



**King Fahd University of Petroleum & Minerals
College of Computer Science and Engineering
Information and Computer Science Department**

BS Program in Software Engineering – Student Guide

September 26, 2021

Table of Contents

1. INTRODUCTION	4
1.1 SOFTWARE ENGINEERING PROGRAM MISSION	4
1.2 SOFTWARE ENGINEERING PROGRAM EDUCATIONAL OBJECTIVES	4
1.3 SOFTWARE ENGINEERING STUDENT OUTCOMES:	4
2. DEGREE REQUIREMENTS.....	5
2.1 DEGREE FLOW CHART	6
2.2 DEGREE PLAN	7
2.3 CONCENTRATION DETAILS	8
3. SUMMARY OF SWE & ICS COURSES	9
3.1 SWE CORE COURSES	9
3.2 CS CORE COURSES.....	9
3.3 SWE/CS ELECTIVE COURSES	9
4. CATALOG DESCRIPTION OF SWE & ICS COURSES	11
4.1 SWE COURSES	11
4.2 ICS COURSES.....	14

Revision History

Date	Version	Description	Author(s)
2021-09-26	5.0	Removed free elective courses from the student guide. Free elective courses are now available as a separate document. Updated elective course list and respective descriptions. Updated CX course details.	Sajjad Mahmood
2021-03-02	4.0	Updated program mission updated new ABET student outcomes (1-7); updated major elective course list & fixed overall formatting issues.	Sajjad Mahmood
2018-9-27	3.3	Revised Free Electives	M Niazi
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2015-5-3	3.3	Updated Free Electives - added MIS 300 and removed GS 220, GS 221 and renumbered GS 423 to GS 342	M Niazi
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2012-10-31	3.1	Added "*" to ICS 343 to show the lab in the pre-requisite chart	M. Alshayeb

1. Introduction

The Department of Information and Computer Science offers a BS in Software Engineering. The current program was revised and approved in April 2008. The program is in full compliance with IEEE/ACM Software Engineering SE2004 guidelines and meets the Engineering Accreditation Criteria (EAC).

1.1 Software Engineering Program Mission

To provide high quality education in software engineering that prepares students for professional careers and postgraduate education with emphasis on application of engineering principles to software development.

1.2 Software Engineering Program Educational Objectives

Graduates of the software engineering program will:

- Be successful in performing the duties of a software engineering related position.
- Be successful in completing an advanced degree program.
- Work as individuals with minimum guidance and as leaders or members in teams.
- Follow appropriate practices within a professional, legal, and ethical framework.
- Maintain currency through self-learning or other professional development.

1.3 Software Engineering Student Outcomes:

The software engineering program enables students to acquire, by the time of graduation, the following learning outcomes:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
6. An ability to develop and conduct appropriate experimentation, analyze, and interpret data, and use engineering judgment to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

2. Degree Requirements

a. General Education Requirements (52 credits)

Basic Science	CHEM 101(4),	PHYS 101(4),	PHYS 102(4)	
Mathematics	MATH 101(4),	MATH 102(4),	MATH 201(3),	
Statistics	STAT 319(3)			
Isla. & Ara. Stu.	IAS 101(2),	IAS 111(2),	IAS 201(2),	IAS 212(2),
	IAS 301(2),	IAS 322(2)		
English	ENGL 101(3),	ENGL 102(3),	ENGL 214(3)	
SE	ISE 307(3)			
Physical Edu.	PE 101(1),	PE 102(1)		

b. Core Requirements (65 credits)

SWE	SWE 205(3),	SWE 215(3),	SWE 312(3),	SWE 316(3),
	SWE 326(3),	SWE 363(3)	SWE 387(3)	SWE 417(3),
	SWE 418(2)			
ICS	ICS 102(3),	ICS 201(4),	ICS 202(4),	ICS 233(4),
	ICS 253(3),	ICS 254(3),	ICS 324(4),	ICS 343(4)
	ICS 353(3),	ICS 431(4)		
COE	COE 202(3)			

c. Elective (15 credits)

SWE/CS Electives	SWE/ICS xxx(3),	SWE/ICS xxx(3),	SWE/ICS xxx(3),
Free Electives	XE xxx(3),	XE xxx(3)	

d. Summer Training (Pass/Fail grade; No credits)

The prerequisites for summer training:

- Student is currently enrolled in the university.
- Student has completed 65 credits or more (including current semester)
- Students has completed or currently doing ENGL 214 and SWE 363.
- Summer training is not in the last semester for the student at the university.

