Records (EHRs)**: Delving into the design, implementation, and ethical considerations of electronic health records, including data security, interoperability, and patient access.
- **Regulatory Affairs in Medical Devices**: Learning about the regulatory environment for medical devices, including FDA approval processes, compliance, and post-market surveillance.
- **Biomedical Signal Processing**: Techniques and applications of signal processing in the analysis of physiological signals, relevant to the development of diagnostic and therapeutic devices.
- **Clinical Trials and Medical Research**: Understanding the principles of designing and conducting clinical trials for new medical technologies, including ethical considerations and regulatory compliance.
- **Telemedicine and Digital Health**: Exploring the rise of telemedicine and digital health solutions, including technology design, patient engagement, data analytics, and remote monitoring.
- **Healthcare Economics and Cost-Benefit Analysis**: Analyzing the economic aspects of healthcare technologies, including cost-effectiveness, budget impact analysis, and value-based healthcare.

- **Biocompatibility and Biomaterials**: Understanding the principles of biocompatibility in the design of medical devices and the selection and application of biomaterials.
- **Human Factors and Ergonomics in Medical Device Design**: Designing medical devices with a focus on user-centered design, ergonomics, and human factors to ensure safety, efficiency, and usability.
- **Artificial Intelligence and Machine Learning in Healthcare**: An introduction to the applications and implications of AI and machine learning in healthcare, including diagnostic tools, predictive analytics, and personalized medicine.

Course Requirements, Evaluation, Grading

Grading will be based on the following components. You can earn a maximum of **186 points**.

Assessment	Number of points
INDIVIDUAL ASSESSMENT	
Workshop assignment	2 × 8 = 16
Individual technical writing	15
Individual presentation skills	15
Design notebook	10 × 2 = 20
Professionalism *(Acting in a professional manner when carrying out the course activities)*	10
SUB-TOTAL	**76**
TEAM ASSESSMENT	
Weekly Progress Report	3 × 10 = 30
Final Report	30
Simulated Internship	10
Alpha Prototype Demonstration	10
Beta Prototype Demonstration	10
Final Demonstration	20
Self & Peer Assessment	Variable adjustment
SUB-TOTAL	**110**
EXTRA CREDIT	
Participation in NEBEC Undergraduate Design Competition (4/4 – 4/5)	(10)
Participation in Orange Open House (4/13)	(10)
SUB-TOTAL	**(20)**
TOTAL:	**186**

Grade	Grade Points / Credit	Percentage Range	Total Points
A	4.0	93 – 100	172 – 186

A-	3.66	90 – 92.9	167 – 171
B+	3.33	87 – 89.9	161 – 166
B	3.0	83 – 86.9	154 – 160
B-	2.66	80 – 82.9	148 – 153
C+	2.33	77 – 79.9	143 – 147
C	2.0	73 – 76.9	135 – 142
C-	1.6	70 – 72.9	130 – 134
D	1.0	60 – 69.9	111 – 129
F	0	< 60	< 111

I do not curve grades in this course. It is theoretically possible for everyone in the class to get an A (or an F). Your performance depends only on how you do, not on how everyone else in the class does. It is therefore in your best interest to help your classmates in every **legal** way possible. Your final grade will be adjusted by self and peer evaluations.

Workshop Assignment: There is a short assignment after each workshop, due at 9 pm in the following week. Most of the workshop assignments can be completed during class. This is an individual submission. Collaboration highly encouraged. Assignment submission will be through Microsoft Team.

Weekly Progress Reports:
Each team will meet with the instructor and teaching assistant on a weekly basis (please refer to the course schedule for details) during studio time. This is a quick 10-min meeting to go through the progress report and color-in Gantt chart. If deemed necessary, the team may need to schedule another meeting outside of class periods with the instructor. Each progress report is worth 3 points. Here is the grading rubric:

A progress report is a report in which you are updating information about a project. Progress reports make it possible for management and your supervisor to stay informed about a project and to change or adjust assignments, schedules, and budgets. In this report you have to describe the work you completed after a certain time period. You should describe in detail the status of your project. The supervisor uses this report to gauge and assess the progress made by each team, make corrections (if any) to project scope and plan, and to advise and guide students in successfully completing their project on time.

