DEPARTMENT OF COMPUTER SCIENCE

MASTER OF SCIENCE IN COMPUTER SCIENCE (MSC CS)

Background information:

a. Introduction

The MSc in Computer Science at University of Ghana is designed for graduates who are looking for a higher degree in Computer Science with a strong emphasis on new advancements in the field of computer science. Department of Computer Science is a well-established department of University of Ghana, with a good number of experienced teaching staff. Students will have an opportunity to specialise via the implementation of a large project or research thesis. They will also acquire new knowledge and skills through our taught courses which will prepare them to work at the cutting edge of industry. Typical applicants will have undertaken a first degree in computer science or an equivalent subject, and will be expected to be familiar with basic concepts and practices. The MSc in Computer Science covers material at an advance level in both theoretical and practical aspects. Students will also be given an in-depth introduction to the elements of research practice. It combines lectures, seminars and project work in various combinations tailored to the individual student need.

b. Programme Objectives

In view of this rationale, the objectives of the programme are:

- to equip students with scientific knowledge and analytical thinking in Computer Science
- to produce computer science academics that are able to support the Computer Science and Information and Communication Technology education in the country.
- to produce computer science professionals that are able to:
    i. to engage in systematic thinking about the relationship between Computer Science and social systems, and
    ii. to suggest innovative solutions.
- to produce computer science academics and professionals required at various levels of the social, economic and industrial development of Ghana and elsewhere.
- to prepare students for advanced research and dissemination of knowledge at the MPhil and PhD level.

The philosophy and objectives of the programme fit into the mission and plans of University of Ghana to be among the first class universities in the world, producing graduates in a variety of scientific disciplines for the development of

Ghana and Africa. It is clear from all national and international debates on human skills availability that the country continues to experience a shortage of properly trained Computer Science personnel.

Students' admission, progression and graduation:

a) Entry Requirements

Applicants for the MSc in Computer Science are expected to have met the following prerequisites:

- The general admission requirement is a Bachelors degree of at least Second Class lower in computer science, mathematics, engineering or closely related or relevant discipline.
- Candidates must demonstrate that they are familiar with at least one programming language.
- Candidates may also be required to sit an entry examination organised by the department
- Candidates not meeting the minimum requirements may be considered and recommended to take prescribed courses, mini-project or coursework
- Candidates must demonstrate that they have a solid background in mathematics having done at least six credits of Mathematics at undergraduate level.

In all cases a departmental interview will be conducted to assess suitability of applicants.

A complete application pack must include:

i. A completed University of Ghana postgraduate application form;

ii. Official transcripts of the applicant's previous academic record at the university level;

iii. A full curriculum vitae

iv. A postgraduate research proposal;

v. Three letters of recommendation commenting on the applicant's ability to do the programme

b) Progression and Graduation of Students

i. Duration

The maximum period for completing the programme as stated in the postgraduate handbook will be adhere to. Deferment periods are included. As long as deferment is on medical grounds and is certified by a medical practitioner the duration clause would not be applicable.

ii. Work Load

The typical workload for students is between 12 and fifteen 15 hours per week. A minimum of 24 and a maximum of 30 credit hours of coursework must be done and passed to make a student eligible for graduation.

iii. Progression

Students will go through a programme of study spanning a minimum of 2 semesters for a year. Full-time students are expected to complete the MSc in Computer Science programme within a period of one year. Part-timers are expected to complete within a period of 2 to 4 years.

iv. Graduation Requirements

Pass in all 18 credits of core courses, pass in a minimum of 6 credits of elective courses, pass in the seminars (6 credits) and pass in the dissertation (30credits) are required to make a student eligible for graduation. In addition, a student must have the required cumulative grade point average as stated in the postgraduate handbook. This is in spite of the fact that he or she may have passed all courses in the programme.

c) Assessment Areas

Students will be assessed in the following areas:

- Knowledge: ability to recall computer science theory, concepts and their applications
- Research Techniques and skills: ability to identify computer science research challenges and opportunities, and design innovative solutions to address them.
- Comprehension: ability to analyse organisational IT problems, to review relevant literature pertaining to them, and to write sound proposals on innovative solutions that can address them.
- Oral presentation and persuasion: ability to convince an audience of the soundness and acceptability of an innovative solution in computer science its sub-domains.

d) Grading System

The postgraduate grading system of the University of Ghana will be used to grade students in this programme. Refer to Section 13 for some details of University of Ghana grading system.

Employment:

The graduates of this programme will be able enter the job market as academics or industry practitioners. They are trained to work as theorists, researchers, or inventors. Their jobs are distinguished by the higher level of theoretical expertise and innovation they apply to complex problems and the creation or application of new technology.

The courses of this programme are advanced areas of computer science which will catalyse the production of expedient computer science manpower needs in Ghana and elsewhere. The contents and structure of the course are such that they will prepare students to take up computer science research and development roles, Information and Communication Technology (ICT) management roles in any organisation, or start their own Technology businesses.

Graduates will be able to initiate ICT adoption projects in organisations. Their in-depth ICT knowledge and skills will enable them to propose innovative software, hardware and network solutions in all human activities. However, they will be aware that solutions to organisational problems are not always purely technological. Many user and organizational issues can be resolved through measures other than purely technological ones.

Consultations:
The programme has been designed in consultation with the board of faculty of the Faculty of Science, the Association of Computing Machinery (ACM) 2013 publication on Computer Science Curriculum Design Guidelines and Industry partners including IBM Ghana, Microsoft Ghana and Airtel Ghana.

Components of the programme:
This is a 12 month programme consisting of two semesters and a Dissertation. It is structured according to the following components:

i. Understanding of fundamental and advanced areas of Computer Science
ii. A Dissertation reporting on the applicant's research and innovation capacities.

The project work is started upon the successful completion of the two semesters and is from June to August.

The coursework for the MSc consists of 3 core courses in the first semester of year 1 and a seminar as well as 1or 2 elective courses. The second semester of year 1 is similarly structure, 3 core courses, a seminar and 1 or 2 elective courses.

Duration of Programme
MSc

Full-Time	2 semesters	(12 months)

Graduation Requirements MSc

Coursework	
Coursework	24-30 credits
Seminar	3 credits
Dissertation	12 credits
Total	**39-45 credits**

First Semester Core Courses

Course Code	Course Title	L	Lab	Credits
CSCD 601	Research Methods	2	1	3
CSCD 603	Advanced Data Structures and Algorithms	2	2	3
CSCD 609	Principles of Wireless and Mobile Systems	2	2	3

First Semester Elective Courses *Select maximum of 6 credits*

Course Code	Course Title	L	Lab	Credits
CSCD 607	Advanced Computer Networks	2	2	3
CSCD 611	Advanced Database Systems	2	2	3
CPEN 641	Advanced Operating Systems	2	2	3
CPEN 637	Human Computer Interaction	2	2	3

Second Semester Core Courses

Course Code	Course Title	L	Lab	Credits
CSCD 602	Advanced Software Engineering	2	2	3
CSCD 604	Distributed Systems	2	2	3
CSCD 610	Seminar I		3	3
CSCD 612	Intelligent Systems	2	2	3

Second Semester Elective Courses *Select maximum of 6 credits*

Course Code	Course Title	L	Lab	Credits
CSCD 606	Bioinformatics	2	2	3
CSCD 608	Advanced Computer Vision	2	2	3
CSCD 614	Wireless Systems Design	2	2	3
CPEN 656	Networks Security	2	2	3
MATH 652	Computational Mathematics	2	1	3

Course Code	Course Title	Credits
CSCD 600	MSc Dissertation	12

The Department of Computer Science reserves the right to replace some these modules with other relevant modules as and when it is considered necessary.

Course Description:
DESCRIPTIONS OF COURSES IN THE PROGRAMME

The following table is a summary of the codes and titles of all courses within the MSc Computer Science degree programme.

CSCD 600 Dissertation 12 credits
The candidate, working closely under the supervision of their advisor shall present a dissertation for assessment. The candidate's dissertation will be the final report on the work done over the period of research investigation. It shall outline the problem, the motivation for the work, previous work done, methodology and present the findings of the current research and any implications for future

directions. The candidate must demonstrate in this dissertation their fundamental contribution to the area of study.

CSCD 601 Research Methods 3 credits
This course is designed to teach students key research skills including: understanding the research process; surveys, sampling, ethnography, qualitative and quantitative research, research tools, validity and threats to validity, test assumptions, distributions: normal, binomial, log linear analysis, difference and nonparametric tests, correlation, regression and prediction tests; how to read research papers; technical writing and technical presentation; and experiment design and statistical analysis of results.

CSCD 602 Advanced Software Engineering 3 credits
Students attending this course are expected to acquire advanced skills in object-oriented programming and design. The course particularly focuses on the design aspects of object-oriented programming and concepts such as responsibility and collaboration analysis, and designing for change. Topics include: software process, agile software development, requirements engineering, systems modelling, dependability and security, software reuse, service oriented architecture, embedded software, component based software engineering, distributed software engineering, software testing and testing process, test planning and control, test analysis and design and test implementation and execution.

CSCD 603 Advanced Data Structures and Algorithms 3 credits
This course will introduce students to a number of highly efficient algorithms and data structures for fundamental computational problems such as primality testing, linear optimisation and string matching. Other topics will include, design and analysis of algorithms, data types, trees, operations on sets, advance set representation methods, directed graphs, undirected graphs, sorting, algorithm analysis techniques, algorithm design techniques, data structures and algorithms for external storage as well as memory management. In addition students are introduced to randomised algorithms and to techniques of amortised complexity analysis.

CSCD 604 Distributed Systems 3 credits
This course would cover both theoretical and practical aspects of distributed computing. It describes the client-server model for developing distributed network systems, the communication paradigms used in a distributed network system, and the principles of reliability and security in the design of distributed network systems. It would review various implementation strategies and techniques for building distributed network systems, including examples in TCP/IP communications, the use of remote procedure call and remote method invocation

techniques, and the development of web-based applications, distributed databases, and mobile computing systems.

CSCD 606 Bioinformatics 3 credits

The aim of this course is to introduce students to the computational techniques used in the field of bioinformatics. To reinforce the theory underlying the concepts and techniques of sequence analysis and post-genomic bioinformatics. This course also provides an understanding of the basic theory behind bioinformatics analyses and experience in practically applying that theory. The course introduces basic concepts of molecule biology, sequence analysis and genomic era biology. It introduces a number of many different tools and their usage, as well as the analysis algorithms behind some of them. Topics include: Basic concepts of molecular biology: genomes, transcripomes, proteomes. Sequence analysis: genome annotation, sequence alignment, multiple sequence alignment, Phylogenetic analysis, Protein families, Database searching tools. Appropriate tools for performing the above, Post genomic analysis: Gene and genomic comparison, protein structure, proteomics. Gene networks, Human computer interaction for bioinformatics

CSCD 607 Advanced Computer Networks 3 credits

This course examines the science underpinning computer communications, such as the basic architectural principles of computer networking and specifically how the Internet works today. Covered topics include network software and hardware, reference model and network layers including Y-comm model, data representation, how errors in transmission can be detected and dealt with, the way information is routed over a large network, how congestion can be avoided, aspects of network security, and socket programming.

CSCD 608 Advanced Computer Vision 3 credits

High-level processing for image understanding and high-level vision. Data structures, algorithms, and modelling. Low-level representation, basic pattern-recognition and image-analysis techniques, segmentation, color, texture and motion analysis, and representation of 2-D and 3-D shape. Applications for content-based image retrieval, digital libraries, and interpretation of satellite imagery. Topics include: Introduction to Computer Vision; Low-level image processing ;Binary image analysis ; Segmentation ;Texture; Color; Pattern recognition techniques; Feature Extraction; Matching; Motion; Applications: Content-based image retrieval ; Applications: Biometrics.

CSCD 609 Principles of Wireless and Mobile Systems 3 credits

Wireless communication has become a ubiquitous part of modern life, from global cellular telephone systems to local and even personal-area networks. This course provides an in-depth introduction to digital mobile wireless networks, illustrating theoretical underpinnings with a wide range of real-world examples. The course will review propagation phenomena, modulation techniques, multiple

access schemes, and coding techniques, air interface design, wireless network planning and operations, GSM, TDMA and CDMA technologies.

CSCD 611 Advanced Database Systems 3 credits

The aim of this course unit is to survey the research landscape of advanced DBMS systems with a view to understanding how DBMS research is responding to challenges arising from new software architectures, new kinds of data resource and new computational fabrics. Topics include: Architecture, Components: The Classical Case and Variations; The Relational Case: Data Models, Databases, Languages; Query Processing (1): Overview, Equivalence-Based Rewriting; Query Processing (2): Algorithms, Evaluation Strategies, Cost-Based Optimization; Parallel DBMSs [2]; Distributed DBMSs and Dataspaces; Massively-Parallel/Massively-Distributed Data Processing; NoSQL and Cloud Database; Stream Data Management; Sensor Network Data Management

CSCD 612 Intelligent Systems 3 credits

This course teaches various machine learning, probabilistic reasoning, expert systems, knowledge acquisition, search, knowledge representation, and planning techniques. Other topics include, automating reasoning, correct and exhaustive reasoning, neural networks, inference in 1st order logic and propositional logic. It also provides students an ability to use Lisp at a moderate to high level of proficiency and be equipped with an ability to develop nontrivial artificial intelligence applications. An ability to work in teams, and also identify the right AI technique to use for a given problem and to understand the issues and tradeoffs involved.

CSCD 614 Wireless Systems Design 3 credits

This course is designed to build on what was done in principles of wireless systems. It takes an in depth look at various emerging wireless systems, including wifi systems, wireless sensor networks, adhoc networks, vehicular networks and wearable systems. In each of these systems, students will be introduced to the various technologies such as channel access, routing techniques, mobility, QoS, and security

CPEN 641 Advanced Operating Systems 3 credits

The advanced operating system course examines the structural aspects of operating system and how these provide support for general purpose, embedded, and real-time operating environments. Topics include survey of early systems, structural design of operating system including process model, inter-process communication, synchronization mechanisms, resource management, CPU scheduling, I/O scheduling, file systems, virtual machines, protection issues, implementation issues of modern operating systems, performance analysis, deadlock detection, recovery and avoidance, operating system for distributed and current systems, review of current research in operating systems.

CPEN 637 Human-Computer Interaction 3 credits

The human computer interaction course provides key approaches to the design, development, and evaluation of human-computer interfaces, with an emphasis on usability, interaction paradigms, computer-mediated human activities, and implications to society. Topics include foundation of HCI and technologies, HCI paradigms and history, nature of human computer interaction, use and context of computers, human characteristics including human information processing, language and communication interaction, and ergonomics, computer system and interface architecture, development process including design approaches, implementation techniques and tools, evaluation techniques, user interface software and error handling, multimedia systems, interaction design for new environment.

