

Final Report – May 2017

Flipping BMEN 211, Modeling and Numerical Methods in Biomedical Engineering

Ed Gatzke

Course Description

BMEN 211 serves as an introduction to the modern computational modeling tools used in biomedical engineering. This course includes topics in programming, analysis, visualization, and image processing using engineering software as applied to problems of interest in biomedical engineering.

This course has many different facets. Over the course of a semester, students are introduced to three different software tools: Excel, Matlab, and COMSOL. They spend time each week in the computer lab using these tools. Students are exposed to basic computer programming concepts such as data structures and flow control syntax. The students must also attend lectures on how to model simple engineering systems, including:

- Chemical systems (flow and reaction of chemical species in biomedical systems)
- Mechanical systems (balancing forces and bending moments for systems)
- Material systems (properties and behaviors of elastic and viscoelastic materials)

Simultaneously, students are exposed to numerical methods that are commonly used to solve the resulting engineering problems. The topics considered include:

- Setting up and solving sets of linear equations
- Solving a single nonlinear equation using Newton's Method or bisection
- Numerical integration using the trapezoidal rule
- Euler integration for approximating solutions to initial value problems
- Computation of basic statistical values

Ultimately, students participate in a group design project. Using COMSOL, the students simulate a biological system or biomedical device. They must prepare a report and presentation on their design work.

Actions

Lecture Period - Typically during the lecture period, students would take a quiz on material they have already completed a few homework problems on. After the quiz, the quiz problem would be worked for them in detail. They were provided a second copy of the quiz to keep. This copy also included other problems, usually similar to a homework problem they just turned in that day. After the quiz was worked, the example problems were considered in a group setting. The instructor and two TAs would walk around and offer help to the groups. Effectively students have many opportunities to learn the skills: the online lecture, the homework problem out of class, the related practice problem in a group setting in class, a more difficult version of the problem as another homework assignment, the quiz, the test, and the final exam.

Book – The book is nearing completion. Additional material was added. Most significantly, numerous practice questions were added. Students at this level want to have many problems to work and many examples worked out for them. They want to just parrot the answer back. This rote problem solving will hurt them later on in their engineering career if they are not mentally flexible or if they lack basic skills needed to solve complex multi-faceted problems.

Online Lectures – The lectures were all provided online using a personalized YouTube channel. The lectures run 10-20 minutes each. Anecdotal feedback from students included the need for the “Spark Note” type format, where they must fill out blank note packets for the lecture. This active learning step helps them focus on a video that they easily could just ignore or not really focus on.

Online Examples – Additional worked examples were provided online. Student seemed to be appreciative of these examples but they wanted more examples online. Many examples were also worked during the class period. Online Computational Instruction – Some online computational videos were provided showing the software packages in action. This was not a substantial focus, as students generally do fairly well on most of the skills related to the software packages. One exception is Matlab programming, and this has a full lecture on the topic. Additional worked examples on this topic could be added online.

Additional SI and Tutoring Sessions – BMEN 211 was provided a Supplemental Instruction assistant in the Fall of 2016. The SI transitioned to a tutoring role, as the SI program does not work well with flipped classrooms and the USC student success center is inflexible in rules. Additionally, two outstanding Teaching Assistants were recruited in Spring of 2017. One TA was the top student in the Fall of 2016. The other was an outstanding graduating senior. Having additional TA support seemed to help the students that did not wish to interact with the professor.

Basic Math Review – Students were given a lengthy math review homework assignment. After completion of this assignment, two very simple five question quizzes were given. In the Fall of 2017 on this simple quiz, 13 of 57 failed at least once and 4 of 13 failed both. The quiz includes topics such as simplifying fractions, plotting a line, and basic trigonometry. This indicates that students are entering the course without the prerequisite math skills, despite having achieved a C or better in Calculus I.

Results and Future Suggestions

Results were mixed. The course requires a C grade before progression to later BMEN courses. Additionally, a course can only be taken twice in the College of Engineering and Computing. One student had failed the course with a different instructor, taken it again in Fall 2016 and received a D+. This student was removed after a week of class due to this rule. The D/F/W rate in the Fall was exactly 50% while the D/F/W rate in Spring was around 25%. This is typical for this course,

as many weak students must take or repeat the course in the Fall. Factoring in the separate honors section taught in parallel in the Fall, the overall D/F/W rate drops to 40%.

