الجامعة الألمانية الأردنية
German Jordanian University

German Jordanian University

School of Computing

Department of Computer Engineering

Master of Science in Computer Engineering
Comprehensive Exam Track

Study Plan 2024

I.   Program Objectives

Program objectives:

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

II.   Learning Outcomes

Learning outcomes:

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

Course Delivery Methods

Courses are in one of the following three methods:

- **Face-to-Face (F2F) Method**
  Courses using this method are delivered by faculty in person in regularly scheduled class sessions physically on campus.
- **Blended (BLD) Method**
  Courses are delivered in a hybrid mode of physical face-to-face class sessions and asynchronous material including online instructional videos, presentations, projects, and similar learning activities.
- **Online (OL) Method**
  Courses are delivered exclusively online. This method consists of a hybrid of synchronous regularly scheduled class sessions delivered via the Internet, and asynchronous material including online instructional videos, presentations, projects, and similar learning activities. Virtual classrooms utilizing different online platforms are used. No physical face-to-face meetings are required.

III.   Admission Requirements

To apply for admission, the following minimum requirements must be met:

a. Obtained a Bachelor of Science degree in one of the following disciplines:
   - Computer science
   - Machine Learning
   - Artificial Intelligence
   - Computer Information Systems
   - Computer Engineering
   - Communications Engineering
   - Software Engineering
   - Electrical/Electronic Engineering
   - Mechatronics Engineering
b. Relevant work 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

3. Machine Learning (ML) and Artificial Intelligence (AI).
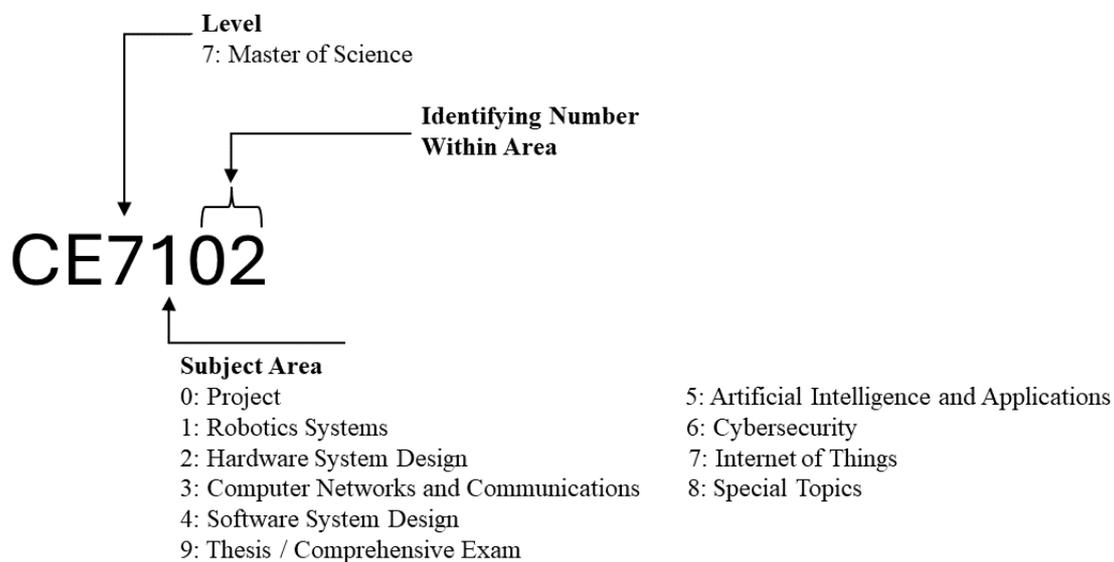
Remedial Courses:

Based on the department decision, the students may be required to take some remedial courses from the undergraduate level prior to starting the program.

