German Jordanian University

School of Electrical Engineering and Information Technology

Bachelor of Science in Computer Science

Study Plan of 2020

Last updated June 30, 2023

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.

Course Codes

The course code is structured as follows (from left to right):

CS: Computer Science.

First digit: 1, 2, 3 or 4 for course level year.

Second digit: subject area as follows:
- 0 = mathematics.
- 1 = programming languages.
- 2 = algorithms.
- 3 = graphics, multimedia and games
- 4 = software engineering.
- 5 = other topics in computer science.
- 6 = databases
- 7 = bio-informatics.
- 8 = special topics in computer science.
- 9 = project and field training.

The rest of the digits are meant to give the course an identifying code.

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	**80**	**12**	**92**
Total =	**127**	**18**	**145**

1) University Requirements: (27 Credit Hours)

1.1) Compulsory: (21 Credit Hours)

Course No.	Course Title	Cr. Hr.	Lecture	Lab.	Prerequisite
ARB099	**Arabic 99**	**0**	3	0	-
ARB100	**Arabic**	**3**	**3**	**0**	**ARB099**
ENGL098	**English I**	**0**	**3**	**0**	**-**
ENGL099	**English II**	**0**	**3**	**0**	**ENGL098**
ENGL101	**English III**	**1**	**3**	**0**	**ENGL099**
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**	**ARB099**
MILS100	**Military Sciences**	**3**	**3**	**0**	**-**
	Total credit hours	**21**			

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**	ENGL101
SFTS101	**Soft Skills**	**3**	**3**	**0**	ENGL101
SE301	**Social Entrepreneurship & Enterprises**	**3**	**3**	**0**	ENGL101
DES101	**Arts Appreciation**	**3**	**3**	**0**	ARB099
EI101	**Leadership and Emotional Intelligence**	**3**	**3**	**0**	ENGL101
BE302	**Business Entrepreneurship**	**3**	**3**	**3**	ENGL101
TW303	**Technical and Workplace Writing**	**3**	**3**	**3**	-
PE101	**Sports and Health**	**3**	**3**	**0**	ARB099

2) School Requirements: (26 Credit Hours)

Course No.	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite
MATH099	Pre Math	0	3	0	-
CS116	Computing fundamentals	3	3	0	-
CS1160	Computing fundamentals lab	1	0	3	Co-requisite CS116
CE212	Digital Systems	3	3	0	-
CE2120	Digital Systems Lab	1	0	3	Co-requisite CE212
CE352	Computer Networks	3	3	0	CS116, CE201
MATH101	Calculus I	3	3	0	MATH099
MATH102	Calculus II	3	3	0	MATH101
ECE317	Linear Algebra	3	3	0	MATH101, Co-requisite: MATH102
GERL201	German III	3	6	0	GERL102
GERL202	German IV	3	6	0	GERL201
	Total Credit Hours	**26**			

3) Program Requirements (92 Credit Hours)

3.1) Compulsory Courses (80 Credit Hours)

Course Number	Course Title	Cr. hr.	Lecture	Lab.	Prerequisite
CS201	Discrete Structures	3	3	0	MATH099
CE201	Computer Architecture and Organization	3	3	0	CE212, CE2120
IE0121	Probability and Statistics	3	3	0	MATH101
CS214	Object-Oriented Programming	3	3	0	CS116, CS1160
CS2140	Object-Oriented Programming Lab	1	0	3	CS116, CS1160, Co-requisite CS214
CS254	Visual Programming	3	2	2	CS214,CS2140
CS355	Web Technologies	3	2	2	CS214, CS2140, CS363
CS222	Theory of Algorithms	3	3	0	CS116,CS1160, CS201
CS223	Data Structures	3	2	2	CS116, CS1160
CS330	Image Understanding	3	2	2	CS223,ECE317
CS342	Software Engineering	3	3	0	CS214, CS2140, CS363
CE357	Operating Systems	3	3	0	CE201
CE3570	Operating Systems Lab	1	0	3	CE357
CS356	Information Security	3	3	0	CS363
CS363	Database Management Systems	3	2	2	CS223
CS477	Mobile Computing	3	2	2	CS214, CS2140, CS363
CS391	Field Training	0	0	0	Completion of 90 C.H.
CS416	Systems Programming	3	2	2	CS223
CS419	Compiler Construction	3	3	0	CS222, CS223
CS323	Computational Theory	3	3	0	CS222, CS223
CS451	Artificial Intelligence	3	3	0	CS223, CS222
CS332	Computer Graphics	3	2	2	CS223, ECE317
CS491	International Internship	12	0	36	CS391
CS492	Senior Project	3	0	9	Completion of 90 C.H.
GERL301	German V	3	9	0	GERL202, co-requisite GERL301IT
GERL302	German VI	3	9	0	GERL301, co-requisite GERL302IT
GERL301IT	German 5 technical	0	0	0	
GERL302IT	German 6 technical	0	0	0	
	Total credit hours	80			

