DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING
OBAFEMI AWOLOWO UNIVERSITY, ILE-IFE

POSTGRADUATE PROGRAMMES

2015/16

COMPUTER SCIENCE

SECTION 1: ADMISSION REQUIREMENTS

1.1. For the Master of Science (M.Sc.) *Computer Science*:

a. Holders of a Bachelor's degree in Computer Science or Computer Engineering with at least Second Class (Lower division) or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

b. Candidates holding a Postgraduate Diploma in Computer Science, with a minimum weighted grade point of 60B+ or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

1.2. For the Master of Philosophy (MPhil.) *Computer Science*:

a. A bachelor's degree with a minimum of Second Class (Upper division) or equivalent, in Computer Science, Computer Engineering, Electronic Engineering or any other recognized equivalent discipline;

b. Candidates with M.Sc. by research degree in Computer Science, Computer Engineering or any other recognized equivalent discipline with a cumulative weighted average less than 60B+;

1.3. For the Doctor of Philosophy (Ph.D.) *Computer Science*:

a. Candidates with a Masters by research degree with a least a 60B+ average from an institution recognized by the Obafemi Awolowo University Senate;

b. Candidates on the MPhil Programme with an appreciable levels of research aptitude can transfer to the Ph.D. programme.

SECTION 2: COURSE CONTENT

(a) (i) List of Core/Compulsory Courses

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CSC 601	Special Topics in Computing Systems	2	✓	✓
CSE 601	Research Methodology in Computer Science & Engineering	3	✓	✓
CPE 601	Advanced Modelling & Simulation	2	✓	✓
CIS 601	Information Theory and Coding	2	✓	✓

(a) (ii) Computer Science Courses

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CSC 610	Advanced Computer Graphics	3	✓	✓
CSC 611	Advanced Multimedia Systems	3	✓	✓
CSC 612	Parallel Computing Systems	3	✓	✓
CSC 613	Advanced Multi-agent Systems	3	✓	✓
CSC 614	Advanced Numerical Computations	3	✓	✓
CSC 615	Advanced Automata Theory	3	✓	✓
CSC 616	Theory of Computation and Complexity	3	✓	✓
CSC 617	Theory of Programming Languages	3	✓	✓
CSC 618	Discrete Mathematics and Computations	3	✓	✓
CSC 619	Principles of Operating System Design	3	✓	✓
CSC 620	Advanced Compiler Design	3	✓	✓
CSC 621	Advanced Data Warehousing	3	✓	✓
CSC 622	Decision Support System	3	✓	✓

(b) The Course Contents are as provided below:

(i) Core/Compulsory Courses

CSC 601: Special Topics in Computing (2 Units)

Special topics in computing systems including areas such as: Emerging issues in computing, Current application and trends; Current research debates.

CSE 601: Research Methodology in Computer Science and Engineering (3 units)

Review of current literature in several areas of Computer Science & Engineering. Major categories, techniques, and processes of doing research in Computer Science and Engineering. Design and use of experimental methods in Computer Science and Engineering research. Overview of surveys, testing, comparisons, case studies, experimenting and prototyping. Information retrieval, formulation of aims for a research project, formulation of scientific problems and hypotheses, selection of methods for solving a scientific problem, qualitative and quantitative research methods, statistical analysis. Overview of Research ethics. Implement a small research project in an area of Computer Science and Engineering. Research findings presentation and reporting.

CPE 601: Advanced Modelling and Simulation (2 units)

Introduction to Systems modelling concepts, continuous and discrete formalisms. Constructing a model, type of model. Framework for simulation and modelling, modelling formalisms and their simulators, discrete time, continuous time, discrete event, process based. Hybrid systems and their simulators. Review of basic probability, probability distributions, estimation, testing of hypotheses. Output analysis, transient behaviour, steady state behaviour of stochastic systems, computing alternative systems, variance reduction techniques. Languages for modelling e.g. Vienna Development Method (VDM), Common Algebraic Specification Language (CASL) and their simulation tools. Model Verification and Validation.

CIS 601: Information Theory and Coding (2 units)

Information; Review of probability theory; Entropy; Mutual information; Data

compression; Huffman coding; Asymptotic equipartition property; Universal source coding; Channel capacity; Differential entropy; Block codes and Convolutional codes; Gaussian Channel

(ii) Computer Science Courses

CSC 610: Advanced Computer Graphics (3 units)
This course will be a hands-on class on advanced computer graphics. It will cover major aspects of digital image generation: geometric modelling, computer animation, and rendering. The goal of the course is to provide a strong foundation for computer graphics principles, and provide a hands-on introduction to recent advanced topics, e.g., subdivision surfaces, real-time global illumination, and physically based animation. Light/object interaction, Geometric object representation; multi-resolution modelling, Deformation modelling, Topics in computer animation and physically based modelling, Texture and environment mapping, Ray tracing, Radiosity, Global illumination and Advanced real-time rendering.

CSC 611: Advanced Multimedia Systems (3 units)
This course lays the foundation for graduate students to build advanced multimedia computing applications comprising of images, videos, and audio. The module covers the important multimedia computing methods by presenting a comprehensive coverage of the underlying content processing, content transformation and resource optimization techniques in a variety of systems such as multimedia information retrieval, conferencing, surveillance and security. By considering the research issues in the multimedia systems areas, it will also prepare the student in formulating novel approaches for future multimedia computing applications. Introduction to Multimedia Computing :Motivation; Fundamentals of Multimedia Computing; Image, Video and Audio Compression Overview; Intro to Information Retrieval: Boolean and Vector Space Models; Relevance Feedback; Latent Semantic Analysis; Content-based Retrieval: Image Retrieval; Video Retrieval; Audio retrieval; Tagging; Multimedia Content Processing: Multi-modal Data Fusion; Visual Attention Experiential Sampling; Multimedia Summarization: Video Summarization; Multimedia Simplification Multi-media Surveillance: Background Modelling; Object Tracking; Use of Multiple Sensors Multimedia Security: Watermarking; Forensics; Computational Multimedia Advertisement: Computational Advertisement Frame-work; Multimedia Analysis for Ad Placement; Current Issues & Trends

CSC 612: Parallel Computing Systems (3 units)
Advances of technologies and system architectures for parallel and distributed computing Components and organization of high speed interconnects; Parallel computing algorithms and representative programming models; Cloud computing and its prevalence; Convergence of parallel, distributed and cloud computing; Performance modelling and system evaluation

CSC 613: Advanced Multi-agent Systems (3 units)

Modelling of agents; properties of multi-agent systems; communication between agents; interaction and cooperation concepts; forming and maintaining organizations; competitive agent environments; learning in multi-agent systems; example systems.