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect	Lab		
CE377	Machine Learning	3		3	0	F2F	
CE342	Microprocessors and Microcomputer Systems	3		3	0	F2F	
EE315	Probability, Statistics, and Random Processes	3		3	0	BLD	
	Total	**9**		**9**	**0**		

IV. Framework for M.Sc. Degree (Credit hours)

Classification	Credit Hours
Compulsory courses	24
Elective courses	09
Comprehensive Exam	00
Total	**33**

Course Delivery Method	Credit Hours	Percentage
Online Courses	3	10%
Blended Courses	12	37%
Face-to-Face Courses	18	53%
Total	**33**	**100%**

Level
7: Master of Science

Identifying Number Within Area

CE7102

Subject Area

0: Project	5: Artificial Intelligence and Applications
1: Robotics Systems	6: Cybersecurity
2: Hardware System Design	7: Internet of Things
3: Computer Networks and Communications	8: Special Topics
4: Software System Design	
9: Thesis / Comprehensive Exam	

V. Curriculum (Credit hours)

1. Common Compulsory Requirements (All Tracks): (15 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect	Lab		
CE7501	Deep Learning	3		3	0	BLD	
CE7502	Cloud for AI	3		3	0	BLD	
CE7503	Big Data Analysis and Visualization	3		3	0	BLD	
CE7001	Master Project 1	3		3	0	BLD	Passing 12 CH
CE7002	Master Project 2	3		3	0	OL	CE7751
CE799	Comprehensive Exam	0		0	0	F2F	
	Total	15		15	00		

2. Compulsory Requirements (Applied Artificial Intelligence Track): (9 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect	Lab		
CE7504	Image Processing	3		3	0	F2F	
CE7505	Computer Vision	3		3	0	F2F	
CE7506	Natural Language Processing	3		3	0	F2F	
	Total	09		09	00		

3. Compulsory Requirements (Artificial Intelligence of Things Track): (9 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect	Lab		
CE7201	Embedded Systems	3		3	0	F2F	
CE7301	Wireless Communication	3		3	0	F2F	
CE7701	Internet of Things	3		3	0	F2F	
	Total	09		09	00		

4. Elective Courses: (09 credit hours out of the following)

4.1 (Applied Artificial Intelligence Track)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect	Lab		
CE7101	Robotics Programming	3		3	0	F2F	
CE7201	Embedded Systems	3		3	0	F2F	
CE7202	Parallel and Distributed Computing	3		3	0	F2F	
CE7401	Enterprise Web Applications Development	3		3	0	F2F	
CE7402	Mobile Computing	3		3	0	F2F	
CE7507	Business Intelligence	3		3	0	F2F	
CE7508	Emerging Technologies in AI	3		3	0	F2F	
CE7601	Cybersecurity	3		3	0	F2F	
CE7701	Internet of Things	3		3	0	F2F	
CE7801	Special Topics in Computer Engineering	3		3	0	F2F	
Minimum required		**09**		**09**	**00**		

4.2 (Artificial Intelligence of Things Track)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect	Lab		
CE7101	Robotics Programming	3		3	0	F2F	
CE7202	Parallel and Distributed Computing	3		3	0	F2F	
CE7203	Advanced Digital Systems	3		3	0	F2F	
CE7401	Enterprise Web Applications Development	3		3	0	F2F	
CE7402	Mobile Computing	3		3	0	F2F	
CE7504	Image Processing	3		3	0	F2F	
CE7505	Computer Vision	3		3	0	F2F	
CE7508	Emerging Technologies in AI	3		3	0	F2F	
CE7601	Cybersecurity	3		3	0	F2F	
CE7801	Special Topics in Computer Engineering	3		3	0	F2F	
Minimum required		**09**		**09**	**00**		

VI. Study Plan Guide

a. (Applied Artificial Intelligence Track)

First Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7501	Deep Learning	3		3	0	BLD	
CE7504	Image Processing	3		3	0	F2F	
	Elective	3		3	0	F2F	
	Total	**9**	**0**	**9**	**0**		

First Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7502	Cloud for AI	3		3	0	BLD	
CE7505	Computer Vision	3		3	0	F2F	
	Elective	3		3	0	F2F	
	Total	**9**	**0**	**9**	**0**		

Second Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7503	Big Data Analysis and Visualization	3		3	0	BLD	
CE7506	Natural Language Processing	3		3	0	F2F	
CE7001	Master Project 1	3		3	0	BLD	Passing 12 CrHr
	Total	**9**	**0**	**9**	**0**		

Second Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7002	Master Project 2	3		3	0	OL	CE7001
	Elective	3		3	0	F2F	
	Total	**6**	**0**	**6**	**0**		

Second Year							
Summer Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE799	Comprehensive Exam	0		0	0	F2F	
	Total	**0**	**0**	**0**	**0**		

b. (Artificial Intelligence of Things Track)

First Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7501	Deep Learning	3		3	0	BLD	
CE7701	Internet of Things	3		3	0	F2F	
	Elective	3		3	0	F2F	
	Total	**9**	**0**	**9**	**0**		

First Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7502	Cloud for AI	3		3	0	BLD	
CE7201	Embedded Systems	3		3	0	F2F	
	Elective	3		3	0	F2F	
	Total	**9**	**0**	**9**	**0**		

Second Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7503	Big Data Analysis and Visualization	3		3	0	BLD	
CE7301	Wireless Communication	3		3	0	F2F	
CE7001	Master Project 1	3		3	0	BLD	Passing 12 CrHr
	Total	**9**	**0**	**9**	**0**		

Second Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE7002	Master Project 2	3		3	0	OL	CE7001
	Elective	3		3	0	F2F	
	Total	**6**	**0**	**6**	**0**		

Second Year							
Summer Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect	**Lab**		
CE799	Comprehensive Exam	0		0	0	F2F	
	Total	**0**	**0**	**0**	**0**		

VII. Course Descriptions

1. Compulsory Courses

CE7001 Master Project 1   03 Cr Hr   00 ECTS

In this course, students will learn the basics of technical writing and drafting a project proposal. The students will learn technical writing tools such as LATEX. By the end of the course, the students should be able to draft a project proposal outlining the objectives of the project, its technical details, a suggested timeline, and its practical applications.

Prerequisites: **Passing 12 Cr Hr**
Corequisites:

CE7002 Master Project 2   03 Cr Hr   00 ECTS

In this course, the student will work on the proposal drafted in Master Project 1. At the end of the course, the student should be able to communicate the result as a technical report and a presentation.

Prerequisites: **CE7001**
Corequisites:

CE7201 Embedded Systems   03 Cr Hr   00 ECTS

This course focuses on learning the techniques to design and program ARM-based embedded systems and implementing them using both assembly language and the standard C language. In this course, the student will learn what are the constraints, software design principles (common schedulers and real time operating systems), and common development flow principles in embedded system design. The student will learn the difference between the different ARM architectures and ARM processors. The student will also learn the concepts, programming, and hardware interfacing of interrupts, General Purpose Input Output (GPIO), analog interfaces (ADCs and DACs), timers, counters, Pulse Width Modulation (PWM) outputs, and serial communication interfaces (UART, I2C, and SPI). Additional topics include, Real-time operating systems, compilers and C code as converted to assembly language, and performance optimization concepts including Direct Memory Access (DMA).

Prerequisites:
Corequisites:

CE7301 Wireless Communications   03 Cr Hr   00 ECTS

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.

Prerequisites:
Corequisites:

CE7501 Deep Learning   03 Cr Hr   00 ECTS

This course concerns the latest techniques in deep learning and representation learning, focusing on supervised and unsupervised deep learning, embedding methods, metric learning, convolutional and recurrent nets, with applications to computer vision, natural language understanding, and speech recognition.

Prerequisites:
Corequisites:

CE7502 Cloud for AI   03 Cr Hr   00 ECTS

course is designed to provide students with an in-depth understanding of how cloud computing technologies empower and enhance AI applications. This course covers the essentials of cloud infrastructure, services, and tools that support the development, deployment, and scaling of AI models. Students will explore key topics such as cloud architecture, Virtualization concept on the various Computer, storage, networking and application levels. The course will also elaborate how the cloud infrastructure can be used to deploy AI based applications and algorithms on realistic cloud environments. Throughout the course, participants will gain hands-on experience in setting up cloud environments, managing AI workloads, and leveraging cloud-based AI services for real-world applications. By the end of this course, students will be equipped with the skills and knowledge to effectively use cloud computing as a powerful tool in AI projects, enabling them to innovate and solve complex problems at scale.

