

# **An Outcome-Driven On-line Graduate Course: Real Time Systems Course**

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## **Abstract**

Teaching strategies for online courses are naturally different from traditional teaching in a regular class room. In a traditional class room, the teacher is in direct contact with the student and the feedback from the students is observable. In an on-line course, however, a student does not have the same opportunities for providing feedback. Creating opportunities for students to exchange information in a forum with other students every week is a good practice and helps provide much-needed feedback opportunities. In this paper we explain the techniques used to increase students interactions in an on-line course.

Normally a course has five or six outcomes or objectives. We expand it to fourteen outcomes and re-arrange the course material so that each week the course material for one of the outcome can be taught. Students do assignments related to the weekly outcome so that we can assess whether the students met the outcome. If necessary more feedback is given so that the students can meet the outcome expected. This paper presents the outcome for a graduate on-line course on 'real time systems'. Syllabus for the course with the text book information and the details of the weekly course material covered is given. The differences between a regular face to face course with normal sequential coverage of topics and the on-line outcome driven course is also presented in the paper.

## **Introduction:**

Objectives of the course are normally written to reflect what we expect the students to learn from the course. When we write the course objectives, we make sure that it is possible to assess the objectives at the end by the instructor and internal or external expert. We need to make sure the teaching activities and feedback from the students are synchronized with the objectives. We need to assess the student's background and knowledge level right during the first week so that we can build the course to suit the students' background. It is also necessary to emphasize active learning instead of passive learning.

Course outcomes describe what students should know and be able to do after taking the course. The terms "Outcomes", "objectives" and "goals" are frequently used interchangeably and there is no agreement on their meaning and applications in course delivery. The term "outcome-based education" refers to overall outcome of students from a school or with a degree. Outcome based education assumes that all students can master tasks and materials if given enough time. The assessment of outcome based education need not result in a numerical grade for a student.

Outcome driven course delivery is different from outcome-based education<sup>1-5</sup>. The tests and exams in the outcome driven course are similar to the normal course, except the course delivery or teaching is more focused from the beginning and constantly checks whether the outcome for the course is achieved. Hence a lot of effort is made to write the course outcome, how each topic is taught each week and how to measure the performance of the students each week. In addition the course topics are re-arranged to meet the weekly outcome for that course.

### **On-line courses**

For On-line courses, our University provides the following platform<sup>6</sup>: Moodle, Camtasia studio – a software tool to integrate power point with narration and video of instructor, tools like Elluminate, Panopto, ePortfolio, eSpace etc. Instructor can add narrated power point slides or documents like a webinar using Camtasia studio, do Blogs using Forum in the Moodle, create a Wiki for collaboration by students to edit a team work or project and do other creative communication with the students. Teachers serve as facilitators or coaches especially in graduate level courses, design challenging student activities and provide guidance to make the students move towards the course outcome.

For some topics, teacher introduces small-group activities, short term projects where a few students form a group and collaborate. Group assignments are done by collaboration/ chatting on the web and it develops brain-storming and innovative design and answers. On-line course provides flexibility of time and students need not be on line at the same time. The on-line course provides limited asynchronous learning between the students during a week. But, it is expected that all the students synchronize their knowledge at the end of the week and meet that week's outcome. The trick is to assign correct amount of learning material each week so that almost all the students can complete the goal in a timely manner. The assignments will develop skills like creativity, what-if analysis, problem-solving and critical thinking. Critical thinking involves questioning the assumptions and normal solutions and encourages finding alternative/ better solutions. Students communicate with the teacher or communicate with other students during the week to clarify and understand the material. Student Forum in the Moodle provides a method for students to communicate. The instructor monitors the discussion in the "Forum" to give his/her input and provide leading questions to direct the students towards the right answer. More detailed feedback is given to the students while grading weekly assignments. Some bright students require more flexibility and hence more than one week course material or advanced optional material is provided on the Moodle.

To make the students demonstrate that they know and are able to do to meet the outcome, the following points are considered.

- Create a weekly course work and assignments that outlines specific and measurable outcomes for every week.
- Consider individual needs of students and make sure that the outcomes are met by all. Provide challenging questions to high performing students and give them higher points.
- Student's abilities and skills differ. Their pre-requisite course knowledge affects their performance in the current course.
- We test the basic pre-requisite knowledge expected from the registered students during the first week of the course and provide necessary feed back to the students.