CSC 614: Advanced Numerical Computations (3 units)
Investigation of numerical and mathematical methods under-ling sophisticated computational processes. Algorithms for linear and non-linear systems of equations. Numerical methods for initial and boundary value problems in ordinary differential equations. Stability of multi-step methods.

CSC 615: Advanced Automata Theory (3 units)
Finite State Automata: Review of algorithms relevant to deterministic and nondeterministic finite automata Kleenes Theorem, Myhill Nerode Theorem, Pumping Theorem, Closure and decidability properties of regular languages, Markov models and hidden Markov models Proof that natural languages are not regular, Push down Automata and Context Free Grammars Review of algorithms relevant to deterministic and non-deterministic push down automata Context Free grammars, Derivations and derivation (parse) trees, Right linear and left linear grammars and regular languages, Equivalence of Push down Automata and Context Free Gram-mars Non-equivalence of deterministic and non-deterministic push down automata, Closure and decidability properties of context free languages, Pumping theorem, Parikh's Theorem Applications to natural languages and programming languages, Turing Machines, Decidable and semi-decidable languages, Turing machines as computers of functions, Equivalent formulations of Turing machines, The Universal Turing machine, Unsolvability of the Halting Problem for Turing machines, Other unsolvable problems reductions to the Halting Problem, Closure properties of the decidable and semi decidable languages, Unrestricted grammars generation of semi decidable languages. Linear Bounded Automata, P and NP, NP-completeness and the Cook-Levin Theorem, Reduction in complexity proofs and Other NP-complete problems.

CSC 616: Theory of Computation and Complexity (3 units)

Part One: Computability Theory – Turing Machines; Decidable and undecidable problems, the undecidability of the halting problem; Reducibility, Rice's theorem; Appendix – Advanced topics in computability theory: The recursion theorem, decidability of logical theories.

Part Two: Complexity Theory – Time complexity, the classes P and NP; NP-completeness, the Cook-Levin theorem, polynomial time reducibility; Space complexity, the class PSPACE, the classes L and NL, NL-completeness; Hierarchy theorems; Advanced topics in complexity theory: approximation algorithms for NP-hard problems, probabilistic algorithms, the class BPP, primality testing.

CSC 617: Theory of Programming languages (3 units)
The Concept of language. The fundamentals of grammar and the Chomsky hierarchy. Language types and format. Programming language design concepts. Programming

language structures. Formal definition languages; operational and formal semantic models; equivalence of semantic models; formal properties of programming languages. Characteristics of language paradigms, abstraction, scoping rules, data typing, parameter passing, control structures, and memory allocation

CSC 618: Discrete Mathematics and Computation (3 units)
Logic: propositional logic, logical equivalence, predicates & quantifiers, and logical reasoning. Sets: basics, set operations .Functions: one-to-one, onto, inverse, composition, graphs. Integers: greatest common divisor, Euclidean algorithm. Sequences and Summations Mathematical reasoning: Proof strategies, Mathematical Induction, Recursive definitions, Structural Induction. Relations: properties, Combining relations, Closures, Equivalence, partial ordering. Counting: basic rules, Pigeon hall principle, Permutations and combinations, Binomial coefficients and Pascal triangle. Probability: Discrete probability. Expected values and variance

CSC 619: Principle of Operating System Design (3 units)
Distributed Operating System: Architectures of distributed sys-tem, Issues in designing a distributed operating system. Communication Networks, Message Passing, Remote procedure call. Synchronization mechanisms in distributed operating system Distributed scheduling. Distributed Shared Memory. Distributed File Systems. Basic idea of Recovery, Fault tolerance and Security

CSC 620: Advanced Compiler Design (3 units)
Introduction to Compiling: Compilers, Phases of a compiler, Compiler construction tools, a simple one pass compiler. Lexical Analysis: Role of a Lexical analyzer, input buffering, specification and recognition of tokens, finite automata implications, designing a lexical analyser generator. Syntax Analysis: Role of Parser, Writing grammars for con-text free environments, Top-down parsing, Recursive descent and predictive parsers (LL), Bottom-Up parsing, Operator precedence parsing, LR, SLR and LALR parsers. Syntax Directed Translation: Syntax directed definitions, construction of syntax tree, Bottom-up evaluation of S-attributed definitions, L-attributed definitions, Top-down translation and Bottom-up evaluation of inherited attributes, analysis of syntax directed definitions. Intermediate Code Generation: Intermediate languages, declarations, assignment statements and Boolean expressions, case statements, back patching, procedure calls. Code Generation: Issues in design of a code generator and target machine, Run time storage management, code generation from Dags and the dynamic code generation algorithm. Code Optimization: Sources of optimization, Data flow analysis and equations, code improving transformation and aliases, Data flow analysis and algorithms, symbolic debugging of optimized code.

CSC 621: Advanced Data warehousing (3 units)
Introduction to Business Intelligence and Corporate Information to the Corporate Information Factory; The Data warehouse component; The external world component; Introduction to Dimensional Modelling; Multidimensional Model; Data warehouse requirements; Basic dimensional modelling techniques; Advanced Dimensional Modelling; Star and snowflake schemas; extended dimension table designs; extended fact

table designs; Building Dimensional Models; Data warehouse management; Data warehouse bus architecture matrix; Managing the dimensional project; Implementation of the data warehouse component; Aggregation goals and risks; Aggregation development; Aggregation navigation; Physical design, Indexing, Physical storage; Standards; Indexing and Physical storage; Standards; Indexing and Physical storage structure ; Data extraction, transformation and loading (ETL); Operational Data Store; Data Staging and ETL Strategies; End User applications and online analytical processing; The application component; Decision support; Data warehouse life cycle and project management; Development and maintenance process; The business dimensional life cycle; Data warehouse project management and data warehouse processes; Data warehouse architectures and back room functions; Back room Functions and Architecture; Data storage; Managing the corporate information factory; Enterprise framework; Infrastructure and Meta data; Meta data repositories, security; Data ware-house infrastructure and environment security; Data warehouse meta data

