MAKERERE UNIVERSITY

FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE

P.O.BOX 7062, KAMPALA, UGANDA

REVISED PHD PROGRAMME IN COMPUTER SCIENCE

DAY/EVENING PROGRAMMES

SEPTEMBER 2009

Table of Contents

1. Introduction

1.1. Background to the faculty of Computing and Information Technology

The rate of growth of Information and Communication Technology (ICT) in Uganda in particular and the African region in general is enormous. In order to sustain the high growth useful to the economy, there is need for highly skilled and specialized ICT labor force to cater for the sophisticated ICT-jobs. Today Makerere University Faculty of Computing and Information Technology (CIT) is the main ICT training, research and consultancy centre in Uganda. CIT was established by the University Council at its 100th meeting held on 15th December 2004 by upgrading the Institute of Computer Science into a faculty with four departments of computer science, networks, and information technology and information systems. The Institute of Computer Science, which was established by the University Council in 1985, grew out of the University Computer Centre.

CIT's Value Statement: The Faculty of Computing and Information Technology is an innovative and industry-oriented Faculty, pursuing excellence in teaching, learning, cutting edge value-added research and consultancy, community outreach, as well as providing a vibrant student life.

Vision: To be a leader in Computing and ICT training, research and services internationally.

Mission Statement: To provide first class teaching, research and services in computing and ICT responsive to national and international needs.

The Faculty has been running a **PhD by research** since 2002 and continues to do. Specifically the Department of Computer Science runs the following graduate Programmes:

- PhD in Computer Science (PhDCS)
- Master of Science in Computer Science
- Postgraduate Diploma in Computer Science

1.2. Objectives

The objectives of the PhD in Computer Science by Coursework and Research programme are to: -

a. Build human resource capacity in the area of Computer Science in both the public and private sectors, especially in universities;
b. Develop research capacity in the area of Computer Science;
c. Address the increasing demand for PhD holders in the area of Computer Science;

d. Strengthen capacity and institutional building in the area of computer science in tertiary institutions, private and public sectors.
e. Provide those masters holders with potential for PhD with opportunities to develop skills in formulating, conducting and presenting their own scholarly research through the production of a research-based dissertations and publications.
f. Foster initiative and potential for independent self-study that will develop the students' motivation and ability to continue updating their knowledge and skills after completion of the course of study in relation to scholarship and research.
g. Enable the students to be able to demonstrate a critical awareness and reflection on research-based information as a basis for problem solving and practice in professional contexts.
h. Enable students to be able to demonstrate ability to interpret and report research findings in areas relevant to their field of study.
i. Enable students to be able to demonstrate the ability to formulate research questions and problems, design and carry out their own small scale research projects and present their findings orally and in writing.
j. Equip students with research and publication skills to enable them publish research from high quality dissertations in reputable journals and/ or presentation of their research findings at academic conferences.

1.3. Collaboration Partners

1.3.1. Univ. of Groningen, Radboud Univ. Nijmegen and Eindhoven Univ. of Technology

The Netherlands Government through the Netherlands Organization for International Cooperation in Higher Education (Nuffic) provided a 5.7 million euro grant for a project on 'Strengthening ICT Training and Research Capacity in the Four Public Universities in Uganda'. This project commenced on 1st June 2007 and will end on 31st May 2011. One of the objectives is to build ICT human resource capacity through staff development and implementation of graduate programmes (M.Sc. and Ph.D.) and 30 PhD students (10 registered at the above institutions in the Netherlands and 20 at Makerere University) are supervised by PhD holders from University of Groningen, Radboud University Nijmegen, Eindhoven University of Technology and Makerere University with support from the project.
Out of the 5.7 million Euros about 2.5 million Euros is to support 10-15visits by Professors from the Institutions in Netherlands per year in a bid to support training and research in Uganda.

1.3.2. University of Bergen

On 18th November 1999 a time frame agreement on research collaboration, scientific competence building, student and staff exchange, and institutional development was signed between University of Bergen and Makerere University in Kampala, Uganda. The agreement has a time frame of fifteen years.

Makerere University Faculty of Computing and Information Technology has an active student and staff exchange with the Department of Informatics and the Department of Information Science and Media at the University of Bergen (UiB) under this collaboration agreement. The staff from UiB has over the years conducted lectures in areas where the Faculty of Computing and Information Technology lacks local expertise.

1.3.3. London South Bank University

In 2005 Makerere University and London South Bank University signed a Memorandum of Understanding (MOU) in which the two universities agreed to:

(a) Develop joint degree programmes (Masters Level) in the following areas: M.Sc. Information Systems; and M.Sc. in Human Resources (International).

(b) To look at the feasibility of developing a distance learning PhD programme to include a cost model and that the programme will be designed with the view of implementation in the Faculty of Computing and Information Technology, Makerere University initially and then extended to the rest of the University in due course.

(c) Identify and seek funding for PhD studentships from the Common Wealth Scholarship Fund, British Council and other funding bodies.

