SUBJECT BENCHMARK STATEMENT

IN

ELECTRICAL ENGINEERING

Quality Assurance and Accreditation Council
University Grants Commission
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CONTENT

FOREWORD

The work in connection with the development of Subject Benchmark Statements was begun in August 2003 as a part of the overall quality assurance framework that supports academic standards and the furtherance and dissemination of good practice in Universities in Sri Lanka. Subject Benchmark Statements will support and promote quality and standards by:

- Providing universities with a common and explicit reference point for internal and external programme approval and review;

- Guiding and promoting curriculum development, especially in new departments and new universities, and in other institutions of higher education;

- Evolving over time to take account of changes and innovations that reflect subject development and new expectations;

- Providing an authoritative and widely recognized statement of expectations of what is expected of a graduate in a specific (or designated) subject area in a form readily accessible to students, employers and others with a stake in higher education;

- Providing a clear and transparent reference point for External Examiners;

- Assisting international comparison and competitiveness of higher education awards and student achievement.

SUBJECT BENCHMARK STATEMENT
ELECTRICAL ENGINEERING

1. INTRODUCTION

1.1 Subject Benchmark Statement – Scope and Purpose

Subject benchmark statement is a layout of expectations to assure the quality of the programme while fostering the systematic pursuit of improvement in the quality of education that satisfies the need of constituencies in a dynamic and competitive environment. In addition, Subject benchmark statements clearly specify the nature and the academic characteristics as well as the required standards of the programme whilst making reference to professional standards required by the external professional or regulatory bodies in the discipline. Subject benchmark statements in general allow for flexibility and innovation in programme design, within an overall conceptual framework established by an academic community.

Subject benchmark statements for Electrical Engineering are intended to assist those involved in programme design, delivery and review. These statements may also be of interest to potential employers, professional or regulatory bodies in the discipline and prospective students, seeking information about the nature and standards of programmes in the subject area of Electrical Engineering.

Subject benchmark statements for Electrical Engineering primarily specify:

- nature and extent of the subject
- programme objectives
- intended learning outcomes (subject knowledge, skills and attitude)
- teaching learning and assessment strategies
- strategies of quality management and quality assurance

and provide:

- reference points for getting approval of new programmes
- mechanism of achieving programme objectives
- framework of ensuring intended learning outcome
- reference points for making judgments on academic standards during review process
- information on the anticipated standard and qualities of graduates from employers
- requirements from professional or regulatory bodies

1.2 Level of Teaching

Electrical Engineering degree programme must be a four year full time degree programme taught at special degree level.

1.3 Nature and Extent

The precise definition of the term Electrical Engineering is not universally agreed upon. However, Electrical Engineering is an engineering field that deals with the

study and application of electricity, electronics and electromagnetism. The field first became an identifiable occupation in the late nineteenth century after commercialization of the electric telegraph and electrical power supply. It is the engineering specialty that has grown the most in recent decades. The field now covers a range of sub-studies including those that deal with power, electronics, control systems and telecommunications. Even subspecialties may include computer engineering, microwave engineering, communications, network engineering and digital signal processing.

Since there is no commonly agreed definition for Electrical Engineering, the content of the curriculum may be different in different universities and may change from time to time even in a given university. Therefore, the subject benchmark statement is formulated in general term considering common elements across all Electrical Engineering degree programmes.

The structure of the curriculum must provide both breadth and depth across the range of Electrical Engineering topics implied by the title of the programme. The curriculum must be focused on application of scientific and engineering principals to the solution of practical problems of the general area of Electrical Engineering systems and process. Moreover, it must emphasis on the relevance of theory and analysis including the ability to develop and use theoretical models from which the behaviour of the physical world can be predicted. Each course should embody and integrate theoretical, practical and project work commensurate with the level of study being pursued.

Curriculum can be open or close in structure. The close structured curriculum ensures that the student has reached the required level of knowledge, skills and training of the specified curriculum. However, in the open structure, it must meaningfully allow a student to decide his individual aspirations by allowing him to specialize in his preferred discipline within the Electrical Engineering stream by permitting him to choose technical modules from a pool of listed elective modules. On the other hand, pre-requisite constrains need to be carefully regulated to ensure that a student acquires a right blend of knowledge, skills and training in every area of specialization.

