Distance Education Experience with Electric Power Courses at the University of Iceland

Egill Benedikt Hreinsson
School of Engineering and Natural Sciences, University of Iceland
Hjardarhagi 6, 107 Reykjavik, Iceland
E-mail: egill@hi.is

Abstract—At universities around the world, web based on-line distance education is increasingly being offered for advanced engineering education. This includes electric power engineering where individual courses and even complete university degrees are being awarded based on internet based distance education resources and on-line interaction between students and their instructors.

This paper describes the experience of the author of giving and managing on-line undergraduate and graduate courses, in particular courses in electric machines and in electric power economics. These courses have for many years been a part of the standard curriculum in electrical engineering at the University of Iceland (UI) based on traditional class-room based instruction. However, this author’s experience of conducting these courses may cast a light on the difficulties of introducing on-line education when a system of traditional class room based education is rigidly in place.

Furthermore, this paper describes the status of on-line education of UI, School of Engineering and Natural Sciences (SENS) and at other Schools within UI. From experience it is this author’s conclusion and belief that on-line distance education will evolve in electric power engineering and other disciplines at UI, but major administrative and management hurdles have to be overcome and various conflicts resolved.

There are numerous challenges to address, and internet based input and contents will most likely complement and support traditional but reduced face to face interaction. Factors such as discipline, inspiration, support and guidance are a part of the instructor student relationship that is a challenge to maintain on the internet. It is expected that internet based education should evolve rapidly in the near future both in electrical engineering and other disciplines. It is this authors opinion that a strong leadership, a focused legal framework and a firm policy are among the elements needed for distance education to be successful in spite of the remarkable opposition and criticism at present.

I. INTRODUCTION

Distance learning courses have come a long way from the correspondence based courses and schools of the era before the internet [6] and [10]. Technology has played a major role in the paradigm shifts that are occurring with the rapid new application of information technology and internet resources. In recent years, with the ease of creating videos, audio slides etc., the potential for on-line education has risen to new heights.

It seems that more and more universities are engaged in on-line education even with complete on-line degrees being offered. In particular, examples of electrical engineering distance education cases are described in [16].

The paper is composed as follows: In Section II we review the basic characteristics of distance education and on-line learning. In Section III we review distance education in electrical engineering in general and in power engineering in particular. In Section IV we review distance education at UI, in particular at SENS, along with this author’s experience in conducting distance education courses, in particular in the courses in (a) electric machines and in (b) power economics, and also in power engineering in general. Section V presents discussions and conclusions and finally the paper is concluded with an acknowledgement and a references section.

II. BASIC CHARACTERISTICS OF ON-LINE LEARNING

There has been an on-going revolution in internet based open access to all kinds of information, which in turn has resulted in a revolution in distance education [3, 4]. It is suggested that “Observation of operational strategies in some 30 universities in Europe and the United States indicated rapid growth and pervasive spread among tertiary institutions” and this constitutes what has been called MOOC ([4], p. 26.) (Massive Open Online Courses) a term recently coined [18, 22] for this concept. This development has resulted in, for instance:

- Open access to research results such as Ph.d. theses, academic journal and conference proceedings.
- Open access sources for software and hardware.
- Other open educational material and resources.
- These concepts are also referred to as web based education and on-line education.

In this debate, it should be clear that the local instructor in the classroom is still a very important element in the education process. However there is no need to offer extensive classroom attendance with traditional methods where the professor draws on the blackboard every detail of his theories, although he may pace his presentation with the traditional "chalk and blackboard" approach, which however may be duplicated to a large extent on-line.

III. ON-LINE EDUCATION IN POWER ENGINEERING

In recent years the power engineering community has been searching for efficient ways to use the internet and information technology to enhance education in power engineering
Examples of such efforts are the University of Michigan [20] and University of Waterloo [17] which has been successfully offering an on-line MEng degree in Power Engineering for several years. Students are from all over the world, and as of 2013 over 120 students are in the program the program [7].

As of 2013 the University of Pittsburgh, Swanson School of Engineering is planning to open a program in power engineering. As stated on their web page [21]:

“...the curriculum is specifically crafted to address the needs of industry professionals and their employers, as well as recent electrical and mechanical engineering graduates...”

These cases are just two examples of the wide spread of distance education in engineering in general, and in power engineering in particular.

We next turn to the core topic of the paper, which is this author’s experience of teaching the power engineering courses at SENS on-line, as listed above.

