German Jordanian University

School of Electrical Engineering and Information Technology

Department of Computer Engineering

Bachelor of Science in Computer Engineering

Study Plan 2022

I.   Program Vision

To be a recognized department of computer engineering in producing highly qualified engineers who are capable of finding effective solutions to emerging problems related to society, environment, and industry by employing trending and innovative technologies.

II.   Program Mission

To arm students with the required knowledge, technical skills, and experience in the field of computer engineering that enables them to fulfill society and market needs.

III.   Program General Description

Emerging global knowledge economies have created a demand for highly skilled Information and Communication Technology (ICT) workforce in all industries. As a result, ICT labor markets have become highly competitive. With the tremendous wealth recently generated in the Gulf States and subsequent industrial booms, such markets in the region became highly attractive to many Jordanian ICT workers. A large number of experienced ICT professionals leave the country every year. Faced with such conditions, the demand for a highly skilled ICT workforce has increased tremendously. As the result of workforce migration, the ICT workforce in Jordan comprise of graduates who are young and possess little experiences and knowledge. Therefore, the necessity to educate and develop a qualified workforce to support Jordan economy and compete on an international level is paramount.

To help meet these emerging demands on ICT education and address market needs, the School of Electrical Engineering and Information Technology envisioned since its inception in 2005 a unique approach to expand on the long experience of the German model of applied science and contribute to building a premier quality and relevant, industry-oriented ICT education in Jordan. Moreover, the department of Computer Engineering introduces new tracks to match the market needs, namely Artificial Intelligence and Machine Learning track, and Computer Vision and Robotics track. The goals are high level quality in education and research, international co-operation, rich interaction and partnerships with enterprises, and focus on relevant academic programs.

In the Artificial Intelligence and Machine Learning track, students will learn about not only the theoretical underpinnings of machine learning techniques, but also gain the practical know-how needed to apply these techniques quickly and powerfully to new problems in different application domains, including biomedical signal processing, robotics, image and video understanding, and financial analysis and prediction. Moreover, several state-of-the-art courses that are related to ML and AI will be offered, such as deep learning, natural language processing, big data, cloud computing, and image processing. Therefore, this track shall allow students to interact with all these key disciplines. Moreover, leading faculty members in the CE department will guide students through the latest breakthroughs in research, cutting-edge technologies, and best practices used for building effective AI-systems.

In the Computer Vision and Robotics track, students will learn about the most effective computer vision, robotics, and machine learning techniques, and how to implement these

techniques. More importantly, students will learn about not only the theoretical underpinnings of computer vision and robotics, but also gain the practical know-how needed to apply these techniques quickly and powerfully to new problems in different application domains, including biomedical, healthcare, robotics, and surveillance domains. Therefore, this track shall allow students to interact with all these key disciplines and get hands-on experience through the state-of-the-art equipment in the computer vision and robotics lab, which includes a robotic arm, a Niryo robotic arm, NAO robot, virtual and augmented reality equipment. Moreover, leading faculty members in the CE department will guide students through the latest breakthroughs in research, cutting-edge technologies, and best practices used for building effective robotic systems.

The B.Sc. in Computer Engineering program at GJU provides a unique educational environment. It offers small classes, outstanding facilities, and an extremely supportive staff. It also offers peer tutoring and technical support sessions that would help students move forward on a road towards success. Our faculty includes some of the distinguished professors and researchers that are specialized in various topics the computer engineering field. In addition, the program presents the students with the opportunity to obtain industrial certificates from prestigious companies, such as Cisco, Red Hat, Huawei, among others. Adding to that the experience gained through the German Year, with six months of industrial training and six months of academic courses, the graduates of this program will have a bright future as a work force in the Industry or as a researcher in academic institutions.

The projected unrivalled quality of education in the Department of Computer Engineering at GJU not only contributes to the advancement and progress in the ICT sector in Jordan, but also began to serve as an icon within the country. The B.Sc. in Computer Engineering program has been able to train professionals and experts who began to contribute to the Jordanian economy.

IV. Program Objectives

The Computer Engineering Department program is offering a CE undergraduate program that augments the liberal education expected of all German Jordanian University undergraduates and imparts a basic understanding of computer engineering built on a foundation of physical science, mathematics, computing, and technology.

Graduates of the undergraduate program should possess knowledge of computer engineering fundamentals and one specialty area. They are expected to have the basic experimental, design, and communication skills to be prepared for continued study at the graduate level or entry level positions that require basic knowledge of computer engineering, science, and technology.

The educational objectives for the Department of Computer Engineering are:

1. Technical Knowledge: Provide a basic knowledge of computer engineering principles along with the required supporting knowledge of mathematics, science, computing, and engineering fundamentals. The program includes depth in one specialty area, currently including Software Systems, Embedded Systems, Computer Networks, Operating Systems, Artificial Intelligence and Machine Learning, and Computer Vision and Robotics.

2. Technical Skills: Provide the technical skills that are sufficient for the students to obtain world-recognized certificates with well-known industry, such as Cisco, Red Hat, Huawei, among others.

3. Laboratory and Design Skills: Develop the basic skills needed to perform and design experimental projects. Develop the ability to formulate problems and projects and to plan a process for solutions taking advantage of diverse technical knowledge and skills.

4. Communications Skills: Develop the ability to organize and present information, and to write and speak effective English.

5. Preparation for Further Study: Provide sufficient breadth and depth for successful subsequent graduate study, post-graduate study, or lifelong learning programs.

6. Preparation for the Profession: Provide an appreciation for the broad spectrum of issues arising in professional practice, including teamwork, leadership, safety, ethics, service, economics, and professional organizations.

V. Learning Outcomes

Computer Engineering graduates bachelor's students with an understanding of fundamental computer engineering concepts, methodologies, and technologies as demonstrated by:

- An ability to apply knowledge of mathematics, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to design a system, component, or process to meet desired needs
- An ability to function on multi-disciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of professional and ethical responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global and societal context
- A recognition of the need for, and an ability to engage in, life-long learning
- A knowledge of contemporary issues
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
- Background for admission to engineering or other professional graduate programs

VI. Framework for B.Sc. Degree (Credit Hours)

Classification	Credit Hours			ECTS		
	Compulsory	Elective	Total	Compulsory	Elective	Total
University Requirements	21	6	27			
School Requirements	26	00	26			
Program Requirements	111	12	123			
Total	**158**	**18**	**176**			

1. University Requirements: (27 credit hours)

1.1. Prerequisite courses (6 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Prerequisites / Co-requisites
				Lect	Lab	
ARB099	Arabic 99[a]	0		3	-	-
ENGL099	English II[a]	0		3	-	
	Total	**0**		**6**	**0**	

1.2. Compulsory: (21 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
ARB100	Arabic	3			3	-	ARB099
ENGL101	English III	1			3	-	ENGL099
ENGL102	English IV	1			3	-	ENGL101
ENGL201	English V	2			3	-	ENGL102, ARB099, MATH099
ENGL202	English VI	2			3	-	ENGL201
GERL101B1	German I B1 track	3			9	-	-
GERL102B1	German II B1 track	3			9	-	GERL101B1
GERL102B2	German II B2 track	3			9	-	GERL101B1
MILS100	Military Science	3			3	-	-
NE101 NEE101	National Education National Education (English)	3			3	-	-
	Total	**21**			**39**	**0**	

1.3. Elective: (6 Credit Hours) (two courses out of the following)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
BE302	Business Entrepreneurship	3			3	-	ENGL101
DES101	Arts' Appreciation	3			3	-	ENGL101, ARB099
EI101	Leadership and Emotional Intelligence	3			3	-	ENGL101
IC101	Intercultural Communications	3			3	-	ENGL101
PE101	Sports and Health	3			3	-	ARB099
SE301	Social Entrepreneurship and Enterprises	3			3	-	ENGL101
SFTS101	Soft Skills	3			3	-	ENGL101
TW303	Technical and Workplace Writing	3			3	3	ENGL102
	Total	**6**			**6**	**0**	

2. School Requirements: (26 Credit Hours)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
GERL201B1	German III B1 track	3		Face_to_Face	6	-	GERL102B1
GERL201B2	German III B2 track	3			6	-	GERL102B2 ARB099, ENGL099, MATH099
GERL202B1	German IV B1 track	3		Face_to_Face	9	-	GERL201B1
GERL202B2	German IV B2 track	3			9	-	GERL201B2
MATH099	Pre-Math	0		Blended	3	-	
MATH101	Calculus I	3		Blended	3	-	MATH099*
MATH102	Calculus II	3		Face_to_Face	3	-	MATH101
ECE317	Linear Algebra	3		Blended	3	-	MATH102
CS116	Computing Fundamentals	3		Face_to_Face	3	-	
CS1160	Computing Fundamentals Lab	1		Blended	3	-	Co-requisite: CS116
CE352	Computer Networks	3		Blended	3	-	CE201
CE212	Digital Systems	3		Face_to_Face	3	-	CS116 ARB099, ENGL099, MATH099
CE2120	Digital Systems Lab	1		Blended	0	3	Co-requisite: CE212
Total		**26**			**0**	**0**	

* Placement test

3. Program Requirements (123 credit hours)

3.1. Program Requirements (Compulsory All Tracks): (99 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lecture	Lab	
GERL301	German V	3		Face_to_Face	6	0	GERL202
GERL302	German VI	3		Face_to_Face	9	0	GERL301
ECE315	Random variables and stochastic processes	3		Blended	3	0	MATH102
CS214	Object Oriented Programming	3		Face_to_Face	3	0	CS116, CS1160, ARB099, ENGL099, MATH099
CS2140	Object Oriented Programming Lab	1		Blended	0	3	Co-requisite: CS214
CE201	Computer Architecture and Organization	3		Face_to_Face	3	0	CE212, CE2120
CE357	Operating Systems	3		Face_to_Face	3	3	CE201
CE3570	Operating Systems Lab	1		Blended	0	3	Co-requisite: CE357
PHYS103	Physics I	3		Blended	3	0	
PHYS104	Physics II	3		Face_to_Face	3	0	PHYS103
PHYS106	Physics Lab	1		Blended	0	3	Co-requisite: PHYS104
CHEM103	General Chemistry	3		Face_to_Face	3	0	
IE121	Engineering Workshop	1		Face_to_Face	0	3	
MATH203	Applied Mathematics for Engineers	3		Face_to_Face	3	0	MATH102, ARB099, ENGL099
MATH205	Differential Equations	3		Face_to_Face	3	0	MATH102, ARB099, ENGL099
BM371	Numerical Methods for Engineers	3		Blended	2	3	MATH203, MATH205, CS116
ENE211	Electrical Circuits I	3		Face_to_Face	3	0	PHYS104 ARB099, ENGL099, MATH099
ENE212	Electrical Circuits II	3		Face_to_Face	3	0	ENE211
ENE213	Electrical Circuits Lab	1		Blended	0	3	ENE211
CS222	Theory of Algorithms	3		Face_to_Face	3	0	CS116, CS1160, CS201 ARB099, ENGL099, MATH099

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours Lect	Contact Hours Lab	Prerequisites / Co-requisites
CS223	Data Structures	3		Face_to_Face	2	2	CS116, CS1160 ARB099, ENGL099, MATH099
ECE241	Electronics 1	3		Face_to_Face	3	3	ENE211
ECE2410	Electronics 1 Lab	1		Blended	0	3	Co-requisite: ECE241
CE354	Computer Security	3		Blended	3	0	CE352
CE331	Signals and Systems	3		Blended	3	0	MATH203
CE342	Microprocessor and Microcomputer Systems	3		Face_to_Face	3	0	CE212
CE3420	Microprocessor and Microcomputer Systems Lab	1		Blended	0	3	Co-requisite: CE342
CE441	Embedded System Design	3		Face_to_Face	3	0	CE201
CE355	Data Communication	3		Face_to_Face	3	0	CE331
CS363	Database Management Systems	3		Blended	2	2	CS223
CE3561	Computer Networks Lab	1		Blended	0	3	Co-requisite: CE352
CE477	Machine Learning	3		Face_to_Face	3	0	ECE315, ECE317
CE502	Parallel Architectures and Parallel Algorithms	3		Face_to_Face	3	0	CE201, CS222, CS223
CE391	Field Training *	0		Face_to_Face	0	0	Department Consent
CE493	International Internship	12		Face_to_Face	0	36	Department Consent
CE592	Senior Project I **	1		Blended	0	3	Department Consent
CE594	Senior Project II	3		Online	0	9	CE592
	Total Credit Hours	**99**					

* The CE391 field training course should be registered after completing at least 115 credit hours of the study plan. The minimum number of training hours is 280 hours and should be performed in an organization that is highly related to the computer engineering field. The training period should be connected without any gaps.