3.2) Elective Course (12 Credit Hours)

Students are required to take 12 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
CS371	Bioinformatics	3	3	0	CS223, CS222
CS333	Game Programming	3	2	2	CS254
CS430	Virtual and Augmented Reality	3	2	2	CS214, CS2140
CS439	Computer Animation	3	3	0	CS332
CS364	Information Retrieval	3	3	0	CS363
CS458	Wireless Networks	3	3	0	CE352
CS4512	Natural Language Processing	3	3	0	CS222
CS450	Operations Optimization	3	3	0	CS222
CS457	Decision Support Systems and Intelligent Systems	3	2	2	CS222
CS357	Cybersecurity	3	3	0	CS363
CS358	Multimedia Systems Design	3	3	0	CS223, ECE317
CS359	Internet of Things	3	3	0	CS214, CS2140
CS460	Data Mining	3	3	0	CS363
CS462	Database Design	3	3	0	CS363
CS489	Special Topics in Algorithms	3	3	0	CS222, CS223
CS481	Special Topics in Computer Graphics	3	3	0	CS332
CS482	Special Topics in Software Engineering	3	3	0	CS342
CS4833	Special Topics in Applied Computer Science	3	3	0	CS222, CS223
CS4832	Special Topics in Applied Computer Science	2	2	0	CS222, CS223
CS4831	Special Topics in Applied Computer Science	1	1	0	CS222, CS223
CS484	Special Topics in Database Technologies and Applications	3	3	0	CS363
CS480	Special Topics in Data Science Technologies and Applications	3	3	0	IE0211, CS201

Study Plan Guide for the bachelor's degree in computer science

First Year				
First Term				
Course No.	Course Title	Cr. hr.	Prerequisite	Co-requisite
ENGL101	English III	1	ENGL099	
GERL101	German I	3		
CS116	Computing Fundamentals	3		
CS1160	Computing fundamentals lab	1		CS116
CS201	Discrete Structures	3	MATH099	
ARB100	Arabic	3	ARB099	
MATH101	Calculus I	3	MATH099	
	University Elective	3		
	Total	20		

Second Term				
Course No.	Course Title	Cr. hr.	Prerequisite	Co-requisite
ENGL102	English IV	1	ENGL101	
GERL102	German II	3	GERL101	
CS223	Data structures	3	CS116, CS1160	
NE101	National Education	3		
CS214	Object-Oriented Programming	3	CS116, CS1160	
CS2140	Object-Oriented Programming Lab	1		CS214
MATH102	Calculus II	3	MATH101	
CS222	Theory of Algorithms	3	CS116, CS1160, CS201	
	Total	20		

Second Year				
First Term				
Course No.	Course Title	Cr. hr.	Prerequisite	Co-requisite
ENGL201	English V	2	ENGL102	
GERL201	German III	3	GERL102	
CS363	Database Management Systems	3	CS223	
CS254	Visual Programming	3	CS214, CS2140	
CE212	Digital Systems	3		
CE2120	Digital Systems Lab	1		CE212
ECE317	Linear Algebra	3	MATH101	MATH102
CS416	Systems Programming	3	CS223	
	Total	21		

Second Term				
Course No.	Course Title	Cr. hr.	Prerequisite	Co-requisite
GERL202	German IV	3	GERL201	
CS342	Software Engineering	3	CS214, CS2140, CS363	
CE201	Computer Architecture and Organization	3	CE212, CE2120	
CS355	Web Technologies	3	CS214, CS2140, CS363	
IE0211	Probability and Statistics	3	MATH101	
CS451	Artificial Intelligence	3	CS222, CS223	
	University Elective	3		
	Total	21		