Prerequisites:
Corequisites:

CE7503 Big Data Analysis and Visualization   03 Cr Hr   00 ECTS

The recent advancements in network bandwidths, the popularity of social networks, and the ubiquity of smartphones have led to the creation of large volumes of mostly unstructured data, such as weblogs, videos, images, recorded speech, emails, and tweets. The "Big Data Analysis and Visualization" course is designed to provide students with the tools and techniques necessary to process, analyze, and visualize these large-scale datasets. In this course, students will explore the complexities of big data, including data collection, storage, processing, and analysis using modern technologies like Hadoop, Spark, and NoSQL databases. This course also emphasizes the importance of visualizing and interpreting the results of big data analysis to communicate insights effectively. Students will learn key topics such as Data Visualization principles, tools and techniques (e.g., Tableau, Power BI), Interactive Data Dashboard design, and Advanced Visualization techniques (including Geospatial and Network Visualization), and Visual Analytics.

Prerequisites:
Corequisites:

CE7504 Image processing   03 Cr Hr   00 ECTS

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 projects, 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.

Prerequisites:
Corequisites:

CE7505 Computer Vision   03 Cr Hr   00 ECTS

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.

Prerequisites:
Corequisites:

CE7506 Natural Language Processing   **03 Cr Hr**   **00 ECTS**

This course will cover the following aspects of Natural Language Processing (NLP): tokenization, tagging, parsing, morphology, electronic dictionaries, problems in homonyms and disambiguation in general, machine translation, syntax, grammatical theories, CD structures, RTNs, ATNs, electronic grammar checking, statistical language processing: Bayes Rules and Hidden Markov Models. The course provides students with understanding the relevance of Natural Language Processing (NLP) as a sub-field of Artificial Intelligence, the complexity of NLP applications, and on the basis of a detailed analysis, point at the problem and become sensible w.r.t a solution, getting familiar with NLP tools and apply them, acquiring knowledge in the subfields of NLP: morphology, Tokenization, Tagging, electronic dictionaries, Syntax, Semantics, Machine Translation (rule-based and statistical), Text Mining, and Speech Recognition, understanding the connection between NLP and Computational Linguistics, i.e. different views on the same field, become sensible to problems in the NLP field - focusing on disambiguation on different levels (word-, sentence-, text-, web), have acquired theoretical skills across the entire field of NLP and will be able to apply them and be able to analyze an NLP problem, design & implement a prototypical solution and document the work.

Prerequisites:
Corequisites:

CE7701 Internet of Things   **03 Cr Hr**   **00 ECTS**

This course provides a sound introduction to the Internet of Things (IoT) technologies and system design concepts. The course will focus on important IoT topics, which includes industrial standards, sensor/actuator/data devices, hardware, software, security, system design and performance analysis techniques.

Prerequisites:
Corequisites:

2. Elective Courses

CE7101 Robotics Programming   **03 Cr Hr**   **00 ECTS**

This course offers an in-depth introduction to the core principles and practices of programming autonomous robots. This course is designed to equip students with the skills needed to develop software that controls robotic systems, covering key areas such as robot motion planning, sensor integration, control algorithms, and real-time decision-making. During this course, students will gain hands-on experience in programming robots using industry-standard frameworks and languages, including Python and ROS (Robot Operating System). The curriculum spans a range of robotic platforms, from mobile robots to complex robotic arms, and delves into topics like kinematics, path planning, machine vision, and sensor fusion. Additionally, students will explore the implementation of AI techniques in robotic applications, preparing them for cutting-edge challenges in the field of robotics.

Prerequisites:
Corequisites:

CE7202 Parallel and Distributed Computing   **03 Cr Hr**   **00 ECTS**

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), multi-process, 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.

Prerequisites:
Corequisites:

CE7203 Advanced Digital Systems   **03 Cr Hr**   **00 ECTS**

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 the 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.

Prerequisites:
Corequisites:

CE7401 Enterprise Web Applications Development   **03 Cr Hr**   **00 ECTS**

This course covers the theoretical and practical aspects of enterprise web applications architecture and design. The web application development process is discussed, and its following phases are applied: specification, analysis, design, development, testing, deployment and maintenance. Moreover, project management related principles, steps and tools are explored. In addition, the multi-tier architecture for web-based enterprise applications is discussed and used to build practical applications. The unified modeling language (UML) is used to visually capture the requirements and design aspects of software systems. Object-oriented analysis and design principles as well as design patterns are also covered and utilized. Specifically, the model-view-controller (MVC) architectural pattern is utilized in various cases. Software quality attributes such as: ease of use, speed, scalability, robustness, reliability, availability and security are explained. All the technologies (e.g., Java, Java EE, HTML, HTTP, Javascript, CSS, JSF, JSP, Servlets, Primefaces, SQL and databases) needed to develop web-based enterprise applications are introduced and used.