** The CE592 Senior project I course should be registered after completing the CE391 course

3.2. Program Requirements (General Track Compulsory): (12 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
CS201	Discrete Structures	3		Face_to_ Face	3	0	ARB099, ENGL099, MATH099
CS342	Software Engineering	3		Blended	3	0	CS214, CS363
CS416	Systems Programming	3		Blended	2	2	CS223
CE452	Network Protocols	3		Face_to_ Face	3	0	CE352

					Total	12			0	0	

3.3. Program Requirements (Artificial Intelligence and Machine Learning Track Compulsory): (12 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
CS451	Artificial Intelligence	3		Face_to_Face	3	0	CS222, CS223
CE561	Deep Learning	3		Face_to_Face	3	0	ECE317, ECE315
CE461	Image Processing	3		Blended	3	0	CE331
EE472	Cloud Computing and Big Data	3		Face_to_Face	3	0	CE352
	Total	12			0	0	

CS201 is to be removed as a prerequisite for courses in this track

3.4. Program Requirements (Computer Vision and Robotics Track Compulsory): (12 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
CE521	Robotics	3		Face_to_Face	3	0	ECE317
CE565	Computer Vision	3		Face_to_Face	3	0	CE461
CE461	Image Processing	3		Face_to_Face	3	0	CE331
CE563	Human Computer Interaction	3		Face_to_Face	3	0	ECE317
	Total	12			0	0	

CS201 is to be removed as a prerequisite for courses in this track

3.5. Program Requirements (General Track Electives [b]): (12 credit hours)

A minimum of 12 credit hours of engineering coursework are required. This list is open for modifications based on school council decisions.

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
CE353	Distributed Systems	3		Face_to_Face	3	0	CE352
CE444	Microcomputer Interface and Peripheral Devices	3		Face_to_Face	3	0	CE342, CE3420
CE4440	Microcomputer Interface and Peripheral Devices Lab	1		Face_to_Face	0	3	Co-requisite: CE444

CE461	Image Processing	3		Face_to_Face	3	0	CE331
CE563	Human Computer Interaction	3		Face_to_Face	3	0	ECE317
CE561	Deep Learning	3		Face_to_Face	3	0	ECE317, ECE315
CE564	Pattern Recognition	3		Face_to_Face	3	0	ECE317, ECE315
CE565	Computer Vision	3		Face_to_Face	3	0	CE461
CE521	Robotics	3		Face_to_Face	3	0	ECE317
CE520	Cognitive robotics	3		Face_to_Face	3	0	CS214
CE463	Advanced Image Processing	3		Face_to_Face	3	0	CE461
CE570	Optimization Methods	3		Face_to_Face	3	0	ECE317
CE471	Software Design and Architecture	3		Face_to_Face	3	0	CS342
CE473	Software Requirements Analysis	3		Face_to_Face	3	0	CS342
CE474	Software Quality Assurance and Testing	3		Face_to_Face	3	0	CS342
CE501	Advanced Computer Architecture	3		Face_to_Face	3	0	CE201
CE512	Advanced Logic Design	3		Face_to_Face	3	0	CE212, CE2120
CE551	Advanced Operating Systems	3		Face_to_Face	3	0	CE357, CE3570
CE552	Advanced Computer Networks	3		Face_to_Face	3	0	CE352
CE558	Special topics in Computer Networks	3		Face_to_Face	3	0	CE352
CE559	Special topics in Operating Systems	3		Face_to_Face	3	0	CE357, CE3570
CE596	Special topics in Intelligent Systems	3		Face_to_Face	3	0	Department Consent
CE587	Special Topics in Gaming	3		Face_to_Face	3	0	Department Consent
CE588	Special Topics in Deep Learning	3		Face_to_Face	3	0	Department Consent
CE579	Special topics in Software Engineering	3		Face_to_Face	3	0	CS342
CE597	Special Topics in Computer Engineering I	1		Face_to_Face	1	0	Department Consent
CE598	Special Topics in Computer Engineering II	2		Face_to_Face	2	0	Department Consent
CE599	Special Topics in Computer Engineering	3		Face_to_Face	3	0	Department Consent
ECE461	Digital Signal Processing	3		Face_to_Face	3	0	CE331

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours Lect	Contact Hours Lab	Prerequisites / Co-requisites
EE472	Cloud Computing and Big Data	3		Face_to_Face	3	0	CE352
EE371	IoT Architecture and Protocols	3		Face_to_Face	3	0	CS214, CS2140
CS419	Compiler Construction	3		Face_to_Face	3	0	CS222, CS223
CS460	Data Mining	3		Face_to_Face	3	0	CS363
CS451	Artificial Intelligence	3		Face_to_Face	3	0	CS363
CS330	Image Understanding	3		Face_to_Face	3	0	ECE317, CS223
CS353	Natural Language Processing	3		Face_to_Face	3	0	CS222
CS430	Virtual and Augmented Reality	3		Face_to_Face	3	0	CS214, CS2140
CS477	Mobile Computing	3		Face_to_Face	3	0	CS214, CS2410

[b]BSC001 International Internship is a prerequisite for all elective courses

3.6. Program Requirements (Artificial Intelligence and Machine Learning Track Electives [b]): (12 credit hours)

A minimum of 12 credit hours of engineering coursework are required. All lists are open for modifications based on school council decisions.

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours Lect	Contact Hours Lab	Prerequisites / Co-requisites
CE563	Human Computer Interaction	3		Face_to_Face	3	0	ECE317
CE564	Pattern Recognition	3		Face_to_Face	3	0	ECE317, ECE315
CE565	Computer Vision	3		Face_to_Face	3	0	CE461
CE521	Robotics	3		Face_to_Face	3	0	ECE317
CE463	Advanced Image Processing	3		Face_to_Face	3	0	CE461
CE570	Optimization Methods	3		Face_to_Face	3	0	ECE317
CE587	Special Topics in Gaming	3		Face_to_Face	3	0	Department Consent
CE588	Special Topics in Deep Learning	3		Face_to_Face	3	0	Department Consent
CE596	Special topics in Intelligent Systems	3		Face_to_Face	3	0	Department Consent
CS330	Image Understanding	3		Face_to_Face	3	0	ECE317, CS223
CS353	Natural Language Processing	3		Face_to_Face	3	0	CS222

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Lect	Lab	Prerequisites / Co-requisites
CS430	Virtual and Augmented Reality	3		Face_to_Face	3	0	CS214, CS2140
CS460	Data Mining	3		Face_to_Face	3	0	CS363
CS477	Mobile Computing	3		Face_to_Face	3	0	CS214, CS2410

[b]BSC001 International Internship is a prerequisite for all elective courses

3.7. Program Requirements (Computer Vision and Robotics Track Electives [b]): (12 credit hours)

A minimum of 12 credit hours of engineering coursework are required. All lists are open for modifications based on school council decisions.

Course ID	Course Name	Credit Hours	ECTS	Teaching method	Contact Hours		Prerequisites / Co-requisites
					Lect	Lab	
CE520	Cognitive Robotics	3		Face_to_Face	3	0	CS222
CE564	Pattern Recognition	3		Face_to_Face	3	0	ECE317
CE561	Deep Learning	3		Face_to_Face	3	0	ECE317, ECE315
CE463	Advanced Image Processing	3		Face_to_Face	3	0	CE461
CE570	Optimization Methods	3		Face_to_Face	3	0	ECE317
CE596	Special topics in Intelligent Systems	3		Face_to_Face	3	0	Department Consent
CE590	Special Topics in Computer Vision	3		Face_to_Face	3	0	Department Consent
CE595	Special Topics in Robotics	3		Face_to_Face	3	0	Department Consent
CE587	Special Topics in Gaming	3		Face_to_Face	3	0	Department Consent
EE371	IoT Architecture and Protocols	3		Face_to_Face	3	0	CS214, CS2140
CS330	Image Understanding	3		Face_to_Face	3	0	ECE317, CS223
CS430	Virtual and Augmented Reality	3		Face_to_Face	3	0	CS214, CS2140
CS451	Artificial Intelligence	3		Face_to_Face	3	0	CS363

[b]BSC001 International Internship is a prerequisite for all elective courses

VII. Study Plan ^c Guide for the Bachelor's Degree in Computer Engineering

Study Plan Guide for the Bachelor Degree in
Computer Engineering ^c
(General Track)

First Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CS116	Computing Fundamentals	3		
CS1160	Computing Fundamentals Lab	1		CS116
ENGL101	English III	1	ENGL099	
GERL101	German I	3		
MATH101	Calculus I	3		
PHYS103	Physics I	3		
CHEM103	General Chemistry	3		
ARB100	Arabic	3		
	Total	**20**		

First Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CS201	Discrete Structures	3	ARB099, ENGL099, MATH099	
CS214	Object Oriented Programming	3	CS116, CS1160, ARB099, ENGL099, MATH099	
CS2140	Object Oriented Programming lab	1		CS214
ENGL102	English IV	1	ENGL101	
GERL102	German II	3	GERL101	
MATH102	Calculus II	3	MATH101	
PHYS104	Physics II	3	PHYS103	
PHYS106	Physics Lab	1		PHYS104
	Total	**18**		

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^c The following study plan guide assumes having passed all placement tests

Second Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE212	Digital Systems	3	CS116, ARB099, ENGL099, MATH099	
CE2120	Digital Systems Lab	1		CE212
CS222	Theory of Algorithms	3	CS116, CS1160, CS201, ARB099, ENGL099, MATH099	
CS223	Data Structures	3	CS116, CS1160, ARB099, ENGL099, MATH099	
ENGL201	English V	2	ENGL102, ARB099, MATH099	
GERL201	German III	3	GERL102, ARB099, ENGL099, MATH099	
MATH203	Applied Mathematics for Engineers	3	MATH102, ARB099, ENGL099	
	Total	**18**		

Second Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE201	Computer Architecture and Organization	3	CE212, CE2120	
MATH205	Differential Equations	3	MATH102, ARB099, ENGL099	
ENGL202	English VI	2	ENGL201	
ENE211	Electrical Circuits I	3	PHYS104, ARB099, ENGL099, MATH099	
GERL202	German IV	3	GERL201	
ECE317	Linear Algebra	3	MATH102	
ECE315	Random variables and stochastic processes	3	MATH102	
	Total	**20**		

Third Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE331	Signals and Systems	3	MATH203	
ECE241	Electronics 1	3	ENE211	
ECE2410	Electronics 1 Lab	1		ECE241
CE357	Operating Systems	3	CE201	
CE3570	Operating Systems Lab	1		CE357
CE352	Computer Networks	3	CS116, CE201	
GERL301	German V	3	GERL202	
ENE212	Electrical Circuits II	3	ENE211	
	Total	**20**		

Third Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
ENE213	Electrical Circuits Lab	1	ENE211	
CS363	Database Management Systems	3	CS223	
CE3561	Computer Networks Lab	1		CE352
CE477	Machine learning	3	ECE315 ECE317	
CE391	Field Training	0	Department Consent	
CE342	Microprocessor and Microcomputer Systems	3	CE212	
CE3420	Microprocessor and Microcomputer Systems Lab	1		CE342
GERL302	German VI	3	GERL301	
CE354	Computer Security	3	CE352	
	Total	**18**		