1.4 Scope of Employment of Learners

The scope of employment is depending on the curriculum that the students have followed. Students who have followed closed structured curriculum are guaranteed the job in their area of specialization depending on the job market for the specific specialization. However, students who have followed the open structured curriculum have less opportunity to find the job in their area of specialization compare to other students. However, since their curriculum is open, they are able to find jobs in general area of Electrical Engineering ranging from Electrical Power, Electronics, Automation, Telecommunication and Software Engineering.

2. SUBJECT AIMS

The major aims of the Electrical Engineering degree programme shall be as below:

- To provide the student with a breadth and depth of knowledge in the broad area of Electrical Engineering.
- To equip students with analytical skills such that they could analyze a practical problem in the broad area of Electrical Engineering and come up with feasible solutions.
- To provide the student with the skills to adapt to the rapidly changing nature of these fields in terms of technology.
- To put forward programmes which are of high quality, current and responsive to the needs of students' society to achieve their goals and lead productive lives in a global society.
- To improve students critical thinking skills along with proficiency in communication and IT.
- To promote and enhance partnership with industry and the community to respond to the technological and economic development of the country while improving the living standards of the people.

In addition, the institution shall aim for the following goals in order to maintain the quality and stability of the programme:

- Obtaining national and international recognition to the programme.
- Improving social harmony among students, staff and the community.
- Creating systematic policies and mechanisms which improve the functionality and stability of the programme.

Curriculum Structure and Content

As we have discussed earlier, different universities are offering different curriculum content to meet their subject aim in Electrical Engineering. In general context, we can list out the range of sub-studies under the Electrical Engineering curriculum as given below:

- Electrical Power Engineering
  - Power Generation and Transmission
  - Energy System and Planning
  - Electrical Machines and Drives
  - High-Voltage Engineering
  - Power Electronics
  - Renewable Energy Systems
- Electronic Engineering
  - Analog and Digital Electronics
  - Microelectronics
  - Photonics
  - Embedded systems
- Automation Engineering
  - Control Systems Engineering
  - Robotics
  - Mechatronics

  - Artificial Intelligence
  - Neural Networks
- Telecommunication Engineering
  - Wireless communication
  - R/F, Microwave Engineering
  - Network Engineering
  - Signal processing
- Biomedical Engineering

Since the scope of the Electrical Engineering is broad based, it is not easy to incorporate all the mentioned content under a single curriculum. Therefore content could be adopted to suit the nature and objectives of the Electrical Engineering degree programme offered by the institution.

In Sri Lankan universities, all the engineering programmes are offered under the course units system. Therefore, it is appropriate to define the course outline based on the course unit (credit) system. Overall we can state the requirements of the programme harmonized with the Institution of Engineers Sri Lanka (IESL) accreditation requirements. Hence the Electrical Engineering Degree Programme must include

- An in-depth core covering an appropriate content from above areas to meet the objectives of the programme.
- A minimum of 150 overall **academic credits*** including the industrial training components.
- A minimum of 25 credits from mathematics, basic sciences and computing.
- A minimum of 75 credits from Engineering Sciences pertinent to the discipline and Electrical Engineering Design.
- A minimum of 20 credits for the studies in management, engineering economics and communications and 10 credits in humanities, social sciences, art and professional ethics.
- Project or research work with the minimum 6 credits.
- Minimum 20 weeks (5 credits) industrial training.

* ***Academic credit***

For an academic activity that is granted academic credit and in which the number of hours associated with it corresponds to the actual contact time of that activity, such as lectures, tutorials, laboratory, design or field work, an active hour is defined as

- *One hour of lecture*
- *Two hours of tutorial, laboratory, design or field work*

One active hour continued over the duration of a semester (about 14 weeks) is defined as an academic credit. For activities in which contact hours cannot be used to properly describe the extent of the work involved, such as project study, work camps or industrial training, the following definitions are used for an academic credit.