(d) Explore various avenues for research funding, which particularly focus on the development needs of Uganda.

(e) Identify ways in which best practice can be shared in the areas of Teaching and Learning.

(f) Collaborate on quality assurance whereby London South Bank University will develop a proposal and costing model to help Makerere University develop mechanisms and procedures to support effective quality assurance and research monitoring at both institutional and subject levels.

A lot has been achieved under the MOU between Makerere University and London South Bank University that is still in force.

1.4. Computing Equipment

The Faculty of Computing and IT has put in place specialized research laboratories (e.g. the Multimedia Laboratory, Geographical Information Systems Laboratory, Mobile Computing Laboratory, Networking and Systems Laboratory, Software Incubation Laboratory, Computer Engineering Laboratory and E-learning Laboratory) and plans are under way to establish more laboratories using funds available under donor funded projects and internally generated funds. For example, under the project on 'Strengthening ICT Training and Research Capacity in the Four Public Universities in Uganda' there is approximately 800,000 Euros reserved for specialized equipment and software for the Faculty for Computing and Information Technology Centre of Excellence. This specialized equipment and software will be availed to the PhD students and their supervisors.

Every PhD student in the Faculty of Computing and Information Technology is given a laptop and personal computer for the whole duration of the programme. Each member of academic staff has a laptop and personal computer in the office.

1.5. Physical facilities

The Faculty has sufficient offices for both staff and PhD students, lecture rooms, seminar rooms and computer laboratories in the faculty buildings.

1.6 Financial Resources

Tuition fee per student shall be 3,000,000 Uganda Shillings per annum for Ugandans and 3000 US Dollars per annum for Non-Ugandans.

2. The Department of Computer Science

2.1 Background

The Department of Computer Science is one of the four departments in the Faculty of Computing and Information Technology. It was established within the Faculty of Computing and Information Technology 2005 The department is active in teaching and research. Currently, the Department runs the following academic programs

(i) Diploma in Computer Science and Information Technology
(ii) Bachelor of Science in Computer Science
(iii) Postgraduate Diploma in Computer Science
(iv) Master of Science in Computer Science
(v) Doctor of Philosophy in Computer Science

The Department also teaches Computer Science as a subject for students in the Bachelor of Science program in the Faculty of Science.

The Department has revised the following programs:

(i) Diploma in Computer Science and Information Technology
(ii) Bachelor of Science in Computer Science
(iii) Postgraduate Diploma in Computer Science
(iv) Master of Science in Computer Science

The Diploma in Computer Science and Information Technology was revised to give students more foundational academic and theoretical courses in computer science as well as stronger hands on skills as technicians. The Bachelor of Science in Computer Science program was revised to strengthen students' abilities in hands on programming, research and development together with availing students with a strong theoretical and mathematical background to Computing. The Master of Science in Computer Science was revised to strengthen the students' research and development capability as well as deepen the students' knowledge in one of the tracks there in – Computer Security and Computer vision & Image processing.

The PhD in computer Science program aims at building on the expertise in the masters program to lay ground for the production of world class researchers and innovators in the areas Computer Security as well as Computer Vision & Image processing. This is to encompass the basic and applied aspects.

2.2 Research in the Department of Computer Science

Being rather young, the Department of Computer Science does not have a long research history. In its early years, the department lacked staff with advanced degrees to create a critical mass to do substantial research. This was addressed by attracting staff with PhDs as well as training the existing staff to PhD level. Currently, the department has 4 PhD holders while 8 members of staff are undertaking doctoral studies. The research activities in the department are therefore on the raise. The department is currently focusing its research efforts into selected priority areas. These are[1]

(i) Computer Security
(ii) Computer Vision & Image Processing
(iii) Study and Optimization of Operational Systems
(iv) Theoretical Foundations of Computing

The department therefore aims at being a center of research excellence in these priority areas. A big portion of its teaching and research at Masters and Doctoral focuses on these areas so as to increase the capacity with in the department as well as the impact in industry. The revision of the PhD curriculum therefore aims at streamlining further the teaching and research capacities with in the department so as to meet the departmental research strategy. This also fits into the broader 10 year university strategy in terms research, innovations, knowledge creation and knowledge dissemination.

