College of Computing
Bachelor of Science in Computer Engineering

1. Overview

This program is designed to grant students the Bachelor of Science in Computer Engineering upon completing the five-year program.

2. Tracks in CEN Degree

There is only one track: Computer Engineering

3. University Graduation Requirements

To graduate with a Bachelor of Science in Computer Science, students must complete a five-year program consisting of **158** credit hours. The distribution of courses is as follows:

4. Degree Requirements

Program Structure	Required/ Elective	No. of courses	Credit Hours	Percentage
Institution Requirements	Required	14	34	21.52%
	Elective	1	3	1.90%
College Requirements	Required	15	37	23.42%
	Elective			
Program Requirements	Required	23	64	40.51%
	Elective	6	15	9.49%
Capstone Course/Project		2	4	2.53%
Field Experience/ Internship		1	1	0.63%
Others				
Total		**62**	**158**	**100%**

4.1 University Requirements

University Requirements consist of 34 credits compulsory and free elective of   3 credit hours distributed as follows:

A. University requirements are listed below:

Course Code	Course Title	Pre-Requisite Courses	Type of requirements (Institution, College or Department)	Credit Hours
ENG 100	General English		I	3
ENGL 206	Technical Writing	ENGL 102	I	3
MATH 110	Mathematics I		I	3

PHE 101	Physical and Health Education		I	1
ENGL 101	Basic Academic English I		I	3
SOCS 101	Islamic Civilization I		I	3
ENGL 102	Basic Academic English II	ENGL 101	I	3
ARAB 101	Basic Academic Arabic		I	3
ARAB 201	Advanced Academic Arabic	ARAB 101	I	3
ENGL 203	Advanced Academic English I	ENGL 102	I	3
MATH 120	Mathematics II	MATH 110	I	3
IT 100	Information Technology		I	3
			Total	**34**

B. Free electives (3 credit hours) could be selected from the following list:

Course Code	Course Title	Pre-Requisite Courses	Credit Hours
ASTR 150	Introduction to Astronomy		3
CHEM 150	Chemistry and Society		3
SOCS 201	Islamic Civilization II	SOCS 101	3
SOCS 202	World Civilization		3
SOCS 203	History of the Kingdom of Saudi Arabia		3
FREN 101	Basic French I		3
PHED 101	Physical Education I		3
CIT 101	Future Technologies		3

4.2 College Requirements

College Requirements consist of <u>37</u> credit hours distributed as follows:

Course Code	Course Title	Pre-Requisite Courses	Type of requirements (Institution, College or Department)	Credit Hours
CSC 100	Introduction to Computing		I	3
MATH 101	Calculus I		I	3
PHYS 101	General Physics I		C	3
PHYS 101L	General Physics I Lab	PHYS 101	C	1
MATH 102	Calculus II	MATH 101	C	3
STAT 230	Probability and Statistics	MATH 201	C	3
CEN 220	Logic Design	MATH 211(co)	C	3
CEN 220L	Logic Design Lab	CEN 220	C	1
CSC 102	Computer Programming I	CSC 100	C	3
CSC 102L	Computer Programming I Lab	CSC 102	C	1
CSC 212	Algorithms and Data Structure	CSC 102	C	3
CEN 221	Computer Organization and Assembly Language	CSC 212	C	3
CEN 221L	Computer Organization and Assembly Lang. Lab	CEN 221	C	1
CSC 492	Computing Ethics		C	3
CEN 320	Computer Architecture		C	3
Total				**37**

4.3 Program Specialization Requirements

Program specialization requirements consist of 84 credit hours; 69 compulsory credit hours and 15 elective credit hours distributed as follows:

