

**Ministry of Education  
King Saud University  
Deanship of Graduate Studies  
College of Computer and  
Information Sciences  
Department of Computer Science**



**Ph.D. Program in Computer Science  
(Courses and Thesis Option)**

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## **Introduction**

The College of Computer and Information Sciences (CCIS) was founded in response to the need for computer specialists by the Royal Decree No. 7/1558/M, dated 10/05/1404 A.H.

The college has five scientific departments offering Bachelor of Science degrees: Computer Science, Computer Engineering, Information Systems , Software Engineering and Information Technology for females' students. Besides, the college offers three Master of Science in Computer Science, Computer Engineering, and Information Systems. The number of graduates from the Computer Science Master programs over the last 5 years is 159 students. The department of Computer Science has 55 faculty members (8 Professors, 9 Associate Professors, and 38 Assistant Professors), most of whom provide many professional and consulting services of diverse computer technology areas for various governmental, public and private sectors.

In the recent decades, the world witness tremendous developments in information technology, computer science, and information and knowledge systems. The reliability aspects of contemporary life and quality of life on many of these technologies has led to the increasing demands for specialized cadre with high expertise in computer science to work in research and development centers at universities, research centers such as King Abdul Aziz City for Science and Technology, etc. In addition, there is an increasing demand for computer graduates, males and females, to work as academic staff in the expanding computer departments in new public and private universities.

Furthermore, it became scientifically important to raise the scientific and technology level of Saudi leaderships and decision makers in the information technology fields. This can be achieved through university graduate programs. The Kingdom's Information Technology National Plan shows that there is a fast growing demand in the next decade for professionals in advanced scientific

and technical areas of computers and communication technologies. The study proposed number of recommendations to address the high shortage level of specialized cadres in computer science and information technology. The most important of which is the expansion in postgraduate programs to qualify Saudi teaching staff and academic faculty. Another important recommendation is to facilitate the attraction of distinguished scholars and scientists in computer science in order to transfer expertise and learning from the international experiences.

The number of graduates from the Ph.D. joint program (computer science, computer engineering, and information science), in the computer science track, over the last three years is more than 15 students. Furthermore, the number of applicants to the computer science track of the Ph.D. joint program is continuously increasing over the last five years.

From these standpoints, a standalone graduate Ph.D. program in Computer Science is proposed herewith to contribute to provide graduate studies and advanced research in the fields of computer science. This will contribute in creating qualified researchers and faculty members in this area.

### **Degree Name**

Ph.D. in Computer Science

### **Program's language**

English

## **Significance and Justifications of Program Amendment**

1. Large number of faculty members competent to supervise Ph.D. theses: 8 Professors and 9 Associate Professors.
2. Diverse specialties of faculty including Networks, Artificial Intelligence, Natural Language Processing, Image Processing, Human-Computer Interaction, and Parallel Processing.
3. Large number of graduates from the CS master program.
4. More than 15 graduates from the Ph.D. Joint Program (CS track).
5. Large number of applicants to the Ph.D. Joint Program (CS track).

### **Program's Vision**

Become a regional and international leader in providing high-quality graduate education and research.

### **Program's Mission**

Provide educational and research environment to prepare graduates for careers as university educators, research scientists or specialized professionals in computer science and in interdisciplinary areas that extend the scope of computer science.

### **Program's Objectives**

1. To promote advanced research and scientific publication and to contribute to the future scientific and technical world advancement in computer science.
2. To prepare highly specialized scholars, professionals and Saudis research personnel, manpower and expertise that meet the Saudi society development needs, and jobs demand; and support the successful

transfer of advanced information technologies in industry, academic and scientific sectors.

3. To create solutions for the persistent computing problems in the public and governmental institutions through a higher level of applied research and IT technology transfer.
4. To provide graduate students and Saudis researchers with skills, means, methodology, innovation and scientific approaches necessary for distinguished professionals in IT sectors.