- *One week project study*
- *Two weeks work camp*
- *Four weeks industrial training*

The curriculum should be structured of providing an in-depth core of scientific and technical contents together with a sufficient breadth of experience in complementary studies, consisting of humanities, social sciences, arts, management, engineering economics, and communication, in order to ensure ongoing awareness of these disciplines. It is appropriate for the programme structure to be designed in such a way that it gives a progressive shift of emphasis from engineering science and principals in the early stages to more integrated studies in the final stages.

Mathematics should include appropriate elements of linear algebra, differential and integral calculus, differential equations, complex variables, probability & statistics, numerical analysis and discrete mathematics.

Engineering science subjects pertinent to the discipline would normally have their roots in basic sciences and mathematics, but carry knowledge further towards creative applications. They may involve the development of mathematical or numerical techniques, modelling, simulation and experimental procedures. Application to the identification and solution of practical engineering problems need to be stressed. In addition to engineering science subjects pertinent to the discipline, the curriculum must include engineering science content that imparts an appreciation of important elements of other engineering disciplines.

The curriculum must end with a significant design experience that is based on the knowledge and skills acquired in earlier coursework. Such a project could give the student an exposure to the concepts of teamwork and project management. Whilst group projects, such as in design exercises, may be appropriate for work in earlier years, the final year project is required to demand individual analysis and judgments. Even though work may be carried out in small groups, the students should be assessed independently.

While considerable flexibility is offered in the choice of suitable courses for complementary studies component of the curriculum, some areas of study are considered to be essential in the education of an engineer. Accordingly, the curriculum must include studies on the impact of technology on society, engineering economics, and subject matter that deals with central issues, methodologies and thought processes of the humanities and social sciences.

Industrial training in a practical engineering environment, directly assisting professional engineers, would give the student a valuable insight into professional practice. Such experience would complement the formal studies at the educational establishment, and should ideally consist of several different types of experience. This must include practical experience in the basic manufacturing and construction techniques applicable to the student's chosen discipline of engineering. The opportunity to observe human and industrial relations, job organization, maintenance, safety and environmental procedures from the point of view of the general workforce is an important component in the early preparation for a career as a professional engineer.

3. SKILLS AND ATTITUDES

3.1 Skills

Skills describe what students are expected to know or be able to do from the programme by the time of Graduation. While some skills are confined to the discipline, some other skills are generic. Here the expected skills are provided under the subject specific skills and the generic skills, respectively.

3.1.1 Subject Specific Skills

- Ability to apply the knowledge of mathematics in science and engineering.
- Ability to display a depth and breadth knowledge in the broad area of Electrical Engineering.
- Ability to identify, formulate and solve problems.
- Ability to design and conduct experiments as well as to analyze and interpret data.
- Ability to design, implement and test a system or component.
- Ability to innovate and devise novel products and system designs.
- Ability to improve his knowledge in the discipline in his own.

3.1.2 Generic Skills

- Ability to function in multi-disciplinary teams.
- Understanding of professional and ethical responsibility.
- Ability to communicate effectively.
- Ability to engage in life-long learning.
- A deep understanding of health and safety issues.
- Understanding the impact of engineering solution in global and social context.
- Ability to stand for contemporary issues.
- Leadership, Managerial and Entrepreneurship skills
- Capability of holding responsible positions at the highest level.
- Ability to work under pressure.
- Ability to complete a task with minimal guidance and maximum autonomy.

3.2 Attitudes

The attitude of an individual is also important to be an Electrical Engineer. Therefore, the programme must ensure that the graduates are qualified to for these attitudes.

- Proactive
- Accountable
- Adoptable
- Self confident
- Strive for challenges

4. TEACHING AND LEARNING STRATEGIES

Existing Electrical Engineering programmes have been developed over many years and deploy a diverse range of teaching and learning methods to enhance and reinforce the student learning experience. This delivery of practice is the strength of the discipline. Whichever methods are employed, strategies for teaching and learning should deliver opportunities for the achievement of the learning outcomes, demonstrate their attainment and recognize the range of student backgrounds. The method of delivery and the design of curriculum should be updated on a regular basis in response to generic and discipline-specific developments, taking into account educational research, change in national policy, industrial practice and the need of employers.

