German Jordanian University

School of Computing

Department of Computer Engineering

Bachelor of Science in Computer Engineering

Study Plan 2023-2024

I. Program Objectives

Computer Engineering program emphasizes the application of technologies and tools in the short term, and the ability to discover, acquire, and adapt new knowledge and skills in the long term, such that our graduates are prepared to:

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.

II. Learning Outcomes

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

- Apply knowledge of mathematics, science, and engineering.
- Design and conduct experiments, as well as to analyze and interpret data.
- Design a system, component, or process to meet desired needs.
- Function on multi-disciplinary and culturally diverse teams.
- Identify, formulate, and solve engineering problems.
- Understand professional and ethical responsibilities.
- Articulate and communicate effectively with other parties.
- Understand the impact of engineering solutions in a global and societal context.
- Recognize the need for, and attain an ability to engage in, life-long learning.
- Elaborate on contemporary issues.
- Use the techniques, skills, and modern engineering tools necessary for engineering practice.
- Background for admission to engineering or other professional graduate programs.

Course Delivery Methods

Courses are in one of the following three methods:

- **Face-to-Face (F2F) Method**
  Courses that are taught through face-to-face learning are delivered at the university campus.
- **Blended (BLD) Method**
  Courses in which teaching consists of face-to-face learning and asynchronous E-learning. The face-to-face learning takes place at the university campus. Asynchronous E-learning takes place through activities, tasks, educational duties, and assignments through the virtual E-learning platforms (Moodle and MyGJU) without direct meetings with course instructors.
- **Online (OL) Method**
  Courses in which teaching consists of synchronous E-learning and asynchronous E-learning. Synchronous E-learning takes place through interactive virtual meetings between instructors and students directly through the virtual E-learning platform (MS Teams). Asynchronous E-learning takes place through activities, tasks, educational duties, and assignments through the virtual E-learning platforms (Moodle and MyGJU) without direct meetings with course instructors.

III. Admission Requirements

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

a. A minimum grade of 80% in General Secondary Education Certificate Examination.

Placement Tests

Applicants must sit for placement tests in the Arabic Language, the English Language, and Mathematics to determine whether the applicant may be required to take remedial courses in the mentioned subjects. Depending on or the applicant scores in the placement tests, some of the following 3-credit-hour remedial courses are required:

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
ARB0099	Elementary Arabic	3	3	3	-	OL	Placement test
ENGL0098	Elementary English	3	3	3	-	F2F	Placement test
ENGL0099	Intermediate English	3	3	3	-	F2F	ENGL0098
MATH0099	Pre-Math	3	3	3	-	OL	Placement test
	Total	**12**	**12**	**12**	**0**		

- Remedial courses are to be completed and passed within the first year of enrollment and are prerequisites for all 200 level courses.
- Passing grade of remedial courses is 60%.
- ECTS (B.Sc.): is the European Credit Transfer and Accumulation, One ECTS is equivalent to 30 actual workload hours.

IV. Degree Requirements

The requirements to obtain a B.Sc. degree in Computer Engineering are the following:

a. A minimum of 12 credit hours of elective courses are to be taken at a partner university in Germany.
b. A minimum of 12 credit hours of International Training to be conducted at an industrial company in Germany.
c. Passing all credit hours.

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

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

Classification	Credit Hours			ECTS		
	Compulsory	Elective	Total	Compulsory	Elective	Total
University Requirements	21	6	27			
School Requirements	27	00	27			
Program Requirements	110	12	122			
Total	**158**	**18**	**176**			

Course Delivery Method	Credit Hours	Percentage
Online Courses	18	10%
Blended Courses	55	31%
Face-to-Face Courses	103	59%
Total	**176**	**100%**

1. University Requirements: (27 credit hours)

1.1. Compulsory: (21 credit hours)

Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
ARB100	Arabic		3	3	3	-	OL	ARB0099
ENGL1001	Upper-Intermediate English		3	3	3	-	F2F	ENGL0099
ENGL1002	Advanced English		3	3	3	-	F2F	ENGL1001
GERL101B1	German I B1-Track		3	6	9	-	F2F	-
GERL102B1	German II	B1-Track	3	6	9	-	F2F	GERL101B1
GERL102B2		B2-Track						
MILS100	Military Science		3	2	3	-	OL	-
NE101	National Education		3	2	3	-	OL	-
NEE101	National Education in English							
		Total	**21**	**25**	**33**	**0**		

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

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
DES101	Arts' Appreciation	3	3	3	-	OL	ENGL0098, ARB0099
EI101	Leadership and Emotional Intelligence	3	3	3	-	F2F	ENGL0098
IC101	Intercultural Communications	3	3	3	-	F2F	ENGL0098
PE101	Sports and Health	3	3	3	-	F2F	ENGL0098, ARB0099
SE301	Social Entrepreneurship and Enterprises	3	3	3	-	F2F	ENGL0098
SFTS101	Soft Skills	3	3	3	-	OL	ENGL0098
BE302	Business Entrepreneurship	3	3	3	-	OL	ENGL0098
TW303	Technical and Workplace Writing	3	3	3	-	OL	ENGL0098
	Minimum required	**6**	**6**	**6**	**0**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

2. School Requirements: (27 Credit Hours)

Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Co-requisites
					Lect.	Prac.		
GERL201B1	German III	B1-track	3	4	6	-	F2F	GERL102B1 or GERL102B2, ARB0099, ENGL0099
GERL201B2		B2-track						GERL102B2, ARB0099, ENGL0099
GERL202B1	German IV	B1-track	3	6	9	-	F2F	GERL201B1 or GERL201B2, ARB0099, ENGL0099
GERL202B2		B2-track						GERL201B2, ARB0099, ENGL0099
MATH101	Calculus I		3	5	3	-	BLD	MATH0099
MATH102	Calculus II		3	5	3	-	F2F	MATH101
EE317	Linear Algebra		3		3	-	BLD	MATH102
CS116	Computing Fundamentals		3		3	-	F2F	
CS1160	Computing Fundamentals Lab		1		-	3	BLD	CS116^{co}
CS117	Object Oriented Programming		3		3	-	F2F	CS116, CS1160^{co}
CS1170	Object Oriented Programming Lab		1		-	3	BLD	CS116, CS1160^{co}, CS117^{co}
CE212	Digital Systems		3		3	-	F2F	CS116, ARB0099, ENGL0099, MATH0099
CE2120	Digital Systems Lab		1		-	3	BLD	CS116, CE212^{co}, ARB0099, ENGL0099, MATH0099
		Total	**27**		**33**	**9**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

3. Program Requirements (122 credit hours)

3.1. Program Requirements (Common Compulsory All Tracks): (98 credit hours)

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE201	Computer Architecture and Organization	3		3	-	F2F	CE212, ARB0099, ENGL0099, MATH0099
CE331	Signals and Systems	3		3	-	BLD	MATH203
CE342	Microprocessor and Microcomputer Systems	3		3	-	F2F	CE212
CE3420	Microprocessor and Microcomputer Systems Lab	1		-	3	BLD	CE212, CE342^{co}
CE352	Computer Networks	3		3	-	BLD	CE201
CE354	Computer Security	3		3	-	BLD	CE352
CE355	Data Communication	3		3	-	F2F	CE331
CE3561	Computer Networks Lab	1		-	3	BLD	CE201, CE352^{co}
CE357	Operating Systems	3		3	3	F2F	CE201
CE3570	Operating Systems Lab	1		-	3	BLD	CE201, CE357^{co}
CE377	Machine Learning	3		3	-	F2F	EE315, EE317
CE391	Field Training *	0		160 Hours		F2F	Dept. approval
CE441	Embedded System Design	3		3	-	F2F	CE201
CE493	International Internship	12		20 weeks		BLD	Dept. approval
CE502	Parallel Architectures and Parallel Algorithms	3		3	-	F2F	CE201, CS222, CS223
CE592	Senior Project I **	1		-	3	BLD	Dept. approval
CE594	Senior Project II	3		-	9	OL	CE592
BM371	Numerical Methods for Engineers	3		2	3	BLD	MATH203, MATH205, CS116
CHEM103	General Chemistry	3		3	-	F2F	
CS201	Discrete Structures	3		3	-	F2F	ARB0099, ENGL0099, MATH0099
CS222	Theory of Algorithms	3		3	-	F2F	CS116, CS1160, CS201, ARB0099, ENGL0099, MATH0099
CS223	Data Structures	3		2	2	F2F	CS116, CS1160, ARB0099, ENGL0099, MATH0099
CS263	Database Management Systems	3		2	2	BLD	CS117, ARB0099, ENGL0099, MATH0099

