CVCD

SUBJECT BENCHMARK STATEMENT

IN

CIVIL ENGINEERING

Committee of Vice-Chancellors & Directors

and

University Grants Commission

Sri Lanka

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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 qualifications;
- 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

CIVIL ENGINEERING

1. INTRODUCTION

The Benchmarking Statement for Civil Engineering is formulated for the purpose of laying down the desirable features of a First Degree Programme in Civil Engineering in the Sri Lankan University System. It is noted that the current first degree engineering programmes in Sri Lanka and many other countries are of duration four years on full-time basis or of equivalent duration on part-time basis. The Benchmark statement is formulated on a generic basis for the purpose of curriculum design. review and approval, assessment of the professional quality of graduates. setting goals to be achieved by students and as reference points for professional recognition and accreditation. Since the actual content of the curriculum may be different in different universities and may change from time to time even in a given university, the Benchmark Statement is formulated in general terms and as such there will be many common elements in Benchmark Statements across all Engineering Degree Programmes.

2. THE DESIRABLE QUALITIES OF A CIVIL ENGINEERING GRADUATE

Civil Engineering is a profession directed towards the skilled application of a distinctive body of knowledge and understanding based on mathematics, science and technology, integrated with business and management, which is acquired through education and professional formation in a particular engineering discipline. The civil engineer must be able to exercise original thought, have good professional judgement and be able to take responsibility for the direction of important tasks. It is necessary therefore that undergraduate programmes for Civil Engineering students foster and inculcate the following knowledge and understanding abilities and qualities of mind.

2.1 Knowledge and Understanding

Graduating Civil Engineering students should demonstrate knowledge and understanding of essential facts, concepts, principles and theories relevant to Civil Engineering, and knowledge and understanding of the constraints within which their engineering judgement will have to be exercised. All Civil Engineering graduates should have a sound grasp of science, mathematics and the technological base relevant to their discipline. It is desirable that all students have some knowledge and understanding of business and management techniques; these should be integrated into their curriculum. Because of the professional context of Civil Engineering, graduating students must also have an understanding of their professional

and ethical responsibilities, the broad education necessary to understand the impact of engineering solutions in a global and societal context, and an awareness of relevant contemporary issues. .

2.2 Intellectual Abilities

Civil Engineers need to be creative and innovative in solving problems, and in designing systems, components and in construction processes. They must be able to apply the appropriate tools from mathematics, science and technology, coupling these with know-how drawn from professional experience. Graduating Civil Engineers should be able to:

(a) solve engineering problems, often on the basis of limited and possibly contradictory information;
(b) analyse and interpret data and when necessary, design experiments to gain new data;
(e) design a system, component or process to meet a need;
(d) evaluate designs, processes and products, and make improvements;
(e) maintain a sound theoretical approach in enabling the introduction of new and advancing technology to enhance current practice.

In all of these cases, the graduate Civil Engineer should be able to:

(i) take an holistic approach, applying professional judgements, balancing costs, benefits, safety, quality, reliability, appearance and environmental impact;
(ii) assess risks, and take appropriate steps to manage those risks.

2.3 Practical Skills

Graduating Civil Engineers will have demonstrated practical skills, particularly concerning project work, use of appropriate instruments and use of relevant software.
They should be able to:

(a) use a wide range of tools, techniques and equipment, including pertinent software;
(b) develop, promote and apply safe systems of work.

2.4 General Transferable Skills

Graduating Civil Engineering students should have transferable skills that would also be of value in other occupations and will be life enriching. These skills include ability to:

(a) communicate effectively with colleagues and others, using both written and oral methods;
(b) use IT effectively;
(c) manage resources and time;
(d) work in a multi-disciplinary team;

(e) undertake lifelong learning, particularly for continuing professional development.

To enable students to become effective Civil Engineers, they need to develop certain qualities of mind, through the study of engineering.

They need to become:

(i) creative, particularly in the design process;
(ii) analytical, in the formulation and solution of problems;
(iii) innovative, in the solution of engineering problems and the transfer of technology;
(iv) self-disciplined and self-motivated, in the pursuit of their studies and professional practice;
(iv) of an enquiring mind, eager for new knowledge and understanding;
(v) independent of mind, with intellectual integrity, particularly in respect of ethical issues;
(vi) enthusiastic, in the application of their knowledge and understanding and skills in the pursuit of the practice of engineering and the promotion of the Civil Engineering.

3. CIVIL ENGINEERING EDUCATION

Civil Engineering education through the university stream consists of the B.Sc. Engineering Degree programme of four years' duration followed by a minimum of three years of practical training at a recognized work place under the supervision of a chartered engineer including at least six months of design office placement and twelve months of responsible work experience in the profession of Civil Engineering. On completion of the required experience after graduation, a professional review is carried out by the Institution of Engineers to determine the suitability of granting the Chartered Engineer' status.

Even after obtaining the charter status, many opportunities are provided by the Faculties of Engineering and the Institution of Engineers for Continuing Professional Development and further enhancement of professional knowledge and skills.

