German-Jordanian University

School of Electrical Engineering and Information Technology

Bachelor of Science in *Computer Science*

Study Plan of 2014

last updated 27 April 2018

Introduction

Computer Science (CS) is centered on the study of information. It is concerned with the study of the theoretical foundations of information and computation and their implementation and application in computer systems. Its activity ranges from theoretical areas such as the theory of automata, system organization and logic design, formal languages and computability theory to applied areas such as scientific computing, programming languages, bioinformatics, and computer systems.

The advent of computers has facilitated a systems approach to solving many problems in science, business, and industry. There is currently a great demand for information analysts to define how systems will perform these functions and for programmers to implement production systems on computers.

The Department of Computer Science at GJU offers a unique and powerful Bachelor Program whose successful completion opens the doors to rewarding professional careers, graduate studies, and lifelong learning.

Program Objectives

The primary objectives of the CS program are to:

1. Create an understanding of the principles of computer science and problem solving.
2. Build an awareness of computing practices in industry and emerging technologies, emphasizing a working knowledge of current software design and development techniques.
3. Provide a broad education that enables graduates to understand the impact of computing technologies in a societal context.
4. Provide a computer science education that enables our graduates to pursue rewarding professional careers, graduate studies, and lifelong learning.

Learning Outcomes

The primary learning outcomes of the CS program are:

1. Demonstrate a fundamental understanding of algorithms, data structures, software design, concepts of programming languages, and computer organization and architecture, and an awareness of the evolution and dynamic nature of the foundational core of computer science.
2. Demonstrate the ability to analyze and solve computing problems.
3. Demonstrate knowledge of a variety of programming languages and a proficiency in at least one higher-level language.
4. Demonstrate understanding of discrete mathematics, differential and integral calculus, and probability and statistics.
5. Demonstrate the ability to collect, analyze, and interpret data.
6. Demonstrate an awareness of emerging technologies and the ability to evaluate and utilize currently available software development tools.
7. Demonstrate knowledge of the principles and practices for software design and development.
8. Demonstrate the ability to successfully apply the principles and practices for software design and development to real problems.

9. Demonstrate the ability to communicate effectively, both orally and in written form, and work in a team environment.
10. Demonstrate familiarity with basic concepts, emerging technologies, and contemporary issues relating to the societal impacts of computing.
11. Demonstrate an understanding of professional and ethical considerations related to computing.
12. Be competitive in the computing job market or be admitted to a good graduate program in computing.
13. Demonstrate an ability to acquire new knowledge in the computing discipline and to engage in life-long learning.

Undergraduate Curriculum - Program of Computer Science

Framework for B.Sc. Degree (Credit Hours):

Classification	Credit Hours		
	Compulsory	Elective	Total
University Requirements	21	6	27
School Requirements	26	0	26
Program Requirements	77	15	92
Total =	124	21	145

1) University Requirements: (27 Credit Hours)

1.1) Compulsory: (21 Credit Hours)

Course No.	Course Title	Cr. Hr.	Lecture	Lab.	Prerequisite
ARB 99	Arabic 99	0			-
ARB 100	Arabic	3	3	0	ARB 99
ENGL98[1]	English I	0	3	0	-
ENGL99	English II	0	3	0	ENGL98
ENGL101	English III	1	3	0	ENGL99
ENGL102	English IV	1	3	0	ENGL101
ENGL201	English V	2	3	0	ENGL102
ENGL202	English VI	2	3	0	ENGL201
GERL101	German I	3	9	0	-
GERL102	German II	3	9	0	GERL101
NE101	National Education	3	3	0	-
MILS100	Military Sciences	3	3	0	-
	Total	21	51	0	

1.2) Elective: (6 Credit Hours)

Students have to choose 6 credit hours from the following courses:

Course No.	Course Title	Cr. Hr.	Lecture	Lab.	Prerequisite
IC101	Intercultural Communications	3	3	0	-
SFTS101	Soft Skills	3	3	0	-
SE301	Social Entrepreneurship & Enterprises	3	3	0	-
DES 101	Arts Appreciation	3	3	0	-
EI 101	Leadership and Emotional Intelligence	3	3	0	-
BE302	Business Entrepreneurship	3	3	0	-

