SCHOOL OF ENGINEERING SCIENCES

DEPARTMENT OF COMPUTER ENGINEERING

DOCTOR OF PHILOSOPHY (PHD) IN COMPUTER ENGINEERING

1.0 Course structure

The PhD course has two main components: required (core) courses and elective courses. The elective courses are structured along three research thematic areas comprising: communications and networks systems; Computer and intelligent systems; and Control and automation systems. Students are required to take a minimum of two (2) electives in their respective research areas.

The detail structure of the programme (semester-by-semester structure) and schedule of courses including detail description of the courses are provided below.

1.1 Computer Systems Engineering Track

Year 1, Semester 1

Core Course

Course code	Course Description	Credits
FAEN 701	Advanced Research Methods	3

Elective Courses:

Candidates are expected to select at least two (2) elective courses

Course code	Course Description	Credits
CPEN 711	Advances in Computer System Engineering	3
CPEN 713	Advances in Bioinformatics	3
CPEN 715	Multithreaded, Parallel, and Distributed Programming	3
CPEN 717	Advances in Information Systems Engineering	3

Year I, Semester 2

Core Course

Course code	Course Description	Credits
FAEN 702	Advanced Project Management and Quality Control	3

Elective Courses:

Candidates are expected to select at least two (2) elective courses.

Course code	Course Description	Credits
CPEN 712	Networked Cyber-Physical Systems	3
CPEN 714	Data Intensive Computing & Storage	3
CPEN 716	Real Time Multimedia Systems	3
CPEN 718	Distributed Real-Time Embedded Systems	3

Year II

Course Code	Course Description	Credits
CPEN 710 Seminar I	Seminar I	3
CPEN 720 Seminar II	Seminar II	3

Year III

Course Code	Course Description	Credits
CPEN 730 Seminar III	Seminar III	3

Year IV

Course Code	Course Description	Credits
CPEN 740 Seminar IV	Seminar IV	3
CPEN 700	Thesis	45

1.2 Telecommunication Systems Engineering Track

Year 1, Semester 1

Core Course

Course code	**Course Description**	**Credits**
FAEN 701	Advanced Research Methods	3

Elective Courses:

Candidates are expected to select at least two (2) elective courses.

Course code	Course Description	Credits
CPEN 721	Distributed Wireless Networks	3
CPEN 723	Radio Resource Management	3
CPEN 725	Network Routing and Optimization	3
CPEN 727	Advances in Optical Networks	3
Total		**9**

Year I, Semester 2

Core Course

Course code	Course Description	Credits
FAEN 702	Advanced Project Management and Quality Control	3

Elective Courses:

Candidates are expected to select at least two (2) elective courses.

Course code	**Course Description**	**Credits**
CPEN 722	Advances in Computer Networks	3
CPEN 724	Advances in Digital Broadcasting and Communications	3
CPEN 726	Advances in Cloud Computing	3
CPEN 728	Advanced Network Security	3

Year II

Course Code	Course Description	Credits
CPEN 710 Seminar I	Seminar I	3
CPEN 720 Seminar II	Seminar II	3

Year III

Course Code	Course Description	Credits
CPEN 730 Seminar III	Seminar III	3

Year IV

Course Code	Course Description	Credits
CPEN 740 Seminar IV	Seminar IV	3
CPEN 700	Thesis	45

1.3 Control and Automation Systems Engineering Track

Year 1, Semester 1

Core Course

Course code	**Course Description**	**Credits**
FAEN 701	Advanced Research Methods	3

Elective Courses:

Candidates are expected to select at least two (2) elective courses.

Course code	Course Description	Credits
CPEN 731	Advances in Computer Controlled Engineering	3
CPEN 733	Advanced Linear Systems and Control	3
CPEN 735	Advances in Automatic and Robust Control	3
CPEN 737	Adaptive Control and Signal Processing	3

Year I, Semester 2

Core Course

Course code	Course Description	Credits
FAEN 702	Advanced Project Management and Quality Control	3

Elective Courses:

Candidates are expected to select at least two (2) elective courses.

