MINISTRY OF EDUCATION AND TRAINING CAN THO UNIVERSITY

PROGRAMME SPECIFICATION

BACHELOR OF ENGINEERING IN COMPUTER SCIENCE

COLLEGE OF INFORMATION AND COMMUNICATIONTECHNOLOGY

2022

Department of Computer Science

College of Information and Communication Technology

Can Tho University

Address: Campus 2, 3/2 Street, Ninh Kieu District, Can Tho City, Vietnam

Website: http://www.cit.ctu.edu.vn

TABLE OF CONTENTS

Part 1. GENERAL INFORMATION

1 **Name and code of the program:** Computer Science (7480101)

2 **Degree awarding institution:** Can Tho University

3 **Training unit:** Faculty of Computer Science, College of Information and Communication Technology

4 **Degree title:** Engineer

5 **Type of training:** Regular

6 **Training time:** 4.5 years (up to 9 years)

7 **Admission applicants:**

Admissions of Computer Science (CS) is done under the guidance of the Ministry of Education and Training (MOET). Admission criteria is based on scores of one of the following two combinations: (i) Math, Physics, Chemistry; and (ii) Math, Physics, English. Before 2020, admission is based on the results of the national high school graduation exam. Particularly in 2020, because of Covid-19, there is a new selection method which based on high school transcripts and candidates can choose the selection method that they want.

8 **Total number of credits:** 161 credits

Part 2. PROGRAM OBJECTIVES AND EXPECTED LEARNING OUTCOMES

1 Program objectives

Based on Vietnam's law on higher education, the BECS has its objectives (POs) aligned with CTU's mission. After graduation from the BECS program, students will:

- PO1: Memorize basic knowledge of law, security and defense, political and social science; build physical health, ethics, social awareness, and professional responsibility according to current regulations;
- PO2: Apply basic knowledge of information technology, programming, applied mathematics in computer science;
- PO3: Integrate knowledge in one of the specialized directions: Image processing and computer vision, data science that enable them to study related fields;
- PO4: Analyze and apply specialized knowledge and skills to meet the practical needs of an individual or an organization in the field of computer science in the context of industry 4.0;

- PO5: Develop professional working style, communication skills, critical thinking to meet the requirements of globalization and lifelong learning.

2 Expected learning outcomes

After graduation from the BECS program, students should have the ability to:

2.1 General knowledge

- ELO 1: Recall the basic knowledge of law, political and social science, national defense and security, physical education, ethics, and professional responsibility in accordance with current regulations;
- ELO 2: Apply basic knowledge of English or French in communication and study equivalent to level 3/6 of Vietnam's Framework of Foreign Language Proficiency (B1 in the European Framework of Reference).
- ELO 3: Demonstrate the basic knowledge of information technology and mathematics for applying to acquire the fundamental and specialized knowledge in computer science.

2.2 Fundamental knowledge

- ELO 4: Explain and generalize the applied mathematics in computer science, fundamental knowledge of information technology (computer architecture, operating systems and computer networks…).
- ELO 5: Apply the knowledge of data structures, algorithms and programming techniques (structured programming, object-oriented programming, web programming);
- ELO 6: Identify and analyze problems related to information systems then apply knowledge to analyze, design and build an information system;

2.3 Specialized knowledge

- ELO 7: Understand and apply knowledge about theory of computation, numerical analysis, linear programming, information theory.
- ELO 8: Apply specialized knowledge and provide solutions for problems related to the following directions: data analysis and mining; computer graphics and computer vision.

2.4 Professional skills

- ELO 9: Programming thinking, ability to develop from theory to building intelligent systems, ability to apply research results into practice.

2.5 Soft skills

- ELO 10: Develop skills about reading, writing technical documents, scientific reports, project reports and presentations, critical thinking, teamwork.

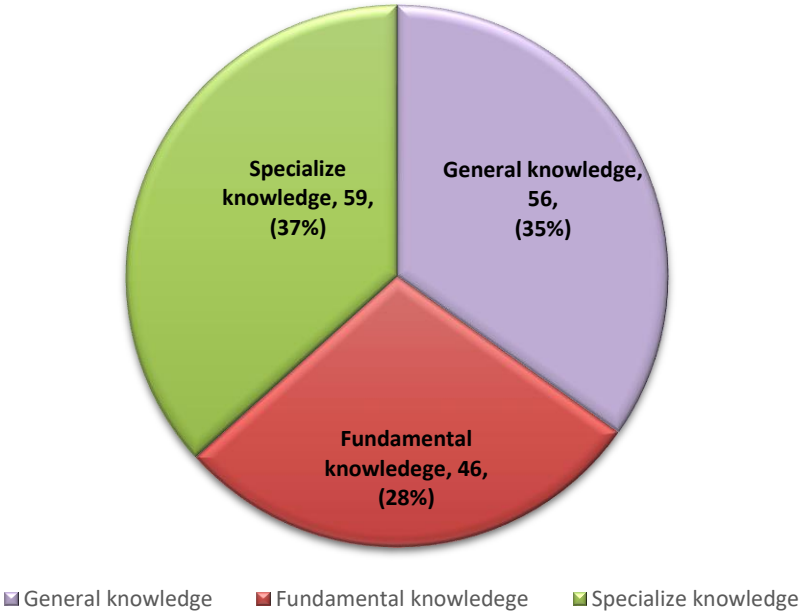
2.6 Attitudes

- ELO 11: Develop a professional working style; compliance with ethics, professional and social responsibility; self-control and lifelong learning habits.

