Online Assessment of Practical Knowledge in Electronics Laboratory

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Abstract—**Increasing globalization and opportunities for engineers around the world to work or study anywhere mean challenges for universities wanting the best students as well as for the companies wanting for the most skilled staff. The social and economic conditions of the country where the student has studied have an impact on his level of knowledge though the attained degree is similar in all countries. It is not enough to use scores as a base for decisions. Some tests for software courses, English language etc. exists. Now the challenge is to design and implement a common test to analyze the knowledge of the student/ test taker and certify him in performing laboratory work and operating electronic instruments. A solution to overcome the problem of recruiting companies in this global market as well as the universities to select the meritorious from worldwide would be by implementing a Common Electronics Lab Operation Test. A test with the operation of the equipment in electronics laboratory has importance as test takers are tested in their knowledge with practical equipment using simulated and remote labs which are identical to the operation of real. The testing system is proposed to be developed using latest remotely operated real labs.**

Keywords-knowledge Engineering; testing;

I. INTRODUCTION

Thousands of students are graduated with a bachelor degree in Engineering/Technology from universities worldwide every year. Increasing globalization make engineers work or apply for master studies anywhere in the world. This makes it necessary to evaluate the technical skills of the engineers. There are a wide range of universities worldwide where many of the students attain the same qualification at the end of their course but their technical skill might not be equal. This motivates to establish a common knowledge level for all electronic bachelor degrees worldwide. There are a number of exams available for testing theoretical knowledge. A survey of such tests and the reasons for testing practical skills is explained in the next section. Section III illustrates the present and future trends in laboratory facilities. The Proposed system of assessment defined in section IV is a solution to evaluate the practical skills of the students and its implementation part is described in section V.

II. PRESENT WAY OF TESTING SKILLS FOR ADMISSION TO HIGHER STUDIES IN DEVELOPED COUNTRIES.

At Present for assessing the student's knowledge for master studies many universities consider GRE, GMAT, and TOEFL/IELTS. IELTS/TOEFL is used to test the skill of the test taker to speak in English as a foreign language [1]. These tests help the student to develop the test takers speaking as well as essay writing in English language [2]. This test is necessary as the student from a different geographical place has a local language and his adaptability to sustain in other country is to be analyzed. GMAT measures the verbal, math and analytical skills of the student which is really required for a MBA admission [3]. GRE General Test which is considered as an admission criteria for many Engineering courses in some of the developed countries analyzes student's verbal and quantitative ability [4].

GRE subject tests are available to test the knowledge in 8 specific fields of study such as Physics, Math, and Computers etc. These subjects are multiple choice questions [5]. The GRE subject test is a good solution for analyzing the technical knowledge but it does not consider the practical ability of the engineers to develop experiments. This exam does not use any simulated environment for testing the test takers practical knowledge.

GRE General Test has nothing to do with the students Engineering discipline or his technical competence in his field of study. The score in this test is based on high English vocabulary and math.

Many industries have a grading scheme which applies for applicants depending on their scores. This hurdle has been overcome by many software industries which have implemented certifications for instance CCNA [6], ORACLE, DBMS, Lab View, etc.

III. PRESENT AND FUTURE TRENDS OF LABORATORY FACILITIES IN EDUCATIONAL INSTITUTIONS:

There is a vast development in the field of technology which has its impact in the field of education. In Electrical Engineering education from many years traditional laboratory equipment are being used such as oscilloscopes, function generator's, multlimeters, components, breadboards etc. In the coming years the traditional laboratories all over the world will be offered online (most of them at present are replaced by the simulated lab benches) which is really a good trend [7]. This helps the experimenters to analyze and understand the behavior of the circuit in a better way and gives the possibility to experiment as he likes by just making a circuit of his interest, adding the components from the components palette provided by the software and run to check its output. This decreases cost, increases time flexibility for making experiments and better research capabilities by analyzing circuits with many options, individually or by a group [8].