3.1 Content of a Civil Engineering Degree Programme

A Civil Engineering Degree Programme should generally consist of Mathematics, Physical Science & Mechanics, Analysis, Design, Communication including Information Technology & Computer Applications, Management and Civil Engineering Practice encompassing the core areas Structures, Materials, Water, Soil & Rocks (as relevant for Civil Engineering), Surveying and Management as well as Applied Subjects such as Transportation, Water Supply, Irrigation, Environmental Conservation, Coastal Studies, Hydro Power and Building Services. It is also desirable to include non-technical subjects to ensure some

degree of all-roundedness in the graduates. Flexibility in the selection of Applied Subjects and Non-technical subjects is desirable to allow for the specific demands of industry and student preferences. One or more research projects should also be included as a very desirable component of the programme. A period of Industrial Training too must be included as an essential part of the programme.

The teaching/leaming process in each of the above subjects may include a variety of forms such as lectures, tutorials, reading assignments, design/drawing exercises, laboratory work, field work, seminar presentations, computer work, problem based learning and self-study assignments as appropriate.

3.2 General Requirements of a Civil Engineering Degree Programme

(a) Mathematics and Science

Mathematics and science are the basic intellectual tools which graduate engineers use to understand and harness the forces of the world. Students need to develop a good understanding of science in general and, depending on their chosen discipline, they will study specific sciences in greater depth. This understanding forms the basis on which the science of Civil Engineering will be further developed within their programme of study.

Engineering and science are strongly quantitative, as expressed through the language of mathematics. Engineers need to be numerate and well versed in the mathematical methods needed to understand the underlying science of their discipline. Students also need the mathematical tools to study the operation and modelling of static and dynamic engineering systems to achieve optimal design.

(b) Communication and Information Technology

An essential component of a Civil Engineering Degree Programme is communication including the presentation of Engineering Information and the use of computer techniques. Students should be taught to use computers for the quantitative analysis, simulation and solution of engineering problems, and the manipulation and presentation of engineering information. Information Technology is essential to the exercise of the engineering activity both in the education of engineers and the practice of engineering. Information Technology provides support throughout engineering and acts as an aid to communication. A basic knowledge of the principles of Information Technology is therefore required together with understanding of how it pervades the practice of engineering.

(C) Design - Creativity and Innovation

Design is at the heart of engineering and it is where professional engineers demonstrate their creativity and innovation. Design studies will include consideration of general principles of design and of techniques specific to particular engineering products and processes. Whilst it may be difficult to teach creativity itself, students should learn to think beyond the obvious and routine, be encouraged to try novel solutions to existing problems and be given the opportunity to meet the challenge of previously unsolved problems. By this means, the required awareness of the creative process may be formed. Since Civil Engineering is ultimately about practical activities, such innovation should include the practical testing of ideas in the laboratory or conducting research for information to develop them further. These activities should be linked to technical analysis and the critical evaluation of results.

(d) Business Context

Civil Engineering is directed to developing, providing and maintaining infrastructure, and services for industry and the community. Programmes need to develop an awareness of the social commercial context of the Civil Engineer's work. This includes an understanding of the constraints imposed by health and safety, the environment, codes of practice, politics, the law and financial viability and of the means by which the various risks may be assessed and managed. Students should be aware of the methods for the assessment of quality and fitness for purpose of engineering services and systems. Programmes should develop the student's ability to analyse, present and communicate technical information to a range of audiences. Society expects professional behaviour from its professional engineers and therefore within programmes, students should become familiar with the expectations and standards inherent in professional codes of practice.

(e) Engineering Practice

The success of new engineering activity is closely related to previous experience. Students need to be familiar with general Civil Engineering practice and with the particular practices of their discipline. Principal amongst these will be the methodology of design and operational practice in Civil Engineering. Related to this is the management of engineering projects, dealing with technical uncertainty and awareness of codes of practice and the regulatory framework. Operational practice will include knowledge of construction processes, methods of control of quality, the assessment of hazards and operational safety. Students need to be aware of the practical dimension to their work, which should be developed in laboratories, workshops and visits to industrial sites.

(f) Teamwork

It is recognised that the management of people, groups of people and their organisation is an important role which most Professional Engineers undertake in their careers. Engineers frequently work in multi disciplinary teams and need to understand the relationship of their work to that of other specialists and to be able to communicate with them. The essential features of this include communication and interpersonal skills, accountability, professional ethics and organisational management, all of which are expected to be refined and developed in the person's career. Students should therefore be introduced to aspects of some of the other disciplines with which they are likely to come into professional contact. The aim is to provide a critical awareness of the interfaces with the work of different specialists and an understanding of the limitations of competency in their own and others' work.

(g) Integration of Knowledge and Understanding

Students should have the opportunity to carry out an extensive piece of work, which allows them to synthesise the many techniques introduced in their programme of study. Extended projects permit the development of many of the general skills that the graduate Civil Engineer may be expected to have. Included in this are: the planning and management of their own work over an extended period of time; meeting deadlines and working within other externally defined constraints; tackling work which lacks a well-defined outcome or which has a wide range of possible answers; opportunities to be creative; putting technical work in a social and commercial context, presentation and interpretation of technical information in various ways; searching published sources of information; applying technical knowledge to unfamiliar problems.

