MAKERERE UNIVERSITY

COLLEGE OF COMPUTING AND INFORMATION SCIENCES

SCHOOL OF COMPUTING AND INFORMATICS TECHNOLOGY

DEPARTMENT OF NETWORKS

P.O. BOX 7062, KAMPALA, UGANDA

REVISED MASTER OF SCIENCE IN DATA COMMUNICATIONS AND SOFTWARE ENGINEERING (MDCSE) DEGREE PROGRAMME

MARCH 2019

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1 Introduction

The ICT industry continues to change not only in Uganda, but Globally. Mobile communications technologies are booming due to the high demand for ubiquitous services. To harness the benefits of mobile infrastructures, we require having local content and service developers. The rise of the "Internet of Things (IoT)" concept in recent year has gained enormous momentum, and is now one of the most popular topics in technology. It is projected that there will be approximately 26 Billion connected devices by 2020, meaning programmes need to consider this new paradigm. Makerere University and CoCIS missions emphasize world class teaching and research that is relevant not only for the region, but globally.
The programme emphasizes all aspects of learning, i.e., theory, research, practical and hands-on skills, transferable skills, group working, and so forth with a view to build a world-class and competitive research oriented programme. The goal is to fulfill the needs of the booming communication technology industry such as advanced high speed network infrastructure, relevant and innovative services, as well as the needs for skilled researchers.

Whereas the previous curriculum for the M.Sc. DCSE programme had three tracks and two plans (Plan A and Plan B), this revised curriculum takes two tracks and maintains the two plans that focuses more on the emerging developments in datacommunication and software engineering discipline and research-oriented work in the second year for plan A while plan B focuses on multi disciplinary industrial solutions as projects. The revisions in this curricullum have been based on several concerns observed during the implementation of the previous curriculum (2009/2010 - 2018/2019) among others including: the need to improve and increase research capacity and productivity leading to innovation development in Uganda; as Makerere University continues striving to become a research-led University.

1.1 Background

1.1.1 College of Computing and Information Sciences (CoCIS)

The College of Computing and Information Sciences (CoCIS) was established by the University Council in 2011 by combining the then Faculty of Computing and Informatics Technology (renamed School of Computing and Informatics Technology) together with the East African School of Library and Information Science.

CoCIS Vision: To be a leader in computing and information sciences education, research and services internationally.

CoCIS Mission: To provide first class teaching, research and services in computing and information sciences responsive to national and international needs.

1.1.2 School of Computing and Informatics Technology (SCIT)

The School of Computing and Informatics Technology (SCIT) in the College of Computing and Information Sciences, Makerere University is the main centre for ICT training, research and consultancy in Uganda. SCIT grew out of the Faculty of Computing and Informatics Technology following the adoption of the collegiate system by Makerere University in 2010. The then Faculty of Computing and Informatics Technology had been earlier 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 Academic Departments, namely: Computer Science, Networks, Information Technology and Information Systems. The Institute of Computer Science that was established by the University Council in 1985 grew out of the University Computer Centre.

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

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

SCITs Value Statement: To be an innovative and industry-oriented School, pursuing excellence in teaching, learning, cutting edge value-added research and consultancy, community outreach, as well as providing a vibrant student life.

1.1.3 Department of Networks

The Department of Networks is currently responsible for running programmes in the following areas: Data Communications Engineering; Software Engineering; Hardware Engineering; Network and System Administration; Network Planning, Design and Management; Data Communication Networks; ICT Policy and Regulation; and related areas. The Department currently runs the following programmes approved by National Council for Higher Education through the University Council:

(i) PhD in Software Engineering;

(ii) Master of Science in Data Communications and Software Engineering (MDCSE) (Communication Networks and Mobile Technologies option; and Software Engineering option);

(iii) Postgraduate Diploma in Data Communications and Software Engineering (PGDCSE) (Communication Networks and Mobile Technologies option; and Software Engineering option);

(iv) BSc. Software Engineering

In addition, members of the department participate in and support research through two research groups:

(i) Networked Systems and Systems Security (NetS);

(ii) The Software Systems Center (formerly Software Engineering Research Group);

1.2 Rationale for Revision of the MDCSE Programme

The MDCSE started running in the academic year 2006/2007 and was last revised in 2009. National Council for Higher Education (NCHE) recommends revision of academic programmes every after three years. In addition, with the continuously changing Information and Communication Technology field and an economy that is based on dynamic skills, we realized a need for revising the curriculum to update our programme and provide the best for our graduates. We understand that for us to achieve an effective curriculum revision, it requires a thorough understanding of the processes and principles of the changing paradigms affecting curriculum development. In lieu of this, we considered various aspects in this process including:

(i) Requirement from NCHE to review academic programmes every after 3 years

(ii) A review of the trends which did not exist at the time of the old curriculum. This was done via faculty discussions, particularly the need to: a)focus on research in strategic areas of importance to the regional and international trends and needs; b) equip students with skills and techniques to carry out high quality research.

(iii) Market analysis: We undertook a preliminary market analysis to evaluate the attractiveness and the dynamics of the Communication Networks and software Engineering Market within East Africa. Special attention was put on the kind of jobs/roles being advertised

within this market segment and the different skills set that are being sought. We compared this with the Internship feedback obtained from our industrial partners where our students get posted. With this information, we were able to identify the opportunities, strengths, weaknesses and threats of our programme.

(iv) To remove redundancy that existed in the previous curriculum eg. reduced from three knowledge areas (tracks/options) to two focused knowledge areas.

(v) Industrial and Alumni feedback: We also held workshops with industrial partners to generate input into this review process. In particular, key stakeholders and experts from regulatory authorities, industry and academia were invited to evaluate our current programme. The feedback generated in this final phase of this process was very important in reconsidering certain content of the courses we have been offering.

(vi) Benchmarking similar programmes in professional bodies (e.g. Association of Computing Machinery) and recognised Universities regionally and internationally.

(vii) To expand the depth and breadth of the content in tracks on the MDCSE.

1.3 Fundamentals of the Revised MDCSE Programme

The revised MDCSE programme has two options:

- Communication Networks and Mobile Technologies
- Software Engineering

The Communication networks and Mobile Technologies option shall cover aspects such as: computer networks, wireless and mobile networks, sensor networks, Internet-of-things (IoT) as well as Mobile communication, network security and wireless security.
The Software Engineering option covers new trends in secure software, advanced software architectures, service-oriented software design and Domain-specific Engineering, as well as emphasizing research in formal methods.
Mobile content development, mobile phone programming and mobile service innovation will be covered by students in both options

1.4 Programme Objectives

The objectives of the MDCSE programme are:

(i) To build an advanced human resource capacity in the Data Communication and Software Engineering discipline in both public and private sectors.

(ii) To foster inter-disciplinary studies which allow the study and application of computational knowledge in non-computational disciplines.

(iii) To address the increasing demand for training at Masters degree level in Data Communication and Software Engineering.

(iv) To develop professionals with theoretical and practical knowledge and skills in Data Communication and Software Engineering.

1.5 Programme Outcomes

(i) Advanced human resource capacity in the Data Communication and Software Engineering discipline in both public and private sectors.

(ii) Multi-disciplinary collaborations and partnerships.

(ii) Increased MSc in Data Communication and Software Engineering graduates.

(iv) Increased expertise in the field of Data Communication and Software Engineering.

1.6 Career Options arising from the MDCSE Programme

Computing professionals might find themselves in a variety of environments in academia, research, industry, government, private and business organizations – analyzing problems for solutions, formulating and testing, using advanced communications or multi-media equipment, or working in teams for product development. Here's a short list of research and vocational areas for MDCSE graduates:

(i) Network Systems Engineering – Network Design, Monitoring and maintenance of network equipment, Notification of all network outages to customers, Troubleshooting and configuration of network device

(ii) Software Engineering – Develop methods for the production of software systems on time, within budget, and with few or no defects.

(iii) Computer Theory – Investigate the fundamental theories of how computers solve problems, and apply the results to other areas of computer science.

(iv) Operating Systems and Networks – Develop the basic software used by computers to supervise themselves or to communicate with other computers.

(v) Software Applications – Apply computing and technology to solving problems outside the computer field - in education or medicine, for example.

(vi) Computer Design and Engineering – Design new computer circuits, microchips, and other electronic components.

(vii) Computer Architecture – Design new computer instruction sets, and combine electronic or optical components to provide powerful but cost-effective computing.

The careers are described in IEEE Computer Society[1] and Computing; ISBN 185824 489 7; Quality Assurance Agency for Higher Education 2000; Published by Quality Assurance Agency for Higher Education, Southgate House, Southgate street, Gloucester GL1 1UB, Tel 01452 557000, Fax 01452 557070, web www.qaa.ac.uk; Printed by Kall Kwik, Gloucester.

2 Research and Development

To make learning more research and development oriented in the curriculum, it is necessary to deliver every course (depending on course type) both core and elective with either a strong research or development bias. In other words, the mode of delivery of respective courses should emphasize on students spending more time researching (including reporting/presenting their work/results) and development rather than keeping in class. This is to enable students to learn

[1] www.computer.org/education/careers.htm

how to conduct research as well as to learn the various research methodologies. The courses in each of the two knowledge areas in the curriculum accommodate research and development components. Regards the development component, courses on IoT, Structure and Interpretation of Computer programmes as well as Mobile software and content development are identified to be taught with a strong development bias using the practical hours as reflected in the curriculum. For the research component, all courses taught in on the curriculum have a theoretical element and some are fully biased to research. The output from the research component are to be considered as research lab papers and will constitute end of semester course work assessment.

3 Programme Description

3.1 Admission Requirements

To qualify for admission, a candidate must fulfill the general Makerere University entry requirements for master's degree, and in addition the candidate must be a holder of either

1. A postgraduate diploma in Software Engineering, Computer Science, Computer Engineering, Telecommuncations Engineering, Electrical and Electronics Engineering or a closely related field from a recognized University/Institution; OR

2. A bachelor's degree in Software Engineering, Computer Science, Computer Engineering, Telecommuncations Engineering, Electrical and Electronics Engineering or a closely related field from a recognized University/Institution.

3.2 Target Group

The programmes is targeted to graduates from Computer Science, Software Engineering, Computer Engineering, Electrical and Electronics Engineering, Telecommunication Engineering who want to gain expert knowledge on communication networks, mobile programming and software engineering.

3.3 Upgrading PGDCSE to MDCSE degree

When a student graduates with a Postgraduate Diploma in Data Communications and Software Engineering (At least Lower Second Class), s/he can apply for the MDCSE to join in second year. In such a scenario, the applicant is expected to either take on Plan A or Plan B. With Plan A, the applicant is expected to undertake research for one year which is equivalent to the second year (semesters III and IV) course load that is covered on the MDCSE programme. With Plan B, the student is expected to undertake the Semester III courses and a project in Semester IV as stipulated in the MDCSE programme.
The upgrading of the PGDCSE to the MDCSE described above must be supported by the relevant academic documents attained from the PGD of Makerere University. This must be done for purposes of analyzing the relevant academic courses that must have been attempted as per the current MDCSE curriculum. Any courses that were not attempted by the applicant as per the first and second semesters course load of the current MDCSE curriculum must be undertaken. On the other hand, when a student graduates with a Postgraduate Diploma in Data Communications and Software Engineering (Pass), s/he can apply for the MDCSE but for two academic years i.e. has to start from first year.

3.4 Nature of the Programme

This is an evening programme that is completely privately sponsored and its duration is two years. Students on the MDCSE Degree Programme will follow either Plan A or plan B study plans.

In the Plan A study programme, students are required to take two semesters of course work and two semesters of dissertation. To start on the plan A research, a student shall have succesfully completed two semesters of course work and have a research proposal latest by the end of semester two.

Students following Plan B are required to take three semesters of coursework and one semester of a project. To qualify for plan B a student shall have completed all their coursework in three semesters and also have a project proposal latest by the end of the third semester.

3.5 Programme Duration

The duration for the MDCSE degree programme is two (2) academic years comprising 4 semesters. Each semester has fifteen weeks of studying and two weeks of examinations.

4 Resources and Infrastructure

4.1 Financial Resources

Tuition fees payable by the students will enable the University to sustain the MDCSE programme. Ugandan (or East African[2]) students are required to pay tuition fees totaling to six Million Ugandan shillings (6,000,000 Ug. Shs) per year. Foreign students are required to pay tuition fees totaling to Four Thousand One Hundred US Dollars ($4,100) per year. Other financial resources include grants from projects and short courses at the CiPSD.

4.2 Administration and Technical Support

The department has a head of department assisted by several coordinators of departmental activities. Further, the department has an administrative assistant to help on different queries that may be raised by students.

To further support community and private partnership the College has a Communications Office that links students and staff to the public. In addition, the College has a Workforce development Office to help and link students to potential employs.

In relation to practicals and Labs, the College has a dedicated ICT services unit to ensure that all ICT facilities are up and running. For student who have their own laptops, there is a wireless access area which is accessible by students anytime. Moreover, each of the Labs has a dedicated Lab assistant and Computer engineer to help students during their free time outside lecture hours.

4.3 Human Resource (Academic Staff)

The Department of Networks has sufficient academic staff to run this programme. Refer to Appendix A for a staff list. Secondly, some cross-cutting courses will be supported by staff from other departments in the School of Computing and Informatics Technology. In addition the full time PhD candidates will conduct tutorials for MDCSE graduate students.

[2]compliance with Uganda government regulations

For a detailed list of academic staff see Appendix A on page 57.

4.4 Physical Facilities

The School of Computing and Informatics Technology is housed in the College of Computing and Information Sciences with 2,500 and 12,000 square meter buildings known as block A and B, respectively.
Block A is mainly administrative, accommodating offices for the administration and teaching staff. The ground floor has a conferencing facility co-shared with AMITY University; Reception at first floor while second floor houses the Information Technology department, Finance and procurement offices, a teaching lab and a lecture room. Third floor houses the networks department, Information systems department, a seminar room for meetings/teaching purposes and Computer sciences department offices for staff while the fourth floor has well furnished seminar room and conference hall, offices including: Dean school of computing and IT, the college principal and deputy principal's offices as well as their administrative assistants, all heads of departments and the kitchen facility, Fifth floor houses the store (logistics and stationary), office of the human resource and also office of the administrative assistants to the dean and heads of department. The sixth floor has a testing centre.
Block B has lecture theaters together the rest of the general and specialized laboratories i.e. Software Development Centre, Multimedia lab, Mobile Applications, students computer labs, among others. The college accounts and registrar's offices are on level 3 while level 5 houses the Center for Innovations and Professional skills development (CiPSD). The main college canteen is on ground floor of the block. The two buildings sufficiently cater for all the lecture and laboratory space requirements at CoCIS. Specifically, CoCIS has thirteen lecture theatres each of 200 square meters (300 seat capacity) of circulation space where students are able to access other services such wireless Internet services.