IV. DEFINING THE TEST:

A certifying test in electronics laboratory has very high importance as it does not contain theory or a multiple choice question like many other examinations. Here the test takers will be tested in their knowledge with practical equipment. The test taker can clear this exam if and only if he has sound knowledge in using the laboratory equipment. In this proposed exam there are three levels of knowledge testing, Basic, Advanced and Professional.

A. Description of the proposed levels of the exam

Basic level: Here the test taker is checked with his knowledge in basic circuits. His practical knowledge is tested by giving the circuits with errors and asking him to correct the circuit to generate output.

Advanced level: Here the test taker has to configure the circuit by him. His practical knowledge is checked in configuring the circuits himself and generating output.

Professional level: In this level the test takers are asked to correct the circuits and also configure them. The level of complexity increases.

B. Syllabus for the proposed tests:

Basic level: Any test takers with a passion towards electronics and his interest towards developing electronics can take this exam. In general this part of the exam focuses on the characteristics of diodes, transistors, oscillators, Rectifiers, operation of Oscilloscope and Function generator etc.

Advanced level: This level has an eligibility condition that the test taker has a qualified bachelor's degree (Electronics) or he has cleared the basic level in this exam. This part of the exam focuses on clippers, clampers, gates, OP AMP, characterizing LED's and timers etc.

Professional level: This level has an eligibility condition that the test taker has a qualified bachelor's degree (Electronics) and cleared the advanced level of the proposed exam. This part focuses on overall syllabus from prior two levels including with Flip Flop, shift registers, logical operations such as converting of ASCII to BCD vice versa and micro controller programming.

These tests provide the test taker with an assessment to his knowledge in operating the electronic laboratory equipment. Passing this exam gives electronic professionals the chance to prove their practical knowledge in operating electronic instruments and expertise.

V. IMPLEMENTATION OF THE PROPOSAL:

This approach of testing can be done using simulated and remotely operated real work benches. Primarily let us consider the reasons whether to use a simulated approach as a solution for this proposed exam or a remotely operated real lab.

Simulated labs already exist from long time based on mathematical calculations. These labs are virtual and made up of software simulations during the last decades simulated labs are encouraged in Engineering education due to the fact that the traditional labs are costly to implement and maintain and also due to the belief that they can replace the real labs [9].

Real labs are indispensable in Engineering Education as a means of developing skills to develop with physical process and Instrumentation. Remote labs have proven valuable for a more efficient exploitation of laboratory resources and can be shared among participants form different places. Having the remote experiments ready all the time, the remote lab concept also provides a tool to sustain the shift towards a student – centric teaching approach, which is more and more relevant in higher education, nowadays [10].

In this proposed assessment of practical knowledge using real labs, the authors are considering 5 real labs such as VISIR, REL, WebLab-Deutso, iLabs etc and a brief description of their functioning is given as follows. One good example of remotely operated real lab is "VISIR System" developed by the Open Labs, BTH [11]. The only difference between this remotely operated real lab and traditional lab is that the student can not feel the instrument by touching it. Virtual front panels of the instruments in the laboratory are displayed on the student's computer screens

which make the students feel as if they are using traditional laboratory.

1) Brief description of the open labs electronics laboratory in BTH, Sweden

Here we can find all the resources needed to make electronic experiments, right here in the browser. As shown in Figure 1 all the basic equipments such as oscilloscope, multimeter, function generator, power supply and a number of electronic components are supplied where it is possible to build circuits on virtual breadboard [12]. The circuits built on the local client software are sent to the server and the measurement is done on the real equipment and the measurement results are displayed [13].

Figure 1. VISIR system developed by BTH,SWEDEN

2) Brief description of the WebLab-deutso in University of Deutso, Spain

WebLab-Deusto is an open-source distributed Remote Lab continuously developed at the University of Deusto. It makes possible to do real experiments with FPGA, CPLD, PIC microcontrollers, etc to a certain group of users through any computer network, such as Internet. The experience of using the experiments remotely is exactly the same as using them in a traditional laboratory. The Figure 2 below shows a webcam image of the CPLD being operated remotely and its display to the experimenter [14].

Figure 2. Web cam image of the remotely accessible lab developed by WebLab-Deutso.

