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An Asynchronous Course/Laboratory Development for Automation Controls

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An Asynchronous Course/Laboratory Development for Automation Controls

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Abstract
The development of asynchronous courses is to help students who are restricted by work requirements, family responsibilities, geographical distance, disabilities, and combination of these factors. It also provides flexibilities to on-campus students. In this paper, the framework structure of an asynchronous course and laboratory development for an automation control is presented. The challenge in this development is to implement the hands-on laboratory experience to those distance learning students who may not be able to access the real equipment. Results of the implementation including opinion feedbacks and grade distributions show that students welcome the format of this development.

1. Introduction

The development of asynchronous courses in the engineering technology is based on the following reasons:

a. A significant number of engineering/engineering technology students are part-time students. For example, in the mechanical engineering field, 7,089 undergraduate students are enrolled as part-time basis in 2008[1]. The number increased to 10,096 in 2012[1]. The development of asynchronous courses is to help those students who are restricted by work requirements, geographical distance, disabilities, and combination of these factors. In the authors' program, 148 out of 327 total enrollments in the academic year of 2014 are part-time students.
b. Because the unprecedented changes occurring on the web, a significant number of students are in the DL education. For example, in year 2012, 12.5% of the total students in the whole nation were enrolled exclusively in DL courses, and approximately 26% were enrolled in some DL courses[2]. In the authors' program, 179 out of 327 total enrollments in the academic year of 2014 to 2015 took DL courses.
c. Students can have more think time than the regular face-to-face teaching. This is critical to some core courses such as thermodynamics, dynamics, fluid mechanics, and machine design, etc. Students can repeat watching/reading the materials until they fully understand the material.

This paper focuses on the asynchronous development of an automation control/lab and the structure can be applied to any other courses. Students will be using simulation wiring software for their homework assignments and laboratory problems. The approach can significantly reduce the gap of hands-on experience and can also provide a preparatory tool for on-campus students.

2. Asynchronous Course Development of Automation Control

As shown in Figure 1, the development followed a framework structure to develop the course[3]: Blackboard Learning Management System[4] and Personal Learning Environment (PLE)[5]. Blackboard is used to deliver content, host discussion forums, and administer exams. It's compatible with Windows and Mac, and also Blackboard Mobile apps are available for mobile devices. The PLE is an interface used in asynchronous courses, designed by the University's Center for Learning and Teaching (CLT). Students can click each items shown in Figure 1.

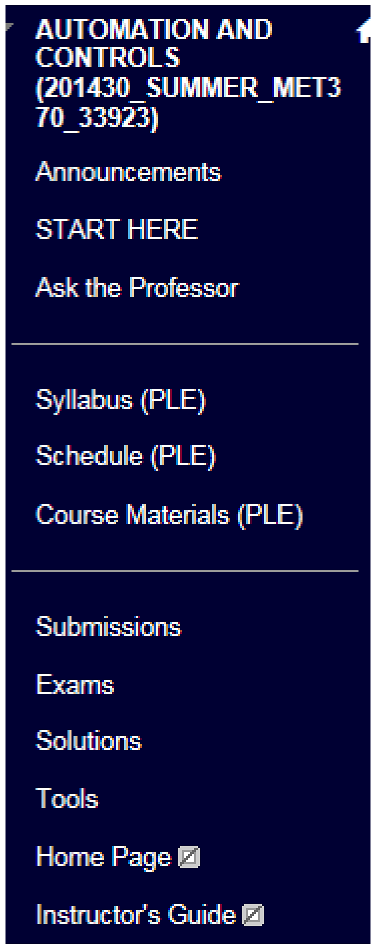


Figure 1: Framework Structure Using PLE and Blackboard

2.1 Announcements

This section explains more details about the class policy, address the most common questions that students raised in homework, laboratory problems, or tests, and inform missing links or corrections for class materials, etc. The announcements can also be sent to students through emails so that all students can have immediate attention.

2.2 Start Here

This section introduces online course, technology prerequisites which include internet browsers readiness, PDF reading capability, and Blackboard and PLE.

2.3 Ask the Professor

Students can use this forum to ask professor questions in the course content or have discussions with other students taking the same course. After subscribing to this forum, students will receive notification from the instructor when something new has been posted. They are also encouraged to contact the instructor through phone and/or emails.

The following three sections are developed through PLE:

2.4 Syllabus (PLE)

The structured syllabus includes required texts and materials, course description, course objectives, how the course works, student responsibilities, grading criteria, course policies, and university policies.

2.5 Schedule (PLE)

Figure 2 shows a typical schedule for Week I class. It includes the title of each class module with topics, reading request, and homework assignments with due dates. Students can send their immediate feedbacks by clicking "Ask the Professor" in the Blackboard.

