CVCD

SUBJECT BENCHMARK STATEMENT

IN

PHYSICS

Committee of Vice-Chancellors & Directors

and

University Grants Commission

Sri Lanka

AUGUST 2006

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

PHYSICS

1. INTRODUCTION

Subject benchmarking is an essential means for the academic community to achieve the academic standards of a given subject. Subject benchmark statement provides the nature and characteristics of the degree relating to a specific subject and the general expectations about the standards of such a degree. It refers also to the skills that a student should be able to demonstrate after successful completion of the degree.

This subject benchmark statement on physics provides the guidance for formulating the learning outcomes for physics. However, it does not specify any detailed curriculum of the subject. Indeed, this benchmark statement provides provisions for variety and flexibility in degree programmes and encourages innovations within an agreed framework. It provides a point of reference for reviewers and an external source of reference when new programmes are designed and developed. It refers to two types of degree programmes, B.Sc. (General) degree and B.Sc. (Special) degree, where physics forms a significant proportion. Normally B.Sc. (General) degree is a three year degree programme and B.Sc. (Special) degree is a four year degree programme.

The document was prepared by a team comprising of Professors and Heads of Departments of Physics in the Sri Lankan universities on behalf of the subject community.

2. GENERAL DESCRIPTION ON THE SUBJECT

Physics is at the core of our intellectual understanding of nature and the foundation of many scientific disciplines. It deals with profound scientific questions ranging from sub atomic particles to the universe and helps develop some of the most important scientific and technical issues today. Physics contributes to the development of chemistry, computing, engineering, environmental science, life sciences, material science, mathematics, medicine, physics education, and statistics.

Physics is both a theoretical and a practical discipline that continually evolves with newer discoveries. It has the foundation of basic principles that govern the nature and extends into many areas in science. Exploiting the principles ranging from classical physics to quantum physics, physics develops models based on

experimental observations. The resulting models help make various predictions that will lead to the exploration of the frontiers in science and technologies.

One important aspect of physics is the development of techniques and skills to make precise experimental measurements. Instruments developed originally in physics can be found in applications in other branches of science and in modem technologies.

Graduates trained in physics will develop skills such as, understanding of fundamental concepts, problem solving, independent thinking, reasoning and analysis, report writing and presentation, research, computing, and self studying. These graduates can apply their training in a wide variety of areas such as, research, industry, academia, computing, and management.

3. SUBJECT KNOWLEDGE AND UNDERSTANDING

In the B.Sc. (General) degree programme physics is one of the components where one or more other subjects are involved. Broader knowledge on core areas in physics and some selected applied topics of relevance are included in the programme. For example, the fundamentals which all students should know to some extent are such as:

- atomic and nuclear physics;
- classical mechanics;
- condensed matter physics;
- electromagnetism;
- quantum mechanics;
- relativity;
- thermal physics;
- wave phenomena.

Selected topics are such as:

- bio physics; .
- electronics;
- environmental physics;
- geophysics;
- industrial physics;
- medical physics;
- meteorology;
- metrology.

The emphasis is given to basic understanding of physical concepts and their applications. The selected physics topics provide the opportunity in the application of physics principles in practical and industrial situations. Laboratory work provides the training in the planning and executing of an experiment,

instrumentation, data acquisition, data processing and interpretation, report writing, and presentation. Also, it provides the training to present results with correct accuracy, error analysis, and proper units.

B.Sc. (Special) degree programmes are designed so that the core subject areas can be covered at a greater depth. A specific special degree programme provides the selection of topics to strengthen the advanced subject areas. A sound knowledge in mathematics is an essential requirement for a physics special degree programme. For experimental part of the programme, electronics is an important component in developing the technical skills. Selected areas in a physics special degree programme may cover the topics such as, industrial physics, geophysics, biophysics, medical physics, meteorology, metrology, electronics, environmental physics, and mathematical physics.

In special degree programmes it is required to carryout an independent research project. This should provide the student with the skills necessary to plan investigations, perform experiments, collect and analyze data, write reports, and make presentations.

4. SKILLS

Students should learn to formulate and solve problems in physics by identifying the appropriate physics principles. Also, they should be able to identify the real world (nature, industry, etc.) physics based problems and arrive at solutions. The confidence to try different approaches in order to solve challenging problems should also be encouraged. Students should be able to construct logical arguments based on the physics principles.

Students should learn to plan, execute and report the results of an independent investigation. Especially, they should learn to conduct experiments or investigations with available resources, an appropriate training that a student in a developing country like Sri Lanka should posses. Students should develop the ability to work independently and in groups as well.

Students should learn to explore the world-wide research literature, databases and possibility of interactions with experts. They should also be able to analyze data with appropriate methods and relate conclusions drawn to the current theories in physics. Students should gain necessary technical skills to use all types of measuring instruments. Also, they should be able to develop mathematical models to explain the results of an investigation. Hence they must be able to critically analyze the results, extend the validity and make predictions. Students should develop their computing skills for data analysis. Data acquisition techniques and ICT are essential skills to be developed.

5. TEACHING AND LEARNING PROCESS

Physics is the most fundamental discipline in science and the conceptual understanding of the basic principles is an essential and compulsory requirement. Practical skills, including an appreciation of the link between theory and experiment should also be developed. To produce graduates who have developed skills mentioned above, teaching and learning strategies should be designed and implemented carefully. The teaching methods that any typical programme may include:

- lectures and tutorial discussions;
- laboratory work;
- assignments;
- use of text books, research literature and web based materials;
- independent research projects;
- writing reports, seminars and presentations;
- study visits and industrial trainings.