4.3.1 Compulsory Specialization Requirements: (69) credit hours:

Course Code	Course Title	Pre-Requisite Courses	Credit Hours
CEN 240	Signal and Systems	ELEE 250(co)	3
CEN 250	Communication Systems	CEN 240	3
CEN 301	Electronics	ELEE 210	3
CEN 301L	Electronics labs	CEN 301	1
CEN 321	Embedded Systems	CEN 220	3
CEN 322L	Digital Systems Lab	CEN 321 (co)	1
CEN 330	Software Design	CSC 212	3
CEN 340	Computer Networks	CEN 240	3
CEN 440L	Networking Lab	CEN 340 (co)	1
CEN 350	Digital Integrated Circuits	CEN 301	3
CEN 360	Operating Systems	CEN 221	3
CEN 210L	Electric Circuits I Lab	ELEE 210	1
ELEE 210	Electric Circuits I	PHYS 102	3
ELEE 250	Electric Circuits II	ELEE 210	3
CHEM 101	College Chemistry		3
CHEM 101L	College Chemistry Lab	CHEM 101	1
CEN 498	Final Year Project I	Senior Standing	1
CEN 499	Final Year Project II	CEN 498	3
MATH 201	Calculus and Analytic Geometry III	MATH 102	3
MATH 202	Differential Equations	MATH 201	3
MATH 211	Discrete Mathematics		3
MATH 215	Linear Algebra and Numerical Techniques	MATH 201	3
PHYS 102	College Physics II	PHYS 101	3
PHYS 102L	College Physics II Lab	PHYS 102 (co)	1
COEN 300	Engineering Economy	STAT 230	3
CEN 398	Summer internship	Senior Standing	1
CEN 434	Cryptography and Computer Security*	Senior Standing	3
CEN 494	Digital Image Processing*	CEN 240	3
CEN 460L	Multimedia Lab		1
Total			**69**

*International Certificate

4.3.2 Computer engineering electives (15 credit hours) could be selected from the following list:

Course Code	Course Title	Pre-Requisite Courses	Credit Hours
CEN 403	Advanced Topics in Computer Engineering*		3
CEN 410	Computer-Aided Analysis and Design of VLSI Circuits		3
CEN 441	Information Theory		3
CEN 421	Advanced Computer Architecture		3
CEN 422	VLSI for Communications and Signal Processing		3
CEN 424	Digital Systems Testing		3
CEN 425	Advanced Embedded Systems		3
CEN 452	Web Server Design And Programming		3
CEN 454	Pervasive Computing Systems And Applications		3
CEN 493	Neural Networks		3
CSC 487	Computer Security		3
CSC 488	System Programming		3

*International Certificate ** Aljahiziah Exam

Course Description

➢ A) Required Courses:

CEN 220/ELEE 220   Logic Design   3(3, 1, 0)

A course that covers number systems and codes, switching algebra; combinational circuit analysis, synthesis, and practice; minimization methods; sequential logic design principles; latches and flip- flops, clocked synchronous state machines, designing state machines using state tables and state diagrams; introduction to the VHDL hardware description language.

Co-requisite: MATH 211.

CEN 220L   Logic Design Lab   1(0, 0, 2)

This laboratory course covers digital logic design. Experiments cover hardware design tools and technologies: hardware description language, high level synthesis

Co-requisite: CEN 220.

CEN 221/ELEE 320   Computer Organization and Assembly Language   3(3, 1, 0)

This is an introductory course in computer organization and architecture. Topics include basic hardware and software structure, addressing methods, programs control, processing units, I-O organization, arithmetic and logic units, main-memory organization, peripherals, microprocessor families, CSIC and RISC architectures, and multiprocessors. Assembly language is used as an aid to studying computer organization.

Co-requisite: CSC 212.

CEN221L/ELEE320L   Computer Organization and Assembly Language Lab   1 (0, 0, 2)

This Lab complements the contents of CEN 221L.

Co-requisite: CEN 221

CEN 240   Signals and Systems   **3(3, 1, 0)**

This course introduces students to the fundamental ideas of signals and system analysis. The topics covered in the course include basic properties of signals and systems, classifications of signals and systems, typical signals, the processing of signals by linear systems, the impulse response, Fourier series and transforms, sampling, discrete-time processing of continuous-time signals. This course should serve as a central building block for students interested in further studying information processing: image processing, communications, control, machine learning, and finance.