## **Program's Outcomes**

### **A-Knowledge and Comprehension**

1. Demonstrate a mastery in applying theories, methodologies, and knowledge, to address research questions.
2. Demonstrate ability to carry out independent and original research.
3. Demonstrate comprehensive knowledge required for undergraduate teaching and assessment of student learning.

### **B- Mental Skills**

1. Develop critical and creative thinking to address fundamental questions in computer science.

### **C- Professional and Practical Skills**

1. Demonstrate professionalism and integrity in teaching and conducting research.
2. Demonstrate oral and written communication skills to be able to publish scientific papers, present technical work in computer science, and communicate with people from various backgrounds.
3. Demonstrate teamwork and managerial skills needed for working within research groups.

## **D– General Skills**

1. Follow the principles of ethics in academia and society.
2. Develop intellectual independence.

## **Program’s Beneficiaries**

1. Saudi students.
2. Non–Saudi students having an official grant.

## **Employment Opportunities Available**

The graduates from the CS Ph.D. program can mainly be employed as:

1. University educators and researchers in Saudi universities.
2. Researchers in Saudi research centers.
3. IT professionals in various IT sectors.
4. IT entrepreneurs and managers.

## **Admission Requirements**

In addition to the admission requirements enumerated in the Unified Law Organizing Graduate Studies at Saudi Universities, and the executive and regulatory procedural rules of King Saud University, the Department has of the following admission requirements:

1. Having a master degree in Computer Science or in another related specialty from King Saud University, and having obtained a minimum grade average of “Very Good” in the master degree, if awarded by a university that uses such a grading system.
2. Having TOEFL–PBT score of at least 500, or passing an equivalent English exam.

3. Having GRE score of at least 148 in the quantitative part, or passing an equivalent exam.
4. Providing a recent CV (with copies of relevant documents).
5. Submitting a report describing research interests, scientific publishing, awards and others. At least three research areas should be highlighted in order of preference (With copies of all related documents).
6. Passing a personal interview.

### **Requirements for Obtaining the Degree**

1. Successful completion of 26 units of graduate courses in the Ph.D. program.
2. To pass a comprehensive exam in the student's specialty or other subspecialties decided by the program council and according to the general rules for the comprehensive exam as issued by the deanship of graduate studies.
3. Completion and successful defense of an original thesis.
4. To publish or obtain an acceptance for at least one publication in a specialized referred journal according to the student's specialty.

## Program's General Structure

Number of required units is (26) in addition to (12) units for a thesis.

Type of Courses	No. of Courses	No. of Units Required
General Courses -list (1)	1	3
Courses from IS or CENX Ph.D. programs -list (2)	2	6
CS Core Courses	4	8
CS Elective Courses -list (3)	3	9
Thesis	1	12
<b>Total</b>	11	<b>(26) study units and (12) thesis units</b>



## Program's Study Plan

### First Level

#	Course Code	Name	No. of Study Units
1	---	General course from list (1)	3(3+0)
2	---	Course from IS or CENX Ph.D. programs - list (2)	3(3+0)
3	---	Course from IS or CENX Ph.D. programs - list (2)	3(3+0)
<b>Total</b>			<b>(9) study units</b>

### Second Level

#	Course Code	Name	No. of Study Units
1	CSC 601	Advanced Computing Science and Applications	3(3+0)
2	---	Elective course (1) from list (3)	3(3+0)
3	---	Elective course (2) from list (3)	3(3+0)
<b>Total</b>			<b>(9) study units</b>

### Third Level

#	Course Code	Name	No. of Study Units
1	CSC 696	Independent Research Study -1-	2(2+0)
2	---	Elective course (3) from list (3)	3(3+0)
3	CSC 699	Thesis Proposal Preparation	1(1+0)
<b>Total</b>			<b>(6) study units</b>

### Fourth Level

#	Course Code	Name	No. of Study Units
1	CSC 697	Independent Research Study -2-	2(2+0)
<b>Total</b>			<b>(2) study units</b>

### Fifth Level

#	Course Code	Name	No. of Study Units
1	COM 700	Comprehensive exam	0
<b>Total</b>			<b>(0) units</b>

## Sixth Level

#	Course Code	Name	No. of Study Units
1	CSC 700	Thesis	12
<b>Total</b>			<b>(12) thesis units</b>

### List (1): General Courses

(The student selects one general course with (3) study units.)