<Tone>
- Whether you are reporting good or bad news, your job in the report is the same: you provide a **clear and concise account of your activities**.
- **Avoid defensive language**. Even if you are behind schedule, maintain honest communication.
- There are instances where you may be tempted to either withhold information or mislead your reader. This is unethical. Always respond honestly.
    - If the deliverable is not what you thought, describe the events that led to the conclusion and explain how the deliverable will be different than what you expected.
    - If you are running out of time, explain why you are behind and give a new expected date for completion.
    - If you are going over budget, you must report this and explain why you need more money.

<Format>
- Create a template of your first progress report for the entire project and use that template for each consecutive report after the first.

- Incorporate headings and subheadings to organize the report and maintain the same headings for the duration of the project.

1 point	Submission of a properly formatted progress report ***before deadline***. Post it on **Microsoft Team** by **noon the day before your next studio time**.
1 point	Accomplish set milestones and is on track as shown on the Gantt chart. Teams will also receive full credit if considerable effort has been demonstrated towards the project, despite not meeting the set target for a particular week.
1 point	Ability to provide a clear, succinct and concise account of your activities. Avoid defensive and vague language.
+1 extra credit	Exemplary progress made; far and beyond the project requirement in terms of quality.

The required format for your progress report is given below.

1. **Title**: Be specific — "Progress Report for XXX January 18, 2024

2. **Project Summary (3-4 sentences):** Describe how your project is proceeding (in general), what percentage of work has been completed, how many tasks remain, problems faced, and other related things.

3. **Color-in Gantt Chart**

4. **Project Status:** This section provides details on the progress made so far.

    (a) **Details of Tasks Completed:** Describe in detail the tasks completed, include as much information as possible with tables, diagrams, graphs, etc.
    (b) **Preliminary Results:** Show the results of any testing or simulations you have conducted based on the tasks you have completed so far. Tabulate your data and produce necessary plots. Analyze the data and/or plots and make comments.
    (c) **List of Tasks Remaining:** List all tasks that remain to be completed.
    (d) **Budget status:** Are you able to complete the project within the estimated budget? How much has been spent? Are you exceeding the original budget?

5. **Project Plan:** Describe how you have managed the project so far:

    - Is it progressing according to schedule (original plan)?
    - Did you make any changes to the original plan?
    - Did you make any changes/improvements to the project scope?
    - What is the outlook for the remaining tasks?
    - Show the updated project plan.

6. **Contribution of Team Members:** Write about the contribution of each team member. (Report in person to the instructor/TA any problems you may be having with members who are not contributing in any way).

7. **Challenges Faced:** Describe all challenges you have faced so far and how you have solved them or found a way around them. Also, describe any challenges you may face in future and how they may impact the project.

    (a) Problems with team members not cooperating/meeting.
    (b) Problems or delays in procuring required parts/components/tools.
    (c) Problems with equipment or components not working or malfunctioning.
    (d) How have the problems impacted the project?

*Note: Facing challenges is an important part of the project experience. These challenges should **NOT** be taken as an excuse for unsatisfactory or incomplete work on the project.*

8. **Conclusions**: Write briefly about the status of your project, the challenges you faced, and the work that remains. What are your feelings about how the project is progressing? Can you complete it in time?

Studio

Each studio time will be broken into

- 70 min – Check-in with instructor/TA (approximately 10 min each team)
- Use the remaining time as your work time

Lab Sessions

The instructor will be spending time with each team delving into project details, e.g., presentation, circuitry, simulation, prototyping, etc. Each team is expected to be proactive in scheduling meetings with the instructor throughout the semester.

