University of Botswana
Faculty of Science
Department of Computer Science

TYPE OF PROPOSAL:
Major amendment

Revised Curriculum for
BSc Computer Science

Approval	Date
Departmental Board	February 14, 2008
Departmental Board 2nd Revision	October 6, 2009
Advisory Board	October 13, 2009
Faculty Board	October 28, 2009
Faculty Executive	November 11, 2009
APRPC	January 12, 2010
Senate	April 2010

Proposed Date of Implementation: August 2011

Contents

1. Introduction

1.1. Background

The Department of Computer Science has been offering a B.Sc. degree in Computer Science since 1992 and a B.Sc. degree in Computer Information Systems since 2004. The department has also been offering M.Sc. degrees in Computer Science and Computer Information Systems since 2004. The last major review of the curriculum for the B.Sc. degree programs was in 2003 and no major review has been done for the M.Sc. programs. Taking into consideration the increasing demand of the industry for IT professionals and the fast development of the computing field, regular revision of curriculum is very important.

Curriculum development is a dynamic process and very much so in the field of computing. Regular revision and updating of the curriculum is vital to improve the quality and relevance of the programs, to cope with the rapid changes in the computing field, and to adapt the curriculum in relation to the needs and conditions of the industry in the country. In light of this, the Department of Computer Science initiated evaluation of its curriculum in 2008 through external review, internal curriculum review committee, and surveys on ICT human resource needs in the country.

The department has been working on the revision of its programs to identify the shortcomings of the current curricula and come up with revised curricula for both undergraduate and graduate programs. In order to identify the shortcomings of the existing curricula and propose modifications, the committee gathered input from various sources. The following are the main sources used during the revision of the current curriculum.

a) the experience gained in the implementation of the programs,

b) input from students who have been on the program,

c) the report of the external reviewer,

d) report of a Fulbright Scholar who spent his sabbatical in the department,

e) the Report of the Maitlamo project (Botswana ICT Policy development project 2005),

f) global trends in the field of computing as reported in the ACM/IEEE-CS/AIS/AITP Computing Curricula report.

In addition to the sources listed above, the department conducted a comprehensive survey on the ICT human resource need in the country so that a better picture of the industry can be captured. The main objective of the survey was to identify ICT human resource shortage in both the private and public sector and the type of knowledge and skills required to successfully accomplish their organizational tasks.

This survey helped us to identify the knowledge and skills gap that may exist between the academic and the industry in the country in the area of computing. For this

purpose, the committee designed three types of questionnaires to gather data from government organizations and private companies which have strong IT departments (32), experienced IT professionals (15) and IT vacancies advertised on news papers for the period January 2008 to December 2008 (7 newspapers in the country which are published daily and weekly with a total of 406 vacancies).

An analysis of the survey data reveals that many organizations expect:

a) *Practical Skills*

Organizations indicated their requirement of specialized (mainly practical), product specific knowledge and skills from computing graduates.

b) *Management/Finance Skills*

In addition, it was observed that organizations expect organizational skills apart from the technical knowledge. A majority of the organizations who took part in the survey indicated their interest in graduates with knowledge of computing combined with management and/or finance.

The challenge is thus to produce graduates who can be as adaptable as possible to different environments with minimum additional training investment. Obviously, an academic degree education can't focus on specific product training but products can be embraced for the practical part of appropriate courses. Academic degree education should provide an adequate knowledge of the principles, concepts and techniques behind such products so that graduates can easily manage different products independently.

Therefore, the revised curriculum emphasizes the use of more applied hands-on experience, practical applications, exercises, and projects where appropriate. For example, to address practical exposure issues, the department proposed the use of products such as Oracle for the practical sessions of Database related courses. In addition, the department is offering certification courses such as CISCO so that interested students can prepare themselves for the industry. The department is also in the process of establishing other certification courses such as Microsoft. Moreover, the curriculum is designed in such a way that students will be equipped with other organizational skills such as project management and team work to complement their technical skills.

Apart from the computing courses designed for computing majors, the department has also the responsibility of providing appropriate computing courses for other departments of the University. We have observed that the current curriculum lacks proper specification of computing courses which are appropriate for students from other departments. Computing service courses are higher level courses needed by other departments but with less rigour than the computing courses which are designed for computing majors. These courses are different from computing GEC courses. Since there are no service courses in the current curriculum, students from other departments are taking courses which are designed for computing majors. This has created a problem for both the Department of Computer Science and the other departments.