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

EE241	Electronics 1		3		3	-	F2F	ENE2111, CS116, CS1160, ARB0099, ENGL0099, MATH0099
EE2410	Electronics 1 Lab		1		-	3	BLD	ENE2111, EE241^{co}, ARB0099, ENGL0099, MATH0099
EE315	Probability, Statistics and Random Processes		3		3	-	BLD	MATH102
ENE2111	Fundamentals of Electrical Circuits		3		3	-	F2F	PHYS104, MATH203^{co}, ARB0099, ENGL0099, MATH0099
ENE213	Electrical Circuits Lab		1		-	3	BLD	ENE2111, ARB0099, ENGL0099, MATH0099
GERL301B1	German V	B1-Track	3	6	9	-	F2F	GERL202B1 or GERL202B2
GERL301B2		B2-Track						GERL202B2
GERL302B1	German VI	B1-Track	3	6	6	-	F2F	GERL301B1 or GERL301B2
GERL302B2		B2-Track						GERL301B2
IE0141	Engineering Workshop		1		-	3	F2F	
MATH203	Applied Mathematics for Engineers		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099, MATH0099
MATH205	Differential Equations		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099, MATH0099
PHYS103	Physics I		3	5	3	-	BLD	
PHYS104	Physics II		3	5	3	-	F2F	PHYS103
PHYS106	Physics Lab		1		-	3	BLD	PHYS103, PHYS104^{co}
	Total		**98**		**81**	**43**		

***** 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 160 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	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE452	Network Protocols	3		3	-	F2F	CE352
EE343	Digital Electronics	3		3	-	F2F	EE241
CS342	Software Engineering	3		3	-	BLD	CS117, CS263
CS416	Systems Programming	3		2	2	BLD	CS223
	Total	**12**		**11**	**2**		

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

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE461	Image Processing	3		3	-	BLD	CE331
CE561	Deep Learning	3		3	-	F2F	EE317, EE315
CS451	Artificial Intelligence	3		3	-	F2F	CS222, CS223
EE570	Cloud Computing and Big Data	3		3	-	F2F	CE352
	Total	**12**		**12**	**0**		

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

Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE461	Image Processing	3		3	-	BLD	CE331
CE521	Robotics	3		3	-	F2F	EE317
CE561	Deep Learning	3		3	-	F2F	EE317, EE315
CE565	Computer Vision	3		3	-	F2F	CE461
	Total	**12**		**12**	**0**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

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	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE4201	Robot Mechanics	3		3	-	F2F	BSC001
CE4202	3D Machine Vision	3		3	-	F2F	BSC001
CE4203	Actuators	3		3	-	F2F	BSC001
CE4204	Dynamics of Industrial Robotics	3		3	-	F2F	BSC001
CE4205	Automation and Production Technology	3		3	-	F2F	BSC001
CE4206	Collaborative Robotics	3		3	-	F2F	BSC001
CE4207	Localization and Mapping	3		3	-	F2F	BSC001
CE4208	Aerial Drones	3		3	-	F2F	BSC001
CE4209	Navigation and Mobile Platforms	3		3	-	F2F	BSC001
CE4300	Speech Recognition and Synthesis	3		3	-	F2F	BSC001
CE444	Microcomputer Interface and Peripheral Devices	3		3	-	F2F	BSC001
CE453	Distributed Systems	3		3	-	F2F	BSC001
CE461	Image Processing	3		3	-	BLD	BSC001
CE4602	Neural Networks	3		3	-	F2F	BSC001
CE463	Advanced Image Processing	3		3	-	F2F	BSC001
CE4604	AI Programming	3		3	-	F2F	BSC001
CE4605	Knowledge Representation and Reasoning	3		3	-	F2F	BSC001
CE4606	Data Engineering	3		3	-	F2F	BSC001
CE4607	Data Visualization	3		3	-	F2F	BSC001
CE4608	Reinforcement Learning	3		3	-	F2F	BSC001
CE4609	Intelligent Transportation Systems	3		3	-	F2F	BSC001
CE471	Software Design and Architecture	3		3	-	F2F	BSC001
CE473	Software Requirements Analysis	3		3	-	F2F	BSC001
CE474	Software Quality Assurance and Testing	3		3	-	F2F	BSC001
CE501	Advanced Computer Architecture	3		3	-	F2F	BSC001
CE512	Advanced Digital Design	3		3	-	F2F	BSC001
CE520	Cognitive robotics	3		3	-	F2F	BSC001
CE521	Robotics	3		3	-	F2F	BSC001
CE551	Advanced Operating Systems	3		3	-	F2F	BSC001
CE552	Advanced Computer Networks	3		3	-	F2F	BSC001
CE558	Special topics in Computer Networks	3		3	-	F2F	BSC001
CE559	Special topics in Operating Systems	3		3	-	F2F	BSC001
CE561	Deep Learning	3		3	-	F2F	BSC001
CE563	Human Computer Interaction	3		3	-	F2F	BSC001
CE564	Pattern Recognition	3		3	-	F2F	BSC001
CE565	Computer Vision	3		3	-	F2F	BSC001
CE5606	AI Applications in Cybersecurity	3		3	-	F2F	BSC001
CE5607	AI Applications in Networks	3		3	-	F2F	BSC001
CE5608	AI Applications in Economy	3		3	-	F2F	BSC001
CE5609	AI Applications in Business	3		3	-	F2F	BSC001
CE570	Optimization Methods	3		3	-	F2F	BSC001
CE579	Special topics in Software Engineering	3		3	-	F2F	BSC001

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

CE587	Special Topics in Gaming	3		3	-	F2F	BSC001
CE588	Special Topics in Deep Learning	3		3	-	F2F	BSC001
CE596	Special topics in Intelligent Systems	3		3	-	F2F	BSC001
CE597	Special Topics in Computer Engineering I	1		1	-	F2F	BSC001
CE598	Special Topics in Computer Engineering II	2		2	-	F2F	BSC001
CE599	Special Topics in Computer Engineering	3		3	-	F2F	BSC001
CS323	Computational Theory	3		3	-	F2F	BSC001
CS330	Image Understanding	3		3	-	F2F	BSC001
CS332	Computer Graphics	3		3	-	F2F	BSC001
CS355	Web Technologies	3		3	-	F2F	BSC001
CS356	Information Security	3		3	-	F2F	BSC001
CS358	Multimedia Systems Design	3		3	-	F2F	BSC001
CS359	Internet of Things	3		3	-	F2F	BSC001
CS374	Hardware Security	3		3	-	F2F	BSC001
CS419	Compiler Construction	3		3	-	F2F	BSC001
CS430	Virtual and Augmented Reality	3		3	-	F2F	BSC001
CS450	Operations Optimization	3		3	-	F2F	BSC001
CS451	Artificial Intelligence	3		3	-	F2F	BSC001
CS4512	Natural Language Processing	3		3	-	F2F	BSC001
CS457	Decision Support Systems and Intelligent Systems	3		3	-	F2F	BSC001
CS458	Wireless Networks	3		3	-	F2F	BSC001
CS460	Data Mining	3		3	-	F2F	BSC001
CS470	Cryptography	3		3	-	F2F	BSC001
CS4714	Digital Forensics	3		3	-	F2F	BSC001
CS477	Mobile Computing	3		3	-	F2F	BSC001
EE371	IoT Architecture and Protocols	3		3	-	F2F	BSC001
EE461	Digital Signal Processing	3		3	-	F2F	BSC001
EE514	Multimedia Communications	3		3	-	F2F	BSC001
EE560	Entrepreneurship in Electrical Engineering	3		3	-	F2F	BSC001
EE562	Wireless Sensor Networks	3		3	-	F2F	BSC001
EE563	Emerging Technologies in Electrical Engineering	3		3	-	F2F	BSC001
EE570	Cloud Computing and Big Data	3		3	-	F2F	BSC001
EE599	Special Topics in Signal Processing	3		3	-	F2F	BSC001
	Total	**12**		**12**	**0**		

[b] All elective courses to be taken at a partner university in Germany.

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	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE4300	Speech Recognition and Synthesis	3		3	-	F2F	BSC001
CE4602	Neural Networks	3		3	-	F2F	BSC001
CE463	Advanced Image Processing	3		3	-	F2F	BSC001
CE4604	AI Programming	3		3	-	F2F	BSC001
CE4605	Knowledge Representation and Reasoning	3		3	-	F2F	BSC001
CE4606	Data Engineering	3		3	-	F2F	BSC001
CE4607	Data Visualization	3		3	-	F2F	BSC001
CE4608	Reinforcement Learning	3		3	-	F2F	BSC001
CE4609	Intelligent Transportation Systems	3		3	-	F2F	BSC001
CE521	Robotics	3		3	-	F2F	BSC001
CE563	Human Computer Interaction	3		3	-	F2F	BSC001
CE564	Pattern Recognition	3		3	-	F2F	BSC001
CE565	Computer Vision	3		3	-	F2F	BSC001
CE5606	AI Applications in Cybersecurity	3		3	-	F2F	BSC001
CE5607	AI Applications in Networks	3		3	-	F2F	BSC001
CE5608	AI Applications in Economy	3		3	-	F2F	BSC001
CE5609	AI Applications in Business	3		3	-	F2F	BSC001
CE570	Optimization Methods	3		3	-	F2F	BSC001
CE587	Special Topics in Gaming	3		3		F2F	BSC001
CE588	Special Topics in Deep Learning	3		3	-	F2F	BSC001
CE596	Special topics in Intelligent Systems	3		3	-	F2F	BSC001
CS330	Image Understanding	3		3	-	F2F	BSC001
CS364	Information Retrieval	3		3	-	F2F	BSC001
CS371	Bioinformatics	3		3	-	F2F	BSC001
CS430	Virtual and Augmented Reality	3		3	-	F2F	BSC001
CS4512	Natural Language Processing	3		3	-	F2F	BSC001
CS460	Data Mining	3		3	-	F2F	BSC001
CS477	Mobile Computing	3		3	-	F2F	BSC001
EE371	IoT Architecture and Protocols	3		3	-	F2F	BSC001
	Total	**12**		**12**	**0**		

[b] All elective courses to be taken at a partner university in Germany.