4.5 Computing Equipment and Software

The CoCIS buildings that house CIT, i.e. Block A and B, have general computing laboratories (for student hands-on training); teaching and specialized laboratories, that are shared amongst the four departments. The School has 7 laboratories each of 800 square meters (1000 seat capacity) and six small laboratories of total area 1200 square meters with a total of approximately 700 computers. All computers in the laboratories are pre-installed with various operating systems and computing applications with a focus on open source applications. The School has access to software for the practical aspects of the programme.

The School of Computing and IT has also 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.

4.6 Use of ICT in availing lecture materials

Currently, Makerere University has an e-learning tool (MUELE) on its Intranet. Initially it was Blackboard but now its Moodle. Students in the Department of networks have adequate access to computers. This creates a good environment for e-learning blended teaching. All courses in the new curriculum will be taught in a blended way. All course materials will be put on the e-learning platform. Staff will, as much as possible, make use of e-learning facilities like discussion forum, blogs and drop boxes. This will increase student activity/participation and

reduce staff effort (e.g. staff will not need to dictate notes). This, in turn, will increase the material covered and taken in by the students.

4.7 Library

Makerere University library supports the College of Computing and Information Science library, which is located on the first level of Block B. The College Library is stocked with up-to-date information resources. The information resources in the College Library have been acquired through purchases made by Makerere University Library and the College of Computing & Information Sciences. Additionally, the University Library has dedicated space for graduate students and provides access to print books, print journals, electronic journal databases, a well-stocked reference section and connections to many online databases like the Uganda Scholarly Digital Library at http://dspace3.mak.ac.ug. The print collection is beefed up by the broad variety of electronic resources provided by the University Library and accessible online at http://muklib.mak.ac.ug. Through the document delivery service, users who fail to get access to full-text articles from the available databases can make requests for articles, which are delivered, to them at no cost. Library users can also access the Online Public Access Catalogue (OPAC) to get bibliographic information about the collections found in the College Library at http://196.43.133.123:8080.

Below is a list of all electronic databases that Makerere subscribes to; a) Institute of Electrical and Electronic Engineers (IEEE)
b) Emerald Insight
c) Springer Verlag
d) Research4life (ARDI & HINARI)
e) Sage Publications
f) E-library (eBook database)
g) Science Direct

5 Programme Regulations

This section reveals regulations specific to the programme. Additional regulations that relate to illness and absence from the programme conduct of examinations can be found in the Graduate hand-book available at Academic Registrar's office, online[3] and at the College of Computing and Information Sciences.

5.1 Grading of Courses

a) Each Course will be graded out of 100 marks and assigned an appropriate letter grade and a grade point as follows:

[3]https://rgt.mak.ac.ug/sites/default/files/GRADUATE%20HANDBOOK%20SEPTEMBER%20%202013.pdf

MARKS %	LETTER GRADE	GRADE POINT	INTERPRETATION
90 - 100	A+	5.0	Exceptional
80 - 89	A	5.0	Excellent
75 - 79	B+	4.5	Very Good
70 - 74	B	4.0	Good
65 - 69	C+	3.5	Fairly good
60 - 64	C	3.0	Pass
55 - 59	D+	2.5	Marginal fail
50 - 54	D	2.0	Clear Fail
45 - 49	E	1.5	Bad Fail
40 - 45	E-	1.0	Qualified Fail
Below 40	F	0	Qualified Fail

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

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

5.2 Minimum Pass Mark

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

5.3 Calculation of Cumulative Grade Point Average (CGPA)

The CGPA shall be calculated as follows: -

$$\text{CGPA} = \frac{\sum_{i=1}^{n}(GP_i \times CU_i)}{\sum_{i=1}^{n} CU_i},$$

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.

5.4 Progression

Progression through the programme shall be assessed in three ways:

5.4.1 Normal Progress

This occurs when a student passes each course taken with a minimum Grade Point of 3.0.

5.4.2 Probationary Progress

This is a warning stage and occurs if either the cumulative grade point average (CGPA) is less than 3.0 and/ or the student has failed a core course. Probation is waved when these conditions cease to hold.

5.4.3 Discontinuation

When a student accumulates three consecutive probations based on the CGPA or the same core course unit(s), s/he shall be discontinued. A student who has failed to obtain at least the pass mark of 60% or Grade Point of 3.0 after the third attempt in the same course unit(s) s/he had retaken shall be discontinued from his/her studies at the University. A student who has overstayed on an academic program by more than two (2) years shall be discontinued from his/her studies at the University.

5.4.4 Re-taking a Course unit or course units

(i) A student shall retake a course unit when next offered in order to obtain at least the pass mark (60%) if s/he had failed the course unit during the first attempt. A student may take a substitute elective course unit where s/he does not wish to retake a failed elective course unit.

(ii) A student who has failed to obtain at least the pass mark of 60% after the second attempt of the same course unit s/he has retaken shall receive a warning.

(iii) Where students miss to sit examinations for justified reasons; they should not be recorded as those who retake when they sit the examinations when next offered.

(iv) A student shall not be allowed to accumulate more than five (5) retake course units at a time. Students are required to register for retake course units first before registering for course units the will be attempting for the first time in that semester and the retake course units should fit into the approved normal load so as to avoid timetable clashes.

(v) Students who have a course unit or course units to retake and where the total credit load for this course unit or course units is more than the set normal semester load for their program will be required to pay additional tuition for the retake course unit(s). Such students will also be required to pay the re-examination fees per retake course unit and the registration fees for that semester.

5.5 Weighting System

The weighting unit is the Credit Unit (CU). A contact hour is equal to; (i) one lecture hour, (ii) two practical hours or (iii) two tutorial hours

5.6 Minimum Graduation Load

To qualify for the award of the degree of MDCSE, a full-time candidate of plan A is required to obtain a minimum of 42 CUs from all courses passed including the core courses and 10 CUs from the Dissertation while plan B is required to obtain a minimum of 58 CUs from all courses passed including the core courses and 5 CUs from the project. All theses should be attained within a period stipulated by the policy of Makerere University, usually not exceeding five (5) years from the date of registration.

5.7 Knowledge Areas Covered in the Programme

The following knowledge areas arecovered in the revised MDCSE Curriculum;

(i) Communication Systems

(ii) Emerging Computer Networks

(iii) Network Applications development

(iv) Ethics and standardsd in Communication networks

(v) Media in communication systems

6 Revised Programme Structure

The revised MDCSE degree programme is an evening programme which shall normally extend over a period of two years and each year will consist of two semesters of 17 weeks each. A full-time student shall not carry less than 18 credit units in any semester. A student on plan A will not carry more than 28 credit units per semester. The proposed programme requires a minimum graduation load of 62 credit units from course work and 20 credit units from the dissertation.

The details of the course structure are shown below, where LH, PH, CH and CU stand for Lecture Hours, Practical Hours, Contact Hours and Credit Units respectively.

The Curriculum for the revised MDCSE has two options as listed below:

6.0.1 MDCSE: Communication Networks & Mobile Technologies Option

Plan A

CODE	COURSE TITLE	CU	LH	PH	CH	New/Current
Semester I (5 Courses)						
4 Core						
MCN7103	System and Network Security	4	60	-	60	Content modified
MCN7106	Mobile Software and Content Development	4	30	60	60	Content modified
MCN7110	Internet of Things	4	30	60	60	New
MCN8104	Network Programming	4	30	60	60	Content modified*
1 Elective						
MCN7105	Structure and Interpretation of Computer programs	4	30	60	60	Content modified
MCN7111	Telecommunications Policies and Standards	4	60	-	60	New
Total Credit Units=20						
Semester II (5 Courses)						
4 Core						
MCN7210	Advanced Computer Networks	4	30	60	60	New
MCN7202	Wireless and Mobile Networking	4	30	60	60	New
MCN7212	Network Simulation & Performance Evaluation	4	30	60	60	New
MIT7116	Research Methodology	4	60	-	60	Content modified*
1 Elective						
MCN7214	Optimisation of Communications Systems	4	30	60	60	New
MCN8101	Innovative Mobile Services	4	30	60	60	Content modified*
Total Credit Units=20						
Semester III and IV						
All Core						
MCS7226	Seminar Series [4]	2	-	60	60	Content modified
MCN8116	Dissertation	10	-	300	300	Old
Total Credit Units = 12						

* Changed semester

[4]Seminar series will only be done in Semester III, the Dissertation continues to semester IV

Plan B

CODE	COURSE TITLE	CU	LH	PH	CH	New/Current
Semester I (5 Courses)						
4 Core						
MCN7103	System and Network Security	4	60	-	60	Content modified
MCN7106	Mobile Software and Content Development	4	30	60	60	Content modified
MCN7110	Internet of Things	4	30	60	60	New
MCN8104	Network Programming	4	30	60	60	Content modified*
1 Elective						
MCN7105	Structure and Interpretation of Computer programs	4	30	60	60	Content modified
MCN7111	Telecommunications Policies and Standards	4	60	-	60	New
Total Credit Units=20						
Semester II (5 Courses)						
4 Core						
MCN7210	Advanced Computer Networks	4	30	60	60	New
MCN7202	Wireless and Mobile Networking	4	30	60	60	New
MCN7212	Network Simulation & Performance Evaluation	4	30	60	60	New
MIT7116	Research Methodology	4	60	-	60	Content modified*
1 Elective						
MCN7214	Optimisation of Communications Systems	4	30	60	60	New
MCN8101	Innovative Mobile Services	4	30	60	60	Content modified*
Total Credit Units=20						
Semester III						
4 Core						
MCN8106	Database Design	4	30	60	60	Content modified
MCN8105	Applied Software Project Management	4	30	60	60	Old
MCS7101	Cloud Technologies and Architectures	4	30	60	60	New from CS
MCS7226	Seminar Series	2	-	60	60	Content modified*
1 Elective						
MCN8103	Multimedia Communication Systems	4	30	60	60	Content modified
MCN8110	Domain-Specific Engineering	4	30	60	60	New
Total Credit Units = 18						
Semester IV						
Core						
MCN8204	Project	5	-	150	150	Old
Total Credit Units = 5						

* Changed semester

6.0.2 MDCSE: Software Engineering option

Plan A

CODE	COURSE TITLE	CU	LH	PH	CH	New/Current
Semester I (5 Courses)						
4 Core						
MCN7103	System and Network Security	4	60	-	60	Content modified
MCN7106	Mobile Software and Content Development	4	30	60	60	Content modified
MCN7110	Internet of Things	4	30	60	60	New
MCN8104	Network Programming	4	30	60	60	Content modified*
1 Elective						
MCN7105	Structure and Interpretation of Computer programs	4	30	60	60	Content modified
MCN7111	Telecommunications Policies and Standards	4	60	-	60	New
Total Credit Units=20						
Semester II (5 Courses)						
4 Core						
MCN7205	Secure Software Architecture and Design	4	60	-	60	Content modified
MCN7209	Formal Methods in Software Engineering	4	30	60	60	Content modified
MCN7213	Advanced Software Engineering Processes	4	30	60	60	New
MIT7116	Research Methodology	4	60	-	60	Content modified*
1 Elective						
MCN7206	Service Oriented Architectures	4	60	-	60	Content modified
MCN8108	Software Quality Assurance and Testing	4	60	-	60	Content modified*
Total Credit Units = 20						
Semester III & IV						
All Core						
MCS 7226	Seminar Series [5]	2	-	60	60	Content modified
MCN 8116	Dissertation	10	-	300	300	Old
Total Credit Units = 12						

* Changed semester

[5]Seminar series will only be done in Semester III, the Dissertation continues to semester IV

Plan B

CODE	COURSE TITLE	CU	LH	PH	CH	New/Current
Semester I (5 Courses)						
4 Core						
MCN7103	System and Network Security	4	60	-	60	Content modified
MCN7106	Mobile Software and Content Development	4	30	60	60	Content modified
MCN7110	Internet of Things	4	30	60	60	New
MCN8104	Network Programming	4	30	60	60	Content modified*
1 Elective						
MCN7105	Structure and Interpretation of Computer programs	4	30	60	60	Content modified
MCN7111	Telecommunications Policies and Standards	4	60	-	60	New
Total Credit Units=20						
Semester II (5 Courses)						
4 Core						
MCN7205	Secure Software Architecture and Design	4	60	-	60	Content modified
MCN7209	Formal Methods in Software Engineering	4	30	60	60	Content modified
MCN7213	Advanced Software Engineering Processes	4	30	60	60	New
MIT7116	Research Methodology	4	60	-	60	Content modified*
1 Elective						
MCN7206	Service Oriented Architectures	4	60	-	60	Content modified
MCN8108	Software Quality Assurance and Testing	4	60	-	60	Content modified*
Total Credit Units = 20						
Semester III						
4 Core						
MCN 8106	Database Design	4	30	60	60	Content modified
MCN 8105	Applied Software Project Management	4	30	60	60	Old
MCS 7101	Cloud Technologies and Architectures	4	30	60	60	New from CS
MCS 7226	Seminar Series	2	-	60	60	Content modified*
1 Elective						
MCN 8103	Multimedia Communication Systems	4	30	60	60	Content modified
MCN 8110	Domain-Specific Engineering	4	30	60	60	Content modified
Total Credit Units = 18						
Semester IV						
Core						
MCN 8204	Project	50	-	150	150	Old
Total Credit Units = 5						

* Changed semester

7 Detailed Curriculum

7.1 Semester I

7.1.1 MCN7103 System and Network Security

Course Name	: System and Network Security
Course Code	: MCN7103
Course Level	: Year 1 and Semester 1
Course Credit	: 4
Contact hours	: 60

Course Description

In this age of universal electronic connectivity, of viruses and hackers, of electronic eavesdropping and electronic fraud, there is indeed no time at which security does not matter. Two trends have come together to make the topics of this course of vital interest. First, the explosive growth in computer systems and their interconnections via networks has increased the dependence of both organizations and individuals on the information stored and communicated using these systems. This, in turn, has led to a heightened awareness of the need to protect data and resources from disclosure, to guarantee the authenticity of data and messages, and to protect systems from network-based attacks. Second, the disciplines of cryptography and network security have matured, leading to the development of practical, readily available applications to enforce network security. This course introduces convers a concise survey of the cryptographic algorithms and protocols underlying network security applications, including encryption, hash functions, digital signatures, and key exchange. It also Covers important network security tools and applications, including Kerberos, X.509v3 certificates, PGP, S/MIME, IP Security, SSL/TLS, SET, and SNMPv3 and Finally the course looks at system-level security issues, including the threat of and countermeasures for intruders and viruses and the use of firewalls and trusted systems.