Fourth Year				
First Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
	Program Elective Course	3		
	Program Elective Course	3		
	Program Elective Course	3		
	Program Elective Course	3		
	Total	12		

Fourth Year				
Second Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE493	International Internship 6 Months Industry intern in Germany	12		
	Total	12		

German year prerequisites are:

1. A minimum GPA of 61.0%
2. Successful completion of 90 credit hours excluding all German language courses
3. Passing GERL302 German VI and B1 German language test (all 4 language skills) conducted by Goethe Institute or another approved provider
4. ENGL201 English V, and Arabic 99
5. Passing four out of the five following courses:
   - CE212: Digital Systems
   - CE357: Operating Systems
   - CE352: Computer Networks
   - CE331: Signals and Systems
   - CE342: Microprocessor and Microcomputer Systems

[d] Courses attended and/or passed during International Internship are not transferable

Fifth Year				
First Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
BM371	Numerical Methods for Engineers	3	MATH203, MATH205, CS116	
	University Elective Course	3		
CE592	Senior Project I	1	Department Consent	
CS416	Systems Programming	3	CS223	
MILS100	Military Science	3		
CE355	Data Communication	3	CE331	
NE101	National Education	3		
	Total	**19**		

Fifth Year				
Second Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE502	Parallel Architectures and Parallel Algorithms	3	CE201, CS222, CS223	
CE452	Network Protocols	3	CE352	
CS342	Software Engineering	3	CS214, CS363	
CE594	Senior Project II	3	CE592	
CE441	Embedded System Design	3	CE201	
IE121	Engineering Workshop	1		
	University Elective Course	3		
	Total	**19**		

Study Plan Guide for the Bachelor Degree in Computer Engineering [c]
(Artificial Intelligence and Machine Learning Track)

First Year				
First Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CS116	Computing Fundamentals	3		
CS1160	Computing Fundamentals Lab	1		CS116
ENGL101	English III	1	ENGL099	
GERL101	German I	3		
MATH101	Calculus I	3		
PHYS103	Physics I	3		
CHEM103	General Chemistry	3		
ARB100	Arabic	3		
	Total	20		

First Year				
Second Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CS214	Object Oriented Programming	3	CS116, CS1160, ARB099, ENGL099, MATH099	
CS2140	Object Oriented Programming lab	1		CS214
CS223	Data Structures	3	CS116, CS1160, ARB099, ENGL099, MATH099	
ENGL102	English IV	1	ENGL101	
GERL102	German II	3	GERL101	
MATH102	Calculus II	3	MATH101	
PHYS104	Physics II	3	PHYS103	
PHYS106	Physics Lab	1		PHYS104
	Total	18		

[c] The following study plan guide assumes having passed all placement tests

Second Year				
First Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE212	Digital Systems	3	CS116, ARB099, ENGL099, MATH099	
CE2120	Digital Systems Lab	1		CE212
CS222	Theory of Algorithms	3	CS116, CS1160, ARB099, ENGL099, MATH099	
ENE211	Electrical Circuits I	3	PHYS104, ARB099, ENGL099, MATH099	
ENGL201	English V	2	ENGL102, ARB099, MATH099	
GERL201	German III	3	GERL102, ARB099, ENGL099, MATH099	
MATH203	Applied Mathematics for Engineers	3	MATH102, ARB099, ENGL099	
	Total	18		

Second Year				
Second Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE201	Computer Architecture and Organization	3	CE212, CE2120	
ECE315	Random variables and stochastic processes	3	MATH102	
ENGL202	English VI	2	ENGL201	
GERL202	German IV	3	GERL201	
MATH205	Differential Equations	3	MATH102, ARB099, ENGL099	
ECE241	Electronics 1	3	ENE211	
ECE2410	Electronics 1 Lab	1		ECE241
ENE213	Electrical Circuits Lab	1	ENE211	
	Total	19		

Third Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE331	Signals and Systems	3	MATH203	
BM371	Numerical Methods for Engineers	3	MATH203, MATH205, CS116	
CE357	Operating Systems	3	CE201	
CE3570	Operating Systems Lab	1		CE357
CE352	Computer Networks	3	CS116, CE201	
CE3561	Computer Networks Lab	1		CE352
GERL301	German V	3	GERL202	
ECE317	Linear Algebra	3	MATH102	
	Total	**20**		

Third Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE477	Machine learning	3	ECE315, ECE317	
CS363	Database Management Systems	3	CS223	
ENE212	Electrical Circuits II	3	ENE211	
CE391	Field Training	0	Department Consent	
CE342	Microprocessor and Microcomputer Systems	3	CE212	
CE3420	Microprocessor and Microcomputer Systems Lab	1		CE342
GERL302	German VI	3	GERL301	
CE354	Computer Security	3	CE352	
	Total	**19**		

Fourth Year				
First Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
	Program Elective Course	3		
	Program Elective Course	3		
	Program Elective Course	3		
	Program Elective Course	3		
	Total	12		

Fourth Year				
Second Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE493	International Internship 6 Months Industry intern in Germany			
	Total	12		

German year prerequisites are:

1. A minimum GPA of 61.0%
2. Successful completion of 90 credit hours excluding all German language courses
3. Passing GERL302 German VI and B1 German language test (all 4 language skills) conducted by Goethe Institute or another approved provider
4. ENGL201 English V, and Arabic 99
5. Passing four out of the five following courses:
   - CE477: Machine Learning
   - CE331: Signals and Systems
   - CE342: Microprocessor and Microcomputer Systems
   - CS214: Object-oriented Programming
   - CS222: Theory of Algorithms

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[d] Courses attended and/or passed during International Internship are not transferable

Fifth Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CS451	Artificial Intelligence	3	CS222, CS223	
	University Elective Course	3		
CE592	Senior Project I	1	Department Consent	
MILS100	Military Science	3		
CE355	Data Communication	3	CE331	
EE472	Cloud Computing and Big Data	3		CE352
CE461	Image Processing	3	CE331	
	Total	**19**		

Fifth Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE502	Parallel Architectures and Parallel Algorithms	3	CE201, CS222, CS223	
CE561	Deep Learning	3	ECE315, ECE317	
NE101	National Education	3		
CE594	Senior Project II	3	CE592	
CE441	Embedded System Design	3	CE201	
IE121	Engineering Workshop	1		
	University Elective Course	3		
	Total	**19**		

Study Plan Guide for the Bachelor Degree in Computer Engineering [c]
(Computer Vision and Robotics Track)

First Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CS116	Computing Fundamentals	3		
CS1160	Computing Fundamentals Lab	1		CS116
ENGL101	English III	1	ENGL099	
GERL101	German I	3		
MATH101	Calculus I	3		
PHYS103	Physics I	3		
CHEM103	General Chemistry	3		
ARB100	Arabic	3		
	Total	**20**		

First Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CS214	Object Oriented Programming	3	CS116, CS1160, ARB099, ENGL099, MATH099	
CS2140	Object Oriented Programming lab	1		CS214
CS223	Data Structures	3	CS116, CS1160, ARB099, ENGL099, MATH099	
ENGL102	English IV	1	ENGL101	
GERL102	German II	3	GERL101	
MATH102	Calculus II	3	MATH101	
PHYS104	Physics II	3	PHYS103	
PHYS106	Physics Lab	1		PHYS104
	Total	**18**		

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[c] The following study plan guide assumes having passed all placement tests

Second Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE212	Digital Systems	3	CS116, ARB099, ENGL099, MATH099	
CE2120	Digital Systems Lab	1		CE212
CS222	Theory of Algorithms	3	CS116, CS1160, ARB099, ENGL099, MATH099	
ENE211	Electrical Circuits I	3	PHYS104, ARB099, ENGL099, MATH099	
ENGL201	English V	2	ENGL102, ARB099, MATH099	
GERL201	German III	3	GERL102, ARB099, ENGL099, MATH099	
MATH203	Applied Mathematics for Engineers	3	MATH102, ARB099, ENGL099	
	Total	**18**		

Second Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE201	Computer Architecture and Organization	3	CE212, CE2120	
CE331	Signals and Systems	3	MATH203	
ENGL202	English VI	2	ENGL201	
GERL202	German IV	3	GERL201	
MATH205	Differential Equations	3	MATH102, ARB099, ENGL099	
ECE241	Electronics 1	3	ENE211	
ECE2410	Electronics 1 Lab	1		ECE241
ENE213	Electrical Circuits Lab	1	ENE211	
	Total	**19**		

Third Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
ECE315	Random variables and stochastic processes	3	MATH102	
CE461	Image Processing	3	CE331	
CE357	Operating Systems	3	CE201	
CE3570	Operating Systems Lab	1		CE357
CE352	Computer Networks	3	CS116, CE201	
CE3561	Computer Networks Lab	1		CE352
GERL301	German V	3	GERL202	
ECE317	Linear Algebra	3	MATH102	
	Total	**20**		

Third Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE477	Machine learning	3	ECE315, ECE317	
CS363	Database Management Systems	3	CS223	
ENE212	Electrical Circuits II	3	ENE211	
CE391	Field Training	0	Department Consent	
CE342	Microprocessor and Microcomputer Systems	3	CE212	
CE3420	Microprocessor and Microcomputer Systems Lab	1		CE342
BM371	Numerical Methods for Engineers	3	MATH203, MATH205, CS116	
GERL302	German VI	3	GERL301	
	Total	**19**		

Fourth Year				
First Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
	Program Elective Course	3		
	Program Elective Course	3		
	Program Elective Course	3		
	Program Elective Course	3		
	Total	**12**		

Fourth Year				
Second Semester				
Course ID	**Course Name**	**Cr Hr**	**Prerequisites**	**Co-requisite**
CE493	International Internship 6 Months Industry intern in Germany			
	Total	**12**		

German year prerequisites are:

1. A minimum GPA of 61.0%
2. Successful completion of 90 credit hours excluding all German language courses
3. Passing GERL302 German VI and B1 German language test (all 4 language skills) conducted by Goethe Institute or another approved provider
4. ENGL201 English V, and Arabic 99
5. Passing four out of the five following courses:
   - CE477: Machine Learning
   - CE461: Image Processing
   - CS222: Theory of Algorithms
   - CE342: Microprocessor and Microcomputer Systems
   - CE3570: Operating Systems Lab

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[d] Courses attended and/or passed during International Internship are not transferable

Fifth Year				
First Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE565	Computer Vision	3	ECE317	
	University Elective Course	3		
CE592	Senior Project I	1	Department Consent	
MILS100	Military Science	3		
CE355	Data Communication	3	CE331	
CE521	Robotics	3	ECE317	
NE101	National Education	3		
	Total	**19**		

Fifth Year				
Second Semester				
Course ID	Course Name	Cr Hr	Prerequisites	Co-requisite
CE502	Parallel Architectures and Parallel Algorithms	3	CE201, CS222, CS223	
CE354	Computer Security	3	CE352	
CE563	Human Computer Interaction	3	ECE317	
CE594	Senior Project II	3	CE592	
CE441	Embedded System Design	3	CE201	
IE121	Engineering Workshop	1		
	University Elective Course	3		
	Total	**19**		

VIII. Compulsory Courses Offered by Computer Engineering Department

CE201: Computer Architecture and Organization   3 Cr Hr (3,0)   ECTS

Basic computer organization, central processing unit, micro-program control and control unit, arithmetic processor, memory units, bus structures, interrupt structures. Taxonomies of computer architectures; addressing methods, programs control, processing units, I-O organization, arithmetic, main-memory organization, peripherals, microprocessor families, RISC architectures and multiprocessors. Von Neumann; Baseline of processor architecture; Memory organization; Parallel computing.

Prerequisites: **CE212, CE2120**

CE212: Digital Systems   3 Cr Hr (3,0)   ECTS

Fundamentals of digital electronics, Binary number system; Boolean algebra, logic operations, algebra and gates, digital circuits analysis, gate-level and block level design of digital circuits, adders, subtractors, comparators, multiplexers, decoders, analysis, design and applications of sequential circuits: flip-flops, registers, counter, and their design procedures, RAM and ROM memory elements.