Part 3. STRUCTURE AND TRAINING PROGRAM

1 Structure

- 161 credits (116 compulsory and 45 elective credits), of which 56 credits are in general knowledge block, 46 credits in fundamental knowledge block and 59 credits in specialized knowledge block (15 credits for graduation thesis)



The BECS program has been appropriately apportioned among general, fundamental and specialized knowledge blocks;

- The average training time is 4.5 years. Depending on their own ability and conditions, students can shorten or extend their study time by making their own study plan. Elective credits allow students to pursue different study and research paths in computer science field or IT field.

2 Training program

- Training program: **Computer Science**
- Program code: 7480101 Type of training: Regular
- Training time: 4.5 years Degree title: Engineer
- Training unit: Deparment of Computer Science, College of Information and Communication Technology

2.1 Curriculum

No	Course ID	Course name	Num of credits	Obligatory	Optional credits	Theory hours	Practice hours	Prerequisite course	Parallel course	Semester
General knowledge										
1	QP006	National Defense Education 1 (*)	2	2		37	8	Taught in groups of majors		
2	QP007	National Defense Education 2 (*)	2	2		22	8	Taught in groups of majors		
3	QP008	National Defense Education 3 (*)	2	2		14	16	Taught in groups of majors		
4	QP009	National Defense Education 4 (*)	2	2		4	56	Taught in groups of majors		
5	TC100	Physical Education 1+2+3 (*)	1+1+1		3		90			I,II,III
6	XH023	Basic English 1 (*)	4			60				I,II,III
7	XH024	Basic English 2 (*)	3			45		XH023		I,II,III
8	XH025	Basic English 3 (*)	3			45		XH024		I,II,III
9	XH031	Advanced English 1 (*)	4			60		XH025		I,II,III
10	XH032	Advanced English 2 (*)	3			45		XH031		I,II,III
11	XH033	Advanced English 3 (*)	3			45		XH032		I,II,III
12	FL001	Basic French 1 (*)	4			60				I,II,III
13	FL002	Basic French 2 (*)	3			45		FL001		I,II,III
14	FL003	Basic French 3 (*)	3			45		FL002		I,II,III
15	FL007	Advanced French 1 (*)	4			60		FL003		I,II,III
16	FL008	Advanced French 2 (*)	3			45		FL007		I,II,III
17	FL009	Advanced French 3 (*)	3			45		FL008		I,II,III
18	ML014	Marxist-Leninism Philosophy	3	3		45				I,II,III
19	ML016	Marxist-Leninism Political Economic	2	2		30		ML014		I,II,III
20	ML018	Scientific Socialism	2	2		30		ML016		I,II,III
21	ML019	History of the Communist Party of Viet Nam	2	2		30		ML018		I,II,III
22	ML021	Hồ Chí Minh's Thought	2	2		30		ML019		I,II,III
23	KL001	General Law	2	2		30				I,II,III
24	ML007	Basic Logic	2			30				I,II,III
25	XH028	Overview of Sociology	2			30				I,II,III
26	XH011	Basic Vietnamese Culture	2			30				I,II,III
27	XH012	Vietnamese in Use	2			30				I,II,III

No	Course ID	Course name	Num of credits	Obligatory	Optional credits	Theory hours	Practice hours	Prerequisite course	Parallel course	Semester
28	XH014	General Management Documents and Archives	2		2	30				I,II,III
29	KN001	Soft Skills	2			20	20			I,II,III
30	KN002	Creation, Innovation, Start-up	2			20	20			I,II,III
31	TN001	Calculus A1	3	3		45				I,II,III
32	TN002	Calculus A2	4	4		60		TN001		I,II,III
33	TN010	Probability and Statistics	3	3		45				I,II,III
34	TN012	Linear Algebra and Analytic Geometry	4	4		60				I,II,III
35	CT100	Study Skills	2	2		20	20			I,II
36	CT200	Fundamentals of Information Technology	4	4		45	30			I,II,III
Total: 56 credits (Obligatory: 41 credits; Optional: 15 credits)										
Fundamental knowledge										
37	CT172	Discrete Mathematics	4	4		60				I,II
38	CT101	Basic Programming A	4	4		30	60			I,II
39	CT177	Data Structures	3	3		30	30	CT101		I,II
40	CT174	Design and Analysis of Algorithms	3	3		30	30	CT177		I,II
41	CT175	Graph Theory	3	3		30	30	CT177		I,II
42	CT176	Object-Oriented Programming	3	3		30	30	CT101		I,II
43	CT173	Computer Architecture	3	3		45				I,II
44	CT178	Principles of Operating Systems	3	3		30	30	CT173		I,II
45	CT112	Computer Network	3	3		30	30	CT178		I,II
46	CT179	System Administration	3	3		30	30			I,II
47	CT180	Databases	3	3		30	30	CT177		I,II
48	CT182	Unified Modeling Language	3	3		30	30	CT176	CT180	I,II
49	CT296	System Analysis and Design	3	3		30	30	CT180		I,II
50	CT190	Introduction to Artificial Intelligence	2	2		30				I,II
51	CT188	Introduction to Web Programming	3	3		30	30			I,II
Total: 46 credits (Obligatory: 46 credits; Optional: 0 credits)										
Specialized knowledge										