2.6 Course Materials (PLE)

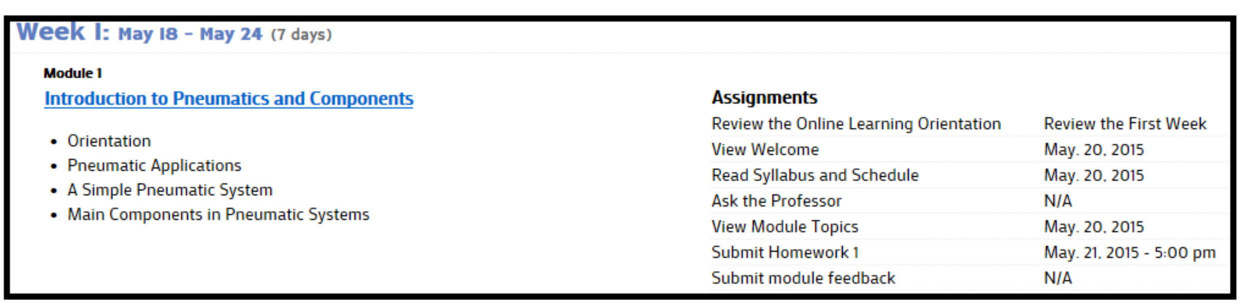
When students click this section, a separate window for the course information will be created and is shown if Figure 3.

2.6.1 WELCOME (PLE)

Figure 3 is also shown when students click the "WELCOME" section. The course developer records a brief video to introduce the course content and motivates students to study the materials.

2.6.2 FACULTY (PLE)

Similarly to Figure 3, a short video is developed to introduce the developer's professional background and teaching philosophy.


Week I: May 18 – May 24 (7 days)

Module 1

Introduction to Pneumatics and Components

- Orientation
- Pneumatic Applications
- A Simple Pneumatic System
- Main Components in Pneumatic Systems

Assignments	
Review the Online Learning Orientation	Review the First Week
View Welcome	May. 20, 2015
Read Syllabus and Schedule	May. 20, 2015
Ask the Professor	N/A
View Module Topics	May. 20, 2015
Submit Homework 1	May. 21, 2015 - 5:00 pm
Submit module feedback	N/A

Figure 2: Typical Format in the Schedule Section

Figure 3: WELCOM Section in PLE

2.6.3 MODULES

Figure 4 shows the topics of twelve modules developed in this course when the "MODULES" is clicked.

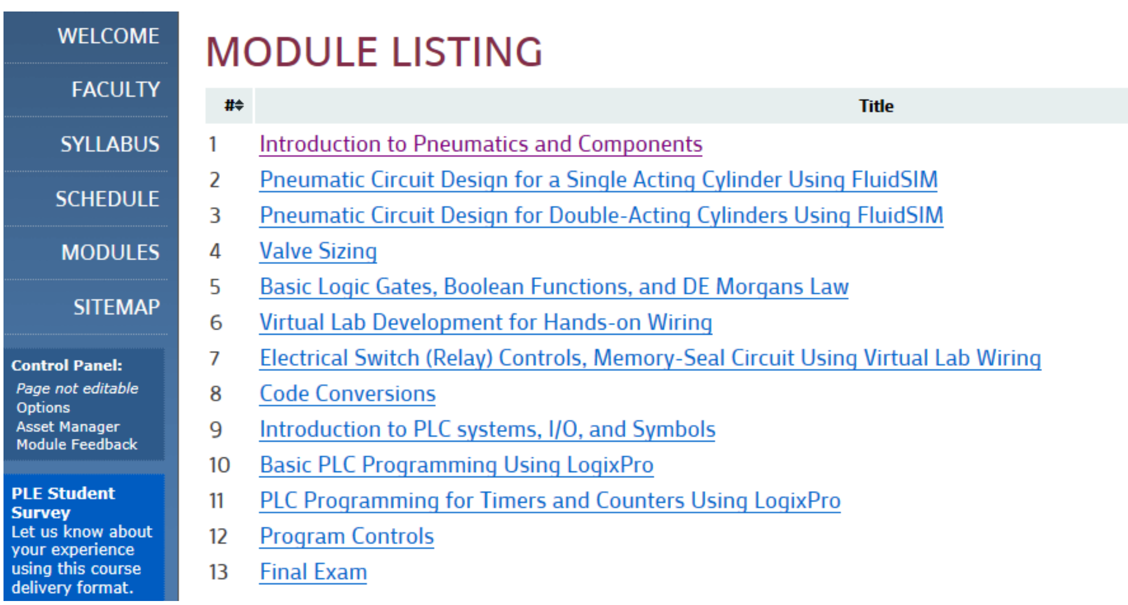


Figure 4: Twelve Modules Developed under the MODULES Section.