Prerequisites: **CS116, ARB099, ENGL099, MATH099**

CE2120: Digital Systems Lab   1 Cr Hr (3,0)   ECTS

The course also includes 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the CE212 course, including basic logic gate experiments, combinational logic circuits experiments, and sequential logic circuits experiments. The experiments on all topics vary from functional troubleshooting to gate and block level design implementation.

Corequisites: **CE212**

CE331: Signals and Systems   3 Cr Hr (3,0)   ECTS

Concepts and mathematical tools in continuous and discrete-time signal processing and linear systems analysis with examples from digital signal processing, communications, and control. Discrete-time signal models. Continuous-discrete-continuous signal conversion. Discrete-time impulse and step response. Frequency domain representations: Fourier series and transforms. Connection between continuous and discrete time frequency representations. Discrete Fourier transform (DFT) and fast Fourier transform (FFT). Digital filter and signal processing examples. Discrete-time and hybrid linear systems. Stability and causality. Z transforms and their connection to Laplace transforms. Frequency response of discrete-time systems.

Prerequisites: **MATH203**

CE342: Microprocessor and Microcomputer Systems   3 Cr Hr (3,0)   ECTS

Introduction to theoretical concepts of 8-bit and 16-bit microprocessors including microprocessor architecture, memory organization, instruction set, input/output organization, and interrupts. Design of microcomputer systems, address maps, system bus, memory maps, peripheral I/O, memory-mapped I/O, interrupt-driven I/O, interface devices, and general-purpose programmable peripheral devices.

Prerequisites: **CE212**

CE3420: Microprocessor and Microcomputer Systems Lab   1 Cr Hr (0,3)   ECTS

The course also includes 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the CE342 course.

Co- requisites: **CE342**

CE357: Operating Systems   3 Cr Hr (3,0)   ECTS

Operating system structures, process concept, hierarchy of processes, semaphores, inter-process communication, CPU scheduling, deadlocks, memory management, virtual memory, secondary storage management, file systems, I/O systems. 3-hours lab covers hands-on-experience on a study development of a sample operating system and alternative designs of operating systems: programming language

development, advanced commands, shell programming, and design principles. The focus of the sample operating system will be on the Linux Open Source to equip students with the right skills to work with open sources software.

Prerequisites: **CE201**

CE3570: Operating Systems Lab   **1 Cr Hr (0,3)**   **ECTS**

The course also includes 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the CE357 course.

Co-requisites: **CE357**

CE352: Computer Networks   **3 Cr Hr (3,0)**   **ECTS**

Study of computer network architectures, protocols, and interfaces. The OSI reference model and Internet architecture. Network models: LAN and WAN; Networking techniques such as multiple access, packet/cell switching, internetworking, end-to-end protocols, and congestion control; IP, UDP and TCP protocols; Internet application protocols and applications: http; DNS; Web services; email protocols: SMTP, POP3; Network security.

Prerequisites: **CS116, CE201**

CE3561: Computer Networks Lab   **1 Cr Hr (0,3)**   **ECTS**

Gain hands on experience on computer network protocols and interfaces, OSI reference model, and Internet protocols.

Co-requisites: **CE352**

CE354: Computer Security   **3 Cr Hr (3,0)**   **ECTS**

Security of networked computer systems; secure network configuration and user management; handling of attacks; Tools for secure network management; System management; System administration; System programming for security; Security: local attacks; network attacks; Firewalls; Security of web servers, ftp servers and mail servers; Virtual private networks, Cryptography, encryption and decryption techniques, primary key and digital certificate principles, Public Key Cryptography and the RSA Algorithm.

Prerequisites: **CE352**

CE355: Data Communication   **3 Cr Hr (3,0)**   **ECTS**

Fundamentals of Data Communications. Transmission Media, Data Encoding, Transmission Techniques, Protocols, Switching Networks, Broadcast Networks, Local Area Networks (LANs) and Wide Area Networks (WANs). Transmissions Technique and Cables. Troubleshooting Methods. Communication Interfaces. Network Security. Error Detection and Correction Methods. Modems Modulation Techniques for Digital Data Transmission, Data Link Protocols. High-Speed Packet Switching and Message Switching. OSI Reference Model. TCP/IP Protocols. Routing and Flow Control. Fundamentals of Frame Relay, ATM, X.25. Application Services, HTTP, Cryptography, MIME, E-mail. Telecommunication Services, ISDN, xDSL. New Technologies, IP Telephony, H323, WAP.

Prerequisites: **CE331**

CE461: Image Processing   **3 Cr Hr (3,0)**   **ECTS**

This course covers image processing theory and techniques. Topics include image models, image transformations, image enhancement, image restoration, image compression, image segmentation, and image recognition.

Prerequisites: **CE331**

CE477: Machine Learning   **3 Cr Hr (3,0)**   **ECTS**

This course focuses on statistical pattern recognition and machine learning techniques. The main topics of the course include: Bayesian decision theory, parametric density estimation (Maximum likelihood estimation (MLE) and non-parametric density estimation (Density Estimation, Parzen Window, K- Nearest Neighbor estimation, PNN, k-Nearest Neighbor classification rule), Bayesian parameter estimation, Hidden Markov models (HMM)), Linear Discriminant Analysis(Linear discriminant functions, generalized

discriminant analysis, Support vector machines), probabilistic graphical models, Multilayer Neural Networks (Perceptron Model, Artificial Neural Networks ANN's, Feed-forward NN, Error Back-propagation Algorithm), deep learning, and feature reduction and selection. This course involves several programming assignments in which students will use Matlab and/or Python to build various machine learning and pattern classification models that can be used to solve real-world problems in the fields of IoT applications, biomedical image and signal analysis, bioinformatics, among others.

Prerequisites: **ECE315, ECE317**

CE391: Field Training	0 Cr Hr (0,0)	ECTS

Students must complete 160 hours of field training in approved industries in Jordan by the end of their third academic year.

Prerequisites: Department Consent

CE441: Embedded System Design	3 Cr Hr (3,0)	ECTS

Embedded system concepts, hardware architecture, design and debugging, embedded processor selection, software development methodologies, real-time Linux, synchronization mechanisms, interrupt latency, application programming interface, interrupt service routine, application design considerations.

Prerequisites: **CE201**

CE452: Network Protocols	3 Cr Hr (3,0)	ECTS

Topics include the TCP/IP networking protocol architectures, layering, encapsulation, PDUs; sliding window algorithms, flow and error control, and the HDLC and PPP protocols; the OSI network layer organization, virtual circuits and datagrams, routing and congestion control algorithms, the X.25 and Frame Relay protocols and, internetworking, IPv4 and the evolving IPv6 internetworking protocols, and the RIP, OSPF, ES-IS, and IS-IS routing protocols, session layer dialog control and activity management, queuing, , packet scheduling, network security protocols; IPSec and VPNs, performance analysis, testing, correctness, SNMP, Wireless network protocols, Multi-Protocol Label Switching (MPLS), multimedia and real time network protocols.

Prerequisites: **CE352**

CE502: Parallel Architectures and Parallel Algorithms	3 Cr Hr (3,0)	ECTS

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, OpenMP); message passing computing; parallelization strategies (embarrassingly parallel, partitioning, pipelined, synchronous); load balance.

Prerequisites: **CE201, CS222, CS223**

CE561: Deep Learning	3 Cr Hr (3,0)	ECTS

This course provides a comprehensive introduction to deep neural networks. Topics include multilayer perceptions, convolutional neural networks, recurrent neural networks, deep unsupervised and reinforcement learning, practical aspects of training deep neural networks. Students will learn basic concepts of deep learning as well as hands on experience to solve real-life problems.

Prerequisites: **ECE317, ECE315**

CE563: Human Computer Interaction	3 Cr Hr (3,0)	ECTS

This course covers fundamental theories and concepts of human-computer interaction (HCI). Students will gain theoretical knowledge of and practical experience in the fundamental aspects of human perception, cognition, and learning as relates to the design, implementation, and evaluation of interfaces. Topics covered include interface design, usability evaluation, universal design, multimodal interfaces (touch, vision, and natural language), virtual reality, and spatial displays.

Prerequisites: **ECE317**

CE565: Computer Vision   **3 Cr Hr (3,0)**   **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: **ECE317**

CE521: Robotics   **3 Cr Hr (3,0)**   **ECTS**

Introduction to basics of modeling, design, planning, and control of robot systems. Topics include robotics foundations in kinematics, dynamics, control, motion planning, trajectory generation, programming, and design.

Prerequisites: **ECE317**

CE493: International Internship   **12 Cr Hr (12,0)**   **ECTS**

A training period of six month to be spent in the industry in Germany, under a follow up of academic faculty in Jordan and in Germany. Periodic reports and a final report need to be submitted for evaluation and an oral examination is required.

Prerequisites: Department Consent

CE592: Senior Project I **   **1 Cr Hr (1,0)**   **ECTS**

Theoretical investigation and practical implementation of a special project under the supervision of an academic faculty member, detailed report as well as an oral examination are required.

Prerequisites: Department Consent

CE594: Senior Project II   **1 Cr Hr (3,0)**   **ECTS**

Theoretical investigation and practical implementation of a special project under the supervision of an academic faculty member, detailed report as well as an oral examination are required.

Prerequisites: **CE592**

IX. Elective Course Offered by Computer Engineering Department

CE353: Distributed Systems **3 Cr Hr (3,0)** **ECTS**

Use and complexity of distributed systems; general integration problems application protocols; technical infrastructures for distributed programming; distribution strategies, i.e. load balancing, replication, fault tolerant systems Architectures and topologies; Distribution models; Reasons for distributed systems; Communication in distributed systems: Review of the OSI reference model; Communication mechanism; Middleware; Server and client programming; Client-server paradigm; Concurrent server programming; Asynchronous clients; Technologies: IP sockets; Remote invocation: RPC paradigm: C RPCs and Java RMI; Distribution strategies; Load balancing ; Fault tolerance and replication.

Prerequisites: **CE352**, **BSC001**

CE444 Microcomputer Interface and Peripheral Devices **3 Cr Hr (3,0)** **ECTS**

This course covers various topics relative to microprocessor/microcontroller interfacing in addition to peripheral devices and their properties. Topics include Processor Architecture Overview, Memory Models, GPIO interfacing, Interrupt handling, ADCs and DACs, Timers and PWM, Serial Interface Controllers, External sensor interfacing, Driving outputs. The course also has a practical part which uses Microcontrollers to conduct experiments based on assembly and the C language that interface with different input and output peripherals.

Prerequisites: **CE342, CE3420, BSC001**

CE4440 Microcomputer Interface and Peripheral Devices Lab **1 Cr Hr (0,3)** **ECTS**

The course also includes 3-hours lab session every week to apply microcontroller interfacing concepts hands-on on a hardware development board. Also includes getting introduced to the necessary toolchain and development tools required for creating and deploying code on a microcontroller platform. Experiments include a variety of interfacing with inputs and outputs, developing mixed code applications in assembly and C, analyzing interrupt sequences, and learning how to debug code by stepping though instructions and reading/interpreting data in microcontroller memory.

Co-requisites: **CE444, BSC001**

CE564 Pattern Recognition **3 Cr Hr (3,0)** **ECTS**

This course provides a comprehensive introduction to pattern recognition This course covers the methodologies, technologies, and algorithms of statistical pattern recognition from a variety of perspectives. Topics including pattern recognition systems, preprocessing and feature extraction, theories of supervised and unsupervised learning, object classification and recognition, artificial neural networks, and other topics as well.

Prerequisites: **ECE317, ECE315, BSC001**

CE520: Cognitive Robotics **3 Cr Hr (3,0)** **ECTS**

This introductory course gives an overview of the cutting-edge world of Robot Operating System (ROS), an open-source system for working with robots. ROS is used widely in research and is starting to be used commercially. This course will mainly focus on utilizing ROS in the field of robot perception such as the perception for manipulating objects, perception of people and other moving objects. Different open-source tools beside ROS will be used such as the Open-Source Computer Vision Library (Open CV), the Point Cloud Processing Library (PCL) to develop a vision and navigation frameworks for robots. In this course, students will be responsible of reading and summarizing a selection of published papers, in order to get the required skills and basics to do state-of-the-art, publishable work in mobile robotic manipulation.