Co- requisite: ELEE 250

CEN 250   Communication Systems   **3(3, 1, 0)**

This course introduces principles of data and computer communications at the physical layer; analog to digital conversion and pulse coded modulation; transmission and reception of digital signals; digital modulation; performance of digital communication systems in the presence of noise and inter-symbol interference; equalization.

Prerequisite: CEN 240

CEN 301   Electronics   **3(3, 1, 0)**

This course covers semiconductors: PN junctions; diodes and diode circuits; field effect transistor; MOS transistor and applications such as amplifier and switch; bipolar junction transistor and applications such as amplifier and switch; and circuit simulation using SPICE.

Prerequisite: ELEE 210.

CEN 301L   Electronics Laboratory   **1(0, 0, 2)**

an introductory experimental laboratory that explores the design, construction, and debugging of analog electronic circuits. This subject covers diodes, transistors, JFETs, op-amps, and basic analog circuit design as applied to audio and radio frequency circuits.   *Co-requisite: CEN 301L*

CEN 320/CSC 363/ELEE 422 Computer Architecture   **3(3, 1, 0)**

Study of computer architecture from classical to advanced perspectives; explores architectural characteristics of modern computer systems such as performance, instruction sets, assemblers, data- paths, pipelining, caching, memory management, I/O considerations, multiprocessing, and other advanced systems.

Prerequisite: CEN 221.

CEN 321/ ELEE 423   Embedded Systems   **3(3, 1, 0)**

Implementation of microprocessors and microcontrollers in embedded digital computer systems; topics include architecture, operations, software; hardware/software design methodology; interfacing of microcomputers to peripherals or other computers for purposes of data acquisition, device monitoring and control, and other communications.

Prerequisite: CEN 220.

CEN 322L   Digital Systems Laboratory   **1(0, 0, 2)**

This laboratory course covers digital systems design. Experiments cover hardware design tools and technologies: hardware description language, high-level synthesis, ASIC and FPGA design flow; hardware/software co-design.

Co-requisite: CEN 321.

CEN 330   Software Design   **3(3, 0, 1)**

Study of the nature of the program development task when many people, modules and versions are involved in designing, developing and maintaining a large program or system; issues addressed include software design, specification, version control, testing, cost estimation and management; study of software systems in different domains such as database systems and HCI systems are also addressed.

Prerequisite: CSC 212.

CEN 340/ CSC 384/ELEE 431   Computer Networks   **3(3, 1, 0)**

This course presents the foundations of computer networks. It includes a top-down view of the layered architectural elements of communication systems: Application Layer, Transport Layer, Network Layer, and the Link Layer. In particular, the emphasis is on the Internet protocols, TCP/IP, client/server systems, packet switching, protocol stacks, queuing theory, application protocols, socket programming, remote service calls, reliable transport (Error detection and recovery, multimedia networking with quality of service and multicasting), UDP, and security.

Prerequisites: CEN 240/ CEN 221, CSC 356.

CEN 350/ ELEE 442   Digital Integrated Circuits   **3(3, 0, 1)**

Study of basic methods of digital integrated circuit design; emphasis will be on structured design methodologies for MOS systems with focus on performance considerations and design methodologies for VLSI IC chips; VLSI CAD tools are used to design and simulate a small CMOS chip.

Prerequisite: CEN 301.

CEN 360 **Operating Systems** 3(3, 0, 1)

A study of the internal design of operating systems; topics include memory management, multiprogramming, virtual memory, paging and segmentation; job and process scheduling; Multiprocessor systems; device and file management; thrashing, cache memory.

Prerequisites: CEN 221 and CSC 212.

CEN 398 **Summer Internship** 1(0, 1, 0)

This is an eight to twelve-week professional training course in computer engineering.

Prerequisite: ENGL 206.

CEN 440L **Networking Laboratory** 1(0, 0, 2)

This laboratory course covers the technologies and protocols of the Internet. The experiments cover the Internet Protocol (IP), Address Resolution Protocol (ARP), Internet Control Message Protocol (ICMP), User Datagram Protocol (UDP) and Transmission Control Protocol (TCP), the Domain Name System (DNS), routing protocols (RIP, OSPF, BGP), network address translation (NAT), dynamic host configuration (DHCP), network management protocols (SNMP), and IP multicast.

