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Quick Flip: A Model of a Virtual Course in Dynamic Systems and Controls During COVID-19

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ABSTRACT

For the 2020 spring term, courses needed to switch from traditional in-person formats to an online format in about a week due to the COVID-19 pandemic. This paper presents the process and tools used to flip the course content and deliver a dynamic systems and controls course online. Initial feedback was gathered through end of term evaluations and faculty reflections at the end of the term. Overall, the format was well received by the students.

Key words: flipped classroom; undergraduate; observations

INTRODUCTION

The academic calendar necessitated a one-week turnaround from the conclusion of an face-to-face course to an entirely virtual course for the spring term. It is a required, senior-level course in Dynamic Systems and Controls focusing on system modeling techniques, frequency response, and control system development in the Laplace domain. Two sections were scheduled to meet for 90-minutes twice a week.

The plan for virtual class was adapted from what worked in the regular classroom, working within the requirements from the academic leadership, learning from my online graduate school experience, and drawing from evidence-based practices. I had already created a set of handouts with gaps (Felder and Brent 2016) for the course that were well received in the in-person format; these would provide structure for the virtual format. The lecture content delivery followed a flipped classroom model (Bishop and Verleger 2013; Lo and Hew 2019) with asynchronous videos that covered the major content and synchronous sessions to answer questions, solve example problems together or MATLAB/Simulink demonstrations. There are previous examples of flipped courses in control systems (Oliveira and Cunha 2017; Čeleda et al. 2020; Croix and Egerstedt 2014; Krauss, Ali, and Lenz 2017; Mason, Shuman, and Cook 2013) and similar engineering courses (Toner and King 2016; Dallal, Dukes, and Clark 2020; Svensson and Adawi 2015). Like most of these examples, I opted to create my own videos to follow existing course content. While creating the asynchronous content was time-consuming, the overall structure was well received by students.

METHODS

The platforms chosen were based on available software at the institution, requirements from academic leadership, and learning curve. During the development of the synchronous and asynchronous content I aimed for a total expected demand on student time to that of the in-person course. The content was centrally located in the campus learning management system (LMS), with all video content produced from home. Assessments were completed in a variety of platforms.

Synchronous Lecture Sections

Our LMS is Blackboard and Blackboard Collaborate was specified as the platform for live, synchronous sessions. Each week, I posted a checklist in Blackboard so the expectations and assignments were clear. During each synchronous section, I announced upcoming assignments, allocated time for students to ask questions from asynchronous videos, and demonstrated additional examples. In some lectures I also did live demonstrations of how to check their work in MALTAB and Simulink. Students were encouraged to attempt to work the example problem on their own first. I did not record any of the synchronous sessions but provided annotated versions of my slides with summaries of the questions and answers after each lecture.

Asynchronous Videos

Each video followed the same format, with cold open introductions followed by 10–20 minute topic presentations. I recorded the cold opens using my Canon DSLR camera in front of a white wall at home. Main content was recorded using voice-over PowerPoint on my Microsoft Surface, so that I could annotate slides while speaking. I edited the segments in Adobe Premier and placed bed music under the cold open and closing summary. To add flare and consistency, I added an animated logo and end credits third-party content. After the video was rendered, I uploaded it to an access-controlled Google Drive, which provides a streaming player or the ability to download and watch later. Then I separately uploaded the video to Otter.ai (2020) which uses voice recognition to transcribe the video. Transcriptions were usually available in an hour, with minor errors due to homonyms, math equations, and technical terms, requiring less than 30 minutes of clean-up. With a free account, users may download the transcription as a text file which can be added to Google Drive, where the captions are automatically aligned with the previously uploaded video. A paid subscription to Otter.ai provides additional features with some caveats. Video links were included in each weekly checklist on Blackboard alongside the relevant topics and page numbers in the handouts. I assigned 2 or 3 videos for students to watch before each synchronous lecture. Example videos are available here: https://rebeccaee.com/2020QuickFlip.