Course Objectives

The course unit aims to equip students with sufficient understanding of the field to pinpoint many mistakes in typical newspaper and magazine articles that refers to computer security. The course unit also aims to introduce students to concepts of computer and network security, and the ability to identify vulnerabilities of IT systems.

Learning Outcomes

Upon completion of this module, the student shall:

1. Have an understanding of network security protocols and applications;
2. Have an understanding of threat models, attacks that compromise security, and techniques for achieving security;
3. Be able to provide security assessment of computer networks;
4. Have ability to use the basic concepts of secure communication via insecure networks to design secure architectures;
5. Have the ability to describe and justify relevant alternatives and decision recommendations;
6. Be able to implement security management in networks.

Detailed Course Content

1. *Module: Course Introduction (3 hours)*
   Computer Security Concepts, The OSI Security Architecture, Security Attacks, Security Services, Security Mechanisms, A Model for Network Security,
2. *Module: Symmetric Encryption and Message Confidentiality(5 hours)*
   Symmetric Encryption Principles, Symmetric Block Encryption Algorithms, Random and Pseudorandom Numbers Stream Ciphers and RC4, Cipher Block Modes of Operation.

3. *Module: Public-Key Cryptography and Message Authentication (5 hours)*
   Approaches to Message Authentication, Secure Hash Functions, Message Authentication Codes, Public-Key Cryptography Principles, Public-Key Cryptography Algorithms. Digital Signatures,
4. *Module: Key Distribution and User Authentication (4 hours)*
   Symmetric Key Distribution Using Symmetric Encryption, Kerberos Key Distribution Using Asymmetric Encryption, X.509 Certificates, Public-Key Infrastructure, Federated Identity Management,
5. *Module: Transport-Level Security (4 hours)*
   Web Security Considerations, Secure Socket Layer and Transport Layer Security Transport Layer Security HTTPS Secure Shell (SSH)
6. *Module: Wireless Network Security (4 hours)*
   IEEE 802.11 Wireless LAN Overview, IEEE 802.11i Wireless LAN Security, Wireless Application Protocol Overview, Wireless Transport Layer Security, WAP End-to-End Security
7. *Module: Electronic Mail Security (4 hours)*
   Pretty Good Privacy, S/MIME, Domain Keys Identified Mail,
8. *Module: IP Security (4 hours)*
   IP Security Overview, IP Security Policy, Encapsulating Security Payload, Combining Security Associations, Internet Key Exchange, Cryptographic Suites.
9. *Module: Intruders: (4 hours)*
   Intrusion Detection, Password Management, Malicious Software, Types of Malicious Software, Viruses, Virus Countermeasures, Worms, Distributed Denial of Service Attacks
10. *Module: Firewalls (4 hours)*
    The Need for Firewalls, Firewall Characteristics, Types of Firewalls, Firewall Basing Firewall Location and Configurations
11. *Module: Selected security attacks (4 hours)*

Mode of Delivery

Teaching delivery shall be based on conventional in-class interaction between lecturers and students. The teaching shall follow the content of the suggested text book in addition to other teaching materials such as papers where possible. Students are expected to learn through lectures and different assessment exercises which shall include quizzes, research coursework, and project. Research course work will be based on identifying a security problem that a student or a group of students will independently research on and present at the class. A project on the other hand may require some programming skills where students to implement various security mechanisms such as firewalls in real systems.

Assessment

- Quiz, Project, Research coursework,(40%)
- Final Examination (60%)

Text Books

- Fundamentals of Network Security by J. Canavan; Artech House (2013)
- Network Security Essentials: Applications and Standards 4th Edition, By William Stallings (2011)

Reference books:

- Network and System Security, Second Edition 2nd Edition by John R. Vacca , Syngress; 2014
- Eric Rescorla, SSL and TLS: Designing and Building Secure Systems, Addison Wesley Professional 2000
- Bruce Schneier, Applied Cryptography: Protocols, Algorithms, and Source Code in C, 2nd Edition, John Wiley & Sons 1995

7.1.2 MCN7105 Structure and Interpretation of Computer Programmes

Course Name	: Structure and Interpretation of Computer Programmes
Course Code	: MCN7105
Course Level	: Year 1 and Semester 1 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

The course provides a survey of techniques and principles in the underlying design and implementation of systems. The course focuses on symbolic computation and less on numerical examples from the calculus and number theory. Effective software engineers need to know efficient techniques that serve as building blocks in the design and implementation of software systems. Today, most systems require a collection of skills to provide an efficient implementation. Therefore this course enriches through broadening rather than acceleration. The programming language used has a simple syntax and an intuitive semantic model, allowing a focus on concepts. Throughout, the focus is on understanding computational tools by building them, rather than covering many language features.

Course Objectives

1. To understand the basic concepts of computer programmes.
2. To enable students write programmes from scratch in the programming language scheme.
3. To skill students on how to attend to design and testing.

Learning outcomes

The aim of the course is to equip students with the knowledge to understand and design software systems. Upon completion of the course, students will;

1. Have a strong understanding of basic concepts of computer programmes (including some material on lists and trees)
2. Have the ability to write programmes from scratch in the programming language scheme while understanding the meaning of what is being written.
3. Be in position to pay proper attention to software design and testing.

Detailed Course Content

1. *Module: Course Introduction: (3 hours)*

2. *Module: The fundamentals of Lisp computation: (7 hours)*
   names and values, evaluation, function definition and evaluation, and predicates.
3. *Module: Higher-order functions (7 hours)*
   Including the use of functions as parameters. Introduce the definition of functions with LAMBDA, and the use of functions that return functions as values.
4. *Module: Function definition and application (7 hours)*
   Making decisions (conditional expressions), working with aggregated data (structures), working with unbounded data (lists and recursion), information hiding (local definitions), functional abstraction (functions as values), mutation (changing name-value bindings), and encapsulation (making objects).
5. *Module: Data abstraction (7 hours)*
   Techniques for implementing "abstraction barriers. Use of scheme pairs to implement lists, trees, and other data structures. Cover advanced data abstraction techniques: tagged data, data-directed programming, and message-passing.

6. *Module: State and assignment (7 hours)*
   The use of state and local assignment to write efficient programmes; introduce the idea of object-oriented programming, assignment, and the environment model of evaluation that is needed to understand how local state is maintained in Scheme.
   Introduction to mutable data, concurrency; streams, model time-varying state information within the functional programming approach
7. *Module: Metalinguistic abstraction (7 hours)*
   The creation of new programming languages, as a still more powerful abstraction technique. Two major examples are presented: Lisp and a logic programming language the course follows the fourth chapter of the text.

Mode of Delivery The course is structured around a strong textbook and associated instructional development environment, though lectures offer elaboration on ideas, different examples, and additional material. Short assignments during this course are interspersed with a substantial programming project using object-oriented techniques, such as an adventure game.

Assessment

- Test, Projects, presentations (40%)
- Final Examination (60%)

Reading Materials

- Clean Architecture: A Craftsman's Guide to Software Structure and Design (Robert C. Martin Series) 1st Edition, Prentice Hall; 1 edition, 2017
- Structure and Interpretation of Computer Programs by Abelson and Sussman (second edition, MIT Press, 1996)

7.1.3 MCN7106 Mobile Software & Content Development

Course Name	: Mobile Software & Content Development
Course Code	: MCN7106
Course Level	: Year 1 and Semester 1
Course Credit	: 4
Contact hours	: 60

Course Description
Writing programmes for mobile devices presents unique challenges. This course gives a general introduction to mobile software development, mobile computing and design of mobile services. It introduces several mobile development platforms. The course concentrates on one programming platform based on its potential, features or popularity. Examples of platforms include android, iOS, Symbian among others. Students will learn the issues in mobile computing and communications.

Course Objectives

1. To highlight students on the characteristics of mobile applications and the history of mobile application frameworks.
2. To skill studnets on Mobile application development languages Objective-C, Python and Java as well as models of mobile application frameworks.
3. To equip students with skills for User-interface design for mobile applications and managing application data.
4. To provide students with an undrstanding on integrating cloud services, networking, the OS and hardware into mobile-applications.

5. To enable students address enterprise requirements in mobile applications performance, scalability, modifiability, availability and security.
6. To skill students on Testing methodologies for mobile applications.
7. To enable students understand Publishing, deployment, maintenance and management of applications and content

Learning Outcomes

Upon successful completion of this course, the students, shall:

1. Be exposed to mobile applications development principles and business trends impacting mobile applications
2. Be competent with the characterization and architecture of mobile applications and mobile operating systems
3. Be competent with understanding enterprise scale requirements of mobile applications as well as the ability to develop mobile applications using one application development framework.
4. Have knowledge in the mobile content development principles

Detailed Course Content

1. *Module: Review of Mobile Computing fundamentals. (3 hours)*
2. *Module: Fundamentals of Mobile Terminal Hardware set-up (4 hours)*
   Radio, DSP, Memory and CPU components. The division into access & application parts. Base Station side radio interface standards.
3. *Module: Introduction to Mobile Operating System Platforms (OSPs) (4 hours)*
   Symbian, Android, Linux & Microsoft mobile, iOS.
4. *Module: User Interface (4 hours)*
   Menu system, and Applications.
5. *Module: Software set-up in modern Mobile Terminals (4 hours)*
6. *Module: Overview of Mobile Multimedia Codecs (4 hours)*
7. *Module: Fundamentals of Mobile Content & Mobile web content design. (3 hours)*
8. *Module: Widgets & W3C Standards (4 hours)*
   Device Recognition & dotMobi.
   The .mobi top level domain (TLD) initiative for mobile optimized web-site creation.
9. *Module: Advanced concepts of programming languages (4 hours)*
   Programmable mobile phones.
10. *Module: The mobile applications (4 hours)*
    Services ecosystem.
11. *Module: The Mobile IP stack and mobile web-browsing (4 hours)*
    The WAP-protocol & Location Information.
12. *Module: Principles of Multimedia Messaging (SMS, MMS) and web services (3 hours)*

Teaching and Learning Patterns

- Lectures, seminars and laboratory exercises

Assessment:

- Assignment, Lab. Tests, Project (40%)
- Semester final examinations (60%)

Reading Materials

- Bill Phillips, Chris Stewart, Brian Hardy, and Kristin Marsicano, Android Programming: The Big Nerd Ranch Guide, Big Nerd Ranch LLC, 2nd edition, 2015.
- Christian Keur and Aaron Hillegass, iOS Programming: The Big Nerd Ranch Guide, 5th edition, 2015
- Tomasz Nurkiewicz and Ben Christensen, Reactive Programming with RxJava, OReilly Media, 2016.
- Raoul-Gabriel Urma, Mario Fusco, and Alan Mycroft, Java 8 in Action: Lambdas, Streams, and Functional-Style Programming, Manning Publications, 2015.
- Benjamin J. Evans and Martijn Verburg, The Well-Grounded Java Developer: Vital Techniques of Java 7 and Polyglot Programming, Manning Publications, 2013.
- Brian Fling, Mobile Design and Development, OReilly Media, Inc., 2009.
- Maximiliano Firtman, Programming the Mobile Web, OReilly Media, Inc., 2nd ed., 2013.
- Cristian Crumlish and Erin Malone, Designing Social Interfaces, 2nd ed., OReilly Media,Inc., 2014.

7.1.4 MCN7110 Internet of Things

Course Name	: Internet of Things
Course Code	: MCN7110
Course Level	: Year 1 and Semester 1
Course Credit	: 4
Contact hours	: 60

Course Description

This course looks at applications of the Internet of Things (IoT) and their relevance to developing countries, with a focus on low-cost, open and sustainable solutions as well as Policy and regulation that apply. Exponentially developing technologies that spawn new services and applications, coupled with regulatory reform, changing legal frameworks and the emergence of new markets, have given rise to increased demands for training and skills development. Further, the impact of convergence and globalization has intensified the ongoing challenge to people in these sectors to remain informed of local developments and international trends and practices. The IoT technology has the potential to change the world, just as the Internet did. This is very much starting to happen, as the continual decrease in size, cost, and energy consumption of wireless devices is dramatically boosting the number of mobile objects. The number of mobile objects composing the IoT will significantly grow: in 2020, between 12 and 50 billion devices are expected to be connected with each other, a 12 to 50-fold increase from 2012. This implies that the traffic generated will explode. The huge amount of traffic will require standardized interfaces and IP address utilization, such as IPv6. The course will cover Introduction to Internet of Things and ICT Standards and Regulation. Stake holders & echo system in communications Technology & Services. QoS regulation in Communications Networks. Enabling policies for Sustainable Communications and Information Technology services.

Course Objectives

1. To introduce students to the concepts of IoT.
2. To Understand IoT Market perspective.
3. To explore the interconnection and integration of the physical world and the cyber space.
4. To design & develop IOT Devices.
5. To provide Data and Knowledge Management skills with the use of Devices in IoT Technology.
6. To understand State of the Art IoT Architecture.
7. To understand the real World IoT Design Constraints, Industrial and Commercial Automation in IoT.

Learning out comes

After successfully completing this course, students should be able to:

1. Discuss the fundamentals of IoT and Wireless sensor network communications
2. Demonstrate an understanding of the basic principles, practices and regulatory objectives to be achieved in licensing services; administering universal service obligations and resources.
3. Work with IoT open software and open hardware
4. Analyse existing IoT Middlewares
5. Design, implement and Deploy an IoT solution
6. Demonstrate an understanding of the basic trends in ICT reform; their drivers and their implications domestically and internationally.
7. Demonstrate an understanding of how policy is made, the roles and functions of different actors in its implementation.
8. Articulate the basic models of regulation; their relevance and application.
9. Articulate the basic tenets of regulatory governance, and the interaction between stakeholders in this regard.
10. Demonstrate an understanding of the basic principles, practices and regulatory objectives to be achieved in administering competition policy; transparent and efficient interconnection and facilities leasing policy; and tariff and rate regulation.
11. Articulate the open model of internet regulation and ongoing discourse on net neutrality.

Detailed Course Content

1. *Module: Introduction To IoT (3 hours)*

2. *Module: WSN (6 hours)*
   - MAC, IEEE 802.15.4
   - WSN Communications (802.15.4, Wifi, Gprs, Bt)

3. *Module: Routing, RPL (3 hours)*

4. *Module: Design and Deployment of IoT solution (6 hours)*
   - Open Software, Open Hardware And Arduino
   - Introduction To Middleware

5. *Module: Law, regulation, governance and the institutional framework; (8 hours)*
   - Licensing and monitoring;
   - Competition policy and resource management;
   - Internet policy and the Internet in effective regulation;

6. *Module: Universal access, universal service and the digital divide; (6 hours)*
   - Net neutrality and the open Internet.