1 Student's score on the English Placement Test will decide the course level

2) School Requirements: (26 Credit Hours)

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite
CS116	Computing fundamentals	3	3	0	-
CS1160	Computing fundamentals lab	1	0	3	Co-requisite CS116
CE 211	Digital Systems	4	3	3	-
CE352	Computer Networks	3	3	0	CS212, CE211
MATH101	Calculus I	3	3	0	-
MATH102	Calculus II	3	3	0	MATH101
MATH231	Probability and Statistics for Engineers	3	3	0	MATH101
GERL201	German III	3	6	0	GERL102
GERL202	German IV	3	6	0	GERL201
	Total	**26**	**30**	**6**	

3) Program Requirements (92 Credit Hours)

3.1) Compulsory Courses (77 Credit Hours)

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite
CS201	Discrete Structures	3	3	0	-
CE201	Computer Architecture and Organization	3	3	0	CE 211
CS212	Object-Oriented Programming	4	3	3	CS116, CS1160
CS 213	Component-Based Computing and Web Applications Development	4	3	3	CS 212
CS 222	Theory of Algorithms	3	3	0	CS116,CS 1160, CS 201
CS 223	Data Structures	3	3	0	CS116, CS 1160
CS 332	Computer Graphics	3	3	0	CS 222, CS 223
CS 342	Software Engineering	3	3	0	CS 212
CE351	Operating Systems	4	3	3	CE201
CS 354	Computer and Networks Security	3	3	0	CE 352
CS 361	Database Management Systems	4	3	3	(or co-requisite) CS 222, CS 223
CS 365	Systems Analysis and Design	3	3	0	CS 222, CS 223
CS 391	Field Training 1	0	0	0	CS116, CS 1160
CS414	Systems Programming	4	3	3	CE 351
CS 419	Compiler Construction	3	3	0	CS 222, CS 223, CE 201
CS 422	Theoretical Informatics	3	3	0	CS 222, CS 223
CS451	Artificial Intelligence	3	3	0	CS222, CS223
CS 458	Wireless Networks	3	3	0	CE 352
CS 491	International Internship	12	0	36	CS 391
CS 4921	Senior Project 1	1	0	3	CS 342
CS 4922	Senior Project 2	2	0	6	CS 4921
GERL301	German V	3	6	0	GERL202
GERL 302	German VI	3	6	0	GERL 301
	Total	**77**	**60**	**60**	

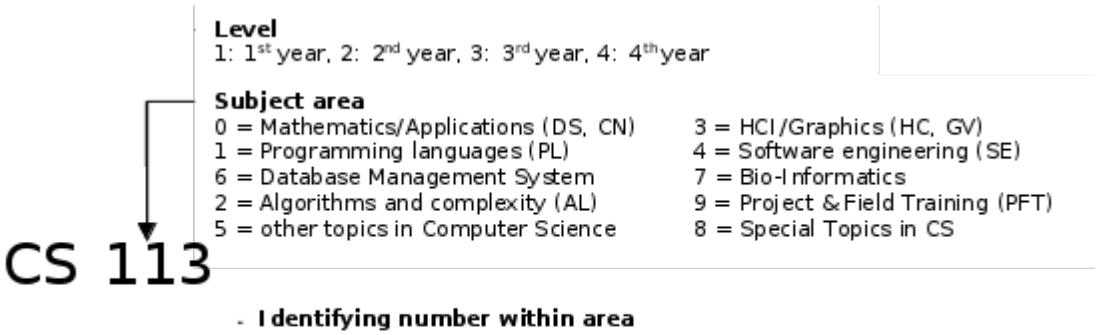
3.2) Elective Course (15 Credit Hours)

Students are required to take 15 credits as elective courses. In addition to the courses listed in the following table, students may also select a maximum of six credits of 300 level and above courses from other departments in the School of Electrical Engineering and Information Technology in order to fulfill the elective requirements.