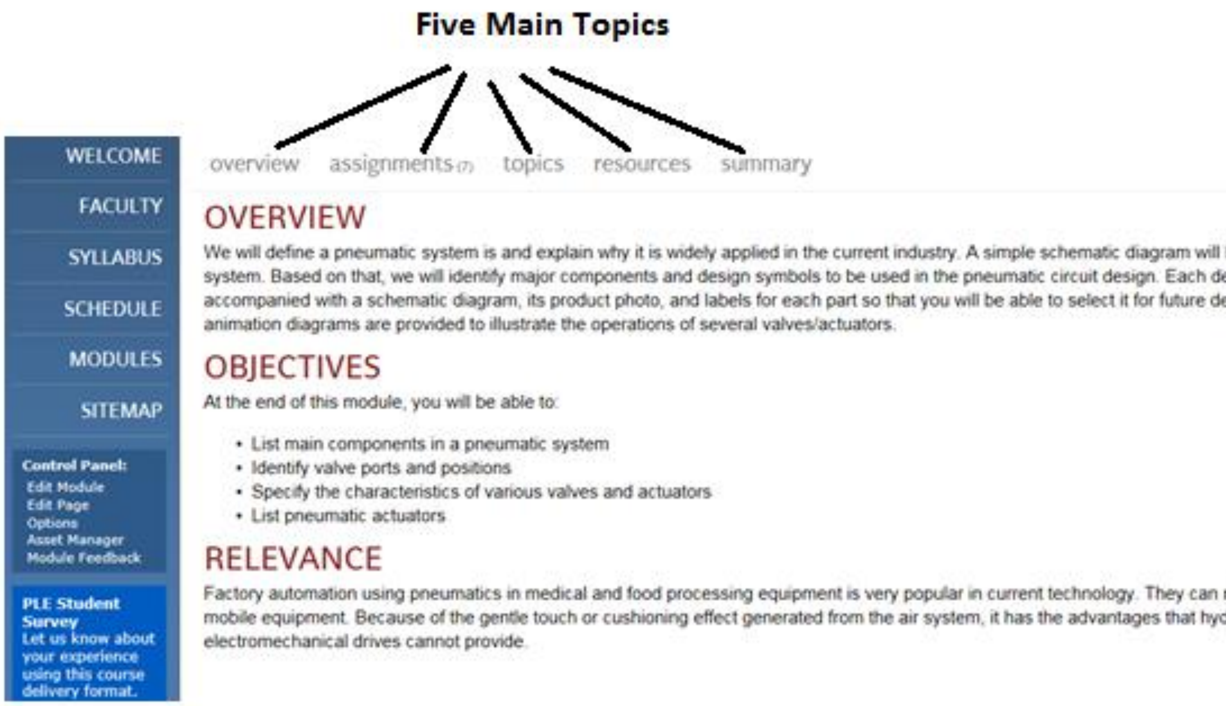


Figure 5: Five Main Structured Topics on the Top Menu When Each Module Is Clicked.

Figure 5 shows five main structured topics on the top menu for each module: overview, assignments, topics, resources, and summary.

2.6.3.1 Overview

Also shown in Figure 5, when the overview section is clicked, it shows three sub topics:

a. OVERVIEW: It provides the introduction of the module.
b. OBJECTIVES: It indicates the subtopics included in the content of the module
c. RELEVANCE: It shows the relevance of the module with current industrial applications.

2.6.3.2 Assignment

When the assignment section is clicked, as shown in Figure 6, it shows three typical topics: module topics, homework assignment, and module feedbacks. Solution for each assignment will be posted after the due date.

2.6.3.3 Topics

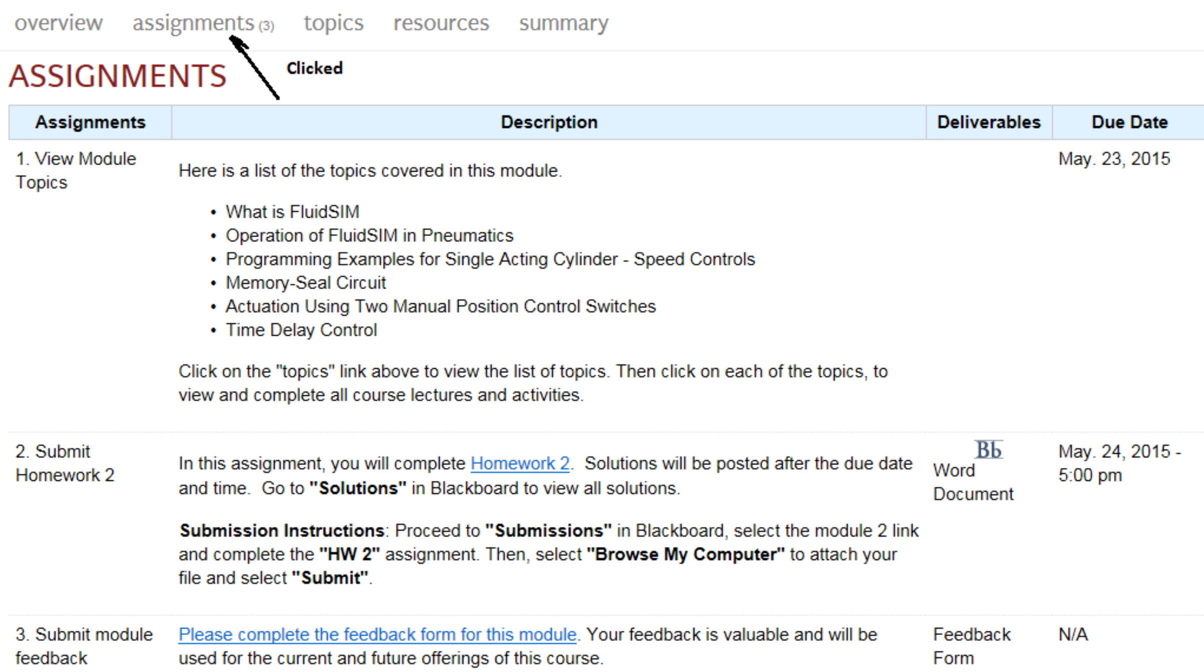
Figure 7 shows that the sub-topics of the module are displayed. Students can click on each topic to read its content.