7. *Module: Interconnection and facilities-leasing; (2 hours)*

8. *Module: Price and tariff regulation; (2 hours)*

9. *Module: Quality of service and consumer protection; (2 hours)*

Mode of Delivery

The delivery mode of the course include contact lectures, seminars that will be delivered by invited guests from industry players e.g. Uganda Communication Commission, Local Telecom providers, National IT Authority, Internet Society Uganda Chapter and many others. In addition, the course will include students' presentations for the topics that will be assigned to them during the lecture. The teaching methodology shall also include reading and learning group discussions, lectures, practical sessions and an assigned student project.

Course Assessment

- Assignments, Laboratory Projects (Arduino and middleware) - 20%
- Discussion around Actual deployment (20%)
- Final Examination (60%)

Text Books

- VijayMadisetti, Arshdeep Bahga, Internet of ThingsA Hands-On- Approach,2014, ISBN:978 0996025515
- Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry. Maciej Kranz, 2016.

Reading Material

- Securing the Internet of Things, 1st Edition, Shancang Li Li Da Xu, 2017
- Samuele Greengard, The Internet of things, 2015
- AdrianMcEwen, Designing the Internet of Things, Wiley Publishers, 2013, ISBN: 978-1-118-43062-0
- Daniel Kellmereit, The Silent Intelligence: The Internet of Things. 2013, ISBN: 0989973700

7.1.5 MCN7111 Telecommunications Policies & Standards

Course Name	: Telecommunications Policies & Standards
Course Code	: MCN7111
Course Level	: Year 1 and Semester 1 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

Policy and regulation within telecommunications must address a dynamic and rapidly changing environment. Exponentially developing technologies that spawn new services and applications, coupled with regulatory reform, changing legal frameworks and the emergence of new markets, have given rise to increased demands for training and skills development. Further, the impact of convergence and globalization has intensified the ongoing challenge to people in these sectors to remain informed of local developments and international trends and practices. The course is designed to provide an introduction to the key issues, developments and trends within the telecommunications sector. The course will cover Introduction to Telecommunications and ICT Standards and Regulation. Stake holders & echo system in communications Technology & Services. Spectrum, Price & QoS regulation in Communications Networks. Enabling policies for Sustainable Communications and Information Technology services.

Course Objectives

1. To provide knowledge of the essential drivers of sector reform locally and internationally, including the impacts of globalisation and convergence;
2. To equip students with skills on the structure and process of policy formulation, regulatory practice and licensing procedures in various African countries;
3. To provide understanding of the relevant theory that applies to the policy and regulatory environment for the electronic communications and ICT sector, including the broadcasting and digital media sector;
4. To provide an understanding of ICT innovation and the implications for policy and regulation that arise from such innovation;
5. To equip studnts with critical analytic skills for any electronic communications and ICT environment in any chosen country with reference to theories, international models and best practice approaches.

Leaning Outcomes

By the end of the course, successful participants will be able to :

1. Demonstrate an understanding of the basic trends in telecommunications reform; their drivers and their implications domestically and internationally;
2. Demonstrate an understanding of how policy is made, and the roles and functions of different actors in its implementation;
3. Articulate the basic models of regulation; their relevance and application;
4. Articulate the basic tenets of regulatory governance, and the interaction between stakeholders in this regard;
5. Demonstrate an understanding of the basic principles, practices and regulatory objectives to be achieved in licensing services; administering universal service obligations and efficient management of spectrum and other resources, such as numbering;
6. Demonstrate an understanding of the basic principles, practices and regulatory objectives to be achieved in administering competition policy; transparent and efficient interconnection and facilities leasing policy; and tariff and rate regulation;
7. Articulate the open model of internet regulation and ongoing discourse on net neutrality.

Detailed Course Content

1. *Module: Course Introduction (03 hours)*
2. *Module:Telecommunications systems, technologies and markets (06 hours)*
3. *Module: International trends driving telecommunications reform (06 hours)*
4. *Module: Law, regulation, governance and the institutional framework (06 hours)*
5. *Module: Universal access, universal service and the digital divide (03 hours)*
6. *Module: Licensing and monitoring (03 hours)*
7. *Module: Competition policy and resource management (03 hours)*

8. *Module: Interconnection and facilities-leasing (03 hours)*

9. *Module: Price and tariff regulation (03 hours)*

10. *Module: Quality of service and consumer protection (03 hours)*

11. *Module: Internet policy and the Internet in effective regulation (03 hours)*

12. *Module: Net neutrality and the open Internet (03 hours)*

Mode of Delivery

The delivery mode of the lecture include contact lectures, seminars that will be delivered by invited guests from industry players e.g. Uganda Communication Commission, Local Telecom providers, National IT Authority, Internet Society Uganda Chapter, etc. In addition, the course will include students' presentations for the topics that will be assigned to them during the lecture. The teaching methodology shall also include reading and learning group discussions.

Course Assessment

- Assignments, tests, research course work (40%)
- final examination (60%)

Reading Materials

- Telecommunications, Media & Technology (TMT) for Developing Economies: How to make TMT Improve Developing Economies in Africa and Elsewhere for the 2020s by H Sama Nwana Gigalen Press; 1 edition, 2014
- The Telecommunications Handbook 1st Edition by Kornel Terplan and Patricia A. Morreale CRC Press; 1 edition ,1999
- Africa's ICT Infrastructure: Building on the Mobile Revolution (Directions in Development) by Mark D.J. Williams, Rebecca Mayer and Michael Minges World Bank Publications, 2011
- Reform, Organizational Players, and Technological Developments in African Telecommunications-An Update: An Update (Studies in African Economic and Social Development, 21) by Chuka Onwumechili and Edwin Mellen Pr, 2003
- Broadband for Africa: Developing Backbone Communications Networks, First American Edition by Mark D. J. Williams, World Bank Publications
- Digital Crossroads: Telecommunications Law and Policy in the Internet Age, second Edition by Jonathan E. Nuechterlein, Philip J. Weiser The MIT Press; second edition, 2013

7.1.6 MCN8104 Network Programming

Course Name	: Network Programmings
Course Code	: MCN8104
Course Level	: Year 1 and Semester 1
Course Credit	: 4
Contact hours	: 60

Course Description

The course discusses a number of programming facilities for the development of network applications. Attention is paid to designing and implementing applications with threads, sockets, RMI/RPC, CGI/BIN, servlets, python, PHP. In addition, attention is paid to security and modern enabling technologies like peer-to-peer systems.

Course Objectives

1. To provide knowledge to create client and server applications using the "Sockets" API.
2. To skill students to be able to compare, contrast, and critique various networking APIs.
3. To Implement a library reflecting 'publish/subscribe' communication paradigms.

Learning Outcomes

At the end of the course, students will;

1. Be able to explain a broad coverage of the main principles of building network, transport, and application-level communication protocols and APIs, including middleware.
2. Be able to explain the conceptual and implementation aspects of network application protocols particularly; transport-layer service models, client-server paradigm, and peer-to-peer paradigm by examining popular application-level protocols such as HTTP, FTP, SMTP / POP3 / IMAP, DNS.
3. Be able to write distributed applications that run across multiple heterogeneous systems simultaneously.
4. Have practical skills in either C, python or Java programming.
5. Be able to build communications software (protocols, applications and middleware) with standard APIs from C, Python or Java.
6. Gain the understanding required to design, build, analyse and test such software.

Detailed Course Content

1. *Module: Introduction and Overview(3 hours)* An outline of the module, including scope, depth and breadth of material to be covered.
2. *Module: Network Programming (10 hours)* Introduction to Tools - make, ant, cvs, doxygen & Socket Programming
3. *Module: Network Application Development(12 hours)*
   Web server, Wireless Sensor Network Applications Wireless Sensor Network Reference Architecture, Middleware (Coordination) Abstractions Active Messages, Hood, Logical Neigborhood, TinyLime and TeenyLime.
   TinnyLime are for wireless sensor networks environment allow access to sensor data while Teenylime takes WSN programming away from operating system level and using basic communication primitives to a higher level of abstraction to shared memory space spanning neighboring nodes, TinyDB
4. *Module: Developing green network applications (10 hours)*
5. *Module: Network protocol development and implementation (10 hours)*

Mode of Delivery

Lectures and students presentations. Students will also learn through reading research papers and implementing course projects.

Course Assessment

- Laboratory assignments, Practical coursework - 40%
- Final Examination - 60%

Reading materials

- Foundations of Python Network Programming 3rd ed. by Brandon Rhodes, John Goerzen, Apress; 2014
- Twisted Network Programming Essentials: Event-driven Network Programming with Python 2nd Edition by Jessica McKellar, Abe Fettig, O'Reilly Media; 2013
- Beej's Guide to Network Programming Using Internet Sockets, 2016
- Java Network Programming, Elliotte Rusty Harold, O'Reilly (2000)
- Computer Networking: A top down approach featuring the Internet by James F. Kurose, Keith W. Ross, McGraw Hill.(2004)

7.2 Semester II

7.2.1 MCN7202 Wireless and Mobile Networking

Course Name	: Wireless and Mobile Networking
Course Code	: MCN7202
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description

The course covers fundamentals of wireless cellular/Mobile/personal communications systems. The following are studied: techniques in the design of second generation wireless networks, Cellular network and protocols, medium access techniques, handoff control, signalling and mobility management, third generation wideband systems, novel technologies and adhoc networks.

Course Objectives

1. To provide knowledge of analysis and design of wireless and mobile cellular systems.
2. To equip students to work in advanced research in wireless and mobile cellular programmes.
3. To exporse studnets to state of the art mobile and wireless communications

Learning outcome

Upon successful completion of this course, the student shall be able to:

1. Discuss the principles of mobile and wireless communications, radio frequency planning, special protocols and mobile networking.
2. Articulate trends on next generation cellular systems and services based on service oriented telecom architectures.
3. Design a network architecture, protocol or algorithm for mobile/wireless networks.
4. Design a simulation platform to analyse an existing architecture/ protocol or algorithm for mobile/wireless networks.

Detailed Course Content

1. *Module: Course Introduction (3 hours)*
   The technology and underlying principles of wireless communications.
2. *Module: Wireless communication spectrum and channel modeling. (6 hours)*
3. *Module: Mobility, Cell-planning & Handoff. (6 hours)*

4. *Module: Introduction to Wireless Intelligent Networking and Prepaid systems. (6 hours)*
5. *Module: Standards for Mobile/Wireless Communication. (6 hours)*
6. *Module: Mobile/wireless Networking Fundamentals. (6 hours)*
7. *Module: Special Features and protocols in Mobile/Wireless Networking. (6 hours)*
8. *Module: Trends in Next Generation Mobile Wireless Communications. (6 hours)*

Mode of Delivery

Teaching method shall mainly include lectures. In addition, students shall learn through take home exercises and research course work. The later shall also provide to students opportunities to learn and practice some transferrable skills such as presentations and working in groups. Some assignments might be tuned to require students to learn simulation tools such as network simulator (ns-2) to implement their course projects

Assessment:

- Assignment, tests , Design Project (40%)
- Semester final examinations (60%)

Reading Materials

- Wireless Communications Principles & Practices, T.S. Rappaport, 2nd edition -2007.
- Wireless Communications & Networks, William Stallings, 2nd Ed., Prentice Hall publishers-2001.
- Wireless & Mobile Network Architectures, Yi-Bing Lin & I.Chlamtac, Wiley publishers-2006.
- UMTS Networks, Architecture, Mobility & Services. H. Karanen, et.al, Wiley Publishers-2005.

7.2.2 MCN7205 Secure Software Architecture and Design

Course Name	: Secure Software Architecture and Design
Course Code	: MCN7205
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description

Capability in the design of systems that meet security goals is an increasingly important skill. This course explores how cost-effective solutions to security needs can be achieved by following well- established architectural practices and detailed security principles. Central to these considerations is meeting the requirements with established solutions, and striking a balance between security and other system requirements.

Very little software is actually written from scratch. Instead, software projects usually rely on existing libraries, frameworks, and components. The course focuses on principles and methods that aid the designer/developer/architect to gain increased confidence in the architectural design. This includes architectural patterns, qualitative and quantitative assessment of architectures, quantitative modeling using architecture description languages such as AADL and MARTE, and qualitative architecture evaluation methods, e.g., ATAM. Finally, the course will also address the specific challenges related to scale, dynamics, and heterogeneity as found in system of systems, and ultra-large scale systems.

Course Objectives

1. To provide an in-depth coverage of the concepts needed to effectively design and analyze a software architecture
2. To quip students with the essential considerations in any architectural design process

Learning Outcomes

At the end of the course, students will;

1. Be able to design software systems that are robust to most security risks.
2. Be knowledgeable in the strengths and weaknesses of different security design techniques.
3. Be able to specify a security solution to fulfill specific design requirements

Detailed Course Content

1. *Module: Course Introduction (3 hours)*

2. *Module: Quality attributes in the context of architecting (3 hours)*
   Qualitative and quantitative assessment of architectures
3. *Module: Architectural modeling (4 hours)*
   Architecture Description Languages (a.k.a. ADLs) such as AADL and OMG MARTE
4. *Module: Managing Security (4 hours)*
   Enterprise business strategies; Promoting security; Information security policy; Defining Properties of Secure Software, How to Influence the Security Properties of Software, How to Assert and Specify Desired Security Properties
   Security Requirements
   Motivation for security requirements; Security requirements artifacts; Specifying security requirements
5. *Module: Requirements Engineering for Secure Software (4 hours)*
   Misuse and Abuse Cases, The SQUARE Process Model, SQUARE Sample Outputs Requirements Elicitation, Requirements Prioritization,
6. *Module: Secure Software Architecture and Design (4 hours)*
   Software Security Practices for Architecture and Design: Architectural Risk Analysis, Software Security Knowledge for Architecture and Design: Security Principles, Security Guidelines, and Attack Patterns
7. *Module: Security Design Process (3 hours)*
   Business continuity; Principles of security design; AEGIS design methodology;
8. *Module: Security Architectures (4 hours)*
   Security design patterns; Platform and channel security components; Enterprise security architectures
   Designing Access Control
   Security and access control; Access control policy; Security policy models;
9. *Module: Designing Secure Systems (3 hours)*
   Security standards; Security decision-making; Design principles; Architecture principles; Security vs other architectural goals, Code Analysis, Coding Practices , Software Security Testing , Security Testing Considerations Throughout the SDLC;
10. *Module: Security and Complexity (4 hours)*
    System Assembly Challenges; Security Failures, Functional and Attacker Perspectives for Security Analysis: Two Examples System Complexity Drivers and Security , Deep Technical Problem Complexity.