IV. DISTANCE EDUCATION AT UI AND AT SENS

A. SENS policy making in power and energy

The SENS policy of power and energy has been to develop this field further by attracting faculty and students to specialize for the benefit of developing Iceland’s renewable energy resources. However, unfortunately, in early 2010, the UI Laboratory of electric machines (See Figure 2) was dismantled and closed down. This old lab included classical machines such as DC, Induction and Synchronous Machines. Certainly in need for some maintenance, after the long period 1977-2009 of 33 years it had however welcomed 518 electrical engineering students at UI who attended lab courses (more than 15 students per year) [9] during this period. It’s closure was certainly unfortunate and unwarranted, considering the future need of hands-on experience for future UI students for instance in the new environmental transportation nodes needs such as electric bikes, trains and cars in a country with an abundance of renewable, emission free energy.

Therefore it seems of utmost importance to develop new methods and approaches to attract new student to this field. Distance education is one possible such approach. A recent working group [18] has published a report on this subject.

We will now describe the experience of conducting two courses in this field in the form of distance education, on-line using internet resources.

B. The Electrical Machines Course (RAF601G), spring 2012

Traditionally, courses at UI had to be a specific number of lectures per week with classroom presence. Two courses were offered in the spring semester of 2012 at the Department of Electrical and Computer Engineering at the University of Iceland. We consider first the electric machines course with the course catalogue ID number RAF601G.

After 15 years of teaching this course in a traditional classroom setting, an on-line version was offered by the author in the spring semester of 2012 [8]. This demanded considerable investment, and a great deal of work, preparing different aspects of the course such as video lectures, and a way to present them to the students. A total of 11 students enrolled in the course and finished the written examination given at the end of the course on April, 27, 2012 at the University of Iceland campus in Reykjavik.

The principal aspects of the course, and its schedule, as presented on the web page for this course [8] were as follows:

- Classroom and weekly schedule. Originally two time slots per week were allocated in the class room in the schedule, totaling 5 x 40 minutes session per week with traditional classroom attendance.
- Video lectures and homework problems. The on-line version of the course was based on video lectures and face to face meeting with a local instructor in the class room - of 2 x 40 minutes per week - in addition to homework problems1.
- Total 14 week duration. The course lasted 14 weeks from January 9th to April 20th, 2012.
- Instructors. Instructors were professor Egill Benedikt Hreinsson (Distant learning resources), and Mr. Magnús Gíslason, as a Guest (Local) instructor in the class room.
- Textbook was: “Electric Machinery” by Fitzgerald, Kingsley and Umans (Referred to as “FKU”) [5] and covered chapters 1,3,4,5,6 and 7 in the book. Therefore chapter 2 on transformers was skipped as it had been covered in a course on Power Systems Analysis. See Table I for the course schedule.

1Unfortunately the laboratory part of the course, as indicated in Figure 2 had to be abandoned since the electric machines laboratory of Figure 2 had been dismantled as previously mentioned.

Figure 1. This Figure shows a sample of 16 of the total of 690 slides used in the Electric Machines course RAF601G taught a distance learning course in the spring semester of 2012 at the University of Iceland. Each of the 690 slides had an short associated audio/video clip as part of the video lectures. The total duration of video lectures was approximately 1600 minutes which corresponds to about 3 minutes per slide. The name of each video lectures is given in the 5th column in Figure/Table 3 and can be viewed on-line, [8] with the appropriate PDF slides in a piecewise manner as defined by the distance learning setting.
• Grades for the course were based 80% on the final examination and 20% on other factors consisting of home-work problems and/or computation projects. To pass the (partial) grade for the examination, the student had to reach 5 or higher on a grading scale of 0 - 10.

• Allocated hours. On the weekly schedule these hours are allocated for this course: Mondays at 10:00-12:20 (AM) and 13:20-14:10 (PM), Thursdays at 8:20 - 9:50 (AM). Classroom is in the 3rd floor in building VR2 on the UI Reykjavik campus.

• Total 14 week schedule. The following total schedule, as shown in Table I, was presented for the 14 week duration of the course:

<table>
<thead>
<tr>
<th>Item</th>
<th>Course Topic</th>
<th>Chapter</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Magnetic Circuits</td>
<td>1</td>
<td>2 weeks</td>
</tr>
<tr>
<td>2</td>
<td>Energy Conversion</td>
<td>3</td>
<td>2 weeks</td>
</tr>
<tr>
<td>3</td>
<td>General Machines</td>
<td>4</td>
<td>2 weeks</td>
</tr>
<tr>
<td>4</td>
<td>The Synchronous Machine</td>
<td>5</td>
<td>2 weeks</td>
</tr>
<tr>
<td>5</td>
<td>The Induction Machine</td>
<td>6</td>
<td>2 weeks</td>
</tr>
<tr>
<td>6</td>
<td>The Direct Current (DC) Machine</td>
<td>7</td>
<td>2 weeks</td>
</tr>
<tr>
<td>7</td>
<td>Special Machines</td>
<td>8</td>
<td>1 week</td>
</tr>
<tr>
<td>8</td>
<td>Review</td>
<td>9</td>
<td>1 week</td>
</tr>
<tr>
<td></td>
<td>TOTAL: 14 weeks</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Extensive e-mail communication took place between the instructors and students several times each week with home work assignments and links to web pages with video lectures solutions to last weeks problems etc.