2.3 Basis for Revision of the program

[1] The choice of these areas was guided by the current regional and international trends in the Computing field

The PhD curriculum has been revised so as to

(i) Focus the research efforts into smaller areas of strategic importance to day and in the future. The areas are
   a. Narrow enough create a unit specialized enough
   b. Wide enough to sustain large research effort over a medium term period

(ii) Equip candidates with prerequisite knowledge on state of the art in their areas of research so as to ease the process of their research

(iii) Equip students with skills and techniques to carry out high quality research expected from a world class university

3. The Revised Programme

3.1 Objectives

The objectives of the PhD (Computer Science) by Coursework and Research programme are to: -

k. Build human resource capacity in the area of computer science in both the public and private sectors, especially in universities;
l. Develop research capacity in the areas of computer science so as to improve research and innovations output in the country and region
m. Address the increasing demand for PhD holders in the areas of computer science
n. Provide masters holders with potential for PhD with opportunities to develop skills in formulating, conducting and presenting their own scholarly research through the production of a research-based dissertations and publications.
o. Foster initiative and potential for independent self-study that will develop the students' motivation and ability to continue updating their knowledge and skills after completion of the course of study in relation to scholarship and research.
p. Enable the students to be able to demonstrate a critical awareness and reflection on research-based information as a basis for problem solving and practice in professional contexts.
q. Enable students to be able to demonstrate ability to interpret and report research findings in areas relevant to their field of study.
r. Equip students with research and publication skills to enable them publish research from high quality dissertations in reputable journals and/ or presentation of their research findings at academic conferences

3.2 Duration

The duration of the PhD Programme is four academic years (8 semesters).

3.3 Tuition

The tuition of the program shall be 3,875,000 Uganda Shillings per year for Ugandan students and 3,500 United States Dollars per year for International students.

3.4 Programme Duration

The program duration shall be four academic years. One academic year shall be for coursework and research proposal writing and three years shall be for research and thesis writing.

3.5 Target Group

The programme targets holders of a Masters in Computer Science and related fields. Holders of other masters degrees may be considered if there is substantial evidence that they have, by virtue of their work or research, acquired sufficient advanced knowledge in Computer Science.

3.6 Admission Requirements

To qualify for admission on the program, the candidate should have

(i) A good Masters degree in Computer Science or a closely related field

(ii) Any Masters degree with evidence of acquisition of sufficient advanced knowledge in computer science by virtue of research or work

3.7 Weighting and Semester Load

The weighting unit is a Credit Unit (CU). The credit unit is a contact hour per week per semester. A contact hour is equal to (i) one lecture hour (LH) (ii) two practical hours (PH) (iii) two tutorial hours (TH). The semester load is between 9 and 15 credit units. The minimum graduation load is 18 credit units done in the first year of the program

3.8 Core and Elective Courses

A major is the subject/ field/ programme of specialization. A core course is compulsory course for the major and an elective course is an optional course for the major.

3.9 Assessment

Assessment will be in form of writing technical reports, reviewing literature, critiquing papers or any other approach a student can use to demonstrate in-depth understanding and synthesis of academic matter. The approach used will depend on the course unit being studied.

3.10 Graduation Requirements

To qualify for the award of the degree of Doctor of Philosophy (Computer Science), a candidate is required to obtain a minimum of 18 credit units for courses passed including all the compulsory courses and the PhD Dissertation within a period stipulated by Makerere University Senate/ Council.

Let LH, CH, and CU stand for Lecture Hour, Contact Hour, and Credit Unit respectively.

3.11 Curricula Review

The major changes in the revised curricula include:

(a) The semester load in first year has been reduced from 12 CU to 9 CU to allow students more time to undertake individual study.
(b) The MCS 9100- Philosophy of Computing and IT has been merged with MCS 9200-Philosophy of Science and Computing Research to form PCS9101 Philosophy of Computing.
(c) MCS 9102 - Advanced Research Methods in Computing and IT has been strengthened by including other research methods to form PIT 9201- Advanced Research Methods.
(d) Three new Specialised Computer Science courses were developed to cater for the specialised research areas within the department

Code	Name	Assessment Method	LH	CH	CU
Semester I					

PSE 9101	Science of Computer Programming	Presentations 40% Scientific review paper -60%	45	45	3
PCS 9101	Philosophy of Computing	Presentations 40% Scientific review paper -60%	45	45	3
PIT 9102	Advanced Research Methods	Presentations 40% Scientific review paper -60%	45	45	3
Semester II: 1 Core Course					
PIS 9203	Presentations, Scientific Writing and Research Ethics	Presentations 40% Scientific paper -60%	45	45	3
2 Elective Course					
PCS 9201	Advances in Digital Security	Presentations 40% Scientific review paper -60%	45	45	3
PCS 9202	Advances in Computer Vision &Image Processing	Presentations 40% Scientific review paper -60%	45	45	3
PCS 9203	Advanced Applied Queuing Systems	Presentations 40% Scientific review paper -60%	45	45	3
PSE 9201	Models of Software Systems	Presentations 40% Scientific review paper -60%	45	45	3

3.12 Grading, Pass mark and progression

Grading will be done on the final score of each course unit using the ranges below

Marks	Letter Grade	Grade Point	
90-100	A+	5	Exceptional
80-89	A	5	Excellent
75-79	B+	4.5	Very Good
70-74	B	4	Good
65-69	C+	3.5	Fairly Good
60-64	C	3	Pass
55-59	D+	2.5	Marginal Fail
50-54	D	2	Clear Fail
45-49	E	1.5	Bad Fail
40-44	E-	1	Qualified Fail
0-39	F	0	Qualified Fail

A student with a grade point greater or equal to 3 (Letter grade C) in a certain course is considered to have passed the course unit.