Generally, we have observed that the computing service courses needed currently are courses like Introduction to Computing (but different from the one designed for computing majors), Introductory Programming (e.g., using VB), and Web Design.

1.2. Weaknesses of the Current Program

Based on the analysis of the input gathered from the different sources, we were able to identify the following shortcomings in the current curriculum.

a) Lack of cohesion between courses and breadth & depth
b) Inadequate program duration for the B.Sc. degree programs (3 years)
c) Curriculum not aligned to development trends in computing
d) Inadequate exposure of programming and practical hands-on experience
e) Weak emphasis on mathematical skills
f) Inadequate service courses
g) Inadequate provision to expose students to business/management and finance concepts

1.3. Changes Proposed

To address the issues listed above, the department devised different strategies. For example, to address the issue of program duration, the department proposed a 4 years program. Experience in implementing the program and considering the computing body of knowledge required of graduates for the market, the 6-semester structure is inadequate. The 6–semester structure does not adequately prepare students for advanced undergraduate courses required for the right calibre of graduates. Therefore, the B.Sc. degree program in Computer Science has been revised into an 8-semester framework so that it commences in Semester I, rather than in Semester III as it is the case presently.

Moreover, the current 4-stream specialization of the B.Sc. degree program in Computer Science does not seem well focused. The market needs as enunciated in the National ICT Policy (the Maitlamo project) requires knowledge and skills in indigenous software development and ICT systems and networks infrastructural support. Our ICT human resource needs survey also revealed that much of the workforce needed is in the area of software development, database design, and computer networks. Hence, the current 4-stream specialization areas have been revised to 2-stream specialization areas: Software Engineering and Systems & Networks.

In summary, the following are the major changes emanated from the program review exercise.

- B.Sc. degree program in Computer Science should have a duration of 4 years as opposed to the current 3 years duration
- Two streams of specializations - Systems & Networks and Software Engineering for the B.Sc. degree program in Computer Science
- Courses have been designed in such a way that students' programming, practical hands-on experience, and mathematical skills are strengthened

- Structural cohesion of the program has been strengthened to take advantage of related knowledge clusters
- Service courses have been designed to cater for the needs of other departments
- Appropriate courses have been identified to cater for other departments who wish to have a minor in Computer Science for their programs

1.4. Aims of the Program

The program aims to provide students with the necessary theoretical and practical computer science knowledge and skills which enable them to evaluate, select, and apply appropriate models, methods, technologies, and tools in the comprehension, manipulation, and development of complex computer-based systems. It also aims to equip students with the ability for critical thinking and life-long learning that helps them keeping in pace with the rapid development of the technology in computer science.

1.5. Objectives of the Program

The objectives of the program are to equip students with the following graduate attributes:

- A sound base in the science of computers and in problem solving skills using computers
- Ability to develop sophisticated computer systems based on a thorough knowledge of database design, software engineering, systems, network and communication technologies and computer architecture
- Interpersonal communication skills, strong sense of social commitment and professional ethics, ability to act independently and organization of thought to solve and analyze abstract and complex problems
- Ability to understand and apply new skills and procedures efficiently and effectively
- The foundation necessary for advanced study in computer science
- Critical and creative thinking skills
- Entrepreneurship and employability skills
- Organizational and teamwork skills

1.6. Graduate Profile

In line with the mission of the department, the graduates of this program will have enhanced capacity for the following

   a. Software development - Software design and implementation, development of medium to large scale systems;

b. Developing effective problem solving - Application or development of computing theory and knowledge of algorithms to ensure the best possible solutions for computational intensive problems;

c. Professional practice - Ability to apply personal goals setting and time management concepts; apply personal decision-making skills; articulate a personal position and respect the opinions of others; adhere to ethical standards; assess organisational and societal impact of computing technological solutions; actively seek and employ current best practices;

d. Devise new ways to use computers - Innovation in application of computing technology; working in computing research and development establishments; involvement in entrepreneurial activities;

e. Working in computing research and development establishments; involvement in entrepreneurial activities;

f. Knowledge advancement in the discipline; and

g. Adaptability to new computing environments.

h. Self-directed, lifelong learning skills

2. Expected Intake and Outputs

The following table presents the current and projected student intake into the Computer Science program of the department.

