Ryerson University

Department of Electrical & Computer Engineering
Faculty of Engineering & Architectural Science

Course Outline (W2017)

BME 800: Biomedical Engineering Capstone Design

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Faculty Lab Co-Ordinators (FLC)	Dr. S. Krishnan, *P.Eng*., Dr. K. Umapathy, *P.Eng*. , Dr. K..Mai, *P.Eng*., Dr. S. Waldman, *P.Eng*., O. Grant, *P.Eng*., and Dr. V. Yang, *P.Eng*.
Calendar Description	This course provides the student with a significant experience in self-directed learning. Project topics are provided from which the students select a topic. The topic selection information search, designs and component sourcing are completed as part of the Fall term course BME 700 Engineering Design. The student individually or in a group, where the topic is a group project, will research the topic, design, implement and make operational a design of currency in the fields of Biomedical Engineering. Professional guidance is provided by faculty on a weekly basis in the laboratory. The completed project must be demonstrated operational by the last week of the term. A final bound project report that conforms to professional guidelines is required.
Prerequisites	*BME 700*
Compulsory Text(s):	*Teamwork and Project Management*, Karl A. Smith, 3rd edition, McGraw Hill, 2004.
Reference Text(s)	• *Design of Biomedical Devices and Systems*, Paul H. King and Richard C. Fries, 2nd edition, CRC press, 2008. • *Standard Handbook of Biomedical Engineering & Design,* M. Kutz, 2002, McGrawHill • *The Biomedical Engineering Handbook*, Joseph D. Bronzino, 2000, CRC Press (Available online at Ryerson Library)
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. Develop skills of problem solving, systematic diagnose, trouble shooting, critical path analysis, logical decision, and engineering trade-off. (4a, 4b, 4e, 4f) 2. Develop creative thinking and capabilities of conducting research/interconnecting various engineering knowledge to formation of realistic designs. (1c, 1d, 4d) 3. Develop students' ability of implementing prototype design, measurement and performance analysis. (5a, 5b, and 5c) 4. Develop project management and teamwork skills, which includes leadership, organization, planning, motivation, conflict resolution, design process management, co-operation and contribution, decomposing project into key tasks, determining tasks inter-relationship, and managing project to meet budget and time line. (6a, 6b, 6c, 11b) 5. Develop reporting and technical writing skills through timely project progress reports and final report. Also, develop presentation skill through milestone demonstrations and public presentation in open-house. (7a, 7b, 7c, 7d, 8a) 6. Demonstrate the ability to consider economic and environmental factors in design implementation decisions. (9a) 7. Demonstrate ability to assimilate existing knowledge of the field, understand how literature is produced and maintain currency (12b)

NOTE: *Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).*

Course Organization

The semester is divided into three phases (I, II, and III). Each phase consists of three weeks (Phase I: Weeks 2-4 weeks, Phase II: Weeks 5-7, and Phase III: Weeks 8-10). One student will act as a project manager/team leader within a phase, thus each student will have a chance to play the role of manager/team leader. The team will select their manager/team leader for each phase at the beginning of each of the phases and provide the names to the FLC.

In Week 1, students will decide on the project manager/team leader for the Phase I and the project manager after discussing with the team members will submit the milestones & deliverables for Phase I to the FLC on the following Monday (i.e., the first day of Week 2). The team will work towards completing the milestone and demonstrating the deliverables for Phase I by the end of the 4th week. During the same week students will choose the project manager for the next phase and the milestone & deliverables for the next phase will be submitted by the project manager to the FLC on the following Monday (i.e., the first day of Week 5) and the cycle repeats until all three phases are complete and the deliverables are demonstrated to the FLC. In Week 6, the project manager responsible for Phase II will also submit the theory and design sections of the EDP report. During each of the phases (i.e., the 3 weeks period) the respective project managers are responsible for submitting weekly progress reports to the FLC. Each of the weekly progress reports should contain 4 sections. Once section for reporting the progress on the "group tasks" and the remaining three sections for reporting progress on "individual tasks".

During the FLC evaluations of deliverables, it will be the project manager's responsibility to explain and discuss with FLC on what was accomplished towards the stated Milestone deliverables; what each member accomplished; and to conduct and manage the demo session. The FLC may ask any member of the team for further verification of his/her aspects of the contributions.