11. *Module: System modeling (3 hours)*
    The role of SysML and its relation to software architecting
    Architecting for evolution and variability
    Partitioned and layered architectures
12. *Module: System-of-Systems (3 hours)*
    Ultra-Large Scale Systems Architectural design guidance
    Design spaces and rules, Application Interface (API) design guidance, domain specific design guidance.
13. *Module: A case study involving integration of large scale systems (3 hours)*

Mode of Delivery

The teaching method shall mainly be based on lectures. In addition, assignments such as reading and course projects shall help students to help a better understanding in security and design requirements for secure systems. Furthermore, class presentations and group work will help students acquire some transferable skills.

Assessment

- Test, Research coursework (40%),
- Final Examination (60%)

Reading Material

- James Ransome & anmol Misra, "Core software Security: Security at the Source", 2013
- Julia H. Allen, Sean Barnum, Robert J. Ellison, Gary McGraw, Nancy R. Mead, "Software Security Engineering: A Guide for Project Managers", 2008, Addison-Wesley Professional. Part of the SEI Series in Software Engineering series
- R. N. Taylor, N. Medvidovic, and E. M. Dashofy.Software Architecture: Foundations, Theory, and Practice, John Wiley & Sons.
- Martin Fowler, Patterns of Enterprise Application Architecture 1st Edition
- L. Bass, P. Clements, R. Kazman. Software Architecture in Practice, Second Edition. Addison Wesley Professional, 2003
- M. McBride. The Software Architect. Communications of the ACM, 50(5):75-81, May 2007
- P. Clements et al. Documenting Software Architectures: Views and Beyond. Addison Wesley Professional, 2003

7.2.3 MCN7206 Service Oriented Architectures

Course Name	: Service Oriented Architectures
Course Code	: MCN7206
Course Level	: Year 1 and Semester 2 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

Service Oriented Architecture (SOA) is a fairly new concept motivated by in explosive increase in services that are increasingly required to interoperate. This course provide fundamental concepts of SOA, requirements for building services, types of services such as Web services and SOA engineering as way of building dynamic, autonomous systems. The course assumes basic knowledge in XML schema and XML namespaces. Practical exercises entail a fair amount of Java programming, usually by extending

and adapting supplied skeleton code; familiarity with OO programming will be helpful. The design discussion assumes a basic reading knowledge of UML.

Course Objectives

The course aims to equip student with understanding of the strengths and weaknesses of a service-based architecture, informed by an ability to implement and deploy simple web services using a suitable development platform. They will also learn to define and design applications as combinations of services, and be able to discuss the emergent properties of those compositions; and to understand the research context and potential future directions for these technologies.

Learning Outcomes

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

1. Design, develop and test Web services.
2. Understand standards related to Web services: Web Services Description Language (WSDL), Simple Object Access Protocol (SOAP), and Universal Description, Discovery and Integration (UDDI).
3. interprete principles of Service-Oriented Architecture and apply these concepts to develop a sample application
4. Conceptually model Web services and formulate specifications of them in the Resource Description Framework (RDF) and the Web Ontology Language (OWL).
5. Tell the approaches to compose services.
6. Evaluate emerging and proposed standards for the main components of Web services architectures.

Detailed Course Content

1. *Module: Course Introduction (3 hours)*

2. *Module: Review of SOA concepts (4 hours)*
   Benefits and challenges of SOA
3. *Module: Pillars of successful SOA adoption (4 hours)*
   Technology, governance, architecture, and business alignment
4. *Module: Design considerations for SOAP services (5 hours)*
   REST services, and services that use platform-specific component technologies
5. *Module: Supporting elements used in SOA designs (5 hours)*
   Service interceptors, messaging infrastructure, ESB, API gateways, and orchestration servers
6. *Module: Design considerations for SOA solutions (5 hours)*
   Microservices vs. monolith, security, transaction management, cloud vs. on-premises, and alternatives for integration with external systems
7. *Module: Service-oriented architectural style (5 hours)*
   The strategies and patterns for realizing its seven design guidelines (standardized service contract, loose coupling, reusability, service autonomy, service statelessness, service discoverability, service composability)
8. *Module: Semantic Web (4 hours)*
   Knowledge representation; Resource Description Framework; Web Ontology Language; Semantic Frameworks.
9. *Module: Service qualities (5 hours)*
   Transactions; performance; security.
   Approaches to service composition

10. *Module: Engineering SOA (5 hours)*
    Organization; lifecycle; versioning; governance.

Mode of Delivery

The teaching method shall mainly be based on lectures. In addition, assignments such as reading and course projects shall help students to help a better understanding in the design of service- oriented systems. Furthermore, class presentations and group work will help students acquire some transferable skills.

Assessment

- Test, Project, (40%)
- Final Examination (60%)

Reading Material

- Service-Oriented Architecture (paperback): Concepts, Technology, and Design, 1st Edition, Thomas Erl, The Prentice Hall Service Technology, Prentice Hall; 2016
- Applied SOA: Service-Oriented Architecture and Design Strategies By Michael Rosen, Boris Lublinsky, Kevin T. Smith, Marc J. Balcer
- Service Oriented Architecture (SOA): Concepts, Technology and Design, 2005 by Thomas Erl
- Service-Oriented Architecture: Principles and Applications, 2015 by Philip Wik

7.2.4 MCN7209 Formal Methods in Software Engineering

Course Name	: Formal Methods in Software Engineering
Course Code	: MCN7209
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description

This course covers formal methods used in the development of software. It studies languages for object-oriented modeling, such as the Unified Modeling Language (UML) along with its Object Constraint Language (OCL) and Action Semantics extensions; the specification of abstract data types, such as Z; and concurrency, such as process algebras and temporal logic.

Course Objectives

1. To equip students with the knowledge of formally verifying spotware specifications
2. To develop and specify a precise mathematical statement of what the software is to do while avoiding explicit (or even implicit) constraints.

Learning outcomes

At the end of the course

1. Student will be able to specify a software systems formally.
2. Student will be able to use formal tools to verify and understand software systems.

Detailed Course Content

1. *Module: Course Introduction (5 hours)*
2. *Module: Predicate Logic Specification (20 hours)*
   Foundations, basic concepts, verification. The Z notation and language. Alloy notation and language or Isabelle (theorem prover) notation and language.

3. *Module: Algebraic Specification (10 hours)*
   Foundations, Basic concepts, Verification: Programme derivation,
4. *Module: Automatic programme synthesis (10 hours)*
   The use tools such as such as , Z animation, The OBJ family of languages and LARCH .Statecharts shall also be covered

Mode of Delivery
The class will be conducted on face to face, in class lecture

Assessment

- Seminar series presentation, Research coursework, Project - 40%
- Final examination - 60%

Reading Material

- An Overview of Formal Methods Tools and Techniques - Springer, JB Almeida - 2011
- Modern Formal Methods and Applications, HOSSAM A. GABBAR Okayama University, Okayama, Japan, 2006
- Diller, Z An Introduction to Formal Methods (2nd ed.), Wiley, 1994.
- I. Van Horebeek & J. Lewi, Algebraic Specifications in Software Engineering
- J. V. Guttag, E. Horowitz & D. R. Musser, "The Design of Data Type Specifications", Current Trends in Programming Methodology (R. T. Yeh, ed.).

7.2.5 MCN7210 Advanced Computer Networks

Course Name	: Advanced Computer Networks
Course Code	: MCN7210
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description
This is an advanced course in computer networks, their architecture, principles of operations, and performance analyses. This course provides a broad overview of computer networking, covering application layer, transport layer, network layer, and link layers. This course provides insight into the rationale of why networks are structured the way they are today and to understand the issues facing the designers of next-generation data networks. Much of the class will focus on network algorithms and their performance. This course will also discuss the tools for the study of networks. It will show how certain common principles permeate the functioning of these diverse networks and how the same issues related to robustness, fragility and interlinkages arise in several different types of networks.

Course Objectives
The course will have the following objectives:

1. To exporse students to the computer network models and structure as well as the theoretical concepts of computer network protocols;
2. To provide deep knowledge of the TCP reference Model and the layer protocols;
3. To equip students with skills and knowledge of analysis of organizational structure and selection of networking architectures;
4. To enable students to specify and identify deficiencies in existing protocols as well as formulate new and better protocols.

Learning Outcome

Upon completion of this course unit, the student will:

1. be very conversant with the computer network models and structure in terms of theoretical concepts of computer network protocols and components;
2. have good understanding of the TCP/IP reference Model and have an understanding of the protocols at each layer;
3. be able to analyze the requirements for a given organizational structure and select the most appropriate networking architecture and technologies;
4. have the knowledge to specify and identify deficiencies in existing protocols, and then go onto formulate new and better protocols.

Detailed Course Content

1. *Module: Computers and the Internet: (06 hours)*
   The Internet, Circuit Switching vs. Packet Switching, Packet Switching vs Message Switching, Connectionless and Connection-Oriented Services, Virtual Circuits, Network Taxonomy & Protocol Stacks, Packet-Switched Networks Classified by Extent
2. *Module: Application Layer: (09 hours)*
   Conceptual and the implementation aspects of network applications, client-server paradigm, Application-level protocols, and their associated application, detailed study of the HTTP, FTP, SMTP, POP3 and DNS protocols, service models that TCP and UDP offer to applications that invoke them
3. *Module: Transport Layer (07 hours)*
   Transport Layer Terminology, Summary TCP/IP Encapsulation, UDP - User Datagram Protocol, TCP (Transmission Control Protocol), TCP Receive Window, Round-Trip Time Estimation and TCP Congestion Control
4. *Module: Network Layer and Routing (07 hours)*
   Challenges in the network layer, Performing routing, underlying principles of routing algorithms, IPv4 and IPv6, current trends in computer networking and the Internet, multicast routing
5. *Module: Link Layer and Local Area Networks: (08 hours)*
   The data link layer - its services, the principles underlying its operation, error detection and correction techniques, multiple access protocols, link-layer addressing, and the construction of extended local area networks via hubs. bridges, and switches, channel partitioning approaches, specific data link layer, protocols in detail - Ethernet, the wireless IEEE 802.11 protocol, and the Point-to-Point protocol, PPP.
6. *Module: Network Management (08 hours)*
   Appropriate tools for the network administrator, management of complex systems, internet Network Management Framework, and the SNMP protocol, fault identification and management, proactive anomaly detection , alarm correlation, and the larger issues of service management

Mode of Delivery

This course will be delivered in class only. Some theory from the reference text books shall be reviewed, however the course will focus on the review of the state of the art research articles in the topics selected below. In addition, students shall be assigned with research coursework where they shall choose an area in networking and conduct independent research on. Students shall be expected to write a preview or summary of the area they have chosen and make presentation of the findings to the class. The aim of the research course work here is to cement the scope of knowledge of networking concepts.

Mode of Assessment

- Course work (Assignments, Tests, Group Research work) 40%
- Final Examination 60%

Reading material

- Computer Networking: A Top-Down Approach, by James F. Kurose, Keith W. Ross Morgan Kaufmann, 2014.
- Advanced Computer Network, Deven Shah, Dayanand Ambawade, Mahendra Mehra, Mayank Agarwal, 9789350040133, Dreamtech Press, 2011.
- Tanenbaum, A. S. Computer Networks. 4th ed. Upper Saddle River, NJ : Prentice Hall, 2003. ISBN: 0130661023.
- Stevens. TCP/IP Illustrated. Reading, MA: Addison-Wesley Pub. Co., c1994-c1996. ISBN: 0201633469.

Reference materials (International journals)

- IEEE/ACM Transaction on Networking, IEEE Communication Magazine,IEEE Network Magazine,
- IEEE Journal on Selected Areas in Communications, IEEE Transaction on Communica- tions, International Conferences in Networking: ACM SIGCOM, IEEE INFOCOM, ICNP.

7.2.6 MCN7212 Network Simulation & Performance Evaluation

Course Name	: Network Simulation & Performance Evaluation
Course Code	: MCN7212
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description

This course introduces the art of applying statistical, analytical, and modeling to carry out performance evaluation of computer networks. The goals of this course are threefold: Firstly, to introduce the students to the scientific method of performance evaluation of networks in an objective, reproducible, and rigorous manner using properly designed experiments and sound statistical techniques for data modeling and analysis. Secondly, to facilitate the students in getting skilled in the art and craft of building purposeful abstracted models that fit their analysis/ design requirements since the application of any scientific method invariably involves some art and judgment based on intuition. Lastly, an important aim is to develop critical thinking skills in the students so that they can perform original work in any of the sub-fields of computer and communication networks while using the performance evaluation skills for methodical analysis and evaluation.

Course Objectives

1. To exporse students to the various network evaluation techniques.
2. To equip students with skills to conduct performance measurements correctly using proper statistical techniques.
3. To equip students with skills to Design measurement and simulation experiments.

Learning Outcomes

By the end of this course, students will:

1. Obtain in-depth theoretical understanding of analytical techniques that are used to analyze the performance of communication networks.

2. Know how to make informed judgments about performance of networks and use these concepts to objectively analyze the performance of computer networks.
3. Have ability to deploy modeling techniques to characterize various features that emerge in communication networks such as traffic workload, user characterization, measurements, etc.
4. Obtain research skills that are very important in conducting research and in better comprehending published research results in computer communications areas.