Prerequisites:
Corequisites:

CE7402 Mobile Computing   **03 Cr Hr**   **00 ECTS**

The goal of this course is to provide an in depth understanding of the fundamental problems in integration of Mobile Devices into Enterprise Systems and study the existing and proposed solutions for these problems from both research and development perspective. This course will introduce students to mobile computing and mobile application development. Topics covered include mobile and wireless environment; mobile device technology; mobile computing architecture and protocols; mobile computing security; and applications in wireless and mobile computing, including distribution applications, mobile middleware, mobile information and database access, mobile multimedia, remote execution, user interface and user experience. Students will be expected to learn at least one mobile application development framework (Android) and use it to implement their assignments and course project.

Prerequisites:
Corequisites:

CE7507 Business Intelligence   **03 Cr Hr**   **00 ECTS**

This course provides a comprehensive exploration of Business Intelligence (BI) and its integration with Artificial Intelligence (AI) to drive data-driven decision-making in modern organizations. Students will learn how to harness BI tools and techniques to gather, analyze, and visualize data, transforming raw information into actionable insights. The course covers the fundamental concepts of BI, including data warehousing, data mining, and reporting, while also delving into advanced AI-driven methodologies such as machine learning, predictive analytics, and natural language processing. Through hands-on projects and case studies, students will gain practical experience in implementing AI-enhanced BI solutions that can optimize business processes, improve customer experiences, and increase operational efficiency.

Prerequisites:
Corequisites:

CE7508 Emerging Technologies in AI   **03 Cr Hr**   **00 ECTS**

This course explores the cutting-edge advancements that are shaping the future of Artificial Intelligence. Students will gain a comprehensive understanding of how these emerging technologies are being applied across industries to solve complex problems and drive innovation. The course covers both theoretical concepts and practical applications, providing hands-on experience with modern tools and platforms that support these technologies.

Prerequisites:
Corequisites:

CE7601 Cybersecurity   **03 Cr Hr**   **00 ECTS**

Methods and techniques for the design of computer networks, management and business perspectives on network design, estimation of traffic demand and application requirements, network cost analysis, topological design, capacity planning and network optimization, availability analysis and survivable network design. Furthermore, this course covers the following main security topics: Cryptography algorithms: Computer Networks concepts. Data encryption algorithms DES, Advanced encryption AES, Hash functions, Trusting issues, Legal and ethical issues in computer security. Access control, System management, User authentication, files protection, designing trusted OS. Writing secure code, Malicious Software, Viruses, static and dynamic buffer overflow attacks, data encapsulation, coupling and cohesion concepts, e-mail security. Threats in networks, network security controls, firewalls, intrusion detection, VPN networks, Key management, RSA algorithm, Digital signature, IPSec, Certificate authorities CA, Denial of service attacks DoS, High-speed network and cloud security (e.g., MPLS Security).

Prerequisites:
Corequisites:

CE7801 Special Topics in Computer Engineering   03 Cr Hr   00 ECTS

This course is offered to graduate level students in computer engineering. It gives them exposure to special topics in computer engineering. Topics may vary each time the course is offered. Details of the course will be advertised by the department at the time of offering.

Prerequisites:
Corequisites:

3. Thesis/Comprehensive Exam/Other

CE799 Comprehensive Exam   00 Cr Hr   00 ECTS

Students can choose one of the following options:

- Practice-Oriented Comprehensive Examination: This is a two-component evaluation combining applied problem-solving and theoretical mastery as follows:
    - o   Component 1: Project or Case-Study Presentation. Students present a project or a case study included in the plan of study to a committee approved by the dean of Graduate Studies.
    - o   Component 2: Oral Comprehensive Exam. Committee-led oral examination assessing gain knowledge, critical thinking, and depth of understanding beyond the applied project.
- Published Research Paper: Publication (or accepted for publication) in a Q1-ranked journal post-completion of course work. The paper must include the student as first author and affiliated with GJU.
- Obtaining one of the following professional certificates:
    - o   Professional Machine Learning Engineer from Google.
    - o   AWS Certified Machine Learning Specialist from Amazon

Prerequisites:
Corequisites: