

Jordan University of Science & Technology

Faculty of

Computer & Information Technology

Curriculum for the Bachelor Degree

IN

COMPUTER SCIENCE

2015-2016



Study Plan for the Computer Science 2015-2016

The Bachelor Degree in Computer Science is awarded at Jordan University of Science & Technology after the successful completion of 132 credit hours distributed as follows:-

Requirements	Mandatory	Elective	Total
University Requirements	16	9	25
Faculty Requirements	27	0	27
Departmental Requirements	68	12	80
Total	111	21	132

and after fulfilling the terms and conditions for awarding the bachelors degree at Jordan University of Science & Technology number (1) issued in 1987 (amended).

1. University Requirements (25 CHs):

1-a) University Mandatory Courses (16 CHs):

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
ARB 101	Arabic Language	3	3	0	-
HSS 100 ⁽¹⁾	Culture and University Behavior	1	1	0	
MS 100 ⁽²⁾	Military Science	3	3	0	-
ENG 111	English Language I	3	3	0	Pass ENG 099 or pass the prelim English exam with 50% or more
ENG 112 ⁽³⁾	English Language II	3	3	0	ENG 111 or pass the prelim English exam with 80% or more
CIS 100 ⁽⁴⁾	Computer Skills	3	3	0	-

NOTE: Non-Arabic speaking students register for the following course instead of (ARB 101):

Course Number	Course Title	Credit Hours	Weekly Hours	
			Lecture	Lab
ARB 101A	Fundamentals of Arabic language for Non-Arabs	3	3	0

1-b) University Elective Courses (9 CHs):

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
NUR 100	Health Promotion (For Non Nursing & Midwifery Students)	3	3	0	-
NF 177	Food Preservation (For Non Nutrition & Food Technology Students) (in English)	3	3	0	-
ADS 100	Oral & Dental Health (For Non Dentistry & Allied Dental Sciences Students)	3	3	0	-
PHAR 104	Drugs and Medicinal Plants: Uses and Side Effect (For Non-Medicine and Pharmacy Students)	3	3	0	-
PH 104	Human Health and Nutrition (For Non-Medicine and Nursing Students)	3	3	0	-

¹. The grade for this course is a Pass/Fail grade.

². The grade for this course is a Pass/Fail grade. Non-Jordanian students can take a substitute course from the elective courses, and the grade for the elective course goes into the calculation of the grade point average.

³. The student who passes the TOEFL test with a grade of 500 or more will be exempted from taking this course.

⁴. The student who passes the computer skills exam with 50% or more, or has ICDL certificate or Cambridge certificate will be exempted from taking this course.

PH 200	First Aid and Emergency Procedures (For Non-Medicine, Pharmacy and Nursing Students)	3	3	0	-
VM 211	Animal Health (For Non-Veterinary Medicine and Agriculture Students)	3	3	0	-
VM 212	Pet Animals Care (For Non-Veterinary Medicine Students)	3	3	0	-
HSS 112	Hadith Shareef	3	3	0	-
HSS 113	Aqideh	3	3	0	-
HSS 114	Fiqh	3	3	0	-
HSS 115	Islam & Contemporary Problems	3	3	0	-
HSS 116	Islamic Economic System	3	3	0	-
HSS 121	Principles of Sociology (For Non-English Language Students)	3	3	0	-
HSS 126	Principles of Psychology (For Non Nursing & Midwifery Students)	3	3	0	-
HSS 127	Education Technology	3	3	0	-
HSS 128	National Education	3	3	0	-
HSS 131	Islamic Civilization	3	3	0	-
HSS 132	The History of the City of Jerusalem	3	3	0	-
HSS 133	Civilization and Recent Cultures	3	3	0	-
HSS 141	Principles of Economics (For Non-Computer and Information Systems Students)	3	3	0	-
HSS 142	Library and Information Research	3	3	0	-
HSS 151	Principles of Management (For Non-Computer and Information Systems Students)	3	3	0	-
HSS 161	Contemporary Problems	3	3	0	-
HSS 166	Man and Science	3	3	0	-
HSS 182	Woman Studies	3	3	0	-
HSS 211	Introduction to Sociology (in English)	3	3	0	-
HSS 212	Arab Society (in English)	3	3	0	-
HSS 213	The Individual and Society (in English)	3	3	0	-
HSS 216	Contemporary International Issues (in English)	3	3	0	-
HSS 221	Introduction to Psychology (For Non Nursing & Midwifery Students) (in English)	3	3	0	-
HSS 222	Creativity and Problem Solving	3	3	0	-
HSS 224	Leadership and Communication Skills	3	3	0	-
HSS 231	History of Sciences in the Arab World	3	3	0	-
HSS 241	Economy in the Third World	3	3	0	-
HSS 242	Information and Research (in English)	3	3	0	-
HSS 250	The History of Music (in English)	3	3	0	-
HSS 429	The Science of Children Behavior and Treatment	3	3	0	-
AP 200	Farm Animal Products and Production (For Non Agriculture And Veterinary Students)	3	3	0	-
PT 100	Wellness & Lifestyle (For Non Physical & Occupational Therapy Students)	3	3	0	-
ES 103	Environment Protection (For Non Environmental Sciences Students)	3	3	0	-
ME 211	Fundamentals of Automobile Engineering (For Non-Mechanical Engineering Students)	3	3	0	-
NR 200	Natural Resources and Man (For Non Agriculture Students)			0	
PP 200	Home Gardens (For Non Agriculture Students)	3	3	0	-
PP 201	Bee Keeping (For Non Agriculture Students)	3	3	0	-

