German Jordanian University
Deanship of Graduate Studies

Master of Science
In
Computer Engineering
(Non-Thesis Track)

Study Plan
Academic Year 2020/2021
v1.0.5.2021

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1. Introduction

Computer Engineering (CE) combines the knowledge, skills, and discoveries in electrical engineering and computer science to build real-life computer systems. It covers several technology fields including computer hardware, software engineering and development, electronics, digital systems, telecommunication and network systems, multimedia, image and signal processing, robotics, and software-hardware integration. Computer engineers play a key role in almost all industries, such as telecommunication, banking and financial services, software development, government and city services, aerospace industry, health care, and manufacturing. The advent of computers has facilitated a systems approach to solving many problems in science, business, and industry.

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

2. Program Objectives

The primary objectives of the MCE program are to:

1. Provide master level education that enables our graduates to pursue rewarding professional careers, postgraduate studies, and lifelong learning.
2. Provide the ICT industry with professional engineers who have sound postgraduate qualification, comprehensive understanding of computer engineering, and ability to tackle complex engineering problems .
3. Create better understanding of the practical applications and profitability of computer systems among industry managers and professionals.
4. Carry out research to solve problems of the local and global industry and to promote a computer system infrastructure for better productivity and quality.

3. Learning Outcomes

The primary learning outcomes of the MCE program are:

1. Provide a solid theoretical education, practical engineering experience, and a comprehensive curriculum that improves the critical thinking and innovation skills of students.
2. Provide students with the education and training in the field of computer engineering that allow them to make real contributions to the society and lead their careers.
3. Build an awareness of computing practices in industry and emerging technologies, emphasizing a working knowledge of current computer design and development techniques.

4. Enrollment

Students wishing to enroll in the Master's degree program in Computer Engineering must have:

A. Obtained a Bachelor of Science degree in the following disciplines with a GPA not less than 70% or equivalent:
   - Computer science
   - Computer Information Systems
   - Management Information Systems
   - Computer Engineering
   - Communications Engineering
   - Software Engineering
   - Electrical/Electronic Engineering
   - Mechanical Engineering
   - Mechatronics Engineering

B. Passed the TOEFL Exam with a minimum score of 500 or equivalent.

C. Relevant working experience is preferable.

Students holding other degrees need to consult with the program director for application. Students are expected to have background spanning the following:

1. Computer Systems Hardware and Software
2. Programming, data and object structures

Above is a minimum foundation of essential prerequisite knowledge needed for all students pursuing this program. Students admitted with B.Sc. in Electrical/Electronic Engineering, Mechanical Engineering, and Mechatronics Engineering must take a set of computer systems foundation courses. These foundation courses are offered at the graduate level, representing a common body of knowledge, and cover more material at a more conceptual level than comparable undergraduate courses.

5. Degree requirements

Students must complete the following requirements to obtain a degree in Computer Engineering:

A. A total of 24 credit hours CE core courses at GJU.
B. A total of 9 credit hours of elective courses.

Classification	GJU semester credit Hours		
	Compulsory	Electives	Total
Computer Engineering Core Courses	24	-	24
Specialization		9	9
Comprehensive Examination	0		0
		Total =	**33**

The core courses provide students with a broad knowledge in various topics in computer systems including Artificial Intelligence and Cyber Physical Systems. The core courses are to be taken at GJU in the first two semesters of the program. After completion of the core courses, students have their choice of elective courses to be offered at GJU. The elective courses cover a variety of topics in software engineering, computer networks, artificial intelligence, internet of things, and others.

At the end of completion of all required courses, all non-thesis students are required to sit for a comprehensive exam covering. The comprehensive exam covers concepts in core courses in the curriculum. In order to sit for the comprehensive exam students are required to register for course code CE 799 in the final semester of their studies.

6. Curriculum

6.1 Core Courses

The core courses are a total of 24 credit hours to be taken at GJU and comprise of the following:

Course Code	Course Name	Credit Hours
CE 701	Probability and Stochastic Modeling	3.0
CE 702	Parallel and distributed systems	3.0
CE 704	Network and communication systems	3.0
CE 706	Big Data Analysis	3.0
CE 716	Machine learning and Pattern Recognition	3.0
CE 707	Embedded Systems	3.0
CE 771	Internet of Things	3.0
CE 717	Image Processing	3.0
	Total =	**24**

6.2 Elective Courses

Elective courses: 9 credit hours to be taken at GJU, selected from the list of the following courses

Course code	Course name	Credit Hours
CE 772	Computer Security	3.0
CE 773	Human Machine Interaction	3.0
CE 715	Computer Vision	3.0
CE 718	Optimization Methods	3.0
CE 705	Real-time Systems	3.0
CE 723	Advanced Digital Systems	3.0
CE 736	Fault-Tolerant Distributed Systems	3.0
CE737	Wireless Communications	3.0
13755	Enterprise Mobile Computing	3.0
CE 719	Linear Algebra with Applications	3.0
CE 713	Mathematics for Robotics and Control	3.0
CE 743	Advanced software analysis and design	3.0
CE 724	Hardware/Software Co-design	3.0
CE 741	Advanced Operating Systems	3.0
CE 761	Reinforcement Learning	3.0
CE 762	Natural Language Processing	3.0
CE 763	Deep Learning	3.0
CE 764	Digital Signal Processing	3.0
CE 791	Special Topics in Computer Engineering	3.0
	Total =	**9**