No	Course ID	Course name	Num of credits	Obligatory	Optional credits	Theory hours	Practice hours	Prerequisite course	Parallel course	Semester
52	CT201	Project – Fundamental Topics	3	3			90	CT174, CT176		I,II
53	CT199	Linear Programming	3		3	30	30			I,II
54	CT479	Calculation Method	3			30	30			I,II
55	CT292	Information Theory	3			30	30			I,II
56	CT121	Theory of Computation	3	3		30	30			I,II
57	CT332	Artificial Intelligence	3	3		30	30			I,II
58	CT294	Applied Machine Learning	3	3		30	30			I,II
59	CT467	Data Management	3	3		30	30	CT180		I,II
60	CT204	Information safety and security	3	3			90	≥ 110 TC		I,II
61	CT316	Image Processing	3	3		30	30	CT176		I,II
62	CT234	Embedded Software Development	3		3	30	30			I,II
63	CT207	Open-source Software Development	3			30	30	CT101		I,II
64	CT449	Web Application Development	3			30	30			I,II
65	CT208	Project – Specialized Topics	3	3			90	CT176, CT201		I,II
66	CT203	Computer Graphics	3	Specialization 1	30	30	30	CT176		I,II
67	CT209	Advanced Graphics	3			30	30	CT203		I,II
68	CT220	Computer Animation	3			30	30	CT203		I,II
69	CT210	Computer Vision	3			30	30	CT316		I,II
70	CT312	Data Mining	3	Specialization 2		30	30			I,II
71	CT202	Principles of Machine Learning	3			30	30	CT294		I,II
72	CT282	Deep Learning	3			30	30	CT294		I,II
73	CT217	Visual Data Analysis	3			30	30			I,II
74	CT219	Natural Language Processing	3			30	30			
75	CT516	Internship in Computer Science	5	5			150	≥ 125 TC		I,II,III
76	CT552	Graduation Thesis	15				450	≥ 125 TC		I,II
77	CT504	Graduation Project	6				180	≥ 125 TC		I,II
78	CT198	English Majoring in Information Technology	3			45				I,II

No	Course ID	Course name	Num of credits	Obligatory	Optional credits	Theory hours	Practice hours	Prerequisite course	Parallel course	Semester
79	CT216	Knowledge Base System	3			30	30	CT332		I.II
80	CT221	Network Programming	3			30	30	CT112, CT176		I,II
81	CT222	System Security	3			30	30			I,II
82	CT274	Programming for Mobile Devices	3			30	30	CT176		I.II
83	CT290	Game Programming	3			30	30			I,II
84	CT284	Question and Answer System	3			30	30			I.II
85	CT189	Introduction to Simulation	3			30	30			I,II
86	CT295	Principles of IoT and Embedded Software	3			30	30			I.II
87	CT233	Cloud Computing	3			30	30	CT112		I,II
Total: 59 credits (Obligatory: 29 credits; Optional: 30 credits)										
Total: 161 credits (Obligatory: 116 credits; Optional: 45 credits)										

2.2 Sample of study plan

No	Course ID	Course Name	Credits	Obligatory credits	Optional credits	Theory hours	Practical hours	Prerequisite course	Parallel course	Note
Semester 1 – The 1st year										
1	QP006	National Defense Education 1	2	2		37	8			Students study according to the
2	QP007	National Defense Education 2	2	2		22	8			
3	QP008	National Defense Education 3	2	2		14	16			
4	QP009	National Defense Education 4	2	2		4	56			
5	TN010	Probability and Statistics	3	3		45				
6	CT100	Study Skills	2	2		20	20			
Total			**13**	**13**	**0**					
Semester 2 – The 1st year										
1	ML014	Marxist-Leninism Philosophy	3	3		45				
2	TC100	Physical Education 1	1		1		30			
3	CT101	Basic Programming A	4	4		30	60			
4	CT172	Discrete Mathematics	4	4		60				
5	CT200	Fundamentals of Information Technology	4	4		45	30			
6	XH023	Basic English 1	4		4	60				
	FL001	Basic French 1	4			60				
	XH031	Advanced English 1	4			60				
	FL007	Advanced French 1	4			60				
Total			**20**	**15**	**5**					
Semester 1 – The 2nd year										
1	ML007	Basic Logic	2		2	30				
	XH028	Overview of Sociology	2			30				
	XH011E	Basic Vietnamese Culture	2			30				
	XH012	Vietnamese in Use	2			30				
	XH014	General Management Documents and Archives	2			30				
	KN001	Soft Skills	2			20	20			
	KN002	Creation, Innovation, Start-up	2			20	20			
2	TN012	Linear Algebra and Analytic Geometry	4	4		60				

3	TN001	Calculus A1	3	3		45				
4	ML016	Marxist-Leninism Political Economic	2	2		30		ML014		
5	CT190	Introduction to Artificial Intelligence	2	2		30	30			
6	CT177	Data Structures	3	3		30	30	CT101		
7	XH024	Basic English 2	3		3	45		XH023		
	FL002	Basic French 2	3			45		FL001		
	XH032	Advanced English 2	3			45		XH031		
	FL008	Advanced French 2	3			45		FL007		
Total			**19**	**14**	**5**					

Semester 2 – The 2nd year										
1	ML018	Scientific Socialism	2	2		30		ML016		
2	TC100	Physical Education 2	1		1		30			
3	CT188	Introduction to Web Programming	3	3		30	30			
4	CT174	Design and Analysis of Algorithms	3	3		30	30	CT177		
5	CT173	Computer Architecture	3	3		45				
6	CT175	Graph Theory	3	3		30	30	CT177		
7	XH025	Basic English 3	3		3	45		XH024		
	FL003	Basic French 3	3			45		FL002		
	XH033	Advanced English 3	3			45		XH032		
	FL009	Advanced French 3	3			45		FL008		
8	KL001E	General Law	2	2		30				
Total			**20**	**16**	**4**					
Semester 1 – The 3rd year										
1	ML019	History of the Communist Party of Viet Nam	2	2		30		ML018		
2	TC100	Physical Education 3	1		1		30			
3	CT178	Principles of Operating Systems	3	3		30	30	CT173		
4	CT180	Databases	3	3		30	30	CT177		
5	CT176	Object-Oriented Programming	3	3		30	30	CT101		
6	CT332	Artificial Intelligence	3	3		30	30	CT190		
7	CT199	Linear Programming	3		3	30	30			
8	CT479	Calculation Method	3			30	30			
9	CT292	Information Theory	3			30	30			
Total			**18**	**14**	**4**					
Semester 2 – The 3rd year										