2. Faculty Requirements (27 CHs):

Course Number	Course Title	Credit Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
MATH 101	Calculus I	3	3	0	-
MATH 102	Calculus II	3	3	0	MATH 101
MATH 241	Discrete Mathematics	3	3	0	-
CS 101	Introduction to Programming	3	3	0	CIS 100 or Concurrent
CS 102	Programming Lab	1	0	3	CS 101 or Concurrent
CS 112	Introduction to Object-Oriented Programming	3	3	0	Passing CS 102
CS 113	Object-Oriented Programming Lab	1	0	3	CS 112 or concurrent
CS 211	Data Structures	3	3	0	MATH 241 + Passing CS 112
CIS 200	Professional & Ethical Issues in Computing	1	1	0	-
CIS 201	Introduction to Web Design	1	0	3	CS 113
CIS 202	Communication Skills	2	2	0	CIS 200 or concurrent
CIS 221	Fundamentals of Database Systems	3	3	0	CS 211

3. Department Requirements (80 CHs):

3-a) Mandatory Departmental Courses (68 CHs):

Course Number	Course Title	Credits Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
CS 181	Linear Algebra	3	3	0	MATH 101
CS 212	Data Structures Lab	1	0	3	CS 211 or concurrent
CS 214	Object-Oriented Software Modeling	3	3	0	CS 112
CS 282	Theory of Computing	3	3	0	MATH 241 + CS 112
CS 284	Analysis and Design of Algorithms	3	3	0	CS 211
CS 315	Contemporary Programming Techniques	3	3	0	Passing CS 112
CS 318	Human-Computer Interaction	3	3	0	CS 315
CS 342	Computer Networks	3	3	0	CS 284
CS 352	Computer Organization and Design	3	3	0	CPE 236
CS 362	Artificial Intelligence	3	3	0	CS 284
CS 375	Principles of Modern Operating Systems	3	3	0	CS 284 or concurrent + CS 352
CS 391	Practical Training	3	0	0	Completion of (90 CHs)
CS 411	Mobile Applications Design and Development	3	3	0	CS 318
CS 442	Wireless Networks	3	3	0	CS 342
CS 451	Computer Architecture	3	3	0	CS 352
CS 475	Emerging Computer Systems	3	3	0	CS 451 + CS 375
CS 484	Computer and Network Security	3	3	0	CS 342 + CS 375
CS 491	Graduation Project I	1	0	0	Completion of (90 CHs)
CS 492	Graduation Project II	2	0	0	CS 491
SE 230	Fundamentals of Software Engineering	3	3	0	CS 214
SE 320	System Analysis and Design	3	3	0	SE 230 + CIS 221
CPE 200	Numerical Analysis	2	2	0	CS 181
CPE 236	Digital Logic Design	3	3	0	CS 113
CPE 237	Digital Logic Design Lab	1	0	3	CPE 236
CPE 300	Workshop in Computers Maintenance and Operation	1	0	3	CPE 237
MATH 233	Probability & Statistics (<i>For Computer Science Students.</i>)	3	3	0	MATH 102

3-b) Department Elective Courses (12 CHs): (*)