CPEN 656 Networks Security 3 credits

The network security course examines the treatment of network security for secure operation. Topics include principles and practice of network and internet security, mathematical principles of cryptography and data security, conventional and modern encryption algorithm techniques, secure communication protocols, public key cryptography, remote access security, firewalls, VPNs, and PKI architecture, secure IP and SSL, intrusion detection systems, electronic mail security, routing protocol security, wireless network security, traffic analysis and alert tools, modern applications such as digital cash and secure distributed computing, operational aspects of network security.

CSCD 610 Seminar I 3 credits

On starting their programme of study, students will be guided to develop a proposal for their research thesis or to define a problem for their project work. The supervisor will recommend up to three journal papers or books for the student to study and use that as a basis for developing a proposal. The full proposal should (1) define a problem of interest to the student, (2) summarize past work, (3) outline work on an approach to solving the problem and (4) define the scope and limitations of the work. This proposal shall form the basis of the work to be carried out in the final year. It is important to note that this is still just a proposal and there will be no requirement on the candidate to continue working in the proposed area. The candidate, with the approval of their supervisor, may modify the scope and direction of research at any time.

CSCD 620 Seminar II 3 credits

This is the final part of the work, a public presentation of the major findings of the research. The presentation will be subject to scrutiny by an external examiner, an

internal examiner, the supervisory team and the general public. The aim is to ensure that the work is of an acceptably high standard deserving of an award of the degree of master of philosophy.

Courses from Other Departments
Please refer to Mathematics for description of MATH 652
Please refer to Computer Engineering for description of CPEN 637, CPEN 641 and CPEN 656

Assessment of students' performance and achievements:
The postgraduate grading system of the University of Ghana will be used to grade students in this programme. Below is a brief description of the assessment system.

Areas of Assessment
Students will be assessed in the following areas:

- Knowledge: ability to recall computer science theory, concepts and their applications
- Research Techniques and skills: ability to identify computer science research challenges and opportunities, and design innovative solutions to address them.
- Comprehension: ability to analyse computer science related problems, to review relevant literature pertaining to them, and to write sound proposals on innovative solutions that can address them.
- Oral presentation and persuasion: ability to convince an audience of the soundness and acceptability of an innovative solution in computer science its sub-domains.

Objectives of Assessment
Any form of assessment such as, a test, quiz or seminar for a course is expected to be both formative and summative:
Formative: The objective is to monitor the candidate's progress and improve his/her performance, and to serve as feedback for both learner and instructor, in case adjustments of learning and teaching have to be made;
Summative: the objective is to give the learner the opportunity to demonstrate understanding, and the teacher the opportunity to assess teaching and learning effectiveness.

Forms of Assessment
For the majority of courses, evaluation of students' performance is by tests, quizzes, laboratory assignments, classroom participation, seminars and end-of-semester examination.
For the end-of-semester assessment, apart from the usual written examination, other forms may be more suitable, such as a seminar or a project within the course. Performance in a course will be marked over a hundred. Details of

students' assessments and grading can be found in the "Handbook for Graduate Studies" of University of Ghana.

- **Certification**

  Students would be awarded a Certificate of **Master of Science in Computer Science** upon the successful completion of the postgraduate (MSc) requirement for Faculty of Science of University of Ghana.

MASTER OF PHILOSOPHY IN COMPUTER SCIENCE (MPHIL CS)

Background information:

a. Introduction

The MPhil in Computer Science at University of Ghana is designed for graduates who are looking for a research degree in Computer Science with a strong emphasis on new advancements in the field of computer science. Department of Computer Science is a well-established department of University of Ghana, with a good number of experienced teaching and research staff. Students will have an opportunity to specialise in a number of computing research areas including Wireless and Wired Networking, Information Security, Graphics and Image Procession etc. They will also acquire new knowledge and skills through our taught courses which will prepare them to work at the cutting edge of industry. Typical applicants will have undertaken a first degree in computer science or an equivalent subject, and will be expected to be familiar with basic concepts and practices. The MPhil in Computer Science covers material at an advance level in both theoretical and practical aspects. Students will also be given an in-depth exposer to the elements of research practices. The programme combines lectures, seminars and project work in various combinations tailored to the individual student need.

b. Programme Objectives

In view of this rationale, the objectives of the programme are:

to equip students with scientific knowledge and analytical thinking in Computer Science

to produce computer science academics that are able to support the Computer Science and Information and Communication Technology education in the country.

to produce computer science professionals that are able to:

to engage in systematic thinking about the relationship between Computer Science and social systems, and

to suggest innovative solutions.

to produce computer science academics and professionals required at various levels of the social, economic and industrial development of Ghana and elsewhere.

to prepare students for advanced research and dissemination of knowledge at the PhD level.

The philosophy and objectives of the programme fit into the mission and plans of University of Ghana to be among the first class universities in the world, producing graduates in a variety of scientific disciplines for the development of

Ghana and Africa. It is clear from all national and international debates on human skills availability that the country continues to experience a shortage of properly trained Computer Science personnel.

Students' admission, progression and graduation:

e) Entry Requirements

Applicants for the MPhil in Computer Science are expected to have met the following prerequisites:

- The general admission requirement is a Bachelors degree of at least Second Class lower in computer science, mathematics, engineering or closely related or relevant discipline.
- Candidates must demonstrate that they are familiar with at least one programming language.
- Candidates may also be required to sit an entry examination organised by the department
- Candidates not meeting the minimum requirements may be considered and recommended to take prescribed courses, mini-project or coursework
- Candidates must demonstrate that they have a solid background in mathematics having done at least six credits of Mathematics at undergraduate level.
- Candidates must demonstrate that they have a solid background to conduct independent academic research.

In all cases a departmental interview will be conducted to assess suitability of applicants.

A complete application pack must include:

vi. A completed University of Ghana postgraduate application form;

vii. Official transcripts of the applicant's previous academic record at the university level;

viii. A full curriculum vitae

ix. A postgraduate research proposal;

x. Three letters of recommendation commenting on the applicant's ability to do the programme

f) Progression and Graduation of Students

v. Duration

The maximum period for completing the programme as stated in the postgraduate handbook will be adhere to. Deferment periods are included. As

long as deferment is on medical grounds and is certified by a medical practitioner the duration clause would not be applicable.

vi. Work Load

The typical workload for students in the first year of the programme is between 12 and fifteen 15 hours per week. A minimum of 24 and a maximum of 30 credit hours of coursework must be done and passed to make a student eligible for graduating into the second year of the MPhil programme.

vii. Progression

Students will go through a programme of study spanning a minimum of 4 semesters for 2 years. Full-time students are expected to complete the MPhil Computer Science programme within a period of 2 years. Part-timers are expected to complete within a period of 3 to 4 years.

viii. Graduation Requirements

Pass in all 18 credits of core courses, pass in a minimum of 6 credits of elective courses, pass in the seminars (6 credits) and pass in the Thesis (30 credits) are required to make a student eligible for graduation. In addition, a student must have the required cumulative grade point average as stated in the postgraduate handbook. This is in spite of the fact that he or she may have passed all courses in the programme.

g) Assessment Areas

Students will be assessed in the following areas:

- Knowledge: ability to recall computer science theory, concepts and their applications
- Research Techniques and skills: ability to identify computer science research challenges and opportunities, and design innovative solutions to address them.
- Comprehension: ability to analyse organisational IT problems, to review relevant literature pertaining to them, and to write sound proposals on innovative solutions that can address them.
- Oral presentation and persuasion: ability to convince an audience of the soundness and acceptability of an innovative solution in computer science its sub-domains.

h) Grading System

The postgraduate grading system of the University of Ghana will be used to grade students in this programme. Refer to section 13 for some details of University of Ghana grading system.

Employment:

The graduates of this programme will be able enter the job market as academics or industry practitioners. They are trained to work as theorists, researchers, or

inventors. Their jobs are distinguished by the higher level of theoretical expertise and innovation they apply to complex problems and the creation or application of new technology.

The courses of this programme are advanced areas of computer science which will catalyse the production of expedient computer science manpower needs in Ghana and elsewhere. The contents and structure of the course are such that they will prepare students to take up computer science research and development roles, Information and Communication Technology (ICT) management roles in any organisation, or start their own Technology businesses.

Graduates will be able to initiate ICT adoption projects in organisations. Their in-depth ICT knowledge and skills will enable them to propose innovative software, hardware and network solutions in all human activities. However, they will be aware that solutions to organisational problems are not always purely technological. Many user and organizational issues can be resolved through measures other than purely technological ones.

Consultations:
The programme has been designed in consultation with the board of faculty of the Faculty of Science, the Association of Computing Machinery (ACM) 2013 publication on Computer Science Curriculum Design Guidelines and industry partners including IBM Ghana, Microsoft Ghana and Airtel Ghana.

Components of the programme:
This is a 24 month programme consisting of two semesters taught courses and two semesters academic research for Thesis. It is structured according to the following components:

iii. Understanding of fundamental and advanced areas of Computer Science

iv. A Thesis reporting on the applicant's research and innovation capacities.

The Thesis work is started upon the successful completion of the two semesters taught courses and is from August to June.

The coursework for the MPhil consists of 3 core courses in the first semester of year 1 and a seminar as well as 1or 2 elective courses. The second semester of year 1 is similarly structured, 3 core courses, a seminar and 1 or 2 elective courses.

Duration of MPhil CS Programme

Full-Time	4 semesters	(24 months)

Graduation Requirements MPhil

Coursework	
Coursework	24-30 credits
Seminar	6 credits
Thesis	30 credits
Total	**60-66 credits**

First Semester Core Courses

Course Code	Course Title	L	Lab	Credits
CSCD 601	Research Methods	2	1	3
CSCD 603	Advanced Data Structures and Algorithms	2	2	3
CSCD 609	Principles of Wireless and Mobile Systems	2	2	3

First Semester Elective Courses *Select maximum of 6 credits*

Course Code	Course Title	L	Lab	Credits
CSCD 607	Advanced Computer Networks	2	2	3
CSCD 611	Advanced Database Systems	2	2	3
CPEN 641	Advanced Operating Systems	2	2	3
CPEN 637	Human Computer Interaction	2	2	3

Second Semester Core Courses

Course Code	Course Title	L	Lab	Credits
CSCD 602	Advanced Software Engineering	2	2	3
CSCD 604	Distributed Systems	2	2	3
CSCD 610	Seminar I		3	3
CSCD 612	Intelligent Systems	2	2	3

Second Semester Elective Courses *Select maximum of 6 credits*

Course Code	Course Title	L	Lab	Credits
CSCD 606	Bioinformatics	2	2	3
CSCD 608	Advanced Computer Vision	2	2	3
CSCD 614	Wireless Systems Design	2	2	3
CPEN 656	Networks Security	2	2	3
MATH 652	Computational Mathematics	2	1	3

Course Code	Course Title	Credits
CSCD 630	MPhil Thesis	30

The Department of Computer Science reserves the right to replace some these modules with other relevant modules as and when it is considered necessary.

Course Description:
DESCRIPTIONS OF COURSES IN THE PROGRAMME

The following table is a summary of the codes and titles of all courses within the MSc Computer Science degree programme.

CSCD 630 Thesis 30 credits
The candidate, working closely under the supervision of their advisor shall present a thesis for assessment. The candidate's thesis will be the final report on the work done over the period of research investigation. It shall outline the

problem, the motivation for the work, previous work done, methodology and present the findings of the current research and any implications for future directions. The candidate must demonstrate in this thesis their fundamental contribution to the area of study.

CSCD 601 Research Methods 3 credits

This course is designed to teach students key research skills including: understanding the research process; surveys, sampling, ethnography, qualitative and quantitative research, research tools, validity and threats to validity, test assumptions, distributions: normal, binomial, log linear analysis, difference and nonparametric tests, correlation, regression and prediction tests; how to read research papers; technical writing and technical presentation; and experiment design and statistical analysis of results.

CSCD 602 Advanced Software Engineering 3 credits

Students attending this course are expected to acquire advanced skills in object-oriented programming and design. The course particularly focuses on the design aspects of object-oriented programming and concepts such as responsibility and collaboration analysis, and designing for change. Topics include: software process, agile software development, requirements engineering, systems modelling, dependability and security, software reuse, service oriented architecture, embedded software, component based software engineering, distributed software engineering, software testing and testing process, test planning and control, test analysis and design and test implementation and execution.

CSCD 603 Advanced Data Structures and Algorithms 3 credits

This course will introduce students to a number of highly efficient algorithms and data structures for fundamental computational problems such as primality testing, linear optimisation and string matching. Other topics will include, design and analysis of algorithms, data types, trees, operations on sets, advance set representation methods, directed graphs, undirected graphs, sorting, algorithm analysis techniques, algorithm design techniques, data structures and algorithms for external storage as well as memory management. In addition students are introduced to randomised algorithms and to techniques of amortised complexity analysis.

CSCD 604 Distributed Systems 3 credits

This course would cover both theoretical and practical aspects of distributed computing. It describes the client-server model for developing distributed network systems, the communication paradigms used in a distributed network system, and the principles of reliability and security in the design of distributed network systems. It would review various implementation strategies and techniques for building distributed network systems, including examples in TCP/IP communications, the use of remote procedure call and remote method invocation

techniques, and the development of web-based applications, distributed databases, and mobile computing systems.

CSCD 606 Bioinformatics 3 credits

The aim of this course is to introduce students to the computational techniques used in the field of bioinformatics. To reinforce the theory underlying the concepts and techniques of sequence analysis and post-genomic bioinformatics. This course also provides an understanding of the basic theory behind bioinformatics analyses and experience in practically applying that theory. The course introduces basic concepts of molecule biology, sequence analysis and genomic era biology. It introduces a number of many different tools and their usage, as well as the analysis algorithms behind some of them. Topics include: Basic concepts of molecular biology: genomes, transcripomes, proteomes. Sequence analysis: genome annotation, sequence alignment, multiple sequence alignment, Phylogenetic analysis, Protein families, Database searching tools. Appropriate tools for performing the above, Post genomic analysis: Gene and genomic comparison, protein structure, proteomics. Gene networks, Human computer interaction for bioinformatics

CSCD 607 Advanced Computer Networks 3 credits

This course examines the science underpinning computer communications, such as the basic architectural principles of computer networking and specifically how the Internet works today. Covered topics include network software and hardware, reference model and network layers including Y-comm model, data representation, how errors in transmission can be detected and dealt with, the way information is routed over a large network, how congestion can be avoided, aspects of network security, and socket programming.