7. Study Plan Guide

1st Year First Term		
Course No.	**Course Title**	**Credit hours**
CE 701	Probability and Stochastic Modeling	3
CE 702	Parallel and distributed systems	3
CE 704	Network and communication systems	3
	Total =	**9**

1st Year Second Term

Course No.	Course Title	Credit hours
CE 706	Big Data Analysis	3
CE 716	Machine learning and Pattern Recognition	3
CE 707	Embedded Systems	3
	Total =	**9**

2nd Year First Term		
Course No.	**Course Title**	**Credit hours**
CE 771	Internet of Things	3
CE 717	Image Processing	3
	Technical Elective	3
	Total =	**9**

2nd Year Second Term		
Course No.	**Course Title**	**Credit hours**
	Technical Elective	3
	Technical Elective	3
	Total =	**6**

8. Course Descriptions

CE 701 - Probability and Stochastic Modeling

Random variables, probability distribution and density functions, functions of random variables, Markov chains, Chapman-Kolmogorov equations, classification of states, limiting probabilities, branching processes, time-reversible processes, Poisson processes, continuous-time Markov chains, birth and death processes, transition probabilities.

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

CE 702 - Parallel and distributed systems

This course covers various fundamental aspects of parallel and distributed computing systems and the techniques used for software development on these systems. The topics covered in the course include parallel hardware architecture such as multi-core, computer cluster, distributed and shared memory, hierarchical memory, graphics processing unit (GPU); multi-thread (OpenMP), multiprocess, message passing (MPI); scheduling and synchronization; parallel algorithm design and multithreaded programs development; high-performance software engineering techniques; parallel applications such as matrix multiplication, matrix transposition, fast Fourier transform, sorting algorithms.

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

CE 703 - Advanced Computer Architecture and organization

This course provides in-depth coverage of fundamental architecture and implementation techniques for modern processor chips. It covers topics such as advanced pipelining, superscalar execution, out-of-order processing, speculative execution, VLIW, data parallelism, multithreading, graphics processors, and multi-core chips. The students will become familiar with complex trade-offs between performance-power-complexity and the common techniques for addressing the challenges in historical and modern processors. A central part of this course is a group project on an open research question. This course assumes a solid background on basic computer organization including instruction set design, pipelining, caching, and virtual memory.

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

CE 704 - Network and communication systems

Fundamentals of network technology based on a layered protocol stack (OSI and IP models), telephone network and Internet architecture, transport protocols (UDP, TCP), upper application layer protocols (such as HTTP, FTP, and SMTP), analysis of link layer protocols and their performance. Wireless LANs, framing and error detection in the data link layer, ARQ protocols, introduction to queuing theory, collision protocols (e.g. ALOHA, CSMA), fast packet switching, routing in data Networks, optimal routing, flow and congestion control, network management fundamentals.

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

CE 705 - Real-time systems

Introduction to real-time systems, real-time scheduling including: multiprocessor scheduling, real-time operating systems (kernels), real-time communication, real-time programming languages, reliability and fault-tolerance, and real-time system requirements and design methods; Design, analysis, and implementation of real-time kernel mechanisms and real-time applications using kernels such as Linux and programming languages such as C++.

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

CE 713 - Mathematics for Robotics and Control

Mathematical introduction to modeling, analysis and control of robotic systems; Theoretical frameworks for modeling, analysis (kinematics and dynamics) and control of generic robotic mechanical systems, rooted in rich traditions of mechanics and geometry; Serial-chain and parallel-chain manipulators, wheeled mobile robots (and hybrid combinations of these systems).

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

CE 715 - Computer Vision

This course covers various algorithms and methods that enable a machine to understand images and videos. The topics covered in this course include image formation, feature detection, segmentation, multiple view geometry, camera geometry, 3-D reconstruction, recognition and learning, and video processing.

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

CE 716 – Machine Learning and Pattern Recognition

This course provides a broad introduction to machine learning and statistical pattern recognition. The topics covered in this course include supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, and support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance tradeoffs; VC theory; large margins); reinforcement learning and adaptive control. The course will also discuss recent applications of machine learning, such as to robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing.

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

CE 717 – Image processing

This course provides a solid background in the fundamentals of digital image processing. It covers various image processing techniques, including image representation, 2D linear systems theory, 2D Fourier analysis, digital filtering, image enhancement, and segmentation. Students in this course will be exposed to real-world applications of image processing in industry, science, engineering, and medicine. Through assignments and course project, students will become familiar with the image processing facilities available in the MATLAB numeric computation environment as well as the Open Source Computer Vision (OpenCV) library.

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

CE 718 – Optimization Methods

This course provides an introduction to various optimization methods and algorithms, including Unconstrained Optimization Methods (One-dimensional Search Methods, Gradient Methods, Newton's Method, Conjugate Direction Methods, Quasi-Newton Methods, Solving Linear Equations, Global Search Algorithms (e.g., Simulated Annealing Algorithm, Particle Swarm Optimization, and

Genetic algorithms)), Linear Programming (Simplex Method, Duality, Non-simplex Methods), and Nonlinear Constrained Optimization Methods (Problems with Equality Constraints, Problems with Inequality Constraints, Convex Optimization Problems, and Algorithms for Constrained Optimization).

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

CE 722 - Parallel Architectures and Parallel Algorithms

Parallelism in processors; multi-core processors; classification of parallel architectures; multiprocessor architectures; interconnections networks; Amdahl's law; abstract parallel machine models; templates for parallel algorithms; searching, merging, sorting; graph algorithms (traversing, spanning trees, connected components); numerical algorithms (matrix algorithms, linear equations). Data dependencies; shared memory computing (threads, Open MP); message passing computing; parallelization strategies (embarrassingly parallel, partitioning, pipelined, synchronous); load balance.

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

CE 723 - Advanced Digital Systems

The course covers advanced topics in digital design, with a special emphasis on how to model, simulate, synthesize and optimize large and complex subsystems. It also covers some of the practical industrial aspects of modern design, including use of hardware description languages (e.g. VHDL) for structured modeling and simulation. Other topics include: controller synthesis and optimization, iterative circuits, high-speed combinational arithmetic circuits, fault tolerance and soft error mitigation, power optimization strategies, asynchronous design, FPGA structures, and floating point arithmetic.

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

CE 724 - Hardware/Software Co-design

The foundations of this lecture lie in the areas of sensors, signal processing, microcontrollers and hardware design. HW/SW co-design deals with the question of which parts of an algorithm should go into software and which into hardware.

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

CE 731 - Computer Communications and Networks

Framing and error detection in the data link layer, ARQ protocols, introduction to queuing theory, Burke's theorem and networks of queues, packet multiple access and the Aloha protocol, fast packet switching, routing in data Networks, optimal routing, flow and congestion control.

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

CE 732 - Fundamentals of Telecommunication Networks

Fundamentals of network technology based on a layered protocol stack, telephone network and Internet architecture, network protocols (IP), transport protocols (UDP, TCP), upper layer protocols (such as HTTP, FTP, and SMTP), analysis of link layer protocols and their performance, Wireless LANs and their protocols such as CSMA/CD and CSMA/CA.

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

CE 736 - Fault-Tolerant Distributed Systems

Fundamentals of the design and analysis of fault-tolerant systems, Models for distributed systems, Fault/error models, Techniques for providing hardware/software redundancy, Fault-detection in multiprocessors, Stable storage, Recovery strategies for multiprocessors (check pointing), System diagnosis, Software design faults, Experimental validation techniques, Case studies in fault-tolerant distributed systems.

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

CE 737 - Wireless Communications

Prerequisites (Fundamentals of Telecommunication networks): Transmission media, analog transmission and multiplexing, digital transmission and multiplexing, link calculations, satellite transmission, microwave transmission, fading channels, nonlinear channels, intermodulation, multiple-access techniques: TDMA, FDMA, point-to-multipoint communications systems, performance objectives, measurement techniques, mobile communications systems.

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

CE 741 - Advanced Operating Systems

This course focuses on advanced operating system topics and recent developments in operating systems research, including advanced concepts of Process/Thread Management, inter-process communication, Kernel memory functions, device drivers, and interrupts. The course also involves readings and lectures on classic and new papers. Topics: virtual memory management, synchronization and communication, file systems, protection and security, operating system structure and extension techniques, fault tolerance, and history and experience of systems programming.

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

CE 742 - Systems Requirements

This course covers the use of systems requirements engineering to develop and maintain large-scale software systems. The topics included in the course include introduction to requirements engineering, project initiation, operation modeling, verification and validation, risks managing, requirements selection, requirements prioritization, requirements managing, requirements engineering, and software design.

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

CE 743 – Advanced Software Analysis and Design

This course covers the theoretical and practical aspects of software systems architecture and design. The topics of the course include covers software specification, software analysis and design, software architecture modeling and design patterns, advanced object-oriented analysis and design. The course provides students with extensive understanding of unified modeling language (UML), design patterns and architectural styles, designing and describing a software system architecture using design patterns, and applying semi-formal notations to specify a software system architecture, design structure, and design behavior.

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

CE 799 – Comprehensive Exam

The Comprehensive Exam is a four-hour written exam, which is held after the end of the fourth semester. It aims to measure the student`s ability in understanding the concepts studied in the core courses in the Master`s program. To pass, the student must have an overall grade of minimum 70%.

9. Tuition and fees

The following table gives a breakdown of tuition and fees at GJU:

Fee Description	Cost (JOD)
Credit hour fee	120
Other Fees	
Admission/Acceptance Fees	120
Refundable Collateral Fees	150
Registration Fees\ per semester	120
Computer Fees\ per semester	60
Medical Insurance Fee\ per semester	50

10. Contact information

For application and other inquiries, please contact:

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Tel: +962 6 429 4100

URL: http://www.gju.edu.jo/content/computer-engineering-1411