Course code	**Course Description**	**Credits**
CPEN 732	Control and Optimization in Energy Networks	3
CPEN 734	Multi-Agent Systems and Control	3
CPEN 736	Control and Stochastic Optimization	3
CPEN 738	Advances in Control, Nonlinear Dynamics and Chaos	3

Year II

Course Code	Course Description	Credits
CPEN 710 Seminar I	Seminar I	3
CPEN 720 Seminar II	Seminar II	3

Year III

Course Code	Course Description	Credits
CPEN 730 Seminar III	Seminar III	3

Year IV

Course Code	Course Description	Credits
CPEN 740 Seminar IV	Seminar IV	3
CPEN 700	Thesis	45

2.0 Description of Courses

CPEN 700 PhD Thesis

The doctoral thesis involves a candidate working closely under the guidance of a supervisor(s) in the Department to investigatean approved original project idea from the candidate's preferred field of specialization, and writing a thesis. The investigation will include a comprehensive review of related works reported in scholarly articles, formulation and development of necessary concepts, implementation, testing, study of the implications of work and potential application. The thesis will be evaluated based either on its academic contribution and advancement to knowledge or contribution to the relevant industrial application. The contributions from theresearch work will be synthesized and compiled into publication-quality research papers.

FAEN 701 Advanced Research Methods

The course will provide students with more specialized knowledge and skills for designing quantitative research at the doctoral level, including understanding multivariate data analysis and applying more advanced statistical concepts. The topics covered include: Exploration of classical quantitative research designs and common statistical tests; importance of quality assurance and ethical and social change implications of conducting quantitative research and producing knowledge; statistical analysis from problem-solving perspective with emphasis on selecting appropriate statistical tests for research design; use of software to calculate statistics and interpret and present results.

FAEN 702 Advanced Project Management and Quality Control

Thiscourse will provide students the knowledge and skills necessary to successfully manage increasingly complex project issues to meet desired organizational goals and objectives. Topics to be covered include strategies for avoidance of costly mistakes in project execution, dealing with evolving stakeholder expectations, using trend analysis to measure project. Students will learn the framework for strategic execution that incorporates a full range of proven approaches and emerging concepts for aligning project and program initiatives with strategic objectives.Other topics to cover include project selection and initiation, project execution methodology, project variance and control, as well as project closure and learning.

CPEN 710 **Seminar I:** Research Proposals Seminar

The PhD seminar I course focuses on development of the skill of PhD candidates to enable them reach the research frontier of the discipline through identification of research topics, submitting a report and making presentations on selected topics of recent interest in the field of computer engineering.The identified research topics by candidates for their PhD programme will be presented in the form of a seminar, which will be evaluated and assessed by senior/faculty members.

CPEN 720 **Seminar II:** Research and Experiential Learning Seminar

The PhD seminar II course focuses on research and experiential learning presentation by PhD candidates. The student will be expected to submit a report, make presentation and share experiences and lessons learnt with Senior/Faculty members during the second year of his PhD Programme. This seminar incorporates strong industrial and academia collaboration leading to solution of industry-level problems through research. The candidate's report and presentation will be evaluated and assessed.

CPEN 730 Seminar III: Thesis Progress Report Seminar

The PhD seminar III course focuses on progress report presentations on the research undertaken by students. Each candidate will be required to submit a formal report and make presentations of his/her preliminary findings of the approved PhD research work. The thesis progress report will be evaluated and assessed.

CPEN 740 Seminar IV: Thesis Findings Seminar

The PhD seminar IV course focuses on thesis findings report and presentations. Each candidate will be required to make presentations of preliminary thesis findings of the research. The candidate's report and presentation will be evaluated and assessed.

CPEN 711 Advances in Computer Systems Engineering

This course will provide an in-depth treatment of the recent and emerging trends in computer systems engineering. A primary aim of this course therefore will be to educate students in the art of critical thinking: the ability to argue for and/or against a particular approach or idea. This will be done by having students read and critique a set of papers each week.The course will cover areas such as operating systems, database systems, file systems, parallel and distributed systems and networking. In addition, candidates will be required to make presentations which aim to advocate or criticize reviewed literature.

CPEN 712 Networked Cyber-Physical Systems

This course will highlight latest research in the emerging field of cyber-physical systems. Cyber-physical systems are a class of networked embedded systems where sensing, computation and actuation are integrated with the dynamics of the physical environment. Recent years havewitnessed a proliferation of embedded systems. Topics to be treated include: modelling of cyber-physical systems, communication and control, computer programming using different frameworks, applications in safety-critical systems, smart grid technology, intelligent buildings, supervisory control and data acquisition systems for manufacturing and utilities, automotive systems, body sensor networks, design of cyber-physical networked systems, battery power management, monitoring and hierarchical control.

CPEN 713 Advances in Bioinformatics

This course will cover several important areas of modern bioinformatics and computational biology for students specializing in bioinformatics drawn from biomedical engineering with strong computer science or engineering backgrounds. They would be exposed to advanced computational tools and scripting languages for bioinformatics research. The course will cover an overview of modern sources of bioinformatics data, high-throughput sequencing and microarrays, clustering and co-expression graphs; hierarchical clustering; K-means and variants; comparative clustering of two datasets, parallel CAST, cliques in the difference co-expression graphs, sequence search and alignment algorithms, and the structure of the eukaryotic genome, and population genetics.

CPEN 714 Data Intensive Computing and Storage

This course will provide new and emerging paradigms for data intensive computing and storage platforms. Data-intensive computing and cloud computing have become important forms of computing nowadays with the internet acting as the backbone. This paradigm of data storage on remote sites and harnessing the computing power of the internet is envisaged to grow into dominant roles. Topics to be treated include: case studies of existing systems, compute and storage architectures, programming

models, middleware and building blocks, and administration/automation, exploration of various metrics of goodness for alternate approaches, including efficiency, performance, robustness, complexity and ease-of-use.

CPEN 715 Multi-threaded, Parallel and Distributed Programming

This course will provide students with a selection of recent advances in software engineering such as multi-threaded, parallel and distributed programming along with some of the challenges and outstanding problems. The course aims at making students aware of key aspects of current software engineering research and to familiarize them with the state-of-the-art research in parallel and distributed programming. Topics to be treated include: introduction to parallel processing, parallel algorithms, complexity and parallel computation models, PRAM shared-memory model algorithms, shared memory implementations, sorting and selection networks, search acceleration circuits, sorting and routing on mesh architectures, hypercubes and their algorithms, task scheduling.

CPEN 716 Real-time Multimedia Systems

This course will provide students with the basic and advanced treatment of multimedia components, systems and applications with an emphasis on networked computers as conveyors of real-time information. Since multimedia has become an indispensable part of modern computer technology, students will be exposed to gaining hands-on experience in the implementation of multimedia streaming system as their term project. Topics to be treated include: multimedia applications, real-time distributed systems, time dependent media, coding, compression, systems and software architectures, multi-modal communication systems, issues in effectively representing, processing, and retrieving multimedia data such as sound and music, graphics, image, video and web technologies.

CPEN 717 Advances in Information Systems Engineering

This course will focus on recent and emerging trends in information systems engineering. It will cover the notion of different types of securities: information security and computer Security: security goals, relation between security-confidentiality, integrity, availability and authorization, vulnerabilities- Principles of adequate protection, operating system security, database security, Program security, network security, program security, types of flaws, buffer overflows, virusesand other malicious code, targeted malicious code, controls against program threats.