#	Course Code	Name	No. of Study Units	Requisite
1	MATH505	Numerical Linear Algebra	3(3+0)	MATH242 -/P MATH244 -/P MATH253 -/P MATH254 -/P
2	STAT503	Probability & Mathematical Statistics	3(3+0)	
3	MATH507	Advanced Operation Research	3(3+0)	MATH253 -/P MATH254 -/P

**List (2): Courses from CENX or IS Ph.D. programs**

(The student selects two courses with a total of (6) study units.)

#	Course Code	Name	No. of Study Units	Requisite
1	CENX621	Advanced Computer Architecture	3(3+0)	
2	CENX631	Advanced Computer Networks	3(3+0)	
3	CENX643	Digital Signal Processing	3(3+0)	
4	IS 601	Enterprise Resources & Planning	3(3+0)	
5	IS 602	IT Project Management	3(3+0)	
6	IS 603	Systems Analysis & Design	3(3+0)	

**List (3): CS Elective Courses**

(The student selects three courses with a total of (9) study units.)

#	Course Code	Name	No. of Study Units	Requisite
1	CSC 618	Selected topics in Computer Systems & Networks	3(3+0)	
2	CSC 619	Selected topics in Computer Security	3(3+0)	
3	CSC 626	Advanced Theory of Computation & Computability	3(3+0)	
4	CSC 627	Design & Implementation of Real-Time Systems	3(3+0)	
4	CSC 628	Selected topics in Programming Languages	3(3+0)	
6	CSC 629	Selected topics in Arabisation	3(3+0)	
7	CSC 637	Parallel Processing	3(3+0)	
8	CSC 647	Software Testing, Validation, & Verification	3(3+0)	
9	CSC 648	Selected topics in Software Engineering	3(3+0)	
10	CSC 657	Pervasive Computing Architecture & Design	3(3+0)	

11	CSC 661	Emergent Computing & Swarm Intelligence	3(3+0)	
12	CSC 662	Artificial Intelligence	3(3+0)	
13	CSC 663	Machine Learning	3(3+0)	
14	CSC 668	Selected Topics in Artificial Intelligence	3(3+0)	
15	CSC 669	Selected Topics in Image Processing & Pattern Recognition	3(3+0)	
16	CSC 677	Selected Topics in Computer Graphics	3(3+0)	
17	CSC 678	Selected Topics in Virtual Reality & Computer Vision	3(3+0)	
18	CSC 679	Human Computer Interaction	3(3+0)	
19	CSC 687	Data Warehouse and Mining Systems	3(3+0)	
20	CSC 688	Selected Topics in Database Systems	3(3+0)	
21	CSC 691	Bioinformatics	3(3+0)	
22	CSC 698	Advanced Topics in Computer Science	3(3+0)	

## Description of the Courses

<b>CSC 601</b>	<b>Advanced Computing Science &amp; Applications</b>	<b>3(3+0)</b>	
Graph theory and applications in computer science – Computational methods and application in computing science – Advanced data structures – Applications in computing – Discrete mathematics applications in computing – New trends in computing science.			

<b>CSC 618</b>	<b>Selected Topics in Computer Systems &amp; Networks</b>	<b>3(3+0)</b>	
New trends and research directions in the area of Computer Systems and Networks, including new trends in the design and performance of computer systems and networks, network programming, error detection in computer systems and networks, security and privacy.			

<b>CSC 619</b>	<b>Selected Topics in Computer Security</b>	<b>3(3+0)</b>	
New trends and research directions in the area of Computer Security including: Threats and vulnerabilities – Identification and authentication – Access control – Intrusion detection – Encryption and privacy – Security policies and their evaluation – Steganography and applications.			