Prerequisite: CEN 340.

CEN 498 **Final Year Project I** 1 (0, 1, 0)

A supervised project in groups of normally three students aimed at providing practical experience in some aspect of computer engineering. Students are expected to complete a literature survey, project specification, critical analysis, and to acquire the necessary material needed for their intended end product.

Prerequisite: Senior standing.

CEN 499 **Final Year Project II** 3 (0, 3, 0)

A course that seeks to impart in students the skill to integrate the knowledge gained in different courses by asking them to deliver a product that has passed through the design, analysis, testing, and evaluation stages. This course includes production of a professional report, design process and outcome, implementation and testing, verification and validation, and critical appraisal of the project.

Prerequisite: CEN 498.

➢ *C) Required Electrical Engineering Courses:*
ELEE 210 **Electric Circuits I** 3(3, 1, 0)

A course on fundamentals of electric circuits; basic elements and laws; independent and dependent sources; techniques of circuit analysis: node voltage, mesh current, and source transformation; circuit theorems: superposition, Thevenin and Norton equivalents; inductors, capacitors, mutual inductance, and transformers; steady-state AC circuits; power calculations; circuit simulation using SPICE.

Prerequisite: PHYS 102.

CEN 210L **Electric Circuits Laboratory** 1(0, 0, 2)

This laboratory course covers passive electronic components; laboratory instruments; voltage- divider circuits; sources and Thevenins's theorem; RC lead-lag networks; the transformer; AC circuits.

Co-requisite: ELEE 210.

ELEE 250 **Electric Circuits II** 3(3, 1, 0)

A course on Laplace transform and its use in circuit analysis; s-domain representation; network functions; transient response of RC, RL, and RLC circuits; frequency-selective circuits; Bode plots; two-port networks; ideal op-amp; active filters; circuit simulation using SPICE.

Prerequisite: ELEE 210.

➢ *D) Elective Courses:*
CEN 403 **Advanced Topics in Computer Engineering** 3(3, 0, 0)

This course covers contemporary topics of interest to students.

Prerequisite: Consent of the instructor.

CEN 410 **Computer-Aided Analysis and Design of VLSI Circuits** 3(3, 1, 0)

This course covers circuit and logic simulation; timing analysis and verification; testing and fault simulation; logic and high-level synthesis; physical design automation.

Prerequisite: CEN 350.

CEN 420/ CSC 385/ ELEE 421   Computer Graphics   3(3, 1, 0)

A course on interactive graphics; graphics hardware; graphical input devices; windowing; clipping; viewports; zooming, geometrical transformations (2D and 3D); data structures; advanced raster display architectures; raster algorithms; special graphics techniques; applications.

Prerequisite: CSC 102/ ELEE 230.

CEN 421   Advanced Computer Architecture   3(3, 1, 0)

A course that focuses on the allocation of hardware and software resources in solving large-scale computing problems, with emphasis on the relationships between hardware organization, system programming, and language support in the evolution of advanced computer architectures.

Prerequisite: CEN 320.

CEN 422   VLSI for Communications and Signal Processing   3(3, 1, 0)

This course introduces concepts in the design and implementation of digital signal processing systems using integrated circuits. The main emphasis is on the architectural exploration, design and optimization of signal processing systems for communications. Algorithm, architecture, and circuit design techniques will be introduced that enable joint optimization across the algorithmic, architectural and circuit domains.

Prerequisite: CEN 350.

CEN 423   Reconfigurable Computing   3(3, 1, 0)

A course dealing with the design issues pertaining to the implementation of application specific architectures using the reconfigurable computing paradigm allowing the same circuit to be reused in order to run different applications. Emphasis will be on the systematic design of reconfigurable computing platforms that exploit a high degree of parallelism.

Prerequisite: CEN 320.