Course No.	Course Title	Cr. Hr.	Lecture	Lab.	Prerequisite
CS 351	Computer Ethics	3	3	0	CS116, CS 1160
CE353	Distributed systems	3	3	0	CE 352
CS 431	Graphical User Interfaces	3	3	0	CS 212
CE471	Software Design and Architecture	3	3	0	CS 342
CE473	Software Requirements Analysis	3	3	0	CS342
CE474	Software Quality Assurance and Testing	3	3	0	CS 342
CS371	Bioinformatics	3	3	0	CS 361
CS439	Computer Animation	3	3	0	MATH 102, CS 332
CS442	Software Engineering and Formal Specification	3	3	0	CS 201, CS 342
CS 452	Enterprise integration	3	3	0	CS213
CS 453	Web Infrastructure, Services, and Applications	3	3	0	CS 213
CS 454	Information Retrieval and Information Management	3	3	0	CS361
CS 455	Business Software	3	3	0	MGT 101
CS462	Database Design	3	3	0	CS361
CS463	Transaction Processing	3	3	0	CS361
CS468	Data Mining and Data Warehousing	3	3	0	CS361
CS477	Mobile Computing	3	3	0	CS212, CE351
CS 489	Special Topics in Algorithms	3	3	0	CS 222, CS 223
CS 481	Special Topics in Computer Graphics	3	3	0	CS 332
CS482	Special Topics in Software Engineering	3	3	0	(or co-requisite) CS 342
CS 483	Special Topics in Applied Computer Science	3	3	0	CS 222, CS 223
CS 484	Special Topics in Database Technologies and Applications	3	3	0	CS 361

Course Code

The numbering system is structured as follows (from left to right):
Alpha digits: CS: Computer Science
Level digit: 1, 2, 3 or 4 for course level year one to four
Subject area digits; One digit: serial number within a given area



The last digit has no specific meaning for all CS 48x courses, which denote the special topics

Study Plan Guide for the Bachelor Degree in Computer Science

First Year				
First Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
ENGL 101	English III	1		
GERL 101	German I	3		
CS 116	Computing Fundamentals	3		
CS1160	Computing fundamentals lab	1		**CS116**
CS 201	Discrete Structures	3		
ARB 100	Arabic	3		
MATH 101	Calculus I	3		
	University Elective	3		
	Total	20		

Second Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
ENGL 102	English IV	1	ENGL 101	
GERL 102	German II	3	GERL 101	
CS 223	Data structures	3	CS116, CS1160	
CS 222	Theory of Algorithms	3	CS116, CS1160, CS 201	
CS 212	Object-Oriented Programming	4	CS116, CS1160	
MATH 102	Calculus II	3	MATH 101	
MILS 100	Military Sciences	3		
	Total	20		

Second Year				
First Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
ENGL 201	English V	2	ENGL 102	
GERL 201	German III	3	GERL 102	
MATH231	Probability and Statistics for Engineers	3	MATH 101	
CS 332	Computer Graphics	3	CS222, CS223	
CE 211	Digital Systems	4		
NE 101	National Education	3		
CS 365	Systems Analysis and Design	3	CS 222,CS223	
	Total	21		

Second Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
GERL 202	German IV	3	GERL 201	
CS 342	Software Engineering	3	CS 212	
CE 201	Computer Architecture and Organization	3	CE 211	
CS 213	Component-based Computing and Web Applications Development	4	CS 212	
CS 361	Database Management Systems	4	CS222,CS223	CS222,CS223
CS451	Artificial Intelligence	3	CS222, CS223	
	Total	20		

Third Year				
First Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
GERL 301	German V	3	GERL 202	
CS 422	Theoretical Informatics	3	CS 222, CS223	
CE 352	Computer Networks	3	CE 211, CS212	
CS 419	Compiler Construction	3	CS222, CS223, CE201	
CS 4921	Senior Project 1	1	CS 342	
	University elective	3		
CE 351	Operating Systems	4	CE 201	
	Total	20		