1	CT201	Project – Fundamental Topics	3	3			90	CT174, CT176		
2	CT121	Theory of Computation	3	3		30	30			
3	CT316	Image Processing	3	3		30	30	CT176		
4	ML021	Hồ Chí Minh's Thought	2	2		30	30	ML019		
5	CT294	Applied Machine Learning	3	3		30	30			
6	TN002	Calculus A2	4	4		60		TN001		
Cộng			**18**	**18**	**0**					
Semester 1 – The 4th year										
1	CT112	Computer Network	3	3		30	30	CT178		
2	CT203	Computer Graphics	3	Spec. 1	Choose 6 credits from spec.1 or spec.2	30	30	CT176		
	CT210	Computer Vision	3			30	30	CT316		
	CT312	Data Mining	3	Spec. 2		30	30			
	CT202	Principles of Machine Learning	3			30	30			
3	CT182	Unified Modeling Language	3	3		30	30	CT176	CT180	
4	CT467	Data Management	3	3		30	30	CT180		
5	CT296	System Analysis and Design	3	3		30	30	CT180		
Total			**18**	**12**	**6**					

Semester 2 – The 4th year										
1	CT208	Project – Specialized Topics	3	3			90	CT176, CT201		
2	CT209	Computer Graphics	3	Spec. 1	Choose 3 credits from Spec 1 or Spec 2	30	30	CT203		
	CT220	Computer Animation	3			30	30	CT203		
	CT282	Deep Learning	3	Spec. 2		30	30			
	CT219	Natural Language Processing	3			30	30			
	CT217	Visual Data Analysis	3			30	30			
3	CT179	System Administration	3	3		30	30			
4	CT204	Information Safety and Security	3	3		30	30			
5	CT234	Embedded Software Development	3		3	30	30			
	CT207	Open-Source Software Development	3			30	30	CT101		
	CT449	Web Application Development	3			30	30			
Total			**15**	**9**	**6**					
Summer Semester – The 4th year										
1	CT516	Internship in Computer Science	5	5			150	≥125 TC		

Total			**5**	**5**	**0**					
Semester 1 – The 5th year										
1	CT552	Graduation Thesis – Computer Science	15		15		450	≥125TC		
	CT504	Graduation Project – Computer Science	6				180	≥125 TC		
	CT198	English majoring in information technology	3			45				
	CT216	Knowledge base system	3			30	30	CT332		
	CT221	Network programming	3			30	30	CT112, CT176		
	CT222	System security	3			30	30			
	CT274	Programming for mobile devices	3			30	30	CT176		
	CT290	Game programming	3			30	30			
	CT284	Question and answer system	3			30	30			
	CT189	Introduction to Simulation	3			30	30			
	CT295	Principles of IoT and Embedded Software	3			30	30			
	CT233	Cloud computing	3			30	30	CT112		
Total			**15**	**0**	**15**					
Total			**161**	**116**	**45**					

3 Correlation Matrix Between Program Objectives and Expected Learning Outcomes

Program objectives (1)	Expected learning outcomes (2)										
	Knowledge (2.1)								Skill (2.2)		Attitude (2.3)
	General Knowledge (2.1.1)			Fundamental Knowledge (2.1.2)			Specialized Knowledge (2.1.3)		Hard Skill (2.2.1)	Soft Skill (2.2.2)	
	ELO1	ELO2	ELO3	ELO4	ELO5	ELO6	ELO7	ELO8	ELO9	ELO10	ELO11
PO1	X										
PO2			X	X	X	X	X		X		
PO3							X		X		
PO4				X	X	X		X	X	X	X
PO5		X	X						X	X	X

4 Correlation Matrix Between Expected Learning Outcomes and Course Learning Outcomes

Courses			Expected learning outcomes (2)										
			Knowledge (2.1)								Skill (2.2)		Attitude (2.3)
			General Knowledge (2.1.1)			Fundamental Knowledge (2.1.2)			Specialized Knowledge (2.1.3)		Hard Skill (2.2.1)	Soft Skill (2.2.2)	
			ELO1	ELO2	ELO3	ELO4	ELO5	ELO6	ELO7	ELO8	ELO9	ELO10	ELO11
General Knowledge													
1	QP010E	National Defense Education 1 (*)	X										
2	QP011E	National Defense Education 2 (*)	X										
3	QP012	National Defense Education 3 (*)	X										
4	QP013	National Defense Education 4 (*)	X										
5	TC100	Physical Education 1+2+3 (*)	X										
6	XH023	Basic English 1 (*)		X								X	
7	XH024	Basic English 2 (*)		X								X	
8	XH025	Basic English 3 (*)		X								X	
9	XH031	Advanced English 1 (*)		X								X	
10	XH032	Advanced English 2 (*)		X								X	
11	XH033	Advanced English 3 (*)		X								X	
12	FL001	Basic French 1 (*)		X								X	
13	FL002	Basic French 2 (*)		X								X	
14	FL003	Basic French 3 (*)		X								X	
15	FL007	Advanced French 1 (*)		X								X	
16	FL008	Advanced French 2 (*)		X								X	

