Educational Methodology  
in Electrical Power Engineering

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Abstract- This paper presents an educational approach to enhance engineering thinking of undergraduate students in the department of electrical power engineering at Yarmouk University. The available software and hardware tools are utilized to improve the way of teaching the theoretical courses, laboratories and other graduation requirements, such as graduation projects and field training. This method is aimed to provide students with the mature way of thinking and decision making for problems faced in their engineering life. In addition, the market will be provided with electrical power engineers having high ability to design and modify products.

Keywords - Electrical Power, Engineering Education

I. INTRODUCTION

The curriculum of power engineering department at Yarmouk University in Jordan [1] is designed to promote the student's ability to deal with technological aspects using decision-making tools and to solve encountered problems following engineering processes. Each course in the curriculum is carefully designed to match the industry market demand and the international standards of engineering education, like ABET standard. In fact, major improvements on the contents are applied every five years. The staff members in the department are divided into groups of different specialties to investigate the changes in the market need, the new technological aspects, up to date educational tools and curriculums of well known electrical engineering departments in the world. These sectors are incorporated in a professional way to provide each improved (or new) course. General meetings are then carried out to discuss the results of each group for each course's contents. In this year, the third major improvement on the curriculum is applied and the final form is published. To acquire mature engineering curriculum, non-technical components are enhanced, especially elements lead to improvements in communication skills and quality control.

This paper presents an educational method applied to undergraduate students in electrical power department. The main target of the approach is to motivate students to achieve professional work methodology [2-4]. This method enhances student's ability to work in a group and also provides a student with an experience to deal with any type of technological problem in a systematic way. In other words, the proposed method is aimed to bring the real world to the lecture room (or the laboratory) using certain tools to make decisions and working as a team.

The general steps in applying the teaching method are problem definition, data collection and analysis, evaluation of student's work and finally conclusions. Power electronic laboratory course is considered in this paper to describe the approach in more details.

II. PROBLEM DEFINITION

In the first meeting of power electronic laboratory, the course's instructor spent approximately one hour to explain the method in teaching the laboratory, motivates students for critical thinking and independent learning of the needed skills. Moreover, students are encouraged to carry out analysis, working in groups and make decisions. The instructor tries to put students in the real company environment, where a student is considered as a specialized engineer in setup power electronic circuits. Therefore, students should feel that they have to learn how to carry out simulations, assembling the required circuit and do practical test, proposing solutions to avoid mistakes. In addition, a student should provide report to the company manager (laboratory instructor) for each designed experiment. Suggestions made by students are beneficial in avoiding mistakes and providing guidelines for students in the following semesters.

III. DATA COLLECTION AND ANALYSIS

In power electron laboratory course sixteen three-hour sessions are planned to be utilized during the semester. In the first session, students learn how to use laboratory tools (oscilloscope, multi-meters, power electronic components, triggering circuits, etc.). During this session the instructor advises students for self learning of the required simulation package; usually Simulink / Matlab software package is adopted. The students follow the course syllabus provided by the instructor.

Second to sixth sessions students have to carry out simulations for each experiment concerning with uncontrolled AC/DC converter circuits. Simulations are usually performed as pre-lab requirement (homework) for each session. During the laboratory session, students have to setup the needed converter circuit, collecting data and writing down any facing problem and number of times the problem occurred. Once the supervisor approves the circuit setup the student's group carries out the required practical tests, obtain the experiment's results, applying analysis on the obtained results and give useful recommendations for future. During sessions seven to fourteen students follow similar procedure for controlled
AC/DC converter circuits. Triac circuits are treated in session fourteen to sixteen.

IV. EVALUATION OF STUDENT’S WORK

For each session of the laboratory, a student has to submit a report including simulation and practical results, discussion about the experiment, comments and recommendations. The instructor marks the reports between 0 and 10 based on the evaluation of the following skills: data collection, problem analysis, team work, decision making and writing ability.

V. CONCLUSIONS

The course’s instructor gives guidelines based on the solutions proposed to be considered by students and instructors in the following semester. In addition, the instructor considers the comments and proposed solutions made by students to improve the course. The teaching method is evaluated by students at the end of each course and the course’s instructor is aware of student ideas and their suggestions for continuous improvements.

VI. RESULTS

Table 1 presents the mistakes faced when the methodology is utilized to teach the course power electronics laboratory in the first semester last year. It can be seen that most mistakes are due to human errors, which include measurement and computational errors. Moreover, it is found that students have mistakes when carrying out simulations as pre-lab requirement. The second important error source is the errors in laboratory equipment, especially oscilloscopes and probes. It is believed that equipment aging and inaccurate calibrations lead to this error type. Several groups proposed different solution to minimize or overcome the errors faced. The author believes that the methodology is providing a strong link between electrical power engineering and decision making. This will provide students with high ability to deal with research and problems they may faced in their future engineering life. Evaluation of the applied teaching method by students is tabulated in table 2. It can be observed that the implementation of the approach is good (70 – 79 %). Improving the methodology is achieved by continuous modifications applied to documentation, equipments, simulation practice and instructor work.

Table 1: Error classification

<table>
<thead>
<tr>
<th>Error Classification</th>
<th>Observations %</th>
</tr>
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<tbody>
<tr>
<td>Human</td>
<td>45</td>
</tr>
<tr>
<td>Equipment</td>
<td>25</td>
</tr>
<tr>
<td>Time</td>
<td>10</td>
</tr>
<tr>
<td>Documentation</td>
<td>16</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2: Evaluation of the educational approach

<table>
<thead>
<tr>
<th>Students No.</th>
<th>Evaluation %</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>90 – 100</td>
</tr>
<tr>
<td>15</td>
<td>80 – 89</td>
</tr>
<tr>
<td>20</td>
<td>70 – 79</td>
</tr>
<tr>
<td>1</td>
<td>60 – 69</td>
</tr>
<tr>
<td>1</td>
<td>50 - 59</td>
</tr>
</tbody>
</table>

Student suggestions and instructor guidelines, which are set to improve documents, give rise to the following actions:

- Arrange simulation (pre-lab) results and the corresponding experimental results on the same page and at the same time the same scale is used for both types of results. This provides an easy comparison and good visualization for the results.
- A check sheet is made to facilitate data collection and to train student for the use of data sheet which is used in the industry.
- Guidelines for laboratory sessions were written in clear way, where more explanations are added

Concerning with simulation practice, student are asked to work in PC laboratories outside the laboratory sessions and moreover instructors help students in learning the right way in carrying out simulations. The results last semester show that number of students who do professional simulations for the required experiment is increased.

To minimize the gap between the industry and university, instructors try to maintain continuous relation with different industrial companies in the country. Moreover, they try to expose students to real industrial problems during the courses. Students have to spend six months in a factory as field training course. During this period, university supervisor try to focus on the relationship between university courses and real industrial problems.

VII. PAPER CONCLUSIONS

The application of the proposed approach has proved as a powerful tool in reducing the gap between university teaching and real engineering life. Moreover, student contribution and satisfactions have moved up. The increased demand for our fresh graduates by national and regional companies proves that the objectives of the teaching approach are satisfied. The other interesting result is that several graduates acquired high ranks, in the national and regional companies they work with, in a very short time. Based on the feedback made by the department’s graduates and industry, modifications on the curriculum are made, for example the elements which deal with soft skills and management have been increased.

REFERENCES