Detailed Course Content

1. *Module: Course Introduction(2 hours)*
   Science of NPE, Common NPE Errors, Network simulation ideas
2. *Module: Introduction to Statistics(3 hours)*
   Probability theory. Summarizing data, Sampling a Population, Hypothesis Testing, Confidence Intervals, Model Fitting (Regression)
3. *Module: Random number generation(3 hours)*
   Removing transients, variance reduction and confidence intervals.
4. *Module: Benefits and limitations of simulations (3 hours)*
   validation and verification aspects.
5. *Module: Workload Characterization(3 hours)*
   Fundamentals of modeling techniques for traffic and user behaviors,
6. *Module: Evaluation and improvement of models (3 hours)*
   Network and data communications
7. *Module: Simulation technique(3 hours)*
   As an engineering tool for analyzing, planning, dimensioning, monitoring, and building real operating networks. The use of measurement data and configuration data from real networks in simulation
8. *Module: Computer network simulation tools(3 hours)*
   NS2, NS3, Omnet, Opnet, MATLAB and others
9. *Module: Introduction and Fundamentals of Queuing Theory(3 hours)*
   Single-Server/Multi Queueing Systems,
   Queueing Networks,
   Operational Analysis,
   Analysis of Queueing Networks
10. *Module: Simulation of queuing models in communication networks (3 hours)*
11. *Module: Simulation of functions and performance of protocols (3 hours)*
    Data traffic on the data link, network, transport, and application levels in data communications
12. *Module: Experimental Design(3 hours)*
    One-Factor Experiment, Full Factorial Designs, Fractional Factorial Designs
13. *Module: Empirical Methods and Measurements (3 hours)*
14. *Module: Network Management (3 hours)*
    Internet Measurement Issues and Tools, Internet Measurement Results
15. *Module: Stochastic Processes (3 hours)*
    Common Stochastic Processes
16. *Module: Discrete-Time Markov Chains (3 hours)*
    Homogeneous discrete and continuous time chains

Mode of Delivery

The content of this course shall be offered through contact hours between the lecturer and students. In addition to offered lecturer, students shall also learn through course assignments, reading assignments, and research course work. Some of the course work shall involve some numerical analysis and programming using MATLAB to simulate and prove some of the theory learnt in the class. Students are expected to get better knowledge of the concepts through these kinds of course work. Students shall also learn through other assessments mainly test and the final examination.

Course Assessment

- Assignments, Test, Research course work (40%)
- Final Examination (60%)

Reading materials

Journal papers on network performance and evaluation

Text books:

- Performance Evaluation by Simulation and Analysis with Applications to Computer Networks, 2015, John Wiley & Sons,by Ken Chen
- Modeling and Simulation of Computer Networks and Systems by Mohammad S. Obaidat, Faouzi Zarai, Petros Nicopolitidis, Publisher: Morgan Kaufmann, 2015
- Network Performance and Evaluation R. Jain, "The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling

Reference

- Queueing Systems. Volume 1: Theory , by Leonard Kleinrock
- Computer Networks and Systems: Queueing Theory and Performance Evaluation 3rd Edition by Thomas G. Robertazzi
- Queueing Networks and Markov Chains: Modeling and Performance Evaluation with Computer Science Applications by Gunter Bolch and Stefan Greiner
- Network Performance Modeling and Simulation 1st Edition by Jean Walrand (Editor), Kallol Bagchi (Editor), George Zobrist (Editor)
- Computer Applications, Volume 2, Queueing Systems by Leonard Kleinrock
- Data Networks, by Bertsekas and Gallegar
- Conferences and Journals: ACM SIGMETRICS, ACM Performance Evaluation, ACM SIGCOMM, IEEE INFOCOM, etc

7.2.7 MCN7213 Advanced Software Engineering Processes

Course Name	: Advanced Software Engineering Processes
Course Code	: MCN7213
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description

This course is about constructing large software systems models, languages, methods, mechanisms, and tools for the elaboration, evaluation, and evolution of products and processes along the entire software lifecycle from requirements specification to software maintenance and reengineering. This is because it is paramount for a software Engineer to have a good understanding of the activities in the all phases of the software engineering process, even when their work is in one of the phases.

Course Objectives

1. To Comprehend, apply, and implement Secure Software Requirements
2. To Comprehend, apply, and implement Secure Software Design
3. To Comprehend and apply Secure Software Implementation
4. To Comprehend, apply, and implement Secure Software Testing

Learning Outcomes:

At the end of the course, students will:

1. Students will have been introduced to various methodologies that are applicable during the software design process.
2. Students will have the skills for the use and application of methodologies by examining how they can be supported by programming language like Java, python, etc languages.
3. Students will be ablle to outline, select and apply the fundamental principles of software engineering.
4. Students will be quiped with a strong grounding in the processes and tools used in engineering software systems

Detailed Course Content

1. *Module: Course Introduction; (3 hours)*
2. *Module: software quality factors; (3 hours)*
3. *Module: software engineering principles; (3 hours)*
4. *Module: System life-cycle models; (6 hours)*
5. *Module: requirements definition and analysis; (6 hours)*
6. *Module: Requirements Metrics (6 hours)*
   Development Quality Metrics &Quality Audit Metrics
7. *Module: behavioral specification; (6 hours)*
8. *Module: Software design; implementation; testing techniques; (6 hours)* The development of software-intensive systems; Design Patterns. Design Metrics. Best Practices in Coding, Code & Test Metrics. Maintenance Metrics. Analysis Tools. Customer Satisfaction Metrics & Process Improvement Metrics. Project Management Metrics &.Human Resources & Training Metrics Customer Care Metrics and Miscellaneous Metrics.
   Goal-question-metric (GQM). Balanced Score Card (BSC).
9. *Module: verification & validation (6 hours)*
   system evolution; software project management.

Mode of Delivery

The teaching method shall mainly be based on lectures. A medium size project shall be given to students in groups or individuals. The students are expected to walkthrough the engineering process using the different projects.

Asessment

- Test, Presentations, assignments (40%)
- Final written exam (60%)

Reading materials

Text books

- Ian Sommerville, Software Engineering., 9th Edition, Addison Wesley, 2010.
- Software Metrics: A Rigorous and Practical Approach, (3rd ed.) (638p.), Norman Fenton and James Bieman, 2014. ISBN 0-534-95425-1.
- Craig Larman, Applying UML and Patterns., 2nd Edition, Prentice Hall, 2002.
- Roger S. Pressman. Software Engineering: A practitioner's approach (7th ed). 2008. McGraw Hill

Recommended:

- Dean Leffingwell, Agile Software Requirements: Lean Requirements Practices for Teams, Programmes, and the Enterprise (Agile Software Development Series) 1st Edition, 2014
- Mark Van Harmelen (Ed), Stephanie Wilson (Author) Object Modeling and User Interface Design: Designing Interactive Systems . Addison Wesley, 2001.
- Martin Fowler. UML Distilled: A Brief Guide to the Standard Object Modeling Language (3rd Ed) 2003. Addison-Wesley Object Technology Series.
- David Flanagan. Java in a Nutshell, 5th Edition. O'Reilly, 2005.
- Joshua Bloch. Effective Java: Programming Language Guide, 1st Edition. Addison Wesley, 2001.

7.2.8 MCN7214 Optimisation of Communication Systems

Course Name	: Optimisation of Communication Systems
Course Code	: MCN7214
Course Level	: Year 1 and Semester 2 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

The course introduces students to how key problems in communication systems, both point-to-point and networked systems, can be formulated and solved as various forms of linear or nonlinear optimisation problems. Introduce the tools of linear and convex optimisation and Lagrange duality. Both theoretical properties and computational algorithms of the optimisation methodology will be learned through specific applications to the analysis and design of communication systems.

Course Objectives

1. To provide knowledge in the area optimised mobile and wireless networks.
2. To equip students to work in optimised communication system environment.
3. To exporse studnets to state of the art optimisation tools and techniques

Learning outcomes

The course shall offer an in-depth understanding of algorithm development and optimisation for communication protocols for wireless and mobile networks. Upon successful completion of the course, students shall be able to:

1. Fill the existing gap of experts in job market in the area optimised mobile and wireless networks.
2. Confidently undertake further research in the field.

Detailed Course Content

1. *Module: Course Introduction (3 hours)*

2. *Module: Information theory (6 hours)*

3. *Module: Channel estimation and detection (4 hours)*

4. *Module: Decoding and equalization algorithms (3 hours)*

5. *Module: Beamforming in multiple antenna systems (6 hours)*

6. *Module: Network resource allocation (5 hours)*

7. *Module: wireless network power control and multiple access (6 hours)*

8. *Module: Optical network provisioning and protection (4 hours)*

9. *Module: Network utility maximization in wired and wireless networks (4 hours)*

10. *Module: Network flow problems (4 hours)*
    IP routing, TCP congestion control, layering as optimisation decomposition.

Mode of Delivery

Teaching method shall mainly include lectures. In addition, students shall learn through take home exercises and research course work. The later shall also provide to students opportunities to learn and practice some transferrable skills such as presentations and working in groups. Some assignments might be tuned to require students to learn simulation tools such as network simulator (ns-2) to implement their course projects.

Assessment

- Assignments, test, research course work/ project (40%)
- Final examinition (60%)

Reading Material

- Algorithms for communication Systems and their Applications by Novio Benvenito
- M. Chiang 2006 and Drafts of Optimisation of Communication Systems
- S. Boyd and L. Vanden berghe Convex Optimisation (Cambridge University Press 2004)
- About 15 journal/conference papers to be distributed in class

7.2.9 MCN8101 Innovative Mobile Services

Course Name : Innovative Mobile Services
Course Code : MCN8101
Course Level : Year 1 and Semester 2 (elective)
Course Credit : 4
Contact hours : 60

Course Description

Defining Criteria for innovativeness of mobile services. Best practices in Innovative Mobile Services for developing regions. Brainstorming sessions to identify and implement localized services and applications that have impact to the community. Invited guests to the course seminars shall specialists from school of art and design, local language experts, professional software developers, in addition to experts in mobile computing field from academia and industry. Students taking this course shall also learn some Entrepreneurship skills.

Course Objectives

1. To equip students with skills of using Web-based resources such as online collections, Web analytics, crowd-sourcing, crowd-funding, and social media to inform and drive an innovation process.
2. To introduce students to online procedures to conduct A-B test and collect feedback.
3. To instill into students the idea and attitude of trial and error.
4. To encourage interaction with potential stakeholders and to conduct productive design critiques.
5. To impart the value of the mobile service market, assess and communicate value proposition.
6. To equip students the skills to conduct a competitive analysis.
7. To teach students how to pitch ideas through writing, oral-visual presentation, and video.

Learning Outcomes

At the end of the course;

1. Students will appreciate the internet for research, ideation, and feedback through leverage of the internet for research, ideation, and feedback.
2. Students will be able to conduct an A-B test and collect feedback online.
3. Students will adopt an attitude of trial and error as well as alternate between exploration and focus.
4. Students will ba able to articulate value in the mobile service market as well as assess and communicate value proposition.

Detailed Course Content

1. *Module: Introduction of Mobile technology and platforms (3 hours)*
2. *Module: Overview of Mobile Services and Applications (7 hours)*
3. *Module: Review of Mobile Computing and Programming (7 hours)*
4. *Module: The impact of mobile communication to the community (7 hours)*
5. *Module: Cultural and language (7 hours)*
   Impact on mobile applications and services
6. *Module: Requirements of Service localization (7 hours)*
   Local languages, cultures, design, etc
7. *Module: Entrepreneurship (7 hours)*

Mode of Delivery

Lectures, seminars, and take-home exercises, laboratory sessions. Students shall be required to undertake some fieldwork to explore issues in the community that can be addressed through innovative mobile services and applications. Students shall be asked to present the findings in the class and propose solutions, which they shall also be asked to implement as part of their course projects

Course Assessment

- Assignments, Group course work , seminars presentation, Individual projects - 40%
- Final Examination - 60%

Reading Material

- Digital Crossroads: Telecommunications Law and Policy in the Internet Age, second Edition by Jonathan E. Nuechterlein, Philip J. Weiser The MIT Press; second edition (July 5, 2013)
- Innovative Mobile and Internet Services in Ubiquitous Computing Proceedings of the 11th International Conference on Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS-2017), Editors: Barolli, Leonard, Enokido, Tomoya (Eds.)
- Mobile Service Innovation and Business Models (2008) Editors:Bouwman, Harry, de Vos, Henry, Haaker Timber
- Designing Innovative Mobile Business Models: Mobile Business Models Paperback August 6, 2012 Mutaz M. Al-Debei
- Africa's ICT Infrastructure: Building on the Mobile Revolution (Directions in Development) by Mark D.J. Williams, Rebecca Mayer and Michael Minges World Bank Publications (June 23, 2011)

7.2.10 MCN8108 Software Quality Assurance and Testing

Course Name	: Software Quality Assurance and Testing
Course Code	: MCN8108
Course Level	: Year 1 and Semester 2 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

Like any other product, the quality of software delivered to the client must be ensured. Software testing is one of the ways of ensuring quality of software. This course provides detailed techniques and approaches for software quality assurance and testing.

Course Objectives

1. To give students an understanding and practical experience of software quality analysis and test.
2. To equip students with different methodologies and techniques to measure the test and ensure quality of software.

Learning Outcomes

At the end of the course, students will have learned;

1. How to write a useful test plan.
2. How to construct test cases.
3. How to do inspections and walkthroughs.
4. How to write automated tests.
5. How to manage actual testing

Detailed Course Content

1. *Module: Course Introduction (5 hours)*
   Introduction to Total Quality Management.
   Quality Management Systems and Standards.
   Configuration management.
   Quality Philosophy and Principles.
   Quality Policy and Objectives.
   Software Quality Management.
   Software Process Improvement.
   Introduction and structure of CMM. Level 2 KPA's (RM). SPP and SPTO. SSM and SQA. SCM.
   ISO 9001:200094(Introduction and Structure).
2. *Module: Quality Function Deployment (10 hours)*
   House of Quality.
   Quality Tools (Pareto Analysis, Cause & Effect Diagram, Flow charts).
   Scatter Diagrams and Control Charts.
   Affinity Diagrams. FMEA, DoE Verification and Validation.
3. *Module: Test Planning (10 hours)*
   Test Cases documentation and Execution.
   Defect / Bug Reports. Six Sigma, Kaizen, Quality Circles.
   Software Quality Measures: Goal based frameworks for software measurement, empirical investigation, measuring internal product attributes, measuring external product attributes, planning a measurement programme.
4. *Module: Software fault avoidance techniques (10 hours)*
   Techniques for preventing failure by finding faults in the system before it is released covering development methodologies, configuration management, verification techniques, and reviews.
5. *Module: Fault detection techniques (10 hours)*
   Techniques for detecting faults in the system covering debugging (for both correctness and performance),
   Testing (component testing, integration testing and system testing)
   Fault tolerance techniques: Atomic transactions, modular redundancy techniques.

Mode of Delivery

The teaching method shall mainly be based on lectures. A medium size project shall be given to students in groups or individuals. The students are expected to walkthrough the different software testing and quality assurance techniques.

Assessment

- Project, assignments - 40%
- Final written exam - 60%

Reading Materials

- Software Testing and Quality Assurance: Theory and Practice, by Kshirasagar Naik and Priyadarshi Tripathy, 2018, Wiley, ISBN-10: 111919475X ISBN-13: 978-1119194750
- Software testing and quality assurance Author B.S.Ainapure, Technical Publications, 2009, ISBN 818431566X, 9788184315660
- A Friendly Introduction to Software Testing, by Bill Laboon , 2016, CreateSpace Independent Publishing Platform
- Cem Kaner, Jack Falk, Hung Quoc Nguyen, Testing Computer Software, Second Edition, Wiley.