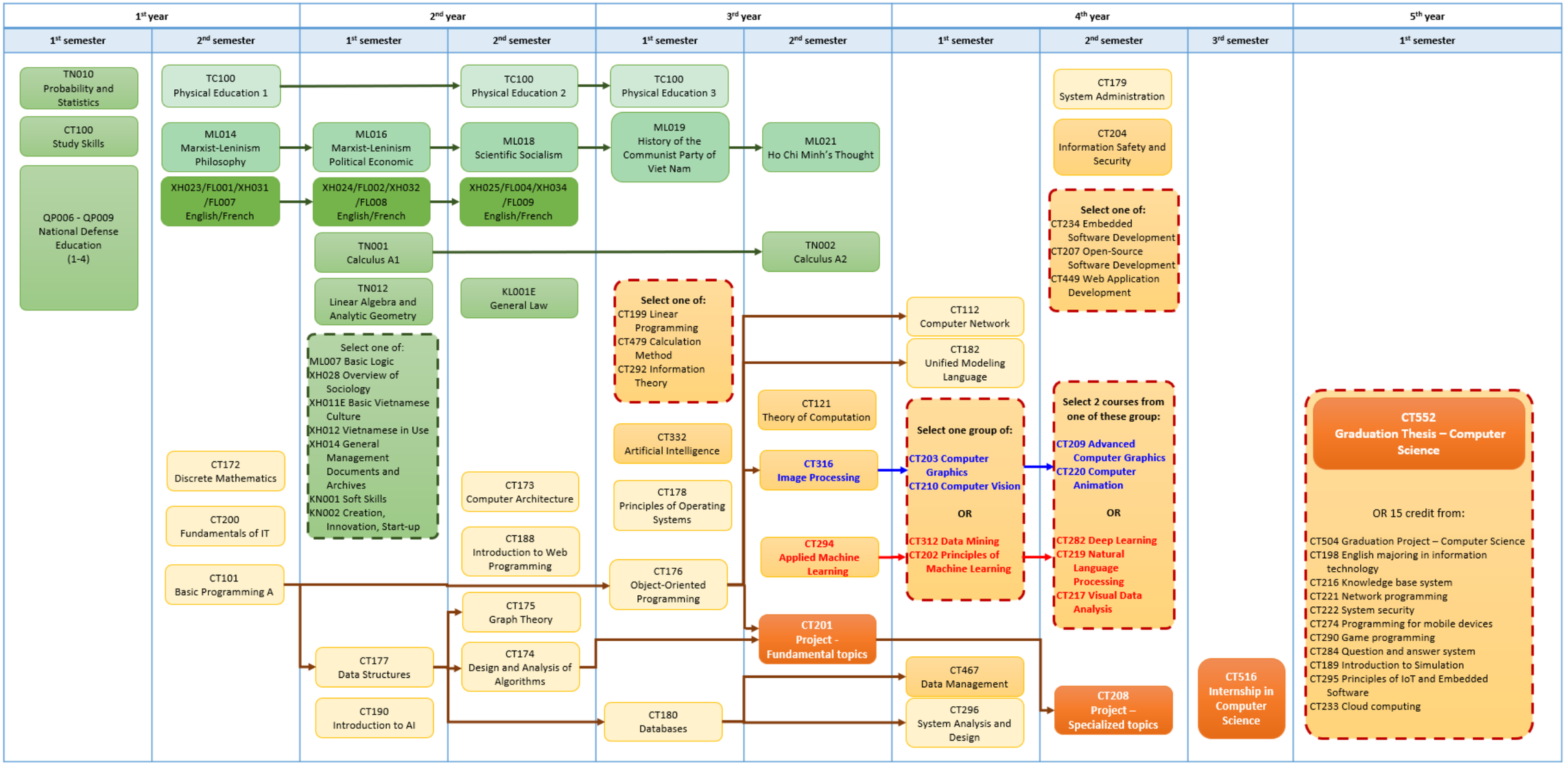
Courses			Expected learning outcomes (2)										
			Knowledge (2.1)								Skill (2.2)		Attitude (2.3)
			General Knowledge (2.1.1)			Fundamental Knowledge (2.1.2)			Specialized Knowledge (2.1.3)		Hard Skill (2.2.1)	Soft Skill (2.2.2)	
			ELO1	ELO2	ELO3	ELO4	ELO5	ELO6	ELO7	ELO8	ELO9	ELO10	ELO11
17	FL009	Advanced French 3 (*)		X								X	
18	ML014	Marxist-Leninism Philosophy	X										
19	ML016	Marxist-Leninism Political Economic	X										
20	ML018	Scientific Socialism	X										
21	ML019	History of the Communist Party of Viet Nam	X										
22	ML021	Hồ Chí Minh's Thought	X										
23	KL001E	General Law	X	X								X	
24	ML007	Basic Logic		X								X	
25	XH028	Overview of Sociology		X								X	
26	XH011E	Basic Vietnamese Culture		X								X	
27	XH012	Vietnamese in Use		X								X	
28	XH014	General Management Documents and Archives		X								X	
29	KN001	Soft Skills		X								X	X
30	KN002	Creation, Innovation, Start-up		X								X	X
31	TN001	Calculus A1		X	X						X		
32	TN002	Calculus A2		X	X						X		
33	TN010	Probability and Statistics		X	X						X		
34	TN012	Linear Algebra and Analytic Geometry		X	X						X		
35	CT100	Study Skills		X								X	X