Second Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
CS4922	Senior Project 2	2	CS 4921	
CS 354	Computer and Networks Security	3	CE 352	
ENGL 202	English VI	2	ENGL 201	
CS414	Systems Programming	4	CE 351	
CS 391	Field Training 1	0	CS116, CS1160	
	Program elective course	3		
CS 458	Wireless Networks	3	CE 352	
GERL 302	German VI	3	GERL 301	
	Total	20		

Fourth Year				
First Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
	elective course	3		
	elective course	3		
	elective course	3		
	elective course	3		
	Total	12		

Second Term				
Course No.	Course Title	**Cr. hr.**	**Prerequisite**	**Co-requisite**
CS 491	International Internship – 20 weeks industry intern in German	12	CS 391	
	Total	12		

Description of courses offered by the Computer Science Department

CS 116: Computing Fundamentals
Basic computer skills, programming concepts, algorithms, variables and data types; arithmetic, logical, relational, Boolean, and assignment operators; simple input and output statements, selection structures, loop structures, single and multidimensional arrays, character strings, functions, data structures, pointers, input/output file operations.
Prerequisites: None
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 1160: Computing Fundamentals Lab
Lab session every week to offer hands-on experience on the topics that are covered in CS116, which are: algorithms, variables and data types; arithmetic, logical, relational, Boolean, and assignment operators; simple input and output statements, selection structures, loop structures, single and multidimensional arrays, character strings, functions, data structures, pointers, input/output file operations.
Prerequisite or co-requisite: CS116
Credit hours: 1, Lecture Hours: 0, Lab Hours: 48

CS115: Computing Fundamentals
Basic information technology (IT) skills and concepts, the Internet and the web, electronic commerce, application software, system software, basics of computer hardware: the system unit, input and output devices, secondary storage; creating web-pages using HTML and cascading style sheets (CSS), database concepts, database management systems, basics of the structured query language (SQL), communications and networks, privacy, security, computer ethics, information systems, systems analysis and design, programming basics: variables, data types, arithmetic and logic expressions, input/output operations, selection structures, loop structures, arrays.
Prerequisite: None
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS1150: Computing Fundamentals Lab
Lab session every week to offer hands-on experience on the topics that are covered in CS115, which are: computer hardware, operating systems, web browsing, word processing programs, presentation programs, spreadsheet programs, creating web-pages using HTML and CSS, database management systems, database queries with SQL, programming basics: variables, data types, arithmetic and logic expressions, input/output operations, selection structures, loop structures, arrays.
Prerequisite or co-requisite: CS115
Credit hours: 1, Lecture Hours: 0, Lab Hours: 48

CS 201: Discrete Structures
Fundamental structures: Functions (surjections, injections, inverses, composition); relations (reflexivity, symmetry, transitivity, equivalence relations); sets (Venn diagrams, complements, Cartesian products, power sets); pigeonhole principle; cardinality and countability. Basic logic: Propositional logic; logical connectives; truth tables; normal forms validity; predicate logic; limitations of predicate logic; universal and existential quantification; modus ponens and modus tollens. Proof techniques: Notions of implication, converse, inverse, contrapositive, negation, and contradiction; direct proofs; proof by counterexample; proof by contraposition; proof by contradiction; mathematical induction; strong induction; recursive mathematical definitions; well orderings Basics of counting: Counting arguments; pigeonhole principle; permutations and combinations; recurrence relations. Discrete probability: Finite probability spaces; conditional probability, independence Bayes' rule; random events; random integer variables; mathematical expectation
Prerequisites: NONE
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 212: Object-Oriented Programming
Object Oriented Programming concepts; Classes, objects and data abstraction, Constructors and destructors; Object-oriented design; encapsulation and information hiding; abstraction and modularization, coupling and cohesion, sample design patterns. inheritance; class and type hierarchies, polymorphism, Abstract classes, Interfaces; Packages; Collection classes,Generics, streams and files, exception handling; unit testing and debugging, Application Programming Interfaces, Javadoc, 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the course using the Java compiler.
Prerequisites: CS116, CS 1160
Credit Hours: 4, Lecture Hours: 48, Lab Hours: 48