Every student is required to participate in a summer training program of real practical experience, submit a formal written report and make a presentation.

e. Total Requirements

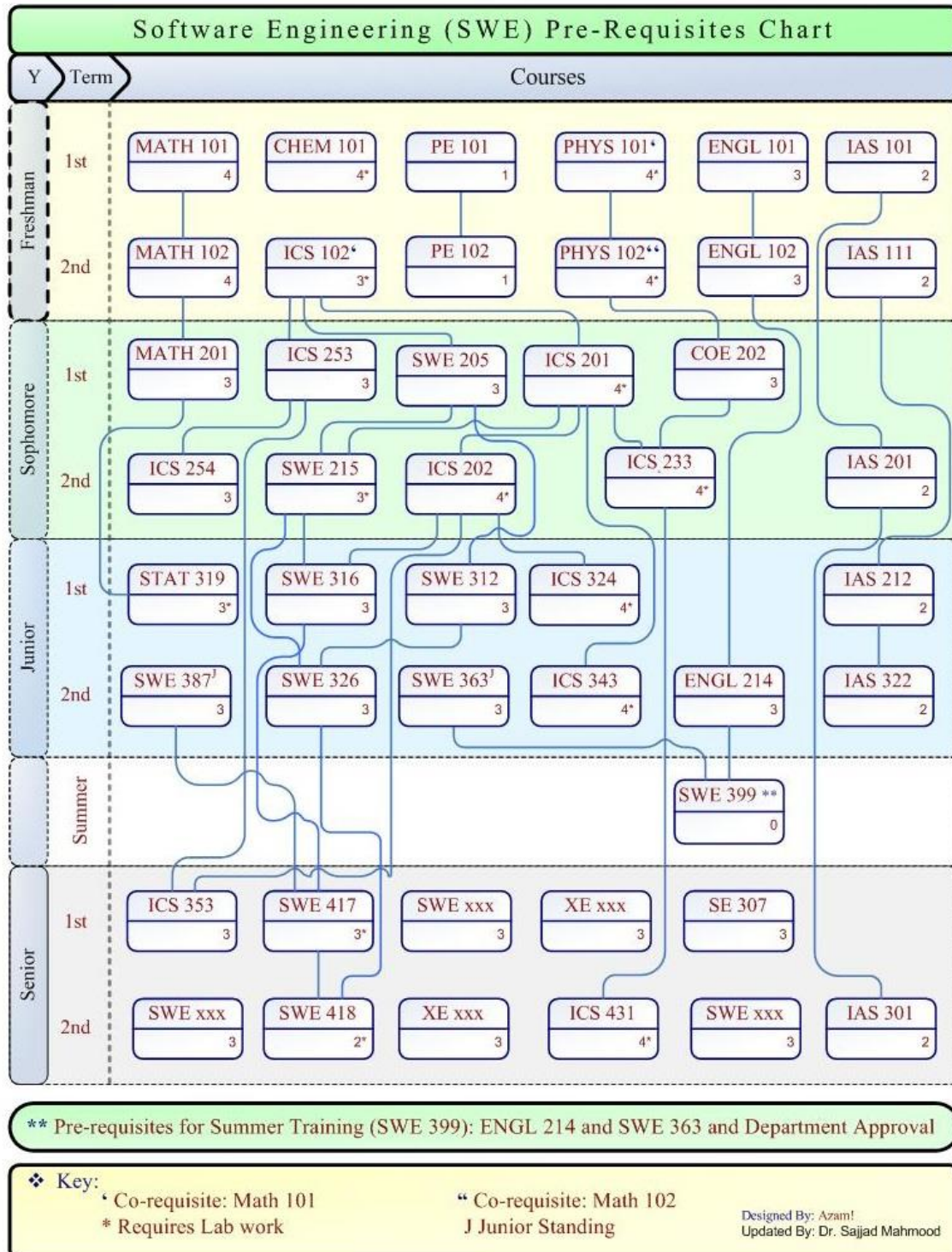
The total required credits for the BS degree in Software Engineering are **132** semester-credit-hours.

2.1 Degree Flow Chart

King Fahd University of Petroleum & Minerals
College of Computer Science & Engineering
Information & Computer Science Department



جامعة الملك فهد للبترول والمعادن
كلية علوم وهندسة الحاسب الآلي
قسم علم الحاسب الآلي والمعلومات