Courses			Expected learning outcomes (2)										
			Knowledge (2.1)								Skill (2.2)		Attitude (2.3)
			General Knowledge (2.1.1)			Fundamental Knowledge (2.1.2)			Specialized Knowledge (2.1.3)		Hard Skill (2.2.1)	Soft Skill (2.2.2)	
			ELO1	ELO2	ELO3	ELO4	ELO5	ELO6	ELO7	ELO8	ELO9	ELO10	ELO11
36	CT200	Fundamentals of Information Technology		X	X						X	X	
Fundamental Knowledge													
37	CT172	Discrete Mathematics				X					X		
38	CT101	Basic Programming A					X						
39	CT103	Data Structures					X						
40	CT174	Design and Analysis of Algorithms					X						
41	CT175	Graph Theory				X	X				X		
42	CT176	Object-Oriented Programming					X						
43	CT173	Computer Architecture				X							
44	CT178	Principles of Operating Systems				X							
45	CT112	Computer Network				X							
46	CT179	System Administration				X							
47	CT180	Databases						X					
48	CT182	Unified Modeling Language						X					
49	CT296	System Analysis and Design						X					
50	CT190	Introduction to Artificial Intelligence				X						X	
51	CT188	Introduction to Web Programming					X						
Specialized Knowledge													
52	CT201	Project – Fundamental Topics								X	X	X	X

Courses			Expected learning outcomes (2)										
			Knowledge (2.1)								Skill (2.2)		Attitude (2.3)
			General Knowledge (2.1.1)			Fundamental Knowledge (2.1.2)			Specialized Knowledge (2.1.3)		Hard Skill (2.2.1)	Soft Skill (2.2.2)	
			ELO1	ELO2	ELO3	ELO4	ELO5	ELO6	ELO7	ELO8	ELO9	ELO10	ELO11
53	CT199	Linear programming							X		X		
54	CT479	Numerical Analysis							X		X		
55	CT292	Information theory							X		X		
56	CT121	Theory of Computation							X	X	X		
57	CT332	Artificial Intelligence							X	X	X	X	X
58	CT202	Principle of Machine Learning							X	X	X	X	X
59	CT467	Data Management							X	X	X		
60	CT204	Information security							X	X	X		
61	CT234	Embedded Software Development							X	X	X		
62	CT207	Open-Source Software Development							X	X	X		
63	CT449	Web application development							X	X	X		
64	CT208	Project - Specialized topics								X	X	X	X
65	CT316	Image Processing							X	X	X		
66	CT203	Computer graphics							X	X	X		
67	CT209	Advanced computer graphics							X	X	X	X	X
68	CT220	Computer animation							X	X	X		
69	CT210	Computer vision							X	X	X	X	X
70	CT312	Data mining							X	X	X	X	X
71	CT294	Applied machine learning							X	X	X	X	X
72	CT282	Deep Learning							X	X	X	X	X
73	CT217	Visual Analysis							X	X	X	X	X

Courses			Expected learning outcomes (2)										
			Knowledge (2.1)								Skill (2.2)		Attitude (2.3)
			General Knowledge (2.1.1)			Fundamental Knowledge (2.1.2)			Specialized Knowledge (2.1.3)		Hard Skill (2.2.1)	Soft Skill (2.2.2)	
			ELO1	ELO2	ELO3	ELO4	ELO5	ELO6	ELO7	ELO8	ELO9	ELO10	ELO11
74	CT219	Natural Language Processing							X	X	X	X	X
75	CT516	Internship in Computer Sciences								X	X	X	X
76	CT552	Gradational Thesis - Computer Science								X	X	X	X
77	CT504	Graduation project - Computer Science								X	X	X	X
78	CT198	English for Information Technology								X	X	X	X
79	CT216	Knowledge-based systems							X	X	X		
80	CT221	Network Programming							X	X	X		
81	CT222	System Security							X	X	X		
82	CT274	Programming for Mobile Devices							X	X	X		
83	CT290	Game development							X	X	X	X	X
84	CT284	Question-Answering System							X	X	X	X	X
85	CT189	Introduction to simulation platform							X	X	X		
86	CT295	Principles of IoT and Embedded Software							X	X	X	X	X
87	CT233	Cloud Computing							X	X	X		

5 Curriculum Map



6 Course description

6.1. National Defense Education 1 (QP010E)

- Number of credits: 02
- Description:

Refers to the Party's basic theory of military lines, including: fundamental issues of Marxism-Leninism, Ho Chi Minh's ideas on war, military and national defense; the Party's views on the people's war, the building of the armed forces, the entire people's defense and the people's security; The Party's views on combining socioeconomic development with enhanced consolidation defense security. A certain amount of time introduces some basic content of the history of Vietnamese martial arts through periods.

6.2. National defense Education 2 (QP011E)

- Number of credits: 02
- Description:

To select the basic contents of tasks of defense and security work of the Party and the State in the new situation, including the building of the militia and self-defense force, the reserve force, physical security, defense techniques, defeat the strategy of "peaceful evolution", the overthrow of hostile forces against the Vietnamese revolution. The course mentions a number of issues related to ethnicity, religion and the fight against enemy use of ethnic and religious issues against the revolution of Vietnam. To build and defend border sovereignty, island sovereignty and national security, fight against crimes and maintain social order and safety, fight against non-traditional security threats in Vietnam.

6.3. National defense Education 3 (QP012)

- Number of credits: 02
- Description:

The theory combines with practice to equip learners with some basic skills in shooting, basic knowledge of maps, military terrain, advanced defense against high technology weapons, train the bravery, health through the military content, practice the class, block. Content includes: unit form (platoon level). Practice fighting skills, fighting command, fighting in combat, defense.

6.4. National defense Education 4 (QP013)

- Number of credits: 02
- Description:

Introduction of history, military tradition, army, organization of forces, army, visit to understand the history, units in the armed forces.

6.5. Physical Education (TC100)

- Number of credits: 03
- Description:

The 1 + 2 + 3 Amateur Physical Education module is a common module that represents the Physical Education modules that non-Physical Education students must study to complete their undergraduate degree programs. In addition, to complete the Physical Education module, students may not register for the TC100 course, but instead must register for each specific module depending on their ability and need to study such as: In Taekwondo, students register for 3 courses: Taekwondo 1(TC003), Taekwondo 2(TC004), Taekwondo 3, (TC019), other Physical Education modules are similar.

6.6. Basic English 1 (XH023)

- Number of credits: 04
- Description:

The Basic English 1 course provides students with basic English vocabulary in basic communication, focusing on topics such as personal information, family, places, things in daily life, sports, free time activities and basic shopping. In addition to developing the ability to communicate in some basic English communication situations on these topics, the curriculum also aims to develop language competence at A2 level for students in 6 Level Framework (VSTEP Vietnam).

6.7. Basic English 2 (XH024)

- Number of credits: 03
- Description:

The Basic English 2 course provides students with basic English vocabulary in basic communication, focusing on topics such as countryside, cities of interest, culinary arts, tourism, fashion, money. In addition to developing the ability to communicate on some basic English communication situations on these topics, the curriculum also targets the development of language proficiency at A2 level for undergraduate students in 6 Level Framework (VSTEP Vietnam).

6.8. Basic English 3 (XH025)

- Number of credits: 03
- Description:

The Basic English 3 course provides students with basic English vocabulary in basic communication, focusing on topics such as introduction to film genres, science and technology, tourism and natural environment. In addition to developing the ability to communicate in some basic English communication situations on these topics, the curriculum also aims to develop language competence at A2 level for students in the 6 Level Framework (VSTEP Vietnam).

6.9. Advanced English 1 (XH031)

- Number of credits: 04
- Description:

Advanced English Course 1 (in Advanced English Program 1-3) provides students with knowledge of English and the opportunity to practice the skills required to meet international communication competence in common situations. The program demonstrates principles and characteristics: (1) to develop competence-based learning; (2) integrated and blended learning; (3) promoting learner independence in learning; (4) through interaction and by doing; (5) purposeful learning; and (6) flexibility. In addition to developing communication and language skills, the curriculum also aims to support students who achieve B1 (tier 3) in Vietnam foreign language competence system (through VSTEP examination).

6.10. Advanced English 2 (XH032)

- Number of credits: 03
- Description:

The Advanced English Course 2 (in Advanced English Program 1-3) provides students with knowledge of English and the opportunity to practice the skills they need to meet international communication skills in common situations. The program demonstrates principles and characteristics: (1) to develop competence-based learning; (2) integrated and blended learning; (3) promoting learner independence in learning; (4) through interaction and by doing; (5) purposeful

learning; and (6) flexibility. In addition to developing communication and language skills, the curriculum also aims to support students who achieve B1 (tier 3) in Vietnam foreign language competence system (through VSTEP examination).

6.11. Advanced English 3 (XH033)

- Number of credits: 03
- Description:

The Advanced English Course 3 (in Advanced English Program 1-3) provides students with knowledge of English and the opportunity to practice the skills they need to meet international communication skills in common situations. The program demonstrates principles and characteristics: (1) to develop competence-based learning; (2) integrated and blended learning; (3) promoting learner independence in learning; (4) through interaction and by doing; (5) purposeful learning; and (6) flexibility. In addition to developing communication and language skills, the curriculum also aims to support students who achieve B1 (tier 3) in Vietnam foreign language competence system (through VSTEP examination).

6.12. Basic French 1 (FL001)

- Number of credits: 04
- Description:

The content of the course aims to communicate in daily life, such as introducing yourself, your family, talking about habits, hobbies, acquaintances and introducing someone, speaking and writing about hours in the common or formal way, etc. In addition, the knowledge of language, French culture is also integrated into the curriculum. Through this course, students will be introduced to pronunciation, intonation, French alphabet, know how to conjugate from Group I, Group II and some Group III verbs in the present time, write a number of simple sentences.

6.13. Basic French 2 (FL002)

- Number of credits: 03
- Description:

The course will continue to equip learners with the basics of Grammar, Phonetics, Vocabulary of French. The content of the course aims to communicate in daily life such as information, explanation, invitation or refusal, talk about your workday, talk about future plans. Students are introduced to questioning, questioning with more complex French pronouns, groupings of groups I and II, and group III verbs in order, directions, positioning in space. In addition, the knowledge of language, French culture is also incorporated into the curriculum content.

6.14. Basic French 3 (FL003)

- Number of credits: 03
- Description:

The content of the course continues to target communication in daily life such as discussing about holidays, Tet, food, depicts people, objects, clothes, express choices, number, introduction family members, tell a story in the past, etc. In this course, students are introduced to 100- or more-word texts, longer conversations, writing about 100-word texts, write letters. Students can apply grammatical knowledge to their writing, such as the number of nouns, adjectives, past tense verbs, past tenses, and so on. Completion of the module, students will also know how to explain and perform simple arguments.

6.15. Advanced French 1 (FL007)

- Number of credits: 04
- Description:

The content of the course continues towards the goal of communication in daily life such as introducing family members; get acquainted with a person; tell daily activities; describe the person, place of residence; quantitative or quality comparison. In addition, the knowledge of language, French culture is also incorporated into the content of the curriculum.

6.16. Advanced French 2 (FL008)

- Number of credits: 03
- Description:

Advance French 2 will provide students with a wealth of knowledge about vocabulary and grammatical structures to help students develop the comprehensive four listening, speaking, reading and writing skills about six mains themes of eating habits, sports, employment, education, communication and recreation.

6.17. Advanced French 3 (FL009)

- Number of credits: 03
- Description:

The Advanced French 3 will provide students with a rich and varied knowledge of vocabulary and grammatical structures to help students develop the comprehensive four listening, speaking, reading and writing skills, which deals with six major themes of speaking, talking about memories, travels, habits, motivations, narrating the words of others.