	Lab								
	1	2	3	4	5	6	7	8	9
	1/19	1/26	2/2	2/9	2/16	3/1	3/8	3/22	4/12
12:45 – 1:20	**Team 1**	**Team 5**							
1:20 – 1:55	**Team 2**	**Team 6**							
2:00 – 2:35	**Team 3**	**Team 7**							
2:45 – 3:20	**Team 4**								

Simulated Internship: Starting February 26th, you will be engaged in a simulated internship experience with the junior bioengineering students. Your team will be the supervisor. Your team will come up with a few tasks for your interns to complete. You will be in charge of the job description, provision of equipment, mentorship and final appraisal of your interns. More details to follow.

NEBEC Conference: The 50th Annual Northeast Bioengineering Conference (NEBEC) will be held from April 4th to April 5th. All teams are encouraged to participate in the undergraduate design competition and present their work in the form of a poster in this conference. It will serve a few purposes: (1) Preparation for the final presentation; (2) Great opportunity for you to experience a regional professional bioengineering conference; (3) Great network opportunities with bioengineering professionals in the academia and industry; (4) Feedback received from the undergraduate design competition.

Workshop Assignment: A few short assignments related to the workshops will be given throughout the semester, and are due one week after they are assigned. Most of the assignments can be completed during class. All assignment must be submitted in a legible and readable format. It is your responsibility to ensure that your submitted word document, pdf, etc. is free of formatting errors and is complete.

Alpha Prototype Demonstration
Alpha, the first alphabet in the Greek language, is used for the first testable prototype variant of a potential product. Testing of the alpha prototypes is usually carried out by the product prototype development company itself, but sometimes, the company also recruits outside volunteers to test the alpha prototype. At the alpha stage, the product prototype can have substantial flaws or missing functions, unfinished documentation and it may even require a special environment in order to operate or function. Alpha testing can go through many iterations, and the prototype variants may add or subtract certain working features while the prototyping experts fix the flaws and make alterations based on the test feedbacks. Once the alpha prototype is fairly functional and closely resembles the envisioned product, it moves to the beta testing. **Your team will deliberate on detailed rubric for your alpha demonstration.**

Beta Prototype Demonstration
Beta prototypes of a potential product are usually much closer to the final product than alpha prototypes. These product prototypes are, in most cases, tested by the prospective consumers as well as general public. A beta prototype is typically an augmentation of an alpha prototype – meaning it has all the functions in place that are expected for the final product. The beta prototype also has fewer flaws than the alpha prototype. The documentation is almost complete or close to complete, and the prototype is usually ready to perform or operate in the real-world environment without any assistance.

Beta testing is usually shorter than alpha testing. The reason for this is that the beta testing is usually designed to identify the minute, last-minute issues before the envisioned product is launched in the market to the actual consumers. Product prototype development, including alpha and beta, is important. The success of the envisioned product predominantly relies on the prototypes. A formal and comprehensive procedure has to be demonstrated to test designs against the clients' requirements. Faculty member has to witness part of the physical testing. **Your team will deliberate on detailed rubric for your beta demonstration.**

Final Presentation:
At the end of the semester you will present your design (hopefully with working prototype, but at least with a detailed design) to the faculty and judging panel. You are also encouraged to practice your short "speech" for your poster. Each team member can have their own "specialty" for the project, but also must be able to answer

all basic questions of the project. Your poster should contain necessary information but should NOT be overly wordy. Bullet points and diagrams are MUCH BETTER than paragraphs of text. You are there to explain your poster. It does not need to stand on its own as a written report would. More details on the final presentation to follow.