CSCD 608 Advanced Computer Vision 3 credits

High-level processing for image understanding and high-level vision. Data structures, algorithms, and modelling. Low-level representation, basic pattern-recognition and image-analysis techniques, segmentation, color, texture and motion analysis, and representation of 2-D and 3-D shape. Applications for content-based image retrieval, digital libraries, and interpretation of satellite imagery. Topics include: Introduction to Computer Vision; Low-level image processing ;Binary image analysis ; Segmentation ;Texture; Color; Pattern recognition techniques; Feature Extraction; Matching; Motion; Applications: Content-based image retrieval ; Applications: Biometrics.

CSCD 609 Principles of Wireless and Mobile Systems 3 credits

Wireless communication has become a ubiquitous part of modern life, from global cellular telephone systems to local and even personal-area networks. This course provides an in-depth introduction to digital mobile wireless networks, illustrating theoretical underpinnings with a wide range of real-world examples. The course will review propagation phenomena, modulation techniques, multiple access schemes, and coding techniques, air interface design, wireless network planning and operations, GSM, TDMA and CDMA technologies.

CSCD 611 Advanced Database Systems 3 credits

The aim of this course unit is to survey the research landscape of advanced DBMS systems with a view to understanding how DBMS research is responding to challenges arising from new software architectures, new kinds of data resource and new computational fabrics. Topics include: Architecture, Components: The Classical Case and Variations; The Relational Case: Data Models, Databases, Languages; Query Processing (1): Overview, Equivalence-Based Rewriting; Query Processing (2): Algorithms, Evaluation Strategies, Cost-Based Optimization; Parallel DBMSs [2]; Distributed DBMSs and Dataspaces; Massively-Parallel/Massively-Distributed Data Processing; NoSQL and Cloud Database; Stream Data Management; Sensor Network Data Management

CSCD 612 Intelligent Systems 3 credits

This course teaches various machine learning, probabilistic reasoning, expert systems, knowledge acquisition, search, knowledge representation, and planning techniques. Other topics include, automating reasoning, correct and exhaustive reasoning, neural networks, inference in 1st order logic and propositional logic. It also provides students an ability to use Lisp at a moderate to high level of proficiency and be equipped with an ability to develop nontrivial artificial intelligence applications. An ability to work in teams, and also identify the right AI technique to use for a given problem and to understand the issues and tradeoffs involved.

CSCD 614 Wireless Systems Design 3 credits

This course is designed to build on what was done in principles of wireless systems. It takes an in depth look at various emerging wireless systems, including wifi systems, wireless sensor networks, adhoc networks, vehicular networks and wearable systems. In each of these systems, students will be introduced to the various technologies such as channel access, routing techniques, mobility, QoS, and security

CPEN 641 Advanced Operating Systems 3 credits

The advanced operating system course examines the structural aspects of operating system and how these provide support for general purpose, embedded,

and real-time operating environments. Topics include survey of early systems, structural design of operating system including process model, inter-process communication, synchronization mechanisms, resource management, CPU scheduling, I/O scheduling, file systems, virtual machines, protection issues, implementation issues of modern operating systems, performance analysis, deadlock detection, recovery and avoidance, operating system for distributed and current systems, review of current research in operating systems.

CPEN 637 Human-Computer Interaction 3 credits

The human computer interaction course provides key approaches to the design, development, and evaluation of human-computer interfaces, with an emphasis on usability, interaction paradigms, computer-mediated human activities, and implications to society. Topics include foundation of HCI and technologies, HCI paradigms and history, nature of human computer interaction, use and context of computers, human characteristics including human information processing, language and communication interaction, and ergonomics, computer system and interface architecture, development process including design approaches, implementation techniques and tools, evaluation techniques, user interface software and error handling, multimedia systems, interaction design for new environment.

CPEN 656 Networks Security 3 credits

The network security course examines the treatment of network security for secure operation. Topics include principles and practice of network and internet security, mathematical principles of cryptography and data security, conventional and modern encryption algorithm techniques, secure communication protocols, public key cryptography, remote access security, firewalls, VPNs, and PKI architecture, secure IP and SSL, intrusion detection systems, electronic mail security, routing protocol security, wireless network security, traffic analysis and alert tools, modern applications such as digital cash and secure distributed computing, operational aspects of network security.

CSCD 610 Seminar I 3 credits

On starting their programme of study, students will be guided to develop a proposal for their research thesis or to define a problem for their project work. The supervisor will recommend up to three journal papers or books for the student to study and use that as a basis for developing a proposal. The full proposal should (1) define a problem of interest to the student, (2) summarize past work, (3) outline work on an approach to solving the problem and (4) define the scope and limitations of the work. This proposal shall form the basis of the work to be carried out in the final year. It is important to note that this is still just a proposal and there will be no requirement on the candidate to continue working in the

proposed area. The candidate, with the approval of their supervisor, may modify the scope and direction of research at any time.

CSCD 620 Seminar II 3 credits

This is the final part of the work, a public presentation of the major findings of the research. The presentation will be subject to scrutiny by an external examiner, an internal examiner, the supervisory team and the general public. The aim is to ensure that the work is of an acceptably high standard deserving of an award of the degree of master of philosophy.

Courses from Other Departments
Please refer to Mathematics for description of MATH 652
Please refer to Computer Engineering for description of CPEN 637, CPEN 641 and CPEN 656

Assessment of students' performance and achievements:
The postgraduate grading system of the University of Ghana will be used to grade students in this programme. Below is a brief description of the assessment system.

Areas of Assessment
Students will be assessed in the following areas:

- Knowledge: ability to recall computer science theory, concepts and their applications
- Research Techniques and skills: ability to identify computer science research challenges and opportunities, and design innovative solutions to address them.
- Comprehension: ability to analyse organisational IT problems, to review relevant literature pertaining to them, and to write sound proposals on innovative solutions that can address them.
- Oral presentation and persuasion: ability to convince an audience of the soundness and acceptability of an innovative solution in computer science its sub-domains.

Objectives of Assessment
Any form of assessment such as, a test, quiz or seminar for a course is expected to be both formative and summative:

Formative: The objective is to monitor the candidate's progress and improve his/her performance, and to serve as feedback for both learner and instructor, in case adjustments of learning and teaching have to be made;

Summative: the objective is to give the learner the opportunity to demonstrate understanding, and the teacher the opportunity to assess teaching and learning effectiveness.

Forms of Assessment

For the majority of courses, evaluation of students' performance is by tests, quizzes, laboratory assignments, classroom participation, seminars and end-of-semester examination.

Normally a quiz is a useful instrument to assess the knowledge of basic definitions, theorems, and techniques. It can be short and is well-suited for selected response types of questions. Quizzes are usually conducted with closed books. A test, which is normally longer than a quiz, assesses the other components outlined above. Tests as well as end-of-semester examinations may be conducted with open books, if the course contents so permit. Regular laboratory assignments give the learner the necessary practical experience to apply techniques acquired to solve problems on his own.

For the end-of-semester assessment, apart from the usual written examination, other forms may be more suitable, such as a seminar or a project within the course. Performance in a course will be marked over a hundred.

Grading Item	**Weight**
Final Examination	60 – 70%
Continuous Assessment	30 – 40%

The Grading System is shown below:

Grade	**% Mark**	**Grade Point**
A	80-100	4.00
B+	75-79	3.50
B	70-74	3.00
C+	65-69	2.50
C	60-64	2.00
D+	55-59	1.50
D	50-54	1.00
*E	45-49	0.5
F	0-44	0

Other Grading System

Grade	**Interpretation**	**Grade Point**
X	Fail	0
Z	Disqualification	0
I	Incomplete	0
Y	Continuing	0
AUDI	Audit	0

- **Grade Point (GP)**

  For each (letter) Grade there is a corresponding Grade Point as indicated above. The Grade Point earned by a candidate for each course completed is computed as the product of the number of credits (credit units) for the course and the Grade Point equivalent of the (letter) grade obtained in the course

- **Grade Point Average (GPA)**

  The Grade Point Average is obtained by dividing the sum of the Grade Points obtained by the total number of credits (credit units) of courses completed. A participant does not earn credits for an F grade.

- **Cumulative Grade Point Average (CGPA)**

  A student's cumulative grade point average is calculated by dividing the total number of Grade Point obtained, up to any specified time, by the total number of credits for all courses for which the participant has completed up to that time.

- **Final Grade Point Average (FGPA)**

  The FGPA is the CGPA for all courses for which the candidate has registered up to the end of the academic programme.

- **Certification**

  Students would be awarded a Certificate of **Master of Philosophy in Computer Science** upon the successful completion of the postgraduate (MPhil) requirement for Faculty of Science of University of Ghana.

DEPARTMENT OF EARTH SCIENCE

REVIEW OF MSc/ MPhil PROGRAMMES

INTRODUCTION

The Department of Earth Science has over the years mounted graduate programmes in various areas of the geosciences. During the process of running these programmes, it became apparent that there was a need for the Department to reorganize and revise them to meet current and contemporary challenges. The present extensive re-organization of the Department's graduate programmes is to meet requests from industry and other end-users of our products and to accommodate global trends. The key thrust in the revision of the programmes stems from the inability of some of the students to complete MPhil programmes they are registered for after the completion of the first year of course work while other students show lack of research capacity during the second year of research.

The courses have been redesigned to reposition the Department to meet the challenges of the day, and also to allow students to window into specific areas of interests at the graduate level. The redesigning is also to introduce new codes to the courses to reflect the Department's new name. The revised programmes are development-based aimed at strengthening the students in the chosen areas of specialization. The Department proposes two-phased graduate level courses for all graduate programmes. This means that a student interested in MPhil in any of our programmes must first complete a Master of Science (MSc) degree in that area before enrolling in MPhil. Thus, the Department will offer Master of Science (MSc) programmes by coursework, followed by research-based Master of Philosophy (MPhil). The widening of scope of the courses in the Department is to ensure diversification of our programmes beyond the scope of geology. The ultimate goal is to significantly increase intake of students taking courses in diverse areas in the earth sciences at the graduate level.

ENTRY REQUIREMENT

The entry point for all Master of Science programmes is a good Bachelors degree (with at least Second Class Lower Division equivalent). Students who wish to do the MSc programme will pursue a one year course work and a project and, graduate with MSc degree. However, MSc students in the Department who have completed the required coursework component with a minimum cumulative grade point average of at least 3.0 at the end of the second semester and wish to transfer directly to the MPhil programme in same field may be considered. Such students will not be required to write the Project. Instead, such students would be required to proceed to the thesis option which will be for one academic year. Similarly, students who graduate with MSc degree may return later to be admitted to the thesis option, covering a one-year research work and graduate with MPhil degree provided they meet the conditions for such admission.

MASTER OF SCIENCE PROGRAMMES

Programme	Mode of Study	Tier	A Good degree in
MSc in Geology	Full time	3	Earth Sciences
MSc in Engineering Geology	Full time	3	Earth Sciences, Physics, Civil Engineering, Mathematics
MSc in Hydrogeology	Full time	3	Earth Sciences, Physical Sciences
MSc in Applied Geochemistry	Full time	3	Earth Sciences, Chemistry
MSc in Applied Geophysics	Full time	2	Earth Sciences, Physics
MSc in Petroleum Geoscience	Full time	2	Earth Sciences, Physical Sciences
MSc in Economic Geology	Full time	2	Earth Sciences, Physical Sciences
MSc in Mineral Exploration	Full time	2	Earth Sciences, Physical Sciences

DURATION OF PROGRAMMES

The programmes are all full time and the normal duration for the completion of the graduate programme is 12 months

REQUIREMENTS FOR GRADUATION

The following are the requirements for graduation in the MSc graduate programmes:

MSc Degree	**(12 months)**
Coursework	30-36 credits (15-18 credits per semester)
Seminar	3 credits
Project	6 credits
Total	39-45 credits

PROGRAMME STRUCTURE

Course Codes

Code	Programme
EASC	Department-wide courses
GLGY	Geology courses
HYGL	Hydrogeology courses
AGPY	Applied Geophysics courses
AGCH	Applied Geochemistry courses
PGSC	Petroleum Geoscience courses
ECGL	Economic Geology
MEXP	Mineral Exploration courses
EGEO	Engineering Geology

MSc IN GEOLOGY

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits
Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
GLGY 605	Regional Geology	3
Total		**9**
Electives: Select 6 – 9 credits		
GLGY 601	Igneous Petrology	3
GLGY 603	Advanced Mineralogy	3
GLGY 607	Clastic Sedimentology	3
GLGY 609	Advanced Stratigraphy	3
GLGY 611	Advanced Structural Geology	3
GLGY 613	Clay Mineralogy	3
GLGY 615	Advanced Micropalaeontology	3
AGCH 601	Trace Element Geochemistry	3
AGCH 603	Isotope Geochemistry	3

SECOND SEMESTER

Code	Title	Credits
Core		
EASC 662	Geostatistics	3
EASC 630	Geoscience Fieldwork	1
GLGY 610	Analytical Techniques in Geology	3
Total		**7**
Electives: Select 9 – 12 credits		
EASC 664	Remote Sensing for Earth Scientists	3
GLGY 602	Metamorphic Petrology	3
GLGY 604	Advanced Geotectonics	3
GLGY 606	Carbonate Sedimentology	3
GLGY 608	Palynology	3
AGCH 602	Solid Earth Geochemistry	3
ECGL 604	Ore Mineralogy	3
AGCH 604	Advanced Environmental Geochemistry	3

MSc IN HYDROGEOLOGY

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits
Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
HYGL 601	Advanced Hydrogeology	3
Total		**9**
Electives: Select 6 – 9 credits		
HYGL 603	Applied Hydrology	3
HYGL 605	Catchment Hydrology	3
GLGY 610	Analytical Techniques in Geology	3
GLGY 605	Regional Geology	3
AGCH 603	Isotope Geochemistry	3
AGPY 603	Borehole Geophysics	3

SECOND SEMESTER

Code	Title	Credits
Core		
EASC 662	Geostatistics	3
[1]EASC 620	Geological Concepts	3
EASC 630	Geoscience Fieldwork	1
AGPY 604	Applied Geophysics in Site Investigations	3
Total		**7 – 10**
Electives: Select 6 – 9 credits		
HYGL 602	Geochemistry of Natural Water Systems	3
HYGL 604	Contaminant Hydrology	3
HYGL 606	Applied Groundwater Modelling	3
HYGL 608	Petroleum Hydrology	3
EASC 664	Remote Sensing for Earth Scientists	3