CPEN 718 Distributed Real-Time and Embedded Systems

The course provides the framework for understanding the role of each current and emerging technology under the perspective of building "real" distributed real-time fault-tolerant embedded systems while stimulating a hands-on approach on a relevant set of selected technologies and platforms. This course addresses a comprehensive set of topics in the area of embedded systems technologies, including embedded computing platforms, embedded operating systems, network interconnecting and real-world interfacing through sensors and actuators.

CPEN 721Distributed Wireless Networks

This course investigates the latest advances in mobile networking and mobile communications, which are expected to impact on the long-term evolution of the field of communications in general. It will explore the aforementioned research area by studying, critically analyzing and discussing, summarizing, and

presenting selected first-rate research articles. Topics include mobile communications, wireless communications, mobile ad hoc networks, mobile and wireless sensor networks, wireless personal area networks, wireless distributed networks, mobility in the future Internet, security in wireless and mobile networks.

CPEN 722 Advances in Computer Networks

This course will present students with the latest advances in computernetworking technology and protocols such as IPv6. It will explore the aforementioned research area by studying, critically analyzing and discussing, summarizing, and presenting selected first-rate published research articles from IEEE.Students will perform critical review of papers from conferences and journals and make presentations while enhancing their hands-on experience of novel techniques in published literature.
Topics include: Self-similarity in internet traffic, introduction to network and web science, network interface design, switching networks, wireless ad hoc networks, game theory applications in networks, network economics, network measurement, and network security threats.

CPEN 723 Radio Resource Management

The radio resource management course combines the fundamentals of resource allocation with innovative algorithms for radio interface utilization from recent research as well as application examples. The aim of radio resource allocation mechanisms is to make the best use of limited resources while ensuring sufficient QoS, under time varying channel conditions. Topics include: principles of radio coverage in cellular systems, basics of radio network planning, practical resource allocation algorithm designs such as adaptive power and rate controls, base station coordinated scheduling, different optimization techniques used in resource allocation, different examples of advanced topics to illustrate the versatility of resource allocation.

CPEN 724 Advances in Digital Broadcasting and Communications

This course will present the recent advances made in digital broadcasting and communications. The objective is to provide students with an opportunity to study and analyze current issues, topics, and trends related to web-based technology use in digital media broadcasting. The topics include: multimedia objects and related models, multimedia compression techniques and standards, multimedia interfaces, multimedia storage techniques, multimedia communication and networking, multimedia synchronization techniques, multimedia information systems, scheduling in multimedia systems, and video indexing and retrieval techniques, introduction to web technologies for digital media, technology and digital media broadcast.

CPEN 725 Network Routing and Optimization

The course will provide extended theoretical and practical knowledge of advanced routing and optimization. It will expose students to the configuration, function and use of various types of routing protocols. Topics to be treated include: modern theory of analysis, control, and optimization for dynamic networks, network layer capacity,mathematical techniques of Lyapunov drift and Lyapunov optimization optimal control of wireless and ad-hoc mobile networks; opportunistic resource allocation, routing, and flow control; backpressure; minimum energy networking; general utilities and constraints; queue stability; Lyapunov optimization; energy-delay and utility-delay trade-offs; peer-to-peer networks; stock market trading.

CPEN 726 Advances in Cloud Computing

This course will present recent advances made in cloud computing and their inherent architectural frameworks for data storage and computation. It will providestudents with advanced concepts of cloud computing and its related topics areas such as parallel and distributed computing platforms. It will cover topics such as cloud computing definitions, data management, data storage, retrieval, computational storage, service level agreements, accounting and billing, data migration, indicative architectural approaches and real-time clouds and their metrics and architecture, real-time cloud computing environments and exploitation of mobile devices through clouds, advanced application areas, virtualization, service-platform-infrastructure (SPI) model, service and deployment models in cloud computing.