- Student must select at least 6 CHs from the Computer Science Department:-

Course Number	Course Title	Credits Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
CS 483	Fundamentals of Bioinformatics	3	3	0	CS 284 + MATH 233
CS 412	Advanced Topics in Programming	3	3	0	CS 211
CS 422	Information Retrieval Systems	3	3	0	CIS 221
CS 441	Network Programming	3	3	0	CS 342
CS 463	Knowledge Engineering	3	3	0	CS 318 + CS 362
CS 464	Game Design and Development	3	2	3	CS 362 + CS 181
CS 472	Compiler Design	3	3	0	CS 282
CS 476	High Performance Computing	3	3	0	CS 475 or Concurrent
CS 481	Computer Graphics	3	3	0	CS 284
CS 482	Image Processing	3	3	0	CS 362 + CS 181
CS 485	Multimedia Systems and Networking	3	3	0	CS 375 + CS 342
CS 486	Simulation and Modeling	3	3	0	MATH 233 + CS 211
CS 496	Special Topics in Theoretical Computer Science	3	3	0	Department Approval
CS 497	Special Topics in Computer Systems	3	3	0	Department Approval
CS 498	Special Topics in Computer Applications	3	3	0	Department Approval
CIS 421	Database Applications	3	3	0	CIS 221 + MATH 241
SE 440	Project Management	3	3	0	SE 230
-	Courses form other departments in the	3	-	-	Department Approval

(*) Students who are trained in academy or professional training programs in the Faculty of Computer and Information Technology with at least 150 training hours and pass the corresponding international certification exam are exempted from 3 CHs.

	faculty (400 level and above)				
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Notes: The following table contains courses offered by the Department of Computer Science to students in other faculties:-

Course Number	Course Title	Credits Hours	Weekly Hours		Prerequisite
			Lecture	Lab	
CS 114	C++ Programming for Engineers	3	2	2	CIS 100
CS 115	C++ Programming Language	3	3	0	CIS 100
CS 116	Selected Programming Language	3	3	0	CIS 100

Course Numbering Convention:

Digit	Meaning	Explanation	
Hundreds	Course Level	1	First year
		2	Second year
		3	Third year
		4	Forth year
Tens	Course Subject	0	Basic Principles
		1	Programming
		2	Database
		3	-
		4	Networks
		5	Hardware
		6	Artificial Intelligence
		7	Systems and Systems Software
		8	Miscellaneous
9	Special Topics and Training		
Ones	Course Sequence	Course sequence number within subject area	

Recommended Study Plan

1st Year

Semester 1			
Course Number	Course Name	# CH	Prerequisite
MATH 101	Calculus I	3	-
CS 101	Introduction to Programming	3	CIS 100 or concurrent
CS 102	Programming Lab	1	CS 101 or concurrent
MS 100	Military Science	3	-
ENG 111	English Language I	3	Pass ENG 099
CIS 100	Computer Skills	3	-
Total		16	

Semester 2			
Course Number	Course Name	# CH	Prerequisite
MATH 102	Calculus II	3	MATH 101
MATH 241	Discrete Mathematics	3	-
ARB 101	Arabic Language	3	-
HSS 100	Culture and University Behavior	1	-
ENG 112	English Language II	3	ENG 111
CS 112	Introduction to Object-Oriented Programming	3	Passing CS 102
CS 113	Object-Oriented Programming Lab	1	CS 112 or concurrent
Total		17	

2nd Year

Semester 1			
Course Number	Course Name	# CH	Prerequisite
CS 181	Linear Algebra I	3	MATH 101
CIS 200	Professional and Ethical Issues in Computing	1	-
CIS 202	Communication Skills	2	CIS 200 or concurrent
CS 211	Data Structures	3	MATH 241 + Passing CS 112
CS 212	Data Structures Lab	1	CS 211 or concurrent
CS 214	Object-Oriented Software Modeling	3	CS 112
-	University Elective	3	-
Total		16	

Semester 2			
Course Number	Course Name	# CH	Prerequisite
MATH 233	Probability & Statistics (<i>for CS Students</i>)	3	MATH 102
CS 282	Theory of Computing	3	MATH 241 + CS 112
CS 284	Analysis and Design of Algorithms	3	CS 211
CIS 201	Introduction to Web Design	1	CS 113
CIS 221	Fundamentals of Database Systems	3	CS 211
CPE 236	Digital Logic Design	3	CS 113
Total		16	