<b>CSC 626</b>	<b>Advanced Theory of Computation &amp; Computability</b>	<b>3(3+0)</b>	
<p>In-depth study of concepts related to computability – Chomsky hierarchy – Turing machines – Computability – Decidability – Nondeterministic automats, recursive function theory – Theory of complexity and complexity classification.</p>			

<b>CSC 627</b>	<b>Design &amp; Implementation of Real-Time Systems</b>	<b>3(3+0)</b>	
<p>Real-Time Systems – Real-Time applications and support Real-Time Languages – Specific hardware interfaces for Real-Time Systems: real-time data collection and processing – Different types and levels of Control in Real-Time Systems (e.g. closed-loop control) – Real-Time Operating Systems – Predictability in Real-Time Systems – Introduction to methodologies for the design and implementation of Real-Time Systems – Cases studies.</p>			

<b>CSC 628</b>	<b>Selected Topics in Programming Languages</b>	<b>3(3+0)</b>	
<p>New trends and research directions in the area of Programming Languages including: Recent developments in programming language design and implementation, correctness, uniformity, practicality, technological advances on the state of the art, new approaches to programming languages.</p>			



<b>CSC 629</b>	<b>Selected Topics in Arabisation</b>	<b>3(3+0)</b>	
New trends and research directions in the area of Arabisation including Arabic language processing and its various applications.			

<b>CSC 637</b>	<b>Parallel Processing</b>	<b>3(3+0)</b>	
Overview of High Performance Computers, parallel program performance measurement, study different paradigms for achieving parallelism including explicit and implicit parallelization, fine grain and data flow models, shared memory and message passing parallel computers, and the difference between the SIMD versus MIMD types of Computers. Experiments will be conducted on different parallel programming frameworks, including PVM, MPI and LAPI as provided with the IBM RS/6000 eServer computer.			

<b>CSC 647</b>	<b>Software Testing, Validation, &amp; Verification</b>	<b>3(3+0)</b>	
Testing in the development life cycle – Testing methodology – Methods for evaluating software for correctness, performance and reliability – Software validation and verification – Static testing – Code inspection – Dynamic testing – Unit testing – System testing – Statistical testing – Testing tools – New trends in software testing.			

<b>CSC 648</b>	<b>Selected Topics in Software Engineering</b>	<b>3(3+0)</b>	
<p>New trends and research directions in the area of software engineering including: software requirements, software project management, software cost, software quality, software testing, software measurements, and software risk management.</p>			

<b>CSC 657</b>	<b>Pervasive Computing Architecture &amp; Design</b>	<b>3(3+0)</b>	
<p>This course covers pervasive computing principles and applications in depth. The topics include: sensor networks; primitive data types for sensor networks; programming sensor networks; mobility support; MANETs; middleware systems; context modeling and awareness; software engineering principles for pervasive computing; usability aspects of pervasive computing; wireless security and privacy.</p>			

<b>CSC 661</b>	<b>Emergent Computing &amp; Swarm Intelligence</b>	<b>3(3+0)</b>	
<p>Evolutionary algorithms – Swarm Intelligence – Artificial Immune Systems – Evolving Connectionist systems – Cellular Automata – Collective Intelligence – Reverse Emergence – Cellular neural network – Amorphous computing – DNA Computing – Quantum Computing.</p>			

<b>CSC 662</b>	<b>Artificial Intelligence</b>	<b>3(3+0)</b>	
<p>AI problem solving - Knowledge representation - Automatic theorem proving - Learning by example - Learning by analogy - Learning by discovery - Self-reference and Self-production - Reasoning: causal reasoning - commonsense reasoning - default reasoning - measure-based approaches - reasoning with uncertainty - Confirmation theory - Belief theory - Necessity and possibility theory - Theory of endorsements - Spatial and temporal reasoning.</p>			

<b>CSC 663</b>	<b>Machine Learning</b>	<b>3(3+0)</b>	
<p>This course covers the theory and practice of machine learning from a variety of perspectives (including Design, analysis, implementation and applications of learning algorithms). The course covers theoretical concepts such as induction, deduction, reinforcement and interaction. Topics include learning decision trees, neural network learning, statistical learning methods, genetic algorithms, Bayesian learning methods, explanation-based learning, and reinforcement learning, support vector machines, decision trees, Bayesian networks, association rules, dimensionality reduction, feature selection and visualization.</p>			