CSC 622: Decision Support Systems (3 Unit)
Expertise: characteristics of Decision Support Systems (DSS), separating of knowledge and inference, knowledge elicitation, knowledge representation, explanation system; knowledge refinement; expertise and knowledge. The Decision Making Process; Approaches to DSS development; DSS Software Tools; DSS Hardware and Operating system platforms; Open source for Building and Implementing Decision Support Systems;

COMPUTER ENGINEERING

SECTION 2: ADMISSION REQUIREMENTS

2.1 The Master of Science (M.Sc) Computer Engineering Entry Requirements

For the Master of Science in Computer Engineering, the following entry requirements apply:

(a) Holders of a Bachelor's degree in Computer Science or Computer Engineering with at least Second Class (Lower division) or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

(b) Candidates holding a Postgraduate Diploma in Computer Science, with a minimum weighted grade point of 60B+ or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

2.2 The Master of Philosophy (M.Phil) Computer Engineering Entry Requirements

The minimum requirement for admission into the MPhil programme in Computer Engineering is:

a. A bachelor's degree with a minimum of Second Class (Upper division) or equivalent, in Computer Science, Computer Engineering, Electronic Engineering or any other recognized equivalent discipline;

b. Candidates with M.Sc. by research degree in Computer Science, Computer Engineering or any other recognized equivalent discipline with a cumulative weighted average less than 60B+;

2.3 The Doctor of Philosophy (Ph.D) Computer Engineering Entry Requirements

The minimum requirement for admission into the PhD programme in Computer Engineering is:

a. Candidates with a Masters by research degree with a least a 60B+ average from an institution recognized by the Obafemi Awolowo University Senate;

b. Candidates on the MPhil Programme with an appreciable levels of research aptitude can transfer to the Ph.D. programme.

SECTION 7: COURSE CONTENT

(a) List of Compulsory Courses Data

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CSC 601	Special Topics in Computing Systems	2	✓	✓
CSE 601	Research Methodology in Computer Science & Engineering	3	✓	✓
CPE 601	Advanced Modelling & Simulation	2	✓	✓
CIS 601	Information Theory and Coding	2	✓	✓

(b) List of Specific Courses Data

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CPE 602	Advanced Engineering systems analysis and design	3	✓	✓
CPE 610	Advanced Multiprocessor System	3	✓	✓
CPE 611	Advanced Digital Systems Design	3	✓	✓
CPE 612	Principles of Embedded computing System	3	✓	✓
CPE 613	Digital Signal Processing Systems	3	✓	✓
CPE 614	Advanced Computer Architecture	3	✓	✓
CPE 615	Distributed Systems Architecture	3	✓	✓
CPE 616	Advanced Digital Communications	3	✓	✓
CPE 617	Wireless and Mobile Systems Technologies	3	✓	✓
CPE 618	Computer Systems and Network Security	3	✓	✓
CPE 619	Satellite and Optical Communications	3	✓	✓
CPE 620	Wireless Sensor Networks	3	✓	✓
CPE 621	Deployment and Applications of Wireless Sensor Networks	3	✓	✓
CPE 622		3	✓	✓

CPE 601: Advanced Modelling and Simulation (2 units)
Introduction to Systems modelling concepts, continuous and discrete formalisms. Constructing a model, type of model. Framework for simulation and modelling, modelling formalisms and their simulators, discrete time, continuous time, discrete event, process based. Hybrid systems and their simulators. Review of basic probability, probability distributions, estimation, testing of hypotheses. Output analysis, transient behaviour, steady state behaviour of stochastic systems, computing alternative systems, variance reduction techniques. Languages for modelling e.g. VDM, CASL and their simulation tools. Model Verification and Validation

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CPE 602: Advanced Engineering Systems Analysis and Design
Engineering systems features, attributes and parameters. Design concepts in engineering system. Components and structure of engineering systems. Analysis of complex engineering systems. Documentation of engineering systems; definitive, accurate, complete and precise

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CPE 610: Advanced Multiprocessor System (3 Units)
Overview of Computer Architecture. Flynns Taxonomy of Computer Architecture Basic computer organization: CPU organization: Micro programmed control: Control memory, Memory organization, Input-output organization: direct memory access (DMA), introduction to multiprocessor system. SIMD Architecture, MIMD Architecture Introduction to Advanced Computer Architecture, Multiprocessors Interconnection Networks, Inter-connection Networks Taxonomy, Performance Analysis of Multiprocessor Architecture. Shared Memory Architecture, Message Passing Architecture. Abstract Models. The PRAM Model and Its Variations. Simulating Multiple Accesses on an EREW PRAM.

CPE611: Advanced Digital Systems Design (3 Units)
Overview of logic design concepts, Examine in details the design methodologies for complex digital systems, including the use of high-level de-sign languages for rapid development; hardware description languages and tools; FPGA based designs; computer arithmetic in digital systems; energy efficient architectures; signal integrity and clock event horizons. Design for production test strategies will also be examined, including: test structures; automated testing techniques; test coverage and economics of testing; enhancing testability, structured design techniques, scan based design and built in self-test. The course will include a substantial design exercise covering a typical FPGA design flow, including design entry using high level hardware description languages, functional simulation and verification, synthesis, structural simulation and verification, place and route, and target mapping, using the latest commercial FPGA design tools.

CPE 612: Principles of Embedded Computing Systems (3 units)
The course examines programmable devices, microcontrollers, application specific standard processors; importance of interrupts; reconfigurable logic; system-on-a-chip; finite state machines; dataflow architectures; and distributed embedded systems. Software for embedded systems, including: programming languages and software architectures; interrupt servicing; multi-tasking; task communications and scheduling; verification; hardware-software co-simulation; and real-time operating systems. The course will also review design methodologies, including: techniques for specification; formal models and specification languages for capturing system behaviour; unified modelling frameworks; design analysis; optimisation and implementation; system verification; rapid prototyping; IP-based designs; hardware-software co-design; and

quality & performance metrics.