CPEN 727 Advances in Optical Networks

This course will present recent advances in the field of optical networking and protocols and their corresponding impact on communication systems in terms of bandwidth usage and efficiency. It will incorporate the advantages of optical networks for telecommunication systems and various architectures over copper transmission systems.Topics include WDM optical networks with their evolution, construction, broadcast, wavelength routed optical WDM network, current challenges of optical WDM network, SONET/SDH, fault management in SONET/SDH, framing techniques, traffic grooming, multiple access protocols, virtual topology design, routing and wavelength assignment, protection and restoration, and optical packet switching.

CPEN 728 Advanced Network Security

The course willinvestigate the latest advances in network security. It will explore the aforementioned research area by studying, critically analyzing and discussing, summarizing, and presenting selected first-rate research articles. Techniques such as thoroughly surveying literature, critical discussion and analysis of scientific articles, and the presentation of the obtained results will be demonstrated by students. Topics will include: practical anonymity in opportunistic wireless networks, contemporary emergency communication systems, physical layer security in Wireless Mesh Networks (WMNs), distributed trust establishment in (WMNs), detection of attacks on MANETs, outlier detection in wireless sensor networks, and constructive interference in WSN.

CPEN 731 Advances in Computer Controlled Engineering

This course will explore the recent advances made in computer controlled engineering systems and will present state-space formulations for engineering problems through computer-aided engineering analysis and design software such as MATLAB/Simulink and its application to dynamic physical systems. Topics covered will include: modern approach to the analysis and engineering applications of linear systems, modelling and linearization of multi-input, multi-output dynamic physical systems, state-space models and transfer functions. State-space computation, structural properties of linear dynamic physical systems, including: controllability, observability and stability, linear state-variable feedback controller and asymptotic observer design, linear-quadratic regulator design, Kalman filtering, separation principle.

CPEN 732 Control and Optimization in Energy Networks

The course covers various aspects of optimization theory with applications to large-scale energy networks such as the electrical power grid, gas and oil field networks. Several control paradigms and optimization

techniques that enable our modern way of living will be presented.This course covers the following topics: engineering systems modeling for design and optimization, selection of design variables, objective functions and constraints, overview of principles, methods and tools in multidisciplinary design optimization for systems, subsystem identification, development and interface design, review of linear and non-linear constrained optimization formulations.

CPEN 733 Advanced Linear Systems and Control

This course provides a deep understanding of certain aspects of linear systems, along with a set of tools which are very useful in system analysis and control design. Topics to be treated include: elementary operator theory, basic traditional control theory topics (controllability, observability, realization theory), and advanced control topics, such as the small gain theorem, robust control problems, quadratic control theory, H-infinity control design, Nehari theorem and its applications.

CPEN 734 Multi-agent Systems and Control

This course will highlight multiagent system technology for control and optimization of complex systems. Multi-agent systems occur in both the natural and the artificial world such as multi-cellular organisms, ecologies, insect societies, distributed computing, communication networks, evolutionary algorithms, and the internet.The topics to be treated include: natural exemplars of multi-agent systems, and methods for task-decomposition, learning, competition, and cooperation among software agents, cooperative control, distributed control and computation, adversarial interactions, uncertain evolution and complexity management.

CPEN 735 Advances in Automatic and Robust Control

This course will present the recent advances made in automation and robust control for engineering applications. Topics will include: H-infinity and H-2 control design; structured-singular value analysis and synthesis; model reduction; convex optimization; semi-definite programming; and interior-point methods. State space models of linear systems, state feedback control, controllability and observability, sampling of linear systems, optimal control of linear system, analysis of nonlinear controlsystems, stability concepts, system linearization and phase plane analysis.Prediction of the amplitude and frequency of stable periodic solutionsusing Lyapunov functions, Lyapunov's linearization method, introduction to the theory of input-output stability, the circle criterion.

CPEN 736 Control and Stochastic Optimization

This course will present the issue of control systems in an uncertain, random environment. It will present key techniques for leveraging the control paradigm in the face of stochasticity. Stochastic search algorithms are an important class of search techniques. They are also very useful in application domains where one needs to take multiple objectives (e.g., performance, weight, cost) into account when optimizing. The topics of the course draw from probability theory, statistics, electrical engineering, computer engineering, stochastic local search, evolutionary computation, machine learning, combinatorial optimization, and artificial intelligence.