Prerequisites: **CS214, BSC001**

CE463: Advanced Image Processing   3 Cr Hr (3,0)   ECTS

This course walks through the phases of image processing pipeline: Pre-processing, segmentation, region description, and classification and decision-making. The course also covers various image processing techniques, including image representation, 2D linear systems theory, 2D Fourier analysis, digital filtering, and image enhancement.

Prerequisites: **CE461, BSC001**

CE570: Optimization Methods   3 Cr Hr (3,0)   ECTS

This course introduces 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).

Prerequisites: **ECE317, BSC001**

CE471: Software Design and Architecture   3 Cr Hr (3,0)   ECTS

In-depth software design concepts; design patterns, frameworks, and architectures; middleware architectures. Design of distributed systems using middleware. Component based design. Measurement theory and appropriate use of metrics in design. Design qualities such as performance, safety, security, reusability, reliability, etc. Measuring internal qualities and complexity of software. Evaluation and evolution of designs. Basics of software evolution, reengineering, and reverse engineering methodologies.

Prerequisites: **CS342, BSC001**

CE473: Software Requirements Analysis   3 Cr Hr (3,0)   ECTS

General principles and techniques for software design. BNF Domain engineering. Techniques for discovering and eliciting requirements. Languages and models for representing requirements. Analysis and validation techniques, including need, goal, and use case analysis. Requirements in the context of system engineering. Specifying and measuring external qualities: performance, reliability, availability, safety, security, etc. Specifying and analyzing requirements for various types of systems: embedded systems, consumer systems, web-based systems, business systems, systems for scientists and other engineers. Resolving feature interactions. Requirement's documentation standards. Traceability. Human factors. Requirements in the context of agile processes. Requirements management and handling requirements changes.

Prerequisites: **CS342, BSC001**

CE474: Software Quality Assurance and Testing   3 Cr Hr (3,0)   ECTS

Quality assurance and verification; Need for a culture of quality. Avoidance of errors and other quality problems; Inspections and reviews; Testing, verification, and validation techniques; Process assurance vs. Product assurance; Quality process standards; Product and process assurance. Problem analysis and reporting; Statistical approaches to quality control

Prerequisites: **CS342, BSC001**

CE501: Advanced Computer Architecture   3 Cr Hr (3,0)   ECTS

This course focuses on advanced system-level architecture techniques for devices such as personal computers, servers, and embedded or portable systems. It covers topics such as cache hierarchies, memory systems, storage and IO systems, virtualization, clusters, fault-tolerance, and low-power design. It also covers the interactions between the hardware and software layers in such systems. The programming assignments introduce performance analysis and optimization techniques for small-scale and large-scale systems.

Prerequisites: **CE201, BSC001**

CE512: Advanced Logic Design   **3 Cr Hr (3,0)**   **ECTS**

Basic semiconductor physics, Digital Systems families, design methodologies, Digital Systems circuits, programmable logic devices, Digital Systems implementation with CPLD and FPGA, Verilog/VHDL compilation for CPLDs and FPGAs, synthesis of Altera/Xilinx CPLD and FPGA, synchronous versus asynchronous design, clock skew and path delays, PCB layout, post routing issues, embedded RAM and design criteria.

Prerequisites: **CE212, CE2120, BSC001**

CE551: Advanced Operating Systems   **3 Cr Hr (3,0)**   **ECTS**

The course covers advance topics: virtual memory management, synchronization and communication, file systems, protection and security, operating system extension techniques, fault tolerance, and the history and experience of systems programming.

Prerequisites: **CE357, CE3570, BSC001**

CE552: Advanced Computer Networks   **3 Cr Hr (3,0)**   **ECTS**

High-speed local networks; metropolitan area networks; bridges; routers; gateways; TCP/IP; application services; IP addressing; IP forwarding, encapsulation, and fragmentation; Address Resolution (ARP& RARP); IP next generation (IPv6); Inter Control Message Protocol (ICMP). Routing Algorithms, MPLS networking technology, VPNs, Network applications and services, Multimedia over internet, Network performance, and Network design. A set of laboratory experiments will provide hands-on experience in related topics.

Prerequisites: **CE352, BSC001**

CE558: Special topics in Computer Networks   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior level students in computer engineering. It gives them exposure to special topics in computer networks. 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: **CE352, BSC001**

CE559: Special topics in Operating Systems   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior level students in computer engineering. It gives them exposure to special topics in operating systems. 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: **CE357, CE3570, BSC001**

CE596: Special topics in Intelligent Systems   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior level students in computer engineering. It gives them exposure to special topics in artificial intelligent, machine learning and pattern recognition. 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: Department Consent

CE587: Special Topics in Gaming   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior level students in computer engineering. It gives them exposure to special topics in Gaming and game developing. 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: Department Consent

CE588: Special Topics in Deep Learning   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior level students in computer engineering. It gives them exposure to special topics in Deep Learning. 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: Department Consent

CE579: Special topics in Software Engineering   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior level students in computer engineering. It gives them exposure to special topics in software 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: **CS342, BSC001**

CE597: Special Topics in Computer Engineering I   **1 Cr Hr (1,0)**   **ECTS**

This course is offered to senior 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: Department Consent

CE598: Special Topics in Computer Engineering II   **2 Cr Hr (2,0)**   **ECTS**

This course is offered to senior 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: Department Consent

CE599: Special Topics in Computer Engineering   **3 Cr Hr (3,0)**   **ECTS**

This course is offered to senior 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: Department Consent

X. Course Offered by Other Departments

ENE211: Electrical circuits I	**3 Cr Hr (3,0)**	**ECTS**

Overview: SI units, voltage and current; Ohm's and Kirchhoff"s Laws, circuits with dependent sources; simple resistive circuits: series, parallel and delta to wye; Techniques of circuit analysis: nodal and mesh analyses, source transformation, Thevenin and Norton equivalents; Amplifiers; Inductance, capacitance, and mutual inductance; Natural and step responses of RL and RC circuits; Natural and step response of series and parallel RLC circuits; Sinusoidal steady state analysis.

Prerequisites: **PHYS104, ARB099, ENGL099, MATH099**

ENE212: Electrical circuits II	**3 Cr Hr (3,0)**	**ECTS**

Calculating average and reactive power, power in parallel loads, maximum power transfer. Analysis of 3-phase circuits: calculating wattmeter readings in 3-phase circuits. Introduction to Laplace Transform: poles and zeros, initial- and final value theorems. The Laplace Transform in circuit analysis. Active filter circuits. Fourier series. The Fourier Transform. Two-port circuits.

Prerequisites: **ENE211**

ENE213: Electrical circuits Lab	**1 Cr Hr (0,3)**	**ECTS**

Resistive circuits, Potentiometers, Superposition, Thevenin's theorem and maximum power transfer, RLC current and voltage characteristics, Frequency response of RL, RC and RLC circuits, Series and parallel resonant circuits, Amplifiers.

Prerequisites: **ENE211**

ECE241: Electronics 1	**3 Cr Hr (3,0)**	**ECTS**

Introduction to (semiconductor) electronic devices. Semiconductor p-n junction, the transistor. Analysis and synthesis of linear and nonlinear electronic circuits containing diodes and transistors. Elementary analog circuit analysis. Fundamentals of transistors and voltage amplification. Characterization of MOS transistors for circuit simulation. Common-source amplifiers, MOSFET source-follower buffer stage, differential amplifier stage, and MOSFET current sources. Operational amplifiers. Development of a Basic CMOS Operational amplifier.

Prerequisites: **ENE211**

ECE2410: Electronics 1 Lab	**1 Cr Hr (0,3)**	**ECTS**

Diode and diode applications including clipper, full-wave and half-wave rectifier, clamper, and voltage Doubler and Tripler. BJT transistor DC analysis for different configurations: Common base, common emitter, and common collector. BJT AC analysis. JFET DC analysis. Introduction to Op-amp

Co-requisites: **ECE241**

ECE315: Random variables and stochastic processes	**3 Cr Hr (3,0)**	**ECTS**

Probability principles and set theory: set definitions, set operations, probability introduced through sets and relative frequency, joint and conditional probability, independent events, combined experiments, Bernoulli trials. Random variables (Univariate and Multivariate): distribution and density functions, relation between distribution and density functions, the Gaussian random variable, other distribution, and density examples (binomial / Poisson / uniform / exponential / Rayleigh), conditional distribution and density functions. Operations on random variables: expectation, moments, functions that give moments, transformations of a random variable. Distribution and density of a sum of random variables, central limit theorem. Random processes: temporal characteristics and spectral characteristics. Concept of stationarity and ergodicity. Correlation function. Power spectrum density. Response of linear systems to random signals.

Prerequisites: **MATH102**

ECE317: Linear Algebra   **3 Cr Hr (3,0)**   **ECTS**

Systems of linear equations. Vector spaces and linear transformations. Independence, bases and dimensions, bases transformation. The fundamental four spaces. Understand a matrix as a linear transformation relative to a bases of a vector space. Orthogonality and Gram-Schmidt process. Projection and projection matrices. Linear models and least squares problems. Determinants and their properties. Eigenvalues and eigenvectors. Matrix decompositions such as LU decomposition, Eigen-decomposition, Singular Value Decomposition. Vector and matrix derivatives. Applying these tools in a wide range of engineering applications.

Prerequisites: **MATH102**

ECE461: Digital Signal Processing   **3 Cr Hr (3,0)**   **ECTS**

Digital Signal Processing begins with a discussion of the analysis and representation of discrete-time signal systems, including discrete-time convolution, difference equations, the z-transform, and the discrete-time Fourier transform. The course proceeds to cover digital network. FIR and IIR digital filters design. The fast Fourier transform algorithm for computation of the discrete Fourier transform. This course includes an internal lab, which is designed to introduce the students to the signal processing in digital domain. DSP Lab is equipped with complete set of Hardware and Software to perform wide range of experiments including Quantization, Fast Fourier Transform, FIR and IIR Filter implementation, Audio signal processing.

Prerequisites: **CE331, BSC001**

EE472: Cloud Computing and Big Data   **3 Cr Hr (3,0)**   **ECTS**

Journey to the Cloud, Classic Data Center (CDC), Application, DBMS, Compute and Storage, Networking, Object based and Unified storage technologies Business continuity overview and backup, Replication technologies. Virtualized Data Center (VDC) – Compute virtualization overview, Compute virtualization techniques, Virtual Machines, Resource management techniques, Physical to virtual conversion, Storage virtualization overview, Virtual Machine Storage. Virtualized Data Center – Networking, VDC networking overview, VDC networking components VLAN and VSAN technologies, Network traffic management. Virtualized Data Center – Desktop and Application, Desktop virtualization, Application virtualization. Introduction and Motivation, Big Data infrastructure, Data Analytics Lifecycle, Basic Data Analytic Methods, Advanced Analytics. Distributed file system such as HDFS, Distributed processing engines such as Map Reduce.

Co-requisites: **CE352, BSC001**

EE371: IoT Architectures and Protocols   **3 Cr Hr (3,0)**   **ECTS**

Introduction to IoT: Sensing & Actuation Sensor Networks Design principles of connected devices IoT Architecture; Reference Models; Physical design of IoT; Logical design of IoT; IoT enabling technologies; Domain specific IoT; Machine-to-Machine communication; Interoperability in IoT; Introduction to SDN; SDN for IoT; IoT physical servers; and cloud offerings Cloud storage models and Fog Computing in IoT environment.

Prerequisites: **BSC001**

CS116: Computing Fundamentals   **3 Cr Hr (3,0)**   **ECTS**

Basic computer skill; Programming concepts; algorithms: data types, arithmetic, logical, relational, Boolean, and assignment operators, simple input and output statements; programming control structures; data structures: single and multidimensional arrays; character strings; functions; pointers; file structures and representation; 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the course using Gnu C compiler on a Solaris/Sun environment. In the last 2 weeks students implement a course project that combines and covers the course topics in one application. The project is carried out during lecture and lab times as well as at home.