2.2 Degree Plan

Course		Title	LT	LB	CR	Course		Title	LT	LB	CR
First Year (Preparatory)											
ENGL	001	Preparatory English I	15	5	8	ENGL	002	Preparatory English II	15	5	8
MATH	001	Preparatory Math I	3	1	4	MATH	002	Preparatory Math II	3	1	4
ME	003	Preparatory Engg. Tech.	0	2	1	PYP	001	Prep Physical Science	2	0	2
PYP	002	Prep Computer Science	0	2	1	PYP	003	University Study Skill	0	2	1
PE	001	Prep Physical Educ. I	0	2	1	PE	002	Prep Physical Educ. II	0	2	1
			18	12	15				20	10	16
Total Credit required in Preparatory Program: 31											
Second Year (Freshman)											
MATH	101	Calculus I	4	0	4	MATH	102	Calculus II	4	0	4
PHYS	101	General Physics I	3	3	4	PHYS	102	General Physics II	3	3	4
ENGL	101	An Intro to Academic Discourse	3	0	3	ENGL	102	Intro to Report Writing	3	0	3
CHEM	101	General Chemistry I	3	4	4	ICS	102	Intro. To Computing I	2	3	3
IAS	101	Practical Grammar	2	0	2	IAS	111	Belief & its Consequences	2	0	2
PE	101	Physical Education I	0	2	1	PE	102	Physical Education II	0	2	1
			15	9	18				14	8	17
Third Year (Sophomore)											
SWE	205	Introduction to SW Eng.	3	0	3	ICS	202	Data Structures	3	3	4
ICS	201	Intro. To Computing II	3	3	4	SWE	215	SW Requirements Eng.	2	3	3
COE	202	Digital Logic Design	3	0	3	ICS	233	Comp. Arch.& As. Lang	3	3	4
MATH	201	Calculus III	3	0	3	ICS	254	Discrete Structures II	3	0	3
ICS	253	Discrete Structures I	3	0	3	IAS	201	Writing for Prof. Needs	2	0	2
			15	3	16				13	9	16
Fourth Year (Junior)											
SWE	312	User-Interface Design	3	0	3	SWE	326	SW Testing & QA	3	0	3
SWE	316	SW Design and Arch.	3	0	3	SWE	363	Web Eng. & Development	3	0	3
ICS	324	Database Systems	3	3	4	SWE	387	Software Project mgt.	3	0	3
STAT	319	Prob.& Stat. for Engrs	2	3	3	ICS	343	Fund. of Comp NW	3	3	4
IAS	212	Professional Ethics	2	0	2	IAS	322	Human Rights in Islam	2	0	2
						ENGL	214	Academic & Prof Comm	3	0	3
			13	6	15				17	3	18
Fifth Year (Senior)											
SWE	417	SWE Project I	1	6	3	SWE	418	SWE Project II	0	6	2
XE	xxx	(Elective I)	3	0	3	ICS	431	Operating Systems	3	3	4
ICS	353	Design and Anal of Algo.	3	0	3	SWE	xxx	(SWE/ICS Elective II)	3	0	3
ISE	307	Eng. Economics Analysis	3	0	3	SWE	xxx	(SWE/ICS Elective III)	3	0	3
SWE	xxx	(SWE/ICS Elective I)	3	0	3	IAS	301	Oral Comm. Skills	2	0	2
						XE	xxx	(Elective II)	3	0	3
			13	6	15				14	9	17
Total credits required in Degree Program: 132											

2.3 Concentration Details

Students can use their four major elective courses to register in one of the concentrations as follows:

1. Artificial Intelligence and Machine Learning

Course	Title	LT	LB	CR
ICS 471	Artificial Neural Networks & Deep Learning	3	0	3
ICS 485	Machine Learning	3	0	3
ICS 483	Computer Vision	3	0	3
ICS 489	Application of Machine Learning	3	0	3

2. Cyber Security & Blockchain

Course	Title	LT	LB	CR
ICS 440	Cryptography & Blockchain Applications	3	0	3
ICS 442	Pen. Testing & Ethical Hacking	3	0	3
SWE 445	Secure Software Development	3	0	3
COE 426	Data Privacy	3	0	3

3. Computer Networks

Course	Title	LT	LB	CR
ICS 445	Network Management and Security	3	0	3
COE 446	Mobile Computing	3	0	3
COE 453	Cloud and Edge Computing	3	0	3
COE 444	Network Design	3	0	3

4. Internet of Things

Course	Title	LT	LB	CR
COE 450	Introduction to Smart Systems	3	0	3
ICS 474	Big Data Analytics	3	0	3
CISE 464	Industrial Internet of Things Technology	3	0	3
COE 454	Internet of Things	3	0	3

5. Decision Analytics

Course	Title	LT	LB	CR
ISE 447	Decision Making	3	0	3
ICS 487	Intelligent Decision Support Systems	3	0	3
ISE 453	Applied Game Theory	3	0	3
ISE 445	Cases in Decision Analytics	3	0	3

3. Summary of SWE & ICS Courses

3.1 SWE Core Courses

SWE 205	Introduction to Software Engineering	3	0	3
SWE 215	Software Requirement Engineering	2	3	3
SWE 312	User-Interface Design	3	0	3
SWE 316	Software Design and Architecture	3	0	3
SWE 326	SW Testing & Quality Assurance	3	0	3
SWE 363	Web Engineering & Development	3	0	3
SWE 387	Software Project management	3	0	3
SWE 399	Summer Training	0	0	0
SWE 417	Software Engineering Project I	1	6	3
SWE 418	Software Engineering Project II	0	6	2

3.2 CS Core Courses

ICS 102	Introduction to Computing I	2	3	3
ICS 201	Introduction to Computing II	3	3	4
ICS 202	Data Structures	3	3	4
ICS 233	Computer Architecture and Assembly Language	3	3	4
ICS 253	Discrete Structures I	3	0	3
ICS 254	Discrete Structures II	3	0	3
ICS 324	Database Systems	3	3	4
ICS 343	Fundamentals of Computer Networks	3	3	4
ICS 353	Design and Analysis of Algorithms	3	3	4
ICS 431	Operating Systems	3	3	4

3.3 SWE/CS Elective Courses

SWE 302	Game Programming	3	0	3
SWE 321	Formal Methods and Models in Software Engineering	3	0	3
SWE 416	Software Architecture	3	0	3
SWE 422	Usability Engineering	3	0	3
SWE 436	Object-Oriented Design Patterns	3	0	3
SWE 440	Information Security Management	3	0	3
SWE 445	Secure Software Development	3	0	3