[1]For only students with weak geology background

MSc IN APPLIED GEOPHYSICS

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits

Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
AGPY 601	Near-Surface Geophysics	3
Total		**9**
Electives: Select 6 – 9 credits		
AGPY 603	Borehole Geophysics	3
AGPY 605	Airborne Geophysics	3
GLGY 605	Regional Geology	3
GLGY 611	Advanced Structural Geology	3
PGSC 607	Seismic Reflection Acquisition and Processing	3

SECOND SEMESTER

Code	**Title**	**Credits**
Core		
[1]EASC 620	Geological Concepts	3
EASC 630	Geoscience Fieldwork	1
AGPY 602	Gravity and Magnetic Methods	3
Total		**4 - 7**
Electives: Select 9 – 12 credits		
AGPY 604	Applied Geophysics in Site Investigations	3
AGPY 606	Earthquake Seismology	3
EASC 664	Remote Sensing for Earth Scientists	3
PGSC 612	Seismic Reflection Interpretation	3

[1]For only students with weak geology background

MSc IN APPLIED GEOCHEMISTRY

Code	**Title**	**Credits**
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	**Title**	**Credits**
Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
AGCH 601	Trace Element Geochemistry	3
AGCH 603	Isotope Geochemistry	3
Total		**12**
Electives: Select 3 – 6 credits		
AGCH 605	Medical Geochemistry	3
MEXP 601	Advanced Exploration Geochemistry	3
GLGY 605	Regional Geology	3

SECOND SEMESTER

Code	Title	Credits
Core		
GLGY 610	Analytical Techniques in Geology	3
[1]EASC 620	Geological Concepts	3
EASC 630	Geological Fieldwork	1
AGCH 602	Solid Earth Geochemistry	3
Total		**10 - 13**
Electives: Select 3 – 9 credits		
AGCH 604	Advanced Environmental Geochemistry	3
HYGL 602	Geochemistry of Natural Water Systems	3
EASC 662	Geostatistics	3
PGSC 618	Petroleum Geochemistry	3

[1]For only students with weak geology background

MSc IN ENGINEERING GEOLOGY

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits
Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
EGEO 601	Advanced Soil and Rock Mechanics	3
EGEO 603	Laboratory and Field Techniques in Engineering Geology	3
Total		**12**
Electives: Select 3 – 6 credits		
HYGL 601	Advanced Hydrogeology	3
EGEO 605	Petroleum Geomechanics	3
GLGY 611	Advanced Structural Geology	3
GLGY 605	Regional Geology	3

SECOND SEMESTER

Code	Title	Credits
Core		
EASC 662	Geostatistics	3
[1]EASC 620	Geological Concepts	3
EASC 630	Geoscience Fieldwork	1
EASC 664	Remote Sensing for Earth Scientists	3
EGEO 602	Applied Engineering Geology	3

Total		**10 – 13**
Electives: Select 3 – 6 credits		
EGEO 604	Disaster Risk Assessment and Management	3
AGPY 603	Applied Geophysics in Site Investigations	3
AGPY 606	Earthquake Seismology	3

[1]For only students with weak geology background

MSc IN MINERAL EXPLORATION

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits
Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
[1]EASC 620	Geological Concepts	3
MEXP 601	Mineral Resource Economics, Policies and Management	3
Total		**9 - 12**
Electives: Select 3 – 9 credits		
AGPY 601	Near-Surface Geophysics	3
AGPY 605	Airborne Geophysics	3
GLGY 605	Regional Geology	3
GLGY 611	Advanced Structural Geology	3
MEXP 603	Advanced Exploration Geochemistry	3

[1]For only students with little or no Geology background

SECOND SEMESTER

Code	Title	Credits
Core		
EASC 630	Geoscience Fieldwork	1
EASC 664	Remote Sensing for Earth Scientists	3
EASC 662	Geostatistics	3
MEXP 602	Environmental and Social Issues in Mining	3
Total		**10**
Electives: Select 6 – 9 credits		
AGPY 602	Gravity and Magnetic Methods	3
AGPY 604	Borehole Geophysics	3
MEXP 604	Exploration Geology	3
AGCH 604	Advanced Environmental Geochemistry	3
GLGY 610	Analytical Techniques in Geology	3

MSc IN ECONOMIC GEOLOGY

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits
Core		
EASC 661	Geoscience Professional Practice	3
EASC 663	GIS Applications in Earth Science	3
[1]EASC 620	Geological Concepts	3
MEXP 601	Mineral Resource Economics, Policies and Management	3
Total		**9 - 12**
Electives: select 3 – 9 credits		
GLGY 605	Regional Geology	3
ECGL 601	Industrial Mineral Deposits	3
ECGL 603	Magmatic and Hydrothermal Ore Deposits	3
GEOL 611	Advanced Structural Geology	3

[1]For only students with little or no Geology background

SECOND SEMESTER

Code	Title	Credits
Core		
EASC 630	Geoscience Fieldwork	1
MEXP 604	Exploration Geology	3
EASC 662	Geostatistics	3
MEXP 602	Environmental and Social Issues in Mining	3
Total		**10**
Electives: Select 6 - 9 credits		
EASC 664	Remote Sensing for Earth Scientists	3
ECGL 602	Sedimentary Ore Deposits	3
ECGL 604	Ore Mineralogy	3
GLGY610	Analytical Techniques in Geology	3

MSc IN PETROLEUM GEOSCIENCE

Code	Title	Credits
EASC 600	Project	6
EASC 610	Seminar I	3

FIRST SEMESTER

Code	Title	Credits
Core		
EASC 661	Geoscience Professional Practice	3

[1]PGSC 601	Basic Petroleum Geology	3
PGSC 603	Sedimentary Basins and Tectonics	3
PGSC 605	Foundations of Petrophysics	3
Total		**9 -12**
Electives: Select one option		
Geophysics Option (select 3 – 9 credits)		
PGSC 607	Seismic Reflection Acquisition and Processing	3
PGSC 609	Seismic and Sequence Stratigraphy	3
EGEO 603	Petroleum Geomechanics	3
AGPY 605	Airborne Geophysics	3
GLGY 611	Advanced Structural Geology	3
Geology Option (select 3 – 9 credits)		
PGSC 607	Seismic and Sequence Stratigraphy	3
GLGY 613	Clay Mineralogy	3
GLGY 607	Clastic Sedimentology	3
GLGY 609	Advanced Stratigraphy	3
GLGY 611	Advanced Structural Geology	3
GLGY 615	Advanced Micropalaeontology	3

SECOND SEMESTER

Code	**Title**	**Credits**
Core		
EASC 630	Geoscience Fieldwork	1
PGSC 602	Basic Economics and Legal Framework of Petroleum Industry	3
PGSC 604	Health, Safety and Environment	2
PGSC 606	Reservoir Characterization and Modeling	3
PGSC 608	Well Log Interpretation	3
Total		**12**
Electives: Select one option		
Geophysics Option (select 3 – 6 credits)		
PGSC 612	Seismic Reflection Interpretation	3
AGPY 602	Gravity and Magnetic Methods	3
EASC 664	Remote Sensing for Earth Scientists	3
EASC 662	Geostatistics	3
Geology Option (select 3 – 6 credits)		
PGSC 616	Reservoir Petrology	3
PGSC 618	Petroleum Geochemistry	3
GLGY 606	Carbonate Sedimentology	3
GLGY 608	Palynology	3
EASC 662	Geostatistics	3

[1]For only students with weak geology background

COURSE DESCRIPTIONS

DEPARTMENT-WIDE COURSES

EASC 600: Project
Students undertake an independent project which is the culmination of the MSc degree programme, and provides students with the opportunity to further their specialist knowledge in a particular area. The dissertation is undertaken under the supervision of faculty. The Project may commonly include a fieldwork component or may entirely consist of the analysis of raw data from industry. The project will normally begin after the second semester examination, from early May until end of July. However, depending on the programme being pursued by the student the project may start by the beginning of the second semester.

EASC 610: Seminar I
This course is intended to provide students planning a research career in Earth Science with the opportunity to develop the skill of critically reading and evaluating research papers. The course is open to all students, and is a required component of the MSc programme. The course will consist of a weekly timetabled session in which students will read, present and discuss influential research papers across a broad range of subject areas.

EASC 661: Geoscience Professional Practice

The objective of this course is to improve the writing and communication skills of students and prepare them for a career in the geoscience profession. Course content: Preparation of geological reports, project proposals and oral presentations. Mining/minerals and petroleum laws and regulation. Corporate structure and management. Exploration management and quality assurance of geological data. Professional ethics. Professional organizations and societies. Professional development and training. Best practice guidelines in the geosciences. In addition, students will learn how to search and apply for job, and how to perform well at interviews. There will be occasional lectures to be delivered by professionals from industry.

EASC 662: Geostatistics
This course deals with the application of geostatistics in the evaluation of natural resources. The different spatial analytical tools will be taught in detail with specific examples from the Ghanaian environment. Topics to be treated include basic statistics, assessment of data accuracy and validity, simple spatial prediction methods, variography, ordinary kriging, co-kriging, kriging with external drift, disjunctive kriging, indicator kriging, and conditional simulation. Much emphasis will be placed on the practical aspects of the course. As such, the final assessment of the course will be based on the successful completion of mini projects which will involve the analyses and interpretation of geospatial datasets from the local Ghanaian environment.

EASC 663: GIS Applications in Earth Science

This course will provide both theory and practical hands-on approach to spatial database design and spatial data analysis with Geographical Information Systems (GIS) as applied to groundwater investigations, mineral exploration, and petroleum exploration. The platform used will be ArcGIS, MapInfo, and Microsoft Excel, but the techniques developed will be applicable to other software. Laboratory work and field exercises provide hands-on experience with collection, mapping and analysis of geologic and other field data using GPS equipment and GIS software.

EASC 664: Remote Sensing for Earth Scientists

The course covers the application of remote sensing to groundwater investigations, mineral exploration, and petroleum exploration. The course covers aerial photography and satellite image interpretations using multispectral, thermal infrared, and radar images. The course includes three hour weekly practical sessions designed to take the student through photogrammetry, aerial photo interpretation, and geological interpretation of satellite images.

EASC 620: Geological Concepts

This course is in two parts. The first part introduces basic concepts in geology, mineralogy, petrography and geological processes. The latter encompasses earth structure, geological time, stratigraphy, deformation of rocks, the geological cycle and plate tectonics. Other topics include weathering, erosion, soil formation and the development of landforms. The second part involves an introduction to map reading and navigation skills using topographic maps, aerial photographs, a compass and global positioning system, as well as identification of common rock types in the field, how to collect and interpret basic structural data and how to prepare a basic geological map.

EASC 630: Geoscience Fieldwork

Fieldwork is an integral part of Earth Science training, and it is used to consolidate students' understanding by illustrating classroom-taught concepts in the field. The course focuses on geological mapping, geophysical surveying or environmental fieldwork depending on which degree programme the student is following. Students study and collect geological data in the field. Geophysics students may however use that time undertaking valuable training in a variety of measuring techniques. A total of seven days are spent in the field under faculty supervision.

MSc PETROLEUM GEOSCIENCE COURSES

PGSC 601: Basic Petroleum Geology

This course is designed for students with little or no background in geology. The primary objectives of the course are to broaden students geological vocabulary, explain selected geological principles and processes, and describe how certain petroleum reservoirs and source rocks are formed. It also covers the fundamentals of drilling, well completions and production operations. Course content include: minerals and rocks; plate tectonics; geological time; surface geological processes; diagenesis; reservoirs; structural geology and petroleum; origin, migration, and trapping of petroleum; reservoir fluid properties; exploration and drilling technology; well completion and workover; and production

operations; offshore operations.

PGSC 602: Basic Economics and Legal Framework of Petroleum Industry
This course covers the basic economics in the petroleum life cycle and the fundamentals of international oil and gas law. Students practice cash flow techniques for economic evaluations and investigate frequently encountered situations. Students also learn how to choose the best investments and how to properly evaluate investment opportunities. They will also be introduced to the philosophy, evolution, and fundamentals of international petroleum contracts. They will be given a basic understanding of the legal fundamentals that make international transactions work.

PGSC 603: Sedimentary Basins and Tectonics
This course is divided into three parts. Part I deals with basin tectonics. It first examines how basins are formed and how they are linked to the Earth's thermal behaviour and plate tectonics. It then describes the mechanisms of crustal and lithospheric thinning. Then the structures associated with the termination of basin formation and the deformation of their contents are described and discussed. Part II deals with the methods used to carry out basin analysis and the applications of basin analysis in the interpretation of geologic history and the identification of fossil fuels. Part III deals with the geology and hydrocarbon potential of the sedimentary basins of Ghana.

PGSC 604: Health Safety and Environment
The course covers the basics of Health, Safety and Environment (HSE) and HES management related to the petroleum industry. Course content includes: Environmental risk management and assessment; emission limits and control; Environmental monitoring and data management; Spill response; Site assessment, management and remediation; Health risk and impact assessment; Food and water hygiene; Medical surveillance/ Industrial hygiene; Safety techniques for hazard and effect management; Process safety and hazards control; Hazard communication; Fire, tool and electrical safety; Noise and vibration; Radiation and radioactive sources; Construction and demolition; Excavation; Risk assessment and management; Planning and procedures; Emergency response; Performance management; Incident reporting & investigation; Audit; Management review.

PGSC 605: Fundamentals of Petrophysics
This course discusses the principles, applications, and integration of petrophysical information for reservoir description. The course begins by considering the nature of the borehole environment, and the way in which the drilling process may alter the properties of rocks and their contained fluids. Next, the general principles of physics are developed to explain the functioning of modern logging tools. Then it covers the basic operations of mudlogging, including the analysis of drill cuttings. Finally it discusses the physical principles behind, and the operation of the major well logging tools.

PGSC 606: Reservoir Characterization and Modeling
This course integrates standard petroleum reservoir data (rock facies, seismic, petrophysics and structural geology) with up-to-date industry modeling software. It

introduces the basic concepts of soft computing techniques applied to reservoir characterization. Some advanced statistical and hybrid models are also presented. The specific applications include different reservoir characterization topics such as prediction of petrophysical properties from well logs and seismic attributes. Students integrate well log, core, thin section, seismic reflection, and other datasets to characterize and develop geologically realistic, predictive computer model of reservoirs. Integrated software systems that incorporate mapping and petroleum systems and play analysis tools will be taught.

PGSC 607: Seismic Reflection Acquisition and Processing

This course is designed to give students an understanding in the standard methods used in acquiring and processing seismic reflection data. The course begins with a brief review of elastic waves and phenomena such as reflection, refraction, diffraction and attenuation which occur as these waves propagate through the earth. The acquisition component outlines the equipment used; survey design; typical acquisition procedures for land and marine surveys; and auxiliary information such as uphole and shallow refraction surveys. The processing component deals in a non-mathematical way with the processes used to convert field data to final section. In particular, velocity analysis, statics, CDP stack, deconvolution and migration will be discussed.