CPE613: Digital Signal Processing Systems

Introduction to digital signal processing algorithms and to hardware related implementation issues. An introduction to signals and systems, including: sampling techniques, aliasing, line spectra, symmetry, anti-alias filters; discrete time systems; FIR and IIR filters; windowing techniques, frequency transformations, auto- and cross-correlation; Fast Fourier Transform (FFT), decimation, twiddle functions and butterflies (DIF & DIT) and an introduction to stochastic signal processing techniques. The course will then examine implementation issues, including: hardware and software structures for FFT implementation and FFT processing rates. It will also examine hardware issues, including: DSP processors; organization, programming model, and on-chip concurrency; MAC units; pipelining; addressing modes; application specific features such as short/long interrupts, hardware do loops, etc.; dedicated architectures vs. programmable DSPs; multi-DSP implementations; and development tools. Case studies of a number of signal processing implementations will be examined. DSP algorithms used in Wireless Communication Systems. Designing real-time embedded systems for wireless communications using different design methodologies and advanced arithmetic techniques suitable for DSP and FPGA implementation. A range of DSP algorithms and applications will be studied and analyzed such as FFT, CDMA, DWT, FIR filters.

CPE 614: Advanced Computer Architecture (3 units)

Basic principles and techniques in parallel computer architecture. Topic include characteristics of ~~parallel processing; parallel computing models and algorithm features; vector~~s processing and vector computers; basic vector architecture, memory structure and cache coherence: parallel programming issues; novel architecture; data flow computers, massive parallel machines, systolic arrays, future trends. Contemporary work in compiler design and implementation for parallel computer systems such as vector/pipeline machines. Superscaled/superpipelined machine; and SIMD/MIND multiprocessor system. Compiling issues for novel architecture with fine-again parallelism. Compiler paradigms for both imperative and declarative programming languages. Complication methods for parallel machines versus Sequential machines.

CPE 615: Distributed Systems Architecture (3 units)

Topics to be covered in this module include System Architecture (Bus Systems, High Performance I/O, Memory Hierarchies, Memory Coherence and File Coherence), Distributed Database, Processor Architecture, File Services, Inter-Process Communication, Naming Services, Resource Allocation and Scheduling, Distributed System Case Studies. Parallel Computing Paradigms, Parallel Programming with MPI/PVM, Cluster Computing Principles (Condor, Sun Grid Engine), Grid Computing Middleware Components (Job Submission, Resource Management and Job Scheduling, In-formation Service, Grid Portal, Grid Security Infrastructure), Grid Standards (OGSA/WSRF), Grid Middleware Case Study with Globus.

CPE 616: Advanced Digital Communications (3 units)

Overview of Data Communication. Analogue and Digital Signal pro-cessing. Advanced topics

in digital communication systems. Techniques used in digital communication systems including more advanced topics in digital wireless communication systems. Channel modelling, coding, dig-ital transmission through wireless channels, advanced error control techniques, spread spectrum (DSSS and FHSS), multi-carrier digital transmission (OFDM and MIMO), and their applications in wireless and cellular mobile communication systems.

CPE 617: Advanced Mobile Systems (3 units)

Introduction to Mobile Systems Concepts. Ubiquitous/ Pervasive Computing Concepts. New technologies for mobile communication systems and more advanced concepts in mobile communication systems. Mobile computing and applications, Exploiting Virtual Machines, Resource-Driven Dynamic Adaptation, Fundamental principles of mobile communication systems. Evolution of new technologies in mobile systems. Location and Con-text Awareness Mobile networking protocols (e.g. Mobile IP, Wireless TCP), and wireless multimedia applications. These includes GSM/GPRS/UMTS, multiple access technologies, Typical commercial wireless and mobile net-works (e.g. wireless sensors, WiMAX, UWB, 2G/2.5G, 3G & 4G systems).

CPE 618: Computer Systems and Network Security (3 units)

Security Structure, Security Types, Information Security, OSI Security Architecture, X-800 ISO Security Architecture, Network Protocols, Attack Types: Active and Passive, Security Mechanisms, Authentication, Key Distribution Systems, Encryption Algorithms, Encrypted File Systems-EFS, Routing Protocols, Link Encryption, Attack Types, Buffer Overflow At-tacks. Introduction to the advanced theory of cryptography. Practical techniques and algorithms that are currently important for efficient and secure communication over wireless networks. Security solutions implementation on Wireless Local Area Networks and Metropolitan Area Networks, Mo-bile Telecommunications Networks and Blue tooth-based communications. Analysis and relative merits of the major types of cryptographic algorithms in current use and the contexts in which they are used.

CPE 619: Satellite and Optical Communications (3 units)

Central to these concepts are satellite orbits, link budget analysis, multiplexing techniques, DVB-S, transponders, satellite networks, optical fibres (signal propagation and attenuation), optical sources, photo detectors and optical networks.

CPE 620: Wireless and Mobile Systems Technologies (3 units)

Overview of Mobile Systems. New technologies for mobile communication systems and more advanced concepts in mobile communication systems. Design and operation of wireless networks through concepts, terminologies. Performance analysis and industrial standards. Introduction to models and sub-systems of typical wireless networks (i.e. Wireless Local Area Network and Wireless Telecommunication Networks). Fundamental principles of mobile communication systems. Evolution of new tech-nologies in mobile systems. These includes GSM/GPRS/UMTS, multiple access technologies, cellular systems, multipath fading, ad-hoc networks, mesh networks and an introduction to WLAN and WiMAX. Mobile IP networks.

CPE 621: Wireless Sensor Networks (3 units)

Introduction to sensor networks, Understanding low-power wireless, architectures and technologies. Wireless sensor network platforms, Hardware and Software. Medium Access Control, Operating system designs, Networking, Broadcast and dissemination, Reliable transport, Time sync and localization, Data aggregation, Storage, Tracking, Dealing with sensor data, Programming models, Energy management, Mobile sensing systems, Acoustic sensor networks, Camera-based sensor networks, Underwater sensor networks.

CPE 622: Deployment and Applications of Wireless Sensor Networks (3 units)
Overview of Wireless Sensor Network. Protocols and Services of WSN. Fundamental technology trends, system software design and implementation, and emerging applications areas. The course will expose students to the platforms, tools, and software used for modern Sensor net research. This course will be mainly project based, examining different applications areas of Wireless Sensors Network. Modeling and Simulation of WSN deployment. Students will read and present research papers, participate in discussion and debate, program and deploy wireless sensor nodes, and complete an independent or group research project. Projects may focus on new platform technology, a novel software system, or a new application area. In particular, applications to personal health, energy, and the environment will be emphasized.

INFORMATION SYSTEMS

SECTION 3: ADMISSION REQUIREMENTS

3.1 The Master of Science in Information System

(c) Holders of a Bachelor's degree in Computer Science or Computer Engineering with at least Second Class (Lower division) or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

(d) Candidates holding a Postgraduate Diploma in Computer Science, with a minimum weighted grade point of 60B+ or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

3.2 The Master of Philosophy in Information System

a. A bachelor's degree with a minimum of Second Class (Upper division) or equivalent, in Computer Science, Computer Engineering, Electronic Engineering or any other recognized equivalent discipline;

b. Candidates with M.Sc. by research degree in Computer Science, Computer Engineering or any other recognized equivalent discipline with a cumulative weighted average less than 60B+;

3.3 The Doctor of Philosophy Entry Requirements

a. Candidates with a Masters by research degree with a least a 60B+ average from an institution recognized by the Obafemi Awolowo University Senate;

b. Candidates on the MPhil Programme with an appreciable levels of research aptitude can transfer to the Ph.D. programme.

SECTION 7: COURSE CONTENT

Information Systems

The courses in this option are specifically meant candidates specializing in Information Systems based research. Note that CIS 610 is compulsory for candidates in this option. Candidates are expected to select appropriate courses from those listed in Table 5.

Table 2.4A: Postgraduate Compulsory Courses

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CSC 601	Special Topics in Computing Systems	2	✓	✓
CSE 601	Research Methodology in Computer Science & Engineering	3	✓	✓

CPE 601	Advanced Modelling & Simulation	2	✓	✓
CIS 601	Information Theory and Coding	2	✓	✓

Table 2.4B: Information Systems Courses Data

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CIS 610	Information Systems in Organizations	3	✓	✓
CIS 611	Information Systems Modelling	3	✓	✓
CIS 612	Advanced Operations Research	3	✓	✓
CIS 613	Advanced Information Storage and Retrieval	3	✓	✓
CIS 614	Software Project Management	3	✓	✓
CIS 615	Informatics	3	✓	✓
CIS 616	Fundamentals of Electronic Commerce	3	✓	✓
CIS 617	Software Theory of Geo-Informatics Systems	3	✓	✓
CIS 618	Human Computer Interaction	3	✓	✓
CIS 619	Content Management Systems	3	✓	✓
CIS 620	Management Support Systems	3	✓	✓
CIS 621	Distributed Database Systems	3	✓	✓
CIS 622	Information Requirements and Databases	3	✓	✓

Add content for compulsory course
Information Systems Courses

CPE 601: Advanced Modelling and Simulation (2 units)
Introduction to Systems modelling concepts, continuous and discrete formalisms. Constructing a model, type of model. Framework for simulation and modelling, modelling formalisms and their simulators, discrete time, continuous time, discrete event, process based. Hybrid systems and their simulators. Review of basic probability, probability distributions, estimation, testing of hypotheses. Output analysis, transient behaviour, steady state behaviour of stochastic systems, computing alternative systems, variance reduction techniques. Languages for modelling e.g. Vienna Development Method (VDM), Common Algebraic Specification Language (CASL) and their simulation tools. Model Verification and Validation.

CSC 601: Special Topics in Computing

CSE 601: Research Methodology in Computer Science and Engineering (3 units)

Review of current literature in several areas of Computer Science & Engineering. Major categories, techniques, and processes of doing research in Computer Science and Engineering. Design and use of experimental methods in Computer Science and Engineering research. Overview of surveys, testing, comparisons, case studies, experimenting and prototyping. Information retrieval, formulation of aims for a research project, formulation of scientific problems and hypotheses, selection of methods for solving a scientific problem, qualitative and quantitative research methods, statistical analysis. Overview of Research ethics. Implement a small research project in an area of Computer Science and Engineering. Research findings presentation and reporting.

CIS 601: Information Theory and Coding (2 units)

Information; Review of probability theory; Entropy; Mutual information; Data compression; Huffman coding; Asymptotic equipartition property; Universal source coding; Channel capacity; Differential entropy; Block codes and Convolutional codes; Gaussian Channel

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CIS 610: Information Systems in Organisations (3 units)

Basic concepts in system theory, business analysis, system design; computer operations, including architecture, operating systems, software, databases, and networks; applications in organisations, including enterprise-wide systems, decision support systems, e-learning, intelligent systems; and issues, including computer security and ethics.

CIS 611: Information Systems modelling (3 units)

Introduction to information modelling techniques; soft systems analysis; structured systems analysis methodologies; data flow modelling; entity modelling; prototyping, and object-oriented approaches (RUP and UML).

CIS 612: Advanced Operations Research (3 units)

Review of Modeling; The Geometry of Linear Models; The Simplex Method; Using AMPL/CPLEX; Duality Theory; Sensitivity Analysis; Large-scale Linear Programming; Network Flow Models; Integer Programming Models; Advanced Models and Methods;

Decision theory and techniques. Decision Trees with probabilities. Inventory problems. Sequencing models. Computational complexity of sequencing problems.

CIS 613: Advanced Information Storage and Retrieval (3 units)

Dictionary and Postings; Tolerant retrieval; Index construction; Index construction; Index compression; Parametric and field searches; Scoring documents: zone weighting and Term weighting; Vector space retrieval; Evaluation; Query Expansion

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CIS 614: Software Project Management (3 units)

Introduction to PM and SPM; Software models and process improvement; Project planning, scheduling, estimation; Personnel and project organization; Change management, monitoring & control; Protocols and standards; Software QA and risk management

INTELLIGENT SYSTEM ENGINEERING

SECTION 4: ADMISSION REQUIREMENTS

4.1 The Master of Science Entry Requirements in Intelligent System Engineering

(a) Holders of a Bachelor's degree in Computer Science or Computer Engineering with at least Second Class (Lower division) or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

(b) Candidates holding a Postgraduate Diploma in Computer Science, with a minimum weighted grade point of 60B+ or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

4.2 The Master of Philosophy Entry Requirements in Intelligent System Engineering

a. A bachelor's degree with a minimum of Second Class (Upper division) or equivalent, in Computer Science, Computer Engineering, Electronic Engineering or any other recognized equivalent discipline;

b. Candidates with M.Sc. by research degree in Computer Science, Computer Engineering or any other recognized equivalent discipline with a cumulative weighted average less than 60B+;

4.3 The Doctor of Philosophy Entry Requirements

a. Candidates with a Masters by research degree with a least a 60B+ average from an institution recognized by the Obafemi Awolowo University Senate;

b. Candidates on the MPhil Programme with an appreciable levels of research aptitude can transfer to the Ph.D. programme.

SECTION 7: COURSE CONTENT

a. **TABLE 2.4a:** General Compulsory Courses

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CSC 601	Special Topics in Computing Systems	2	✓	✓
CSE 601	Research Methodology in Computer Science & Engineering	3	✓	✓
CPE 601	Advanced Modelling & Simulation	2	✓	✓
CIS 601	Information Theory and Coding	2	✓	✓

TABLE 2.4b: Intelligent Systems Engineering Courses

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CIE 610	Information Theories of Intelligent Systems	3	✓	✓
CIE 611	Introduction to Robotics and Motion Planning	3	✓	✓
CIE 612	Human Language Processing & Applications	3	✓	✓
CIE 613	Applied Bio-Informatics	3	✓	✓
CIE 614	Formal Logic in Intelligence System	3	✓	✓
CIE 615	Soft-computing and Applications	3	✓	✓
CIE 616	Theories and Concepts of Computing in African Culture	3	✓	✓
CIE 617	Computational Linguistics	3	✓	✓
CIE 618	Knowledge Engineering	3	✓	✓
CIE 619	Games Theories and Applications	3	✓	✓
CIE 620	Speech and Language Technologies	3	✓	✓

b. List content provided in the BMAS but which is not included in the curriculum of the proposed programme:

CSC 601: Special Topics in Computing Systems

CSE 601: Research Methodology in Computer Science and Engineering (3 units)
Review of current literature in several areas of Computer Science & Engineering. Major categories, techniques, and processes of doing research in Computer Science and Engineering. Design and use of experimental methods in Computer Science and Engineering research. Overview of surveys, testing, comparisons, case studies, experimenting and prototyping. Information retrieval, formulation of aims for a research

project, formulation of scientific problems and hypotheses, selection of methods for solving a scientific problem, qualitative and quantitative research methods, statistical analysis. Overview of Research ethics. Implement a small research project in an area of Computer Science and Engineering. Research findings presentation and reporting.

CPE 601: Advanced Modelling and Simulation (2 units)
Introduction to Systems modelling concepts, continuous and discrete formalisms. Constructing a model, type of model. Framework for simulation and modelling, modelling formalisms and their simulators, discrete time, continuous time, discrete event, process based. Hybrid systems and their simulators. Review of basic probability, probability distributions, estimation, testing of hypotheses. Output analysis, transient behaviour, steady state behaviour of stochastic systems, computing alternative systems, variance reduction techniques. Languages for modelling e.g. Vienna Development Method (VDM), Common Algebraic Specification Language (CASL) and their simulation tools. Model Verification and Validation.

CIS 601: Information Theory and Coding (2 units)
Information; Review of probability theory; Entropy; Mutual information; Data compression; Huffman coding; Asymptotic equipartition property; Universal source coding; Channel capacity; Differential entropy; Block codes and Convolutional codes; Gaussian Channel

CIE 610: Fundamentals of Intelligent Systems Engineering (3 units)
Introduction to Artificial Intelligence (AI): intelligence, some characteristics; classical AI examples; the Turing test. The potentials and danger of the AI approach. Problems solving: problem expression, generate and test methods with optimisations; state space problems. Search methods: local vs. global information; heuristic search. The principles and practices of artificial intelligence. Issues in intelligent systems engineering, constraint satisfaction, knowledge representation, machine learning, robotics and natural-language processing. Conceptual dependency (CD) theory, primitive elements; scripts, players, props, events, headers and exceptions; goal and plan directed understanding.

CIE 611: Introduction to Robotics and Motion Planning (3 Unit)

Robotics: Concept and principles of robotic, brief history of robotics, robotic system specification and design. Robot world: Scene construction and recognition, waltz constraint satisfaction algorithm. Planning: viewed as state space search, means-ends heuristics representation; separability interactions, Sussmans anomaly; example worlds, Blocks world, robot world and program synthesis; problems and extensions, monotonic and non-monotonic planning. Learning: rote, trial and error, Pavlovian and history learning by exploration, hill climbing, learning games and programs, credit assignment and term selection problems; linear and non-linear evaluation functions; learning search through operator and concept spaces. Case Study: "Kokoro" the ant.

CIE 612: Human Language Processing and Applications (3 units)
The concept of language as a mechanism for expression and computation. Approaches to language modelling and design. The Chomsky Theory of language. An intensive introduction to the principle and methods of grammatical analysis. The structure of samples from Yoruba, Hausa or Igbo. Essential formal notions and empirical results in grammatical analysis. Central concept of representation ambiguity. Properties of relations and constraints on expression representations. Taxonomy of relations exemplified using African concepts. Formalised grammatical relations, illustrated. Cross-linguistic evidence and considerations. Development of simple applications such as dictionary, natural language parsing, morphological analyser, letter to sound system, tone and intonation models and so on, using the Python Programming language.

CIE 613: Applied Bio-Informatics (3 Units)
Basic concepts of Molecular Biology, Strings, Graphs and Algorithms, Pair-wise and Multiple alignments, Protein Modelling and sequences, In-formation retrieval from biological databases, Database homology Search, DNA Sequence fragment assembly, MSDN (Microbial Strain Data Net-work); Sequence analysis; Secondary Structure predictions; Tertiary Structure predictions; Markov Chain, Hidden Markov Models; Applications in Biotechnology.

CIE 614: Formal Logic in Artificial Intelligence (3 Unit)
Background of classical logic; meta-theorems, theorem proving; advanced adaptations of classical logic used in artificial intelligence - temporal and modal logics, reason maintenance and intentional logic. Formalising concept representation and reasoning. Formal languages for AI systems, CPS, CASL, etc.

CIE 615: Soft Computing and Applications (3 Units)
Fundamentals of soft computing. Definition and concepts of soft computing. Tools in soft computing: Introduction to Artificial Neural Network (ANN): overview of biological Neurosystem, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms-Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms, perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Applications of Artificial Neural Networks. Competitive learning networks, Kohonen self-organizing networks, Hebbian learning; Hopfield Networks, Associative Memories, The boltzman machine; Applications. Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Classical Logic. Genetic algorithms(Gas),Evolution strategies(Es), Evolutionary programming (EP), Genetic Programming (GP), Selecting, crossover, mutation, schema analysis, analysis of selection algorithms; convergence; Markov & other stochastic models. Other Soft computing approaches: Simulated Annealing, Tabu Search, Ant colony based optimisation, etc.

CIE 616: Theories and Concepts of Computing in African Culture (3 Unit)

Explore computing ideas underlying various mental and physical activities across African culture. (i) Concept register, representation and organisation. (ii) Structure in African thoughts e.g. tree, queue, order. (iii) Computations and logic in African culture (iv) Time and Calendar Computations, (v) Computations underlying systems of relationships, (vi) African fractals, (vii) Number systems and Computation in African, (viii) Computations underlying African geometries. (ix) Computations underlying African Divination systems

CIE 617: Computational Linguistics (3 Unit)

Examine computational processes underlying natural language. Use of linguistic knowledge and procedures in implementing computing systems. (i) fundamental principles of Computing and natural languages, (ii) computational lexicography (iii) morphological analysis (iv) natural language parsing and its relation to syntactic theory, lexical classes and lexical semantics, (v) computational ontology, (vi) Corpus linguistics and language resource development. Applications in Speech synthesis, Speech recognition, Language recognition, allophones, dictionary, morphology and rule based letter to sound approaches, stress and intonation. Automatic translation, summarizers, spells checkers, grammar checkers. Mobile speech and language applications development. Hands-on and research components leading to the development of software using Python.

CIE 618: Knowledge Engineering (3 units)

Concepts of integrated artificial intelligence cooperating expert systems, distributed artificial intelligence, time critical artificial intelligence and the construction and analysis of domain dependent specific shells. Advance knowledge engineering methodologies, justification and explanation facilities, learning and verification and validation of the resultant over all expert system will also covered.

CIE 619: Games Theory and Applications (3 Units)

General concepts of games and gaming. Game space; representation game trees. Two persons and multi-player games; games space search methods; minimax/maxmin search; alpha beta search. Zero sum games; Nash equilibrium. Case study of selected African games. Ayo` game model and simulation. Applications of games.

CIE 620: Speech and Language Technologies (3 units)

Speech synthesis, Speech recognition, Language recognition. Speech synthesis, allophones, dictionary, morphology and rule based letter to sound approaches, stress and intonation. Automatic translation, summarizers, spell checkers, grammar checkers. Mobile speech and language applications development.

SOFTWARE ENGINEERING

SECTION 5: ADMISSION REQUIREMENTS

5.1 For the Master of Science (M.Sc.) Software Engineering:

a. Holders of a Bachelor's degree in Computer Science or Computer Engineering with at least Second Class (Lower division) or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

b. Candidates holding a Postgraduate Diploma in Computer Science, with a minimum weighted grade point of 60B+ or an equivalent qualification from an institution recognized by the Obafemi Awolowo University Senate.

5.2 For the Master of Philosophy (MPhil.) Software Engineering:

a. A bachelor's degree with a minimum of Second Class (Upper division) or equivalent, in Computer Science, Computer Engineering, Electronic Engineering or any other recognized equivalent discipline;

b. Candidates with M.Sc. by research degree in Computer Science, Computer Engineering, or any other recognized equivalent discipline with a cumulative weighted average less than 60B+;

5.3 For the Doctor of Philosophy (Ph.D.) Software Engineering:

a. Candidates with a Masters by research degree with a least a 60B+ average from an institution recognized by the Obafemi Awolowo University Senate;

b. Candidates on the MPhil Programme with an appreciable levels of research aptitude can transfer to the Ph.D. programme.

: COURSE CONTENT

(a) Postgraduate Compulsory Courses

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain
CSC 601	Special Topics in Computing Systems	2	✓	✓
CSE 601	Research Methodology in Computer Science & Engineering	3	✓	✓
CPE 601	Advanced Modelling & Simulation	2	✓	✓
CIS 601	Information Theory and Coding	2	✓	✓

(b) List of Software Engineering Courses Data

Course Code	Course Title	Unit	Semester	
			Harmattan	Rain

CSE 602	Advanced Software Systems Analysis and Design	3	✓	✓
CSE 610	Software Maintenance and Reuse	3	✓	✓
CSE 611	Advanced Software Testing	3	✓	✓
CSE 612	Special Topics in Web-based Software	3	✓	✓
CSE 613	Advanced Database Management Concepts	3	✓	✓
CSE 614	Data Mining Techniques	3	✓	✓
CSE 615	Software for Scientific Data and Image Visualization	3	✓	✓
CSE 616	Advanced Topics in Computer Security	3	✓	✓
CSE 617	Object Oriented Software Design & Implementation	3	✓	✓
CSE 618	Formal Methods and Models in Software Engineering	3	✓	✓
CSE 619	Software Engineering Environment	3	✓	✓
CSE 620	Software for Advanced Engineering Systems	3	✓	✓
CSE 621	Open-source Software Architecture	3	✓	✓

Lists of Course Contents

CSC 601: Special Topics in Computing (2 Units)
Special topics in computing systems including areas such as: Emerging issues in computing, Current application and trends; Current research debates.

CPE 601: Advanced Modelling and Simulation (2 units)
Introduction to Systems modelling concepts, continuous and discrete formalisms. Constructing a model, type of model. Framework for simulation and modelling, modelling formalisms and their simulators, discrete time, continuous time, discrete event, process based. Hybrid systems and their simulators. Review of basic probability, probability distributions, estimation, testing of hypotheses. Output analysis, transient behaviour, steady state behaviour of stochastic systems, computing alternative systems, variance reduction techniques. Languages for modelling e.g. Vienna Development Method (VDM), Common Algebraic Specification Language (CASL) and their simulation tools. Model Verification and Validation.

CSE 601: Research Methodology in Computer Science and Engineering (3 units)
Review of current literature in several areas of Computer Science & Engineering. Major categories, techniques, and processes of doing research in Computer Science and Engineering. Design and use of experimental methods in Computer Science and Engineering research. Overview of surveys, testing, comparisons, case studies, experimenting and prototyping. Information retrieval, formulation of aims for a research project, formulation of scientific problems and hypotheses, selection of methods for solving a scientific problem, qualitative and quantitative research methods, statistical analysis. Overview of Research ethics. Implement a

small research project in an area of Computer Science and Engineering. Research findings presentation and reporting.