2.6.3.4 Resource

The “Resources” provides supplementary reading materials for each module. In this first stage of the development, no resource is provided.

2.6.3.3 Summary

Figure 8 shows that the result when the “Summary” is clicked. Students can review the benefit after studying this module



Assignments	Description	Deliverables	Due Date
1. View Module Topics	Here is a list of the topics covered in this module. • What is FluidSIM • Operation of FluidSIM in Pneumatics • Programming Examples for Single Acting Cylinder - Speed Controls • Memory-Seal Circuit • Actuation Using Two Manual Position Control Switches • Time Delay Control Click on the "topics" link above to view the list of topics. Then click on each of the topics, to view and complete all course lectures and activities.		May. 23, 2015
2. Submit Homework 2	In this assignment, you will complete Homework 2. Solutions will be posted after the due date and time. Go to **"Solutions"** in Blackboard to view all solutions. **Submission Instructions**: Proceed to **"Submissions"** in Blackboard, select the module 2 link and complete the **"HW 2"** assignment. Then, select **"Browse My Computer"** to attach your file and select **"Submit"**.	Bb Word Document	May. 24, 2015 - 5:00 pm
3. Submit module feedback	Please complete the feedback form for this module. Your feedback is valuable and will be used for the current and future offerings of this course.	Feedback Form	N/A

Figure 6: When the “assignment” on the Top Menu Is Clicked

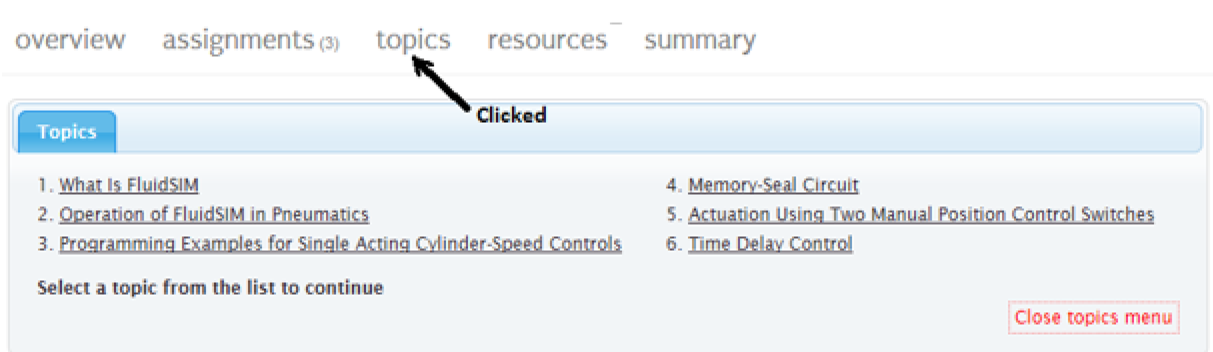


Figure 7: When the “topics” Is Clicked

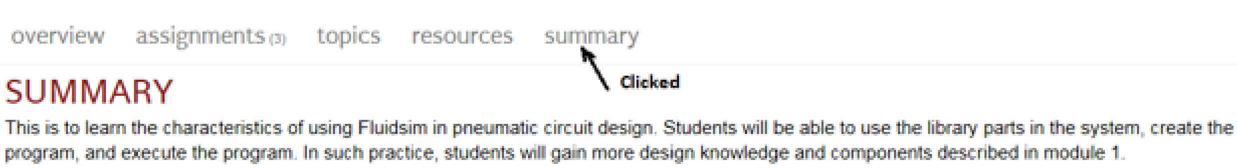


Figure 8: When “summary” Is Clicked

3. Asynchronous Course Development of Automation Control Lab

Figure 9 shows that fifteen lab problems are developed for the automation control lab and are frame structured similar to the class development. In this development, Labs 1 to 5 are pneumatic circuits; Labs 6 to 10 are electro-pneumatic circuits; Labs 11 to 15 are PLC programming. A video demonstration of each lab using the real equipment is posted in the Blackboard when due date is passed. To enhance their hands-on experience, three software were applied in this class:

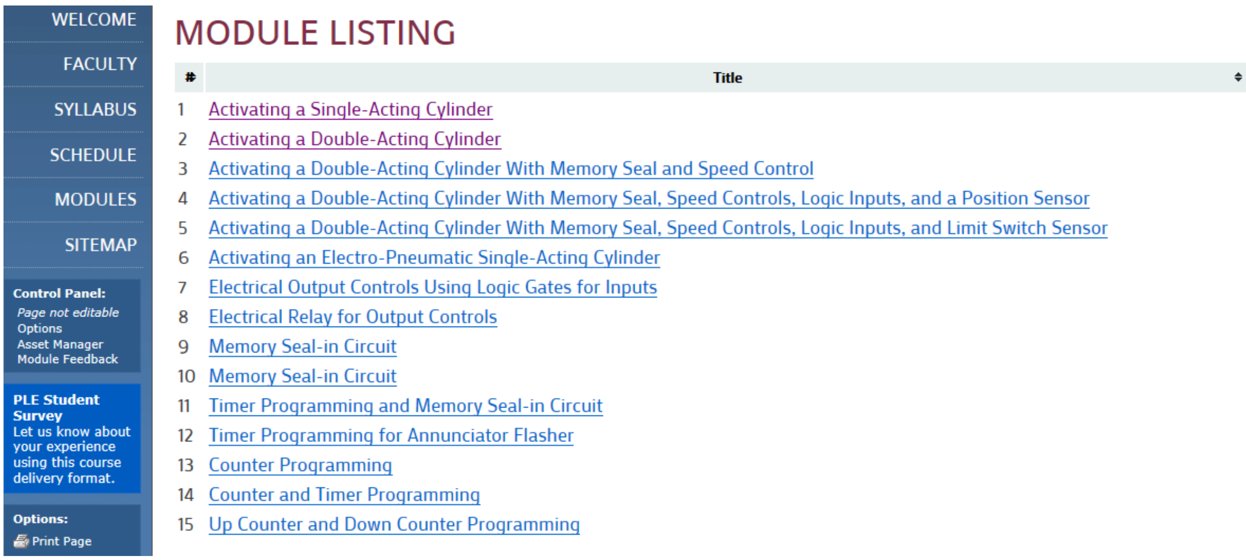


Figure 9: Fifteen Modules Developed for Automation Control Lab

3.1 Electro-Pneumatic Software

Figure 10 shows the electro-pneumatic software[6] that students used in the lab. Students use this design software as the first stage in the lab. The simulation capability in the software can confirm the expected result. The software is used in the pneumatic and electro-pneumatic circuit designs.

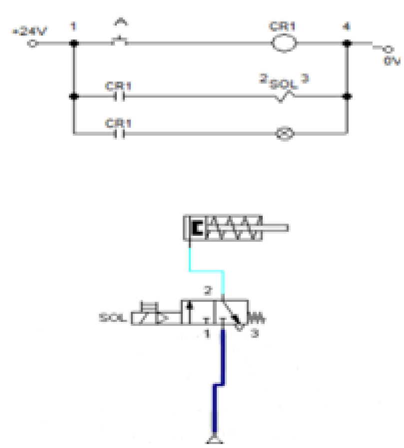


Figure 10: Electro-Pneumatic Software

3.2 Virtual Lab for Electrical Wiring[7]

Figure 11 shows the software of Virtual Lab for Electrical Wiring. The software was developed through the help of the university research grant. It includes three main components: power supply, manual switches, and electrical switches. Students can perform their wiring practice using the software which has exact the same capability as the real equipment. Figure 12 shows the electrical wiring of the OR gate circuit. The software has received the Certificate of Registration from the U.S. Government[8].

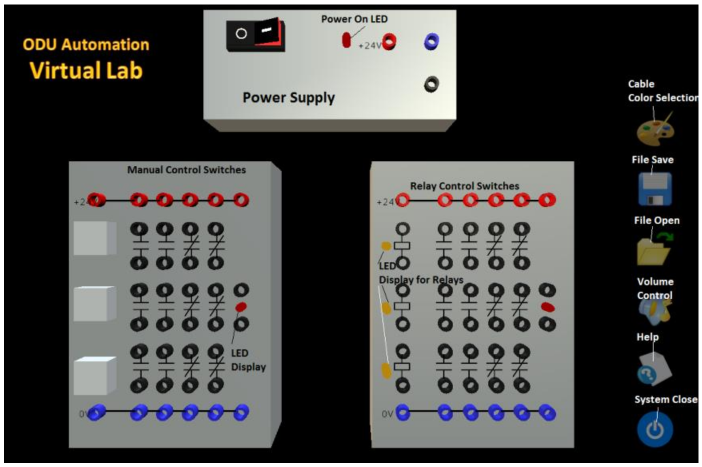


Figure 11: Virtual Lab for Electrical Wiring[6]