CPEN 737 Adaptive Control and Signal Processing

This course will cover fundamentals of learning and adaptation for control system design and signal processing. Both continuous and discrete time systems will be considered. Adaptive control topics include: Lyapunov stability theory, uniform boundedness, system identification techniques, direct and indirect adaptive control strategies, and adaptive inverse control. Adaptive signal processing topics

include: learning algorithms for digital filters, self-optimization, quadratic performance functions, speed of convergence, and applications.

CPEN 738 Advances in Control, Nonlinear Dynamics and Chaos

This course will present the recent advances made in control and nonlinear dynamics. It will expose students to the concept of approximation theory for real systems, including control systems. Topics to be covered include logistics map and its applications in biology, economics, business, music, and engineering, bifurcations, Poincare maps, strange attractors, and characteristic behavior of nonlinear systems, nonlinear differential equations for control systems and explore the dynamics of a controlled, electrostatically actuated systems, Hopf bifurcations, and chaos.

DEPARTMENT OF MATERIALS SCIENCE & ENGINEERING
DOCTOR OF PHILOSOPHY (PHD) PROGRAMMES

1.0. Introduction

The Department of Materials Science and Engineering (MSE), is a foundation member of the School of Engineering Sciences established in 2004 with a makeup of five Departments. With the onset of the collegiate system in August 2014, the Department became part of the College of Basic and Applied Sciences under the School of Engineering Sciences.

Materials Science and Engineering is an interdisciplinary course focusing on the relationship between the structure and properties of materials, factors controlling the internal structure and processes for altering the structure. The field has evolved from metals, ceramics, polymers and composites to recent design of nanomaterials.

1.2. Aims

1. To provide students access to a highly specialized background in Material Science and Engineering focused on scientific research, technological development and innovation.
2. To provide students with an advanced graduate education that will prepare them for professional careers as high-level materials scientists and engineers in industry, academia, or the public sector.

1.3. Objectives

1. Identify and strengthen research areas that define the Materials Engineering program of the University
2. Foster collaborative research to explore our local resources for energy and other materials related applications
3. To have a solid background knowledge in advanced MSE and able to conduct independent investigation and write technical reports and dissertation
4. Training of well-educated personnel to engage in research and teaching and research in other public and private universities within and outside the country
5. Prepare students who desire to pursue academic and professional careers in Materials Engineering to respond to the growing need for advanced studies in engineering research necessary to meet the 21st century developmental requirements.

2.0. Admission Requirements: MEng. Materials Science and Engineering

A relevant Masters Degree

3.0. DURATION

3.1. PhD Materials Science and Engineering

Normally four (4) years for full-time and six (6) years for part-time

4.0. GRADUATION REQUIREMENTS

Course Work	18 – 24 credits
Seminar (4)	12 credits
Thesis	45 credits
Total	75 - 81 credits

In addition to the above requirements, candidates are required to take at least one elective course per semester

5.0. Structure of Programme and Courses

Year 1

First Semester		**Credits**
Core Courses		
FAEN 701	Advanced Research Methods	3
Elective Courses	**(At least two electives to be selected)**	
MTEN 701	Advanced Seminar in Materials Science and Engineering	3
MTEN 703	Materials for Solar Energy	3
MTEN 705	Advanced Structural Materials	3
MTEN 707	Materials for Oil and Gas Engineering	3
BME 701	Advanced Regenerative Engineering	3
BME 703	Advanced Biomaterials for Health Care Delivery	3

Second Semester		**Credits**
Core Courses		
FAEN 702	Advanced Project Management and Quality Control	3