Prerequisites:

CS1160: Computing Fundamentals Lab   **1 Cr Hr (1,0)**   **ECTS**

Basic computer skill; Programming concepts; algorithms: data types, arithmetic, logical, relational, Boolean, and assignment operators, simple input and output statements; programming control structures; data structures: single and multidimensional arrays; character strings; functions; pointers; file structures and representation; 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the course using Gnu C compiler on a Solaris/Sun environment. In the last 2 weeks students implement a course project that combines and covers the course topics in one application. The project is carried out during lecture and lab times as well as at home.

Co-requisites: **CS116**

CS201: Discrete Structures   **3 Cr Hr (3,0)**   **ECTS**

Fundamental structures: Functions (surjections, injections, inverses, composition); relations (reflexivity, symmetry, transitivity, equivalence relations); sets (Venn diagrams, complements, Cartesian products, power sets); pigeonhole principle; cardinality and countability. Basic logic: Propositional logic; logical connectives; truth tables; normal forms validity; predicate logic; limitations of predicate logic; universal and existential quantification; modus ponens and modus tollens. Proof techniques: Notions of implication, converse, inverse, contrapositive, negation, and contradiction; direct proofs; proof by counterexample; proof by contraposition; proof by contradiction; mathematical induction; strong induction; recursive mathematical definitions; well orderings Basics of counting: Counting arguments; pigeonhole principle; permutations and combinations; recurrence relations. Discrete probability: Finite probability spaces; conditional probability, independence Bayes' rule; random events; random integer variables; mathematical expectation

Prerequisites: **MATH099, ARB099, ENGL099**

CS214: Object Oriented Programming   **3 Cr Hr (3,0)**   **ECTS**

Object Oriented Programming concepts; Classes, objects and data abstraction, Constructors, and destructors; Object-oriented design; encapsulation and information hiding; abstraction and modularization, coupling and cohesion, sample design patterns. inheritance; class and type hierarchies, polymorphism, Abstract classes, Interfaces; Packages; Collection classes, Generics, streams and files, exception handling; unit testing and debugging, Application Programming Interfaces, Javadoc, 3-hours lab session every week to enhance hands-on experience on topics that are theoretically covered in the course using the Java compiler on a Solaris/Sun environment.

Prerequisites: **CS116, CS1160, ARB099, ENGL099, MATH099**

CS2140: Object Oriented Programming Lab   **1 Cr Hr (1,0)**   **ECTS**

Lab session every week to enhance hands-on experience on topics that are theoretically covered in the course: Object Oriented Programming concepts; Classes, objects and data abstraction, Constructors, and destructors; Object-oriented design; encapsulation and information hiding; abstraction and modularization, coupling and cohesion, sample design patterns. Inheritance; class and type hierarchies, polymorphism, Abstract classes, Interfaces; Packages; Collection classes, Generics, streams and files, exception handling; unit testing and debugging, Application Programming Interfaces, Javadoc.

Co-requisites: **CS214**

CS222: Theory of Algorithms   **3 Cr Hr (3,0)**   **ECTS**

Complexity bounds and asymptotic analysis: standard complexity classes; Empirical measurements of performance; Time and space tradeoffs in algorithms; analysis of algorithms. Algorithms: recursion; recursive algorithms; divide-and-conquer strategies; backtracking; design of algorithms; sorting algorithms including heapsort, merge sort and quicksort, automata, and string matching.

Prerequisites: **CS116, CS1160, CS201, ARB099, ENGL099, MATH099**

CS223: Data Structures   **3 Cr Hr (3,0)**   **ECTS**

Lists, stacks, and queues; hash tables; binary search trees; balanced trees, B-Trees, graphs; depth- and breadth-first traversals; shortest-path algorithms; transitive closure; minimum spanning tree; topological sort. implementation strategies for data structures; strategies for choosing the right data structure; 3-hours lab session every week allows for implementing and using sample data structures and algorithms discussed during the course using Gnu C compiler.

Prerequisites: **CS116, CS1160, ARB099, ENGL099, MATH099**

CS342: Software Engineering   **3 Cr Hr (3,0)**   **ECTS**

The product and the process, Software project management: Basic concepts, Software process and project metrics, Software project Planning, Risk management, Project scheduling and tracking, Quality assurance, Configuration management; Classical approaches: Waterfall and Spiral models; Object-oriented approach; Unified Modeling Language (UML); Concepts and notations of object-oriented analysis: Base concepts; Static concepts; Dynamic concepts; Object-oriented analysis: Analytical process; Analysis patterns; Static model; Dynamic model; Design notations and diagram; Design patterns. Course project that covers hands on experience on Computer Aided Software Engineering (CASE) tools such as Rational Rose and Course Team Projects.

Prerequisites: **CS214, CS363**

CS363: Database Management Systems   **3 Cr Hr (2,2)**   **ECTS**

DBMS Architecture, Storage Hierarchy, Indexes, Entity-relationship (E-R) modeling, The relational model, Relational Query Language (SQL), Query processing and optimization, Creation and manipulation of databases; Indices and views; Access rights management; Programming in SQL; Transaction Processing (Transactional properties, Concurrency control, Locking, and Crash recovery); Data dictionaries; Required software tools: A main-stream commercial DBMS such as MS SQL, Oracle; 3-hours lab covers hands on experience with design and implementing databases.

Prerequisites: **CS223**

CS416: Systems Programming   **3 Cr Hr (2,2)**   **ECTS**

System-level UNIX API's: Process manipulation; IO operations; Use of OS functionality; System- level programming in C; Shell programming; Unix system services: file system, process and thread management, inter-process communication: pipes, shared memory, and message queues, semaphores; Network programming, and synchronization; Microsoft Windows and UNIX TCP and UDP Communications; Connection-Oriented Client-Server Architecture; Remote procedure calls and COM overview

Prerequisites: **CS223**

CS419: Compiler Construction   **3 Cr Hr (3,0)**   **ECTS**

Formal grammars; Context sensitive, context free, regular grammars; Phases of compilation; Lexical analysis and a review of parsing; Compiler-compilers and translator writing systems; Top-Down Parsing and bottom-up parsing; Lexical scanners generators. Parser generators; Compilation of modern procedural languages; Scope rules; block structure; Symbol tables; Runtime stack management; Parameter passage mechanisms; Stack storage organization and templates; Heap storage management; Intermediate code generation. Machine code generation; Macros; Templates.

Prerequisites: **CS222, CS223, BSC001**

CS460: Data Mining   **3 Cr Hr (3,0)**   **ECTS**

The course introduces students to data mining, by studying their principles, algorithms, implementation methodology, and applications. It provides a comprehensive introduction to data mining, including data selection, cleaning, coding, using different pattern recognition techniques, and reporting; and introduce students to the applications of data mining by using commercial tools for creating business applications.

Prerequisites: **CS363, BSC001**

CS451: Artificial Intelligence   **3 Cr Hr (3,0)**   **ECTS**

Mathematical principles of AI; introducing several AI approaches and techniques and their underlying mathematical/algorithmic structure. Problems; problem spaces, and search. Heuristic search techniques, simulated annealing, genetic algorithms and Tabu search. Knowledge representation and logic; Constraint logic programming; Statistical reasoning; Fuzzy set theory and reasoning; Neural networks

Prerequisites: **CS222, CS223, BSC001**

CS330: Image Understanding   **3 Cr Hr (3,0)**   **ECTS**

This course is an introduction to fundamental concepts in image understanding. This course explores several algorithms for extracting useful semantic content from image data. In general, the course theme spans over three main topics: image processing, features and matching, geometry in vision, and recognition. In particular, the course will include algorithms and techniques related to linear filters, edge detection, image pyramids, SIFT, Harris Corner detection, feature selection, camera models, homography, stereo vision, image search, fast retrieval, image classification, objection detection, HOG detector.

Prerequisites: **ECE317, CS223, BSC001**

CS353: Natural Language Processing   **3 Cr Hr (3,0)**   **ECTS**

Introduction to language: words, symbols, sentences, documents, corpus. Variation in languages & dialects. Information retrieval. Words: Stemming, Lemmatization. Sentences: Syntactic parsing, Chunking. Named entity recognition (NER). Word sense disambiguation (WSD). Classification: Sentiment Analysis, Spam detection. Applications: Question Answering, Dialogue Systems, Summarization, Information Extraction.

Prerequisites: **CS222, BSC001**

CS430: Virtual and Augmented Reality   **3 Cr Hr (3,0)**   **ECTS**

VR systems: Discipline, features, Architecture. VR hardware: tracking systems, motion capture systems, visual displays. Fundamentals of the human visual system. Haptic rendering: Haptic sense. Haptic devices. Algorithms for haptic rendering. VR software development: Challenges in VR software development. Windowing, viewing, input/output, networking. Master/slave and Client/server architectures. Cluster rendering. Game Engines. Publicly available SDK for different hardware (HTC VIVE, Oculus, Google VR). AR software development: AR software. Camera parameters and camera calibration. Marker-based augmented reality. Pattern recognition. AR Toolkits.

Prerequisites: **CS214, CS2140, BSC001**

CS477: Mobile Computing   **3 Cr Hr (3,0)**   **ECTS**

An introduction to mobile computing with a strong emphasis on application development for the Android operating system. Topics will include Introduction to Android IDE, Layout & Activity, Preference and Service Menu, Thread (message), Thread (progress, post, broadcast, & Intent filter), Notification, Dynamic layouts, TTS, and clocks SQLlite. This course will cover mobile phone programming components like UI programming, data management, localization, and programming sensors like the accelerometer and compass, and mobile OS services. The course will focus on the Android platform and how to use cloud services in applications. Android tablets will also be given.

Prerequisites: **CS254, CS363, BSC001**

XI. Courses offered by Other Schools

ARB099: Arabic 99   **0 Cr Hr (3,0)**   **0 ECTS**

This course aims to develop student's ability to read, comprehend, literary analyze, grammatically analyze, linguistically analyze, poetically analyze, and rhetorically analyze texts properly. The course also includes a selection of Arabic literature in poetry and prose representing different literary ages, in addition to several common forms of writing such as scientific article, news article, and others.

Prerequisites: -

ARB100: Arabic   **3 Cr Hr (3,0)**   **3 ECTS**

This course aims to improve the student's competence in the various linguistic skills in terms of reading, comprehension, and taste. This is achieved through the study of selected texts with many implications that raise issues in spelling, grammar, composition, meaning, and inference, and the use of an old and modern thesaurus.

*Prerequisites: **ARB099***

ENGL099: English II   **0 Cr Hr (3,0)**   **0 ECTS**

Students will focus on English at a pre-intermediate level concentrating on the receptive skills of reading and listening and the productive skills of writing and speaking. These will include such things as comparatives and superlatives, quantifiers, possessive adjectives and pronouns, vocabulary building, role-play activities for speaking, reading comprehension and writing short descriptive paragraphs.

Prerequisites: -

ENGL101: English III   **1 Cr Hr (3,0)**   **3 ECTS**

Students will focus on English at an intermediate level concentrating on the receptive skills of reading and listening and the productive skills of writing and speaking. These will include collocations, tense review, affirmative, negative statements, synonyms and antonyms, time clauses, conditionals, active and passive forms, reported speech, phrasal verbs, reading comprehension with detailed questions, vocabulary and writing developed descriptive and opinion essays.

*Prerequisites: **ENGL099***

ENGL102: English IV   **1 Cr Hr (3,0)**   **3 ECTS**

Students will focus on English at an upper-intermediate level concentrating on the receptive skills of reading and listening and the productive skills of writing and speaking. Model verb review, silent letters and proper pronunciation, jobs and careers, requests and offers, more phrasal verbs with vocabulary building, relative clauses and relative pronouns, narrative tenses for writing exercises, wishes and regrets, reading and comprehending longer passages with direct and inference questions of medium difficulty, hypothesizing, and writing fully developed descriptive, argumentative, and analytical essays of 350 words.