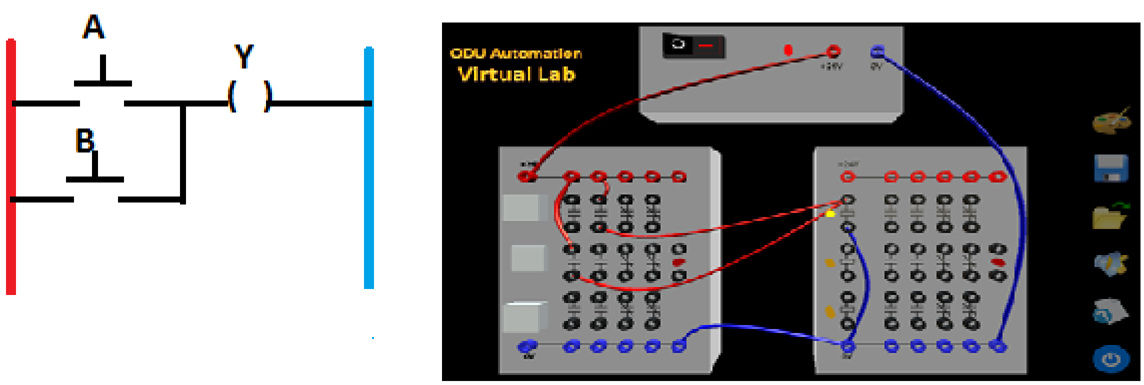


Figure 12: Electrical Wiring of the OR Gate Circuit[6]

3.3 Assembly Platform

Before students start working on the lab problems, an on-line tutorial on how to use the simulation software of "Assembly Platform" is given by clicking the top menu "Topics" and then "Orientation" on each module, as shown in Figures 13 and 14.

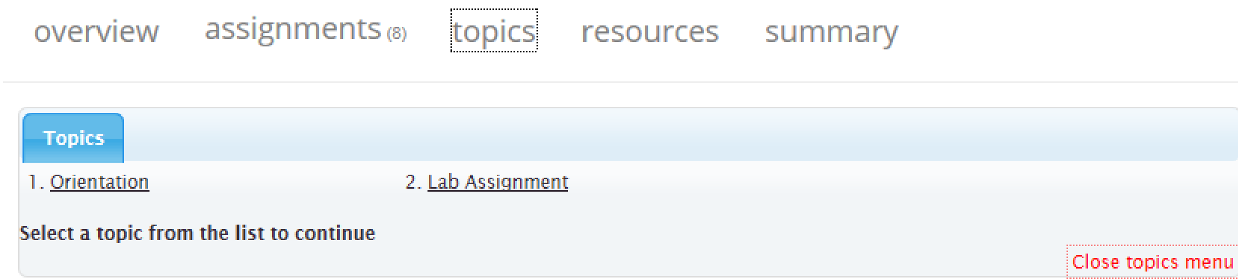


Figure 13: On-Line Training Orientation

Figure 14: On-Line “Assembly Platform Tutorial” Training

Figure 15 shows the software of Assembly Platform developed through the university’s CLT. It lists the components in the bottom. Students can click and drag the components and place them on the platform for electrical and pneumatic circuit wirings. Figure 16 shows the wiring for a lab problem. The software is used in Labs 6 to 10. Students have to submit the lab reports using electro-pneumatic software and Assembly Platform.