FAEN 704	Industrial Attachment	3
Elective Courses	**(At least one elective to be selected)**	
MTEN 702	Special Topics in Materials Science and Engineering	3
MTEN 704	Materials for Energy Storage	3
MTEN 706	Advanced Sustainable Materials	3
MTEN 708	Micro and Nanomaterials	3
MTEN 710	Seminar 1	3
MTEN 720	Seminar 2	3
MTEN 730	Seminar 3	3
MTEN 740	Seminar 4	3
MTEN 700	PhD Thesis	45

6.0. COURSE DESCRIPTIONS

FAEN 701: Advanced Research Methods and Analysis

The course will provide students with more specialized knowledge and skills for designing quantitative research at the doctoral level, including understanding multivariate data analysis and applying more advanced statistical concepts. The topics covered include: Exploration of classical quantitative research designs and common statistical tests; importance of quality assurance and ethical and social change implications of conducting quantitative research and producing knowledge; statistical analysis from problem-solving perspective with emphasis on selecting appropriate statistical tests for research design; use of software to calculate statistics and interpret and present results.

FAEN 702: Advanced Project Management and Quality Control

This course covers such topics as avoiding mistakes when executing and controlling a project, dealing with evolving stakeholder expectations, using trend analysis to measure project. Some other topics to deal with include project selection and initiation, project execution methodology, project variance and control as well as project closure and learning. Advanced and newly developed quality control and improvement methods such as modified and acceptance charts,

multiple stream process control, control charts with adaptive sampling and engineering process control for quality, international standards of acceptance sampling, economic design and implications of quality control and improvement procedures will be dealt in details. Quality policies and objectives will also be treated.

MTEN 700: PhD Thesis

The doctoral thesis involves a candidate working closely under the guidance of a supervisor(s) in the Department to investigate an approved original project idea from the candidate's preferred field of specialization, and writing a thesis. The investigation will include a comprehensive review of related works reported in scholarly articles, formulation and development of necessary concepts, implementation, testing, study of the implications of work and potential application. The thesis will be evaluated based either on its academic contribution and advancement to knowledge or contribution to the relevant industrial application. The contributions and results from the research work will be synthesized and compiled into publication-quality research papers.

MTEN 701: Advanced Seminar in Materials Science and Engineering

Students are required to complete guided thematic topical areas that are relevant to their research interest within the focal areas of the department. These include: Biomaterials, Materials for Energy and the Environment, Sustainable/Structural Materials.

MTEN 702: Special Topics in Materials Science and Engineering

In this course guided thematic topics that are relevant to materials science and engineering in the form of case studies will be addressed pulling together all necessary theoretical concepts. It will focus on the three specialized areas: Biomaterials, Materials for Energy and the environment, Sustainable/Structural Materials.

MTEN 703: Materials for Solar Energy

The course will focus on advance solar energy concepts and challenges in both semi-conductor and organic solar cell systems as well as natural dyes. The advantages and disadvantages of thin film solar and bulk solar technologies will be reviewed and discussed in detail. Case studies will be used to convey concepts of state of the art device fabrication and operation. The course will culminate with a mini research project.

MTEN 704: Materials for Energy Storage

This course focuses on the properties of the different materials used in electrochemical energy storage systems, the benefits and drawbacks of the various materials, and the selection of materials based on a specific application. Topics include electrochemical reactions; anode and cathode materials; electrolyte materials; electrochemical testing of materials; typical responses of

common materials; life testing; unconventional geologic fuels and biofuels; photovoltaic materials and solar energy conversion; materials for future wind energy needs; thermoelectric materials for solid state energy conversion; materials for electrical energy storage; materials for hydrogen production, storage, and use; solid-state lighting materials; and materials challenges in nuclear energy. In addition, trade-offs in material performance are discussed.

MTEN 705: Advanced Structural Materials
This course presents an advance treatment of structural materials and their applications following a brief review of the basic theory of alloy and composite design. The course also present case studies of design of ferrous and non-ferrous materials for engineering applications. The structure and properties of intermetallics and composites are then presented along with recent advances in the understanding of amorphous and nanostructured materials.