Design Notebook: Each student is responsible for maintaining a design notebook. This is a record of **EVERYTHING** you do for your design project (ideas, CAD drawings, test results, meeting discussions, background research, etc.). This is one of your only ways of communicating to me what you do for the project. This can be a hard copy or electronic if desired as long as Dr. Yung can have access to the notebook. If hard copy, it must be a hard bound book (not spiral, nor a binder, and no lose pages). You must date every entry in your book. Everyone should at least have a description of the project, functional requirements, constraints, and summaries of meetings in their notebook, in addition to all other work that you individually or collectively did for the project. **The notebook should be clearly labeled and written so that someone unfamiliar with the project (but with a technical background) could follow your work and repeat your results.** All designs, ideas, testing protocols, testing results, conclusions, etc. must be well documented in the notebook. **It will be collected electronically twice during the semester.** Each design notebook submission counts for 10 points.

1 point	Regular entry (at least one entry per week)
4 points	Sufficient amount of contents (e.g., designs, ideas, testing protocols, testing results, conclusion) and technical details so that someone unfamiliar with the project (but with a technical background) could follow your work and repeat your results
2 points	Individual activities supplemented by well annotated visual aids, such as sketches, diagrams, CAD, circuit design, etc.
3 points	Ability to provide a clear, succinct and concise account of your individual activities. Avoid defensive and vague language.
+ extra credit	Exemplary details; far and beyond the project requirement in terms of quality.

Final Design Reports: Your final report must contain a table of contents, page numbers on every page, a title, all authors, references cited properly with at least 10 peer-reviewed references (i.e., Wikipedia is NOT an acceptable source!). **Your report must be written so that someone with a high school diploma can understand your design and the general process you took to reach your design solution. Someone with similar technical knowledge (i.e., a senior bioengineering student, not on the project) must be able to follow exactly what you did and recreate it.** There is no page limit or minimum *per se*, but as a general goal reports are typically around 40-70 pages with references and appendices. Brevity while describing in sufficient detail is key. Repeating the same thing over and over or adding fluff that is not useful to the report will result in low scores.

It is your responsibility to ensure that your submitted word document, pdf, etc. is free of formatting errors and is complete: this includes figures appropriately sized to be legible when printed and NOT covering any text, all text is complete and not cut-off. All graphs and tables must be appropriately labeled and "stand alone" in a document – i.e., the reader must be able to flip through your report and understand your figure/table COMPELTELY by just reading the title, legend, axis labels, and captions WITHOUT needing to read the text of your paper. All graphs and tables must also be referenced appropriately in the body of your paper (e.g., "Sample A had a lower modulus than Sample B, as seen in Figure 1A").

FAILURE IS AN OPTION! If your design is not successful at the end of the semester you must expand upon problems encountered and future work/areas of improvement IN DETAIL to explain WHY your design failed and HOW you could come to a successful design solution with more time, money, etc. The report will be collected twice in the semester as checkpoints for feedback and continued improvement.

BEN 487 Design Report Scoring Rubric

Criteria	Does not meet expectations (C or below)	Meets Expectations (B)	Exceeds Expectations (A)
Background	☐ Background/rationale for the project are incorrect, incoherent, or flawed ☐ Does not reflect understanding of subject matter and associated literature / products ☐ Poor needs assessment and identification of gaps ☐ Objectives are poorly substantiated ☐ [if applicable] Demonstrates poor understanding of theoretical concepts	☐ Background/rationale for the project coherent and clear ☐ Reflects understanding of subject matter and associated literature / products ☐ Adequate needs assessment and identification of gaps ☐ Objectives are adequately supported ☐ [if applicable] Demonstrates understanding of theoretical concepts	☐ Background/rationale for the project are superior ☐ Exhibits mastery of subject matter and associated literature / products ☐ Superior needs assessment and identification of gaps ☐ Objectives are superiorly supported ☐ [if applicable] Demonstrates mastery of theoretical concepts
Methods/Process/Strategies, Planning & Implementation	☐ Methods/Design tasks are partially aligned with objectives ☐ Methods/Design tasks are poorly described ☐ Variables, targets, measures, and implementation process is unclear and poorly developed ☐ Methods do not include an evaluation component (e.g., preliminary implementation and quantitative evaluation, qualitative feedback, review by experts or end-users) ☐ Insufficient documentation (e.g., CAD schematic, circuit diagram, code, design schematic, photos, simulation results) ☐ [if applicable] Proposed analyses are wrong, inappropriate, or missing	☐ Methods/Design tasks are adequately aligned with objectives ☐ Methods are adequately described (e.g., process, setting, participants, measures) ☐ Variables, targets, measures, and implementation process is clear and adequately developed ☐ Methods include an evaluation component; the evaluation is adequate (e.g., preliminary implementation and quantitative evaluation, qualitative feedback, review by experts or end-users) ☐ Sufficient documentation (e.g., CAD schematic, circuit diagram, code, design schematic, photos, simulation results) ☐ [if applicable] Proposed analyses are routine, objective, correct	☐ Methods/Design tasks are fully aligned with objectives ☐ Methods are superiorly described (e.g., process, setting, participants, measures) ☐ Variables, targets, measures, and implementation process is clear, fully developed, and imaginative ☐ Methods include an evaluation component; the evaluation is robust (e.g., preliminary implementation and quantitative evaluation, qualitative feedback, review by experts or end-users) ☐ Superior preparation of documentation (e.g., CAD schematic, circuit diagram, code, design schematic, photos, simulation results) ☐ [if applicable] Proposed analyses are sophisticated, robust, precise
Results/Products/Outcomes	☐ Results/products/outcomes are partially aligned with objectives ☐ Results/products/outcomes are poorly described and do not align with description of methods/design process ☐ Tables/figures/products/outcomes are missing or do not clearly present the project	☐ Results/products/outcomes are adequately aligned with objectives ☐ Results/products/outcomes are adequately described and aligned with description of methods/design process ☐ Tables/figures/products/outcomes are present and adequately present the project	☐ Results/products/outcomes are fully aligned with objectives ☐ Results/products/outcomes are superiorly described and aligned with description of methods/design process ☐ Tables/figures/products/outcomes are present and superiorly present the project

	findings (e.g., formatting, appropriate # of tables/figures to display the range of results) ☐ Results/products/outcomes have limited practical, programmatic, or clinical utility ☐ Interpretation of data (e.g., quantitative or qualitative) or outcomes is wrong, inappropriate	findings ☐ Results/products/outcomes have marginal practical, programmatic, or clinical utility ☐ Interpretation of data (e.g., quantitative or qualitative) or outcomes is routine, objective, correct	findings ☐ Results/products/outcomes have superior practical, programmatic, or clinical utility ☐ Interpretation of data (e.g., quantitative or qualitative) or outcomes is sophisticated, robust, precise
Discussion/Conclusion/Evaluation & Reflection	☐ Key findings are poorly summarized with reference to objectives ☐ Poor integration and interpretation of results across findings (e.g. simply repeats results or describes no results in discussion) ☐ Findings poorly evaluated within the context of the literature (e.g., restatement of background, no or very limited discussion of new literature) ☐ Does not identify or poorly describes project limitations ☐ Poor discussion of short-term impact on community setting/practice/end-users in public health ☐ Poor discussion of potential long-term implications and future directions ☐ Weak recommendations are made to community settings/practices/end-users; recommendations are poorly linked to results/products/outcomes ☐ Simple identification of which competencies were addressed with no discussion of how they were met	☐ Key findings are adequately summarized with reference to objectives ☐ Adequate integration and interpretation of results across findings ☐ Findings adequately evaluated within the context of the literature ☐ Project limitations are adequately identified and described ☐ Adequate discussion of short-term impact on community setting/practice/end-users in public health ☐ Adequate discussion of potential long-term implications and future directions ☐ Adequate recommendations are made to community settings/practices/end-users; recommendations are linked to results/products/outcomes ☐ The competencies addressed were identified; some discussion of **how** the specified competencies were addressed	☐ Key findings are fully summarized with reference to objectives ☐ Superior integration and interpretation of results across findings ☐ Findings fully evaluated within the context of the literature ☐ Project limitations are superiorly identified and described ☐ Superior discussion of short-term impact on community setting/practice/end-users in public health ☐ Superior discussion of potential long-term implications and future directions ☐ Superior recommendations are made to community settings/practices/end-users; recommendations are very clearly linked to results/products/outcomes ☐ The competencies addressed were identified; thoughtful and extensive discussion of **how** the competencies were addressed
Significance/Scope	☐ Project represents limited expansion upon previous research/work and has limited evidence of public health / biomedical engineering significance ☐ Demonstrates rudimentary critical thinking skills	☐ Project builds upon previous research/work and show some evidence of public health / biomedical engineering significance ☐ Demonstrates average critical thinking skills	☐ Project greatly extends previous research/work and shows exceptional evidence of public health / biomedical engineering significance ☐ Exhibits mature, critical thinking skills
Quality of writing and formatting	☐ Few references (25%) are timely and	☐ Many references (50%) are timely and	☐ Most references (75%) are timely and

	appropriate to the subject matter ☐ References selected below average or poor for the chosen subject (relies on websites or non-peer reviewed sources; outdated; missing key works) ☐ Statements consistently not supported by references when references are clearly needed ☐ In-text and reference list citations are formatted incorrectly or inconsistently (e.g., switching between formatting styles, websites improperly cited, etc.)	appropriate to the subject matter ☐ References selected are adequate for the chosen subject ☐ Statements generally supported by references when references are clearly needed ☐ The majority of in-text and reference list citations are properly cited (e.g., switching between formatting styles, websites improperly cited, etc.)	appropriate to the subject matter ☐ References selected are the best available for the chosen subject ☐ Statements always supported by references when references are clearly needed ☐ All in-text and reference list citations are properly cited (e.g., switching between formatting styles, websites improperly cited, etc.)
Professionalism	☐ Project timeline poorly managed by student; consistently missed deadlines; consistently required prompting by instructor ☐ Student rarely sought feedback; feedback was clearly needed ☐ Minimally responsive to written/verbal feedback	☐ Project timeline mostly managed by student with some oversight from instructor; some deadlines missed ☐ Student sought some feedback and occasionally asked for help when it was needed ☐ Adequately responsive to written/verbal feedback	☐ Project timeline completely managed by student; student worked independently and met all project deadlines ☐ Student struck an exceptional balance between working independently but asking for necessary feedback/help ☐ Exceptionally responsive to written/verbal feedback
Final rating	☐ DOES NOT MEET EXPECTATIONS (EQUIVALENT TO C OR BELOW)	☐ MEETS EXPECTATIONS (EQUIVALENT TO B)	☐ EXCEEDS EXPECTATIONS (EQUIVALENT TO A)

SENIOR DESIGN FINAL REPORT TEAM REFLECTION

BEN 487– Bioengineering Capstone Design II	***Department of Biomedical & Chemical Engineering*** *College of Engineering & Computer Science* *Syracuse University*

Assignment: As a summation and reflection of your senior design project, please provide the following information. Attach the answers to each set of questions in an Appendix in your final senior design report.

Provide the following information at the top of the reflection

- List Student Names
- List Current Term
- Title of Project
- Client(s) (organization, contact information)

Q1. What are the desired functions of the design?
Q2. What constraints related to the main function(s) must the design satisfy?
Q3. What are the performance objectives of the design? (Use quantitative metrics as much as possible)
Q4. What alternative design concepts were considered?
Q5. What analysis were used to select among the alternative design concepts?
Q6. Which concepts or skills learned in your previous coursework were applied to the design? (Please provide a list with each entry providing the course number of the course, plus a brief description of the concept or skill used.)
Q7. Evaluate your design, relative to its function(s) and constraints. How well did your design meet each of the performance objectives? How well does your design compare to other, existing solutions to the problem?
Q8. What impact do you see your design, if implemented, having upon public health, safety, and welfare, as well as upon current global, cultural, social, environmental, and economic concerns?
Q9. What format did your design take? (For example, is it a complete set of CAD drawings, a working prototype, a circuit design, a mobile app, software algorithm, a full finished product, a system configuration, a process map, something else, etc.)
Q10. What engineering standards were considered and why? If none were considered, explain why it was not necessary to consider engineering standards.
Q11. Discuss how JEDI (Justice, Equity, Diversity, and Inclusion) plays in role in your project.
Q12. Describe each student's role in the design project.

Teamwork & Peer Evaluation

Teamwork is one of the most important competences in engineering and most professionals, and it is therefore imperative that it be included in the capstone design process. There are many advantages to cultivating teamwork skills from a social, professional and educational point of view. These include, among others, students' active engagement, positive interdependence, individual accountability, equal participation, higher understanding and retention of concepts, social skills, improving democratic skills in citizenship education and co-constructing knowledge.

This is the teamwork rubric used in this course:

	Exemplary 4	Accomplished 3	Developing 2	Beginning 1
Contributes to Team Meetings	Helps the team move forward by articulating the merits of alternative ideas or proposals.	Offers alternative solutions or courses of action that build on the ideas of others.	Offers new suggestions to advance the work of the group.	Shares ideas but does not advance the work of the group.
Facilitates the Contributions of Team Members	Engages team members in ways that facilitate their contributions to meetings by both constructively building upon or synthesizing the contributions of others as well as noticing when someone is not participating and inviting them to engage.	Engages team members in ways that facilitate their contributions to meetings by constructively building upon or synthesizing the contributions of others.	Engages team members in ways that facilitate their contributions to meetings by restating the views of other team members and/or asking questions for clarification.	Engages team members by taking turns and listening to others without interrupting.
Individual Contributions Outside of Team Meetings	Completes all assigned tasks by deadline; work accomplished is thorough, comprehensive, and advances the project. Proactively helps other team members complete their assigned tasks to a similar level of excellence.	Completes all assigned tasks by deadline; work accomplished is thorough, comprehensive, and advances the project.	Completes all assigned tasks by deadline; work accomplished advances the project.	Completes all assigned tasks by deadline.
Fosters Constructive Team Climate	Supports a constructive team climate by doing all of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.	Supports a constructive team climate by doing any three of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.	Supports a constructive team climate by doing any two of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.	Supports a constructive team climate by doing any one of the following: • Treats team members respectfully by being polite and constructive in communication. • Uses positive vocal or written tone, facial expressions, and/or body language to convey a positive attitude about the team and its work. • Motivates teammates by expressing confidence about the importance of the task and the team's ability to accomplish it. • Provides assistance and/or encouragement to team members.
Responds to Conflict	Addresses destructive conflict directly and constructively, helping to manage/resolve it in a way that strengthens overall team cohesiveness and future effectiveness.	Identifies and acknowledges conflict and stays engaged with it.	Redirecting focus toward common ground, toward task at hand (away from conflict).	Passively accepts alternate viewpoints/ideas/opinions.

Responsibilities and Policies:

Academic Integrity: Syracuse University's Academic Integrity Policy reflects the high value that we, as a university community, place on honesty in academic work. The policy defines our expectations for academic honesty and holds students accountable for the integrity of all work they submit. Students should understand that it is their responsibility to learn about course-specific expectations, as well as about university-wide academic integrity expectations. The policy governs appropriate citation and use of sources, the integrity of work submitted in exams and assignments, and the veracity of signatures on attendance sheets and other verification of participation in class activities. The policy also prohibits students from submitting the same work in more than one class without receiving written authorization in advance from both instructors. Under the policy, students found in violation are subject to grade sanctions determined by the course instructor and non-grade sanctions determined by the School or College where the course is offered as described in the Violation and Sanction Classification Rubric. Syracuse University students are required to read an online summary of the University's academic integrity expectations and provide an electronic signature agreeing to abide by them twice a year during pre-term check-in on MySlice.