CS 213: Component-Based Computing and Web Applications Development
Component fundamentals; Interfaces; Object lifecycle services; Object brokers; Marshalling; Mobile components; Architecture of component-based systems; Component-oriented design; Event handling: detection, notification, and response; Middleware: object-oriented paradigm within middleware, Object request brokers, Transaction processing monitors, Workflow systems; Design patterns and components; Creational, structural and behavioral patterns; Component technologies such as J2EE and .NET, design, distribute, and re-use of software; Java Server Pages; Java Servlets, Enterprise Java Beans (EJB) – Session versus Entity beans, MVC-Struts design framework; 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the course using Java and Gnu C/C++ compilers.
Prerequisites: CS 212
Credit Hours: 4, Lecture Hours: 48, Lab Hours: 48

CS 222: Theory of Algorithms
Complexity bounds and asymptotic analysis: standard complexity classes; Empirical measurements of performance; Time and space tradeoffs in algorithms; analysis of algorithms. Algorithms: recursion; recursive algorithms; divide-and-conquer strategies; backtracking; design of algorithms; sorting algorithms including heapsort, mergesort and quicksort, automata and string matching.
Prerequisites: CS116, CS 1160, CS 201
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 223: Data Structures
Lists, stacks and queues; hash tables; binary search trees; balanced trees, B-Trees, graphs; depth- and breadth-first traversals; shortest-path algorithms; transitive closure; minimum spanning tree; topological sort; implementation strategies for data structures; strategies for choosing the right data structure.
Prerequisites: CS116, CS 1160
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 332: Computer Graphics
Basic concepts of computer graphics, general features of graphics hardware, raster graphics versus vector graphics, drawing primitive objects: lines, poly-lines, polygons, circles, ellipses, curves; filling methods: scan-line fill and flood fill; Basic two-dimensional (2D) geometric transformations: translation, rotation, scaling and reflection; 2D composite transformations, 2D viewing: clipping window and windowing transformation; basic three-dimensional (3D) geometric transformations: translation, scaling, rotation and reflection; composite 3D geometric transformations, viewing a 3D scene: setting a 3D viewing-coordinate reference, transformation from world to viewing coordinates; projection transformations, 3D object representations: lines, planes, polyhedra, curved surfaces, spheres, ellipsoids; visible-surface detection methods, illumination models and surface-rendering methods, shadow mapping, transparency and surface rendering, interactive graphics.
Prerequisites: CS 222, CS 223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 342: Software Engineering
The product and the process, Software project management: Basic concepts, Software process and project metrics, Software project Planning, Risk management, Project scheduling and tracking, Quality assurance, Configuration management; Classical approaches: Waterfall and Spiral models; Object-oriented approach; Unified Modeling Language (UML); Concepts and notations of object-oriented analysis: Base concepts; Static concepts; Dynamic concepts; Object-oriented analysis: Analytical process; Analysis patterns; Static model; Dynamic model; Design notations and diagram; Design patterns. 3-hours lab covers hands on experience on Computer Aided Software Engineering (CASE) tools such as Rational Rose and Course Team Projects.
Prerequisites: CS 212
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 351: Computer Ethics
This course introduces and discusses the ethical aspects of implementing and using information technology. Ethical concepts and theories; critical thinking skills and argumentation; professional ethics and codes of ethics; privacy; security; cybercrime; intellectual property, copyright, copyleft; regulation in the internet; social inclusion and digital divide; community, identity and virtual reality; pervasive computing; trust to computers; computers and work; social interactions via computers and the internet. The course is a seminar like course where active student participation in discussions is required.
Prerequisites: CS116, CS 1160
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 352: Business Processes
business processes, workflows and the modeling of business processes; management processes, operational processes and supporting processes; modeling techniques; business process analysis, business process reengineering and business process management.
Prerequisites: MGT 101
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 353: IT Project Management
This course discusses issues of Project Management in general and specific issues related to the management of IT projects.
Prerequisites: CS 342
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CE 354: Computer and Network Security
Security of networked computer systems; secure network configuration and user management; handling of attacks; Tools for secure network management; System management; System administration; System programming for security; Security: local attacks; network attacks; Firewalls; Security of web servers, ftp servers and mail servers; Virtual private networks, Cryptography, encryption and decryption techniques, primary key and digital certificate principles, Public Key Cryptography and the RSA Algorithm.
prerequisite: CE 352
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 361: Database Management Systems
DBMS Architecture, Storage Hierarchy, Indexes, Entity-relationship (E-R) modeling, The relational model, Relational Query Language (SQL), Query processing and optimization, Creation and manipulation of databases; Indices and views; Access rights management; Programming in SQL; Transaction Processing (Transactional properties, Concurrency control, Locking, and Crash recovery); Data dictionaries; Required software tools: A main-stream commercial DBMS such as MS SQL, Oracle; 3-hours lab covers hands on experience with design and implementing databases.
Prerequisite or co-requisite: CS 222, CS 223
Credit Hours: 4, Lecture Hours: 48, Lab Hours: 48