3rd Year

Semester 1			
Course Number	Course Name	# CH	Prerequisite
CS 315	Contemporary Programming Techniques	3	Passing CS 112
CS 342	Computer Networks	3	CS 284
CS 352	Computer Organization and Design	3	CPE 236
CPE 237	Digital Logic Design Lab	1	CPE 236
SE 230	Fundamentals of Software Engineering	3	CS 214
-	University Elective	3	-
Total		16	

Semester 2			
Course Number	Course Name	# CH	Prerequisite
CS 318	Human-Computer Interaction	3	CS 315
CS 362	Artificial Intelligence	3	CS 284
CS 375	Principles of Modern Operating Systems	3	CS 284 or concurrent + CS 352
SE 320	System Analysis and Design	3	SE 230 + CIS 221
-	University Elective	3	-
CPE 300	Workshop in Computers Maintenance and Operation	1	CPE 237
Total		16	

Semester 3 (Summer)			
Course Number	Course Name	# CH	Prerequisite
CS 391	Practical Training	3	Completion of (90 CHs)
Total		3	

4th Year

Semester 1			
Course Number	Course Name	# CH	Prerequisite
CS 411	Mobile Applications Design and Development	3	CS 318
CS 451	Computer Architecture	3	CS 352
CS 484	Computer and Network Security	3	CS 342 + CS 375
CS 491(*)	Graduation Project I	1	Completion of 90 (CHs)
-	Department Elective	3	-
-	Department Elective	3	-
Total		16	

Semester 2			
Course Number	Course Name	# CH	Prerequisite
CPE 200	Numerical Analysis	2	CS 181
CS 442	Wireless Networks	3	CS 342
CS 475	Emerging Computer Systems	3	CS 375 + CS 451
CS 492	Graduation Project II	2	CS 491
-	Department Elective	3	-
-	Department Elective	3	-
Total		16	

(*) Students must register "CS 491" before the graduation semester (Semester 1 or Semester 2).

Course Description

CS 098: Basics in Computer Science

3 Credit Hours

Understand basic computer components. Use windows. Type papers and reports using MS-Word. Create charts and analyze data using MS-Excel. Create presentation using MS-Power Point. Browse and search through the internet. Transfer files using WS-FTP. Use Outlook Express (dealing with email).

CS 101: Introduction to Programming

3 Credit Hours

Prerequisite: CIS 100 or concurrent

This course introduces the student to object-oriented programming through a study of the concepts of program specification and design, algorithm development, and coding and testing using a modern software development environment. Students learn how to write programs in an object-oriented high-level programming language. Topics covered include fundamentals of algorithms, flowcharts, problem solving, programming concepts, classes and methods, control structures, arrays, and strings. Throughout the semester, problem solving skills will be stressed and applied to solving computing problems. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.

CS 102: Programming Lab

1 Credit Hour

Prerequisite: CS 101 or concurrent

This course consists of a set of laboratory experiments and projects that provide hands-on experience in programming. The student is expected to achieve and demonstrate satisfactory individual programming skills.

CS 112: Introduction to Object-Oriented Programming

3 Credit Hours

Prerequisite: Passing CS 102

Using a language that supports object-oriented programming concepts, the following topics are covered: classes, objects, properties, indexers, attribute encapsulation, data abstraction, inheritance, polymorphism, generalization, specialization, exception handling, aggregation, and associations. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.

CS 113: Object-Oriented Programming Lab

1 Credit Hour

Prerequisite: CS 112 or concurrent

This course consists of a set of laboratory experiments and projects that provide hands-on experience in object-oriented programming. The student is expected to achieve and demonstrate satisfactory individual as well as group-level object-oriented programming skills.

CS 114: Programming for Engineers

3 Credit Hours

Prerequisite: CIS 100

A programming course customized for Faculty of Engineering students. It covers C++ programming concepts, variables and basic data types, control structures and loops, functions, arrays, structures, classes and objects, constructors and destructors, inheritance, pointers and references to objects, streams and files. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.

CS 115: C++ Programming Language**3 Credit Hours**

Prerequisite: CIS 100

C++ programming concepts, variables and basic data types, control structures and loops, functions, arrays, structures, classes and objects, constructors and destructors, inheritance, pointers and references to objects, streams and files. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.