MTEN 706: Advanced Sustainable Materials
This course will present advanced concepts and challenges associated with the design and implementation of sustainable materials used in the state of the art green systems. Specific topics will be presented which include the structure and properties of sustainable building materials from earth-based matrices, industrial waste and natural/synthetic fibers. The course will also introduce the application of materials concepts to the remediation of mining and plastic waste and oil and gas spills. Projects will utilize green material concepts and modern software tools to design and evaluate materials systems that address societal needs.

MTEN 707: Materials for Oil and Gas engineering
This course presents materials concepts that are required for robust operations of oil and gas engineering structures and components. These include: the corrosion and erosion of pipe line structures; fracture mechanics modelling of the fracture and fatigue behaviour of pipe lines and offshore structures; welded structures and components and non-destructive evaluation of oil and gas structures. The course will include case studies of the applications of these concepts in the oil and gas industry.

MTEN 708: Micro and Nanomaterials
Course covers advanced micro and nanomaterials critical to health delivery, green energy harvesting and sustainable systems necessary address societal needs. Concepts associated with size scale physical phenomena, nanoscale material fabrication and their implementation. e.g., nano magnetic particles for imaging, gold nano particles for detecting diseased cells, nanoscale clusters for plasmonic and cloaking applications, carbon nanotubes for energy catalysis and layered structures for energy or hydrogen storage.

BME 701 Advanced Regenerative Engineering/nanotechnology
This course focuses on concepts of scaffolds in regenerative engineering. The criteria for using different scaffolds in a variety of application areas would be discussed. This includes nano, micro and macro encapsulation of cells, in-situ polymerization and implantable gels, micro and macroporous scaffolds in the delivery of bioactive molecules. The course will also cover some scaffold materials.

BME 703 Advanced Biomaterials for Health Care Delivery

The course will treat modern concepts relating to glassy, rubbery and organized states of bulk polymers. Solid-state structure, dynamics, and mechanical properties of non-crystalline and semi-crystalline polymers will be considered. It will also consider polymer viscoelasticity, diffusion, failure mechanism, and elementary polymer rheology. A review of the principal experimental methods used to reveal the microstructure and chemistry of materials.

MTEN 710: Seminar 1

The PhD Seminar I will focus on the development of candidate skills to do research in their respective discipline by making presentations on topics of interest in the international materials community. Scholarly articles and books will be reviewed by the students to develop a proper understanding of the subject matter before making the presentation that brings out problem identification, methodology, analysis and the importance and or significance of knowledge advancement of the subject matter in society.

MTEN 720: Seminar 2

The experiential learning will involve industrial placement for students to appreciate materials engineering activities in real life. Candidates will be assigned work on a peculiar materials engineering problem and to prescribe solution. It is considered essential as it links theory and practice. A Departmental supervisor, in consultation with the industry supervisor and the candidate, is responsible for maintaining the academic quality of the Industrial Attachment. The internship is to cover a period of one academic year.

MTEN 730: Seminar 3

During the middle part of the second semester of the third year, the candidate will also be required to give progress report on the research work in a seminar. It is mandatory for candidates to participate in Departmental seminars and workshops.

MTEN 740: Seminar 4

This course focuses on the candidate's research work. Progress on research activities will be evaluated and preliminary findings presented and discussed. Candidates are also required to participate in Departmental seminars and workshops.

7.0. Details of Experiential Research Learning

During the course of the PhD programme candidates will be required to undertake attachment either at the industry, work with some professors on specific projects or visit partner universities/laboratories to participate in selected programmes/research that are of mutual benefit and capable of leading to the acquisition of special skills. Such areas as hands on training in the use of specialized equipment for microstructural analysis, novel chemical methods in materials synthesis will be key in this regard. Students will be guided in the choice of the attachment programme in order to ensure effective monitoring.

Participation in Research Projects

In addition to the wide-ranging activities outlined above, students will be engaged in on-going projects in the department.