SWE 463	Mobile Application Development	3	0	3
SWE 487	Software Processes and Process Improvements	3	0	3
SWE 490	Special Topic I	3	0	3
SWE 491	Special Topic II	3	0	3
SWE 497	Undergraduate Research	3	0	3
ICS 344	Information Security	3	0	3
ICS 355	Theory of Computing	3	0	3
ICS 381	Principles of Artificial Intelligence	3	0	3
ICS 410	Programming Languages	3	0	3
ICS 412	Compiler Construction Techniques	3	0	3
ICS 415	Computer Graphics	3	0	3
ICS 424	Advanced Database Systems	3	0	3
ICS 437	Distributed Systems	3	0	3
ICS 440	Cryptography and Blockchain Applications	3	0	3
ICS 441	Digital Forensics Techniques	3	0	3
ICS 442	Penetration Testing and Ethical Hacking	3	0	3
ICS 443	Network Design & Management	3	0	3
ICS 445	Network Management and Security	3	0	3
ICS 446	Cluster Computing	3	0	3
ICS 447	Computer Network Technologies	3	0	3
ICS 448	Network and Security Administration	3	0	3
ICS 471	Artificial Neural Networks and Deep Learning	3	0	3
ICS 472	Natural Language Processing	3	0	3
ICS 473	Bioinformatics Mining and Algorithms	3	0	3
ICS 474	Big Data Analytics	3	0	3
ICS 483	Computer Vision	3	0	3
ICS 484	Arabic Computing	3	0	3
ICS 485	Machine Learning	3	0	3
ICS 486	Agent-Based Systems and Swarm Intelligence	3	0	3
ICS 487	Intelligent Decision Support Systems	3	0	3
ICS 488	Knowledge-Based Systems and Soft Computing	3	0	3
ICS 489	Applications of Machine Learning	3	0	3

ICS 490	Special Topics I	3	0	3
ICS 491	Special Topics II	3	0	3

4. Catalog Description of SWE & ICS Courses

4.1 SWE Courses

SWE 205 Introductions to Software Engineering (3-0-3)

Introduction to software engineering and software processes. Construction techniques and principals. Concepts of Programming Languages: Syntax and semantics. Analysis and Design Modes. Ethical and professional responsibilities.

Prerequisites: ICS 102

SWE 215 Software Requirements Engineering (2-3-3)

Requirements engineering process. Methods, tools and techniques for eliciting, organizing and documenting software requirements. Analysis and validation techniques, including need, goal, and use case analysis. Requirements documentation standards. Traceability. Requirements management. Handling requirements changes. Students participate in a group project on software requirements.

Prerequisites: ICS 201 and SWE 205

SWE 302 Game Programming (3-0-3)

Introduction to games; Game programming principles; Game development engines: PyGame and Unity3D; Game data structures; Game intelligence; Simulation; Graphics and animation; Collision detection; Strategy games; Action games; Games research; Application of games to other domains.

Prerequisites: SWE 206 or equivalent

SWE 312 User Interface Design (3-0-3)

Study of both theoretical and practical issues in human-computer interfaces. User interface design process. Usability engineering. Development, programming, and evaluating interface designs. Design of windows, and menus. Commands and natural languages I/O. Visual prototyping. User manuals, online help and tutorials. Students participate in a group project on software user interface design.

Prerequisites: SWE 205

SWE 316 Software Design and Architecture (3-0-3)

Study of design concepts and notations. Architecture, middleware architectures, design patterns, frameworks and components. Designing for qualities such as performance, security, reusability, reliability. Metrics and measurement. Basics of software evolution, reengineering, and reverse engineering. Students participate in a group project on software design.

Prerequisites: ICS 202 and SWE 215

SWE 321 Formal Methods and Models in Software Engineering (3-0-3)

Mathematical foundations for formal methods. Formal languages and techniques for specification and design, including specifying syntax using grammars and finite state machines. Analysis and verification of specifications and designs. Use of assertions and proofs. Automated program and design transformation.

Prerequisites: ICS 202 and ICS 253

SWE 326 Software Testing and Quality Assurance (3-0-3)

Concept of software quality, and software quality metrics. Software quality assurance planning & implementation. Quality process standards. Validation & verification. Reviews, walkthroughs, &

inspections. Mechanisms for validating software systems. Techniques for generating and validating test data. Students participate in a group project on software validation and verification.

Prerequisites: SWE 215 and SWE 312

SWE 363 Web Engineering and Development (3-0-3)

Web Engineering fundamentals: requirements, analysis modeling, design modeling, testing. Internet basics for web applications. Technologies and tools for developing web applications: markup languages, styling, data description and transformation, client and server side programming. Web services. Advances in web engineering.

Prerequisites: Junior Standing

SWE 387 Software Project Management (3-0-3)

Introduction to project management concepts, tools, and techniques: integration management and project planning, scope management, scheduling, budget control, human resource management, communication management, risk analysis and management, project quality management, and procurement management.

Prerequisites: Junior Standing

SWE 399 Summer Training (0-0-0)

A summer period of 8 weeks spent as a trainee in industry, business, or government agencies for the purpose of familiarizing the student with the real job world and enabling him to apply and relate his academic knowledge to a real work environment. The student is required to participate in computer science related activities and use his time to get acquainted with the computer science related functions and resources used by his employing organization. Besides progress reports, the student is required to submit a final report and do a presentation on his experience and the knowledge he gained during his summer training program. The student receives a zero-credit Pass/Fail grade.