The following additional letters will be used, where appropriate: -

W - Withdraw from Course;
I - Incomplete;
P - Pass;
F - Failure.

3.13 Minimum Pass Mark

A minimum pass grade for each course shall be 3.0 grade points.

3.14 Calculation of Cumulative Grade Point Average (CGPA)

The CGPA shall be calculated as follows: -

$$CGPA = \frac{\Sigma^{n}_{i=1}(GP_i * CU_i)}{\Sigma^{n}_{i=1} CU_i},$$

Where GP_i is the Grade Point score of a particular course i;
CU_i is the number of Credit Units of course i; and
n is the number of courses so far done.

3.15 Normal Progress

A student is considered to be under normal progression if he/she has a grade point of at least 3 in each of the courses that make his/her full semester load.

3.16 Probationary

A student is under probational progress if he/she has at least a course unit in his/her full semester load where the grade point is less than 3

3.17 PhD Dissertation

Students are required to demonstrate their ability to independently formulate a detailed dissertation proposal, as well as develop and demonstrate their dissertation thoroughly.

a. A candidate shall be allowed to formally start on the dissertation after completion of the coursework part.
b. A candidate shall submit a dissertation proposal to the Faculty of Computing and Information Technology Higher Degrees Committee during the first semester of the first academic year.
c. The candidate shall execute the dissertation after acceptance of the dissertation proposal.
d. The candidate shall be required to submit reports of progress to the Faculty Higher degrees committee every 6 months
e. The candidate shall, in the process of PhD research, publish at least three peer reviewed articles one of which must be in a specialised journal/conference
f. The candidate shall submit a dissertation report before the end of the fourth year (8^{th} semester).

To pass the Dissertation, the candidate shall satisfy the Internal Examiner, External Examiner, and Viva Voce Committee independently.

3.18 Discontinuation from the Program

A student shall be discontinued from the program if

(i) He/she fails to get a grade point of at least 3.0 from any course unit for three sittings
(ii) By the end of the third semester, he/she does not have an approved research proposal
(iii) Without a credible reason, he/she fails to submit the 6 monthly reports two consecutive times
(iv) The candidate shows no substantial progress for two academic years
(v) Overstays on the program for more than two years
(vi) Fails to pass on the third submission of the dissertation

4. The Revised Curriculum

4.1 Areas of Research

The curriculum focuses on four research areas

1. Theoretical Computer Science
2. Computer Security
3. Computer Vision and Image Processing
4. Modeling and Optimization of Operational Systems

Graduates from the program are expected to have a high level of competence in one of them. At the same time, the curriculum focuses on equipping students with skills in

(i) Technical writing and presentations

(ii) Research project writing and management

(iii) Advanced Research Methodology

4.2 The curriculum

Code	Name	LH	CH	CU
Semester I: 3 Core Courses				
PSE 9102	Science of Computer Programming	45	45	3
PCS 9101	Philosophy of Computing	45	45	3
PIT 9102	Advanced Research Methods	45	45	3
Semester II: 1 Core Course				
PIS 9203	Presentations, Scientific Writing and Research Ethics	45	45	3
2 Elective Course				
PCS 9201	Advances in Digital Security	45	45	3
PCS 9202	Advances in Computer Vision &Image Processing	45	45	3
PCS 9203	Advanced Applied Queuing Systems	45	45	3
PSE 9201	Models of Software Systems	45	45	3
Semester III, IV, V , VI, VII, VIII				
	Independent Research, Publication, and dissertation compilation			

4.3 Detailed Courses

4.3.1 PSE 9102: Science of Programming (3CU)

a) Course Description

This course introduces foundational concepts and techniques of programming languages. We use typed λ-calculi and operational semantics as models of programming language concepts. These models are applicable to the design, analysis, and implementation of programming languages. We demonstrate the utility of a mathematical approach to programming languages in answering questions about program correctness, the pro's and con's of various languages, compiler correctness, and other practical issues. We focus on two of the most successful styles of semantic description: denotational and operational. We deal with small "core" languages, each chosen to illustrate a specific paradigm. We use semantics to prove properties of a language, to analyze programs, to design correct programs, to prove correctness of compiler optimizations, and to prove general laws of program equivalence.

b) Aims

The objective is to

- To study formal techniques for describing computation and compilation.
- Provide a more general understanding of programming languages, specification, logic, mathematics, and proof theory.
- Apply formal reasoning to nondeterministic programs and to concurrent programs, and provide an introduction to reasoning about distributed systems (temporal logic).

c) Learning Outcome

At the end of the course students will be able to: describe and relate different programming paradigms and the mathematical models on which they build; select appropriate methodology to use in the final research work and dissertation.