<b>CSC 668</b>	<b>Selected Topics in Artificial Intelligence</b>	<b>3(3+0)</b>	
<p>New trends and research directions in the area of artificial intelligence, including: knowledge representation, searching, reasoning and uncertain reasoning, planning, and applications.</p>			

<b>CSC 669</b>	<b>Selected Topics in Image Processing &amp; Pattern Recognition</b>	<b>3(3+0)</b>	
<p>New trends in the area of digital image processing and pattern recognition including: Images enhancement – Images segmentation – Representation of objects – Pattern Classes – Recognition based on Decision Theoretic and Structural Methods.</p>			

<b>CSC 677</b>	<b>Selected Topics in Computer Graphics</b>	<b>3(3+0)</b>	
<p>New trends in the area of Computer Graphics: Three dimensional Modeling and viewing – Surfaces and curves in three dimensions – Solid bodies modeling – Three dimensional viewing – Visible surface – Illumination and shades – Texture mapping – Animation techniques</p>			

<b>CSC 678</b>	<b>Selected Topics in Virtual Reality &amp; Computer Vision</b>	<b>3(3+0)</b>	
<p>New trends and developments in the area of Virtual Reality and Computer Vision including developments in stereoscopic perception and rendering, sensor fusion, human perception, and virtual reality technology.</p>			

<b>CSC 679</b>	<b>Human Computer Interaction</b>	<b>3(3+0)</b>	
<p>Design of user interfaces based on the capabilities of computer technology and the needs of human factors. Design process. Implementation support. Evaluation. User models. Task models and dialogues. Virtual and augmented reality . Hypertext and multimedia. Approaches and developments in the field.</p>			

<b>CSC 687</b>	<b>Data Warehouse &amp; Mining Systems</b>	<b>3(3+0)</b>	
<p>Decision Support Systems (DSS) - Development of DSS - Data Modeling Techniques and Development of Data Warehouse in an architected Environment - Study of different Data Warehouse Architectures and Development Techniques - User-Interface for Data Warehouses - Data Mining - Application Domains for Data Warehouse and Mining - Project: Development of a Prototypical Data Warehouse/Mining System.</p>			

<b>CSC 688</b>	<b>Selected Topics in Database Systems</b>	<b>3(3+0)</b>	
<p>New trends and developments in the area of Database Systems including: Developments in object oriented, deductive, spatial, temporal and constraint database management systems - New database applications and architectures such as multi-databases and their applications in multimedia and mobility domains.</p>			

<b>CSC 691</b>	<b>Bioinformatics</b>	<b>3(3+0)</b>	
<p>Bioinformatics is a rapidly evolving field that studies biological systems and biological data (such as DNA/protein sequences, macromolecular structures and functional genomics data) using analytic theory and practical tools of computer science, mathematics and statistics. The topics include concepts of molecular genetics, biological databases, database searching, sequence alignments, phylogenetic trees, structure prediction, and microarray data analysis.</p>			

<b>CSC 696</b>	<b>Independent Research Study -1-</b>	<b>2(2+0)</b>	
<p>The student selects a research topic and conducts a literature review in relation to the topic.</p>			

<b>CSC 697</b>	<b>Independent Research Study -2-</b>	<b>2(2+0)</b>	
<p>The student selects a research topic and conducts a literature review in relation to the topic.</p>			

<b>CSC 698</b>	<b>Advanced Topics in Computer Science</b>	<b>3(3+0)</b>	
<p>In this course, students study some advanced topics in Computer Science. The content and syllabi of this course is designed by a member of staff and approved by the department.</p>			

<b>CSC 699</b>	<b>Thesis Proposal Preparation</b>	<b>1(1+0)</b>	
<p>Identify an original research topic. Formulate a problem statement. Understand the background of the research project. Study related work. Develop or adapt potential research directions. Summarize the state of the project as a thesis proposal.</p>			