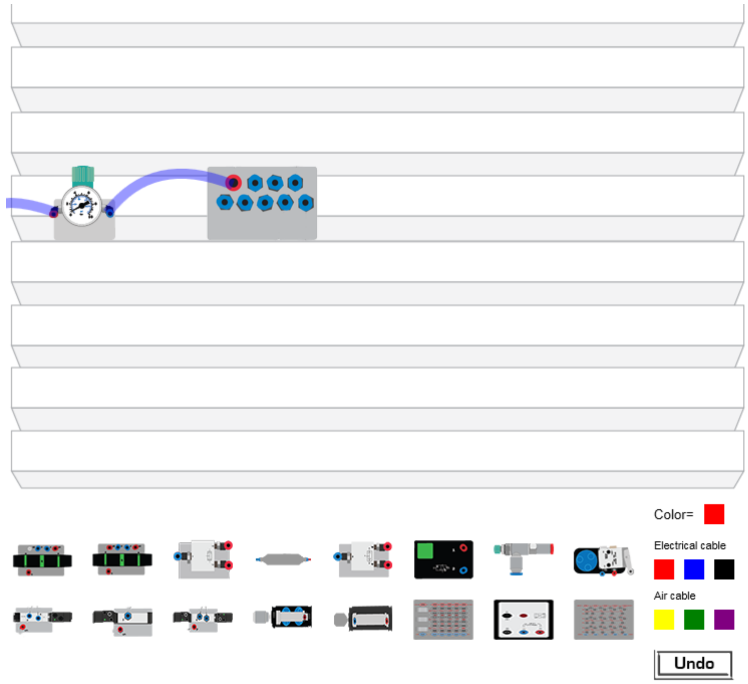


Figure 15: Assembly Platform

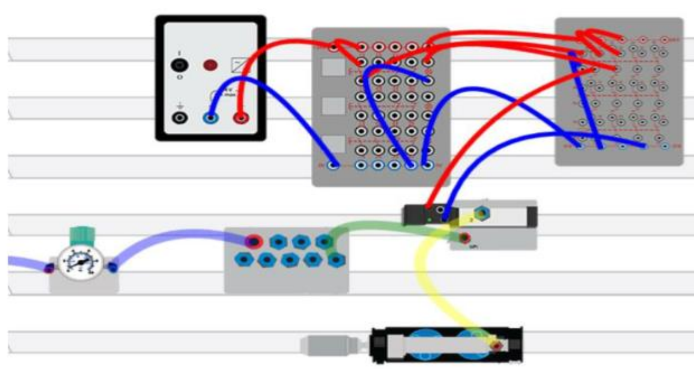


Figure 16: An Electro-Pneumatic Circuit Wiring Using Assembly Platform

3.4 PLC Software

Figure 17 shows that students use a PLC Sofware[9] for timer and counter programming. The software is used in Labs 11 to 15. It offers simulation capability so that students can check their design before submitting the reports. The software is the same as the one used in the real equipment.

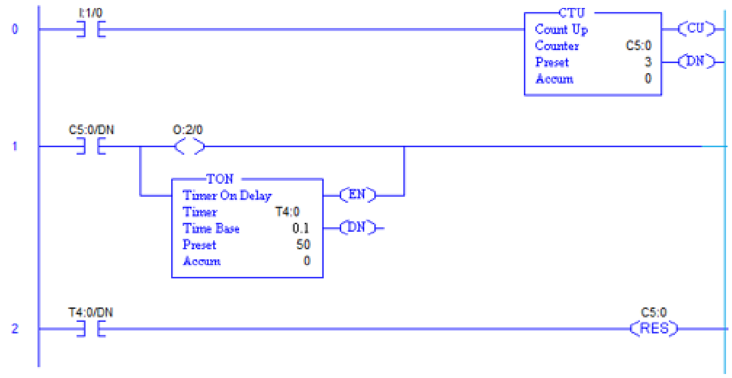


Figure 17: PLC Software for Timer and Counter Programming

4. Course Implementation

The course was implemented in summer 2015 and went smoothly as planned. Fifty students were enrolled in the class. During the deployment, the instructor kept checking the "Module Feedback" in the PLE and responded to students' comments and questions, posted homework and exam solutions after passing the due dates. Students also used emails or phone calls for their questions in homework problems, lab reports, and exams. The university used ProctorU[10], an online proctoring company, to proctor midterm and final exams. When problems occurred during the exams, the proctor immediately called to the instructor for immediate solutions. However, because of the three-hour time difference between Pacific and Eastern Time zones, some issues had to wait until the following day.

After the deadline of each lab is passed, a video using the real equipment for the lab is posted. While students don't really touch the real equipment, the photo images of the devices developed in the software are very similar to the real devices. Students can easily relate their simulated lab experience to the video using the real equipment. The hands-on gap is therefore greatly reduced.

Figure 18 shows the student feedback for Module 1; Figure 19 shows the positive comment feedbacks; Table 1 shows the scores of module feedbacks. The weighted average score of the feedback survey in Table 1 is 4.02/5.00, with very low number of responses toward the end of the semester. Figure 20 shows the grade distribution in this deployment. The performance is similar to the regular face-to-face teaching.