CS 365: Systems Analysis and Design
Introduction to systems development; Development life cycle; System Development feasibility; Development of fact finding methods; Context diagram; Data flow diagram; Decision tables and trees; Data dictionary; Installation; Training; Development Tools: Documentation, Maintenance, Conceptual design, DB design, Reverse engineering, Graphical user interface, Systems life cycle, System conversion, System charts and flow of control;
Case study.
Prerequisites: CS 222, CS 223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 371: Bioinformatics
Introduction to bioinformatics: historical context, implications of bioinformatics on biology and computer science; principles, concepts, methods, techniques, algorithms, tools, and strategies to transform and process the masses of information from biological experiments, focusing particularly on biological sequence data. It covers topics such as: DNA and protein sequence alignment and analysis, sequence analysis software, database searching, database search heuristic algorithms, sequence alignment dynamic programming algorithms, RNA folding, and multiple sequence alignment and analysis.
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 391: Field Training 1
Students must complete 160 hours of field training in approved industries in Jordan by the end of their third academic year.
Prerequisites: CS116, CS 1160
Credit Hours: 0; Lecture Hours: 0, Lab Hours: 0

CS 414: Systems Programming
System-level UNIX API's: Process manipulation; IO operations; Use of OS functionality; System-level programming in C; Shell programming; Unix system services: file system, process and thread management, inter-process communication: pipes, shared memory, and message queues, semaphores; Network programming, and synchronization; Microsoft Windows and UNIX TCP and UDP Communications; Connection-Oriented Client-Server Architecture; Remote procedure calls and COM overview; 3-hours lab covers hands on experience with design and implementing course subject using Linux, Solaris and Windows operating Systems.
Prerequisites: CE 351
Credit Hours: 4, Lecture Hours: 48, Lab Hours: 48