In total, I created 51 videos totaling about 12 hours and 45 minutes over the course of the 10-week term. To get reasonably polished videos, I spent about 80 additional hours on slide creation, multiple takes, video editing, and caption editing. Two lessons I learned about PowerPoint along the way: (1) stop recording at the end of each slide because it is less to rerecord after making a mistake, and (2) only write on a slide while recording audio.

Assessments

Assessments were completed in Blackboard, GradeScope, and MATLAB Grader. I had used all three platforms in previous terms, so the learning curve was not too much for me. However, some students initially resisted learning how to add equations in GradeScope with LaTeX syntax. In Blackboard, frequent 2-point autograded quick review assessments ensured students were watching the videos and staying on track in the course, see Figure 1 for a screenshot. The quick review assignments took about 5-10 minutes to create and did not require any time to grade. Exams and weekly quizzes were completed in GradeScope and MATLAB Grader. GradeScope was selected over Blackboard for its ease of grading open response questions. The online assignment feature was used so students were not required to scan or take pictures to complete their assignment, as multiple students indicated by survey they did not have the ability to upload their work by hand. A screenshot from one quiz is included in Figure 2. The quizzes and exams were only slightly modified from their face-to-face versions and only took an additional 10 to 20 minutes each to enter in to GradeScope's interface. Since the course relied heavily on MATLAB and Simulink, MATLAB Grader provided a helpful autograding interface for MATLAB based assignments. The MATLAB Grader assignments did not require any additional time over a normal face-to-face course.