Prerequisites: SWE 363, ENGL 214

SWE 416 Software Architecture (3-0-3)

Study the concepts, principles, methods, and best practices in software architecture. Different architectural styles, patterns and product lines are presented and compared. Methods to analyze, evaluate and document software architectures are also discussed. Students participate in a group project on software architecture design.

Prerequisites: SWE 316

SWE 417 Software Engineering Project I (1-6-3)

This is the first part of a two-semester senior-year capstone project. Student teams employ knowledge gained from courses throughout the program such as development of requirements, design, implementation, and quality assurance to develop a software solution to a real-world problem from conception to completion. In this part students develop project plan, software requirement specification and software design document.

Prerequisites: SWE 316 and SWE 387

SWE 418 Software Engineering Project II (0-6-2)

This is the second part of a two-semester, senior-year capstone project. Student teams employ knowledge gained from courses throughout the program such as development of requirements, design, implementation, and quality assurance to develop a software solution to a real-world problem from conception to completion. In this part, students implement the design they produced in SWE 417, test their code, and evaluate their final product.

Prerequisites: SWE 417 and SWE 326

SWE 422 Usability Engineering (3-0-3)

Design, implement and evaluate software system interfaces with focus on usability, interaction paradigms and human computer activities. The lifecycle of an interactive human computer interface is studied from both engineering and end-user perspectives.

Prerequisites: SWE 206 or equivalent

SWE 436 Object-Oriented Design Patterns (3-0-3)

A depth study of object-oriented design patterns. How design patterns solve design problems? How to select a design pattern? How to use a design pattern? Detailed study of creational patterns, structural patterns, and behavioral patterns. Case studies.

Prerequisites: SWE 316

SWE 439 Software Quality Engineering (3-0-3)

Overview of engineering foundations of software, basics of measurement theory, empirical experimentation in software engineering, software metrics and measuring software quality.

Prerequisite: SWE 316 and STAT 319

SWE 440 Information Security Management (3-0-3)

Introduction to information security management principles, management of threats to and vulnerabilities of information security, risk management, and to apply the knowledge of people and technical security controls.

Prerequisite: Senior Standing

SWE 445 Secure Software Development (3-0-3)

Security in requirements engineering; Secure designs; Risk analysis; The SQUARE Process Model; Threat modeling; Defensive coding; Software protection; Fuzzing; Static analysis and security assessment; Memory leaks, buffer and heap overflow attacks, injection attacks.

Prerequisite: Senior Standing

SWE 463 Mobile Application Development (3-0-3)

Comprehensive introduction to building mobile applications for devices based on Android and iOS operating systems, including use of standard integrated development environment: Android Studio and Xcode, as well as testing and debugging on devices and emulators/simulators. Topics cover programming language for iOS programming, and mobile platform APIs for user interface, graphics, networking, data, and web services

Prerequisite: ICS 108 or equivalent

SWE 487 Software Processes and Process Improvements. (3-0-3)

Software process models. Software process analysis. Life cycle process models and standards. Process implementation at various levels like organization, project, team, or individual. Measurement and analysis of software process. Process improvements.

Prerequisite: SWE 326

SWE 490 Special Topics I (3-0-3)

In-depth study of a selected special topic relevant to software engineering

Prerequisites: Senior Standing

SWE 491 Special Topics II (3-0-3)

In-depth study of a selected special topic relevant to software engineering

Prerequisites: Senior Standing

SWE 497 Undergraduate Research**(3-0-3)**

The course introduces students to research. Explains the differences between different publications channels like conferences, journals, books, and book chapters. Introduces students to metrics like impact factor and H-index. Teaches how to search and locate relevant literature on a given research topic. Introduces students to research methodology, experimentation design, and ways to conduct experiments and report the results. It also teaches students on how to prepare a research article.

Prerequisites: Consent of the Instructor

4.2 ICS Courses**ICS 102 Introduction to Computing I****(2-3-3)**

Overview of computers and computing. Introduction to a typical object-oriented programming language. Basic data types and operators. Basic object-oriented concepts. Wrapper classes. Console input/output. Logical expressions and control structures. Classes and methods. Arrays and strings.

Co-requisite: MATH 101 or MATH 132

ICS 201 Introduction to Computing II**(3-3-4)**

Advanced object-oriented programming; inheritance; polymorphism; abstract classes and interfaces, container and collection classes, packages, object-oriented design, software modeling, event-driven programming, recursion, use of stacks, queues and lists from API, searching and sorting.

Prerequisite: ICS 102

ICS 202 Data Structures**(3-3-4)**

Review of object-oriented concepts; Introduction to design patterns; Basic algorithms analysis; Fundamental data structures - implementation strategies for stacks, queues and linked lists; Recursion; Implementation strategies for tree and graph algorithms; Hash tables; Applications of data structures (e.g. data compression and memory management).

Prerequisite: ICS 201

ICS 233 Computer Architecture and Assembly Language**(3-3-4)**

Machine organization; assembly language: addressing, stacks, argument passing, arithmetic operations, decisions, modularization; Input/Output Operations and Interrupts; Memory Hierarchy and Cache memory; Pipeline Design Techniques; Super-scalar architecture; Parallel Architectures.

Prerequisite: COE 202, ICS 201

ICS 253 Discrete Structures I**(3-0-3)**

Propositional Logic, Predicate Logic, Sets, Functions, Sequences and Summation, Proof Techniques, Mathematical induction, Inclusion-exclusion and Pigeonhole principles, Permutations and Combinations (with and without repetitions), The Binomial Theorem, Recurrence Relations; Graphs terminology and applications, Connectivity, Isomorphism, Euler and Hamilton Paths and Circuits, Planarity and Coloring; Trees terminology and applications.

Prerequisite: ICS 102

ICS 254 Discrete Structures II**(3-0-3)**

Number Theory: Modular Arithmetic, Integer Representation, Fermat's Little Theorem, Chinese Remainder Theorem, RSA.; Proof Techniques: Methods of Proofs, Applications from Number Theory, Recursive Definitions; Algorithm Correctness; Relations: Closures and Equivalence Relations, Partial Orderings and Lattices, Hasse Diagrams; Recurrence Relations and Generating Functions; Automata Theory: Finite State Machines, Regular Expressions, DFA, NFA and their equivalence, Grammars and Chomsky Hierarchy, Introduction to Turing Machines.; Abstract Algebra: Groups, Homomorphisms and Lagrange's Theorem, Applications.

Prerequisite: ICS 253

ICS 324 Database Systems (3-3-4)

Basic database concepts, conceptual data modeling, relational data model, relational theory and languages, database design, SQL, introduction to query processing and optimization, and introduction to concurrency and recovery.

Prerequisite: ICS 202

ICS 343 Fundamentals of Computer Networks (3-3-4)

Introduction to computer networks and layered architectures: connectivity, topology, circuit and packet switching, TCP/IP and ISO models; Application layer: C/S model, DNS, SMTP, FTP, WWW, socket programming and network security; Transport layer: TCP and UDP, congestion control; Network layer: internetworking, addressing and routing algorithms and protocols; Data link layer: framing, flow and error control protocols, PPP, MAC and LANs; Physical layer: principles of data communications, circuit switching, coding, multiplexing and transmission media.

Prerequisite: ICS 201

Note: This course cannot be taken for credit with COE 344.

ICS 344: Information Security (3-0-3)

Security properties; Confidentiality, integrity, authentication, non-repudiation; Attack vectors, malicious software and countermeasures; Risk management and analysis; Security mechanisms; Secure software development; Defensive programming; Input sanitization; Symmetric and public-key cryptography; User authentication and access control; Internet security: Email and web security, network security protocols and standards such as IPsec and SSL/TLS; Security technologies and systems: Firewalls, VPNs and IDSs/IPs; Information security process, ethical and legal issues.

Prerequisites: ICS 343 or COE 344

ICS 353 Design and Analysis of Algorithms (3-0-3)

Algorithms and Problem Solving; Basic Algorithmic Analysis; Advanced algorithmic analysis; Advanced Data Structures; Algorithmic strategies & Analysis of fundamental computing algorithms; Basic computability; The complexity classes P and NP.

Prerequisites: ICS 202 and ICS 253

ICS 355: Theory of Computing (3-0-3)

Regular grammars: Equivalence of DFA, NFA and regular expressions, pumping lemma, emptiness, and membership; Context-Free Grammars: parsing and ambiguity, normal forms, applications, equivalence of PDA's and CFG's, pumping lemma, emptiness and membership; Turing machines: Programming techniques for Turing machines, universal Turing-machine; Undecidability: Recursively enumerable and recursive languages, undecidability, problem reduction, undecidable problems of CFG's, RE's and TM's.

Prerequisites: ICS 253

ICS 381: Principles of Artificial Intelligence (3-0-3)

AI history and applications; Intelligent agents and expert systems; Introduction to AI programming; Problem solving agents by uninformed, heuristic and local search; Constraint satisfaction and programming, games and adversarial search; Knowledge-based agents: Propositional and first-order logic, Forward and backward chaining and inference; Planning and reasoning in uncertain situations; Basics of machine learning; Natural language processing; Exposure to other applications of AI (e.g. Vision and Robotics)

Prerequisites: ICS 253

Co-requisites: STAT 319

ICS 410: Programming Languages (3-0-3)

Programming paradigms: Object-oriented, imperative, functional, and logic; Application development in these paradigms; Fundamentals of Language Design: Syntax and semantics; Language implementation: virtual machines; Compilation, interpretation, and hybrid.

Prerequisites: ICS 202

ICS 412: Compiler Construction Techniques (3-0-3)

Compiler techniques and methodology; Organization of compilers; Lexical and syntax analysis; Parsing techniques; Object code generation and optimization, detection and recovery from errors; Contrast between compilers and interpreters.

Prerequisites: ICS 202, ICS 253

ICS 415: Computer Graphics (3-0-3)

Applications of computer graphics; Graphics systems and devices; Output primitives and their attributes; Geometric transformations; Window to viewport mapping and clipping; Curves and surfaces; Three-dimensional viewing; Hidden surface removal; illumination and color models; Animation.

Prerequisites: ICS 202

ICS 424: Advanced Database Systems (3-0-3)

Data preprocessing, data warehousing and OLAP; Security, transaction processing, concurrency control techniques, and backup and recovery of relational databases; Introduction to non-relational database systems such as NoSQL and NewSQL databases.

Prerequisites: ICS 324

ICS 431 Operating Systems (3-3-4)

This course introduces the fundamentals of operating systems design and implementation. Topics include history and evolution of operating systems; Types of operating systems; Operating system structures; Process management: processes, threads, CPU scheduling, process synchronization; Memory management and virtual memory; File systems; I/O systems; Security and protection; Distributed systems; Case studies.

Prerequisite: ICS 233.

ICS 437: Distributed Systems (3-0-3)

Introduction to distributed systems; Distributed systems architecture; Computer networks for distributed systems; Distributed objects and remote invocation; Distributed naming; Distributed file systems; Security and synchronization in distributed systems; Distributed coordination and agreement; Distributed transactions; Distributed replication; Distributed multimedia systems, distributed shared memory; Case studies.

Note: It cannot be taken for credit with COE 423.

Prerequisites: ICS 343 or COE 344

ICS 440: Cryptography and Blockchain Applications (3-0-3)

Secret key encryption; Block and stream ciphers, Encryption standards; Number theory: Divisibility, Modular arithmetic, Group theory and Finite fields; Public key encryption: RSA, ElGamal and Rabin cryptosystems; Diffie-Hellman key exchange; Cryptographically secure hashing; Authentication and digital signatures; Digital signature standard (DSS), Randomized encryption; Cryptocurrency, Blockchain models and applications. Security issues and their solutions in Blockchain models and applications. Blockchain payment networks.

Prerequisites: MATH 208 and STAT 319

ICS 441 Digital Forensics Techniques (3-0-3)

Major phases of digital investigation; Data acquisition of physical storage devices; Study of file systems with a main focus on Microsoft Windows and Linux systems; File system analysis and file recovery; File carving and document analysis; Information hiding and steganography; Time, registry and password recovery; Email and database forensics; Memory acquisition.

Prerequisites: ICS 253 or Consent of Instructor

ICS 442: Penetration Testing and Ethical Hacking (3-0-3)

Introduction to penetration testing and ethical hacking, requirements and legal issues, setting up virtual lab; Exploring Kali Linux and Metasploit framework, hacking and penetration testing phases; Information gathering through passive and active reconnaissance, footprinting, social engineering, port scanning; Advanced fuzzing techniques; Exploitation, password attacks and gaining access to remote services; Web penetration testing and web-based exploitation; Maintaining access with backdoors and rootkits; Bypassing defense applications; Wireless and mobile device hacking techniques; Writing penetration testing report; Tools and programming available for penetration testers in both Windows and Linux platforms such as Kali Linux, OpenVAS, Burp, NMAP, Netcat, Python, etc.

Prerequisites: ICS 343 or COE 344 or COE 353

ICS 443: Network Design & Management (3-0-3)

Overview of network design and management; Design methodologies; Network management strategies; Network configuration management; Network management protocols: SNMP, and RMON; Network management tools and systems; Network management applications; Desktop and web-based network management; Network troubleshooting.

Note: This course cannot be taken for credit with COE 444.

Prerequisites: ICS 343 or COE 344

ICS 445: Network Management and Security (3-0-3)

Network Management Standards, Models, and protocols. Network Management Applications, Tools, and Systems. Remote Monitoring and Management (RMM). Large scale network management techniques and systems. Security of LANs, wireless LANs, and cellular networks. Authentication, authorization, accountability, and access controls of computer networks. Network protection tools: Firewalls, Intrusion Detection and Prevention Systems, Sandboxing, proxies. Study of diverse attack types: DDoS, spoofing, flooding, hijacking, poisoning, DNS, replay attacks and their countermeasures. Hands-on experiences in network security using Kali Linux. Hands-on experiences in implementing secure, manageable networks.

Note: It cannot be taken for credit with COE 555.

Prerequisites: ICS 343 or COE 344 or EE 400

ICS 446: Cluster Computing (3-0-3)

Introduction to high performance computing: Types of parallel computers, system architectures and performance measures; Message passing programming; Complexity analysis of parallel algorithms; Embarrassingly parallel computations; Partitioning and divide-and-conquer strategies; Pipelined computations; Synchronous computations; Load balancing and termination detection; Programming with shared memory; Parallel sorting algorithms; Numerical algorithms; Parallel image processing; Searching and optimization.

Note: It cannot be taken for credit with COE 420.

Prerequisites: ICS 202 and Junior Standing

ICS 447: Computer Network Technologies (3-0-3)

Performance measures and evaluation techniques; Advanced network architectures and differentiated services in IP networks; Switched, fast and gigabit Ethernet; VLANs; Wireless LANs; ISDN and ATM; Frame relay; Mobile computing and mobile IP; VPN and enterprise networks; Emerging network trends and technologies.

Note: It cannot be taken for credit with COE 446.

Prerequisites: ICS 343 or COE 344

ICS 448: Network and Security Administration (2-3-3)

Installing, configuring, securing, and administering network services. Assessing tools for improving data/service protection; Securing remote and local network infrastructures; DNS servers, web servers, network file sharing, and other common network communication components; Practical experience through hands-on lab exercises.