d) Learning and Teaching

Classes are held as a group discussion. Reading material which includes journal papers is distributed a week in advance, and students take it in turns to research and present new topics. The lecturer addresses questions to the students to encourage them to think about and understand the material. The lecturer should become aware of the students' proposed topics of research so that the discussion

explores how the principles in the course apply to these topics. The students make presentations of their review paper for critique from both the students and the lecturer.

e) Indicative Content

- Inductive definitions.
- Static and dynamic semantics.
- Type safety.
- Function, product, and sum types.
- Universal types and polymorphism.
- Existential types and data abstraction.
- Recursive types.
- Object types.
- Sub typing.
- Equational reasoning.
- Type inference and unification
- denotational and operational, referential transparency, criteria for choosing models
- Sequential imperative programs: state transformations, partial and total correctness, traces and runtime
- Machine language: jumps and continuations, compiling sequential pro-grams, correctness of compiler optimizations
- Parallel programming: data ow networks, shared-memory parallelism, communicating processes, safety and liveness, fair execution
- Functional programs: types and polymorphism, call-by-value, direct-and continuation-style semantics

f) Assessment

Progressive assessment will be based on the quality of presentations in class by each student. The final assessment will be based on a scientific review paper.

g) Reading

I. John C. Reynolds. Theories of Programming Languages. Cambridge University Press, 1999.
II. Glynn Winskel. The Formal Semantics of Programming Languages. MIT Press, 1993.
III. John C. Mitchell. Foundations for Programming Languages. MIT Press, 1996.

IV. Martin Abadi and Luca Cardelli. A Theory of Objects. Springer-Verlag, 1996.
V. Jean-Yves Girard. Proofs and Types. Cambridge University Press, 1989.

4.3.2 PCS 9101: Philosophy of Computing (3CU)

a) Description:

This course explorer the philosophical foundations of the computing field. It explores the computational understanding of the major parameters that make up and support the computing field. It explores their foundations and philosophical underpinnings.

b) Aims and Objectives

The aims of the course are:

- To give students an avenue of exploring the philosophical foundations of computing as an academic field
- To give students the historical foundation of computational thinking and interpretation
- To expose students to the philosophical thinkings of the different areas of computing

c) Learning Outcomes

By the end of the course, the students should be able to:

- Explain the philosophical foundations of computing
- Explain the foundations of theoretical thinking and interpretations
- Explain the philosophical thinkings of the different fields of computing

d) Teaching and Learning patterns

Teaching will be by lectures, group work, group discussions and presentations

e) Indicative content

- Mind and Artificial Intelligence (AI): The philosophy of artificial intelligence and its critique, computationalism, connectionism and the philosophy of mind

- Real and virtual worlds: Ontology, virtual reality, the physics of information, physics as a traditional model of the ideal science of the philosophy of science, cybernetics and artificial life
- Language and knowledge: Information and content, knowledge, the philosophy of computer languages, hypertext.
- Logic and probability: probability in artificial intelligence, game theory – Nash equilibrium

f) Assessment

Assessment will be by take-home assignments and presentations. Students will be given tasks to read and write about then present in class. The lecturer will award marks for the final a final scientific review paper.

g) References

I. Floridi, Luciano (1999) *Philosophy and Computing: An Introduction*. Routledge: London / New York.

II. Bynum, Terrel Ward; Moor, James H. (2000) *The Digital Phoenix: How Computers are Changing Philosophy*. Blackwell Publishers: Oxford, UK.

III. Colburn, Timothy R. (2000) *Philosophy and Computer Science*. M.E. Sharpe: Armonk, NY, USA

4.3.3 PIS 9101: Presentations, Scientific Writing and Research Ethics

a) Description:

Most PhD students struggle with scientific writing and presentations in English, and normally much time in a PhD study is spent revising papers and preparing for conference talks. Given the amount of time that PhD students spend writing and preparing to present, students should invest in a systematic study of scientific writing and presentations. The course deals with the publication process from the perspectives of the author of a scientific paper and the editor of a scientific journal. It is intended for PhD students in the fields of computing and Information technology, engineering and natural sciences.

b) Aims and objectives: The aim is to give the participants the following:

- awareness of the importance of scientific writing,
- motivation to write scientific papers, and

- Prerequisites for publishing in first-class scientific journals.

c) Learning outcomes: At the end of this course, students will be able to:

- Make a quality conference presentation
- Write a quality journal article
- Appreciate ethics-related issues when writing a scholarly/scientific paper.
- Understand the prerequisites for choosing the market for publishing

d) Teaching and learning patterns: Classes are held as a group discussion. Reading material which includes books and journal papers on scientific writing and ethics are distributed a week in advance, and students take it in turns to research and present. The students are also given reading material on how to make excellent presentations. The lecturer addresses questions to the students to encourage them to think about and understand the material. The classes will also include viewing of recorded seminar presentations by leading academics in the field.

e) Indicative content:

- Science and writing. Reports and scientific publications. The IMRAD format. Scientific journals. Why, what, when, with whom and where publish?
- Structure of a scientific paper. The different parts of a scientific paper. Language and style. The publication process. Writing a paper. Dealing with editors, reviewers and publishers.
- Critical review of scientific papers by groups of participants.
- General principles of expository writing, pre-writing and planning. Typical formats, structure and language for scientific writing, emphasis on scientific articles as published in (primary) international scientific journals. English grammar essential to scientific papers. Designing tables, figures and graphs for scientific papers. Good style for readability. The refereeing and publishing process, what referees are looking for, how to deal with editors. Paragraphing, linking paragraphs to make the logic clear. Writing informative abstracts and crafting clear titles.
- Ethics: Honesty and credibility in scientific writing.

f) Assessment: Progressive assessment will be based on the quality of presentations in class by each student. The final assessment will be based on a scientific review paper.

g) **References:**

I. How to write and publish a scientific paper, Robert A. Day and Barbara Gastel, ISBN:0-313-33027-1, 6TH Edition, 2006.

II. Research ethics, edited by Anna Smith IItis, 1st Edition, 2006.

III. The student's guide to research ethics, Oliver, 2003.

4.3.4 PIT 9201 Advanced Research Methods

(a) Course Objectives: the objectives of this course are to provide:

(i) Philosophical underpinnings of research in computing and IT

(ii) Practical aspects on doing research

(b) **Learning outcome:** At the end of the course the students will be able to apply computing and IT research methods in their research

(c) **Course Content:** The first part of the course is devoted to the philosophical underpinnings of research, which crucially influence choice of research methods and interpretations of data. The course then moves on to the more practical aspects of 'doing research' - looking at developing a research strategy as well as ways of collecting data, analysing data and communicating research findings. This course will also give guidance to students on how to identify a research problem. Students will be presented with various research paradigms and models of methodology and assisted with designing an appropriate method for their research. Students will be trained in the analysis and presentation of results, exposition of processes and methods used and conclusions drawn.

Key philosophical and epistemological bases for research are explored, and alternative methodologies are examined in relation to varied theoretical approaches. Selected sets of methods and techniques are critically appraised, while the range and scope of techniques with which students are familiar is extended. The structure of the course aims to achieve a balance between theory and practice. Considerable emphasis is therefore placed upon the logistics of setting-up, doing and disseminating research. The course not only introduces a range of research ideas and skills central to sound socio-environmental enquiry in general, but also acts as a critical and practical research forum where discussion and preparation for the PhD dissertation takes place.

(d) **Teaching and Learning pattern:** Classes are held as a group discussion. Reading material which includes journal papers is distributed a week in advance, and students take it in turns to research and

present new topics. The lecturer addresses questions to the students to encourage them to think about and understand the material. Each student undertakes a review of the different research methodologies and makes a presentation before the class. The students will identify researchable problems from which they will apply the concepts taught in class with an aim of producing research proposals by the end of the semester. The students will be required to build on their proposals on a weekly basis in line with the new concepts that will be taught. The students will make presentations of their draft proposal for critique and feedback from both the students and the lecturer.

(e) **Assessment method:** Evaluation shall be based on presentations from a variety of reviewed papers and a research proposal produced by the end of the semester.

(f) References

I. Qualitative research and evaluation methods; By Michael Quinn Patton; Edition: 3, illustrated; Published by SAGE, 2002; ISBN 0761919716, 9780761919711; 598 pages.

II. Research Design & Statistical Analysis; Third Edition; By Jerome L. Myers, Arnold D. Well, Arnold D. Well, Robert F. Lorch, Jerome L. Myers; Pages: 736**;** Published by: Routledge; Publication Date: 1st November 2002; ISBN: 978-0-8058-4037-7

III. *Are Your Lights On? How to Figure out what the Problem Really Is,* by Donald C Gause and Gerald M Weinberg, Dorset House, USA, 1990. A brilliant book about getting ready to make decisions.

IV. Bordens, K.S. & Abbott, B.B. (1988) Research design and methods: A process approach. Mayfield.

4.3.5 PCS 9201: Advances in Digital Security (3CU)

a. Description

This course aids students to explore in depth selected areas in digital security. It helps them get the general knowledge as well as getting an in-depth knowledge of the current state of practice. It also guides them in making in depth reading so as to be able to critique recent research works as well as identify some existing research gaps.

b. Aims

The aims of the course are to:

- Equip students with the general state and challenges in security of computer systems
- Assist students explore the current state of the art in selected aspects of digital security
- Assists students make deep analysis of the current literature in digital security and identify research gaps

c. Learning outcomes

By the end of the course, the students should be able to

- Comprehensively elaborate the typical security challenges in the digital world today
- Explain ways of attack and techniques of defense on software, hardware and data
- Have an in-depth understanding of the current research trends in some areas of digital security
- Comprehend and critique state of the art research findings in digital security

d. Teaching and Learning Patterns

The lecturer will chose an area and subject matter to be focused on over a period of time and ask students to do the reading. The lecturer will provide the main reading materials (like journal papers, books, technical reports). The students will do the reading; write their findings (like critique, technical report, etc). The students will make the write up and presentations in class.