CEN 424   Digital Systems Testing   3(3, 1, 0)

A course on digital systems testing and testable design; test economics, fault modeling, logic and fault simulation, testability measures, test generation for combinational and sequential circuits, memory test, delay test, scan design, built-in self-test and boundary scan.

Prerequisite: CEN 220.

CEN 425   Advanced Embedded Systems   3(3, 1, 0)

This course covers embedded hardware and software design; system design process requirements: analysis, specification, hardware/software co-design, testing; Embedded computing platforms: general- and special-purpose processors, hardware accelerators, systems-on-a-chip, intellectual property (IP) core-based design, embedded networks; Software design tools and technologies: CAD tools, compilers, and assemblers. Hardware design tools and technologies: hardware-description languages, high-level synthesis tools, ASIC and FPGA design flows; Real-time operating systems: multiple tasks and processes, context switching, task scheduling, inter-process communication mechanisms.

Prerequisite: CEN 321.

CEN 426   Computer System Analysis   3(3, 1, 0)

This course focuses on the development of analytical models of computer systems and application of such models to performance evaluation. Topics covered include scheduling policies, paging algorithms, multi-programmed resource management, and queuing theory.

Prerequisite: CEN 320.

CEN 430   Database Systems   3(3, 1, 0)

A course that covers the nature and purposes of database systems and an introduction to data modeling: entity relationship model, relational model with relational algebra, relational calculus and SQL; integrity constraints; file organization and index files; and normalization.

Prerequisite: CEN 330.

CEN 431   Distributed and Object Database Systems   3(3, 1, 0)

Fragmentation, replication and allocation; strategies used in executing distributed queries subject to given criteria and the commit protocols for managing transactions in a distributed environment; parallel database implementations and the design of object database management systems; designing distributed database systems using a design project that requires the implementation of low level functionality associated with the functions of distributed database system.

Prerequisite: CEN 430.

CEN 432   Design and Analysis of Algorithms   3(3, 1, 0)

Sorting algorithms including merge-sort, quick-sort, and counting-sort; median and order statistics algorithms; sorting lower bound; divide-and-conquer design strategy; polynomial and matrix multiplication algorithms; balanced search trees; hash tables; augmenting data structures; number- theoretic algorithms; dynamic programming; greedy algorithms; graph algorithms including graph traversal algorithms and applications, minimum spanning tree, shortest path algorithms; distributed algorithms;

introduction to NP-completeness and intractability.

Prerequisite: CSC 212.

CEN 433   Advanced Topics in Algorithms   3(3, 1, 0)

General principles of algorithm design and analysis; linear programm   ing; randomized algorithms; advanced graph algorithms; NP completeness; introduction to complexity theory; approximation algorithms; number theoretic algorithms; selected topics.

Prerequisite: CEN 432.

CEN 435   Optimizing Compilers   3(3, 1, 0)

This course covers theoretical and practical aspects of building modern optimizing compilers. Topics: intermediate representations, basic blocks and flow graphs, data flow analysis, partial evaluation and redundancy elimination, loop optimizations, register allocation, instruction scheduling, and inter-procedural analysis. Students will implement significant optimizations within the framework of a modern research compiler.

Prerequisites: CSC 212 and CEN 320.

CEN 441/ELEE 472   Information Theory   3(3, 1, 0)

This course introduces the field of information theory and its applications to communications theory, computer science, statistics, and probability theory. Covering all the essential topics in information theory, we introduce the basic quantitie s of entropy, relative entropy, and mutual information, and show how they arise as natural answers to questions of data compression, channel capacity, rate distortion, and hypothesis testing; Shannon's fundamental coding theorem.

Prerequisites: CEN 240

CEN 442/ ELEE 473   Coding Theory   3(3, 1, 0)

This course introduces the theory of error-correcting codes. The course will focus on results of asymptotic or algorithmic significance. Topics include: construction and existence results for error-correcting codes; limitations on the combinatorial performance of error-correcting codes; BCH codes, Reed-Solomon codes; low density parity check codes; algebraic geometric codes; Turbo codes; and decoding algorithms; unique and soft decoding; applications in computer engineering such as: computer storage, compact disk player, satellite communications, bandwidth-limited systems.