Students were surveyed at the end of Spring 2016. Respondents did not strongly dislike having lectures online. They did appreciate the use of lecture periods for group work and practice problems. Student comments were collected directly related to the course. Many would like additional example problems worked online. There were problems provided, but they always want more. They also want lectures before they take a quiz. They fail to realize that they have worked a problem on homework and in class related to quiz topics. Student survey responses and free-response feedback is included in the appendix.

There are some suggested future actions for this course. Additional example problems could be worked online. This is not a significant effort. Similarly, a 1-2 slide summary of each lecture could be provided in class. This would provide them an opportunity to ask questions regarding the lecture topic.

The workload to flip this course did seem substantially increased. This could be due to the increased lecture preparation time. Instead of spending most of the lecture regurgitating old slides then giving a quiz, in-class activities must be generated for every lecture. Additionally, the lectures and examples must be put online. Without significant investment in this type of course, faculty will choose the path of least resistance: in-class lectures, a few homework sets, a mid-term and a final exam.

Appendix

Q1 In BMEN 211, did it help to have lectures available online for viewing and re-watching at any time?

Q2 How did you feel about using extra time during lecture periods for more evaluation and practice problems?

Q3 How did you feel about group activities during lecture periods?

Score	Q1	Q2	Q3
1	1	0	1
2	4	2	2
3	10	5	6
4	27	22	26
5	10	23	18
Average:	3.79	4.27	4.10

Student Comments Related to Example Issues

a few more examples to solidify understanding of topics covered.

add examples with your videos

Give more example problems for new material before assigning homework, and having quizzes on new material.

I wish more example problems were worked out online before homework was due. I really struggled with understanding issues without going to the tutoring sessions and I couldn't always attend.

I wish there was more examples on online lectures.

I would've liked to have more example problems to complete before tests.

Include more examples/practice problems to apply concepts introduced in the notes, maybe more detailed step-by-step walkthroughs

More class examples

More examples in the videos, or extra videos with just example problems.

More in class examples

More in class teaching on the lessons. Maybe prior quizzes or instead of group work. Teach with an example and give a chance for us to ask questions.

Provide an example problem with actual numbers and values in the online lecture. Some of the topics were hard to translate from equations to numbers.

Put more examples in the online video presentations that are similar to the homework.

I feel like a small summary in each class would be appreciated at the end. The examples were nice, but notes on the examples would be better.

I think the ability to have practice problems with the solutions on hand would be very beneficial for students.

I wish that we learned things in person a little more because it was hard to do the homework with only the help of the videos and text

If the course is going to use flipped classroom there should be more practice problems available to learn the material.

In the videos I would try to do all steps of a problem and have more practice problems before having to turn them in for a grade.

Student comments elated to in-class review and quizzes

be able to go over new lesson before taking the quiz on that material

I wish we covered material more in class before having quizzes on it. My stress levels were high.

It would be helpful to learn some of the material in person before we are evaluated on it in quiz format.

More review on a topic before each quiz/quiz at the end of each lecture

Personally, I like the traditional lecture during class, quiz at the end style. I felt that often, even after watching the lecture, I still had questions going into class and didn't get them answered until after the quiz.

Post solutions to the quizzes instead of going over them in class. That way there is more time to do new problems.

to have a five minute review in class on the ideas taught in the video, would help before taking a quiz

Flipped classrooms are only effective when we go over homework the next class and then more practice problems.

Go over the concepts a little more in class instead of just through video lecture

It would be helpful if knew subjects were taught a little bit in class before homework was due

Maybe go over how to do things before assigning the homework.

Other student comments

Better explanation of certain concepts like Viscoelastic

Even though we had the schedule, sometimes I still wasn't sure what the quizzes were on.

For the COMSOL project, I feel that groups shouldn't be up to the students. Groups should be chosen by professor.

Give more homework problems rather than a few, that way we get a little bit more practice for each of the concepts. And give better feedback than just telling us we were wrong.

Go over the topic in class before assigning homework on it

I like the idea of the flipped classroom and it is helpful to have extra lecture videos online to explain some concepts but I would still give at least a shortened version of the lectures in class because I found it difficult to pick up on some of the more complex concepts through a video.

I think the MatLab and Comsol parts of the class were very difficult, so maybe some better guidance for those two things. Overall the class was great

keep the videos online but ditch the flipped classroom

more group work, not projects but smaller in class assignments to enhance collaboration skills

No more flipped classroom.

the online notes were fine, but the actual content of the notes could use improvement

The topics covered should be broaden