## Outcome for real- time Systems course

The text book used for this on-line course is by Laplante<sup>7</sup>. A number of reference text books, papers and material from web sites are also used<sup>8-18</sup>. The course outcome (Sometimes called as course objectives) is: Upon completion of this course students will be able to:

- Know the definition and characteristics of Real Time systems
- Know the various task assignment and scheduling methods. For example RM and EDF scheduling.
- Become familiar with Real Time system development tools like Matlab RT tool box, ETAS tools
- Know the important characteristics of Real Time Operating System, Know about the RT System requirement, design, and performance analysis.

The above course outcome is generic and need to be expanded to weekly outcomes for the course. Example weekly outcomes for real time system course are given below.

- Week 1: Know the characteristics of Real Time systems- Soft, Hard, Hybrid systems. Recollect the pre-requisite material- Embedded systems characteristics and basic design.
- Week 2: Know the definitions of various terms in Real Time systems and discussions on real time system design issues. Hardware design issues for RTS.
- Week 3: Know the Characteristics of Real-Time-Operating –System (RTOS), various RTOS available in the market. Basic concepts of task scheduling: Clock driven, Priority driven, RM scheduling, EDF scheduling and others.
- Week 4: Know the various real time software tools and their applications. Matlab Real time tool box (Simulink coder), ETAS tools like Intecrio and ASCET for simulating real time scheduling. Free tools as add on to Matlab for testing Schedulability and graphing the time line.
- Week 5: Know the challenges and solutions for “Dead lock and Live lock”. Use of UML to support Real time system design stages.
- Week 6: Know the use of UC/Cos real time operating system details and use for a simple application.
- Week 7: Know the details of the following: Slack stealing, fast slack stealing, priority inversion blocking, how to use priority inheritance, priority ceiling protocol, resource sharing, direct blocking, push through blocking, resource management.
- Week 8: Make a presentation using power point on one of the advanced issues or topics in real time systems. Submit on the Moodle audio embedded on power point. These slides will be viewed by other students and questions are asked using Moodle “Forum”. The questions and answers are viewed by all the students. This activity increases more interaction between students.
- Week 9: Know the challenges and details of real time communication: CAN protocol, Ethernet protocol.
- Week 10: know the details of Real time data bases and applications.

- Week 11: Know how to use Cheddar software tools to perform timing simulation and analysis of RTS.
- Week 12: Know how to do performance estimation, performance analysis and do engineering considerations.
- Week 13: Know how to apply Divisible Load Theory and Fault Tolerance in RTS
- Week 14: Know to demonstrate the knowledge gained in this course as a term project with a report and also as a power point with audio and share it on the Moodle with all the students and answer the questions and doubts on the “Moodle Forum”.

### **Measurement of the weekly outcome**

The weekly homework assignments, monthly tests, group discussions on the forum, mid-term paper presentation on the Moodle, and final project and presentation, are used to measure the weekly outcomes. Some examples are available on the course web site. The grading and tests are similar to a regular graduate course. The quality and quantity of the material taught in the on-line course is identical to that taught in a class room based course. This course is taught in some semesters as a regular course and in some semesters as on-line course.

Since we monitor and assess the course outcome every week the outcome based on-line course meets the course objectives much better than the traditional course. In an on-line course, some students put in less effort some weeks, and barely meet the overall course objectives. In our method of weekly outcome based on-line course, the students are monitored for the outcome every week and they tend to meet all the weekly outcomes.

### **Assessment of outcomes**

A simple survey questionnaire listing the weekly outcomes were given to the students and the feedback is collected. At the end of the course the survey for course objectives were given. The students taking the outcome based course met the course objectives much more than that of the traditional course. The problem solving skills and critical thinking skills<sup>19-20</sup> for the students are especially developed well since they are emphasized every week indirectly when we design the course for weekly outcome.

### **Conclusion**

Since the instructor is now more focused on weekly outcome, the course is taught more creatively with effective guidance. The students interact with the instructor more and meet the outcome expectations. Delivering an on-line course is more challenging and combined with outcome driven concepts, the effort for teaching is much more, but greatly rewarding and effective.

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## Biography



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