Table 1: Projected student intake and output

Academic Year	2010/2011	2011/2012	2012/2013	2013/2014
Intake	60	60	80	80
Output	25	25	50	65
Attrition rate	5	5	10	15

3. Resources

3.1. Human Resources

The staff to student ratio, taking into consideration the GEC courses, is about 1:100 and without the GEC courses is 1:10. Attracting the necessary human resources requirement for the department has been a source of challenge since the inception of the department because of high demand for computing academicians globally.

The revised curriculum being proposed will allow the department of Computer Science to attract more students into its program. This will essentially require more teaching staff and assistants. But if the trend from recent years persists, not only are we going to be in short of teaching staff, we will also be facing a problem of recruiting enough capable teaching assistants. As most courses already exist in the current program, the requirement for new staff members is not urgent. The program can be run with the existing staff. However, it is important to fill those positions as per the department's

establishment in order to strengthen the program. The major problem for the department so far has been the difficulty of recruiting senior staff members to fill the existing positions. Currently, the department has 2 associate professors, 4 senior lecturers, and 17 lecturers.

3.2. Physical Resources

3.2.1. Available Physical Resources

The department of Computer Science has six laboratories dedicated to undergraduate students and two laboratories to graduate student research. There are two other research laboratories for lecturers and students. Find following how the laboratories are designated:

- Computer labs 232-117 and 232-118 are used for teaching programming in the UNIX environment.
- Computer labs 232-119 and 232-120 are used for teaching programming in the Microsoft Windows environment.
- Computer labs 232-115 and 232-116 are dedicated for final year projects and primarily used by final year students.
- Computer labs 232-111 and 232-112 are used for graduate students research and teaching.
- Computer lab 233-G05 is used for computer network teaching and research (this is also a faculty lab).
- Computer lab 229-2 and others within the university are for GEC 121 and GEC122.
- Computer lab 232-116 is a small office converted to be the staff research laboratory.

3.2.2. Additional Physical Resources Requirements

The physical resources at the moment require upgrading due mainly to the increase in class sizes, mostly from other faculties requiring the services of the department. This is forecasted to increase due to faculties offering programs with a significant IT requirement. To mention a few of these faculties, we have Humanities, Science, FET, Social Sciences, Education, etc.

The department of Computer Science takes cognizance of the plan to provide more computing laboratories in the new multi-disciplinary and health sciences buildings. However, the current laboratories need to be upgraded to improve the quality of service we are offering to our students and the University. The computers, especially our server farm, are in dire need of larger uninterrupted power supply units to cater for the incessant power disruption within campus. Hopefully, the new laboratories will be equipped appropriately and in line with the department's mission and vision.

Therefore, as part of this revised program, what the department requires is the upgrading of the existing laboratories (as shown in Table 2 below) and fully furnishing the new computing laboratories in the new building which can be handled according to the normal budget process.

3.2.3. Available Physical Facilities and Future needs

The available physical facilities and future departmental needs are as specified in Table 2 below.

<p align="center">Table 2: Available Physical Resources and Future Needs</p>

	Laboratory	Current State	Future Requirement
1	232/105 Fourth Year Laboratory	– 23 PCs(MS Windows XP) – 1 security camera – 2 x 24 port Cisco switches – 30 garden chairs	– Newer Machines (MS Vista compatible) – 17 " TFT Screens – Mounted overhead projector – Extra security camera – New network switch – Proper laboratory chairs
2	232/106 Fourth Year Laboratory	– 23 PCs(MS Windows XP) – Limited to 30 PCs – 1 Security camera – 2 x 24 port Cisco switches – 30 garden chairs	– New machines(MS Vista compatible) – 17 " TFT Screens – Mounted overhead projector – Extra security camera – New network switch – Proper laboratory chairs
3	232/109 Server Room	– 3 Linux/Servers – 3 MS Windows Servers – No security camera	– Security camera – New master network switch
4	232/111 Master's Laboratory	– 8 PC's(MS Windows XP) – 1 security camera – 1 x 24 port Cisco switch	– 15 PC's(MS Vista Compatible) – Mounted overhead projector – Extra security camera – New network switch – Proper laboratory chairs
5	232/112 Master's Laboratory	– 30 thin clients – 1 security camera – 1 x 24 port network switch	– Mounted overhead projector – Extra security camera – New network switch – Proper laboratory chairs
6	232/116 Research Laboratory	– Connection to network via UTP cabling – CCNA Bundles for networking course.	– Fibre optic cabling – Mounted overhead projector – Security camera – New network switch – Proper laboratory chairs – Blade server for High performance computing.
7	232/117 Second Year	– 40 PC's running Linux	– Mounted overhead