Third Year				
First Term				
Course No.	Course Title	Cr. hr.	Prerequisite	Co-requisite
GERL301	German V	3	GERL202	
CS323	Computational Theory	3	CS222, CS223	
CE352	Computer Networks	3	CS116, CE201	
CS419	Compiler Construction	3	CS222, CS223	
CS332	Computer Graphics	3	CS223, ECE317	
CE357	Operating Systems	3	CE201	
CE3570	Operating Systems Lab	1		CE357
	Total	19		

Second Term				
Course No.	Course Title	Cr. hr.	Prerequisite	Co- requisite
CS492	Senior Project	3	Completion of 90 C.H.	
CS356	Information Security	3	CS363	
ENGL202	English VI	2	ENGL201	
CS477	Mobile Computing	3	CS214, CS2140, CS363	
CS391	Field Training	0	Completion of 90 C.H.	
CS330	Image Understanding	3	CS223, ECE317	
MILS100	Military Sciences	3		
GERL302	German VI	3	GERL301	
	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**
CS491	International Internship – 20 weeks industry intern in German	12	CS391	
	Total	12		

Description of courses offered by the computer science department

CS116: 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

CS1160: 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.
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.
Co-requisite: CS115
Credit hours: 1, Lecture Hours: 0, Lab Hours: 48

CS201: Discrete Structures
Fundamental structures: Functions (surjections, injections, inverses, composition); relations (reflexivity, symmetry, transitivity, equivalence relations); sets (Venn diagrams, complements, Cartesian products, power sets); Basic logic: Propositional logic; logical connectives; truth tables; predicate logic; universal and existential quantification; Proof techniques: Notions of implication, direct proofs; proof by counterexample; proof by contraposition; proof by contradiction; mathematical induction; recursive mathematical definitions; Basics of counting: pigeonhole principle; permutations and combinations. Discrete probability: Finite probability spaces; conditional probability, independence Bayes' rule; random events; random integer variables; mathematical expectation.
Prerequisites: MATH099
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS214: 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.

Prerequisites: CS116, CS1160
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS2140: Object-Oriented Programming Lab

Lab session every week to enhance hands-on experience on topics that are theoretically covered in CS214, which are: 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.

Co-requisite: CS214
Credit Hours: 1, Lecture Hours: 0, Lab Hours: 48

CS222: Theory of Algorithms

Complexity bounds and asymptotic analysis, standard complexity classes, empirical measurements of performance, time and space tradeoffs in algorithms, mathematical analysis of recursive and non-recursive algorithms, algorithm design strategies, backtracking algorithms, dynamic programming, sorting algorithms, string matching, graph algorithms, optimization algorithms.

Prerequisites: CS116, CS1160, CS201
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS223: Data Structures

Advanced C language applications (Structures, Pointers), 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, CS1160
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS332: 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, polyhedral, curved surfaces, spheres, ellipsoids; visible-surface detection methods, illumination models and surface-rendering methods, shadow mapping, transparency and surface rendering, interactive graphics.

Prerequisites: CS223, ECE317
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS342: 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.
Prerequisites: CS214, CS2140, CS363
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS363: 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.
Prerequisite: CS223
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS371: Bioinformatics
history of bioinformatics; 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: CS223, CS222
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS416: 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.
Prerequisites: CS223
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS419: Compiler Construction
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 generation. Machine code generation; Macros; Templates.
Prerequisites: CS222, CS223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS323: Computational Theory
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: CS222, CS223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS439: 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: CS332
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS451: 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: CS222, CS223
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS364: Information Retrieval
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: CS363
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS458: 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.
Prerequisite: CE352
Credit Hours: 3, Lecture Hours: 0, Practical Hours: 0