*Prerequisites: **ENGL101***

ENGL201: English V   **2 Cr Hr (3,0)**   **3 ECTS**

Students will focus on English at an Advanced level. Students will analyze and produce 2 – 3 page essays with an emphasis on argumentation and persuasion working both independently and cooperatively to gather, evaluate, and synthesize necessary information. Class activities include interactive lectures, small group and class discussions, informal debates, peer feedback, individual presentations, focused listening exercises and focused viewing exercises as well as assorted reading, writing, and grammar assignments. There will be some poetry analysis together with reading and understanding a short story and a drama using basic literary terms and concepts.

*Prerequisites: **ENGL102, ARB099, MATH099***

ENGL202: English VI   **2 Cr Hr (3,0)**   **3 ECTS**

Students will continue to focus on English at an Advanced level. Students will analyze and produce 4 – 5 page essays emphasizing argumentative, persuasive and discursive styles of writing, working both

independently and cooperatively to gather, evaluate, and synthesize necessary information. Students will integrate the practice of critical thinking and reading into the writing process. Class activities include interactive lectures, small group and class discussions, informal debates, mini-conferences, peer feedback, individual presentations, focused listening exercises and focused viewing exercises as well as assorted reading, writing, and grammar assignments. There will be some poetry analysis together with reading and understanding a short story and a drama using stronger and more intensive literary terms and concepts than in 201.

Prerequisites: **ENGL201**

GERL101B1: German I B1 track   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:
- Comprehend very familiar, everyday expressions and very simple sentences and structures related to areas of most immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the Level A1.1 (beginners without pre-knowledge).
- Introduce herself/himself and others, express likes and dislikes, fill out a personal form, ask questions and give answers in present and partially in past tense, set private and semi-official appointments, describe people and things and express frequency and quantity in a very basic way both orally and in writing.
- Communicate with native speakers on a very basic level if those involved in the conversation speak slowly and clearly and are willing to support the non-native speaker.

Prerequisites: Intensive pre-course (only for 1st semester of an academic year)

GERL102B1: German II B1 track   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:
- Understand and use familiar, everyday expressions and very simple sentences and structures related to areas of most immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A1.2 (basic users).
- Introduce herself/himself and others, express likes and dislikes, fill out a personal form, ask questions and give answers in present and past tense, set private and official appointments, describe people and things, ask for directions, express frequency and quantity in a basic way both orally and in writing.
- Communicate with native speakers on a very basic level if those involved in the conversation speak slowly and clearly and, if need be, are willing to support the non-native speaker.

Prerequisites: **GERL101B1**

GERL201B1: German III B1 track   **3 Cr Hr (6,0)**   **4 ECTS**

By the end of this module, the student will be able to:
- Understand and use familiar, frequently used expressions and simple sentences and structures related to areas of a wider immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A2.1 (basic users).
- Talk about their academic and/or professional background, describe their living conditions, express likes and dislikes, ask questions and give answers in present and past tense, ask for help and support, make suggestions and give advice, describe health problems and talk with medical doctors and nurses, express pity, sorrow and hopes, express frequency and quantity in a basic way both orally and in writing.
- Communicate with native speakers within simple and familiar tasks requiring a simple and direct exchange of information on familiar and routine matters.

Prerequisites: **GERL102B1, ARB099, ENGL099, MATH099**

GERL202B1: German IV B1 track   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:
- Distinguish between familiar expressions, sentences and structures related to areas of immediate relevance and more elaborated components like the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A2.2 (basic users) and, partially, at the level B1.1 (independent user).

- Talk about personal experiences with languages, express feelings of happiness, joy and discomfort, describe own media consumption habits, describe travel experiences, convince others, describe and report in official situations, describe statistics, write formal invitations and short emails, make suggestions and talk about future events and situations, describe dreams hopes and ambitions and briefly give reasons or explanations for opinions and plans.
- Communicate with native speakers about essential points and ideas in familiar contexts.
- Understand the characteristics of the official B1 exam according to the CEFR and use strategies to overcome obstacles while solving said exam.

Prerequisites: **GERL201B1**

GERL301B1: German V B1 track **3 Cr Hr (9,0)** **6 ECTS**

By the end of this module, the student will be able to:
- Understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B1.1 and B1.2 (independent user).
- Deal with most situations likely to arise whilst traveling in an area where German is spoken, produce simple connected texts on topic which are familiar or of personal interest, describe experiences and events, dreams, hopes and ambitions, statistics, and briefly give reasons and explanations for opinions and plans.
- Understand the main point of many radio or TV programmes on current events and topics, understand the description of events, feelings and wishes in personal letters, write personal letters/texts describing experiences and impressions, write straightforward connected texts on topics which are familiar or of personal interest.
- Communicate with native speakers about essential points and ideas in familiar contexts and about topics of personal or partially professional interest.
- Follow a lecture or talk within her/his field, provided the subject matter is familiar and the presentation straightforward and clearly structured.
- Understand simple technical information, such as operating instructions for everyday equipment.
- Understand all characteristics of the official B1 exam according to the CEFR and use a variety of strategies to overcome obstacles while solving said exam and all its components.

Prerequisites: **GERL202B1**

GERL302REG: German VI Regular **3 Cr Hr (6,0)** **6 ECTS**

By the end of this module, the student will be able to:
- Successfully manage the application process for a six months internship in Germany which is part of the obligatory 'German Year' for all GJU students. The process consists of finding and understanding a suitable add in accordance with the students' major, writing a convincing CV and cover letter, and mastering an effective and mostly fluent interview, departing spontaneously, taking initiatives, expanding ideas with little help, or prodding from the interviewer.
- Successfully manage the most significant situations which the student, in accordance with the currently studied major, encounters during her/his theoretical and practical semester in Germany. This process is being achieved within a technical language training focussing on action orientated and communicative scenarios like following lectures, taking notes, summarizing academic and technical texts, writing official emails and texts related to academic and vocational encounters, holding presentations, communicating both verbally and in writing with professors, university staff, students as well as with colleagues and customers during an internship.
- Understand the concept of general intercultural phenomena, reflect and understand the differences between culture and cultural standards in Jordan and in Germany, understand the concept of 'culture shock' and potentially cope with its different stages, reflect about appropriate and inappropriate behaviour in Germany as well as understand the concepts of open-mindedness and 'culture clash'.

Prerequisites: **GERL301B1**

GERL302INT: German VI Intensive   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:

- Successfully manage the application process for a six months internship in Germany which is part of the obligatory 'German Year' for all GJU students. The process consists of finding and understanding a suitable add in accordance with the students' major, writing a convincing CV and cover letter, and mastering an effective and mostly fluent interview, departing spontaneously, taking initiatives, expanding ideas with little help, or prodding from the interviewer.
- Successfully manage the most significant situations which the student, in accordance with the currently studied major, encounters during her/his theoretical and practical semester in Germany. This process is being achieved within a technical language training focusing on action orientated and communicative scenarios like following lectures, taking notes, summarizing academic and technical texts, writing official emails and texts related to academic and vocational encounters, holding presentations, communicating both verbally and in writing with professors, university staff, students as well as with colleagues and customers during an internship.
- Understand the concept of general intercultural phenomena, reflect and understand the differences between culture and cultural standards in Jordan and in Germany, understand the concept of 'culture shock' and potentially cope with its different stages, reflect about appropriate and inappropriate behavior in Germany as well as understand the concepts of open-mindedness and 'culture clash'.
- Understand all characteristics of the official B1 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and its different components.

Prerequisites:

GERL102B2: German II B2 track   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:

- Understand and use familiar, everyday expressions and simple sentences and structures related to areas of most immediate relevance according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A1.2 and, partially, A2.1 (basic users).
- Talk about their academic and/or professional background, describe their living conditions, express likes and dislikes, ask questions and give answers in present and past tense, ask for help and support, make suggestions and give advice, express pity, sorrow and hopes, express frequency and quantity in a basic way both orally and in writing.
- Introduce herself/himself and others, express likes and dislikes, fill out a personal form, ask questions and give answers in present and past tense, set private and official appointments, describe people and things, ask for directions, express frequency and quantity in a basic way both orally and in writing.
- Communicate with native speakers on a basic level if those involved in the conversation speak slowly and clearly and, if need be, are willing to support the non-native speaker.

Prerequisites: **GERL101B1**

GERL201B2: German III B2 track   **3 Cr Hr (6,0)**   **4 ECTS**

By the end of this module, the student will be able to:

- Distinguish between familiar expressions, sentences and structures related to areas of immediate relevance and more elaborated components like the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level A2.1 and A2.2 (basic users).
- Talk about their academic and/or professional background, describe their living conditions, express likes and dislikes, ask questions and give answers in present and past tense, ask for help and support, make suggestions and give advice, describe health problems and talk with medical doctors and nurses, express pity, sorrow and hopes, describe simple statistics, express frequency and quantity in a basic way both orally and in writing, express feelings of happiness, joy and discomfort and write personal emails and letters, understand and produce comments, blogs and reports.
- Communicate with native speakers in simple and familiar tasks requiring a simple and direct exchange of essential information on familiar and routine matters.

GERL202B2: German IV B2 track   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:

- Understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure etc. according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B1.1 and B1.2 (independent user).
- Deal with most situations likely to arise whilst traveling in an area where German is spoken, produce simple connected texts on topic which are familiar or of personal interest, describe experiences and events, dreams, hopes and ambitions and briefly give reasons and explanations for opinions and plans.
- Understand the main point of many radio or TV programmes on current events and topics, understand the description of events, feelings and wishes in personal letters, write personal letters/texts describing experiences and impressions, write straightforward connected texts on topics which are familiar or of personal interest.
- Communicate with native speakers about essential points and ideas in familiar contexts and about topics of personal or partially professional interest.
- Follow a lecture or talk within her/his field, provided the subject matter is familiar and the presentation straightforward and clearly structured.
- Understand simple technical information, such as operating instructions for everyday equipment.
- Understand all characteristics of the official B1 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and all its components.

Prerequisites: **GERL201B2**

GERL301B2: German V B2 track   **3 Cr Hr (9,0)**   **6 ECTS**

By the end of this module, the student will be able to:

- Largely understand and produce rather complex texts on both concrete and abstract topics, including technical discussions in her/his field of specialisation and according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B2.1 (independent user).
- Interact with an initial degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party.
- Largely understand standard spoken language, live or broadcast, on both familiar and unfamiliar topics normally encountered in personal, social, academic or vocational life.
- Show a relatively high controlled degree of grammatical control without making errors which cause misunderstanding and with the growing ability to correct most of her/his mistakes.
- Largely follow essentials of lectures, talks, reports, and other forms of academic/professional presentation which are propositionally and linguistically complex.
- Understand announcements and messages on concrete and abstract topics spoken in standard dialect at normal speed.
- Scan quickly through long texts, locating relevant details and understand and exchange complex information and advice on the full range of matters related to her/his occupational role.
- Understand the main characteristics of the official B2 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and its different components.

Prerequisites: **GERL202B2**

GERL302B2: German VI B2 track   **3 Cr Hr (6,0)**   **6 ECTS**

By the end of this module, the student will be able to:

- Understand and produce rather complex texts on both concrete and abstract topics, including technical discussions in her/his field of specialisation and according to the discretionary standards in the *Common European Framework of Reference for Languages* (CEFR) at the level B2.2 (independent user).
- Interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party.
- Understand standard spoken language, live or broadcast, on both familiar and unfamiliar topics normally encountered in personal, social, academic or vocational life.