Emphasis should be given to impart the subject knowledge through fundamental principles of physics and create excitements of the understanding of nature and the applications. It should be encouraged to have smaller discussion classes to enable every student to participate actively in the discussions.

It is important that the expected skill development should be achieved in the context of physics. In particular, through learning physics they should develop the skills of problem solving, analysis and synthesis, computation, use of programmes for simulations, use of computers for controlling equipment and acquisition of data.

6. ASSESSMENT

The assessment methods are aimed at testing the attainment of the subject knowledge and the other expected skills. There are variety of assessment methods such as, end of semester written examinations, quizzes, continuous assessment of practical and tutorials, mid semester examinations, evaluation of laboratory project reports, assignments, dissertations and presentations. Students in physics may encounter a mixture of these assessment methods.

7. BENCHMARK STANDARDS

All students completing a degree programme in physics should demonstrate knowledge, ability and skills mentioned in this statement. However, there may be different levels of attainment between the B.Sc. (General) degree and the B.Sc. (Special) degree programmes in physics. It is the responsibility of the institution

to ensure that their regulations and procedures of assessments guarantee standards of their awards. .

The minimum acceptable level of attainment (Threshold Level) and an Good Level of attainment are proposed for both B.Sc. (General) and B.Sc. (Special) degree programmes.

In particular, the levels of attainment in the

7.1 B.Sc. (General Degree)

(i) Threshold Level

B.Sc. (General) degree should be awarded to students who have demonstrated:

- a basic knowledge of understanding of concepts in physics and ability to use them in problem solving and other applications;
- an ability to conduct experiments, analyze the results, and arrive at conclusions;
- an ability in numerical manipulation and to present and interpret information graphically;
- a knowledge in safe and proper handling of laboratory equipment;
- a knowledge in use of software packages for the analysis of data and retrieval of information;
- an ability to write scientific reports and communicate scientific information;
- potential to update the knowledge of physics.

(ii) Good Level

B.Sc. (General) degree with a class should be awarded to students who have demonstrated:

- a sound knowledge of understanding concepts in physics, ability to use them in applications and problem solving, and the competence in applications in diverse areas in physics;
- an ability to conduct experiments, analyze the results critically, produce valid conclusions, compare with available results, and make predictions;
- a good knowledge in safe and proper handling of laboratory equipment;
- an ability in numerical manipulation and to present and interpret information graphically;
- competence in use of software packages for the analysis of data and retrieval of information;
- an ability to write scientific reports and communicate scientific Information;

- an ability to construct possible arguments to support explanations;
- potential to update the knowledge of physics.

7.2 B.Sc. (Special) Degree

(i) Threshold Level

B.Sc. (Special) degree should be awarded to students who have demonstrated:

- a basic knowledge on the more fundamental principles in physics, ability to use them in problem solving and to apply them in various branches in physics;
- an ability to solve advanced problems of physics using mathematical tools;
- an ability to plan and execute an experiment or an investigation, analyze results to draw valid conclusions, and compare the results with available information;
- a good knowledge in safe and proper handling of laboratory equipment; .
- an ability to select the suitable equipment for a given problem;
- an ability to develop experimental tools needed to perform experiments;
- competence in use of software packages for the analysis of data, retrieval of information, simulation, data acquisition, and operation of equipment.
- working knowledge of experimental and mathematical techniques for current research in physics;
- potential to update the knowledge of physics.

ii) Good Level

B.Sc. (Special) degree with a class should be awarded to students who have demonstrated:

- an in depth knowledge on more fundamental principles in physics, ability to use them in problem solving and to apply in various branches in physics and other disciplines;
- an ability to solve advanced problems in physics and to formulate models using mathematical tools;
- an ability to plan and execute an experiment or an investigation under supervision, analyze results critically to draw valid conclusions, compare with available results and theoretical predictions, and develop models to explain the results;
- an ability to propose modifications to the model to suit for experimental behaviour of the system under investigation;
- a very good knowledge in safe and proper handling of laboratory equipment;
- an ability to select the suitable equipment for a given problem and to develop or modify experimental tools when and where necessary to perform experiments;

- an ability to construct possible arguments to support explanations in defending the conclusions of a research project concisely, accurately and informatively;
- competence in use of software packages for the analysis of data, retrieval of information, simulation of models, and for data acquisition and operation of equipment;
- a sound knowledge of experimental and mathematical techniques for current research in physics;
- capabilities in maintaining and enhancing the knowledge of physics.

APPENDIX 1 - MEMBERS OF THE BENCHMARKING PANEL

1.	Prof. W G D Dharmaratne	University of Ruhuna
2.	Dr. J K D S Jayanetti	University of Colombo
3.	Prof. E M Jayasinghe	The Open University of Sri Lanka
4.	Dr. L Jeyanathan	University of Jaffna
5.	Dr .S R D Kalingamudali (Rapporteur)	University of Kelaniya
6.	Prof. B S B Karunaratne	University of Peradeniya
7.	Dr. L S G Liyanage	The Open University of Sri Lanka
8.	Dr .N Pathmanathan	Eastern University of Sri Lanka
9.	Prof.W P Siripala (Chairman)	University of Kelaniya
10.	Prof. D. A. Tantrigoda	University of Sri Jayewardenepura