Prerequisites: ICS 344 or Consent of Instructor

ICS 471: Artificial Neural Networks and Deep Learning (3-0-3)

The course will review linear models and stochastic optimization. It will develop an in-depth understanding of Feedforward networks, Loss functions, Back-propagation training, Regularization, Convolutional neural networks, Recurrent and recursive networks, Vanishing gradient problem, Long-short term memory (LSTM) model, Gated recurrent units (GRUs), Processing sequences, images, and hierarchical structures, Auto-encoders, Transfer learning, and Generative adversarial networks. The course will develop models for several domain problems such as automatic speech recognition, image recognition, drug discovery, and recommendation systems, etc.

Prerequisites: COE 292 or ICS 381) and (MATH 208 or MATH 260 or ICS 254) and STAT 319

ICS 472: Natural Language Processing (3-0-3)

Foundations of natural language processing (NLP); Different algorithms and techniques for NLP: Word-level, syntactic, and semantic; Quantitative NLP using large corpora, statistical models for acquisition, disambiguation, parsing and the construction of representative systems.

Prerequisites: ICS 381 or Consent of Instructor

ICS 473: Bioinformatics Mining and Algorithms (3-0-3)

Foundations of bioinformatics; Sequence alignment; Sequence motifs/patterns; Protein structures prediction; Microarray data analysis; Biological networks modeling and mining.

Prerequisites: [ICS 202 and ICS 381] or Consent of Instructor

ICS 474: Big Data Analytics (3-0-3)

Introduction and foundation of big data and big-data analytics. Sources of big data. Smart clouds. Hadoop file system and Apache Spark. Storage management for big data. Machine learning and visualization with big data. Applications of big data. Big data security, privacy, and its societal impact

Prerequisites: (MATH 101 or MATH 106), (ISE 205 or STAT 201 or STAT 211 or STAT 212 or STAT 319 or EE 315)

ICS 483: Computer Vision (3-0-3)

Image acquisition, Digital image and its properties, Image preprocessing, Segmentation (Thresholding, edge- and region-based segmentation), Morphological image processing. Image feature extraction. Bag of words. Image segmentation. Object detection and classification. Shape analysis. Feature tracking. Motion analysis. Case studies (object recognition / object tracking).

Note: It cannot be taken for credit with COE 487 or EE 410.

Prerequisites: Senior Standing

ICS 484: Arabic Computing (3-0-3)

Arabic language characteristics; Arabic character sets; Standardization; Unicode; Arabization systems; Arabic software tools; Arabic programming languages and introduction to Arabic computations.

Prerequisites: ICS 108 or Consent of Instructor

ICS 485: Machine Learning (3-0-3)

This course provides a thorough grounding in a wide range of machine learning methods, for classification, regression, conditional probability estimation, clustering, and dimensionality reduction. It provides the students with the essential foundations of machine learning and their applications to real world problems.

Prerequisites: COE 292 and MATH 208 and STAT 319

ICS 486: Agent-Based Systems and Swarm Intelligence (3-0-3)

Fundamental concepts and models of multi-agent systems (MAS) and their characteristics; Models of agency; Architectures and languages; Logics for MAS; Deductive and practical reasoning agents; Reactive and hybrid agents; Coordination, negotiation and coalition mechanisms; Learning in MAS; Agent and swarm-based models to solve an optimization problem using PSO, Ants, and GA; Implementing agent and swarm-based applications (e.g. in electronic commerce, semantic Web agents, and information retrieval).

Prerequisites: ICS 381

ICS 487: Intelligent Decision Support Systems (3-0-3)

Introduction and need for Decision Support Systems (DSS). Nature of Decision problems and the elements of the decision process with examples. Essential elements of decision-making. Evolution of DSS: management information systems, decision support systems (DSS), intelligent decision support systems (IDSS). IDSS architecture, data collection, data analysis & exploration, design and implementation. IDSS techniques: case-based reasoning, decision trees, knowledge representation. Case studies and projects: e-commerce, knowledge management, recommender systems and actions.

Prerequisites: ISE 205 or STAT 319 or EE 315

ICS 488: Knowledge Based System and Soft Computing (3-0-3)

Introduction to knowledge and soft computing based systems; Handling imprecision and uncertainty; Probabilistic reasoning and rough sets; Structured approach to fuzzy reasoning; Machine learning and neuro computing; Evolutionary computation and genetic algorithms; Immunological computing; Hybrid computational intelligence methods; Neuro-fuzzy inference systems; Combination of genetic algorithms with neural networks; Combination of genetic algorithms with fuzzy based systems; Applications to real life applications for building expert systems and pattern recognition.

Prerequisites: ICS 381

ICS 489: Applications of Machine Learning (3-0-3)

This is a multidisciplinary course that covers applications of artificial intelligence (AI) and machine learning (ML) in different domains. Students will use the knowledge earned from AI & ML concentration courses to develop industry-relevant solutions on electrical engineering, computer linguistics, embedded systems, and health domains. Students will work on several programming assignments and mini projects in signal processing, natural language processing and medical imaging. In addition, students will learn how to implement energy-efficient, real-time ML-based solutions.

Prerequisites: ICS 485

ICS 490: Special Topics I (3-0-3)

State-of-the-art topics in Computer Science and Information Systems.

Prerequisites: Senior Standing

ICS 491: Special Topics II

(3-0-3)

State-of-the-art topics in Computer Science and Information Systems.

Prerequisites: Senior Standing