A list of teaching and learning strategies could be practiced depending on the nature of the subject. The list may include

- Conventional lectures
- Audio visual aids
- Laboratory classes
- Tutorials
- Design work
- Seminars
- Discussion sessions
- Project work
- Field visits
- Industrial training
- Open-ended problem solving
- Self directed studies
- Web based studies

5. ASSESSMENT STRATEGIES

Assessment means that by which students are measured against benchmark criteria. Assessment methods are designed to ensure that the student achievement is effectively measured. Assessment methods should be designed in such a way that the outcome should match with the students' intended learning outcomes. Even though, a variety of assessment methods can be used to determine the level of performance of students within the same discipline, every method must ensure that it reflects the students' quality appropriately.

Assessment methods may include,

- Closed / Open book examinations
- In class assessments
- Laboratory assessments / Lab reports
- Tutorials or take home assignments
- Seminar presentations
- Project reports, presentation and viva-voce examinations
- Case study reports, presentations and viva-voce examination
- Industrial training reports and viva-voce examination

6. MAINTAINING STANDARDS

The programme must demonstrate that it regards a quality engineering education as a significant and long-term component of its activities. It must have adequate arrangements for planning, development, delivery and review of electrical engineering education programme. In order to ensure that the said standards are maintained, the university must have systems in place that the stated outcomes are met and that the programme objectives and quality are continuously reviewed and improved. Thus the system should include:

- Involvement of local and foreign external examiners in exam paper moderation and marking.
- Upholding periodic subject reviews. The review process must integrate the feedback/suggestions from industry, alumni and professional bodies.
- Getting accreditations from the professional bodies.
- Maintaining internal quality assurance activities within the department and faculty level.
- Process for securing feedback and comments from students, graduates, employers of graduate engineers and representatives of wider community and systematic application of those feedbacks for continuing improvement of programme objectives, curriculum development, teaching and learning.
- Maintaining a post-programme process that includes graduate employment data, employers' survey and alumni achievement records.
- Maintaining full-time academic staff to student ratio at 1:12 or better and continuing regular peer review process of staff members.

7. STUDENTS ATTAINMENT AND BENCHMARK LEVEL (STANDARD)

Electrical engineering degree programme is a special degree programme that generally offers First Class Honours, Second Class (upper division) Honours, Second Class (lower division) Honours and Pass as the student level of achievements based on their performance in the programme. In general, we can categorize First Class and Second Class (upper division) holders as *good level* while Second Class (lower division) holders as *moderate level* and just Pass student as *threshold* level. This classification is made using the depth of understanding of the principles, the breadth of knowledge in the discipline and the level of other essential skills as the criteria.

The benchmark level of skills for *good level* and *threshold level* are:

(a) Threshold Level

- Demonstrate a reasonable understanding of the principals of Electrical Engineering covered in the programme.
- Skills of using mathematics as a tool are limited.
- Able to identify, formulate and solve discussed problems.
- Able to design and test a device with the help of others.
- Supervision and Guidance is badly needed in analytical / innovative work.
- Depended on the group-mates and the project supervisor in the undergraduate project work.
- Marginal communication and presentation skills.

- Some understanding of the impact of engineering solutions in global and social context.
- Some understanding of ethical and professional responsibilities.
- Ability of completing the task with maximum guidance and minimum autonomy.

(b) Good Level

- Demonstrate a sound understanding of the principals of Electrical Engineering covered in the programme.
- Skills of using mathematics as a tool are in broad based.
- Able to identify, formulate and solve new problems.
- Able to design and test a device independently.
- Minimal Guidance is required in analytical / innovative work.
- Barely depended on the project supervisor in the undergraduate project work.
- Affluent communication and presentation skills.
- Very good understanding of the impact of engineering solutions in global and social context.
- Recognition of ethical and professional responsibilities.
- Ability of completing the task with minimum guidance and maximum autonomy.

8. ANNEX1. MEMBERS OF THE BENCHMARK GROUP

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Dr. P. D. C. Perera	University of Ruhuna
Dr. A. M. U. S. K. Alahakoon	University of Peradeniya
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