The principal aspects were as follows: Again, there were 2 instructors: (A) The distance instructor and (B) Local instructor (Guest instructor). The distance lecturer (This author) was located away from the campus of UI at the time the course was given, but with good internet connection to carry out the distance education factor in this course.

Other principal features of the distance learning course were the following
1) Weekly packages. These packages sent to student each week contained the course material for all the previous weeks and new assignment and course material for the present week in question.
2) Powerpoint slides. New slides were posted in each weekly package and the student could view all older slides as well with the appropriate video lecture.
3) Video lectures. New video lectures were delivered on a weekly basis and the total duration of all lectures is about 1600 minutes or about 27 hours. This is - counting time/minutes - approximately equivalent to three sessions per week each with a duration of 40 minutes for the 14 week duration of the course $(3 \times 40 \times 14 = 1680$ minutes).
4) Home work assignments from distance instructor. Home work assignments (Problem solving sessions) where weekly homework was assigned to students and they submitted their solution back to the distance instructor.
5) Piecewise delivery of course material. In this author’s opinion, this was a very important element. All the course material including video lectures and home work problems were delivered weekly, where students would receive new video lectures for the current week and new home work problems by receiving a web page with links. These links included all new material and all old material for the previous weeks from the beginning of the course up to the current week.
6) Local guest instructor with face to face interaction and discussions/problem solving in class room with help in solving the home work problems and additional problem solving sessions. This way less time would be needed an face to face interaction than in a traditional setting. The extent of these sessions was 2 x 40 minutes per week.
7) Q&A and support sessions through e-mail. Frequent e-mail interactions was between me as a the primary instructor and the student. A total of 280 e-mails was exchanged between the distance instructor and the students in these 13 weeks. Many of these e-mails were group e-mails to all 11 students in the course.

In making videos of the distance instructor explaining the material on audio or video PowerPoint slides, great care was taken to explain the material in a similar manner as would be in the class room, so the student would gain a similar experience as if he/she was present in a classroom at the University of Iceland campus in Reykjavik.

As explained above, with the weekly packages, a total of 1600 minutes or approximately 27 hours of video lectures were delivered with sound power point type slides and where the number of slides were close to 690 available as PDF files. In addition home study assignments were in 40 home work problem sessions and with 52 demonstration examples. As previously explained, a local instructor was available each week for 2-3 hours per week for the 13 - 14 week duration of the course.

The course schedule is shown in Table/Figure 3 and the software used was for delivering the video lectures was Screenflow [2], Camtasia studio [1] and Emission [19] which is installed on many classroom computers at UI for overhead projection and available for UI faculty/instructors and thus part of the UI policy regarding electronic delivery of course contents.

C. The Electric Power Economics course (RAF610M)

This master level course was also conducted in the spring semester 2012 and was a so called "reading course", as the number registered students was less than the minimum limit set for "regular instruction". Therefore this course had no associated implicit class attendance. It was based on self study and the associated term projects where students did a short thesis, with computations and models in some cases.

The student/instructor interaction was therefore, traditionally in any case, almost entirely based on e-mail exchanges,
and therefore such a course was extremely well suited for distance education and very easily adaptable to this form of course delivery. The total number of students enrolled in this course in the spring semester of 2012 was 8 with "Fundamentals of Power System Economics" [11] as the textbook used.

D. General comments

The offering of these courses was at the time rather unusual at UI and comments and criticism are needed to conduct such courses in on-line form in the future, especially with reference to the course resources, as shown in Table I and Figure 3. It should be noted that UI has an explicit policy to implement distance education, although it may not be clear in all cases how such implementation is to be executed. It is hoped that the management of SENS will clarify the future policy regarding distance education courses in the future and how they should be conducted.

Finally it should be mentioned that this author received a grant from the Ministry of Education, Reykjavik and the former Rektor of the University of Iceland (UI) to conduct distance education courses in the case of the Faroe Island [14].