CS 116: Selected Programming Language**3 Credit Hours**

Prerequisite: CIS 100

This course is taught using a selected programming language such as Visual Basic (VB). It includes the following topics: fundamental computer concepts, components of the integrated development environment (IDE), basic problem-solving techniques, conditional and repetition statements, other control structures, data types, Sub and Function procedures, arrays, various built-in functions, GUI, and sequential and random-access files. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.

CS 181: Linear Algebra**3 Credit Hours**

Prerequisite: MATH 101

Matrices, basic algebraic operations, reduced forms, rank and inverse solutions of systems of linear equations. Determinants and their properties. Vector spaces, subspaces, intersection and sum of subspaces, linear independence, spanning set, bases and dimension, line transformations and matrices of linear transformations, eigenvalues and eigenvectors.

CS 211: Data Structures**3 Credit Hours**

Prerequisite: MATH 241 and Passing CS 112

Introduction to data structures using an object-oriented programming language. Logical and physical representation of data structures, collection types, array-based lists, linked lists, stacks, queues, basics of algorithm analysis, binary trees, binary search trees, hashing, and heaps. Applications and algorithms based on data structures are covered in this course. Weekly laboratory experiments will provide hands-on experience in topics covered in this course.

CS 212: Data Structures Lab**1 Credit Hour**

Prerequisite: CS 211 or concurrent

This course consists of a set of laboratory experiments and projects that provide hands-on experience in building programs that make use of the data structures discussed in CS 211. The student is expected to achieve and demonstrate satisfactory individual as well as group-level skills.

CS 214: Object-Oriented Software Modeling**3 Credit Hours**

Prerequisite: CS 112

Introduction to the concepts of object-oriented software modeling (techniques and methodologies). A general modeling language (e.g., UML), structure modeling, behavior modeling, domain modeling, architecture modeling, model checking, limitations of modeling, validation of models, comparison of different approaches considering their advantages and disadvantages. An internal laboratory is included.

CS 282: Theory of Computing

3 Credit Hours

Prerequisite: MATH 241 and CS 112

Formal languages' types and representations, grammars that generate formal languages, machines that accept formal languages. Regular languages and regular expressions, regular grammars, finite automata (deterministic and non-deterministic). Moore and Mealy machines. Context free languages. Context free grammars. Deterministic and non-deterministic pushdown automata. Phrase structure languages. Phrase structure grammars. Turing machine. Chomsky machine. Chomsky's normal form. Parsing tree. Chomsky's hierarchy computer.

CS 284: Analysis and Design of Algorithms

3 Credit Hours

Prerequisite: CS 211

This course is an introductory course to the design, implementation and analysis of computer algorithms. Topics covered include the growth of functions, the time complexity of algorithms, recurrence relations and their solutions, the design and analysis of various sorting algorithms (insertion, merge, quick, and heap sort), graph searching algorithms (breadth-first and depth-first search), and spanning trees. Programming projects.

CS 315: Contemporary Programming Techniques

3 Credit Hours

Prerequisite: CS 211

Contemporary programming techniques using a language or languages suitable for exploring such techniques. Topics include exception handling, multithreading, introduction to Windows programming, programming based on events, basics of network programming, and database access. Programming projects and lab assignments.

CS 318: Human-Computer Interaction

3 Credit Hours

Prerequisite: CS 315

Various human-computer interaction topics, including tools and skills for user interface design, user experience design (UxD), Emotional Interaction, user interface software architecture, rapid prototyping and iterative design, Wireframes, evaluation techniques, and computer-supported cooperative work. The course focuses on User-centered design approach (UCD).

CS 342: Computer Networks

3 Credit Hours

Prerequisite: CS 284

Introduction to the concepts and architecture of computer networks using the OSI and TCP/IP models. The physical and data link layers, LANs, high-speed networking; fundamentals of TCP/IP, congestion control, presentation layer. Introduction to distributed processing, security, and data compression.

CS 352: Computer Organization and Design**3 Credit Hours**

Prerequisite: CPE 236

Basic computer organization; memory systems including caches, computer arithmetic, processors, controllers, input/output, buses, DMA; data formats; addressing modes; instruction sets and microcode; design of a simple computer.

CS 362: Artificial Intelligence**3 Credit Hours**

Prerequisite: CS 284

Introduction to the types of Artificial Intelligence problems and techniques. Problem-Solving methods. Major structures used in Artificial Intelligence programs. Study of knowledge representation techniques such as predicate logic, non-monotonic logic, and probabilistic reasoning. Application areas such as game playing, expert systems, natural language understanding and robotics. Projects using one of the Artificial Intelligence programming languages.