Prerequisites: STAT 230 and MATH 215.

CEN 447   Queuing Theory   3(3, 1, 0)

Poisson counting and renewal processes; Markov chains and decision theory, branching processes, birth death processes, and semi-Markov processes; simple Markovian queues, networks of queues, general single and multiple-server queues, bounds and approximations.

Prerequisite: STAT230, CEN340

CEN 450   Client-Server Computing   3(3, 1, 0)

Internet and intranet technologies; the client-server model of interaction; design and implementation of clients and servers; interactive and concurrent servers; distributed computing; application gateways; design project.

Prerequisite: CEN 340.

CEN 451   Internet Engineering   3(3, 1, 0)

Examining major protocols used in Internet: IP, ICMP, TCP, UDP; new technologies introduced on the Internet: IP Multicast, Mobile IP, IPv6, VPNs, and quality of service; routing on the Internet; network security and firewall design; overview of the application protocols: SMTP, HTTP, RTP, and SNMP.

Prerequisite: CEN 340.

CEN 452   Web Server Design and Programming   3(3, 1, 0)

Major technologies used in building Web servers. Alternate versions are to be given each year: The Windows-based IIS Server and the Linux-based Apache server. For IIS, ASP.NET along with C# will be used for programming Web servers. For Apache, PHP will be the language of choice. The course starts with a fast track on client programming, the HTTP protocol, SQL database servers, and XML programming.

Prerequisite: Senior standing.

CEN 453   Multimedia and Networking   3(3, 1, 0)

Multimedia topics: system requirements, performance requirements, representation and compression; Multimedia networking is emphasized by discussing multicasting, streaming, multimedia networking protocols and quality of service based traffic management protocols; synchronization, VoIP, and Internet2; Multimedia networking applications are designed and implemented as student projects.

Prerequisite: CEN 340.

CEN 454   Pervasive Computing Systems and Applications   3(3, 1, 0)

Technologies involved in integrating front-end mobile devices into local and global networks.; emphasis is placed on the programmability and networking of mobile phones, PDAs, and Pocket PCs; hands on experience involve programming in Java2 ME, C/C++ for Palm OS, and .NET Compact Framework for Windows CE; general coverage of underlying technologies and standards: XML, WAP, UMTS, GPRS, Bluetooth, and Jini.

Prerequisite: Senior standing.

CEN 491/ ELEE 451   Digital Signal Processing   3(3, 1, 0)

Revision of signals, systems, and transforms; design of Digital Filters: FIR and IIR; sampling and reconstruction of signals; multi-rate signal processing with applications; effects of finite word length; discrete random signals and Spectral Estimation; introduction to 2D signal and image processing.

Prerequisite: CEN 240.

CEN 493   Neural Networks   3(3, 1, 0)

Perceptron, Madeline, back propagation, and adaptive neural networks; transformation by layered networks, statistical neuro-dynamics, associative memory, and neural learning; applications to functional approximations, signal filtering, and pattern classification.

Prerequisite: Senior standing.

CEN 434   Cryptography and Computer Security   3(3, 1, 0)

Overview of encryption and computer security; classical encryption techniques, block ciphers and the data encryption standard, finite fields, advanced encryption standard, confidentiality using symmetric encryption, public-key cryptography, key management, hash and MAC algorithms, digital signatures; authentication applications, intruders, and malicious software.

Prerequisite: Senior standing.

CEN 494/ ELEE 454   Digital Image Processing   3(3, 1, 0)

Two-dimensional signals and systems; image formation and perception; representation, coding, filtering restoration, and enhancements; feature extraction and scene analysis; introduction to computer vision.

Prerequisite: CEN 240

CEN 460L Multimedia Laboratory   1(0, 0, 2)

This laboratory course covers the technologies used in multimedia storage and communications. Multimedia formats for voice, music, and video are covered. Experiments also cover coding, streaming, and quality of service for multimedia applications.

Prerequisite: CEN 494.