7.2.11 MIT7116 Research Methodology

Course Name	: Research Methodology
Course Code	: MIT7116
Course Level	: Year 1 and Semester 2
Course Credit	: 4
Contact hours	: 60

Course Description

In this course, guidance will be given to students on how to identify a research problem. Instructions will be provided which will enable students to perform effective literature reviews. Students will be presented with various research paradigms and models of methodology and assist 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. Guidelines outlining the preparation and writing of a research dissertation and or a project will be provided at the conclusion of the course.

Course Objectives

This course intends to:

1. Equip students with research knowledge and skills relevant to their area of specialization.
2. Enable students to explore various areas of specialization and formulate appropriate research problems
3. Enhance the capacity of students to conceptualize and interpret research outcomes from a wide variety of approaches
4. Enhance the systematic process of collecting and analyzing gender disaggregated information to increase the students understanding of the phenomenon under study.

Learning outcomes

By the end of this course, candidates should be able to:

1. Apply research knowledge and skills in their area of specialization.
2. Demonstrate the application research knowledge and skills in their area of specialization.
3. Formulate a good research question, and matching it to a systematic research design
4. Conceptualize and interpret research outcomes from a wide variety of approaches
5. Assess of the roles and needs of women and men while designing projects
6. Understand gender-differentiated systems for access to resources, labor uses, rights and the distribution of benefits and products not to compromise anyone
7. Focus on gender relations to produce sustainable projects (looking at differences, inequalities, power imbalances, differential access to resources including technologies for women and men)

Detailed Course Content

The course will cover the following modules:

1. *Module: Introduction (6 hours)*
   Research methods and research methodology
2. *Module: Research paradigms in Computing (8 hours)*
3. *Module: Research Planning and Management (6 hours)*
4. *Module: Types of Research Methods (10 hours)*

5. *Module: Scientific writing and presentation (8 hours)*
   abstracts; identifying research problems, research objectives and questions; Interpretation of technical literature
6. *Module: Selection of methodological approach(8 hours)*
   Selection of suitable data collection methods.

   Selection of systematic process of collecting and analyzing gender disaggregated information to establish research needs, produce gender sensitive indicators and assess the viability of any undertaking towards informing scientific decision making and development of innovations.
7. *Module: Analysis techniques (8 hours)*
   Interpretation and conclusion of the research; Presentation of research findings
8. *Module: Research ethics and plagiarism (6 hours)*

Mode of Delivery

This course can be delivered in different forms including but not limited to these: Guest Speakers/Lectures, seminar series and presentations, lectures and discussion groups

Course Assessment

For the modes of delivery above, the corresponding modes of assessment is shown below.

1. Seminar participation 5%
2. Reading Assignments 15%
3. Presentations 20%
4. Position papers 60%

Reference books

- Zikmund, W.G. et.al (2010) Business Research Methods (8th Ed.) Thomson South Western
- Paul D. Leedy, Jeanne E. Ormrod, Jeanne Ellis Ormrod (March 2004), Practical Research: Planning and Design Paperback, Prentice Hall
- Robert V. Smith, (May 1998), Graduate research: A guide for Students in the sciences Paperback, University of Washington
- Anthony M. Graziano, Michael L. (May 2006) Research Methods: A process of Inquiry Raulin, Hardcover, Prentice Hall
- Taylor, Steven J.; Bogdan, Robert, Hoboken, (1998) Introduction to qualitative research methods: A guidebook and resource: (3rd Ed.) NJ, US: John Wiley & Sons Inc.
- Yin, R.K. (2009). Case Study Research, Design and Methods. 4th ed Newbury Park, Sage Publications.
- Neuman, W.L. (2003). Social Research Methods: Qualitative and Quantitative Approaches. Pearson Education, Inc. USA.
- Myers, M.D. (2009) Qualitative Research in Business and Management. Sage Publications, London.
- MoGLSD 1999, Balancing the Scales: Addressing Gender Concerns in National Development Programmes,Kampala, Uganda.
- Ssali, Ahikire, and Madanda, 2007, Gender Concepts Handbook (Popular Version), Gender mainstreaming Division, Makerere University: Kampala.

7.3 Semester III

Plan A

7.3.1 MCN8116 Dissertation

Course Name	: Dissertation
Course Code	: MCS8116
Course Level	: Year 2 and Semester 3 & 4
Credit Units	: 20

Description

Students are required to demonstrate their ability to independently formulate a detailed dissertation proposal, as well as develop and demonstrate their dissertation thoroughly. This is a masters research in the relevant option to cover a period of two semesters in which the student is work on an independent research (in that option) with guideance of the supervisor.

1. A candidate shall be allowed to formally start on the dissertation after the second semester.
2. A candidate shall submit a dissertation proposal to the School of Computing and Informatics Technology Higher Degrees and Research Committee (HDRC) during the second semester of the first academic year.
3. The candidate shall execute the dissertation during second year (the third and fourth semesters).
4. The candidate shall submit a dissertation report by the end of the fourth semester for examination

Programme Objectives

The programme intends to:

1. Equip students with the ability to do independent research under an academic supervisor.
2. Develop the students' ability in technical writing.
3. Develop the students' presentation skills.

Learning outcomes

By the end of this programme, candidates should be able to:

1. Read and internalize scientific academic material in their area of specialization.
2. Adequately and competently report academic findings in technical documents.
3. Perform independent research.
4. Prepare good presentations for dissemination of scientific findings.
5. Competently present scientific findings.

7.3.2 MCS7226 Seminar Series

Course Name	: Seminar Series
Course Code	: MCS7226
Course Level	: Year 2 and Semester 3
Course Credit	: 2
Contact hours	: 60

Course Description

This course will help to strengthen students' ability to do guided research. Through class presentations, students will provide progress on their master's research plans. This course will also help students to be equipped with scholarly writing and presentation skills. However, what is expected out of the students will be explicitly given to them and examined. The course is done by both plan A and Plan B students

Course Objectives

This course intends to:

1. Equip students with the ability to search for and internalize scientific academic material.
2. Develop the students' ability in technical writing.
3. Develop the students' presentation skills.

Learning outcomes

By the end of this course, candidates should be able to:

1. Read and internalize scientific academic material in their area of specialization.
2. Adequately and competently report academic findings in technical documents (reports, articles, etc)
3. Prepare good presentations for dissemination of scientific findings.
4. Competently present scientific findings.

Mode of Study

This course can be delivered in different forms including but not limited to these: seminars and presentations, lectures and discussion groups.

Detailed Course Content

Teaching of this course will be in 4 modules. Each module will be a complete unit of teaching and will be assessed at independently during continuous assessments. This course is broken up into the following modules;

1. *Scientific Paper Writing (6 hours)*
2. *Scientific Paper Presentation (6 hours)*
3. *Presentation of Research Plan (15 hours)*
4. *Presentation and discussion of research progress (18 hours)*

Course Assessment

Assessment will be made up of 4 parts:

- Attendance of weekly research talks 10%
- Report write up 40%
- Research Progress 30%
- Knowledge of subject matter 20%

Reading Materials

1. Justine Zobel (2014) Writing for Computer Science, Springer. How to Present a Paper in Theoretical Computer Science
2. A Speaker's Guide for Students https://larc.unt.edu/ian/pubs/ speaker.pdf
3. Giving a Talk: Guidelines for the Preparation and Presentation of Technical Seminars http://www.comm.toronto.ed
4. M.D. Hill Oral Presentation Advice Computer Sciences Department, University of Wisconsin-Madison, 1997.

Plan B

7.3.3 MCN8103 Multimedia Communication Systems

Course Name	: Multimedia Communication Systems
Course Code	: MCN8103
Course Level	: Year 2 and Semester 3 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

This course introduces student to the theory, principles, and practical techniques associated with implementing next-generation networked multimedia communications systems. We discuss the challenge of multimedia communications in providing services that integrate text, sound, image and video information and to do it in a way that preserves the case of use and interactivity. We will address how to efficiently represent multimedia data and how to deliver them over a variety of networks. In the coding aspect, state-of-the-art compression technologies will be presented. In the aspect of multimedia networking, special considerations for sending multimedia over the Internet and wireless networks, such as video adaptation, error resilience, error concealment, and quality of service will be discussed.

Course Objectives

The aim of the course unit is to impart practical skills associated with implementing next-generation networked multimedia communications as well as understand the different media streams; compare and contrast different multicast protocols, mechanisms for providing QoS guarantees in the network and to propose experiments to analyze their performance.

Learning Outcomes

Upon the completion of the course, the student should be able to;

1. Describe the ways in which multimedia information is captured, processed, and rendered
2. Describe the multimedia communication standards and compression techniques.
3. Introduce multimedia quality of service (QoS) and to compare subjective and objective methods of assessing user satisfaction
4. Analyse the utility of QoS management schemes and the ability of unicast and multicast protocols to provide QoS guarantees
5. Discuss privacy and copyright issues in the context of multimedia

Detailed Course Content

1. *Module: Course Introduction (3 hours)*
2. *Module: Networked multimedia (3 hours)*
   Theory, principles, techniques, standards, and examples
3. *Module: Audio-visual integration (3 hours)*
   Multimedia processing, organization, storage, and retrieval
4. *Module: Networked multimedia systems (4 hours)*
   Models and elements
5. *Module: Audio-visual integration (4 hours)*
   Media integration, lip synchronization, audio-to-visual mapping, and joint audio-video coding
6. *Module: Multimedia processing, in depth (4 hours)*
   Perceptual coding; transform and audio sub band coders; CD audio coding; image and video coding; and watermarking
7. *Module: Practical techniques for organization, storage, and retrieval (4 hours)*
   Advanced neural network processing systems

8. *Module: Current and emerging MPEG standards (4 hours)*
   MPEG-4, MPEG-7, and MPEG-21
9. *Module: Multipoint data conferencing (4 hours)*
10. *Module: Networking issues (4 hours)*
    Error resilience, network characteristics, Quality of Service (QoS) and congestion management
11. *Module: Multimedia over IP (4 hours)*
    Multicast, RTP/RTCP, packetization, streaming
12. *Module: Multimedia over wireless/mobile networks (4 hours)*

Mode of Delivery

Lectures and students presentations. Students will also learn through reading research papers and implementing course projects .

Course Assessment

1. Projects, Assignments, tests , research course work (40%)
2. final examination (60%)

Reading Material

Text books:

1. Wireless Multimedia Communication Systems: Design, Analysis, and Implementation 1st Edition,by K.R. Rao, Zoran S. Bojkovic, Bojan M. Bakmaz, CRC Press, 2014
2. Multimedia Communication Systems-Techniques, Standards and Networks 2nd Edition, DRAGORAD A. MILOVANOVIC, Publisher:DRAGORAD A.-2012
3. Digital Video : An Introduction to MPEG-2, Barry G. Haskell, Atul Puri, Arun N. Netravali, Chapman & Hall, New York, NY
4. MPEG Video: Compression Standard, Joan L. Mitchell (Editor), William B. Pennebaker (Editor), Chad E. Fogg, Didier J. LeGall, Chapman & Hall, New York, NY
5. JPEG: Still Image Data Compression Standard, by William B. Pennebaker, Joan L. Mitchell, Van Nostrand Reinhold, New York, NY
6. Digital Coding of Waveforms: Principles and Applications to Speech and Video, N.S. Jayant and Peter Noll, Prentice Hall, Englewood Cliffs, NJ

Recommended References:

1. IEEE/ACM Transaction on Networking
2. IEEE Communication Magazine
3. IEEE Network Magazine
4. IEEE Journal on Selected Areas in Communications
5. IEEE Transaction on Communications
6. International Journal of Communication Systems
7. Iain E G Richardson, "H.264 and MPEG-4 Video Compression", John Wiley & Sons, September 2003, ISBN 0-470-84837-5

7.3.4 MCN8105 Applied Software Project Management

Course Name	: Applied Software Project Management
Course Code	: MCN8105
Course Level	: Year 2 and Semester 3
Course Credit	: 4
Contact hours	: 60

Course Description

This course covers the core processes, tools, techniques and fundamentals of software project management. The class covers both traditional and agile project management methodology. At the end of the class, students will understand pros and cons of both methodologies and will know how to apply the appropriate methodology to a given situation.

The traditional portion of the class focuses on the five processes of project management. We will learn key tools such as work breakdown structures, network diagrams, calculating critical paths and tools associated with risk management. We will also explore the leadership aspects of project management.

In the Agile portion of the class, we will start with learning the principles and fundamental concepts that drive Agile. You will go through a series of hands-on class exercises that will help you learn how to apply the agile mindset to product definition, project estimation, planning, tracking, and incremental development.

Course Objectives

The course aims at blending some software engineering issues with management questions that arise therein. The course further is aimed to introduce students to the five process groups and nine knowledge areas of the Project Management Institute(PMI) Body of Knowledge (BOK) and to intruduce students to the efficient techniques for managing each phase of the systems/sotware development lifecycle.

Learning outcomes

On completion of the course, the student will be able to:

1. Independently describe the area of software project management (standards, key concepts, software quality definitions etc.) and name a number of key issues related to this area.
2. Harness group, or independent work to identify project management tools suggesting likely candidates for different project types.
3. Apply elearned knowledge to define risk management issues in software project management.
4. Execute a project with accompanying deliverables through involvement in a team project to completion.
5. Explain the difference between traditional project management and contemporary software project management.
6. Prepare a project plan for a software project that includes estimates of size and effort, a schedule, resource allocation, configuration control, change management, and project risk identification and management.
7. Carry out post-mortem analysis with accompanying process improvement suggestions.

Detailed Course Content

1. *Module: Course Introduction (3 hours)*
2. *Module: Job description of a software manager (4 hours)*
3. *Module: Successful software development management (5 hours)*
   Organizing the software development team;
   interfacing with other engineering organizations (systems engineering, quality assurance, configuration management, and test engineering);

4. *Module: Assessing development standards (4 hours)*
   Selecting the best approach and tailoring the process model;
5. *Module: Estimating software cost and schedule (4 hours)*
6. *Module: Planning and documenting the plan (4 hours)*
7. *Module: Staffing the effort (4 hours)*
8. *Module: Managing software cost and schedule during development (5 hours)*
9. *Module: risk engineering (4 hours)*
10. *Module: Continuous process improvement (4 hours)*
11. *Module: Continuous software delivery (4 hours)*
    Software delivery line

Mode of Delivery

The participants will work in teams executing a project. The course starts with an introductory lesson and then consists of a series of workshops and lessons that are conducted in parallel to the participants' projects. The teams must plan, execute and finalize a project and the examination is solely performed through two team assignments (Assignment 1-2) and one individual assignment

(Assignment 3). In Assignment 1-2 a number of artifacts must be delivered indicating that the team is following the previously established project plan. Assignment 3 requires the participant to individually perform an analysis (post-mortem) of the project with an accompanying process improvement recommendation of the project.