3) Brief description of the iLabs in MIT, USA.

iLabs provides an open portal to selected remote laboratories and is developed at the MIT University, USA sponsored by Microsoft Corporation. It makes possible to do real experiments with Microelectronics Device Characterization, Dynamic Signal Analyzer, Microelectronics Device Simulator, etc to a certain group of users through any computer network, such as Internet. The experience of using the experiments remotely is exactly the same as using them in a traditional laboratory. The vision of iLab is to create a worldwide network of shared laboratory instruments and educational materials [15].

4) Brief description of the Remote Electronic lab and Remote Lab for E-Learning in Microprocessors.

The ~~–~~Remote Electronic Lab" (REL) is a system for carrying out electronic experiments via the Internet in the context of distance education. It is based on remote control of real laboratory instruments. Figure 3 displays the image of the electronic instruments that are connected to the server to operate remotely.

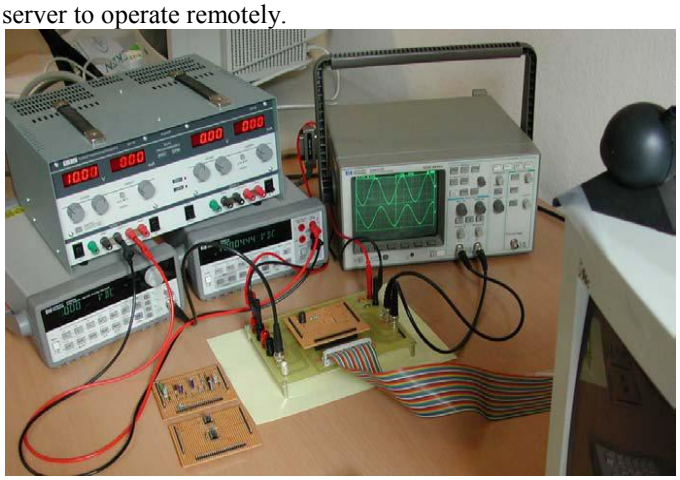

Figure 3. Remote Electronics Lab at CUAS

The Figure 4 consists of a microprocessor remote lab which was developed for the presence learning and teaching as the starting point. The mock-up was used to implement Problem Based learning methodology in both undergraduate and master subjects [16].

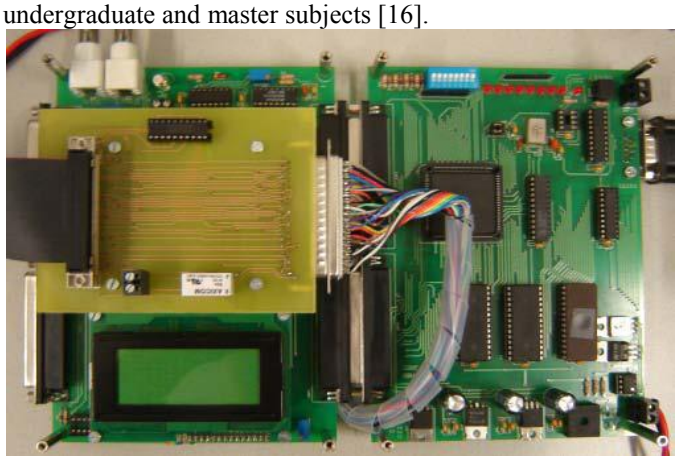

Figure 4. Web image of a Micro Controller that can be accessed remotely

In face to face learning environment users in remote are allowed to download their own code, monitor and control the registers, memory contents, executing the program and reading the display output for example pressing a key on the keyboard and observing the response of different switches.

This exam can be implemented by the engineering associations such as IAOE –The International Association of Online Engineering" & IEEE –Institute of Electrical & Electronics Engineers" combined together formulate syllabus for different levels of certification. Depending on the qualification of the test taker as electronics engineer the level of certification is assigned (for instance bachelor or master etc.) The syllabus in general is the course curriculum the student has studied for attaining the degree.

