CVCD

SUBJECT BENCHMARK STATEMENT

IN

MATHEMATICS & STATISTICS

Committee of Vice-Chancellors & Directors

and

University Grants Commission

Sri Lanka

CONTENTS

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
MATHEMATICS & STATISTICS

1. GENERAL DESCRIPTION OF THE SUBJECTS

Mathematics plays a unique and crucial role in the development of humankind. Unlike any other subject, Mathematics has applications in almost every branch of study whether it is Physical/Biological Sciences, Social Sciences, Business and Finance, or Information and Communication Technology. It is the key to understanding the world around us. It studies patterns and makes generalizations and abstractions about them. This may lead to drawing conclusions about the physical world, or through logical deductive reasoning, prove theorems on abstract entities. The latter is the main focus of Pure Mathematics. It is difficult to predict if and when an area of Mathematics will find real-life applications. A more recent example of this comes from Number Theory, the abstract study of numbers. More than 2500 years ago, ancient Greeks studied properties of prime numbers. They knew the Fundamental Theorem of Arithmetic. Euclid's Elements contain a proof of the statement that there are infinitely many primes. Number Theory flourished with contributions from the greatest mathematicians of all time like Euler and Gauss. Until recently no one expected it to revolutionize our day-to-day life. The Public-key cryptosystem invented by Rivest, Shamir and Adelman has done just that by using results in Number Theory. Mathematics consists of full spectrum of studies spanning from purely abstract to highly applicable.

Statistics is a subject that is closely related to Mathematics. It derives its mathematical standing partly through its use of probability. With its axiomatic foundations the theory of probability can even be classified as a sub-area in Mathematics. Statistics concerns with the collection, presentation and analysis of data, and interpretation of results. It is an important area of study in its own right and it provides the necessary tools for designing of experiments and making inferences based on limited information. Statistics has applications in all areas where data has to be analyzed. Physical, Biological and Social Sciences, Business, Economics and Management are some of the areas that use statistical techniques in interpretation of results.

2. RANGE OF PROGRAMMES

A wide variety of Mathematics and Statistics programmes are currently prevailing in the universities in Sri Lanka. Two main categories are the three-year general degree programmes and the four-year special degree programmes. In addition to these, there is also the distance education programme conducted by the Open University, which is a four-year general degree programme.

Under the category of general degree programmes there are two main sub-categories: Programmes with Mathematics as a single subject and programmes with Mathematics fulfilling requirements of two subjects. In programmes where Mathematics is offered to fulfill requirements of two subjects, the first one usually consists of Pure Mathematics

and the second one consists of classical/modern Applied Mathematics. In some cases the two subjects are classified as Pure Mathematics and Applied Mathematics. Statistics is always offered as a single subject. With the flexibility provided to the students in selection of courses by the introduction of the Course Unit System in the universities, there are compulsory core course requirements for each of the programmes. In each case there is also a minimum credit requirement in order for a subject to be considered as a principal subject:

- General Degree Programmes with Mathematics/Statistics as a single subject - 24 Credits
- General Degree Programmes with Mathematics in place of two subjects - 48 Credits
- Special Degree Programmes in Mathematics/Statistics - 72 Credits

(1 Credit = 15 hours of lectures)
In many programmes the courses offered in the first two years are compulsory.

Special degree programmes are designed such that the core areas are covered at a greater depth and to meet the current international standard of preparation for postgraduate degrees in Mathematics/Statistics.

3. SUBJECT-SPECIFIC KNOWLEDGE

Students must have knowledge and understanding of key results and methods relevant to their programme and have the ability to appreciate the axiomatic foundation, proofs, generalizations, abstractions and be able to apply these for problem solving. Students must be provided with adequate core material of sufficient variety in the first two years of their study so that they are able to make an informed decision if selected to a special degree programme.

The core areas that must be covered in any of the programmes mentioned in item 2 of this statement must include courses in Algebra and Analysis. In addition, students in programmes with Mathematics in place of two subjects must also offer Mathematical Modeling and Numerical Analysis. The core areas in Statistics must include Probability Theory and Estimation.

Geometry, Differential Equations, Operations Research, Classical Mechanics, Fluid Mechanics, Sampling Techniques, Regression Analysis and Design of Experiments are some of the main areas from which other core/optional courses could be drawn.

Special Degree Programmes in Mathematics/Statistics must include a treatment of more advanced topics. Examples of possible areas are Galois Theory, Measure Theory, Functional Analysis, Topology, Multivariate Analysis, Time Series, Non-parametric Statistics.

In addition to taught courses offered, students in Special Degree Programmes are required to carry out an independent study/research project, submit a report in the form of a dissertation and make an oral presentation based on their project.