	Programming Lab	– 2 x 24 port Cisco switches – 1 security camera – 40 garden chairs	projector – Extra security camera – New network switch – Proper laboratory chairs
8	232/118 Second Year Programming Lab	– 30 PC's running Linux – 2 x 24 port Cisco switches – 1 security camera – 30 garden chairs	– Mounted overhead projector – Extra security camera – New network switch – Proper laboratory
9	232/119 Third Year Laboratory	– 30 PC's(MS Windows) Vista capable – 2 x 24 port Cisco switches – 1 security camera – 30 garden chairs	– Mounted overhead projector – Extra security camera – New network switch – Proper laboratory chairs
10	232/120 Third Year Laboratory	– 30 PC's(MS Windows) Vista Capable – 2 x 24 port Cisco switches – 1 security camera – 30 garden chairs	– Mounted overhead projector – Extra security camera – New network switch – Proper laboratory chairs
11	209/2 GCE Laboratory	– 29 PC(MS Windows) 5years old	

4. Departmental Regulations

4.1. Preamble

The department has found it prudent to update its entrance requirements to be able to compete fairly for students with its competitors. Therefore, entry to the program will be direct entry to year 1 as opposed to the current practice where students enter into the program after completing their first year at the Faculty of Science.

4.2. General Provisions

Subject to the provisions of General Academic Regulations, the following Departmental Regulations shall apply.

4.3. Programs and Titles of Programs

The program is a single major program leading to the award of B.Sc. in Computer Science.

4.4. Entry Requirements

Subject to the General Academic Regulation 00.5, the following departmental program entry requirements shall apply for the program:

For entry to the B.Sc. (Computer Science), the following entry requirements shall apply.

i) For entry into 100-level, candidates must have a minimum grade of C in Mathematics and two other science subjects with Computer Studies recognized as a science subject, with a minimum grade of D in English.

ii) For entry into the program at higher level:

a. Transfer students from a Computer Science or equivalent program from a higher institution considered equivalent to the University of Botswana, subject to General Academic Regulation 00.313.
b. Candidates holding a post Secondary qualification which is considered by the department as being at least equivalent to the 100-level of the program. For those who do not meet this criterion, they may be required to take some 100-level courses.

4.5. Assessment

Subject to the General Academic Regulation 00.81, the following Special Regulations shall apply:

a. Where examination is involved in the assessment of a course, the weighting between CA and examination shall be 1:1 for practical courses and 1:2 for theoretical courses and the final grade shall be calculated as weighted average of CA marks and Final Exam marks.
b. Duration of Final Exams – 2 to 3 hours.
c. CA marks will be calculated based on at least three assessments for a course
d. Specific requirements for CA marks calculations shall be as specified for each course.
e. The final year project course, CSI405, shall be assessed according to the guidelines provided by the department.

4.6. Additional Streams

Additional streams of specialization areas shall be defined from time to time as the department may deem necessary.

4.7. Progression from Semester to Semester

Regulations governing progression are as set out in General Regulations 00.9.

4.8. Award

To be awarded a degree, a student must satisfy appropriate provision of General Academic Regulation 23.71.

5. Program Structure

Note: The courses in bold format in the following tables are new courses introduced as part of the revision of the program's curriculum.

5.1.   B.Sc. (Computer Science)

Semester I

Courses	Type	Credits	Prerequisite
CSI131 Discrete Structures I	Core	3	
CSI141 Programming Principles	**Core**	**3**	
CSI161 Introduction to Computing	**Core**	**3**	
MAT111 Introductory Mathematics I	Core	4	
GEC111	GEC	2	
GEC121	Exempt		
Total		**15**	

Semester II

Courses	Type	Credits	Prerequisite
CSI132 Discrete Structures II	Core	3	CSI131
CSI142 Object-Oriented Programming	**Core**	**4**	**CSI141**
MAT122 Introductory Mathematics II	Core	4	MAT111
STA122 Introductory Concepts of Probability	Core	4	
GEC112	GEC	2	
GEC122	Exempt		
Total		**17**	

Semester III

Courses	Type	Credits	Prerequisite
CSI242 Data Structures	Core	3	CSI132, CSI142
CSI243 Functional Programming	**Core**	**3**	**CSI142**
CSI213 Discrete Structures III	Core	3	CSI132
MAT221 Calculus I	Core	3	
Elective*		3	
Total		**15**	