PGSC 608: Well Log Interpretation

In this course students are given good grounding in the interpretation of well log data. It covers the major well logging tools, i.e., caliper logs, self-potential, resistivity, gamma ray, sonic, density and neutron logs, and dipmeter logs. The course will teach valuable skills on how well log data can be used in the determination of lithology, fluid type, saturation, and porosity, and in paleoenvironment analysis. Hands-on exercises provide practice in the interpretation of various logs. Such interpretation ranges from identifying the lithologies and the presence of water and hydrocarbons to paleoenvironmental interpretations of logged rock sequences.

PGSC 609: Seismic and Sequence Stratigraphy

This course involves the application of the techniques of exploration seismology to stratigraphic study. The course is divided into two parts. The first part focuses on the fundamental principles of sequence stratigraphy, and methods and applications of sequence stratigraphy which include investigation of sedimentary cycles at various scales and identification of key surfaces, depositional sequences, and depositional system tracts at various scales. The second part of the course introduces students to seismic stratigraphy, which involves identifying and interpreting unconformities and other reflector terminations such as offlaps and onlaps. A variety of practical exercises are used, and these form the basis of assessment.

PGSC 612: Seismic Reflection Interpretation

This course aims to give students an understanding into the interpretation of seismic reflection data. Topics covered in the lectures include time and depth sections, artificial structure caused by velocity variations, unconformities, folds, faults, piercement structures, bright spots, dim spots, polarity reversals and flat spots, time-structural maps, and seismic modelling. Practical work involves interpretation of 2D and 3D seismic data

on paper. The practical sessions stress the effort and discipline involved in producing a self-consistent interpretation of horizons and faults.

PGSC 616: Reservoir Petrology
In this course students will learn how to unravel the complex geologic history of clastic and carbonate reservoirs from deposition through diagenesis to emplacement of hydrocarbons. The course covers clastic and carbonate mineralogy, depositional textures, microfacies, diagenesis, permeability, and porosity. The course teaches the invaluable skill of examining and describing drill core for sedimentology, reservoir quality, depositional environments and sequence stratigraphy. Sampling methods, types of sampling equipment and sedimentary rock analytical techniques, both available at the drilling rig-site and in the laboratory, are presented and discussed. Practical session will involve both macroscopic and microscopic examination of sandstones and carbonates.

PGSC 618: Petroleum Geochemistry
The course begins with the development and concepts of petroleum geochemistry in petroleum exploration. It then discusses accumulation and sedimentation of organic matter, composition and structure of organic matter and crude oil deposits, transformation of kerogen to petroleum, methods of source rock analysis, thermal maturity and organic facies evaluation, biomarker groups and their applications, and hydrocarbon migration. Oil and gas characterisation and source correlation. Oil from coals. It then considers modelling hydrocarbon generation and geochemical characterization of reservoir fluids, sampling and analytical protocols. Finally the applications of reservoir geochemistry to field appraisal and field development will be discussed.

MSc APPLIED GEOPHYSICS COURSES

AGPY 601: Near-Surface Geophysics
This course provides an overview of the theory, principles, and practice of methods and techniques of shallow subsurface geophysical exploration. It will discuss relative utility of various methods, including refraction seismology, electrical, and electromagnetic and detail their application to exploration activities at shallow depths. Applications to shallow as well as deep survey will be elucidated, compared, and contrasted. Students will be taught the techniques of instrumentation, acquisition, processing and interpretation of near-surface geophysical data. The topics are illustrated by case studies, giving the students the tools to plan, conduct and analyze a near-surface geophysical survey.

AGPY 602: Gravity and Magnetic Methods
This course is designed for students to understand the techniques used to acquire, process and interpret gravity and magnetic data with a focus on mineral and oil industry applications. Topics to be covered include: instrumentation, field acquisition, processing, and interpretation of gravity and magnetic data (land and marine) and anomaly enhancement to define and map geological structures and their depth. Hands-on exercises provide practice in the use of gravity and magnetic data define ore deposits and to

recognize the presence and estimate size of any sedimentary basins, and identify some features within them, such as salt domes.

AGPY 603: Borehole Geophysics
This course discusses the basic principles of the many tools and techniques used in borehole logging projects. Applications are presented in terms of broad project objectives, providing a hands-on guide to geophysical logging programmes, including specific examples of how to obtain and interpret data that meet a specific hydrogeologic or environmental objective. Topics to be covered include: Planning a logging programme; log analysis – qualitative versus quantitative; log quality control; electric logs; nuclear logs; acoustic logs; borehole imaging logs; caliper logs; fluid logs; well construction logs; case histories.

AGPY 604: Applied Geophysics in Site Investigations
This course deals with geophysical imaging methods that provide solutions to a wide variety of environmental and engineering problems: protection of soil and groundwater from contamination; disposal of chemical and nuclear waste; geotechnical site testing; landslide and ground subsidence hazard detection; location of archaeological artifacts; detection and mapping of sinkholes and shallow buried objects, etc. The course comprehensively discusses the theory, data acquisition and interpretation of all of the principal geophysical methods used in engineering and environmental investigations. Each topic is supported by a large number of richly illustrated case histories.

AGPY 605: Airborne Geophysics
In this course students will understand the essentials of airborne geophysics so that they can evaluate the usefulness and application potential of the methods and results in their projects. Airborne geophysical methods to be taught include: aeromagnetic method; airborne electromagnetic method; airborne gamma-ray spectrometry; airborne gravity method; and remote sensing methods. All aspects of these methods will be discussed, including theoretical considerations, data acquisition, and data processing and interpretation, with the objective of locating concentrations of natural resources and defining their extent. Practical sessions will involve the interpretation of raw airborne geophysical data.

AGPY 606: Earthquake Seismology
The course presents and discusses recent findings on the physics of earthquakes. Topics to be covered include seismicity studies from pre-historic periods to the most modern studies on a global scale, deep earthquakes, nucleation, stress transfer, triggering, hydrological processes, and recently discovered slow slips at plate boundaries. Practical understanding of the most commonly used processing techniques in earthquake seismology will also be treated. Each topic will be introduced with the basic theory followed by practical examples and exercises from both manually printed materials and computer exercises based on public domain software. There will be field visits to earthquake observatories, seismograph stations and seismometer sites.

MSc APPLIED GEOCHEMISTRY COURSES

AGCH 601: Trace Element Geochemistry

The course consists of a series of lectures on the application of trace element geochemistry to the understanding of trace element partitioning during partial melting and fractional crystallization. The emphasis of the course is on the use of trace element geochemistry to understand the origin and evolution of igneous rocks. The approach is to discuss the parameters that control partitioning of trace elements between phases and to develop models for the partitioning of trace elements between phases in igneous systems, especially between minerals and melt. Throughout the course, lectures are interspersed with papers that are to be read by students and discussed during class.

AGCH 602: Solid Earth Geochemistry

This course presents an advanced study into the geochemistry of planet earth. It discusses the composition and evolution of the planet earth and the geochemical methods used to make these determinations. Additional topics include phase transitions, the primitive mantle, differentiation of the mantle, mantle geochemical reservoirs, and evolution of the depleted upper mantle and mantle plume reservoirs, composition of the oceanic and continental crust, mid-oceanic ridge basalts, oceanic island, plateau and submarine mountain basalts; geochemical characteristics, intra-crust differentiation, partition of minor elements in crustal conditions.

AGCH 603: Isotope Geochemistry

This course is divided into two parts. The first part deals with the principles of radioactivity and its geochemical applications to several geological processes and systems. Students will learn how to infer the chemical characteristic of long-lived geochemical reservoirs using radiogenic isotopes as tracers and also how to use the latter to analyse mixing of materials from different reservoirs. The second part covers stable isotopes of H, C, O and S, and its application to several geological processes and systems. On completion of this part, students will be familiar with the application of stable isotope methods in the study of the Earth's major geochemical cycles.

AGCH 604: Advanced Environmental Geochemistry

This course is about natural processes of Earth's surface and the impacts of human activities on environments. It will cover natural and anthropogenically perturbed aspects of the Earth's hydrosphere and its interaction with surface rocks, sediments, soils, the biosphere and the atmosphere. Special attention will be given to the geochemical processes that relates to the mining environment. Oxidation of sulfide minerals, water chemistry in a mining environment, acid neutralization capacity of rocks, acid mining drainage (AMD) and its prevention will be discussed in details with case studies.

AGCH 605: Medical Geochemistry

This course deals with the study of the relationships between the geochemistry of the environment in which we live and public health, with special emphasis on the tropical environment. The course will explore the field of medical geochemistry as it relates to environmental toxicology, epidemiology, pathology, geochemistry, and biological risk

assessment. Discussion will include current data on the extent, distribution, and consequences of exposure to water- and soil-related toxins and other harmful agents. Each student will be expected to write a report on a selected element after doing a literature survey, and also give presentation.

MSc MINERAL EXPLORATION COURSES

MEXP 601: Mineral Resource Economics, Policies and Management
The course deals with subjects such as current mineral markets, legal and fiscal considerations, environmental regulations, problems of mining and processing, exploration design, and financial management. Aspects of mineral projects evaluation techniques covering time value of money concept, the concept of cash flow and cash flow criteria, mineral projects evaluation criteria, non-discounted and discounted cash flow methods, mining taxation considerations, inflation effects on project evaluation, and sensitivity and risk analysis techniques are also included in this course.

MEXP 602: Environmental and Social Issues in Mining
Social and environmental issues have become critical variables with respect to the economics of exploration and mining projects. There is strong understanding that geologists should have due considerations for these issues right from reconnaissance exploration to the start of mining and beyond. However, traditionally, geologists have little training in these traditional liberal courses. This course seeks to address this knowledge gab. It looks at contentious environmental and social issues with respect exploration and mining projects' development, environmental and social impact assessment for minerals projects, social accountability schemes, global and national initiatives to address environmental and social issues in mining, livelihood challenges, issues of mining development and communities relocations, etc.

MEXP 603: Advanced Exploration Geochemistry
This course is devoted to modern geochemical techniques required for the detection of mineral anomalies, both in known mining areas and in "virgin" areas. The course will cover the principles and different types and methods of geochemical exploration. Also included are planning, sampling, laboratory analysis, data handling, and data interpretation. The course will involve lectures, practical exercises, and laboratory exercises. Throughout the course, lectures are interspersed with discussion of research articles that deals with recent advances in the field of exploration geochemistry, such as the mobile metal ion technology.

MEXP 604: Exploration Geology
This course presents a practical step-by-step description of the key geological field mapping techniques needed by today's exploration geologists involved in the search for mineral deposits. It discusses the various types of mapping techniques fundamental to the

collection, storage and presentation of geological data and useful for the location of ore deposits. Essentials of sampling and drilling techniques including pitting, trenching, rotary, percussion, reverse circulation, diamond core drilling, and core logging are also included. The course also covers exploration programme design, discusses the different types of surveys and provides an overview of quality assurance – quality control procedures for mineral exploration projects ranging from reconnaissance through to pre-feasibility.

MSc ECONOMIC GEOLOGY COURSES

ECGL 601: Industrial Mineral Deposits
This course deals with the examination of the origin of the different industrial mineral deposits, as well as discussion of their treatment and uses. Topics to be covered include the geological occurrence, classification, mineralogical characterization, exploration and mining methods, and processing of industrial minerals. The course will also look at the economic importance, resource estimation and environmental assessments of industrial minerals. The course also includes field visits to industrial sites.

ECGL 602: Sedimentary Ore Deposits
This course is intended to provide knowledge on the geology and evolution of sedimentary basins and their contained mineral deposits, paleo-environmental conditions that may have contributed to the formation and preservation of the ores, mineralization during subsequent burial and diagenesis, and ore systems developed during metamorphism and deformation of sedimentary basins. Students will gain an understanding of techniques widely used in exploration and research on ores in sediments, using real examples to illustrate the fundamental links between regional and deposit-scale geology and the origins of different deposit types.

ECGL 603: Magmatic and Hydrothermal Ore Deposits
This course concerns the global distribution, geology and petrogenesis of magmatic and hydrothermal ore deposits. It will provide a broad overview of recent developments in the understanding of magmatic-hydorthermal processes. The course will review new ideas related to magmatic-hydorthermal processes, the techniques and approaches that have led to these ideas, and the implications for a variety of types of deposits, with special emphasis to the Birimian deposits. Individual papers review important concepts, and in several cases, present new results. After completion of the course students will thus have gained an improved capability to contribute to exploration for magmatic and hydrothermal ore deposits in Ghana and elsewhere.

ECGL 604: Ore Mineralogy
This course is intended to encourage students to be both proficient and confident with the identification and interpretation of ore minerals. Students will learn about contemporary methods of ore investigation and how they can be applied to different types of ore deposits. Particular emphasis will be placed on deposits of the base and precious metals.

Attention will be given to worked case examples. In Laboratory sessions students will use the reflected light microscope to identify and interpret ore mineral associations and textures. Thin section specimens will come from both deposits in Ghana and some selected base and precious metal ores from around the world.

MSc ENGINEERING GEOLOGY

EGEO 601: Advanced Rock and Soil Mechanics
This course is designed for students to gain an advanced understanding of the geo-mechanical behaviour of rocks and soils and how they behave under different geotechnical design scenarios. Students will develop key skills in the assessment, description and testing of geological materials in order to understand and quantify their behaviour, using local and international standards. Students will also gain an advanced understanding of engineering and design in soils and rock masses, including fundamental design principles associated with common geotechnical solutions encountered on engineering geological and civil engineering projects.

EGEO 602: Applied Engineering Geology
In this course students will be taught the key techniques for the identification and assessment of contaminated land and groundwater resources in an engineering geological context. Students will also be trained in the development of geological ground models and geomorphological terrain models within the content of engineering geological practice. They will, in addition, gain advanced experience in ground investigation using invasive techniques, in-situ tests and geophysical methods. Fieldwork component will involve training in techniques such as geomorphological mapping and walk-over surveys combined with interpretation of remote sensing and aerial photography.

EGEO 603: Laboratory and Field Techniques in Engineering Geology
The course covers the conventional tests for soils used to index and classify soils, and to measure their permeability, consolidation characters, and shear strength. Content include: Basic instruction in rock core logging for geotechnical purposes; Techniques of site investigation including: sample description; soil drilling and sampling; in situ testing by cone, SPT, vane, field loading and pressuremeter testing; Principles of the laboratory measurement of load, stress, strain and pore water pressure; measurements with electronic sensors; selection of testing procedures and testing strategies; Field measurements of full-scale behaviour including: earth pressure cells; displacement gauges and piezometers; Analysis of potential errors and approaches for their mitigation.