VI. ADVANTAGES

International online laboratory skills testing exam will be a valid and reliable indicator of true skills in electronics laboratory for education, professional accreditation and is very helpful in succeeding as a professional in the electronics laboratory for experimenting with the electronic equipment and provide measurable benefits to the employer. This type of exam or certification helps the test taker to differentiate him with others with the similar qualification in the present global market as well as improve his practical skills.

For E-Lab professionals each certification level signifies a benchmark of experience and expertise recognized with the electronics industry. The proposed certification exam validates the ability of the test taker to install, configure, operate, and troubleshoot with the electronic equipment, including implementation and verification of connections to various electronic components. Earning certification adds credibility to test takers expertise in using the electronic equipment. For organizations and hiring managers, certification can be a credible prerequisite to identify the expertise for hiring, promoting, and outsourcing decisions. This test certifies that that the test taker is technically competent to handle with the electronic instruments so as to promote sustainable society.

VII. CONCLUSION

The concept of evaluating skills of individuals from different countries and providing opportunities based on their knowledge exists since long time and now is the time to extend it to the electronics engineers. This proposed test brings valuable knowledge outcome from the students, rewards to electronic professionals and the companies employing them, the universities admitting them and Research oriented institutes to access the applicant's knowledge in the area of Electronic design and implementation. The fruit of knowledge grading through individual subject related examinations which is presently enjoyed by many software companies should not be limited to their industry itself but to be extended to other core fields such as electronics, mechanics, chemical, electrical, etc. This test enhances skills of electronic professionals which is a benefit for both the employee and employer. Through this paper the authors try to get it to the notice of the engineering organization worldwide that the time has come to develop qualitative engineers and to promote sustainability.

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REFERENCES

[1] www.ets.org/toefl/

[2] http://www.ielts.org/

[3] http://www.mba.com/mba/thegmat

[4] http://www.ets.org/gre/general/about/index.html

[5] http://www.ets.org/gre/subject/about/

[6] http://www.cisco.com/web/learning/le3/le2/le0/le9/learning_certification_type_home.html

[7] Z. Nedic, J. Machotka, and A. Nafalski, –Remote Laboratories Versus Virtual and Real Laboratories," *Proc. 33rd ASEE/IEEE Frontiers in Education Conf.,* Nov. 2003.

[8] J. Ma and J.V. Nickerson, –Hands-On, Simulated, and Remote Laboratories: A Comparative Literature Review," *ACM Computing Surveys,* vol. 38, 2006.

[9] http://www.eta-i.org/index.html

[10] Luis Gomes and Javier Garcia-Zubia: "Advances on remote laboratories and e-learning experiencs" University of Deusto, Bilbao, Spain, 2007, ISBN 978-84-9830-077-2, pp. 15 – 36.

[11] http://openlabs.bth.se/electronics/

[12] I Gustavsson, "A traditional electronics laboratory with Internet access", Proceedings of the International Conference on Networked e-learning for European Universities in Granada, Spain, 23 - 25th November 2003, ISBN 9090175148 - Publisher EUROPACE.

[13] I Gustavsson, "Traditional Laboratory Exercises and Remote Experiments in Electrical Engineering Education", Proceedings of the ICEE 2003 Conference in Valencia, Spain, July 21 - 25, 2003.

[14] Javier García-Zubia, Ignacio Angulo, Unai Hernandez, Pablo Orduña, –Plug&Play Remote Lab for Microcontrollers: WebLab-DEUSTO-PIC",7th European Workshop on Microelectronics Education May 28–30, 2008, BME – Budapest, Hungary.

[15] Jiwaji, A., Hardison, J., Ayodele, K., Tickodri-Togboa, S., Mwambela, A., Harward, J., del Alamo, J., Harrison, B., Gikandi, S. "Collaborative Development of Remote Electonics Laboratories: The ELVIS iLab." ASEE. June 14, 2009. Austin, TX

[16] Auer, M.E.; Gallent, W.: The –Remote Electronic Lab" as a Part of the Telelearning Concept at the Carinthia Tech Institute, Proceedings of the ICL2000, Villach/Austria, 28./29.09.2000