*- students are advised to take MGT202 which is a pre-requisite to MGT303

Semester IV

Courses	Type	Credits	Prerequisite
CSI262 Database Concepts	Core	3	CSI242
CSI223 Systems Programming	Core	3	CSI242
CSI251 Computer Architecture & Organization	Core	3	CSI161, CSI141
MAT212 Introductory Linear Algebra	Core	3	
Elective		3	
Total		**15**	

Semester V

Courses	Type	Credits	Prerequisite
CSI322 Algorithms	Core	3	CSI242
CSI354 Operating Systems	Core	3	CSI242, CSI251
CSI374 Computer Networks	Core	3	CSI142, CSI251
CSI342 Systems Analysis & Design	Core	3	CSI262
Elective		3	
Total		**15**	

Semester VI

Courses	Type	Credits	Prerequisite
CSI315 Web Technology and Applications	Core	3	CSI262, CSI374
CSI332 Programming Languages	Core	3	CSI243
CSI341 Introduction to Software Engineering	Core	3	CSI342
Min 6 credits from:			
CSI344 Artificial Intelligence	Optional	3	CSI242
CSI392 Human Computer Interaction	Optional	3	CSI342
MGT303 Entrepreneurship and New Business Formation	Optional	3	MGT202
Total		**15**	

Winter Semester

Course	Type	Credits	Prerequisite
CSI352 Industrial Attachment	Core	3	CSI354, CSI374, CSI342

For semester VII and VIII, students choose from the following areas of specializations.

1. Software Engineering
2. Systems & Networks

Semester VII

Courses	Type	Credits	Prerequisite
CSI411 Theory of Computation	Core	3	CSI322
CSI472 Social Informatics	Core	3	CSI352
CSI481 Database Systems	Core	3	CSI262
Software Engineering stream (minimum 6 credits)			
CSI471 Software Design	Optional	3	CSI341
CSI441 Requirements Engineering	Optional	3	CSI341
CSI432 Intelligent Systems	Optional	3	CSI342

Total		**15**	
Systems & Networks stream (minimum 6 credits)			
CSI462 Distributed Computing	Optional	3	CSI354, CSI374
CSI451 Sensors Networks	**Optional**	**3**	**CSI374**
CSI493 Computer Graphics	Optional	3	CSI242
Total		**15**	

Semester VIII

Courses	Type	Credits	Prerequisite
CSI405 Project	Core	4	CSI352, CSI315, CSI341
CSI412 Programming Language Translation	Core	3	CSI411
CSI461 Computer Networks & Security	Core	3	CSI374
Software Engineering stream (minimum 6 credits)			
CSI444 Software Project Management	**Optional**	**3**	**CSI441 or CSI471**
CSI392 Human Computer Interaction	Optional	3	CSI342
CSI345 Integrative Programming	**Optional**	**3**	**CSI223, CSI354**
Elective		3	
Total		**16**	
Systems & Networks stream (minimum 6 credits)			
CSI464 Mobile Computing	**Optional**	**3**	**CSI374**
CSI424 Network Algorithms	**Optional**	**3**	**CSI374, CSI322**
Elective		3	
Total		**16**	

5.2.   B.Sc. (Computer Science - Minor)

The following courses constitute a minor in Computer Science with a total credit of 34.

First Year	CSI131 Discrete Structures I
	CSI141 Programming Principles
	CSI161 Introduction to Computing
	CSI132 Discrete Structures II
	CSI142 Object-Oriented Programming
Second Year	CSI242 Data Structures
	CSI262 Database Concepts
	CSI251 Computer Architecture & Organization
Third Year	CSI354 Operating Systems
	CSI374 Computer Networks
	CSI315 Web Technology and Applications

5.3.   Service Courses

The following courses are available as service courses for other departments. All these courses are new courses.

CSI101 Computing Fundamentals   3 credits
CSI102 Programming with C++   3 credits
CSI104 Programming with VB.NET   3 credits
CSI105 Introduction to Web Design   3 credits

6. Credit Summary

		Core	Optional	Elective	GEC	Total
Year 1	Sem. 1	13			2	15
	Sem. 2	15			2	17
Year 2	Sem. 1	12		3		15
	Sem. 2	12		3		15
Year 3	Sem. 1	12		3		15
	Sem. 2	9	6			15
	Winter Sem.	3				3
Year 4	Sem. 1	9	6			15
	Sem. 2	9	6			15
	Total	**94**	**18**	**9**	**4**	**125**