EGEO 604: Disaster Risk Assessment and Management
This course deals with contemporary concepts and practices in disaster risk management and the tools and methods that can be used in the reduction of disaster risk. It also involves determining the probability of a hazard occurring and estimating the consequences. It discusses methods for calculating the vulnerability of infrastructure assets to the common natural hazards. The course also reviews the important role GIS and remote sensing data play in disaster risk assessment and management. It emphasizes

on the use of such spatial data during pre- and post-disaster management as well as in the design of risk reduction measures. Visits to organisations and other sites may be organised where appropriate.

EGEO 605: Petroleum Geomechanics
In this course students will be taught the basics of geomechanics for wellbore applications; the origin of stresses in the subsurface and how in situ stresses can be understood from wellbore data. The course will also cover mechanical properties such as rock strength, and the origins of pore pressure and how it can be measured and estimated. The course will then proceed to elucidate how these data are applied to critical problems in petroleum exploration and field development. There are detailed case studies on wellbore stability sand production and hydraulic fracturing. The course also includes an introduction to reservoir geomechanics, showing the geomechanical influence of pressure changes in the reservoir.

MSc HYDROGEOLOGY

HYGL 601: Advanced Hydrogeology (3 Credits)
This course provides a basic understanding of the physical characteristics of the water-bearing formations and groundwater flow. It covers the understanding of boundary and initial conditions that pertain during groundwater flow including flownet analysis. Groundwater-surface water interactions and the underlying principles for the interaction between freshwater and seawater shall be treated. This course also exposes the student to the behaviour of the various aquifer systems during groundwater flow. It presents the fundamental principles underlying the determination of the hydraulic characteristics of the various aquifer systems and the understanding of the mechanisms and equations of groundwater flow.

HYGL 602: Geochemistry of Natural Water Systems
The course will entail detailed analyses of the major controls on surface and subsurface water chemistry. It will begin with discussions on the major chemical constituents in natural water and the various sources of these chemical constituents. Rock-water interactions, ion exchange processes, sorption processes, and redox reactions in surface and subsurface systems will be treated in detail. Geochemical inverse modeling, chemical speciation, and geochemical analyses using mineral stability and ternary diagrams will be treated. The course will also assess the possibility of reconstructing the reactive mineralogies of basins using detailed geochemical models based on surface and groundwater geochemical data.

HYGL 603: Applied Hydrology
This course will provide detailed training on the dynamics of the hydrological systems with emphasis on tropical environments. Topics to be discussed include hydrological processes, hydrological design and analysis. Students will be taken through the regiments of hydrological data collection, and the application of statistical models to hydrological data. Time series analysis, long term hydrological data for the prediction of floods,

rainfall patterns and water resources assessment and management will be copiously treated. To this end, students will learn the basics of hydrological modelling, ARMA, ARIMA, AR, MA models, frequency analysis, Fourier transforms amongst others.

HYGL 604: Contaminant Hydrology
This course will treat all kinds of contaminants in surface and subsurface water systems. Organic, inorganic, radioactive, and biological contaminants, their characteristics, modes of transport in surface and subsurface waters, their reactivities, and toxities will be discussed in detail. Retardation and natural attenuation processes of contaminants in the vadose and saturated zones as well as surface flow systems will be discussed in detail. This course will also assess the various methods available for remediating contaminated surface and surface waters and contaminant source control measures. Contaminant transport using familiar numerical codes such as MT3DMS, RT3D, SEAM3D, SEEP2D, and WASH will treated as part of the course.

HYGL 605: Catchment Hydrology
This course deals with the hydrological processes around a catchment in a basin. It provides a comprehensive treatment of the fundamentals of catchment hydrology, principles of isotope geochemistry, and the isotope variability in the hydrologic cycle. Topics to be covered include: evapotranspiration and land-atmosphere interaction; observations and modeling of runoff generation; stream-groundwater interaction and hyporheic zone processes; transport of agrichemicals in catchments; and biogeochemical cycling and acid deposition.

HYGL 606: Applied Groundwater Modeling
The objective of this course is to equip students with the necessary background knowledge in the application of numerical groundwater flow codes to groundwater resources management and the estimation of the familiar aquifer parameters. It will comprise the application of mainly finite element and finite difference numerical groundwater flow simulation codes with a strong background in the mathematics of groundwater flow and contaminant transport in groundwater systems. The course will comprise a limited lecture session and detailed practical sessions. Laboratory exercises will entail the use of MODFLOW, FEMWATER, MODPATH, MT3DMS, and UTCHEM. The application of isotope data to constrain aquifer properties in groundwater studies will be discussed in detail.

HYGL 608: Petroleum Hydrogeology
This course uses the similarities in flows between petroleum resources and groundwater to study the transport of both resources in tandem. The course is designed to enable students apply the concepts of groundwater flow and storage to study the transport of petroleum resources. It is intended to be practical and will use current exploration activities in Ghana's major sedimentary terrains as case studies. Conductive properties of porous media and the unique properties of petroleum and groundwater will be discussed using case studies. Students will learn how to apply groundwater flow models in deep reservoirs to study the migration and accumulation of petroleum resources.

MSc GEOLOGY COURSES

GLGY 601: Advanced Igneous Petrology

This course covers the history of and recent developments in the study of igneous rocks. It will review advanced concepts in the origin and evolution of magmatic systems, effects of different tectono thermal regimes on magma genesis, magma dynamics, and phase equilibria in magmatic systems. It involves the integration of geochemical, geological, and petrographic data in the interpretation of the origin of igneous rocks. Concepts are illustrated by rock suites from Ghana and elsewhere. Students review the chemistry and structure of igneous rock-forming minerals and proceed to study how these minerals occur and interact in igneous rocks.

GLGY 602: Advanced Metamorphic Petrology

This course involves the study of advanced concepts in the evolution of metamorphic bodies and systems. Students will learn how to interpret metamorphic processes on the basis of mineral assemblages, mineral chemistry, chemical thermodynamics, transport theory, experimental petrology, and field studies. They will also learn about mineral reactions and textural changes in response to dynamothermal processes and the applications of geothermobarometry and petrochonology to rocks from a variety of tectonic environments. Isotope mobility and thermal models for orogenic belts will also be studied. The course involves lectures and laboratory work.

GLGY 603: Advanced Mineralogy

This course will provide a comprehensive review and practical understanding of advanced concepts in mineralogy, crystal chemistry and the methods that are applied in modern research. It will discuss the causes and consequences of compositional variation in common silicate minerals, the thermodynamic consequences of mineral stability and energetic consequences of solid solution, exsolution and phase diagrams. At the end of the course students should be able to (i) predict the protolith, composition and metamorphic grade on the basis of petrography, and (ii) be familiar with the most common structural features of minerals, kinetic processes in mineralogy, and the causes and consequences of transformation processes in mineralogy.

GLGY 604: Advanced Geotectonics

This course comprises recent advances in the knowledge on structure and development of the Earth, especially of its crust and mantle. It discusses older and new geological ideas concerning development of the crust, with emphasis on the plate tectonics. It focuses on the examination of modern tectonic principles and fundamental tectonic elements of the earth's lithosphere - orogenic belts, cratons, island arcs, rift zones, continental margins, etc., and discusses geotectonic models emphasizing modern plate tectonic concepts.

GLGY 605: Regional Geology

This course concerns the advanced treatment of the geology of West Africa. It will look at selected geological provinces in West Africa considers their evolution (i.e., genesis, petrology, tectonics, geochemistry, etc). Emphasis will also be placed on the economic mineral potential of these provinces. In order to increase efficiency of learning, the

number of passive lectures will be minimised by means of practical sessions and seminar. Practicals will be terrane analysis through interpretation of maps, photographs and other data. Each student is further required to give a presentation on a reviewed paper to be followed by a discussion.

GLGY 606: Carbonate Sedimentology

This is an advanced course that examines carbonate sedimentology and depositional environments. Students to identify depositional facies in a carbonate ramp or platform and analyze the spatial distribution of the carbonate facies belts and their relation to basin configuration and tectonic development. It will consider the economic importance of carbonates: major reservoirs for petroleum, base metals and potable water. Lectures will discuss the origin of carbonate rocks. It will also discuss the various types of carbonate depositional environments, their dimensions, geometry and distribution of facies belts, and how these parameters can be used to reconstruct the paleogeography of carbonate basins.

GLGY 607: Clastic Sedimentology

The course discusses processes of erosion, transport and deposition of sediments by water and wind. Sedimentary fluid dynamics are related to sedimentary bed forms which, in turn, are related to the lamination and bedding styles that characterize most sandstone. The processes of sediment gravity flows are related to the textures of their products and to the forms of their depositional units. Alluvial, deltaic, coastal, shallow-marine, slope, deep-marine and aeolian settings are all discussed in terms of processes, facies and facies organization. Particular attention is given to the principles by which depositional settings are interpreted using both outcrop and sub-surface data.

GLGY 608: Palynology

This course concerns palynology and its application to palaeoenvironmental reconstruction and hydrocarbon exploration. It first considers the morphology, classification, biology, ecology, palaeoecology, biostratigraphy and evolutionary history of the following group of palynomorphs: (a) dinoflagellates (b) acritarchs (c) chitinozoans. It then considers the morphology, dispersal, deposition and preservation, classification, and evolution of fossil spore and pollen and their applications in palaeoenvironmental reconstruction, climate change studies, archaeological investigations and hydrocarbon exploration. Practical sessions involve sample preparation and microscopic study of palynomorphs from the sedimentary basins of Ghana.

GLGY 609: Advanced Stratigraphy

This course is divided into two sections: Lithostratigraphy and Biostratography. The Lithostratigraphy section begins with the study of stratigraphic principles by discussing the nature of lithostratigraphic units and the various types of contacts that separate these units. It then considers the concepts of sedimentary facies and depostional sequences. Finally the nomenclature, classification and correlation of lithostratigraphic units are considered. The Biostratigraphy section begins by examining the concept that fossil constitute a valid basis for stratigraphic subdivision. Next, organic evolution and the

distribution of organisms in both time and space are explored. Finally the important role that biostratigraphy plays in correlation of stratigraphic units is discussed.

GLGY 610: Analytical Techniques in Geology
This course is designed to train students in a wide variety of techniques commonly used to collect standard types of data used in geological research. These techniques include x-ray diffraction; x-ray fluorescence; atomic absorption spectrophotometry; neutron activation analysis, scanned electron microscope, etc. Sampling methodologies for rocks, soils, stream sediments, water and biogeochemical samples is also covered. The course will also provide an overview of statistical tests and parameters used in the testing and quantitative evaluation of analytical data. Lectures will be given on the theory of the techniques used and on data quality and interpretation.

GLGY 611: Advanced Structural Geology
This course covers the mechanisms of crustal deformation applied to geological structures and mineral deposits. It will focus on terrane analysis and structural controls on the localization and genesis of mineral deposits. The course also covers advanced topics such as orthorhombic faults, applied structural interpretation of geophysical data, and digital measurement, visualization and analysis of structural data. It will examine regional and local structural controls using the lode gold deposits of the Birimian greenstone belts as a case study. The course includes a field study to the Birimian Greenstone belts, to undertake mine-scale to regional mapping and interpretation exercises.

GLGY 613: Clay Mineralogy
This course demonstrates in a practical way how clay minerals can be identified and characterized using the analytical techniques of XRD, infrared spectroscopy (IR) and SEM. Students will understand the nature, properties, behaviour and occurrence of clays in the context of hydrocarbon exploration and production. Course content include: Chemistry and Mineralogy of Clay minerals; Geology of Clays; Principles of XRD, IR and SEM; Preparation of Clays for XRD Analysis; Measurement and Analysis of Clay XRD Patterns; Particle Size, Surface Area and Morphology of Clays; Clay Minerals and Drilling Fluids; Clay Analysis and Assessment of Formation Damage by SEM; Clay Mineralogy and Shale Instability; Clay Mineralogy and Reservoir Quality.

GLGY 615: Advanced Micropalaeontology
Micropaleontology is concerned with microfossils and nanofossils (the latter being smaller than 50 μm). The course involves the study of morphology, classification, biology, and evolutionary history of the following group of microfossils: Foraminfera, Calcareous nannofossils, Ostracods, Conodonts, Diatoms. The course also covers micropalaeontological techniques: processing and microscopy and the application of these microfossils in the fields of oil exploration, biostratigraphy, palaeobiology, paleoclimatology and paleoenvironments is essential.

MPHIL PROGRAMMES

Programme	Mode of Study	Tier	A Good degree in
MPhil in Geology	Full time	3	Earth Sciences
MPhil in Engineering Geology	Full time	3	Earth Sciences, Physics, Civil Engineering, Mathematics
MPhil in Hydrogeology	Full time	3	Earth Sciences, Physical Sciences
MPhil in Applied Geochemistry	Full time	3	Earth Sciences, Chemistry
MPhil in Applied Geophysics	Full time	3	Earth Sciences, Physics
MPhil in Economic Geology	Full time	3	Earth Sciences, Physical Sciences

ADMISSION REQUIREMENTS

Admission to MPhil programmes in the Earth Science shall be a good MSc degree in the relevant field. However, MSc students in the Department who have completed the required coursework component with a minimum cumulative grade point average of at least 3.0 and wish to transfer directly to the MPhil programme in same field may be considered.

DURATION OF PROGRAMME

The duration for the completion of MPhil degree shall normally be one year for full-time students and two years for part-time students.

REQUIREMENTS FOR GRADUATION

The following are the credits that a registered student is required to earn in order to graduate:

Seminar	6 Credits
Thesis	30 Credits
Total	**36 Credits**

EASC 660: Thesis

A thesis describing original and independent research by the candidate is required for the MPhil degree. The thesis format must comply with the guidelines for preparing graduate dissertations and theses in the Graduate Handbook. The dissertation must be successfully defended in an oral examination before an examination committee.

EASC 670: Seminar II

Students will present research proposal seminar. In addition, students will present seminars on advanced topics of current interest in their area of interest and attend departmental seminars, and attend and participate in internal and external conferences and workshops.

EASC 680: Seminar III
Students will do oral presentations on (i) research progress, and (ii) research results.

DEPARTMENT OF STATISTICS

MSc. ACTUARIAL SCIENCE

The Department of Statistics is proposing to run two additional programmes at the post graduate level. These are M. Sc and M. Phil in **ACTUARIAL SCIENCE**.