CS460: Data Mining
The course introduces students to data mining, by studying their principles, algorithms, implementation methodology, and applications. It provides 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 mining by using commercial tools for creating business applications.
Prerequisites: CS363
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS477: 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: CS214, CS2140, CS363
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS481: Special Topics in Computer Graphics
Selected state-of-the-art topics in computer graphics, animation and their applications.
Prerequisites: CS332
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS482: Special Topics in Software Engineering
Selected state-of-the-art topics in software engineering.
Prerequisite: CS342
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS4833: Special Topics in Applied Computer Science
Selected state-of-the-art topics in areas of applied computer science.
Prerequisites: CS222, CS223
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS4832: Special Topics in Applied Computer Science
Selected state-of-the-art topics in areas of applied computer science.
Prerequisites: CS222, CS223
Credit Hours: 2, Lecture Hours: 32, Practical Hours: 0

CS4831: Special Topics in Applied Computer Science
Selected state-of-the-art topics in areas of applied computer science.
Prerequisites: CS222, CS223
Credit Hours: 1, Lecture Hours: 16, Practical Hours: 0

CS484: Special Topics in Database Technologies and Applications
Selected state-of-the-art topics in database technologies and applications.
Prerequisites: CS363
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS489: 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: CS222, CS223
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0

CS480: Special Topics in Data Science Technologies and Applications
Selected state-of-the-art topics in the field of big data analysis techniques and their applications.
Prerequisite: IE0211, CS201
Credit Hours: 3, Lecture Hours: 48, Practical Hours: 0.

CS491: 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: CS391
Credit Hours: 12, Lecture Hours: 0, Practical Hours: 36 Hours/week

CS492: Senior Project
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: Completion of 90 credit hours
Credit Hours: 3, Lecture Hours: 0, Practical Hours: 9 hours per week

CS358: Multimedia Systems Design
This course covers the state-of-the-art technology for multimedia systems. This course introduces students to different media types (e.g., images, video, audio, graphics) and how they are used to create multimedia content and systems, algorithms and standards to compress and distribute them via networked systems to a variety of end clients. In general, the course includes issues related to a) content creation: media capture and representation, methods to assemble media types to create multimedia content; b) compression / Storage: students will study algorithms, protocols architectures related to compression; and c) distribution: Aspects of wired and wireless network distribution, Quality of Service, as well as digital rights management of distributed multimedia (watermarking & encryption). For each of the above ISO and ITU standards will also be addressed - JPEG, MPEG1, MPEG2, MPEG4, H.261, H.263, H.264, G.711, G.722, mp3, AAC, Dolby AC3, THX, surround sound, etc. We will also study applications and systems around multimedia – such as database applications with metadata (MPEG-7, MPEG-21). The course's goal will also be to explain modern distributed multimedia systems that take some or all of the above components to create practical applications, e.g., multimedia authoring, digital cinema, content management, multimedia databases, etc.
Prerequisite: CS223, ECE317
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS330: Image Understanding
This course explores several algorithms for extracting useful semantic content from image data. In general, the course theme spans over three main topics: image processing, features and matching, and image analysis. In particular, the course will include algorithms and techniques related to feature extraction, edge detection, SIFT, Harris Corner detection, feature selection, camera models, homography, stereo vision, image search, image classification, objection detection, HOG detector, and image segmentation. The course enables students to work with real applications including real images, e.g., urban street images and medical images.
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32
Prerequisite: CS223, MATH203

CS333: Game Programming
This course is a comprehensive introduction to the wide variety of topics within game programming, physics of games and AI in games. Primary learning outcomes of this course include a) using the Unity Editor to create exciting game levels, b) understanding the fundamentals of using 2D and 3D graphics, c) creating game scripts (e.g., using C++ and the Unity API), d) becoming acquainted with advanced topics such as shaders, physics, AI, and Network based games, and c) understanding the process of game development from idea to beta version.
Prerequisite: CS254
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS254: Visual Programming

This course explores topics in Visual programming fundamentals; This course aims to introduce the students who have built a solid background in console systems to the concepts of Visual/GUI design using structured and OO programming skills acquired in previous courses. Topics include Windows Forms and Controls, Event-Driven Programming, Error Handling, Files, Multi-threading; Animation and graphics; Database connectivity. The practical part of this course will focus on training the students on various visual programming development kits, e.g., .NET framework. The course also includes a project, which brings together students coding, and user-interface design principles.