CS 375: Principles of Modern Operating Systems**3 Credit Hours**

Prerequisite: CS 284 or concurrent and CS 352

Introduction to fundamental issues in design and development of parallel programs for various types of parallel computers. Various programming models according to both machine type and application area. Cost models, debugging, and performance evaluation of parallel programs with actual application examples. Emphasis will be on MPI parallel programming language.

CS 391: Practical Training**3 Credit Hours**

Prerequisite: Completion of (90 CHs)

Students will train in companies, factories, governmental agencies, and private establishments in a preapproved computer-related activity for a period of twelve weeks under the supervision of a faculty member. Approval of the training topic is carried out by the department head upon recommendation of the supervising faculty member.

CS 411: Mobile Applications Design and Development**3 Credit Hours**

Prerequisite: CS 318

Mobile application development frameworks; Architecture, design and engineering issues, techniques, methodologies for mobile application development. It focuses on Web-based mobile applications, and thus covers issues of Web service design (RESTful service design), mobile platforms (iPhone, Android, Symbian/S60, WebOS, Windows Mobile, BlackBerry OS, BREW, JavaME/JavaFX, Flash Light), and the specific constraints and requirements of user interface design for limited devices. The course combines a conceptual overview, design issues, and practical development issues.

CS 412: Advanced Topics in Programming**3 Credit Hours**

Prerequisite: CS 211

This course covers advanced programming skills and how they can be used to solve the basic material for competitive programming and exciting problems that have appeared in international programming contests. It presents a diverse and interesting set of topics in programming, algorithms, discrete mathematics and artificial intelligence through puzzles.

CS 422: Information Retrieval Systems**3 Credit Hours**

Prerequisite: CIS 221

Functional view of information retrieval, types of information retrieval systems, design issues: keyword-based retrieval, file structures, and thesaurus construction. Information retrieval data structures and algorithms: lexical analysis, stemming, term weighting, associative indexing, Boolean operations, and string searching and matching techniques. Relevance feedback and query modification. Applications and case studies.

CS 441: Network programming**3 Credit Hours**

Prerequisite: CS 342

Introduction to various aspects of computer network programming. Fundamental concepts are covered, including host TCP/IP configuration, TCP/IP addressing, socket programming, data presentation issues, the client/server programming model, and HTTP. This course is directed at developing traditional and multithreaded client/server applications in both the TCP/IP and UDP/IP domains. Weekly lab sessions.

CS 442: Wireless Networks**3 Credit Hours**

Prerequisite: CS 342

Motivation, wireless network architectures and wireless network devices, wireless standards, mobile computing issues, wireless local area networks and satellite-based networks, sensor networks, mobile Internet protocol, extending the client-server model for mobility, mobile data access, language support for mobile and wireless computing, and technologies such as infrared devices and Bluetooth.

CS 451: Computer Architecture**3 Credit Hours**

Prerequisite: CS 352

The role of performance, essential notions of computer systems design, datapath and control of processor, memory hierarchies, control units, registers, data transfer and buses. The characteristics of instruction sets, pipeline techniques, high-speed memories like cache, and multiprocessors.

CS 463: Knowledge Engineering**3 Credit Hours**

Prerequisite: CS 318 and CS 362

This course enables learners to gain the fundamentals of Semantic Web technologies and how they are applied for knowledge representation in the World Wide Web. Learners will learn how to represent knowledge with ontologies and how to access and benefit from semantic data on the Web (e.g. SPARQL). Furthermore, Learners will learn how to develop Web applications using HTML5 and JavaScript MVC frameworks, such as backbone.js, ember.js, AngularJS, Sencha, Kendo UI, and more. Moreover, learners will also learn how to make use of Linked Data and the Web of Data, as the most popular applications based on Semantic Web technologies.

CS 464: Game Design and Development**3 Credit Hours**

Prerequisite: CS 362 and CS 181

An introduction to the fundamental concepts of computer game programming such as: game memory management, GUI programming for games, differing game types, modes, & perspectives, game & level design, and gaming industry issues. Students design and develop original games for PCs applying proven game design and software engineering principles.

CS 472: Compiler Design

3 Credit Hours

Prerequisite: CS 282

Basic concepts, compiler components, lexical analysis, symbol tables, parsing techniques, error handling and recovery, syntax-directed translation, type checking, run-time organization, intermediate code generation, code generation, and code optimization. The students will write a parser according to specified grammar rules.

CS 475: Emerging Computer Systems

3 Credit Hours

Prerequisite: CS 375 and CS 451

Definition and characteristics of distributed computer systems, architectural and software models, remote procedure calls, distributed objects, processes and threads, logical clocks and ordering of events, distributed algorithms (e.g., mutual exclusion, consensus and election, termination detection), pervasive computing, distributed multimedia systems, distributed file systems, replication, and transactions and concurrency control.

CS 476: High Performance Computing

3 Credit Hours

Prerequisite: CS 475 or concurrent

Definition and characteristics of distributed computer systems, architectural and software models, remote procedure calls, distributed objects, processes and threads, logical clocks and ordering of events, distributed algorithms (e.g., mutual exclusion, consensus and election, termination detection), pervasive computing, distributed multimedia systems, distributed file systems, replication, and transactions and concurrency control.

CS 481: Computer Graphics

3 Credit Hours

Prerequisite: CS 284

Types of graphics, hardware-point plotting, vector and raster technologies, techniques for defining image-point, vector and raster based approaches, graphical data and program structure, two- and three-dimensional transformations, techniques for producing perspective, hidden line removal, shading, clipping, windowing, and graphical art and animation. Demos using software packages.

CS 482: Image Processing

3 Credit Hours

Prerequisite: CS 362 and CS 181

Review of image formation and acquisition; image transformation; image enhancement and restoration; image compression; morphological image processing; edge detection and segmentation; architecture for image processing.

CS 483: Fundamentals of Bioinformatics**3 Credit Hours**

Prerequisite: CS 284 and MATH 233

Broad overview of bioinformatics with a significant problem-solving component, including hands-on practice using computational tools to solve a variety of biological problems. Topics include: database searching, sequence alignment, gene prediction, RNA and protein structure prediction, construction of phylogenetic trees, and comparative and functional genomics.

CS 484: Computer and Network Security**3 Credit Hours**

Prerequisite: CS 342 and CS 375

This course is intended to give the students the principles and concepts of computer security. The students should be able to understand what it means for a system to be secure. Furthermore, the students will get to know about computing systems vulnerabilities, threats, and security controls. The course includes the following topics: Introduction to cryptography, confidentiality, authentication, digital signatures, program security, operating systems security, and network security.

CS 485: Multimedia Systems and Networking**3 Credit Hours**

Prerequisite: CS 342 and CS 375

Introduction to the principles and to the current technologies of multimedia system design and gain hands-on experience in this area. Topics include multimedia systems design, multimedia hardware and software, issues in effectively representing, processing, and transmitting multimedia data such as text, graphics, sound and music, image and video.

CS 486: Simulation and Modeling**3 Credit Hours**

Prerequisite: CS 211 and MATH 233

This course discusses different topics in simulation and modeling, such as the uses, advantages and disadvantages of simulation, types of models, the steps in discrete-event system simulation, statistical models, simple queuing models, random numbers and random variates, input modeling, model verification and validation, and its use in input-output analysis. Sample implementations for queuing system simulations are discussed using selected languages.

CS 491: Graduation Project I**1 Credit Hours**

Prerequisite: Completion of (90 CHs)

Provides the senior student with the opportunity to undertake a substantial graduation project under the supervision of a faculty member. At least two weeks prior to registration, an interested student must submit to the department chair a written request for permission to select a project. The request is to include a preliminary description of the proposed project and the name of the supervising faculty member. During this course, the student is expected to specify and design the proposed system or software.

CS 492: Graduation Project II**2 Credit Hours**

Prerequisite: CS 491

This is a continuation of CS 491, where the student implements, tests and presents the proposed system or software to a 3-member faculty committee that includes the project's supervisor. A written report is to be submitted to the department and committee.

CS 496: Special Topics in Theoretical Computer Science

3 Credit Hours

Prerequisite: Department Approval

The department chooses some topic related to the field of theoretical computer science.

CS 497: Special Topics in Computer Systems

3 Credit Hours

Prerequisite: Department Approval

The department chooses some topic related to the field of computer systems.

CS 498: Special Topics in Computer Applications

3 Credit Hours

Prerequisite: Department Approval

The department chooses some topic related to the field of computer applications.