MSc
The M. Sc programme is One-year comprising of course work of two semesters and a project work. Students will undertake a project in some applied area of the Actuarial profession that runs over 3 – 6 months and presents a report at the end of the year of study.

2 ADMISSION REQUIREMENTS

The programme is appropriate for individuals with strong ***mathematical aptitude***, i.e. formal background in mathematics, statistics and economics, who wish to enter or advance in the actuarial profession. It is also appropriate for those who are working as entry-level actuaries who wish to prepare for the Actuarial Professional examinations within the context of a structured academic program.

A Good first degree in **Mathematics, Statistics, Finance, Economics** or ***Any Quantitative related Course, at least a second class lower division***, including at least two years of University Mathematics. Each short-listed applicant must pass a selection interview.

3 REQUIREMENTS FOR GRADUATION

The candidate to be awarded MSc. degree in Actuarial Science must satisfy the following graduation requirements:

Coursework	24-36 Credits
Seminar	3 Credits
Dissertation	6 Credits
Total	**33-45 Credits**

4 PROGRAMME STRUCTURE

FIRST SEMESTER
CORE

Course Code	Course Title	Credits

ACTU 601	Stochastic Processes	3
STAT 603	Probability Theory	3
ACTU 603	Actuarial Mathematics	3
ACTU 605	Accounting and Financial Reports for Actuaries	3
ACTU 650	Seminar	3
ELECTIVES		
Electives (Minimum of 3 Credits and a maximum of 7 Credits) To be selected upon the Advice of the Department		
ACTU 607	Survival Models	3
ACTU 609	Risk Mathematics	3
ACTU 611	Regression and Time Series	4
ACTU 613	Insurance Applications and Principles for Actuarial Practice	3
STAT 617	Research Methodology	3

Minimum Credits for Semester 1 15
Maximum Credits for Semester 1 18

SECOND SEMESTER
CORE COURSES **Credits**

Course Code	Course Title	Credits
ACTU 600	Dissertation	6
ACTU 602	Actuarial Computing	3
ACTU 604	Contingencies	3
ACTU 606	Economics for Actuaries	3
ACTU 650	Seminar	3
ELECTIVES		
Electives (Minimum of 6 Credits and a maximum of 9 Credits) To be selected upon the Advice from the Department		
ACTU 608	Accounting Principles in Finance	3
ACTU 612	Life Insurance	3
ACTU 614	Non-Life Insurance	3
ACTU 616	Pensions	3
ACTU 618	Health Insurance	3
ACTU 620	Internship in Actuarial Science	3
ACTU 622	Non-Life Insurance Mathematics	3

Minimum Credits for Semester 2 15
Maximum Credits for Semester 2 18

5 COURSE DESCRIPTION

ACTU 600: Dissertation
A project is undertaken in an applied area after presenting a proposal as specified in ACTU 650. Students would then submit a proposal write-up for approval by their

supervisor(s) by the end of the first semester examinations. The final write-up of the project itself should be submitted by the end of the academic year (and not later than three months after the academic year) in which the second semester examinations take place.

ACTU 601: Stochastic Processes

This course is to provide grounding in stochastic processes and their use in models for actuarial work. It provides a broad introduction to stochastic processes for postgraduates with an emphasis on financial and actuarial applications. Some of the topics that need to be covered include: Principles of modeling, Principles and classification of stochastic processes, Martingales, Markov Chains, Markov processes, Poisson Processes, Brownian motion, stochastic differential equations and diffusion processes, Gauss-Wiener processes. Simulation methods for stochastic processes and Applications in Finance and Actuarial Science.

ACTU 602: Actuarial Computing

This course is to provide grounding in modern computing methods necessary for the work of an actuary. The student is expected to have a working knowledge of modern Information Communications Technology (ICT) appropriate for the work of an actuary. Programming in a high level language such as C (preferred) or FORTRAN is preferred. Introduction to programming and of developing skills required to write statistical software. Should there be previous exposure to programming, this unit can be replaced by a more advanced unit in object-oriented programming in C++ or Java. Topics should include simple syntax, loops, pointers and arrays, functions, input/output, and linking to databases. Numerical analysis and statistical applications i.e. graphics, descriptive statistics, representation of multivariate data, simple hypothesis tests, analysis of variance, and linear regression. Packages such as MINITAB, SAS, or SPSS are recommended to be used.

ACTU 603: Actuarial Mathematics

This course provides grounding in Actuarial mathematics and their applications. Topics include: Deterministic theory of interest (i.e. traditional compound interest, cash-flow modelling; annuities certain, bond market theory), Introduction to contingent claims analysis (i.e. definition of derivative securities, no arbitrage principle); Stochastic calculus for finance (conditional expectation, introduction to martingales, stochastic integrals and differential equations, pricing and hedging of derivatives); Stochastic theory of interest; interest rate models (discrete and continuous time); derivatives on interest rates and bonds; Dynamic portfolio management (asset-liability modeling; introduction to

stochastic optimal control); Introductory applications to insurance liabilities (embedded options in life insurance; valuation techniques for embedded options).

ACTU 604: Contingencies

This course is to provide mastery in the mathematical techniques which are of particular relevance to actuarial work in life insurance, health insurance and pensions. Topics to be discussed should include the following: Formulae for annuity values and assurance factors for single life and joint life assurances and annuities; Surrender values and policy alternations; The use of computational tools; Random future loss; Net premiums and net premium reserves; Gross premiums and gross premium reserves. Practical applications should be explored.

ACTU 605: Accounting and Financial Reports for Actuaries

This is to provide students the ability to interpret the accounts and financial statements of companies and financial institutions Topics include: Different types of business entity, Financial structures of business entities, Basic principles of personal and corporate taxation, Taxation of investments held by individuals, Taxation of investments held by institutions, The role of the main institutions in financial markets, Basic structure of company accounts i.e. profit and loss (revenue) account, balance sheet, cash flow statement, provisions and reserves; Basic principles of group accounts, Calculation and use of accounting ratios, Limitations of company accounts.

ACTU 606: Economics for Actuaries

This course is to provide grounding in the fundamental concepts of economics as they affect the operation of insurance and other financial systems with applications to the actuarial profession. Topics to be treated include: Supply, demand and equilibrium price (in both free and controlled markets), Elasticity of supply and demand, Utility theory and consumer choice (including analysis of insurance problems), Theory of the firm under differing market structures, General equilibrium theory, Public sector finance and taxation, Aggregate national income: measurement and analysis, The multiplier, accelerator and aggregate supply and demand, Government policies and their effects (direct and via the banking system), Domestic macroeconomic factors and their management, International trade, exchange rates and the balance of payments

ACTU 607: Survival Models

This course is to provide grounding in survival models with its applications in the Actuarial profession. Topics include: Survival models, Statistical models of transfers between multiple states, State-space and Markov models for life insurance, Maximum likelihood estimators for transition intensities, Construction of a multiple decrement table; Binomial model of mortality, Graduation; Comparison of actual against expected

experience, The use of single figure indices, for describing the variation of mortality and sickness, Heterogeneity within a population with regard to mortality and sickness.

ACTU 608: Accounting Principles in Finance

This course is to instill the ability to apply, in simple situations, the principles of actuarial planning and control to the appraisal of investments, to the measurement of investment performance, and to the selection and management of investments appropriate to the needs of investors. Topics include: Financial Markets: Characteristics of different types of investment; Investment indices; Price and valuation; Principles of regulation and accounting; Arbitrage-free markets; Corporate Finance: Cash-flow techniques (deterministic *v.* stochastic; risk neutral *v.* deflators); Cost of capital and capital budgeting; Performance measurement (e.g. EVA, economic profit, economic capital, RAROC etc) and management; Portfolio Theory: Market efficiency; Financial risk management and diversification; Capital Asset Pricing Model (CAPM); Arbitrage Pricing Theory (APT)

ACTU 609: Risk Mathematics

The aim of this course is to provide mastery in risk mathematics and its use in actuarial work. Topics include: Loss distributions; Risk models; Aggregate claim distributions for short term insurance contracts; Ruin theory; The impact of reinsurance; Credibility theory; Loss reserving; No claim discount (NCD) systems; Use of scenario testing and simulation for dynamic financial analysis of general insurance business of a company with particular reference to the Actuarial profession.

ACTU 611: Regression and Time Series Analysis

This course aims at providing mastery in regression and time series models with its applications in actuarial work. Topics include: Theory of Least Squares Estimation, Optimality Property and distribution theory, Interval Estimation and tests under the General Linear Models (GLM), Polynomial and Multiple Linear Regression, Analysis of Variance and Covariance. Time series, Stationarity, Autocorrelation, ARIMA models, identification, estimation, diagnostic checking and linear prediction. Non-stationarity and differencing. Spectral analysis. Applications in Finance and Actuarial Science.

ACTU 612: Life Insurance

This course is to instill the ability, in simple situations, to use judgment and apply the principles of actuarial planning and control needed for the operation on sound financial lines of providers of life insurance. Topics include: Principal terms; The main contract types; The principles of life insurance markets; Data requirements and verification; Product pricing; Reserving; Surrender values; Policy alterations; Derivation of actuarial assumptions; Measurement and analysis of surplus; Methods of distributing surplus to policyholders; Principles of investment and asset-liability modeling; Principles of regulation and accounting; Risk and uncertainty in life insurance business; Principles of

risk management including reinsurance; Life insurance regulations, including: Taxation, Accounting, Supervisory regulation; Experience rating; Future financial requirements including dynamic financial analysis; Value of a life company; Evaluation of the capital requirements of a life insurer for the purpose of determining the strategy for growth in business.

ACTU 613: Insurance Applications and Principles for Actuarial Practice

This course is to instill the ability to apply, in very simple situations, the principles and practices of actuarial processes that are needed for the operation of providers of insurance on sound financial lines. Topics include Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities- immediate and apportionable annuities-due. Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Net premium reserves : Continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves,

ACTU 614: Non-Life Insurance

This course is to instill the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation of providers of general insurance on sound financial lines. Topics include: Principal terms; Product types; The principles of general insurance markets; Data requirements and verification; Pricing bases for general insurance contracts; Tariff systems; Methods of determining the value of the insurance liabilities of a general business insurer and the value of the assets, in terms of emerging costs and in terms of discounted values, for the purposes of

- the establishment of provisions and reserves for the accounts
- the estimation of solvency
- the pricing of products

Experience rating; Claim reserving; Modelling the uncertainty in claim frequency and amount; Bases for valuing the assets and liabilities of a general business insurer; Methods of analysing the experience of a general business insurer for the purposes of determining pricing and valuation assumptions and identifying the main sources of profit and loss; Principles of investment for general business insurers' assets. Principles of regulation and accounting for general insurance; Risk and uncertainty in general insurance business; Principles of risk management including reinsurance.

ACTU 616: Pensions Management

This course aims at instilling the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of pensions of all types. Topics include: Principal terms; Benefit types; The needs and roles of the various parties that may be involved; Methods of financing provision; The regulatory environments in which benefits may be provided; Risks and uncertainties; Re-insurance as a means of risk management; Actuarial models to project income and outgo; Principles of financing, including asset and liability relationships; Determining assumptions for valuing future benefits and contributions; Placing values on assets, future benefits and future contributions for the purpose of

- financing
- the establishment of provisions and reserves for the accounts
- the estimation of solvency
- the determination of benefits including guarantees and options

Monitoring and analysing experience; Calculation and distribution of surplus

ACTU 618: Health Insurance

This course is to instill in students the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of health insurance/living benefits. Topics include: Principal terms; Different models for financing health care; features of mixed public/private financial health care systems; major types of health insurance product, including sickness insurance, critical illness insurance, long-term care insurance, medical expenses insurance and disability insurance. Principles of health insurance markets and of accounting for health insurance; Major areas of risk and uncertainty in health insurance; Principles of investment for health insurers' assets; Valuation data and verification procedures; Analysis of the experience of a health insurer; Pricing of health insurance products; Valuation of the liabilities for the purposes of the establishment of reserves for the accounts and determination of solvency.

ACTU 622: Non-Life Insurance Mathematics

This course introduces students to the aspects of Non-Life Insurance Mathematics. Topics include: Models that are based on stochastic processes and their applications to the actuarial profession, which are important for insurance companies; Quantification of risks; Types of risks; estimation of probabilities of risks; estimation of probabilities of extreme or rare events. Practical applications of risks in the actuarial profession will be explored.

ACTU 650: Seminar

Each student in the Department or Programme is expected to attend all seminars specified. Each student is expected to make his/her own presentation on a selected topic to an audience and also present a project proposal seminar. Seminars are offered for special topics related to actuarial science, life insurance, casualty insurance, insurance medicine, mortality and mobility, health outcomes, economics, policy, pension, social insurance, mathematical finance, statistics, and other related fields with particular reference to the actuarial profession.

STAT 603: Probability Theory

This course introduces students to the aspects of Probability theory that enhances their understanding and its application to the Actuarial Profession. Topics include: Basics of Probability Theory, Independence and Bernoulli Trials, Random Variables; Binomial Random Variable Applications, Conditional; Probability Density Function; Function of a Random Variable; Mean, Variance, Moments and Characteristic Functions; Two Random Variables; One Function of Two Random Variables; Two Functions of Two Random Variables; Joint Moments and Joint Characteristic Functions; Conditional Density Functions and Conditional Expected Values; The Weak Law and the Strong Law of Large numbers

M. Phil ACTUARIAL SCIENCE PROGRAMME

The Department of Statistics is proposing to run two additional programmes at the post graduate level. These are M. Sc and M. Phil in **ACTUARIAL SCIENCE**.

M. Phil
The M. Phil course is a two-year degree progamme. Students will take exams in the first year and undertake a research and present a thesis at the end of the second year of study.

2 ADMISSION REQUIREMENTS

The programme is appropriate for individuals with strong ***mathematical aptitude***, i.e. formal background in mathematics, statistics and economics, who wish to enter or advance in the actuarial profession. It is also appropriate for those who are interested in taking up an academic career in Actuarial training.

A Good first degree in **Mathematics, Statistics, Finance, Economics** or ***Any Quantitative related Course, at least a second class lower division***, including at least two years of University Mathematics. Each short-listed applicant must pass a selection interview. Candidates with M. Sc (Actuarial Science) may also apply, such students may take some top-up courses and write a thesis for an M. Phil.