CS 419: Compiler Construction
Review of formal grammars; Context sensitive, context free, regular grammars; Phases of compilation; Lexical analysis and a review of parsing; Compiler-compilers and translator writing systems; Top-Down Parsing and bottom up parsing; Lexical scanners generators. Parser generators; Compilation of modern procedural languages; Scope rules; block structure; Symbol tables; Runtime stack management; Parameter passage mechanisms; Stack storage organization and templates; Heap storage management; Intermediate code; Intermediate code generation. Machine code generation; Macros; Templates.
Prerequisites: CS 222, CS 223, CE 201
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 422: Theoretical Informatics
Introduction to automata; languages and grammars; complexity theory and computability; Base mathematics and theoretical concepts behind computing: Finite automata; Regular expressions; Grammars; Stack machines; Turing machines; Decidability and reducibility; Complexity Classes; De-notational Semantics.
Prerequisites: CS 222, CS 223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 431: Graphical User Interface
Definition and basics of graphical user interfaces, usability and design considerations,; Architecture of GUI libraries; Layout management; Manager Components; Layout components; elements of graphical user interfaces and interaction modes; internationalization and localization: Aspects of designing UIs for different devices like PCs and PDAs, event handling, Software engineering and architectural aspects of GUIs, Hands-on experience is gained during a GUI project that is implemented in parallel to the theoretical inputs.
Prerequisites: CS 212
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 439: Computer Animation
Fundamentals of Computer Animation;Applications of Computer Animation; Animation principles and types; Interpolation;Differential equations; Key frame animation; Particle dynamics and systems; Body dynamics and systems; Procedural animation; Physics-based methods; Motion capture techniques; Image morphing; Object deformation; Controlling groups of objects; Data-driven motion synthesis; Character Animation: basic motion (reaching, grasping, walking), facial animation, fluid animation, inverse kinematics, inverse dynamics;Lighting, shading, and anti-aliasing; Space-time constraints; Mathematics optimization; High-level control; Hierarchical and articulated models; Statistical models; Advanced modeling and rendering.
Prerequisites: MATH 102, CS 332
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 442: Software Engineering and Formal Specification
Formal methods for enabling the construction of large, highly reliable software;Formal Software Specification; The Z notation; Schema calculus; Generic constructions; Formal software development; Refinement and verification; Tools and case studies; Rigorous software development; Semi-formal specification languages; Clean-room software engineering; Test generation; Selected topics in current software engineering issues.
Prerequisites: CS 201, CS 342
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 451: Artificial Intelligence
Mathematical principles of AI; Introducing several AI approaches and techniques and their underlying mathematical/algorithmic structure. Problems; problem spaces, and search. Heuristic search techniques, simulated annealing, genetic algorithms and Tabu search. Knowledge representation and logic; Constraint logic programming; Statistical reasoning; Fuzzy set theory and reasoning; Neural networks.
Prerequisites: CS 222, CS 223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 452: Enterprise integration
This course focuses on the integration of information systems in organizations, the process by which different computing systems and software applications are linked together physically or functionally. It examines the strategies and methods for blending a set of interdependent systems into a functioning or unified whole, thereby enabling two or more applications to interact and exchange data seamlessly. The course will explore tools and techniques for systems integration as well as proven management practices for integration projects.
Prerequisites: CS213
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 453: Web infrastructure, services, and applications
Internet and Web technology; Web development, web services and standards, : SOAP, WSDL, and UDDI, design of web services and applications to use them within a service-oriented architecture, HTML, XML, and scripting languages, Programming techniques for consumption and implementation of web services
Prerequisites: CS 213
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 454: Information Retrieval and Information Management
Introduction to Information Retrieval and Information Management from a user and design perspectives. The course covers formal models, evaluation and performance measurement, implementation structures and algorithms, and automatic organization of information including: indexing, clustering, and NLP. Advanced topics include: knowledge representation, semantic nets, fuzzy, and rough sets, web search, and internet technologies.
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 455: Business Software
This course discusses different kinds of medium and large size business software like enterprise resource planning systems, customer relationship management systems, workflow systems, groupware systems, management information systems: definition, characteristics, and standards. For sample systems the architecture and functionality is discussed. The use of such systems in a company is equally discussed based on case studies.
Prerequisites: MGT 101
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 458: Wireless Networks:
introduction to wireless network devices, protocols and architectures; wireless networking standards, wireless local/wide area networks protocols, mobile internet protocols, ad hoc networks, wireless sensors networks.
prerequisites: CE 352
Credit Hours: 3, Lecture Hours: 0, Practical Hours: 0