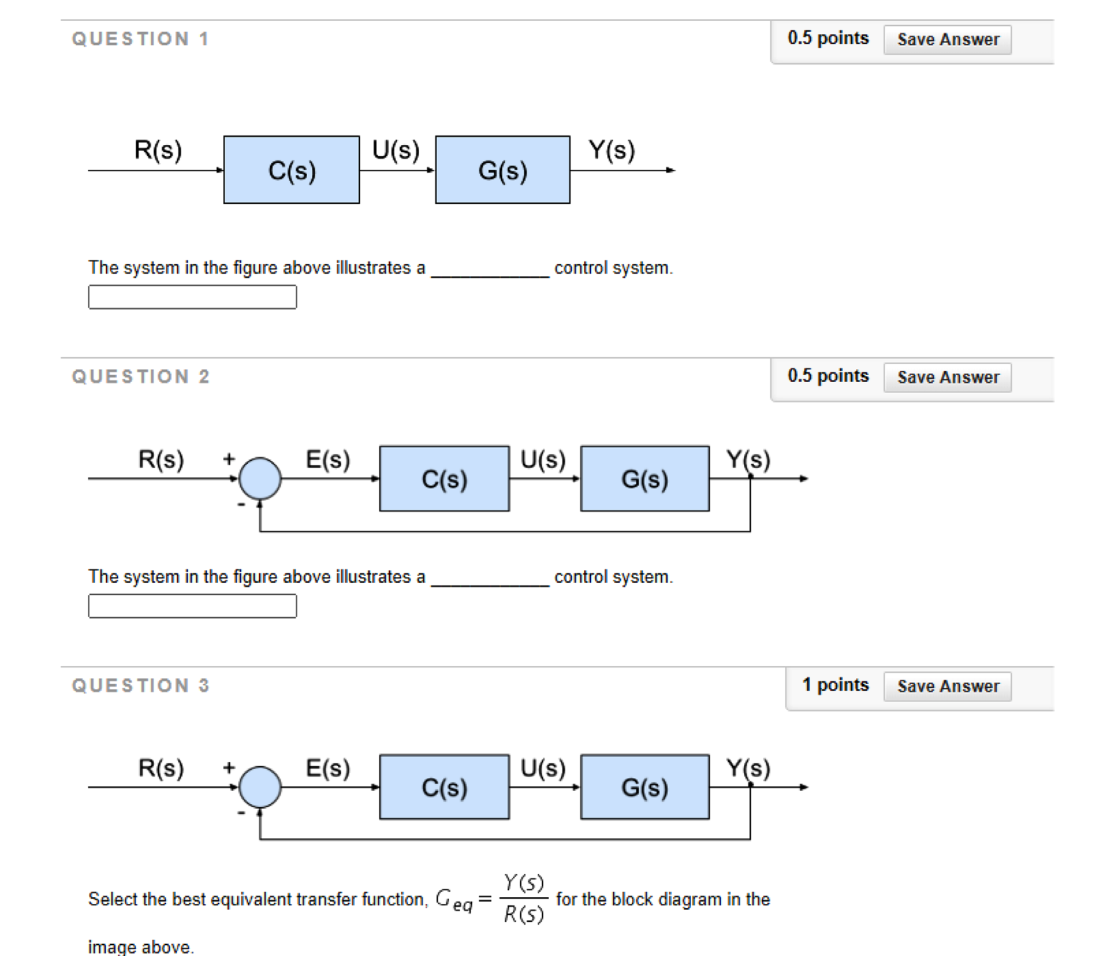

Figure 1. Screenshot of the submission for one quick review assignment in Blackboard.

PRELIMINARY RESULTS

Overall, the course was well received by the students. There were 25 students enrolled in the first section and 27 in the second section. Participation in the synchronous sessions was over 90% for all but one session when it dropped to about 80% right after the midterm. Select Likert items from the end of term evaluations are summarized in Table 1. The open response comments were generally positive from both sections. One student in the first section said:

> “Literally cannot say thank you enough, she did an excellent job transitioning to online and doing it in a way that wasnt [sic] detrimental to the student experience. We still covered all of the information we would have with live classes and this was the only class where that was the case.”