e. Indicative content

- Advances in software security
- Advances in hardware security
- Advances in cryptosystems

f. Assessment method

Assessment will be by evaluating the students write ups and presentations. For each write up and presentations, the lecturer will award marks depending on the extent to which the objectives of the assignment has been met. The lecturer will also award marks on the extent to which the student demonstrates his/her mastery of the subject matter during presentations and final write up of a scientific review paper.

g. Reading lists

Reading materials will largely be got from the publications in journals and conferences of digital security. These include:

- International conference on privacy , security and trust
- Security Journal
- Journal of Computer Security
- International journal of Information Security
- International journal of applied cryptography

4.3.6 PCS 9202: Advances in Computer Vision &Image Processing

a. Description

This course gives students exposure to cutting edge research in the fields of image processing, computer vision, machine learning, pattern recognition and computational statistics. It examines common methodologies in these fields. It also examines current research trends in these fields

b. Aims/Goals

By the end of the course, students should:

- Become familiar with major areas of research within the fields of image processing and pattern recognition
- Become familiar with established methodologies and tools which are used in recent mainstream research in these fields.
- Narrow down a topic of interest which would be suitable for PhD research.
- Be able to critically evaluate the strengths and weaknesses of a research paper in image processing.
- Specific topics are to be selected based on the interests of students,
- who would generally be expected to have some exposure to these fields
- (e.g. having studied the M.Sc. courses on Image Processing and Computer
- Vision, Pattern Recognition). These could include such areas as:

c. Learning outcomes

By the end of the course, the student shall be able to

- Identify the current trends in the specific areas of computer vision and image processing
- Make a critical review of current literature in selected areas of computer vision and image processing
- Identify realistic open research areas in the areas of computer vision and image processing

d. Teaching and Learning patterns

The course will generally take the form of a reading group. Papers are selected in advance each week, and students take it in turn to lead a discussion through that paper, explaining the methodology used and identifying its strengths and weaknesses. The lecturer is on hand to

Moderate the discussion, to provide explanations of difficult material (e.g. mathematical techniques which students are not familiar with) and to correct any misunderstandings which arise.

The course will also make use of video lectures available online (e.g. from www.videolectures.net, which is particularly strong on machine learning material). Students should watch these videos of research presentations or tutorials in their own time, and then the class meets to discuss and compare notes.

e. Indicative content

- Feature extraction, scale/rotation invariant feature transforms
- Mathematical morphology
- Dynamical models
- Multi target tracking
- Bayesian modeling, graphical models
- Data mining
- Ensemble methods
- Structure learning
- Image segmentation

f. Assessment Method

Students should identify at least one core paper, which is a high-impact recent publication that they think will be relevant to their PhD research. Assessment is based on presentations made during class and a short research

paper with a critical literature review of their core papers and surrounding literature, and accompanying seminar presentation.

g. Reading lists

Papers for reading each week are to be selected according to specific interests, from recent papers in significant conferences and journal including the following:

- Transactions on Pattern Analysis and Machine Intelligence
- IEEE International Conference on Computer Vision and Pattern Recognition
- IEEE International Conference on Acoustics, Speech and Signal Processing
- International Conference on Machine Learning
- Machine Learning
- Advances in Neural Information Processing Systems

4.3.7 PCS 9203: Advanced Applied Queuing Systems (3CU)

a. Description

Most of the interesting questions in Computer Science in some way involve finding an optimal solution to some problem given a set of constraints. This course gives students exposure to cutting edge research in the fields of optimization, combinatorics, graph theory, resource allocation, scheduling and applications.

b. Aims

By the end of the course, students should:

- Become familiar with major areas of research within the theory and application of optimization.
- Identify the shortcomings of different optimization methods and where the research opportunities are in terms of extending/modifying existing systems or applying them to new types of data.
- Narrow down a topic of interest which would be suitable for PhD research.
- Be able to critically evaluate the strengths and weaknesses of a research paper in optimization.

c. Learning outcomes

By the end of the course, the student should:

- Demonstrate sufficient knowledge on the application of queues in real life problems
- Have knowledge on the approaches of solving queue based problems
- Have knowledge on the current research trends in queuing systems

d. Teaching and Learning Patterns

Teaching and Learning will be by study groups. The Teacher will identify the papers and students will study, analyze and report on the papers. They will

e. Indicative content

- Network flow algorithms and their applications,
- Transportation problem and its variants
- Multi objective optimization
- Formulation of large optimization problems

f. Assessment methods

Students will present and write technical reports in selected areas of the course. The depth and expectations shall be prescribed by the lecturer conducting the course. Such expectations can be identification of gaps, describing the state of the art/practice or critiquing a certain paper/set of paper. The student's score in at least two presentations and technical reports will constitute the score.