CS 462: Database Design
Three-level information architecture: External schema, Conceptual schema,Logical data model; DB server/user toolkit architecture: Query languages; Report writers; Query and application development tools; Data-modeling: CASE tools; Relational technology fundamentals; Components of a relational DBMS; Relational Database design; Developing the logical data model; Mapping the data model to the relational model; Entity-relationship modeling; Normalizing data to design tables: Identifying functional dependencies; Applying rules for normalization; Implementing relational databases using a CASE tool; Physical database design; Manipulating and controlling a database using SQL; Creating and using views; Enforcing business rules for data integrity; Modeling in analysis and design; Focusing on business rules; Creating an intelligent server; Stored procedures and triggers.
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 463: Transaction Processing
This course is for students interested in learning about (1) properties of transactions and their implications for system behavior and performance, (2) models of transactions and how they influence the design of applications involving transactional access to a database, (3) implementation and support of transaction processing in modern relational and non-relational database transaction processing systems, such as concurrency control and logging, and (4) architecture of modern transaction processing systems and how communication, security, and replication are implemented in distributed transaction processing systems. Specific topics include serializability theory, atomicity, concurrency control, recovery, durability, distributed commit protocols, replication, parallelism, distribution design, and federated and multi-databases.
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 468: Data Mining and Data Warehousing
This course aims to introduce students to a new frontier in database technology, "data warehousing and data mining", by studying their principles, algorithms, implementation methodology, and applications. It will analyze the components of a data warehouse, including data source and transformation tools, metadata management, query reporting and OLAP (online analytical processing); provide a comprehensive introduction to data mining, including data selection, cleaning, coding, using different pattern recognition techniques, and reporting; and introduce students to the applications of data warehousing and data mining by using commercial tools for creating business applications.
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 477: Mobile Computing
An introduction to mobile computing with a strong emphasis on application development for the Android operating system. Topics will include Introduction to Android IDE, Layout & Activity, Preference and Service Menu, Thread (message), Thread (progress, post, broadcast, & Intent filter), Notification, Dynamic layouts, TTS, and clocks SQLlite. This course will cover mobile phone programming components like UI programming, data management, localization, and programming sensors like the accelerometer and compass, and mobile OS services. The course will focus on the Android platform and how to use cloud services in applications. Android tablets will also be given.
Prerequisites: CS 212, CE351
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS 481: Special Topics in Computer Graphics
Selected state-of-the-art topics in computer graphics, animation and their applications
Prerequisites: CS 332
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 482: Special Topics in Software Engineering
Selected state-of-the-art topics in software engineering
prerequisite or co-requisite: CS 342
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 483: Special Topics in Applied Computer Science
Selected state-of-the-art topics in areas of applied computer science
Prerequisites: CS 222, CS 223
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 484: Special Topics in Database Technologies and Applications
Selected state-of-the-art topics in database technologies and applications
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 485: Special Topics in Information Management
Selected state-of-the-art topics in information and knowledge management and applications
Prerequisites: CS 361
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 486: Special Topics in Business Informatics
Selected state-of-the-art topics in business informatics
Prerequisites: MGT 101
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 487: Special Topics in Business Software / Standard Applications
Selected state-of-the-art topics in business software / standard applications
Prerequisites: CS 455
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 488: Special Topics in IT Management
Selected state-of-the-art topics in IT Management
Prerequisites: CS 342
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 489: Special Topics in Algorithms
Selected state-of-the-art topics in the field of data structures, algorithms, theoretical foundations of computing and their applications.
Prerequisites: CS 222, CS 223
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS 491: International Internship
Field training is a period of six month to be spent in the industry in Germany, under supervision of the academic faculty in Jordan and in Germany. Periodic reports and a final report need to be submitted for evaluation and an oral examination is required.
Prerequisites: **CS 391**
Credit Hours: 12, Lecture Hours: 0, Practical Hours: 36 Hours/week

CS 4921: Senior Project 1
Students must complete select their senior project and outline all the required work to successfully complete the project. The project selection must be approved by the supervisor.
Prerequisites: **CS 342**
Credit Hours: 1; Lecture Hours: 0, Lab Hours: 0

CS 4922: Senior Project 2
Theoretical investigation and practical implementation of a special project under the supervision of an academic faculty member, detailed report as well as an oral examination are required.
Prerequisites: CS 4921
Credit Hours: 2, Lecture Hours: 0, Practical Hours: 0