3 GRADUATION REQUIREMENTS

The candidate to be awarded M.Phil degree in Actuarial Science must satisfy the following graduation requirements:

Coursework	24-36 Credits
Seminars	6 Credits
Thesis	36 Credits
Total	**66-78 Credits**

4 PROGRAMME STRUCTURE

YEAR 1
FIRST SEMESTER
CORE

Course Code	Course Title	Credits
ACTU 601	Stochastic Processes	3
STAT 603	Probability Theory	3
ACTU 603	Actuarial Mathematics	3
ACTU 605	Accounting and Financial Reports for Actuaries	3

ACTU 630	Seminar I	3
ELECTIVES		
Electives (Minimum of 3 Credits and a maximum of 7 Credits) To be selected upon the Advice of the Department		
ACTU 607	Survival Models	3
ACTU 609	Risk Mathematics	3
ACTU 611	Regression and Time Series	4
ACTU 613	Insurance Applications and Principles for Actuarial Practice	3
STAT 617	Research Methodology	3
ACTU 620	Internship in Actuarial Science	3

Minimum Credits for Semester 1 15
Maximum Credits for Semester 1 18

YEAR 1
SECOND SEMESTER
CORE COURSES **Credits**

Course Code	Course Title	Credits
ACTU 602	Actuarial Computing	3
ACTU 604	Contingencies	3
ACTU 606	Economics for Actuaries	3
ACTU 630	Seminar I	3
ELECTIVES		
Electives (Minimum of 6 Credits and a maximum of 9 Credits) To be selected upon the Advice from the Department		
ACTU 608	Accounting Principles in Finance	3
ACTU 612	Life Insurance	3
ACTU 614	Non-Life Insurance	3
ACTU 616	Pensions Management	3
ACTU 618	Health Insurance	3
ACTU 620	Internship in Actuarial Science	3
ACTU 622	Non-Life Insurance Mathematics	3

Minimum Credits for Semester 2 15
Maximum Credits for Semester 2 18

YEAR 2
CORE COURSES **Credits**

Course Code	Course Title	Credits
ACTU 640	Seminar II	3
ACTU 610	Thesis	36

5 COURSE DESCRIPTION

ACTU 601: Stochastic Processes

This course is to provide grounding in stochastic processes and their use in models for actuarial work. It provides a broad introduction to stochastic processes for postgraduates with an emphasis on financial and actuarial applications. Some of the topics that need to be covered include: Principles of modeling, Principles and classification of stochastic processes, Martingales, Markov Chains, Markov processes, Poisson Processes, Brownian motion, stochastic differential equations and diffusion processes, Gauss-Wiener processes. Simulation methods for stochastic processes and Applications in Finance and Actuarial Science.

ACTU 602: Actuarial Computing

This course is to provide grounding in modern computing methods necessary for the work of an actuary. The student is expected to have a working knowledge of modern Information Communications Technology (ICT) appropriate for the work of an actuary. Programming in a high level language such as C (preferred) or FORTRAN is preferred. Introduction to programming and of developing skills required to write statistical software. Should there be previous exposure to programming, this unit can be replaced by a more advanced unit in object-oriented programming in C++ or Java. Topics should include simple syntax, loops, pointers and arrays, functions, input/output, and linking to databases. Numerical analysis and statistical applications i.e. graphics, descriptive statistics, representation of multivariate data, simple hypothesis tests, analysis of variance, and linear regression. Packages such as MINITAB, SAS, or SPSS are recommended to be used.

ACTU 603: Actuarial Mathematics

This course provides grounding in Actuarial mathematics and their applications. Topics include: Deterministic theory of interest (i.e. traditional compound interest, cash-flow modelling; annuities certain, bond market theory), Introduction to contingent claims analysis (i.e. definition of derivative securities, no arbitrage principle); Stochastic calculus for finance (conditional expectation, introduction to martingales, stochastic integrals and differential equations, pricing and hedging of derivatives); Stochastic theory of interest; interest rate models (discrete and continuous time); derivatives on interest rates and bonds; Dynamic portfolio management (asset-liability modeling; introduction to stochastic optimal control); Introductory applications to insurance liabilities (embedded options in life insurance; valuation techniques for embedded options).

ACTU 604: Contingencies

This course is to provide mastery in the mathematical techniques which are of particular relevance to actuarial work in life insurance, health insurance and pensions. Topics to be discussed should include the following: Formulae for annuity values and assurance factors for single life and joint life assurances and annuities; Surrender values and policy alternations; The use of computational tools; Random future loss; Net premiums and net premium reserves; Gross premiums and gross premium reserves. Practical applications should be explored.

ACTU 605: Accounting and Financial Reports for Actuaries

This is to provide students the ability to interpret the accounts and financial statements of companies and financial institutions Topics include: Different types of business entity, Financial structures of business entities, Basic principles of personal and corporate taxation, Taxation of investments held by individuals, Taxation of investments held by institutions, The role of the main institutions in financial markets, Basic structure of company accounts i.e. profit and loss (revenue) account, balance sheet, cash flow statement, provisions and reserves; Basic principles of group accounts, Calculation and use of accounting ratios, Limitations of company accounts.

ACTU 606: Economics for Actuaries

This course is to provide grounding in the fundamental concepts of economics as they affect the operation of insurance and other financial systems with applications to the actuarial profession. Topics to be treated include: Supply, demand and equilibrium price (in both free and controlled markets), Elasticity of supply and demand, Utility theory and consumer choice (including analysis of insurance problems), Theory of the firm under differing market structures, General equilibrium theory, Public sector finance and taxation, Aggregate national income: measurement and analysis, The multiplier, accelerator and aggregate supply and demand, Government policies and their effects (direct and via the banking system), Domestic macroeconomic factors and their management, International trade, exchange rates and the balance of payments

ACTU 607: Survival Models

This course is to provide grounding in survival models with its applications in the Actuarial profession. Topics include: Survival models, Statistical models of transfers between multiple states, State-space and Markov models for life insurance, Maximum likelihood estimators for transition intensities, Construction of a multiple decrement table; Binomial model of mortality, Graduation; Comparison of actual against expected experience, The use of single figure indices, for describing the variation of mortality and sickness, Heterogeneity within a population with regard to mortality and sickness.

ACTU 608: Accounting Principles in Finance

This course is to instill the ability to apply, in simple situations, the principles of actuarial planning and control to the appraisal of investments, to the measurement of investment performance, and to the selection and management of investments appropriate to the needs of investors. Topics include: Financial Markets: Characteristics of different types of investment; Investment indices; Price and valuation; Principles of regulation and accounting; Arbitrage-free markets; Corporate Finance: Cash-flow techniques (deterministic *v.* stochastic; risk neutral *v.* deflators); Cost of capital and capital budgeting; Performance measurement (e.g. EVA, economic profit, economic capital, RAROC etc) and management; Portfolio Theory: Market efficiency; Financial risk management and diversification; Capital Asset Pricing Model (CAPM); Arbitrage Pricing Theory (APT)

ACTU 609: Risk Mathematics

The aim of this course is to provide mastery in risk mathematics and its use in actuarial work. Topics include: Loss distributions; Risk models; Aggregate claim distributions for short term insurance contracts; Ruin theory; The impact of reinsurance; Credibility theory; Loss reserving; No claim discount (NCD) systems; Use of scenario testing and simulation for dynamic financial analysis of general insurance business of a company with particular reference to the Actuarial profession.

ACTU 610: Thesis

A project is undertaken in an applied area after presenting a proposal as specified in ACTU 630 and ACTU 640. Students would then submit a proposal write-up for approval by their supervisor(s) by the end of the second semester of year one. The final write-up of the project itself should be submitted by the end of the academic year (i.e. year two of study).

ACTU 611: Regression and Time Series Analysis

This course aims at providing mastery in regression and time series models with its applications in actuarial work. Topics include: Theory of Least Squares Estimation, Optimality Property and distribution theory, Interval Estimation and tests under the General Linear Models (GLM), Polynomial and Multiple Linear Regression, Analysis of Variance and Covariance. Time series, Stationarity, Autocorrelation, ARIMA models, identification, estimation, diagnostic checking and linear prediction. Non-stationarity and differencing. Spectral analysis. Applications in Finance and Actuarial Science.

ACTU 612: Life Insurance

This course is to instill the ability, in simple situations, to use judgment and apply the principles of actuarial planning and control needed for the operation on sound financial lines of providers of life insurance. Topics include: Principal terms; The main contract types; The principles of life insurance markets; Data requirements and verification;

Product pricing; Reserving; Surrender values; Policy alterations; Derivation of actuarial assumptions; Measurement and analysis of surplus; Methods of distributing surplus to policyholders; Principles of investment and asset-liability modeling; Principles of regulation and accounting; Risk and uncertainty in life insurance business; Principles of risk management including reinsurance; Life insurance regulations, including: Taxation, Accounting, Supervisory regulation; Experience rating; Future financial requirements including dynamic financial analysis; Value of a life company; Evaluation of the capital requirements of a life insurer for the purpose of determining the strategy for growth in business.

ACTU 613: Insurance Applications and Principles for Actuarial Practice

This course is to instill the ability to apply, in very simple situations, the principles and practices of actuarial processes that are needed for the operation of providers of insurance on sound financial lines. Topics include Life insurance: Insurance payable at the moment of death and at the end of the year of death-level benefit insurance, endowment insurance, deferred insurance and varying benefit insurance, recursions, commutation functions. Life annuities: Single payment, continuous life annuities, discrete life annuities, life annuities with monthly payments, commutation functions, varying annuities, recursions, complete annuities- immediate and apportionable annuities-due. Net premiums: Continuous and discrete premiums, true monthly payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Payment premiums, apportionable premiums, commutation functions, accumulation type benefits. Net premium reserves : Continuous and discrete net premium reserve, reserves on a semi-continuous basis, reserves based on true monthly premiums, reserves on an apportionable or discounted continuous basis, reserves at fractional durations, allocations of loss to policy years, recursive formulas and differential equations for reserves,

ACTU 614: Non-Life Insurance

This course is to instill the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation of providers of general insurance on sound financial lines. Topics include: Principal terms; Product types; The principles of general insurance markets; Data requirements and verification; Pricing bases for general insurance contracts; Tariff systems; Methods of determining the value of the insurance liabilities of a general business insurer and the value of the assets, in terms of emerging costs and in terms of discounted values, for the purposes of

- the establishment of provisions and reserves for the accounts
- the estimation of solvency
- the pricing of products

Experience rating; Claim reserving; Modelling the uncertainty in claim frequency and amount; Bases for valuing the assets and liabilities of a general business insurer; Methods of analysing the experience of a general business insurer for the purposes of determining pricing and valuation assumptions and identifying the main sources of profit and loss;

Principles of investment for general business insurers' assets. Principles of regulation and accounting for general insurance; Risk and uncertainty in general insurance business; Principles of risk management including reinsurance.

ACTU 616: Pensions Management

This course aims at instilling the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of pensions of all types. Topics include: Principal terms; Benefit types; The needs and roles of the various parties that may be involved; Methods of financing provision; The regulatory environments in which benefits may be provided; Risks and uncertainties; Re-insurance as a means of risk management; Actuarial models to project income and outgo; Principles of financing, including asset and liability relationships; Determining assumptions for valuing future benefits and contributions; Placing values on assets, future benefits and future contributions for the purpose of

- financing
- the establishment of provisions and reserves for the accounts
- the estimation of solvency
- the determination of benefits including guarantees and options

Monitoring and analysing experience; Calculation and distribution of surplus

ACTU 618: Health Insurance

This course is to instill in students the ability to apply, in simple situations, the principles of actuarial planning and control needed for the operation on sound financial lines of providers of health insurance/living benefits. Topics include: Principal terms; Different models for financing health care; features of mixed public/private financial health care systems; major types of health insurance product, including sickness insurance, critical illness insurance, long-term care insurance, medical expenses insurance and disability insurance. Principles of health insurance markets and of accounting for health insurance; Major areas of risk and uncertainty in health insurance; Principles of investment for health insurers' assets; Valuation data and verification procedures; Analysis of the experience of a health insurer; Pricing of health insurance products; Valuation of the liabilities for the purposes of the establishment of reserves for the accounts and determination of solvency.

ACTU 620: Internship in Actuarial Science

The course is offered in both semesters to students who seek practical applications of actuarial principles in insurance companies, financial institutions, pension consulting firms, and other related fields. The course requires students to participate in an internship program within the industry. Students need to submit monthly progress reports and a final semester report to the Head, Department of Statistics, University of Ghana, Legon.

[This Course is available to only M. Phil students]

ACTU 622: Non-Life Insurance Mathematics

This course introduces students to the aspects of Non-Life Insurance Mathematics. Topics include: Models that are based on stochastic processes and their applications to the actuarial profession, which are important for insurance companies; Quantification of risks; Types of risks; estimation of probabilities of risks; estimation of probabilities of extreme or rare events. Practical applications of risks in the actuarial profession will be explored.

ACTU 630: Seminar I

Each student in the Department or Programme is expected to attend all seminars specified. Each student is expected to make his/her own presentation on a selected topic to an audience and also present a project proposal seminar. Seminars are offered for special topics related to actuarial science, life insurance, casualty insurance, insurance medicine, mortality and mobility, health outcomes, economics, policy, pension, social insurance, mathematical finance, statistics, and other related fields with particular reference to the actuarial profession.

ACTU 640: Seminar II

This is the second in the sequel of seminar presentations. Each student in the Department or Programme is expected to attend all seminars specified. Each student is expected to make his/her own presentation on a selected topic to an audience and also present a project proposal seminar.
Seminars are offered for special topics related to actuarial science, life insurance, casualty insurance, insurance medicine, mortality and mobility, health outcomes, economics, policy, pension, social insurance, mathematical finance, statistics, and other related fields with particular reference to the actuarial profession.

STAT 603: Probability Theory

This course introduces students to the aspects of Probability theory that enhances their understanding and its application to the Actuarial Profession. Topics include: Basics of Probability Theory, Independence and Bernoulli Trials, Random Variables; Binomial Random Variable Applications, Conditional; Probability Density Function; Function of a Random Variable; Mean, Variance, Moments and Characteristic Functions; Two Random Variables; One Function of Two Random Variables; Two Functions of Two Random Variables; Joint Moments and Joint Characteristic Functions; Conditional Density

Functions and Conditional Expected Values; The Weak Law and the Strong Law of Large numbers

STAT 617: Research Methodology

This course entails an overview of Research Methodology, Approaches to conducting research, purposes of conducting research etc.; types of research and their evaluation; an overview of the research process; proposal writing; Definitions and functions of a proposal; research design; sampling techniques; designing research instrument: questionnaire and interview/focus group guide; survey methods; pre-testing and piloting; dealing with non-response issues etc. Qualitative research methods and analysis; Field and Interview Skills; Research Ethics; Report Writing: Types of reports; Requirements to compete in readership market; Secrets of a well-written report; Organizing report writing.