g. Reading lists

Students will read papers from existing high quality journals/conferences in the broad area of optimization. These include but not limited to

- Journal of Optimization Theory and Applications
- Queuing Systems: Theory and Applications
- European Journal of Operations Research

4.3.8 PSE 9201: Models of Software Systems (3CU)

a) Course Description

Scientific foundations for software engineering depend on the use of precise, abstract models for characterizing and reasoning about properties of software systems. This course considers many of the standard models for representing sequential and concurrent systems, such as state machines, algebras, and traces. It shows how different logics can be used to specify properties of software systems, such as functional correctness, deadlock freedom, and internal consistency. Concepts such as composition mechanisms, abstraction relations, invariants, non-determinism, inductive definitions and denotational descriptions are recurrent themes throughout the course.

b) Aims

By the end of the course you should be able to

- understand the strengths and weaknesses of certain models and logics, including state machines, algebraic and trace models, and temporal logics.
- to select and describe abstract formal models for certain classes of systems. to reason formally about the elementary properties of modeled systems

c) Learning Outcome

At the end of the course students will be able to: describe and relate different models of software systems; select appropriate methodology to use in the final research work and dissertation.

d) Learning and Teaching

Classes are held as a group discussion. Reading material which includes journal papers is distributed a week in advance, and students take it in turns to research and present new topics. The lecturer addresses questions to the students to encourage them to think about and understand the material. The lecturer should become aware of the students' proposed topics of research so that the discussion explores how the principles in the course apply to these topics. The students make presentations of their review paper for critique from both the students and the lecturer.

e) Indicative Content

- what is a model?
- Foundations Logic, Proof Techniques
- Sets, Relations, Functions, Proof Techniques
- State Machines ,Variations , FSP and LTSA , Reasoning about State
- Machines
- Z Techniques
- Refinement & Abstraction
- Modeling Concurrency in FSP , Modeling Techniques, Reasoning about Concurrency,
- Model Checking Linear Temporal Logic, Promela/Spin
- Petri Nets
- UML

f) Assessment

Assessment will be by take-home assignments leading to presentations and a scientific review paper. Students will be given tasks to read and write about then present in class. The lecturer will award marks for each write up of a scientific review paper.

g) Reading

- Concepts and Notations for Concurrent Programming," Andrews and Schneider. Computing Surveys, Vol. 15, No. 1, March 1983.
- "Formal Methods: State of the Art and Future Directions", ACM Computing Surveys, Vol. 28, No. 4, December 1996, pp. 626-643. Available as CMU-CS-96-178.
- "Statecharts: a visual formalism for complex systems." D. Harel. Science of Computer Programming, 8:231-274, 1987.
- "FAA En Route Resectorization - A Formal Specification." V.J. Harvey, and P.R.H Place. Unpublished manuscript, September 1999.
- "Coloured Petri Nets: A High Level Language for System Design and Analysis." K. Jensen. In High-level Petri Nets: Theory and Application. K. Jensen and G. Rozenberg (eds.) Springer-Verlag, 1991.
- "Temporal Logic." Draft version of chapter from book in preparation. 1996.
- Concurrency: State Models and Java Programs. J. Magee and J. Kramer. Wiley, 1999.
- "Petri Nets." J. L. Peterson. ACM Computing Surveys, Sept 1977.
- Software Engineering Mathematics. J. Woodcock and M. Loomis, Addison-Wesley 1988.

5. Budge

Income: 5 students each paying UGX 3,000,000 => UGX 15Million.

Expenditure:	**UGX**	**15,000,000**
Teaching Materials	UGX	1,250,000
Research Materials	UGX	2,500,000
Teaching allowances	UGX	6,750,000
Administrative allowances	UGX	750,000
Attending conferences	UGX	2,500,000
Expenditure at the centre	UGX	1,250,000

6. Staff

Code	Name	Assessment Method	Staff
PSE 9102	Science of Computer Programming	Presentations 40% Scientific review paper -60%	Dr John Quinn
PIS 9203	Presentations, Scientific Writing and Research Ethics	Presentations 40% Scientific review paper -60%	Dr. Agnes Rwashana Semwanga
PIT 9101	The Philosophy of Computing	Presentations 40% Scientific review paper -60%	Dr. John Ngubiri
PIT 9102	Advanced Research Methods	Presentations 40% Scientific research proposal -60%	Dr. Josephine Nabukenya
PCS 9201	Advances in Digital Security	Presentations 40% Scientific review paper -60%	Dr John Ngubiri
PCS 9202	Advances in Computer Vision and Image Processing	Presentations 40% Scientific review paper -60%	Dr Jose Quenum
PCS 9203	Advanced Applied Queuing Systems	Presentations 40% Scientific review paper -60%	Dr John Quinn
PSE 9201	Models of Software Systems	Presentations 40% Scientific review paper -60%	Dr. Benjamin Kanagwa