<b>CSC 700</b>	<b>Thesis</b>	<b>(12) thesis units</b>	<b>CSC 699 -/P</b>
<p>Complete the research work proposed (thesis proposal). Publish the results of the research. Write a dissertation which describes the research work and presents the results. Final defense.</p>			

## Description of the General Courses from College of Sciences

<b>STAT503</b>	<b>Probability &amp; Mathematical Statistics</b>	<b>3(3+0)</b>	
<p>Probability. Random Variable. Expectation. Some Distributions. Functions of R.V. Sampling distributions. Estimation. Hypothesis, Testing, Correlation and Regression. Analysis of Experiments.</p>			

<b>MATH505</b>	<b>Numerical Linear Algebra</b>	<b>3(3+0)</b>	MATH242 -/P MATH244 -/P MATH253 -/P MATH254 -/P
<p>Direct &amp; Iterative methods for solving system of linear equations (including cases with special matrices) along with error convergences analysis. Numerical methods for solving least square problems and approximation of functions. Various methods for computing the Eigen values and Eigenvectors for symmetric and non-symmetric matrices. Applications.</p>			

<b>MATH507</b>	<b>Advanced Operation Research</b>	<b>3(3+0)</b>	MATH253 -/P MATH254 -/P
<p>Linear optimization models. Geometric interpretation. Simplex, two phase, revised simplex and Karmarkar's methods for solving linear programming. Duality and sensitivity analysis. Parametric programming. Applications. Introduction to the nonlinear programming.</p>			



## Description of the Courses from CENX or IS Ph.D. programs

<b>CENX621</b>	<b>Advanced Computer Architecture</b>	<b>3(3+0)</b>	
<p>Instruction set principles, Pipelining, pipelining hurdles. Instruction level parallelism, Data hazards avoidance, Dynamic Scheduling, Dynamic Hardware prediction. Memory Hierarchy Design, Cache design, Storage systems, Busses, I/O performance measures. Interconnection Networks, Introduction Multiprocessors architectures.</p>			

<b>CENX631</b>	<b>Advanced Computer Networks</b>	<b>3(3+0)</b>	
<p>Review of OSI layered Architecture, TCP/IP Protocols, Data link layer: HDLC, Window flow control, Network layer: Datagram and virtual circuit, Transport protocol: Error-detection and recovery, Presentation layer: Security, Privacy, Text compression, Application layer: Distributed computing, Network operating systems.</p>			

<b>CENX643</b>	<b>Digital Signal Processing</b>	<b>3(3+0)</b>	
<p>Discrete time signals, Z-transforms. Discrete Fourier transform (DFT). Fast Fourier transform (FFT). Design of finite impulse response filter (FIR) and Infinite impulse response filter (IIR), Effects of finite word length.</p>			

<b>IS 601</b>	<b>Enterprise Resources &amp; Planning</b>	<b>3(3+0)</b>	
<p>Basic elements and considerations of an enterprise computing solution, including systems integration issues, people versus technology issues, plus project management and implementation issues. Concepts of production planning and control with ERP systems, relationship with manufacturing and logistics strategies. Other ERP related topics, including technical, management, and global issues common to a typical business and manufacturing environment.</p>			

<b>IS 602</b>	<b>IT Project Management</b>	<b>3(3+0)</b>	
<p>Introduction to Project Management. The nine project management knowledge areas – project, integration, scope, time, cost, quality, human resource, communications, risk, and procurement management. The five process groups – initiating, planning, executing, controlling, and closing. Project Management and Information Technology Context, Project Integration Management, Project Scope Management, Project Time Management, Project Cost Management, Project Quality Management, Human Resource Management, Project Communications Management, and Project Risk Management.</p>			

<b>IS 603</b>	<b>Systems Analysis &amp; Design</b>	<b>3(3+0)</b>	
<p>Approaches used by information system developers to discover and model the requirements. Construct an acceptable design to implement a successful system solution. Tools and techniques that the programmer or analyst uses to develop information systems.</p>			