4. TEACHING AND LEARNING

The knowledge, understanding and skills are acquired through a combination of lectures, tutorials/problem discussion classes, practical classes (where relevant) and self-study throughout the programme. As a general rule, Instructors should make every effort to communicate the beauty, utility and excitement of Mathematics/Statistics. Teaching methods must be chosen to support the aims and objectives of a course. It is desirable and encouraged to have tutorial/problem discussion classes in smaller groups to enable students to actively participate in class discussion. It is also desirable to use modern technology in the teaching of courses. Taking into account the lack of text-books for student's use, it is highly recommended to provide students with printed notes for courses. Best practices employed by different universities must be shared. Instructors are required to have office hours for the purpose of allowing students to discuss their difficulties in a course with the Instructor.

Students should learn to appreciate Mathematics as an intellectual endeavor in its own right. They should learn to analyze, synthesize and make abstractions and also develop problem solving skills. They should be competent in carrying out a rigorous mathematical proof. They should develop communication skills in Mathematics. They should, where relevant, be competent in using mathematical/statistical packages for mathematical/statistical modeling and computation.

5. ASSESSMENT

Knowledge, understanding and skills are assessed according to the aims and objectives of a course. There are a variety of assessment methods available and Instructors should choose assessment methods appropriate for their courses. It may consist of a combination of written examinations and take-home problem sets and/or oral presentations. Continuous assessment based on student's performance at tutorials/problem sets, quizzes, mid-semester examination and end-semester examination is considered to be the best. It is important to have a mechanism to provide feed-back at each stage of assessment. Instructors are free to use different methods taking into account student's educational background and experience. Instructors should be competent in using assessment results to assign grades to students. This whole process must be fair not only by the students, but also by the other users of grades earned by students. It must also be valid and reliable.

6. BENCHMARK STANDARDS

All students completing a programme of study with Mathematics/Statistics as a subject are expected to demonstrate knowledge, ability and skills that are specified above in this statement, but there will be differences in their levels of attainment. In particular, there will be a difference between levels of attainment by a general degree student and a special degree student.

Benchmark standards are defined at two levels for general degree programmes and for special degree programmes. These levels are classified as *threshold level* and *good level.*

This classification is made using the depth of understanding, the breadth of knowledge and level of other essential skills as criteria.

Graduates in any of the programmes with a First Class or a Second Class (Upper Division) are required to achieve the good level performance.

7. Level of Achievements

General Degree

(i) Threshold Level

A ***general degree graduate*** who has reached the ***threshold level*** should

- be able to demonstrate a reasonable understanding of the fundamental concepts covered in the programme;
- have acquired a reasonable level of skill in analysis, synthesis, abstraction and problem solving;
- be able to distinguish between a valid argument/conclusion from an invalid argument/ conclusion;
- be able to understand a rigorous mathematical proof;
- be able to present straightforward arguments clearly and accurately;
- be able to relate the knowledge to applicable situations.

(ii). Good Level

A ***general degree graduate*** who has reached the ***good level*** should

- be able to demonstrate a sound understanding of the fundamental concepts covered in the programme;
- have acquired a higher level of skill in analysis, synthesis, abstraction and problem solving;
- have a reasonable ability to solve non-routine problems and be able to relate the knowledge to applicable situations;
- be able to distinguish between a valid argument/conclusion from an invalid argument/ conclusion;
- be competent in carrying out a rigorous mathematical proof;
- be able to present arguments clearly and accurately.

Special Degree

(i). Threshold Level

A ***special degree graduate*** who has reached the ***threshold level*** should

- be able to demonstrate a reasonable understanding of the fundamental concepts covered in the programme;

- have acquired a higher level of skill (compared to general degree graduates) in analysis, synthesis, abstraction and problem solving;
- be able to present arguments clearly and accurately;
- have a reasonable ability to solve non-routine problems and be able to relate the knowledge to applicable situations;
- become effective in using computers in mathematical/statistical modeling and computation;
- have a reasonable ability in design/data analysis and modeling/inference;
- have the ability to work under guidance.

(ii). Good Level

A ***special degree graduate*** who has reached the ***good level*** should

- be able to demonstrate a sound understanding of the fundamental concepts covered in the programme;
- have acquired a higher level of skill (compared to special degree threshold level graduates) in analysis, synthesis, abstraction and problem solving;
- be self-motivated and be an independent learner;
- be accurate and effective when applying mathematical/statistical processes;
- have the ability to recognize interconnections within and outside Mathematics/Statistics;
- become competent in using computers in mathematical/statistical modeling and computation;
- be fluent in design/data analysis and modeling/inference;
- be able to present complex arguments clearly and accurately;
- have the ability to solve non-routine problems and be able to relate the knowledge to applicable situations;

APPENDIX 1 - MEMBERS OF THE BENCHMARKING PANEL

1.	Prof. K. Tillekeratne	University of Kelaniya
2.	Prof. R.A. Dayananda	University of Sri Jayawardenapura
3.	Prof. D.D.S. Kulatunge	University of Kelaniya
4.	Prof. S. Weerakoon	University of Sri Jayawardenapura
5.	Dr. A.A.S. Perera	University of Peradeniya
6.	Dr. R. Vigneswaran	Eastern University of Sri Lanka
7.	Dr. W.C.W. Perera	Open University of Sri Lanka
8.	Mr. C. de Silva	University of Kelaniya.