Project work is an excellent opportunity for both individual effort and teamwork and in some programmes, the teams may be multi disciplinary. Some departments prefer to offer alternatives to the extended project, such as more, smaller projects: where this is the case, departments should demonstrate that the objectives listed above are being met.

Seminars and tutorials offer students the opportunity to practise the analytical and theoretical skills which have been introduced in lectures, and to deal with a wide range of applications. Design classes provide an opportunity to undertake design case studies as well as stimulating thought through open-ended problems. Practical laboratory based sessions allow students to carry out experimental work to support the theoretical material presented in lectures. This enables the student to gain an understanding of the limitations and assumptions used in theoretical and modelling tools. Other practical sessions might include workshop sessions for some

aspects of engineering practice and computing classes where students use software and numerical tools to analyse engineering problems, or as design tools.

The essential content of a Civil Engineering Degree programme is summarized in the annexed Table 1(Page 11).

3.3 Assessment

Assessment of the student performance may be based on conventional examinations as well as on continuous assessment and assessment of performance in exercises such as seminar presentations, viva-voce examinations, and field work. The assessment processes and the grading scheme must be formulated in such a way that the level of performance reached by a student reflects his true competence.

3.4 Delivery

The nature of the delivery of each programme will depend upon its aims and the student population. Appropriate teaching and learning methods will need to be developed uninhibited by over-prescriptive guidance. However, there are some elements which it is felt should be part of the student experience. All students should be aware of the aims and objectives of the degree programme, the assessment regulations and strategy, and the learning outcomes of the modules or subjects studied. There should be some formal contact with staff teaching on the programme in structured settings, and this may be through a variety of different experiences, such as lectures, seminars, tutoria1s, practical sessions, design classes and workshop sessions. This formal contact provides a broad framework for the programme, introducing students to the underlying principles and concepts central to Civil Engineering. Such experiences should offer an interpretation and a perspective on the core material within each subject, whilst covering the applications of particular theoretical and analytical tools. Lectures will be more appropriate to certain kinds of subjects than others and it is for programme teams to decide on their optimum deployment.

Table 1. Criteria for content of a Civil Engineering Degree Programme

Item	Knowledge & Understanding of	Intellectual abilities	Practical Skills	General Transferable Skills
Mathematics	Appropriate mathematical methods	Ability to select appropriate mathematical methods	Skills to use appropriate mathematical methods	Sorting & analysis of data
Basic Engineering Sciences	Principles of basic Engineering Sciences	Ability to grasp the theories & principles	Basic practical & laboratory skills including measurement	Use of Scientific principles in understanding & solving problems
Core & Extended Civil Engineering Sciences	Applications of sciences relevant to the practice of Civil Engineering including Environmental Conservation	Ability to grasp the theories & principles	Basic practical & laboratory skills including measurement	Use of Scientific principles in understanding & solving problems
Business & Social Context	Management & business practices including finance, law, marketing, personnel & quality	Ability to grasp the theories & principles	Basic practical & laboratory skills including measurement	Use of Scientific principles in understanding & solving problems
Engineering Practice	Construction & ethics	Grasp of common construction procedures, regulations & ethical standards	Ability to appreciate the possibilities and limitations including assessment of risk	Ability to take effective decisions based on accepted principles & sound judgment
Analysis & Design	Analysis & Design of Structures & Process	A sound knowledge of analysis & design including the use of codes of practice & standards	Ability to appreciate the possibilities and limitations including assessment of risk	Ability to take effective decisions based on accepted principles & sound judgment
Communication including IT	Communication of Engineering Information including IT methods	A sound understanding of the techniques of effective communication	Ability to communicate clearly & effectively using appropriate methods	Ability to select and use appropriate techniques for presenting information
Research Orientation	Research Methods	A knowledge of the methodologies for different types of research	Ability to carry out research projects systematically and to produce reports thereof	Competency in the use of a variety of research tools
Industrial Training	Training through exposure to the real world of Civil Engineering practice	A sound understanding of techniques & procedure adopted in the field	Ability to take decisions and to seek advise when necessary	Competency in a variety of non-site management procedures
Non Engineering Components	Components to round-off the human person	Understanding & appreciation of disciplines that enhance the human qualities	Ability to use the knowledge gained to enhance the quality of life	Ability to keep developing human qualities, values and the total personality

APPENDIX 1 - MEMBERS OF THE BENCHMARKING PANEL

1.	Prof. D.C.H. Senarath	University of Moratuwa
2.	Prof. M.P .Ranaweera	University of Peradeniya
3.	Prof. Nimal Seneviratne	University of Peradeniya
4.	Prof. S.B.S. Abeykoon	University of Peradeniya
5.	Dr. Saman Thilakasiri	University of Moratuwa
6.	Mr. DA.R. Dolage	Open University of Sri Lanka
7.	Dr. A.M.N. Alagiyawanne	University of Ruhuna
8.	Dr. G.HA Silva	University of Ruhuna