- Show a highly controlled degree of grammatical control without making errors which cause misunderstanding and with the growing ability to correct most of her/his mistakes.
- Follow essentials of lectures, talks, reports and other forms of academic/professional presentation which are propositionally and linguistically complex.
- Understand announcements and messages on concrete and abstract topics spoken in standard dialect at normal speed.
- Scan quickly through long texts, locating relevant details and understand and exchange complex information and advice on the full range of matters related to her/his occupational role.
- Understand all characteristics of the official B2 exam according to the CEFR and use different strategies to overcome obstacles while solving said exam and its different components.
- Successfully manage the application process for a six months internship in Germany which is part of the obligatory 'German Year' for all GJU students. The process consists of finding and understanding a suitable add in accordance with the students' major, writing a convincing CV and cover letter, and mastering an effective and mostly fluent interview, departing spontaneously, taking initiatives, expanding ideas with little help, or prodding from the interviewer.
- Successfully manage the most significant situations which the student, in accordance with the currently studied major, encounters during her/his theoretical and practical semester in Germany. This process is being achieved within a technical language training focussing on action orientated and communicative scenarios like following lectures, taking notes, summarizing academic and technical texts, writing official emails and texts related to academic and vocational encounters, holding presentations, communicating both verbally and in writing with professors, university staff, students as well as with colleagues and customers during an internship.
- Understand the concept of general intercultural phenomena, reflect and understand the differences between culture and cultural standards in Jordan and in Germany, understand the concept of 'culture shock' and potentially cope with its different stages, reflect about appropriate and inappropriate behaviour in Germany as well as understand the concepts of open-mindedness and 'culture clash'.

Prerequisites: **GERL301B2**

BE302: Business Entrepreneurship	**3 Cr Hr (3,0)**	**3 ECTS**

The course focuses on critical skills necessary to develop appropriate financing strategies for new venture creation and growth. Students will use case studies and team projects in course studies. Three primary topics are covered: first, an overview of the entrepreneurial finance process and involved players; second, performing business valuations; and third, securities law with emphasis on developing term sheets and private placement memorandums. Student teams will complete a valuation and mock securities offering for an existing small to mid-size business. Financial valuations and terms sheets developed by student teams will be presented to a panel of venture capital professionals for evaluation and critique.

Prerequisites: **ENGL101**

DES101: Arts Appreciation	**3 Cr Hr (3,0)**	**3 ECTS**

An introductory course designed for non-art students to give them the basic knowledge of arts and simple approaches to the understanding of the history, development, elements, criticism, esthetics and materials of different art forms (visual, aural and performing arts). A comparative approach between the different arts is given to enhance the students' global understanding of arts and to give them the ability to look at art works and form their own opinions. The course is combined with examples of audio and visual arts.

Prerequisites: **ARB099, ENGL101**

EI101: Leadership and Emotional Intelligence	**3 Cr Hr (3,0)**	**3 ECTS**

In this course, students will be introduced to the concept of Emotional Intelligence as a means to improve self-management and relationship management. The operative concepts are applied to social, family, academic and professional relationships with an emphasis on leadership implications. The majority of the curriculum is based upon the book by Daniel Goleman entitled: "Leadership: The Power of Emotional Intelligence," and covers leadership styles and their appropriate applications, the emotional intelligence model, and neurological aspects of the limbic system. The class is a lecture format which encourages

student participation.

IC101: Intercultural Communication　　　　　　　**3 Cr Hr (3,0)**　　　**3 ECTS**

This course is designed to provide prospective students (whose majors have an international flavor) with tools that offer powerful possibilities for improving the communication process. We will examine the process of sending and receiving messages between people whose cultural background could lead them to interpret verbal and nonverbal signs differently. We will learn about the diversity of these cultural differences and at the same time learn how we might overcome them. Our efforts to recognize and surmount cultural differences will hopefully open up business opportunities throughout the world and maximize the contribution of all the employees in a diverse workforce.

Prerequisites: **ENGL101**

MILS100: Military Science　　　　　　　　　　**3 Cr Hr (3,0)**　　　**3 ECTS**

History of the Jordanian Arab Army. United Nations Peace Keeping Forces. Preparation of the nation for defense and liberation. History of the Hashemite Kingdom of Jordan and its development

Prerequisites:

NE101, NEE101: National Education　　　　　　**3 Cr Hr (3,0)**　　　**3 ECTS**

In a context of striving towards democracy like the one Jordan enjoys today, the meaning and practice of active and responsible citizenship becomes more crucial. It is often argued that democracy requires "democrats" to flourish and become well established. Democrats are those women and men who recognize pluralism, inclusion, positive engagement, and participation as the main values that govern their interaction with the state as citizens and with each other as diverse people of different interests. In this course you will be able to understand your rights and responsibilities as Jordanian citizen expand your knowledge about the frameworks, and processes that regulates citizen-state relationships as well as the basic necessary skills for you to practice your citizenship rights in a civic manner.

Prerequisites:

PE101: Sports and Health　　　　　　　　　　**3 Cr Hr (3,0)**　　　**3 ECTS**

The course focuses on providing students with information related to Sport, fitness and health culture, Voluntary work Nutrition, First Aid. It covers also Special physical preparation and general sports cultural issues.

Prerequisites: **ARB099**

SE301: Social Entrepreneurship and Enterprises　　　**3 Cr Hr (3,0)**　　　**3 ECTS**

This course will serve as an introduction to the field of social entrepreneurship and social enterprises.
Through lectures, field visits, analyses of relevant literature, case studies and exercises, this course will explore social entrepreneurship's potentials, opportunities and limitations. The topics will cover Defining Social Entrepreneurship. Contextualizing Social Entrepreneurship (need, motives, forms, criteria). Role of Leadership, Creativity and Innovation. Locating SE on the profit/non-profit continuum. SE in the larger fields of development, social change, community activism. Social Enterprises (Missions, Markets, Finances). Ethical business and corporate social responsibility.

Prerequisites: **ENGL101**

SFTS101: Soft Skills　　　　　　　　　　　　**3 Cr Hr (3,0)**　　　**3 ECTS**

This course is designed to help develop strong oral and written communication skills. The student will be given opportunities to practice writing and editing professional correspondence and technical reports. Additionally, the student will compose and deliver oral presentations. Assignments will include the use of inductive and deductive approaches to conveying a variety of messages. The course emphasis the use of software tools to prepare presentations, stress management, confidence, and sensitivity to others. It also stresses on resume writing and conducting interviews.

Prerequisites: **ENGL101**

TW303: Technical and Workplace Writing **3 Cr Hr (3,0)** **3 ECTS**

Technical and Workplace Writing course focuses on essentials; it introduces students to professional and technical writing through a straightforward structure, adding knowledge while practicing different forms and skills. Since this course is a practical one, the course offers the "how" (instructions) and the "what" (examples) with discussion topics and exercises designed to make instruction straightforward. Students are exposed to certain genres, such as web page design, summaries, proposals, user guides, and job application materials. This is why this course is designed with a student/worker in mind, who would greatly benefit from the techniques of writing presented throughout the course.

Prerequisites: **ENGL102**

MATH099: Pre-Math **0 Cr Hr (3,0)** **0 ECTS**

This course is intended as a preparation for Calculus MATH101 with a focus on functions and algebraic techniques preparatory to Calculus. The functions studied include polynomial, rational functions, exponential and logarithmic functions, and trigonometric functions along with analytic trigonometry.

Prerequisites:

MATH101: Calculus I **3 Cr Hr (3,0)** **3 ECTS**

This course introduces the student to the calculus of single-valued functions. Topics include limits, continuity, rates of change, rules for differentiating, differentials and local linear approximations, maxima and minima problems, L'Hôpital's rule, related rates, logarithmic and implicit differentiation, inverse trigonometric and hyperbolic functions, Rolle's theorem, the mean-value theorem, and applications of derivatives and integrals

Prerequisites: **MATH099**

MATH102: Calculus II **3 Cr Hr (3,0)** **3 ECTS**

This is a course in multivariate calculus as a continuation of Calculus I. The course focuses on power series, polar coordinates and polar functions, sequences and infinite series, vectors, functions of several variables and their limits, partial differentiation and their applications. The course views multiple integrals: double and triple, line integrals, surface integrals, Green's theorem, Gauss's divergence theorem, and Stoke's theorem.

Prerequisites: **MATH101**

MATH203: Applied Mathematics for Engineers **3 Cr Hr (3,0)** **3 ECTS**

Vector analysis in Cartesian coordinates; Curvilinear coordinates and transformations to Cartesian, Spherical, and Cylindrical coordinates; line integrals, surface integrals, Green's theorem, Gauss's divergence theorem, and Stokes's theorem. Scalar and vector potential. Review of Series. Linear Algebra; Matrices and linear equations; Matrices and Linear Operators; Determinants, Eigenvalues and eigenvectors. Complex Numbers and Complex Variable; Representation of complex numbers, DeMoivre's formula, Powers and roots of complex numbers, Functions of complex variable.

Prerequisite: **MATH102, ARB099, ENGL099**

MATH205: Differential Equations **3 Cr Hr (3,0)** **3 ECTS**

First-order ordinary differential equations, Second-order ordinary differential equations, System of ODEs. Solution Techniques including Laplace transforms, Fourier series: eigenvalue problems and expansions in orthogonal functions. Partial differential equation: classification, separation of variables, solution by series and transform methods. Models in Applied Mathematics; Applications to illustrate typical problems and methods of applied mathematics in solid and fluid mechanics, fields of physics, dynamics and vibrations, wave phenomena, diffusion phenomena, heat conduction, and biological processes.

Prerequisite: **MATH102, ARB099, ENGL099**

PHYS103 Physics I **3 Cr Hr (3,0)** **3 ECTS**

Physics and measurement. Motion in one dimension. Vectors. Motion in two dimensions. Force and motion. Kinetic energy and work. Potential energy and conservation of energy. Linear momentum and collisions. Rotation. Rolling and angular momentum.

PHYS104: Physics II   **3 Cr Hr (3,0)**   **3 ECTS**

Electric Fields. Gauss's Law. Electric Potential. Capacitance and Dielectrics. Current and Resistance. Direct Current Circuits. Magnetic Fields. Sources of Magnetic Field. Faraday's Law.

*Prerequisites***: PHYS103**

PHYS106: General Physics Lab   **1 Cr Hr (0,3)**   **3 ECTS**

Developing a good understanding of a few important concepts in Mechanics, Electricity, and Magnetism. Learning to apply these concepts to familiar and unfamiliar situations and gaining the ability to reason qualitatively and quantitatively. This lab consists of 12 experiments, six in Mechanics and six in Electricity and Magnetism.

*Prerequisites***: PHYS104**

CHEM103: General Chemistry   **3 Cr Hr (3,0)**   **3 ECTS**

Stoichiometry of formulas and equations. Gases and the kinetic-molecular theory. Quantum theory and atomic structure. The components of matter. The major classes of chemical reactions (precipitation, acid-base, oxidation-reduction, and reversible reactions). Thermodynamics: energy flow and chemical change. Quantum theory and atomic structure. Electron configurations and chemical periodicity. Kinetics: rates and mechanisms of chemical reactions. Equilibrium: The extent of chemical reactions. Acid-base equilibria.

*Prerequisites***:**

BM371: Numerical Methods for Engineers   **3 Cr Hr (3,0)**   **3 ECTS**

Fundamentals of error analysis, numerical solutions of linear and nonlinear equations, numerical solution of system of equations, curve fitting, numerical integration and differentiation, numerical solution of ordinary differential equations. Application of numerical methods using relevant software packages.

*Prerequisites***: MATH203, MATH205, CS116**

IE121: Engineering Workshops   **1 Cr Hr (0,3)**   **3 ECTS**

General safety, materials, and their classifications, measuring devices and their accuracy, basic household plumbing and electricity, fits and tolerances, theoretical background for the practical exercises including fitting, forging, carpentry, casting, welding, mechanical saws, shearers, drills, lathes, milling machines, shapers, and grinders.

*Prerequisites***:**

ME343 Automatic Control Systems   **4 Cr Hr (3,3)**   **ECTS**

Modeling of electrical, pneumatic, hydraulic, and mechanical systems, Transfer functions, block diagrams, and signal flow graph. Time domain analysis, test signals, transient response, steady state error and stability. Root locus, bode plots, PID control, phase-lead, phase lag. Software application such as Matlab and Simulink.

*Prerequisites***: MATH203, BSC001**