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	Contact Hours		Type	Prerequisites / Co-requisites
				Lect.	Prac.		
CE4201	Robot Mechanics	3		3	-	F2F	BSC001
CE4202	3D Machine Vision	3		3	-	F2F	BSC001
CE4203	Actuators	3		3	-	F2F	BSC001
CE4204	Dynamics of Industrial Robotics	3		3	-	F2F	BSC001
CE4205	Automation and Production Technology	3		3	-	F2F	BSC001
CE4206	Collaborative Robotics	3		3	-	F2F	BSC001
CE4207	Localization and Mapping	3		3	-	F2F	BSC001
CE4208	Aerial Drones	3		3	-	F2F	BSC001
CE4209	Navigation and Mobile Platforms	3		3	-	F2F	BSC001
CE4300	Speech Recognition and Synthesis	3		3	-	F2F	BSC001
CE463	Advanced Image Processing	3		3	-	F2F	BSC001
CE520	Cognitive Robotics	3		3	-	F2F	BSC001
CE561	Deep Learning	3		3	-	F2F	BSC001
CE564	Pattern Recognition	3		3	-	F2F	BSC001
CE570	Optimization Methods	3		3	-	F2F	BSC001
CE587	Special Topics in Gaming	3		3	-	F2F	BSC001
CE590	Special Topics in Computer Vision	3		3	-	F2F	BSC001
CE595	Special Topics in Robotics	3		3	-	F2F	BSC001
CE596	Special topics in Intelligent Systems	3		3	-	F2F	BSC001
CS330	Image Understanding	3		3	-	F2F	BSC001
CS430	Virtual and Augmented Reality	3		3	-	F2F	BSC001
CS451	Artificial Intelligence	3		3	-	F2F	BSC001
EE371	IoT Architecture and Protocols	3		3	-	F2F	BSC001
	Total	**12**		**12**	**0**		

[b] All elective courses to be taken at a partner university in Germany.

VI. Study Plan [c] Guide for B.Sc. Degree in Computer Engineering (General Track)

First Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS116	Computing Fundamentals	3				F2F	
CS1160	Computing Fundamentals Lab	1		-	3	BLD	CS116[co]
GERL101B1	German I B1-Track	3	6	9	-	F2F	
MATH101	Calculus I	3	5	3	-	BLD	MATH0099
PHYS103	Physics I	3	5	3	-	BLD	
CHEM103	General Chemistry	3		3	-	F2F	
ARB100	Arabic	3	3	3	-	OL	ARB0099
	Total	**19**	**0**	**21**	**3**		

First Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS201	Discrete Structures	3		3	-	F2F	ARB0099, ENGL0099, MATH0099
CS117	Object Oriented Programming	3		3	-	F2F	CS116, CS1160[co]
CS1170	Object Oriented Programming lab	1		-	3	BLD	CS116, CS1160[co], CS117[co]
GERL102B1	German II B1-Track	3	6	9	-	F2F	GERL101B1
GERL102B2	German II B2-Track						
ENGL1001	Upper-Intermediate English	3	3	3	-	F2F	ENGL0099
MATH102	Calculus II	3	5	3	-	F2F	MATH101
PHYS104	Physics II	3	5	3	-	F2F	PHYS103
PHYS106	Physics Lab	1		-	3	BLD	PHYS103, PHYS104 [co]
	Total	**20**	**0**	**24**	**6**		

[c] The following study plan guide does not take into account possible remedial courses.

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Second Year								
First Semester								
Course ID	**Course Name**		**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
					Lect.	**Prac.**		
CE212	Digital Systems		3		3	-	F2F	CS116, ARB0099, ENGL0099, MATH0099
CE2120	Digital Systems Lab		1		-	3	BLD	CS116, CE212 [co], ARB0099, ENGL0099, MATH0099
CS222	Theory of Algorithms		3		3	-	F2F	CS116, CS1160, CS201, ARB0099, ENGL0099, MATH0099
CS223	Data Structures		3		2	2	F2F	CS116, CS1160, ARB0099, ENGL0099, MATH0099
ENGL1002	Advanced English		3	3	3	-	F2F	ENGL1001
GERL201B1	German III	B1-Track	3	4	6	-	F2F	GERL102B1 or GERL102B2, ARB0099, ENGL0099, MATH0099
GERL201B2		B2-Track						GERL102B2, ARB0099, ENGL0099, MATH0099
MATH203	Applied Mathematics for Engineers		3	5	3	-	F2F	MATH102 ARB0099, ENGL0099, MATH0099
		Total	**19**	**0**	**20**	**5**		

Second Year								
Second Semester								
Course ID	**Course Name**		**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
					Lect.	**Prac.**		
CE201	Computer Architecture and Organization		3		3	-	F2F	CE212, ARB0099, ENGL0099, MATH0099
CS263	Database Management Systems		3		2	2	BLD	CS117, ARB0099, ENGL0099, MATH0099
MATH205	Differential Equations		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099, MATH0099
ENE2111	Fundamentals of Electrical Circuits		3		3	-	F2F	PHYS104, MATH203[co], ARB0099, ENGL0099, MATH0099
GERL202B1	German IV	B1-Track	3	6	9	-	F2F	GERL201B1 or GERL201B2, ARB0099, ENGL0099, MATH0099
GERL202B2		B2-Track						GERL201B2, ARB0099, ENGL0099, MATH0099
EE317	Linear Algebra		3		3	-	BLD	MATH102
EE315	Probability, Statistics and Random Processes		3		3	-	BLD	MATH102
		Total	**21**	**0**	**26**	**2**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Third Year								
First Semester								
Course ID	**Course Name**		**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
					Lect.	**Prac.**		
CE331	Signals and Systems		3		3	-	BLD	MATH203
EE241	Electronics 1		3		3	-	F2F	ENE2111, CS116, CS1160, ARB0099, ENGL0099, MATH0099
EE2410	Electronics 1 Lab		1		-	3	BLD	ENE2111, EE241[co], ARB0099, ENGL0099, MATH0099
CE357	Operating Systems		3		3	-	F2F	CE201
CE3570	Operating Systems Lab		1		-	3	BLD	CE201, CE357 [co]
CE352	Computer Networks		3		3	-	BLD	CE201
GERL301B1	German V	B1-Track	3	6	9	-	F2F	GERL202B1 or GERL202B2
GERL301B2		B2-Track						GERL202B2
CE377	Machine learning		3		3	-	F2F	EE315, EE317
		Total	**20**	**0**	**24**	**6**		

Third Year								
Second Semester								
Course ID	**Course Name**		**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
					Lect.	**Prac.**		
ENE213	Electrical Circuits Lab		1		-	3	BLD	ENE2111
CE3561	Computer Networks Lab		1		-	3	BLD	CE201, CE352[co]
EE343	Digital Electronics		3		3	-	F2F	EE241
CE391	Field Training		0		160 hours		F2F	Dept. approval
CE342	Microprocessor and Microcomputer Systems		3		3	-	F2F	CE212
CE3420	Microprocessor and Microcomputer Systems Lab		1		-	3	BLD	CE212, CE342 [co]
GERL302B1	German VI	B1-Track	3	6	6	-	F2F	GERL301B1 or GERL301B2
GERL302B2		B2-Track						GERL301B2
CE354	Computer Security		3		3	-	BLD	CE352
NE101	National Education		3	2	3	-	OL	
	University Elective Course		3	3	3	-		
		Total	**21**	**0**	**21**	**9**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Fourth Year							
First Semester							
Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Total	**12**	**0**	**12**	**0**		

Fourth Year							
Second Semester							
Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
CE493	International Internship[d]	12		20 weeks		BLD	
	Total	**12**	**0**	**0**	**0**		

German year prerequisites are:

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

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Fifth Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
BM371	Numerical Methods for Engineers	3		2	3	BLD	MATH203, MATH205, CS116
CE592	Senior Project I	1		-	3	BLD	Dept. approval
CS416	Systems Programming	3		2	2	BLD	CS223
MILS100	Military Science	3	2	3	-	OL	
CE355	Data Communication	3		3	-	F2F	CE331
CS342	Software Engineering	3		3	-	BLD	CS117, CS263
	Total	**16**	**0**	**13**	**8**		

Fifth Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CE502	Parallel Architectures and Parallel Algorithms	3		3	-	F2F	CE201, CS222, CS223
CE452	Network Protocols	3		3	-	F2F	CE352
CE594	Senior Project II	3		-	9	OL	CE592
CE441	Embedded System Design	3		3	-	F2F	CE201
IE0141	Engineering Workshop	1		-	3	F2F	
	University Elective Course	3	3	3	-		
	Total	**16**	**0**	**12**	**12**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Study Plan [c] Guide for B.Sc. Degree in Computer Engineering

(Artificial Intelligence and Machine Learning Track)

First Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS116	Computing Fundamentals	3		3	-	F2F	
CS1160	Computing Fundamentals Lab	1		-	3	BLD	CS116 [co]
GERL101B1	German I B1-Track	3	6	9	-	F2F	
MATH101	Calculus I	3	5	3	-	BLD	MATH0099
PHYS103	Physics I	3	5	3	-	BLD	
CHEM103	General Chemistry	3		3	-	F2F	
ARB100	Arabic	3	3	3	-	OL	ARB0099
	Total	**19**	**0**	**24**	**3**		

First Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS201	Discrete Structures	3		3	-	F2F	ARB0099, ENGL0099, MATH0099
CS117	Object Oriented Programming	3		3	-	F2F	CS116, CS1160[co]
CS1170	Object Oriented Programming lab	1		-	3	BLD	CS116, CS1160[co], CS117[co]
ENGL1001	Upper-Intermediate English	3	3	3	-	F2F	ENGL0099
GERL102B1	German II B1-Track	3	6	9	-	F2F	GERL101B1
GERL102B2	German II B2-Track						
MATH102	Calculus II	3	5	3	-	F2F	MATH101
PHYS104	Physics II	3	5	3	-	F2F	PHYS103
PHYS106	Physics Lab	1		-	3	BLD	PHYS103, PHYS104 [co]
	Total	**20**	**0**	**24**	**6**		

[c] The following study plan guide does not take into account possible remedial courses.

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Second Year								
First Semester								
Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
CE212	Digital Systems		3		3	-	F2F	CS116, ARB0099, ENGL0099, MATH0099
CE2120	Digital Systems Lab		1		-	3	BLD	CS116, CE212[co], ARB0099, ENGL0099, MATH0099
CS222	Theory of Algorithms		3		3	-	F2F	CS116, CS1160, CS201, ARB0099, ENGL0099, MATH0099
CS223	Data Structures		3		2	2	F2F	CS116, CS1160, ARB0099, ENGL0099, MATH0099
ENGL1002	Advanced English		3	3	3	-	F2F	ENGL1001
GERL201B1	German III	B1-Track	3	4	6	-	F2F	GERL102B1 or GERL102B2, ARB0099, ENGL0099, MATH0099
GERL201B2		B2-Track						GERL102B2, ARB0099, ENGL0099, MATH0099
MATH203	Applied Mathematics for Engineers		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099, MATH0099
		Total	**19**	**0**	**20**	**5**		

Second Year								
Second Semester								
Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
CE201	Computer Architecture and Organization		3		3	-	F2F	CE212, ARB0099, ENGL0099, MATH0099
EE315	Probability, Statistics and Random Processes		3		3	-	BLD	MATH102
GERL202B1	German IV	B1-Track	3	6	9	-	F2F	GERL201B1 or GERL201B2, ARB0099, ENGL0099, MATH0099
GERL202B2		B2-Track						GERL201B2, ARB0099, ENGL0099, MATH0099
MATH205	Differential Equations		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099
EE317	Linear Algebra		3		3	-	BLD	MATH102
MILS100	Military Science		3	2	3	-	OL	
CS263	Database Management Systems		3		2	2	BLD	CS117, ARB0099, ENGL0099, MATH0099
		Total	**21**	**0**	**26**	**2**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Third Year								
First Semester								
Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
CE331	Signals and Systems		3		3	-	BLD	MATH203
ENE2111	Fundamentals of Electrical Circuits		3		3	-	F2F	PHYS104, MATH203^{co}, ARB0099, ENGL0099, MATH0099
CE357	Operating Systems		3		3	-	F2F	CE201
CE3570	Operating Systems Lab		1		-	3	BLD	CE201, CE357^{co}
CE352	Computer Networks		3		3	-	BLD	CE201
CE3561	Computer Networks Lab		1		-	3	BLD	CE201, CE352^{co}
GERL301B1	German V	B1-Track	3	6	9	-	F2F	GERL202B1 or GERL202B2
GERL301B2		B2-Track						GERL202B2
CE377	Machine learning		3		3	-	F2F	EE315, EE317
		Total	**20**	**0**	**24**	**6**		

Third Year								
Second Semester								
Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
EE241	Electronics 1		3		3	-	F2F	ENE2111, CS116, CS1160, ARB0099, ENGL0099, MATH0099
BM371	Numerical Methods for Engineers		3		2	3	BLD	MATH203, MATH205, CS116
CE391	Field Training		0		160 hours		F2F	Dept. approval
CE342	Microprocessor and Microcomputer Systems		3		3	-	F2F	CE212
CE3420	Microprocessor and Microcomputer Systems Lab		1		-	3	BLD	CE212, CE342^{co}
GERL302B1	German VI	B1-Track	3	6	6	-	F2F	GERL301B1 or GERL301B2
GERL302B2		B2-Track						GERL301B2
CE354	Computer Security		3		3	-	BLD	CE352
NE101	National Education		3	2	3	-	OL	
		Total	**19**	**0**	**20**	**6**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Fourth Year							
First Semester							
Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Total	**12**	**0**	**12**	**0**		

Fourth Year							
Second Semester							
Course ID	Course Name	Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
				Lect.	Prac.		
CE493	International Internship[d]	12		20 weeks		BLD	
	Total	**12**	**0**	**0**	**0**		

German year prerequisites are:

Passing four out of the five following courses:

- CE377: Machine Learning
- CE331: Signals and Systems
- CE342: Microprocessor and Microcomputer Systems
- CS117: Object-oriented Programming
- CS222: Theory of Algorithms

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

Fifth Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS451	Artificial Intelligence	3		3	-	F2F	CS222, CS223
	University Elective Course	3	3	3	-		
CE592	Senior Project I	1		-	3	BLD	Dept. approval
EE2410	Electronics 1 Lab	1		-	3	BLD	ENE2111, EE241^{co}, ARB0099, ENGL0099, MATH0099
ENE213	Electrical Circuits Lab	1		-	3	BLD	ENE2111, ARB0099, ENGL0099, MATH0099
CE355	Data Communication	3		3	-	F2F	CE331
EE472	Cloud Computing and Big Data	3		3	-	F2F	CE201, CE352^{co}
CE461	Image Processing	3		3	-	BLD	CE331
	Total	**18**	**0**	**15**	**9**		

Fifth Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CE502	Parallel Architectures and Parallel Algorithms	3		3	-	F2F	CE201, CS222, CS223
CE561	Deep Learning	3		3	-	F2F	EE315, EE317
CE594	Senior Project II	3		-	9	OL	CE592
CE441	Embedded System Design	3		3	-	F2F	CE201
IE0141	Engineering Workshop	1		-	3	F2F	
	University Elective Course	3	3	3	-		
	Total	**16**	**0**	**12**	**12**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Study Plan [c] Guide for B.Sc. Degree in Computer Engineering

(Computer Vision and Robotics Track)

First Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS116	Computing Fundamentals	3		3	-	F2F	
CS1160	Computing Fundamentals Lab	1		-	3	BLD	CS116 [co]
GERL101B1	German I B1-Track	3	6	9	-	F2F	
MATH101	Calculus I	3	5	3	-	BLD	MATH0099
PHYS103	Physics I	3	5	3	-	BLD	
CHEM103	General Chemistry	3		3	-	F2F	
ARB100	Arabic	3	3	3	-	OL	ARB0099
	Total	**19**	**0**	**24**	**3**		

First Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CS201	Discrete Structures	3		3	-	F2F	ARB0099, ENGL0099, MATH0099
CS117	Object Oriented Programming	3		3	-	F2F	CS116, CS1160[co]
CS1170	Object Oriented Programming lab	1		-	3	BLD	CS116, CS1160[co], CS117[co]
ENGL1001	Upper-Intermediate English	3	3	3	-	F2F	ENGL0099
GERL102B1	German II B1-Track	3	6	9	-	F2F	GERL101B1
GERL102B2	German II B2-Track						
MATH102	Calculus II	3	5	3	-	F2F	MATH101
PHYS104	Physics II	3	5	3	-	F2F	PHYS103
PHYS106	Physics Lab	1		-	3	BLD	PHYS103, PHYS104[co]
	Total	**20**	**0**	**24**	**6**		

[c] The following study plan guide does not take into account possible remedial courses.

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Second Year								
First Semester								
Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
CE212	Digital Systems		3		3	-	F2F	CS116, ARB0099, ENGL0099, MATH0099
CE2120	Digital Systems Lab		1		-	3	BLD	CS116, CE212[co], ARB0099, ENGL0099, MATH0099
CS222	Theory of Algorithms		3		3	-	F2F	CS116, CS1160, CS201, ARB0099, ENGL0099, MATH0099
ENE211	Fundamentals of Electrical Circuit		3		3	-	F2F	PHYS104, MATH203[co], ARB0099, ENGL0099, MATH0099
ENGL1002	Advanced English		3	3	3	-	F2F	ENGL1001
GERL201B1	German III	B1-Track	3	4	6	-	F2F	GERL102B1 or GERL102B2, ARB0099, ENGL0099, MATH0099
GERL201B2		B2-Track						GERL102B2, ARB0099, ENGL0099, MATH0099
MATH203	Applied Mathematics for Engineers		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099, MATH0099
		Total	**19**	**0**	**21**	**3**		

Second Year								
Second Semester								
Course ID	Course Name		Credit Hours	ECTS	Contact Hours		Type	Prerequisites / Corequisites
					Lect.	Prac.		
CE201	Computer Architecture and Organization		3		3	-	F2F	CE212, ARB0099, ENGL0099, MATH0099
EE315	Probability, Statistics, and Random Processes		3		3	-	BLD	MATH102
GERL202B1	German IV	B1-Track	3	6	9	-	F2F	GERL201B1 or GERL201B2, ARB0099, ENGL0099, MATH0099
GERL202B2		B2-Track						GERL201B2, ARB0099, ENGL0099, MATH0099
MATH205	Differential Equations		3	5	3	-	F2F	MATH102, ARB0099, ENGL0099, MATH0099
EE317	Linear Algebra		3		3	-	BLD	MATH102
MILS100	Military Science		3	2	3	-	OL	
CS263	Database Management Systems		3		2	2	BLD	CS117, ARB0099, ENGL0099, MATH0099
		Total	**21**	**0**	**26**	**2**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Third Year								
First Semester								
Course ID	**Course Name**		**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
					Lect.	**Prac.**		
CS223	Data Structures		3		2	2	F2F	CS116, CS1160, ARB0099, ENGL0099, MATH0099
CE331	Signals and Systems		3		3	-	BLD	MATH203
CE357	Operating Systems		3		3	-	F2F	CE201
CE3570	Operating Systems Lab		1		-	3	BLD	CE201, CE357^{co}
CE352	Computer Networks		3		3	-	BLD	CE201
CE3561	Computer Networks Lab		1		-	3	BLD	CE201, CE352^{co}
GERL301B1	German V	B1-Track	3	6	9	-	F2F	GERL202B1 or GERL202B2
GERL301B2		B2-Track						GERL202B2
CE377	Machine learning		3		3	-	F2F	EE315, EE317
		Total	**20**	**0**	**23**	**8**		

Third Year								
Second Semester								
Course ID	**Course Name**		**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
					Lect.	**Prac.**		
EE241	Electronics 1		3		3	-	F2F	ENE2111, CS116, CS1160, ARB0099, ENGL0099, MATH0099
CE461	Image Processing		3		3	-	BLD	CE331
CE391	Field Training		0		160 hours		F2F	Dept. approval
CE342	Microprocessor and Microcomputer Systems		3		3	-	F2F	CE212
CE3420	Microprocessor and Microcomputer Systems Lab		1		-	3	BLD	CE212, CE342^{co}
BM371	Numerical Methods for Engineers		3		2	3	BLD	MATH203, MATH205, CS116
GERL302B1	German VI	B1-Track	3	6	6	-	F2F	GERL301B1 or GERL301B2
GERL302B2		B2-Track						GERL301B2
NE101	National Education		3	2	3	-	OL	
		Total	**19**	**0**	**20**	**6**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

Fourth Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Program Elective Course	3		3	-	F2F	
	Total	**12**	**0**	**12**	**0**		

Fourth Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CE493	International Internship[d]	12		20 weeks		BLD	
	Total	**12**	**0**	**0**	**0**		

German year prerequisites are:

Passing four out of the five following courses:

- CE377: Machine Learning
- CE461: Image Processing
- CS222: Theory of Algorithms
- CE342: Microprocessor and Microcomputer Systems
- CE3570: Operating Systems Lab

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

Fifth Year							
First Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CE565	Computer Vision	3		3	-	F2F	EE317
	University Elective Course	3	3	3	-		
CE592	Senior Project I	1		-	3	BLD	Dept. approval
CE561	Deep Learning	3		3	-	F2F	EE317, EE315
EE2410	Electronics 1 Lab	1		-	3	BLD	ENE2111, EE241^{co}, ARB0099, ENGL0099, MATH0099
ENE213	Electrical Circuits Lab	1		-	3	BLD	ENE2111, ARB0099, ENGL0099, MATH0099
CE355	Data Communication	3		3	-	F2F	CE331
CE521	Robotics	3		3	-	F2F	EE317
	Total	**18**	**0**	**15**	**9**		

Fifth Year							
Second Semester							
Course ID	**Course Name**	**Credit Hours**	**ECTS**	**Contact Hours**		**Type**	**Prerequisites / Corequisites**
				Lect.	**Prac.**		
CE502	Parallel Architectures and Parallel Algorithms	3		3	-	F2F	CE201, CS222, CS223
CE354	Computer Security	3		3	-	BLD	CE352
CE594	Senior Project II	3		-	9	OL	CE592
CE441	Embedded System Design	3		3	-	F2F	CE201
IE0141	Engineering Workshop	1		-	3	F2F	
	University Elective Course	3	3	3	-		
	Total	**16**	**0**	**12**	**12**		

F2F: Face-to-face BLD: Blended OL: Online co: Corequisite

VII. 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, ARB0099, ENGL0099, MATH0099**

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, ARB0099, ENGL0099, MATH0099**

CE2120: Digital 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 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.

Prerequisites: **CS116, ARB0099, ENGL0099, MATH0099**

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.

Prerequisites: **CE212**

Corequisites: **CE342**

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: **CE201**

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**

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.

Prerequisites: **CE201**
Corequisites: **CE352**

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.

Prerequisites: **CE201**
Corequisites: **CE357**

CE377: Machine Learning **3 Cr Hr (3,0)** **ECTS**

In this course, students will be introduced to the fundamental principles, techniques, and practical applications of machine learning. It encompasses both the theoretical foundations and hands-on implementations, enabling students to build a strong foundation in this transformative field. Throughout

this course, students will delve into an in-depth exploration of a wide array of machine learning models, unraveling the intricacies of their implementation and showcasing their extensive applications. Machine learning models serve as valuable tools across various domains, including data mining, the creation of analytical models, and their relevance in fields such as security, scientific research, education, healthcare, and more. Our primary objective is to empower students with the knowledge and skills necessary to comprehend the diverse landscape of machine learning models, understand their theoretical foundations, and effectively apply them within the realm of engineering across a variety of domains. Students will apply their knowledge of machine learning techniques using Python to solve real-world predictive analysis problems. They will work on a series of hands-on assignments and projects that cover various aspects of machine learning, including data pre-processing, feature engineering, model selection, and evaluation. Students will have gained practical experience in building and evaluating machine learning models to make data-driven predictions and decisions.

Prerequisites: **EE315, EE317**

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: Dept. approval

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**

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**

CE493: International Internship **12 Cr Hr (0,36)** **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: Dept. approval

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**

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: **EE317**

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

In this course, students will be introduced to the fundamental principles, techniques, and practical applications of deep learning. It encompasses both the theoretical foundations and hands-on implementations, enabling students to build a strong foundation in this transformative field. Throughout this course, students will delve into an in-depth exploration of a wide array of deep learning models, unraveling the intricacies of their implementation and showcasing their extensive applications. Deep learning, a branch of machine learning concerned with the development and application of modern neural networks. Deep learning algorithms extract layered high-level representations of data in a way that maximizes performance on a given task. Deep learning is behind many recent advances in AI, including Siri's speech recognition, Facebook's tag suggestions and self-driving cars. We will cover a range of topics from basic neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning, and applications to problem domains like speech recognition and computer vision. Prerequisites: a strong mathematical background in calculus, linear algebra, probability and random variables, as well as programming in Python.

Prerequisites: **EE317, EE315**

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: **EE317**

CE592: Senior Project I ** **1 Cr Hr (0,3)** **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: Dept. approval

CE594: Senior Project II **1 Cr Hr (0,9)** **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**

VIII. Elective Course Offered by Computer Engineering Department

CE453: 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: **BSC001**

CE4201: Robot Mechanics **3 Cr Hr (3,0)** **ECTS**

Robotics History. Classification of robots. Parts/Components. State of the art + trends and developments. Economic aspects. Application examples according to platforms. Basics of effectors. Basics of actuators. Basics of robot control. Coordinate systems / frames. Description of rotations (rotation matrix, Euler angle, rotation vector, quaternions). Transformation matrices / coordinate transformation. Denavit-Hartenberg convention. Forward and backward kinematics. Human-robot collaboration.

Prerequisites: **BSC001**

CE4202: 3D Machine Vision **3 Cr Hr (3,0)** **ECTS**

3D camera systems and 3D reconstruction: TOF, epipolar geometry, correspondence problem, descriptors (HoG, SIFT, SURF, etc.), optical flow (small baseline), feature matching (large baseline), stereo vision, structured light projection. Stereo camera calibration. Structure from motion (SfM). 3D position and pose estimation. Point clouds. Introduction to OpenCV (e.g. in Matlab). Application examples: Multiview 3D reconstruction, object tracking.

Prerequisites: **BSC001**

CE4203: Actuators **3 Cr Hr (3,0)** **ECTS**

Magnetic circuits. Operating principles of electromechanical energy converters and overview about design variants. DC motors: Construction, Mathematical modelling, Stationary operating behavior. Control of electrical drives: Fundamentals of power electronics, Cascaded feedback-control structure, Design of current, speed and position controllers, Constraints in practice. Permanent-magnet synchronous motors: Construction, Mathematical modelling, Space vectors and field-oriented control.

Prerequisites: **BSC001**

CE4204: Dynamics of Industrial Robotics **3 Cr Hr (3,0)** **ECTS**

Speed and acceleration of the kinematic chain. Direct and inverse kinematics of complex industrial robots. Force control. Newton-Euler and Lagrange equation. Jacobi matrix. Singularities. Path planning.

Prerequisites: **BSC001**

CE4205: Automation and production technology **3 Cr Hr (3,0)** **ECTS**

Selection and design of grippers. Planning of automated production lines. Handling and processing with industrial robots. Assembly processes. PLC technology. Industrial communication. IoT in the industrial environment.

Prerequisites: **BSC001**

CE4206: Collaborative Robotics **3 Cr Hr (3,0)** **ECTS**

Application areas and potentials of collaborative robots. Types of human-robot collaboration. Safety-relevant components for collaborative workplaces. Grippers for HRC applications. Legal framework (norms and standards). Structure and design of collaborative workplaces. Torque/force sensors in

collaborative robots. Control concepts for force control. Literature and other learning resources.

Prerequisites: **BSC001**

CE4207: Localization and mapping **3 Cr Hr (3,0)** **ECTS**

Perception in indoor and outdoor areas. Landmark and path marker recognition. GPS/IMU-based localization. Particle filter and Kalman filter in localization. Environment models. Odometry in the context of mobile platforms. SLAM.

Prerequisites: **BSC001**

CE4208: Aerial drones **3 Cr Hr (3,0)** **ECTS**

Sensors for flight control. Visual odometry. Flight / attitude control technology. Power requirements and power limits. Aerodynamics of aircraft and drones. Drone platforms. Power supply. Data transmission. Electric drives for drones. Legal aspects.

Prerequisites: **BSC001**

CE4209: Navigation and mobile platforms **3 Cr Hr (3,0)** **ECTS**

Land-based, water and underwater platforms for mobile robots. Steering of wheel-driven platforms. Types of locomotion. Kinematics of land-based robots. Path planning with path map, cell map and potential field methods. Obstacle avoidance. Navigation architectures.

Prerequisites: **BSC001**

CE4300: Speech recognition and synthesis **3 Cr Hr (3,0)** **ECTS**

Object oriented programming with Python. Speech signal processing from microphone to the source filter model of voice. Speech synthesis with the vocoder. Classification with artificial neural networks. Real-time implementation on low-budget-hardware. Implementation of a keywordspotter under the MIT license.

Prerequisites: **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: **BSC001**

CE4602: Neural Networks **3 Cr Hr (3,0)** **ECTS**

This course will delve into fundamental neural network structures and training techniques, with a focus on their utilization in tasks related to pattern recognition, image manipulation, and computer vision. We will explore three distinct modes of learning, namely supervised, unsupervised, and reinforcement learning, and investigate their practical applications. Throughout the course, students will have the opportunity to experiment with various neural network models in hands-on exercises aimed at solving real-world problems.

Prerequisites: **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: **BSC001**

CE4604: AI Programming **3 Cr Hr (3,0)** **ECTS**

The course provides students with the opportunity to learn essential programming skills for developing and implementing various classic AI algorithms. These skills enable them to utilize these algorithms as modules for constructing AI-based solutions in areas such as speech, language, and image processing. The course covers topics in high-level programming languages like Python, including fundamental Python programming concepts, as well as Python tools and packages for machine learning, deep learning, data mining and representation, and data analysis and visualization. Through this course, students will gain an in-depth understanding of AI in practice by solving real-life AI problems.

Prerequisites: **BSC001**

CE4605: Knowledge Representation and Reasoning **3 Cr Hr (3,0)** **ECTS**

The course introduces students to the fundamentals of Knowledge Representation and Reasoning (KRR), which are at the core of Artificial Intelligence. KRR is concerned with representing knowledge in symbolic form and utilizing this knowledge for reasoning. The topics covered include commonsense reasoning, propositional and first-order logic, answer set programming, planning, reasoning about action, and constraint programming. The course provides students interested in Artificial Intelligence with the opportunity to deepen their knowledge in this crucial area, equipping them with a solid background for conducting their research and work in this field.

Prerequisites: **BSC001**

CE4606: Data Engineering **3 Cr Hr (3,0)** **ECTS**

The course introduces students to fundamental technologies and methodologies essential for deriving valuable insights and identifying underlying patterns from frequently encountered real-life data, which is often raw, incomplete, noisy, and corrupted. It offers students the opportunity to explore advanced data analytics solutions, including dimensionality reduction, sparse encoding, compressive sensing, nonlinear filtering, manifold learning, and generative data modeling.

Prerequisites: **BSC001**

CE4607: Data Visualization **3 Cr Hr (3,0)** **ECTS**

The course introduces students to key principles of analytic design and useful visualization techniques for exploring and presenting univariate and multivariate data. This course is highly practical, emphasizing the application of data visualization in the sciences. Students will learn how to evaluate data visualizations based on analytic design principles, construct compelling visualizations using statistical and data analysis tools, and effectively explore and present their data using visual methods.

Prerequisites: **BSC001**

CE4608: Reinforcement Learning **3 Cr Hr (3,0)** **ECTS**

Reinforcement learning is a subfield of machine learning but is also a general-purpose formalism for automated decision-making and AI. In this course, students study the theoretical aspects and practical applications of reinforcement learning as well as the tools necessary to implement RL algorithms and train intelligent agents. Students learn how to formalize problems as Markov Decision Processes and learn classic and modern algorithms in reinforcement learning. Students learn to implement, train, and test their own RL agent, understand value functions, basic exploration methods, and the comparison between exploration and exploitation methods. Finally, students explore how to deploy trained agents and build an AI system that solves a real-world problem.

Prerequisites: **BSC001**

CE4609: Intelligent Transportation Systems **3 Cr Hr (3,0)** **ECTS**

The Intelligent Transportation Systems (ITS) course provides an in-depth exploration of the innovative technologies, strategies, and principles that revolutionize modern transportation systems. This multidisciplinary course integrates concepts from engineering, computer science, and urban planning to equip students with a comprehensive understanding of ITS.

Prerequisites: **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: **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: **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: **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: **BSC001**

CE512: Advanced Digital 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: **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: **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: **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: **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: **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: **BSC001**

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: **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: **BSC001**

CE5606: AI Applications in Cybersecurity **3 Cr Hr (3,0)** **ECTS**

The AI Applications in Cybersecurity course is designed to provide students with a comprehensive understanding of how artificial intelligence (AI) and machine learning (ML) techniques are leveraged to address the complex challenges of cybersecurity. This course explores the synergy between AI and cybersecurity, equipping students with the knowledge and skills needed to protect organizations and individuals from evolving cyber threats.

CE5607: AI Applications in Computer Networks **3 Cr Hr (3,0)** **ECTS**

The AI Applications in Computer Networks course offers an in-depth exploration of how artificial intelligence (AI) and machine learning (ML) technologies are harnessed to enhance the efficiency, security, and management of computer networks. This course equips students with the knowledge and skills needed to leverage AI for optimizing network performance, detecting anomalies, and addressing emerging challenges in the field of computer networking.

Prerequisites: **BSC001**

CE5608: AI Applications in Economy **3 Cr Hr (3,0)** **ECTS**

The AI Applications in Economics course delves into the transformative impact of artificial intelligence (AI) on economic theory, policy, and practice. This course provides students with a comprehensive understanding of how AI technologies are reshaping economic models, decision-making processes, and industries. Through a multidisciplinary approach, students will explore the applications, challenges, and opportunities that AI presents in the field of economics.

Prerequisites: **BSC001**

CE5609: AI Applications in Business **3 Cr Hr (3,0)** **ECTS**

The AI Applications in Business course offers a comprehensive exploration of how artificial intelligence (AI) technologies are revolutionizing various aspects of modern business operations. This course equips students with the knowledge and skills needed to understand, implement, and leverage AI tools and strategies in diverse business contexts, making them well-prepared to drive innovation and competitiveness in the digital age.

Prerequisites: **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: **BSC001**

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: **BSC001**

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: **BSC001**

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: **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: **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: **BSC001**

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: **BSC001**

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: **BSC001**

IX. Course Offered by Other Departments

ENE2111: Fundamentals of Electrical Circuit **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, ARB0099, ENGL0099, MATH0099**

Corequisites: **MATH203**

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: **ENE2111, ARB0099, ENGL0099, MATH0099**

EE241: 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: **ENE2111, CS116, CS1160, ARB0099, ENGL0099, MATH0099**

EE2410: 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

Prerequisites: **ENE2111, ARB0099, ENGL0099, MATH0099**

Corequisites: **EE241**

EE315: Probability, Statistics and Random 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**

EE317: 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**

EE343: Digital Electronics **3 Cr Hr (3,0)** **ECTS**

General properties and definitions of digital circuits. Review of BJT and its modes of operation. Resistor Transistor Logic (RTL). Diode Transistor Logic (DTL). Transistor – Transistor Logic (TTL). Emitter – Coupled Logic (ECL). Review of Field Effect Transistors (FET). Metal Oxide Semiconductor FETs (MOSFETs). MOS digital Circuits: NMOS, N-channel MOSFET, PMOS, and CMOS families. Regenerative Logic Circuits: bistable, monostable, and astable multivibrators. D/A and A/D converters.

Prerequisites: **EE241**

EE461: 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: **BSC001**

EE570: 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.

Prerequisites: **CE201**
Corequisites: **CE352**

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**

EE562: Wireless Sensor Networks **3 Cr Hr (3,0)** **ECTS**

Wireless Sensor Networks definition, applications, major components and architecture, clustering protocols, routing protocols, wireless communication protocols, implementation platforms, power saving modes. Interrupts, Security.

Prerequisites: **BSC001**

EE514: Multimedia Communication **3 Cr Hr (3,0)** **ECTS**

Introduction to audio and video signals, audio and video Signal Compression, audio/video processing tools, computer graphic tools and Video Production tools, Design fundamentals: Points, lines, design and creativity, Multimedia Processors, Multimedia Networks and Applications: Audio and Video Conferencing.

Multimedia application over the Intranet and the Internet. In the aspect of multimedia networking, special considerations for sending multimedia over the Internet and wireless networks, such as video adaptation, error resilience, error concealment, and quality of service will be discussed. Note: the course will encourage the usage of open access software such as Audacity, Speex, and FFMPEG.

Prerequisites: **BSC001**

EE563: Emerging Technologies in Electrical Engineering **3 Cr Hr (3,0)** **ECTS**

This course introduces the students to the fundamentals of machine learning algorithms and their implementation in Matlab and/or Python programming languages, and then the application of different machine learning techniques in several fields of electrical engineering systems such as signal detection, channel estimation, configuration of intelligent surfaces, network traffic control, resource allocation and management in wireless and power networks, fault control in power systems, load forecasting.

Prerequisites: **BSC001**

EE560: Entrepreneurship in Electrical Engineering **3 Cr Hr (3,0)** **ECTS**

The course will discuss the emergence of new technologies in electrical engineering focusing particularly on technology entrepreneurial opportunities and its process in electrical engineering industries. In addition, the course will identify high-potential, technology-intensive commercial opportunities and reviewing what is relevant and currently discussed in industry.

Prerequisites: **BSC001**

EE599: Special Topics in Signal Processing **3 Cr Hr (3,0)** **ECTS**

The course will cover recent advances in signal processing, which may include but not limited to, transforms, digital filters (structures, design, and implementation), numerical roundoff errors, quantization effects, introduction to multi-rate signal processing, power spectrum estimation, linear prediction, Weiner filtering, parameter estimation, signal detection, hypothesis tests, likelihood ratio tests, time-frequency analysis, space-time processing, the Short-time Fourier Transform, compressive sensing and sparse recovery.

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 (0,3)** **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.

Corequisites: **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: **ARB0099, ENGL0099, MATH0099**

CS117: 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**
Corequisites: **CS1160**

CS1170: Object Oriented Programming Lab **1 Cr Hr (0,3)** **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.

Prerequisites: **CS116**
Corequisites: **CS117, CS1160**

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, ARB0099, ENGL0099, MATH0099**

CS223: Data Structures **3 Cr Hr (2,2)** **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, ARB0099, ENGL0099, MATH0099**

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: **CS117, CS263**

CS263: 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: **CS117, ARB0099, ENGL0099, MATH0099**

CS364: Information Retrieval **3 Cr Hr (3,0)** **ECTS**

Introduction to Information Retrieval and Information Management from a user and design perspectives. The course covers formal models, evaluation and performance measurement, implementation structures and algorithms, and automatic organization of information including indexing, clustering, and NLP. Advanced topics include knowledge representation, semantic nets, fuzzy, and rough sets, web search, and internet technologies.

Prerequisites: **BSC001**

CS371: Bioinformatics **3 Cr Hr (3,0)** **ECTS**

History of bioinformatics; implications of bioinformatics on biology and computer science; principles, concepts, methods, techniques, algorithms, tools, and strategies to transform and process the masses of information from biological experiments, focusing particularly on biological sequence data. It covers topics such as: DNA and protein sequence alignment and analysis, sequence analysis software, database searching, database search heuristic algorithms, sequence alignment dynamic programming algorithms, RNA folding, and multiple sequence alignment and analysis

Prerequisites: **BSC001**

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: **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: **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**

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: **BSC001**

CS4512: 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: **BSC001**

CS355: Web Technologies **3 Cr Hr (3,0)** **ECTS**

This course explores topics in Internet and Web technology; Mobile components; Event handling: detection, notification, and response; Web applications development; Standard web services and protocols: WSDL, and UDDI, and SOAP; Design of web services and applications within a service-oriented architecture; Web application languages: HTML, XML, and scripting languages; Programming techniques for consumption and implementation of web services; Server web applications; Java servlets, and Java Server Pages; PHP basics; PHP forms and sessions; Databases connection with SQL and PHP. The practical part of this course will focus on training the students on various web development tools, like HTML, XML, and PHP.

Prerequisites: **BSC001**

CS356: Information Security **3 Cr Hr (3,0)** **ECTS**

This course covers fundamental issues surrounding information security and privacy. Course topics include confidentiality, integrity, availability; authentication models, protection models, security kernels, secure programming, audit, intrusion detection and response, operational security issues, physical security issues, personnel security, policy formation and enforcement, access controls, information flow; legal and social issues, identification and authentication in local and distributed systems, classification and trust modeling, risk assessment, data aggregation, behavioral advertising, privacy-preserving data mining, privacy-preserving data publishing, website privacy policies and practices, and anonymous communication.

Prerequisites: **BSC001**

CS359: Internet of Things **3 Cr Hr (3,0)** **ECTS**

Application areas of Internet of Things (IoT), Internet in Mobile Devices, Cloud and Sensor Networks, building blocks of Internet of Things and characteristics, design and program IoT-based devices and prototypes, Security of IoT devices, IoT with cloud computing, wireless technologies used in IoT systems,

such as Wi-Fi, 6LoWPAN, Bluetooth and ZigBee

Prerequisites: **BSC001**

CS374: Hardware Security **3 Cr Hr (3,0)** **ECTS**

This course exposes the students to the different aspects of Hardware security including secure hardware design and the different types of attacks targeting Hardware. The course includes access control, secure key storage, authentication techniques, hardware root of trust design, and IC supply chain risks.

Prerequisites: **BSC001**

CS323: Computational Theory **3 Cr Hr (3,0)** **ECTS**

Introduction to automata; languages and grammars; complexity theory and computability; Base mathematics and theoretical concepts behind computing: Finite automata; Regular expressions; Grammars; Stack machines; Turing machines; Decidability and reducibility; Complexity Classes; De-notational Semantics.

Prerequisites: **BSC001**

CS332: Computer Graphics **3 Cr Hr (3,0)** **ECTS**

Basic concepts of computer graphics, general features of graphics hardware, raster graphics versus vector graphics, drawing primitive objects: lines, poly-lines, polygons, circles, ellipses, curves; filling methods: scan-line fill and flood fill; Basic two-dimensional (2D) geometric transformations: translation, rotation, scaling and reflection; 2D composite transformations, 2D viewing: clipping window and windowing transformation; basic three-dimensional (3D) geometric transformations: translation, scaling, rotation and reflection; composite 3D geometric transformations, viewing a 3D scene: setting a 3D viewing-coordinate reference, transformation from world to viewing coordinates; projection transformations, 3D object representations: lines, planes, polyhedral, curved surfaces, spheres, ellipsoids; visible-surface detection methods, illumination models and surface-rendering methods, shadow mapping, transparency and surface rendering, interactive graphics.

Prerequisites: **BSC001**

CS458: Wireless Networks **3 Cr Hr (3,0)** **ECTS**

Introduction to wireless network devices, protocols and architectures; wireless networking standards, wireless local/wide area networks protocols, mobile internet protocols, ad hoc networks, wireless sensors networks.

Prerequisites: **BSC001**

CS4714: Digital Forensics **3 Cr Hr (3,0)** **ECTS**

This course introduces a theoretical and practical knowledge on the principles and practices of digital forensics. It covers the sources of digital evidence, digital investigation, and fundamentals of computer forensics. Coverage includes disk examination, memory acquisition, and logging analysis. The course also includes registry, e-mail, and database forensics.

Prerequisites: **BSC001**

CS470: Cryptography **3 Cr Hr (3,0)** **ECTS**

This course introduces the students to the classical and modern cryptographic techniques and their applications. Extensive study of required mathematical techniques is introduced including number theory, modular arithmetic, prime numbers, Fermat's and Euler's theorems, and testing for primality. The students then will be thoroughly exposed to different cryptographic techniques and algorithms: Block and Stream ciphers, Symmetric and Asymmetric Key encryption, Public Key encryption, One-time padding. The students will also learn about the different Key Creation and Exchange techniques, Digital Signatures, Message Authentication Codes, and Hash Algorithms

Prerequisites: **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: **BSC001**

CS450: Operations Optimization **3 Cr Hr (3,0)** **ECTS**

Linear Programming, Simplex Method, Integer Linear Programming, Transportation Models, Network Models, Queuing Systems, Inventory Models, Game Theory, Dynamic Programming, Decision Theory, Nonlinear Programming.

Prerequisites: **BSC001**

CS457: Decision Support Systems and Intelligent Systems **3 Cr Hr (3,0)** **ECTS**

This course explores topics in fundamentals of organizational information analysis OIS and executive information systems EIS; Management support systems; Solutions to the decision-making problems in real world; Decision making strategies and models; Design, development, and evaluation of decision support systems; Intelligent decision support technologies such as expert systems, neural network systems, data and text mining, and decision tree. The practical part of this course will focus on training the students on various DSS tools and enriching their skills towards developing different DSS solutions for real world applications.

Prerequisites: **BSC001**

CS358: Multimedia Systems Design **3 Cr Hr (3,0)** **ECTS**

This course covers the state-of-the-art technology for multimedia systems. This course introduces students to different media types (e.g., images, video, audio, graphics) and how they are used to create multimedia content and systems, algorithms and standards to compress and distribute them via networked systems to a variety of end clients. In general, the course includes issues related to a) content creation: media capture and representation, methods to assemble media types to create multimedia content; b) compression / Storage: students will study algorithms, protocols architectures related to compression; and c) distribution: Aspects of wired and wireless network distribution, Quality of Service, as well as digital rights management of distributed multimedia (watermarking & encryption). For each of the above ISO and ITU standards will also be addressed - JPEG, MPEG1, MPEG2, MPEG4, H.261, H.263, H.264, G.711, G.722, mp3, AAC, Dolby AC3, THX, surround sound, etc. We will also study applications and systems around multimedia – such as database applications with metadata (MPEG-7, MPEG-21). The course's goal will also be to explain modern distributed multimedia systems that take some or all of the above components to create practical applications, e.g., multimedia authoring, digital cinema, content management, multimedia databases, etc.

Prerequisites: **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: **BSC001**

X. Courses offered by Other Schools

ARB0099: Elementary Arabic **3 Cr Hr (3,0)** **3 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: **ARB0099**

ENGL0098: Elementary English **3 Cr Hr (3,0)** **3 ECTS**

Students will focus on English at an elementary level through the receptive skills of reading and listening and the productive skills of writing and speaking. English III is aimed at students who have achieved a grade of between 0 and 60 on the English Placement Test. This course is zero credit hours. This course enables students to contribute their own knowledge or experience in speaking activities, and use the language correctly. The exposure to a wide variety of listening material with a variety of accents, including some non-native speakers of English improves their level. English III integrates the focus on individual sounds of word and sentence stress where students are encouraged to copy the rhythm of English. Pronunciation is also integrated into Grammar and Vocabulary activities.

Prerequisites: -

ENGL0099: Intermediate English **3 Cr Hr (3,0)** **3 ECTS**

Students will focus on English at an intermediate level through the receptive skills of reading and listening and the productive skills of writing and speaking. English IV is aimed at students who have successfully passed English III or achieved a grade of between 61-80 on the English Placement Test. This course is zero credit hours. Attendance: Students are required to attend regularly according to the regulations of GJU and should provide the instructor with official excuses in case they are absent for a long time. Participation and homework: Students are required to participate in the group discussion in class. Interaction is necessary as well as oral presentations will be given to measure how fluent students are and to improve their skill of speaking. Medium of communication: GJU email, face to face (on campus) and during office hours. Teaching method: Explaining, discussing and doing the exercises given to students.

Prerequisites: **ENGL0098**

ENGL1001: Upper-Intermediate English **3 Cr Hr (3,0)** **3 ECTS**

"Education is the ability to listen to almost anything without losing your temper or your self-confidence." Robert Frost (1874 - 1963) English V is aimed at students who have achieved a passing grade in English IV or a grade between 81 and above on the English Placement Test. English V is equal to three credit hours. Students will focus on English at an upper intermediate level. Students will analyze and produce 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. Note: The process of argumentation enables us to clarify and develop our own responses to important issues, and a significant part of that process involves dialogue with both those who share our opinions and those who do not. In order to participate responsibly and effectively in meaningful dialogue, we must maintain an attitude characterized by openness, responsibility, rationality, and respect

for all participants. Upon finishing this level, all students are eligible to receive an English language proficiency letter indicating their level according to the Common European Framework Reference for Languages (CEFR) varying between B1 and B2 according to the grade they get upon finishing this level.

Prerequisites: **ENGL0099**

ENGL1002: Advanced English **3 Cr Hr (3,0)** **3 ECTS**

Advanced English, is the last of the English levels at the German Jordanian University to arm graduates with the best command of the English language in its varied aspects: Reading, Writing, Speaking, Listening and Understanding. It is aimed at students who successfully pass English V and it is three credit hours. This level focuses on a higher level of enhancement of their language. Students can address any audience, through delivering a persuasive speech, making an informative presentation, or analyzing controversial News through News Analysis. The students' Thesis Statements are backed up with: mistake-free language, persuasive logic and verified statistics, numbers and facts to convince the audience with their points of view. Other tools are enhanced involving their language, including specific terminology, tone, intonation and body language to make them acquire the best outcome. Students can also address any topic in writing. With the language skills provided in this level, GJU graduates become more equipped with outstanding abilities and get better chances in the work market, in addition to their knowledge and education in the major fields. The assessment of the students applies Bloom's Taxonomy where the learning objectives are classified according to the different domains including: learning (remembering), understanding, applying, analyzing, evaluating, the creating. Upon finishing this level, all students are eligible to receive an English language proficiency letter indicating their level according to the Common European Framework Reference for Languages (CEFR) varying between B2, C1 or C2 according to the grade they get upon finishing this level.

Prerequisites: **ENGL1001**

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

Can understand and use familiar, everyday expressions and very simple sentences, which aim at the satisfaction of specific needs. Can introduce oneself, and others, and ask others questions to themselves - e.g. where they live, which people they know or what kind of things they have - and can give answers on questions of this kind. Can communicate on a basic level if those involved with him/ her in a conversation speak slowly and clearly and are willing to help.

Prerequisites:

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

Can understand sentences and frequently used expressions if those are connected with things of immediate meaning (e.g., information to the person and to the family, buying, work, closer environment). Can communicate in simple, routine situations, with the purpose of a simple and direct exchange of information about familiar and common things. Can describe with simply means their own origin and training, direct environment and things that are in connection with direct needs.

Prerequisites: **GERL101B1**

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

Can understand the main points if no dialect is used and if it concerns familiar things about work, school, spare time etc. Can master most situations, which one encounters on journeys in a German speaking area. Can express oneself simply and coherently about familiar topics and areas of personal interest. Can report experiences and events, describe dreams, hopes and goals and give short reasons or explanations about plans and opinions.

Prerequisites: **GERL102B1 or GERL102B2, ARB0099, ENGL0099, MATH0099**

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

Can understand the main contents of complex texts, as well as concrete and abstract topics; even discussions between specialists in his/ her own special field. Can communicate spontaneously and fluidly a normal discussion with native speakers, without larger effort on both sides. Can express oneself clearly, in detail in a broad spectrum of topics, describe a point of view to a current question, and indicate the pro and cons of different possibilities.

Prerequisites: **GERL201B1 or GERL201B2, ARB0099, ENGL0099, MATH0099**

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

Can understand and seize implicit meanings of a broad spectrum of demanding, longer texts. Can express oneself spontaneously and fluidly, recognizing words without having to search for words frequently. Can use the language effectively and flexibly in social and vocational life or in training and study. Can express oneself clearly, structured and detailed, to complex subjects and use appropriate different means for linkage of texts.

Prerequisites: **GERL202B1 or GERL202B2**

GERL302B1: German VI B1-Track **3 Cr Hr (6,0)** **6 ECTS**

German VI is a strongly practice-oriented course in preparation for your German Year. The course includes the modules "Intercultural Communication", "Job Application Training" and the technical languages. In part, it includes a special support program for students who did not achieve their language goal of a full B1 certificate in German V.

Prerequisites: **GERL301B1 or GERL301B2**

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.

Prerequisites: **GERL102B2, ARB0099, ENGL0099, MATH0099**

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, ARB0099, ENGL0099, MATH0099**

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: **ENGL0099**

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: **ARB0099, ENGL0099**

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.

Prerequisites: **ENGL0099**

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: **ENGL0099**

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: **ARB0099**

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: **ENGL0099**

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: **ENGL0099**

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: **ENGL0099**

MATH0099: Pre-Math **3 Cr Hr (3,0)** **3 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: Placement Test

MATH101: Calculus I **3 Cr Hr (3,0)** **5 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***: MATH0099**

MATH102: Calculus II **3 Cr Hr (3,0)** **5 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)** **5 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)** **5 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)** **5 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.

*Prerequisites***:**

PHYS104: Physics II **3 Cr Hr (3,0)** **5 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)** **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)** **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)** **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**

IE0141: Engineering Workshops **1 Cr Hr (0,3)** **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***:**