In Week 11, individual project contribution summary will be submitted to the FLCs. Individual oral exam will be scheduled during Weeks 12-13. The team will submit their final EDP report during Week 13. Following Week 13, the team will present their project during the open house scheduled by the department and will submit the final EDP report to the dept for binding and one unbound copy to the FLC.

LAB: 5 hrs/wk

Course Evaluation

Project Management & Teamwork	15%
Weekly Project Progress	15%
Milestones Demonstration	9%
Oral Examination & Final Demonstration	25%
Open-House Participation	6%
Final Engineering Design Report	30%
TOTAL:	100%

(a) *Project Management*: The FLC will mark each student in each period in his/her role as a Manager/Team Leader (Leadership, Conductor of meetings, Organizer/planner/motivator, Conflict resolution) or as a Team Member (Co-operation, Contribution, Conflict resolution). More details on project management are given at the end of this course outline.

(b) *Oral Examination*: Students are required to demonstrate a working prototype and "individually" show a thorough knowledge of their EDP through an oral examination by their assigned FLC. Failure to do so will automatically result in a *FAIL* grade. *Students*

	who do not keep their FLC advised of their progress on at least a biweekly basis may be refused an oral examination because authorship and contribution to the project is questionable. (c) *Open House Presentation*: Students are required to participate in an "Open House" exhibition that will be scheduled by the department. Please advise prospective employers of this requirement. At the Open House, students will demonstrate and discuss their project with visitors from the academic community, their peers, and visitors from industry. Participation in this exhibit may result in a grade revision for enhancements or improvements to the project. Students absent from the Open House will have their grade reflect this. (d) *Final Engineering Design Report*: **The main body of the report is limited to 40 pages**, including text, analysis equations/algorithms diagrams, schematics, tables and references list. Additional material (e.g. source code, datasheets, etc.), not subjected to grading, can be inserted in the APPENDIX. Mark reduction will be applied for report exceeding the 40-page limit. One unbound copy of your group final Engineering Design report is required to submit to your FLC by the deadline set by dept/Course Coordinator. A report submitted without prior satisfactory demonstration of your group project will automatically be given a FAIL grade. The format of the report should conform to professional standards and adequately document the design activities. If the project includes software, a *disk* containing the source code must be included with the report. The unbound final report will be returned to the students during the Open House together with corrections and suggestions for improvement. The students must make the necessary revisions and submit to ENG478 by the deadline set by the department/CC for binding. A checklist that specifies how the report is to be physically organized for binding will be available in April. One bound Engineering Design report must be submitted to the Department. If the deadline set by the department/CC is not met for Engineering Design Report submission, the student will not be eligible to graduate. *All written reports will be assessed not only on their technical merit, but also on the communication skills of the author as exhibited through these reports.*
EDP Grading Considerations	The EDP grade awarded to a student who has completed all the requirements, including a successful and timely project demonstration and oral examination, is based on an assessment made by their FLC. Though the wide variation in EDP topics, approach, and challenges encountered by the student does not allow a precise marking scheme to be uniformly applied, the factors described below will be weighted by the FLC in determining the student grade. a. *Laboratory Work* All EDPs require that a concept, an idea, bounded by design specifications in the EDP topic description be researched to provide sufficient knowledge to enable a realistic design be fleshed out. This design is implemented in the laboratory. **The foundations for the EDP grade rest on the design and implementation process. Unless the design is sound and based on solid engineering, the laboratory time will be inefficiently used and the effort frustrating to all involved including the FLC.** Even with a good design, the student will be challenged with implementation and bringing the design to life. The key aspect is the process by which the student tackles the challenges encountered. Is a problem analysed to thoroughly understand its root and a logical decision made as to what options are viable and a strategy devised to confirm the diagnosis and attempt a solution, or is a trial and error quick-fix method employed? How systematic and skilled are the troubleshooting procedures employed; for instance, are results studied carefully or program flow examined etc?

Other factors used in evaluating lab performance include time and project management skills. How well did the student meet milestones and GANTT chart schedules, and the consistency with which the project was tackled and ongoing technical documentation?

The variations in project topic and approach, student creativity, ingenuity, novelty and complexity of implementation or success in meeting practical implementation challenges are all factors in grading decisions.

Although a project that has been demonstrated as meeting or exceeding the initial requirements is fundamental for a good grade, the FLC will consider all the aspects in establishing the final grade.

b. *EDP Report*

The EDP report, an essential course component, is the document on which anyone not intimately involved with the laboratory work assesses the project. The report should adequately describe the design activities undertaken in the project.

A good EDP report will improve the primary assessment based on the laboratory work. In general, a good EDP report is required to consolidate the laboratory and project development work performed by the students. A poor EDP report will certainly demerit even excellent laboratory performance and will be reflected in the overall course grade

The EDP report will normally contain the standard sections:
Introduction, Acknowledgements, Certification of Authorship, Index, Abstract, Objectives, Theory, Design, Documentation including Schematics and Parts Lists, Measurement Procedure, Performance Measurements, Analysis of Performance, Conclusions, Appendices, and References.

A seminar on the EDP report writing may be scheduled. A few key suggestions are offered:

Particularly in engineering, it is essential that a project be properly designed. A designer must satisfy the examiner, the FLC, that the program or circuit will perform its tasks to specification under all or at least the usual, variations in the operating or manufacturing environment. Such issues as component tolerance, voltage variations, maximum and minimum computer cycle times and data throughputs are examples of variables. In other words, the examiner must be convinced that the project is battle-proof and its operation at the demonstration is not an unusual event.

Another guide used to assess whether the design is competent is to consider the mass production of this prototype. Could one anticipate a reasonable yield and customer satisfaction?

The working prototype performance must be measured to quantify the extent to which it meets the design specifications. The procedure used to measure performance is to be described in sufficient detail that the reader can repeat it. The measured results must be documented in conjunction with appropriate schematics or flow charts. The results should be analysed to ensure that they fit the anticipated performance and if not an explanation is called for.

The abstract must accurately précis the entire report contents in half a page or less. The conclusions should address the project's objectives; to what extent were they met? Where schematics and quotations are taken verbatim from other sources, these sources must be acknowledged to avoid the potentially serious charges of plagiarism.

It is recommended that the hardware be photographed with a digital camera along with a photograph of the student author. These photographs are to be included in the final report.

c. *Project Management*

The project teams are required to demonstrate their project management skills by implementing the theory learnt in BME700 into practice in BME800. The objectives of the evaluation process in BME800 are as follows:

- Each team member receives fair amount of training in project management, and is required to demonstrate the skills of a project manager.
- A project manager is evaluated for his/her capability of planning and achieving a tangible deliverable that can be demonstrated.
- Each student is also required to demonstrate the behavior of a professional team member.

Following management attributes and skills are used in the evaluation process:

- Project Management Attributes
    - Leadership
    - Manager of design process
    - Motivator
    - Organizer/planner
- Skills used to exhibit project management attributes
    - Understanding and managing scope of work/deliverables
    - Design review meeting, recording of minutes and design discussion
    - Timely follow-up
    - Learn to identify strengths/weaknesses
    - Conflict resolution
    - GANTT chart, Critical Path analysis

The semester is divided into three phases of three weeks each:

- Phase 1: Week 2, 3 and 4
- Phase 2: Week 5,6 and 7
- Phase 3: Week 8,9 and 10

- One student will act as a manager/team leader within a phase, thus each student will get a chance to play the role of manager/team leader
- The team will select their manager/team leader for each phase at the beginning of the respective phases and provide the names to the FLC
- Each student is marked in each phase out of 5 marks in his/her role according to the following metric:
    - Manager/Team Leader
        - Leadership
        - Conductor of meetings
        - Organizer/planner/motivator
        - Conflict resolution
    - Team Member
        - Co-operation
        - Contribution
        - Conflict resolution

Project management evaluation:

- FLC will attend one group meeting in each phase as an observer
- Each project manager is required to submit a tangible deliverable that can be demonstrated in the lab at the end of his/her term, and a plan to achieve that deliverable.
- Student's role is evaluated during the weekly progress meeting, through milestone submissions and exhibits.
- The group may be requested to provide necessary information/documents that help FLC in evaluating their project management role.

If there are any changes, announcements will be posted in BME800 Course D2L. Please check the course site regularly, at least once a week.

Course Activity Schedule

WEEK	PRESENTERS/ EVALUATORS	ACTIVITIES
1	**CC**	Course introduction, Students meet FLCs, Selection of project manager for Phase I
2	**FLC**	Phase I milestone & deliverables submission
3	**Industry**	Seminar / Lab work
4	**FLC**	Phase I deliverables demo. and evaluation, project manager submits weekly progress to FLC, Selection of project manager for Phase II
5	**FLC/CC**	Phase II milestone & deliverables submission Seminar / Lab work
6	**FLC**	Theory and design sections of report submission
7	**FLC**	Phase II deliverables demo. and evaluation, project manager submits weekly progress to FLC, Selection of project manager for Phase III
8	**FLC**	Phase III milestone & deliverables submission
9	**FLC/CC**	Seminar / Lab work
10	**FLC**	Phase III deliverables demo. and evaluation, project manager submits weekly progress to FLC
11	**FLC**	Individual project contribution summary submission prior to oral examination
12	**FLC**	Individual Oral examination/Final Demo.
13	**FLC**	Individual Oral examination/Final Demo. Group Final EDP report submitted to FLC
TBD		Open House Exhibition
TBD		EDP final report submitted to ENG478 for binding, and one unbounded copy for FLC

Important Notes

1. All of the required course-specific written reports will be assessed not only on their technical/academic merit, but also on the communication skills exhibited through these reports.

2. All assignment and lab/tutorial reports must have the standard cover page which must be signed by the student(s) prior to submission of the work. Submissions without the cover page **will not** be accepted. The cover page can be found on the departmental web site: Standard Assignment/Lab Cover Page

3. Should a student miss a mid-term test or equivalent (e.g. studio or presentation), with appropriate documentation, a make-up assessment ***may*** be scheduled. Alternatively, the weight of the missed work is placed on the final exam, or another single assessment. This may not cause that exam or assessment to be worth more than 70% of the student's final grade. If a student misses a scheduled make-up test or exam, the grade may be distributed over other course assessments even if that makes the grade on the final exam worth more than 70% of the final grade in the course. Make-up assessments cover the same material as the original assessment but need not be of an identical format.

4. Students who miss a final exam for a verifiable reason and who cannot be given a make-up exam prior to the submission of final course grades, must be given a grade of INC (as outlined in the *Grading Promotion and Academic Standing Policy)* and a make-up exam (normally within 2 weeks of the beginning of the next semester) that carries the same weight and measures the same knowledge, must be scheduled.

5. Medical or Compassionate documents for the missing of an exam must be submitted within 3 working days of the exam. Students are responsible for notifying the instructor that they will be missing an exam as soon as possible.

6. **If a student is requesting accommodation due to a religious, aboriginal and/or spiritual observance, he or she must submit a Request for Accommodation of Student Religious, Aboriginal, and Spiritual Observance AND an Academic Consideration form within the FIRST TWO WEEKS OF CLASS or, for a final examination, within two weeks of the posting of the examination schedule**. If the required absence occurs within the first two weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these forms should be submitted with as much lead time as possible in advance of the required absence.
   Both documents are available at http://www.ryerson.ca/senate/forms/relobservforminstr.pdf. Full-time or part-time degree students must submit the forms to their own program department or school.

7. The results of the first test or mid-term exam will be returned to students before the deadline to drop an undergraduate course in good Academic Standing.

8. Students are required to adhere to all relevant University policies including:
   - Undergraduate Grading, Promotion and Academic Standing: http://www.ryerson.ca/senate/policies/pol46.pdf
   - Student Code of Academic Conduct: http://www.ryerson.ca/senate/policies/pol60.pdf
   - Student Code of Non-Academic Conduct: http://www.ryerson.ca/senate/policies/pol61.pdf
   - Undergraduate Academic Consideration and Appeals: http://www.ryerson.ca/senate/policies/pol134.pdf
   - Examination Policy: http://www.ryerson.ca/senate/policies/pol135.pdf
   - Course Management Policy: http://www.ryerson.ca/senate/policies/pol145.pdf
   - Accommodation of Student Religious, Aboriginal and Spiritual Observance: http://www.ryerson.ca/senate/policies/pol150.pdf
   - Establishment of Student E-mail Accounts for Official University Communication: http://www.ryerson.ca/senate/policies/pol157.pdf

9. Students are required to obtain and maintain a Ryerson e-mail account for timely communications between the instructor and the students.

10. Any changes in the course outline, test dates, marking or evaluation will be discussed in class prior to being implemented.

11. Assignments, projects, reports and other deadline-bound course assessment components handed in past the due date will receive a mark of ZERO. Marking information will be made available at the time when such course assessment components are announced.

12. If you have taken the course previously and are currently looking to get a laboratory exemption, then you must fill out this form: http://www.ee.ryerson.ca/guides/ECE-LabExemptionForm.pdf

Approved by: _____ Date _____
Course Instructor

Approved by: _____ Date _____
Associate Chair or Program Director