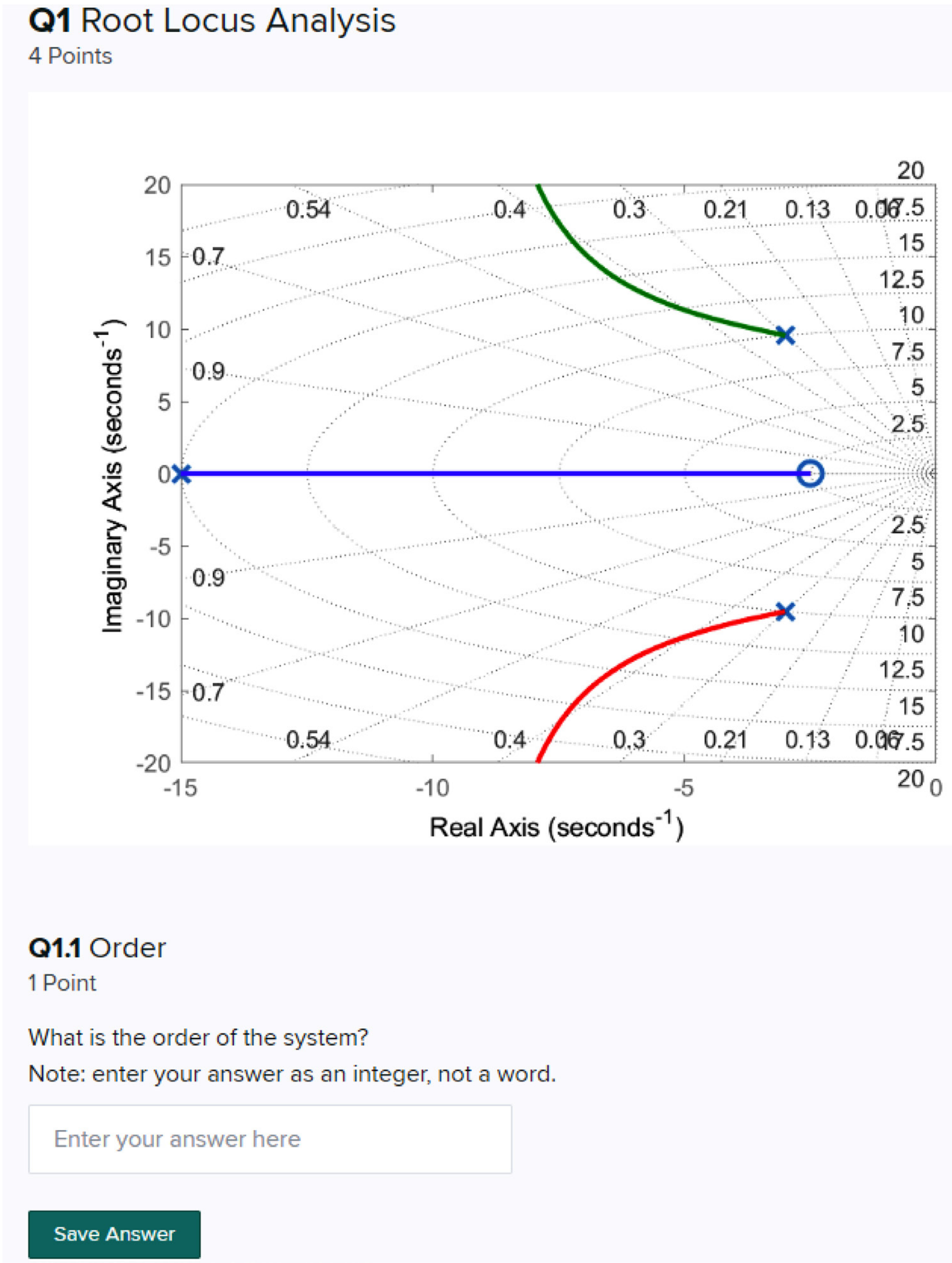

Figure 2. Screenshot of submission interface for part of a quiz in GradeScope.

In the second section, one student stated:

“At first I really did not like the flipped classroom, but the organization and the ability to re-watch some or all of previous lectures was worth the additional homework time.”

Table 1. Summary of Likert items from end of term evaluations.

	Section 1 (n = 10)		Section 2 (n = 7)	
Question Text	**Average**	**St. Dev.**	**Average**	**St. Dev.**
Course organized to help learning	4.9	0.3	4.7	0.8
Instructor presented organized content	5	0	4.9	0.4
Material organized around learning outcomes	4.8	0.4	4.9	0.4
Instructor encouraged participation	5	0	4.4	1.1
Overall effectiveness of instructor's teaching technique	5	0	4.9	0.4
Instructor created an environment conducive to learning	5	0	4.9	0.4

Note: These items were rated with a standard Likert scale with 5 = strongly agree and 1 = strongly disagree

After reviewing the total amount of time, I overshot the goal of having the time spent between the synchronous and asynchronous content equal the same amount of previous face-to-face time. The videos, if watched at normal speed, covered all but about 45 minutes of the normal face-to-face time. There was additionally 60 to 90 minutes of synchronous time each week. With more time to plan and edit videos I may have been better able to meet the goal for student time-commitment to the course. However, in an example of flipping a mechatronics course, the instructors required additional time to watch videos because the in-class time replaced other work that was previously expected outside of class time (Toner and King 2016). Although Mason, Shuman, and Cook (2013) found that they covered content faster in a flipped classroom, I did not see the same magnitude of gains. However, they had more time to plan and edit their video content.

NEXT STEPS

In the future I would like to learn to capture examples directly in MATLAB and/or Simulink to include in the asynchronous content so that those examples were not exclusively in the synchronous sessions. I would also work harder to limit video length to 10 minutes. Finally, I would like students to collaborate more during synchronous sessions. For example, I only once asked them to work in small groups to complete an example and report out to the class. It went well and I would like to incorporate more activities like this.

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