Prerequisites: CS214, CS2140
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS355: Web Technologies

This course explores topics in Internet and Web technology; Mobile components; Event handling: detection, notification, and response; Web applications development; Standard web services and protocols: WSDL, and UDDI, and SOAP; Design of web services and applications within a service-oriented architecture; Web application languages: HTML, XML, and scripting languages; Programming techniques for consumption and implementation of web services; Server web applications; Java servlets, and Java Server Pages; PHP basics; PHP forms and sessions; Databases connection with SQL and PHP. The practical part of this course will focus on training the students on various web development tools, like HTML, XML, and PHP.

Prerequisites: CS214, CS2140, CS363
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS457: Decision Support Systems and Intelligent Systems

This course explores topics in fundamentals of organizational information analysis OIS and executive information systems EIS; Management support systems; Solutions to the decision making problems in real world; Decision making strategies and models; Design, development, and evaluation of decision support systems; Intelligent decision support technologies such as expert systems, neural network systems, data and text mining, and decision tree. The practical part of this course will focus on training the students on various DSS tools and enriching their skills towards developing different DSS solutions for real world applications.

Prerequisites: CS222
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS356: Information Security

This course covers fundamental issues surrounding information security and privacy. Course topics include confidentiality, integrity, availability; authentication models, protection models, security kernels, secure programming, audit, intrusion detection and response, operational security issues, physical security issues, personnel security, policy formation and enforcement, access controls, information flow; legal and social issues, identification and authentication in local and distributed systems, classification and trust modeling, risk assessment, data aggregation, behavioral advertising, privacy-preserving data mining, privacy-preserving data publishing, website privacy policies and practices, and anonymous communication.

Prerequisites: CS363
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS357: Cybersecurity

This course covers an essential range of topics for securing modern enterprises. Course topics include Cryptographic Tools, user authentication, database and cloud Security, malicious software, denial of service attacks, intrusion detection, firewalls and intrusion prevention systems, IT security management and risk assessment, human resources security, legal and ethical aspects, enterprise roles, security metrics, risk management, standards and regulations, physical security, and cybercrime issues and investigation.

Prerequisite: CS363
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS359: Internet of Things

application areas of Internet of Things (IoT), Internet in Mobile Devices, Cloud & Sensor Networks,

building blocks of Internet of Things and characteristics, design and program IoT-based devices and prototypes, Security of IoT devices, IoT with cloud computing, wireless technologies used in IoT systems, such as WiFi,6LoWPAN, bluetooth and ZigBee.
Prerequisite: CS214, CS2410
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS4512: Natural Language Processing
Introduction to language: words, symbols, sentences, documents, corpus. Variation in languages & dialects. Information retrieval. Words: Stemming, Lemmatization. Sentences: Syntactic parsing, Chunking. Named entity recognition (NER). Word sense disambiguation (WSD). Classification: Sentiment Analysis, Spam detection. Applications: Question Answering, Dialogue Systems, Summarization, Information Extraction.
Prerequisite: CS222
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS430: Virtual and Augmented Reality
VR systems: Discipline, features, Architecture. VR hardware: tracking systems, motion capture systems, visual displays. Fundamentals of the human visual system. Haptic rendering: Haptic sense. Haptic devices. Algorithms for haptic rendering. VR software development: Challenges in VR software development. Windowing, viewing, input/output, networking. Master/slave and Client/server architectures. Cluster rendering. Game Engines. Publically available sdk for different hardware (HTC VIVE, Oculus, Google VR). AR software development: AR software. Camera parameters and camera calibration. Marker-based augmented reality. Pattern recognition. AR Toolkits.
Prerequisite: CS214, CS2140
Credit Hours: 3, Lecture Hours: 32, Lab Hours: 32

CS450: Operations Optimization
Linear Programming, Simplex Method, Integer Linear Programming, Transportation Models, Network Models, Queuing Systems, Inventory Models, Game Theory, Dynamic Programming, Decision Theory, Nonlinear Programming.
Prerequisite: CS222
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS462: 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 views; Enforcing business rules for data integrity; Modeling in analysis and design; Creating an intelligent server; Creating informative data visualizations; Transactions and Database Security.
Prerequisites: CS363
Credit Hours: 3, Lecture Hours: 48, Lab Hours: 0

CS391: Field Training
Eight consecutive weeks of training where students must complete 160 hours of field training in approved industries in Jordan.
Prerequisites: completion of 90 credit hours
Credit Hours: 0; Lecture Hours: 0, Lab Hours: 0