All academic integrity expectations that apply to in-person quizzes and exams also apply to online quizzes and exams. In this course, all work submitted for quizzes and exams must be yours alone. Discussing quiz or exam questions with anyone during the quiz or exam period violates academic integrity expectations for this course.

Using websites that charge fees or require uploading of course material (e.g. Chegg, Course Hero) to obtain exam solutions or assignments completed by others and present the work as your own violates academic integrity expectations in this course.

Learner Responsibilities: As a student in this class, I expect you to take responsibility for your own learning, be prepared for class, be an enthusiastic participant during class, treat others with tolerance and respect, act responsibly and reliably in group work, and set high standards for your work.

Instructor Responsibilities: As your instructor, I commit to communicating openly and frequently with you about this class. I will maintain a professional, safe learning environment adhering to the policies of the university. You can generally expect a reply to communication, *via* e-mail or in person, within 24 business hours. As your instructor, I retain the right to make changes to this syllabus based on the timeline of the class, feedback from learners, and/or logistical issues and will inform you as soon as a change is made.

Blackboard & Email: A Blackboard course site has been created for this class and can be accessed at http://blackboard.syr.edu/. You are expected to check the course site regularly for announcements, assignments, and additional resources. Additionally, your current course grade can be accessed there. I will make major announcements both *via* Blackboard and your SU email account, which you are also expected to check regularly. "I didn't check my email/Blackboard" is not an acceptable excuse.

Collection of Student Work: I will be collecting and copying a portion of students' graded work for the purpose of inclusion in the supporting materials of the BMCE Department's self-study report for ABET accreditation. All such materials will be scrubbed of personally identifying information prior to inclusion in the self-study, and this practice is in compliance with federal privacy regulations (FERPA).

Faith Tradition Observances: Syracuse University's Religious Observances Policy recognizes the diversity of faiths represented in the campus community and protects the rights of students, faculty, and staff to observe religious holy days according to their traditions. Under the policy, students are given an opportunity to make up any examination, study, or work requirements that may be missed due to a religious observance, provided they

notify their instructors no later than the academic drop deadline. For observances occurring before the drop deadline, notification is required at least two academic days in advance. Students may enter their observances in MySlice under Student Services/Enrollment/My Religious Observances/Add a Notification.

Students with Special Needs: Syracuse University values diversity and inclusion; we are committed to a climate of mutual respect and full participation. There may be aspects of the instruction or design of this course that result in barriers to your inclusion and full participation in this course. I invite any student to contact me to discuss strategies and/or accommodations (academic adjustments) that may be essential to your success and to collaborate with the Center for Disability Resources (CDR) in this process.

If you would like to discuss disability-accommodations or register with CDR, please visit Center for Disability Resources. Please call (315) 443-4498 or email disabilityresources@syr.edu for more detailed information.

The CDR is responsible for coordinating disability-related academic accommodations and will work with the student to develop an access plan. Since academic accommodations may require early planning and generally are not provided retroactively, please contact CDR as soon as possible to begin this process.

Discrimination or Harassment: The University does not discriminate and prohibits harassment or discrimination related to any protected category including creed, ethnicity, citizenship, sexual orientation, national origin, sex, gender, pregnancy, disability, marital status, age, race, color, veteran status, military status, religion, sexual orientation, domestic violence status, genetic information, gender identity, gender expression or perceived gender.

Any complaint of discrimination or harassment related to any of these protected bases should be reported to Sheila Johnson-Willis, the University's Chief Equal Opportunity & Title IX Officer. She is responsible for coordinating compliance efforts under various laws including Titles VI, VII, IX and Section 504 of the Rehabilitation Act. She can be contacted at Equal Opportunity, Inclusion, and Resolution Services, 005 Steele Hall, Syracuse University, Syracuse, NY 13244-1120; by email: titleix@syr.edu; or by telephone: 315-443-0211.