V. CONCLUSIONS AND DISCUSSION

A. Specific conclusions and suggestions

The following are the main conclusion of the experience with the distance education course:

<table>
<thead>
<tr>
<th>Week no.</th>
<th>Date</th>
<th>First Lecture</th>
<th>2nd Lecture</th>
<th>Video slide reference</th>
<th>Homework problems and due date</th>
<th>Textbook chapter</th>
<th>Solutions previous week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>9 - 13 Jan.</td>
<td>F01 Intro</td>
<td>F02 magnetic Circuits</td>
<td>F01a(1-41) F02a(41-51)</td>
<td>M1: 1.1, 1.5 og 1.16</td>
<td>Chapter 1</td>
<td>1/1 solutions</td>
</tr>
<tr>
<td>2</td>
<td>16 - 20 Jan.</td>
<td>F03 Magnetic Circuits 2</td>
<td>F04 Magnetic Circuits 3</td>
<td>F03a(1-5) F04a(1-8)</td>
<td>M2: 1.1, 2.2, 3.3</td>
<td>Chapter 1</td>
<td>1/2 solutions</td>
</tr>
<tr>
<td>3</td>
<td>23 - 27 Jan.</td>
<td>F05 Energy Conversion 1</td>
<td>F06 Energy Conversion 2</td>
<td>F05a(16-29)</td>
<td>M3: 1.4, 3.5, 6 og 3.14</td>
<td>Chapter 4</td>
<td>1/3 solutions</td>
</tr>
<tr>
<td>4</td>
<td>30 Jan - 3 Feb.</td>
<td>F07 Energy Conversion 3</td>
<td>F08 Energy Conversion 4</td>
<td>F07a(2) F08a(2)</td>
<td>M4 4, 3.16, 3.17</td>
<td>Chapter 4</td>
<td>1/4 solutions</td>
</tr>
<tr>
<td>5</td>
<td>6 - 10 Feb.</td>
<td>F09 General Machines 1</td>
<td>F10 General Machines 2</td>
<td>F09a(6-16)</td>
<td>M5 4.1, 4.2, 4.5 og 4.6</td>
<td>Chapter 5</td>
<td>1/5 solutions</td>
</tr>
<tr>
<td>6</td>
<td>13 - 17 Feb.</td>
<td>F11 General Machines 3</td>
<td>F12 General Machines 4</td>
<td>F11a(1-15)</td>
<td>M6 4.3, 4.8, 4.9 og 4.14</td>
<td>Chapter 6</td>
<td>1/6 solutions</td>
</tr>
<tr>
<td>7</td>
<td>20 - 24 Feb.</td>
<td>F13 Synchronous Machines 1</td>
<td>F14 Synchronous Machines 2</td>
<td>F13a(1-10)</td>
<td>M7 5.1, 5.3, 5.5 og 5.7</td>
<td>Chapter 7</td>
<td>1/7 solutions</td>
</tr>
<tr>
<td>8</td>
<td>27 - 2 Mar.</td>
<td>F15 Synchronous Machines 3</td>
<td>F16 Synchronous Machines 4</td>
<td>F15(1-17)</td>
<td>M8 6.1, 6.2 og 6.3</td>
<td>Chapter 8</td>
<td>1/8 solutions</td>
</tr>
<tr>
<td>9</td>
<td>5 - 9 Mar.</td>
<td>F17 Induction Machines 1</td>
<td>F18 Induction Machines 1</td>
<td>F17(1-15)</td>
<td>M9 6.5, 6.21</td>
<td>Chapter 9</td>
<td>1/9 solutions</td>
</tr>
<tr>
<td>10</td>
<td>12 - 16 Mar.</td>
<td>F19 Induction Machines 3</td>
<td>F20 Induction Machines 1</td>
<td>F19(1-17)</td>
<td>M10 6.2 og 6.3</td>
<td>Chapter 9</td>
<td>1/10 solutions</td>
</tr>
<tr>
<td>11</td>
<td>19 - 23 Mar.</td>
<td>F21 DC Machines 1</td>
<td>F22 DC Machines 1</td>
<td>F21(1-18)</td>
<td>M11 7.1, 7.3, 7.8 og 7.15</td>
<td>Chapter 7</td>
<td>1/11 solutions</td>
</tr>
<tr>
<td>12</td>
<td>26 - 30 Mar.</td>
<td>F23 DC Machines 3</td>
<td>F24 DC Machines 1</td>
<td>F23(1-10)</td>
<td>M12 7.1, 7.3, 7.8 og 7.15</td>
<td>Chapter 7</td>
<td>1/12 solutions</td>
</tr>
<tr>
<td>13</td>
<td>2 - 5 Apr.</td>
<td>F25 DC Machines 1</td>
<td>F26 DC Machines 1</td>
<td>F25(1-9)</td>
<td>M13 7.1, 7.3, 7.8 og 7.15</td>
<td>Chapter 7</td>
<td>1/13 solutions</td>
</tr>
</tbody>
</table>