CIS 601: Information Theory and Coding (2 units)

Information; Review of probability theory; Entropy; Mutual information; Data compression; Huffman coding; Asymptotic equipartition property; Universal source coding; Channel capacity; Differential entropy; Block codes and Convolutional codes; Gaussian Channel

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CSE 602: Advanced Engineering Systems Design and Analysis (3 Units)

Engineering systems features, attributes and parameters. Design concepts in engineering system. Components and structure of engineering systems. Analysis of complex engineering systems. Documentation of engineering systems; definitive, accurate, complete and precise

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CSE 610: Software Maintenance and Reuse (3 Units)

Perfective maintenance, Reuse of software components and patterns, Evolving software systems, Principles of object-oriented analysis and development. Presents issues regarding technologies supporting perfective soft-ware maintenance and reuse. Techniques for the design and development of secured and fault-tolerant programs that mitigate potential security vulnerabilities. Verification of program correctness through the development of sound test plans and the implementation of comprehensive test cases. Creation of programming solutions that use data structures and existing libraries.

CSE 611: Advanced Software Testing (3 Units)
Advanced software test analysis, design, and execution. Definition and execution of tasks required to put a test strategy into action. Analysis of software system, taking into account the user's quality expectations. Evaluation of system requirements as part of formal and informal reviews, using an understanding of a software development domain. Validity determination. Analysis, design, implementation, and executing of tests, using risk considerations to determine the appropriate effort and priority for tests. Re-porting the testing progress and provide necessary evidence to support your evaluations of system quality.

CSE 612: Special Topics in Web-based Software (3 Units)
Advanced topics in specifying, designing, modelling, development, deployment, testing, and maintaining software written as web applications and web services. Web based generation and Web architecture and organization; web relate security and reuse issues.

CSE 613: Advanced Database Management Concepts (3 Units).
Database support for scientific data management. Requirements and properties of scientific databases; data models for statistical and scientific databases; semantic and object-oriented modelling of application do-mains; statistical database query languages and query optimization; advanced logic query languages; and case studies such as the human genome project and Earth orbiting satellite. Studies models and techniques that empower database systems with intelligent and cooperative behaviour, with emphasis on subjects such as knowledge-rich databases, logic databases, epistemological queries, intentional answering, and knowledge discovery. User interfaces, cooperative query interfaces, interactive query constructors, graphical interfaces, and browsers; uncertainty representing, manipulating, and retrieving uncertain, imprecise, or incomplete information; and formulating and interpreting vague or incomplete queries.

CSE 614: Data Mining Techniques (3 Unit)
Introduction to Data mining, knowledge discovery process. Data pre-processing: data cleaning, data integration and transformation, Data reduction, Discretisation and concept hierarchy generation. Data mining technique; Association rule, classification and regression, clustering, Anomaly detection and neural networks. Current trends in data mining

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CSE 615: Software for Scientific Data and Image Visualisation (3 Unit)
Human perception and cognition, introduction to graphics laboratory, elements of graphing data, representation of space-time and vector variables, representation of 3D and higher dimensional data, dynamic graphical methods, and virtual reality. Students required to work on visualization project. Emphasizes software tools on Silicon Graphics workstation, but other workstations and software may be used. Case study examples from variety of disciplines.

CSE 616: Advanced Topics in Computer Security (3 Units)
Introduction to Test Process and Models, Test Planning and Control, Test Analysis and Design, Test Implementation and Execution, Evaluating Exit Criteria and Reporting Test Closure Activities Test Management Documentation, Test Plan Documentation, Templates Test Estimation, Scheduling and Test Planning, Test Progress Monitoring and Control, Business Value of Testing, Outsourced and In sourced Testing. Type of testing: dynamic; static. Testing methods: Equivalence partitioning, Boundary value analysis, Decision tables, Use case tests,

State-based tests, Pairwise tests, Classification trees, Defect-taxonomy tests, Error-guessing tests, Checklist-based tests, Exploratory tests, Software attacks.

CSE 617: Object-Oriented Software Design and Implementation (3 Unit)
Specifications, design patterns, and abstraction techniques, including typing, access control, inheritance, and polymorphism. Students will learn the proper engineering use of techniques such as information hiding, classes, objects, inheritance, exception handling, event-based systems, and concurrency. Construct multiple-file or multiple-module programming solutions that use class hierarchies, inheritance, and polymorphism to reuse existing design and code.

CSE 618: Formal methods and Models in Software Engineering (3 Units)
Safety critical systems standards, formal testing, survey of formal methods used in industry, computational model for reactive systems, specification language: temporal Logic, verification methods for sequential programs: assertional invariants and variants, model checking of finite-state systems: explicit state and symbolic variants, deductive verification, and scaling up: abstraction and (De)composition.

CSE 619: Software Engineering Environment (3 Units)
Definition of a project support environment reference model, the Use of an environment classification model, Information Technology Engineering and Measurement Model, Modelling Software Engineering Environment Capabilities, Applications of an Information Technology Model to Software Engineering Environments, Process enactment within an environment.

CSE 620: Software for Advanced Engineering Systems (3 Units)
How to generate applications from high-level business models to reduce time-to-market and development costs, how to evolve legacy systems and promote business processes in an economy dominated by the need to offer and integrate, on demand, new services, software measurement and quality assurance system re-engineering

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CSE 621: Open source Software Architecture (3 Units)
Open-source culture, avant-garde architectural theory, language theory, spatial design towards a collaborative use of social software, adaptive reuse, and business models for open-source software

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SECTION 6: GRADUATION REQUIREMENT

i) O'level credit requirement for entry to the programme may be deferred (to be passed before graduation or before issuance of degree certificate) for the following subjects (please list them, if any):

- O'level requirement will be as approved for the undergraduate

ii) Minimum number of Earned Credit Hours for graduation: 24 units for M.Sc. and MPhil; 30 units for PhD.

iii) Minimum number of years of graduation: 2 years for M.Sc. and MPhil.; 3 years for PhD

iv) Minimum residency requirement in years, if any: Not Applicable

v) Minimum CGPA for graduation: 50 Weighted Average

vi) Other requirements (please specify):

Submission of a research-based thesis and passing the stipulated oral examination.