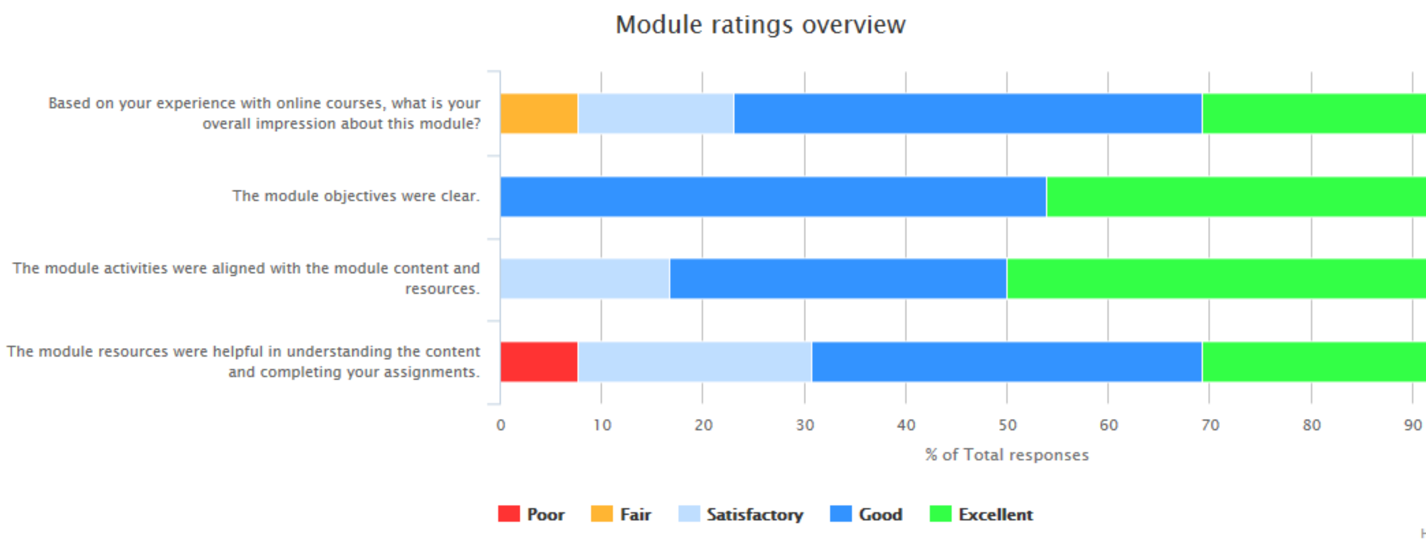


Figure 18: Module Feedbacks

What worked best for you in this module?

1. The Videos
2. Step by step module - fairly straightforward
3. The organization of the module was very helpful
4. N/A
5. Most of the content was helpful in completing the homework
6. videos explaining the actuators were great
7. The pictures and videos helped me understand the concept a lot better.
8. The module seemed to flow properly from one topic to the next.
9. Each section was broken down into simple and easy to understand sections based on the specific subject.
10. the information
11. The layout of the module and topics. Everything was clear and easy to follow.

Figure 19: Positive Feedbacks from Students

Table 1: Scores of Module Feedbacks

5: Excellent; 4: Good; 3: Satisfactory; 2: Fair; 1: Poor

Module Number	Scores (1-5)	Responses
1	4.17	13
2	4.38	6
3	3.90	6
4	4.07	4
5	2.64	3
6	3.13	2
7	4.43	4
8	4.00	1
9	3.75	2
10	4.00	1
11	4.50	2
12	4.00	1

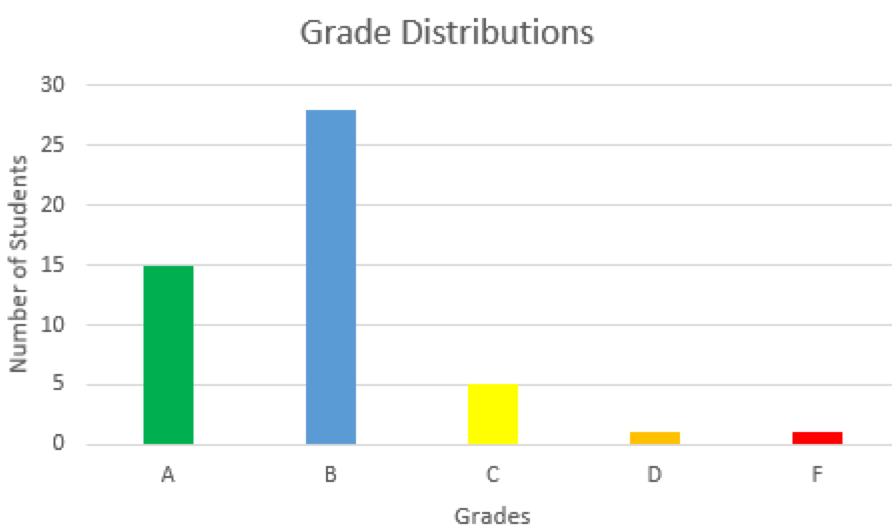


Figure 20: Grade Distribution of the Course

5. Summary

The staff working in managing the asynchronous system plays the key role in securing the success of implementation. They need to keep close communication with the course instructor and proctors and also need to make immediate changes and responses to each student's requests when needed. Students may need extra time to take an exam or re-submit a homework because of the software issues in their personal computers. The instructor will need to check and respond to his/her emails frequently as some students may choose to submit their homework or lab reports through the emails. The instructor may also receive calls from proctors during the early morning hours because of the time zone differences. To better assess the course performance, the number of responses participating in the Module Feedbacks needs to be increased, although the instructor did receive several encouraging messages from students.

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