Figure 2. This laboratory for electrical machines at the University of Iceland was unfortunately dismantled and closed down in 2010 in order to use the 50m² space as a classroom for regular lectures. The machinery was put in storage and the plan was to establish a new laboratory at a new location near Keflavik airport so students could take the bus there from Reykjavik to attend laboratory sessions. Unfortunately this as not yet happened and the apparatus of classical electrical machines is currently inactive in storage waiting for new opportunity - or to be scrapped. Unfortunately, there are considerable costs associated with reopening such a lab, with these classic machines - or new machines. Fortunately, it is an open question how UI is going to meet this need for future needs for hands-on training for future engineers that need to be well versed in electrical transistors, elect cars, electric bikes and designing and operating future transportation systems in Iceland and elsewhere. It is this authors opinion that Matlab™ simulations (Although very useful) are not sufficient in educating electrical engineering students in this respect.

Figure 3. This table shows an example of the weekly schedule for the Electric Machines course RAF601G in the spring semester of 2012 for the 13th of the 14 week duration of the courses. The packages delivered to students for other weeks were similar, containing links to all material for the current and previous week. These "packages" were delivered over the Internet each week with links to PDF slides, videos and new weekly homework problem. Also solutions to the problems from the week before were delivered each week. The columns contain from left to right: Week number, dates, links to PDF files and slides for the first lecture of each week and subsequently the same for the 2nd lecture. There were links to videos explaining the slides and the number of slides in each video session. Next are links to homework problems for the week, then instructions on which chapter to read in the textbook for the week and finally solutions to the homework problems for the week before. Unfortunately this delivery on-line was terminated around Week 13 (of the total of 14 weeks). Reference [8] is the link to the web page with this information. Note again, that each week a new web page was presented to the students with all links of the previous weeks and links to the current week’s assignments added, but links, files, videos etc. for future weeks were not displayed, although general plans were set forth for all weeks from the beginning of the course.
The local instructor is a very important element where discussion and face to face interaction between student and instructor is provided with a framework for the student with personal communication to be established. In the course about 2 - 3 sessions, each of 40 minutes were provided each week.

The required extent of such meetings with the local instructor are reduced when compared to the traditional form - with traditional lectures that are given in class room based instructions. There seem to be no urgent need for a full number of hours per week of traditional lectures, when such lectures are provided on-line by video, explaining in detail similar features as given in class room lectures. With modern internet based technology, and using media such as power point slides with audio/video (See Figure 1) these presentations can replace to a large extent traditional lecture room sessions.

University of Iceland (UI) and its administration, has set the goal to be among the top 100 universities in the world [15] in the near future. The SENS policymaking, as discussed in this paper, in particular regarding power and energy, should try to overcome the obstacles regarding the above goal by increasing the use of on-line education and other modern technology based means to reach the above goal. Therefore SENS should not try to ban distance education methods, when they are used with an appropriate share of face to face contacts and meetings with an experienced local instructors. SENS should perhaps rather encourage faculty in utilizing multimedia and information technology, such as video lectures, on-line text discussions and even face to face discussion in and out of the classroom. But the important student-teacher relationship should always be borne in mind, with the appropriate encouragement and demand to the student.

UI should attempt to accelerate the implementation of this policy on distance, web based, education to mitigate the uncertainty and danger, regarding the legal and regulatory framework that instructors and faculty are exposed to, when trying to initiate innovative featured in their instruction methods, such as those based on distance education and internet based instruction, as exemplified by the courses described in this paper. For instance, a court order should not be necessary for professors when they try to initiate novel methods of tuition utilizing modern information technology.

ACKNOWLEDGMENTS

The author would like to thank the following people: Dr. Gíslí Már Gíslason, Mr. Magnús Gíslason (Guest Instructor), Dr. Kristján Jónasson, Dr. Jónas Elísson and all the people at the University of Iceland for their helpful discussion and support regarding the implementation and aftermath of the controversial on-line courses in electric power and energy in the spring semester of 2012, as discussed above.

REFERENCES

[16] University of North Dakota. Bachelor of Science in Electrical Engineering. Internet site. URL http://distance.nd.edu/degree/?id=electricalengs.
[17] University of Waterloo. MEng Electric Power (online). Downloaded from website, February, 7 2014. URL https://uwwaterloo.ca/electrical-computer-engineering/future-graduate-students/meng-electric-power-online.