Course Assessment

- Test, Project, Research coursework: 60%
- Final Examination: 60%

Reading Material/Sources

- Microsoft Project 2016 Step by Step 1st Edition, Microsoft Press; 2016
- Introduction to Software Project Management, Adolfo Villafiorita, 2014 by Auerbach Publications
- Applied Software Project Management, Andrew Stellman and Jennifer Greene, 2005
- IEEE GuideAdoption of the Project Management Institute (PMI) Standard A Guide to the Project Management Body of Knowledge (PMBOK Guide), Fourth Edition, IEEE Computer Society, 2011
- Boehm, B (1986) A Spiral Model of Software Development and Enhancement, ACM SIGSOFT Software Engineering

7.3.5 MCN8106 Database Design

Course Name	: Database Design
Course Code	: MCN8106
Course Level	: Year 2 and Semester 3
Course Credit	: 4
Contact hours	: 60

Course Description

Relational database technology is the dominant approach to information storage, with products that offer an unmatched combination of abstraction and performance. To use these products effectively, however, requires an understanding of the underlying principles and concepts.

Course Objectives

The aim of the course is to give students a thorough introduction to the underlying principles of modern relational databases and be able to use these insights in designing data models

Learning outcomes

At the end of the course, students will learn;

1. How to write and design data models
2. How to Implement database driven systems

Detailed Course Content

1. *Module: Course Introduction (6 hours)*
   Evolution of database systems; database system architecture; database management systems.
2. *Module: The entity-relationship model (6 hours)*
   Semantic modelling; entity-relationship diagram elements; entity-relationship diagrams; design principles; modelling constraints; limitations of the entityrelationship model.
3. *Module: The relational data model (6 hours)*
   Objectives; aspects; terminology; relational integrity; views; relational algebra; relational calculus; limitations of the relational data model.
4. *Module: SQL (6 hours)*
   Queries; subqueries; full relation operations; modifying databases; defining relation schemas; defining views; constraints and triggers.
5. *Module: Normalisation (6 hours)*
   Functional dependencies and normalisation; denormalisation.
6. *Module: Query optimization (6 hours)*
   Query processing; query decomposition; a heuristical approach to query optimisation.
7. *Module: Transaction management, recovery; concurrency. (6 hours)*
8. *Module: Distributed databases (6 hours)*
   Principles; client/server systems; DBMS independence; data warehousing.

Mode of Delivery

The teaching method shall mainly be based on lectures. A medium size project shall be given to students in groups or individuals. The students are expected to walkthrough the different database design and construction techniques.

Assessment

1. Research coursework, Project, assignments - 40%
2. Final written exam - 60%

Reading Material

- ClydeBank Technology, SQL: QuickStart Guide - The Simplified Beginner's Guide To SQL (SQL, SQL Server, Structured Query Language), Media LLC; 1 edition, 2015.
- Michael J. Hernandez, "Database Design for Mere Mortals: A Hands-On Guide to Relational Database Design" (3rd Edition), Addison-Wesley Professional, 2013
- "Database in Depth: Relational Theory for Practitioners" 1st Edition

7.3.6 MCN8110 Domain-Specific Engineering

Course Name	: Domain-Specific Engineering
Course Code	: MCN8110
Course Level	: Year 2 and Semester 3 (elective)
Course Credit	: 4
Contact hours	: 60

Course Description

Establishing firm and precise requirements is an essential component of successful software development. This course covers a range of methods from the hard semi-formal approaches to softer methods, and some innovative techniques. Practical guidance is also included.

Course Objectives

1. To understand non-trivial Software Requirements
2. To evaluate user requirementts
3. To formulate user requirementts

Learning outcomes

At the end of the course the student will have a breadth of knowledge about the range of requirements methods, tools, and techniques. They will gain an appreciation of at least two methods, and obtain practical guidance on elicitation techniques. Upon successful completion of this course, students will:

1. be able to clearly document non-trivial requirements
2. be able to evaluate and formulate the user requirements in systems.

Detailed Course Content

1. *Module: Course Introduction (3 hours)*

2. *Module: Principles, tools, and techniques (10 hours)*
   for requirements elicitation, specification, and analysis.
3. *Module: Focus on understanding the role of requirements (10 hours)*
   in system development and maintenance, and the difficulties of specifying requirements for real systems, and effective methods tools and techniques.
4. *Module: Principles, tools, and techniques to establish a software specification (10 hours)*
   captures correctly and completely the requirements of a software system under development and the expectations of the potential user.
5. *Module: System and Software System Engineering (12 hours)*
   Software Requirements Concepts, Requirements Elicitation, Software Requirements Analysis, Software Requirements Specifications, Software Requirements Tools, Software Requirements Verification, Software Requirements Engineering Management, Developing a Successful Software Requirement

Mode of Delivery

The class will be conducted on face to face, in class lecture

Course Assessment

- Test, Project, Research coursework, (40%)
- Final Examination (60%)

Reading Material

- Journals papers and conference proceedings
- Requirements Engineering: Processes and Techniques (Worldwide Series in Computer Science) by Gerald Kotonya and Ian Sommerville (Aug 24, 1998)
- Software Requirements Engineering, 2nd Edition by Richard H. Thayer and Merlin Dorfman 1999
- Geri Schneider and Jason P. Winters. Applying Use Cases: A Practical Guide. 1998. Addison-Wesley.

7.3.7 MCS7101 Cloud Technologies and Architectures

Course Name	: Cloud Technologies and Architectures
Course Code	: MCS7101
Course Level	: Year 2 and Semester 3
Course Credit	: 4
Contact hours	: 60

Course Description

Cloud Computing technologies are emerging as a common way of provisioning infrastructure services, applications and general computing and storage resources on-demand. Cloud computing enables new possibilities for highly elastic and potentially infinite computing power with scalability, big data analytics, and support for delivery of mission-critical secure enterprise applications and services. During this course student will gain hands-on experience with various types of cloud models and explore areas such as programming models and application development for cloud systems, cloud management technologies, the underlying system architectures, data centers, virtualization, and cloud storage. The course prepares graduates to enter a range of professional positions related to cloud systems, including developing cloud-based applications, managing cloud systems and designing cloud infrastructures.

Course Objectives

The objectives of the course are to:

1. provide an understanding of the field of Cloud Computing, its enabling technologies, main building blocks, and architectures
2. provide hands-on experience for solving relevant and cloud computing real-world problems
3. develop the skills needed to become a practitioner or carry out research projects in the Cloud Computing domain

Learning Outcomes

At the end of this course, students will have:

1. an understanding of the field of Cloud Computing, its enabling technologies, main building blocks, and architectures
2. gained hands-on experience for solving relevant and real-world problems through projects that utilize various cloud tools including programming models and cloud systems such as Amazon, Microsoft Azure, Google App Engine, etc
3. developed the skills needed to become a practitioner or carry out research projects in the Cloud Computing domain

Detailed Course Content

Teaching of this course will be in **4** modules. Each module will be a complete unit of teaching and will be assessed at independently during continuous assessments. The course is broken up into the following modules.

1. *Module 1: Cloud Computing Systems and Architectures (12 hours)*
   This module will provide a broad overview of cloud computing, its history, technology overview, benefits, risks and the economic motivation for it. The module will also cover cloud computing types: Infrastructure as a service (IaaS), Software as a service (SaaS), Platform as a service (PaaS) - Architectures and Models: local/distributed, private/public, hybrid. The modules will involve experimentation through case studies using popular cloud systems like Amazon S3, EC2, Force.com, MS Azure, Google App Engine, etc.
2. *Module 2: Cloud Computing Technologies (12 hours)*
   Topic will include Virtualisation - Multi-tenancy - Data management - Elastic and resilient environments - Cloud and Load Balancing. Students will learn how virtualization can allow software and hardware images (e.g., virtual machines) to run side-by-side on a single cloud data center yet provided security, resource and failure isolations. They will understand how virtualization enables clouds to offer software, computation, and storage as services as well as attain agility and elasticity properties. We will discuss resource virtualization in detail and present multiple examples from Xen and VMware. Finally, we will present real use cases such as Google App Engines and Amazon EC2.
3. *Module 3: Programming Models for Cloud Computing (12 hours)*
   Students will be given an overview on a variety of cloud-applicable programming models. Students will understand the benefits and limitations of each so that they can assess applicability based on the problem domain. Students will gain working experience in one (or two) of these programming models. Upon completion of this module students will be able to: Explain the fundamental aspects of parallel and distributed programming model, demonstrate an understanding of the different cloud programming models (Dryad, MapReduce, Spark, GraphLab, Pregel).
4. *Module 4: Challenges and Trends: Self-* properties (9 hours)*
   This module will cover Data and Information Integration - Security/Trust Management and Governance - Legislative and economic environment - Cloud computing future trends.
   Self-healing, self-stabilizing, self-organizing, self-adaptive, self-optimizing, self-protecting, and self-managing.

Mode of Delivery

The teaching will be highly student centered. It will involve teaching, online/class room discussions, demonstrations, group/individual projects and self guided research. A student will be expected to do self paced research in each of the module.

Course Assessment

1. Progressive assessment (40%). This will include in-class quizzes and cross-module projects
2. End of semester examination (60%). Part of the final exam may be a practical project.

Reading Material The materials shall include textbooks, journal/conference papers, cloud platforms, and several freely available online resources.

7.4 Semester IV

Plan A

7.4.1 MCN8116 Dissertation - Continues

Plan B

7.4.2 MCN8204 Project

Course Name	: Project
Course Code	: MCN8204
Course Level	: Year 2 and Semester 4
Credit Units	: 10

Description

Students are required to demonstrate their ability to independently formulate a detailed project proposal, as well as develop and demonstrate their project thoroughly. This is a master's project underpinnig a prevailing industrial problem in the relevant option to cover a period of one semesters in which the student works on an independent project (in that option) with guideance of the supervisor.

1. A candidate shall be allowed to formally start on the project after the third semester.
2. A candidate shall submit a project proposal to the School of Computing and Informatics Technology Higher Degrees and Research Committee (HDRC) during the third semester.
3. The candidate shall execute the project during second semester of second year (the fourth semesters).
4. The candidate shall submit a project report by the end of the fourth semester for examination

Programme Objectives

The programme intends to:

1. Equip students with the ability to excecute independent projects under an academic supervisor.
2. Develop the students' ability in technical writing.
3. Develop the students' presentation skills.

Learning outcomes

By the end of this programme, candidates should be able to:

1. Read and internalize scientific academic material in their area of specialization.
2. Adequately and competently report academic findings in technical documents.
3. Initiate and execute independent project to completion.
4. Prepare good presentations for dissemination of findings or solutions.
5. Competently present or pitch solutions or findings.

Appendix A: ACADEMIC STAFF LIST

NAME	Qualifications and Awarding Institution	Area of Specialization	
Networks Dep't:			**Load/sem**
Swaib Kyanda Kaawaase, (Ag. HoD)	PhD. Eng (Haerbin Eng. Univ.), MSc. CS (Mak), BSc. Sc(Mak)	Wireless networks, Wireless Net Protocols, Wireless Net security	10
Julianne Sansa Otim	PhD. Maths and Nat. Sciences (RUG), MSc. CS (Mak), BSc. (CS, Maths) (Mak)	Internet of Things, Networking Protocols, Network security	10
Tonny Eddie Bulega	PhD. South China Univ. Of Tech, Guangzhou (SCUTG), MSc. Eng (SCUTG), BSc Eng (Mak)	Mobile Wireless Nets, Wireless Sensor Nets, Communication System	10
Johnson Mwebaze	PhD. Maths and Nat. Sciences (RUG), MSc. CS (Mak), PGDCS (Mak), BSc. (CS, Maths) (Mak)	Data Comms and Nets, Scientific Data Processing, Web & Computer Programming	10
Benjamin Kanagwa	PhD	Software Development	10
Joseph Balikuddembe	PhD	Software Development	10
Drake Patrick Mirembe	PhD	Network Security, Security Protocols	10
Moses Ntanda	PhD	Artificial Intelligencet	10
Ruth Mbabazi Mutebi	M.Sc	Network protocol Design & Development	10
Joab Ezra Agaba	PhD (Mak), M.Sc CS (Mak), BSc. (Mak)	Software Development and Re-usability in Instructional Design	10

Other staff

NAME	HIGHEST DEGREE	RANK	Load/sem
Computer Science Dep't:			
Engineer Bainomugisha	PhD	Associate Professor	10
Joyce Nakatumba-Nabende	PhD. CS (TU Eindhoven), MSc. CS(Mak), BCS (MUST)	Lecturer	10

NAME	HIGHEST DEGREE	RANK	Load/sem
Information Systems Dep't:			
Dr. Rehema Baguma	PhD. IS (RUN2), MSc Computer Application Technology (Huazhong University), PGD Cs (Mak) and BSc Lib & IS (Mak)	S.Lecturer	10
Dr. Raymond Mugwanya	PGD Education (UCT5) Ph.D. Computer Science (UCT), M.Sc. Computing (Liverpool), and B.Sc. Statistics (Mak).	Lecturer	10
Dr. Peter Khisa Wakholi	Ph.D. (Bergen), M.Sc. Internet & Database Systems (LSBU),& B.Sc. CS (Mak).	Lecturer	10

Appendix B: ANNUAL PROGRAMME BUDGET

A	**SUMMARY**		**(UGX)**
i	**Tuition Fees**		
	EXPECTED INCOME		
	Total Admission Number	**50**	
	Number of Semesters per year	**2**	
	Amount Payable per student per Semester		3,000,000
	Total Amount per Semester		150,000,000
	Total Amount per year		300,000,000
ii	**DISTRIBUTION**		
	College (33.3%)		99,900,000
	Central Activities (66.7%)		200,100,000
	Total		300,000,000
B	**DETAILED COSTING**		
	INCOME		
	College Collection		99,900,000
	EXPENDITURE		
i	**Teaching Expences**		
	Lecture/tutorial/practical hours	@ 50,000 x 1070 CH	53,500,000
	Masters supervision/pannels	50 x 250,000	12,500,000
ii	**Administrative Activities**		
	College Activities (Administration/ Cleaning, Furnishing, Ware and Tear)	-	27,000,000
iii	**Teaching Materials**		

Item	**Quantity**	**Amount**
Laboratory Costs & Specialised Software	–	5,000,000
Contingencies (Photocopying, Meetings, binding, etc)	–	1,900,000