6.18. Marxist-Leninism Philosophy (ML014)

- Number of credits: 03
- Description:

The module presents the following basic contents: dialectical materialism, dialectic materialism, historical materialism. Namely, mention the basic theory of the Party on the military line, including fundamental issues of Marxist-Leninist doctrine, Ho Chi Minh's thoughts on war, army, and national defense, and the Party's views on the people's war. The building of the armed forces, the all-people national defense, and the people's security; the Party's thoughts on combining socio-economic development with strengthening defense and security consolidation. Spend a certain amount of time introducing some primary content about the history of Vietnamese military art through the periods. Building and protecting border sovereignty, sovereignty over seas and islands, national security, and ensuring social order and safety.

6.19. Marxist-Leninism Political Economic (ML016)

- Number of credits: 02
- Description:

This course introduces students to following issues: the preconditions for the production of goods; goods; currency; value law; The transformation of money into capital; production process of surplus value; wages in capitalism; transformation of surplus value into capital - capital accumulation; circulation of capital and surplus value; capital forms and expressions of surplus value; Monopoly capitalism; state monopoly; today's capitalism and its manifestations; the role, limitations and movement tendencies of capitalism.

6.20. Scientific Socialism (ML018)

- Number of credits: 02
- Description:

This course introduces students to the historical mission of the working class; socialist revolution; Socio-economic form of communism; To build socialist democracy and the socialist state; building a socialist culture; solve ethnic and religious problems; Real socialism; the crisis, the collapse of the Soviet socialist model and its causes; the prospect of socialism.

6.21. History of the Communist Party of Viet Nam (ML019)

- Number of credits: 02
- Description:

The content of the course presents the line of the Communist Party from 1930 to present. Thereby, it provides students with basic knowledge about the birth of the Communist Party of Vietnam and the first political platform of the Party; The way to fight for government (1930-1945); Resistance war against French colonialists and American invaders (1945-1975); Industrialization; The way to build a socialist-oriented market economy; The way to build the political system; The way of building, developing culture and solving social problems; Foreign policy.

6.22. Hồ Chí Minh's Thought (ML021)

- Number of credits: 02
- Description:

This course helps the understanding of the foundation of thought, the guiding principles of the Party and the revolution of our country, basic knowledge of Marxism-Leninism contributing to building a new human moral foundation. In addition to the opening chapter, the content of the course includes 7 chapters: Chapter 1 presents the basics, the formation and development of Ho Chi Minh ideology; Chapters 2 through 7 present the basic contents of Ho Chi Minh Thought according to the course objectives, providing a systematic understanding of Ho Chi Minh's thought, morality and cultural values.

6.23. General Law (KL001)

- Number of credits: 02
- Description:

The course introduces the basic theoretical issues of Marxist-Leninist doctrine on the state and law from the origin, nature, form, function as well as the types of state and law that have formed and existed and developed through various socioeconomic forms in human history. In addition, the course also includes the study of the state's position in the political system, the constitution the state apparatus, and the systems of government. The large volume of basic knowledge in the common law disciplines of Vietnam is also introduced such as fundamental rights and obligations of citizens, crimes, violations of administrative law, the law on marriage, divorce, and inheritance.

6.24. Basic Logic (ML007)

- Number of credits: 02
- Description:

This course introduces the basic knowledge of formal logic, including judge, inference, hypothesis, demonstrate, reject.

6.25. Overview of Sociology (XH028)

- Number of credits: 02
- Description:

This course studies the laws, the rules of formation, the movement of relationships, the interaction between people and society. Research subjects of sociology are social relations, social interaction manifested through behaviors between people in groups, organizations and social systems.

6.26. Basic Vietnamese Culture (XH011)

- Number of credits: 02
- Description:

Basic knowledge of this course is presented in five chapters, covering from theory to practice. Chapter 1 presents the concepts, scientific terminologies (culture, cultural study, cultural process, cultural exchange, cultural adaptation, etc.), and various types of Vietnamese culture. Chapters 2, 3, 4 present the knowledge of the cultural values and the manifold expression of their diversity in the material and spiritual life of the Vietnamese people. Chapter 5 focuses on the characteristics of identity and the future of national culture.

6.27. Vietnamese in Use (XH012)

- Number of credits: 02
- Description:

The course is designed in 4 chapters. Each chapter consists of two main sections that are interwoven: theoretical and practical exercises. Chapter 1 focuses on characters and grammar. Chapter 2 focuses on the use of words. Similarly, the content of chapter 3 is the practice of sentence skills. Chapter 4 focus on the practice of text writing and reading comprehension skills.

6.28. General Management Documents and Archives (XH014)

- Number of credits: 02
- Description:

This course provides theoretical and practical knowledge of management documents and archives, helping students become aware of the role of administrative documents and archives for management. Besides, this course also helps the learner master the method of drafting and managing scientific types of administrative documents, know how to select and classify documents for archives; know how to look up, use archives to do well in school management as well as in general agencies.

6.29. Soft Skills (KN001)

- Number of credits: 02
- Description:

This module provides basic knowledge and instructions to practice on the required skills for learners such as: communication skills, general principles of communication; effective listening, speaking and presentation skills; teamwork skills to ensure good cooperation in learning and working; creative thinking skills; time management skills and emotional management skills.

6.30. Creation, Innovation, Start-up (KN002)

- Number of credits: 02
- Description:

The course focuses on general knowledge of creation, innovation and start-up ideas, business ownership, property rights. In addition, students are also provided with basic knowledge and skills of the market such as assessing strengths, opportunities, threats, risks of commercializing products from business ideas, discovering business potential. business and start-up planning. Students have the opportunity to share their startup experiences from successful entrepreneurs and / or visit a successful

startup model.

6.31. Calculus A1 (TN001)

- Number of credits: 03
- Description:

The course consists of four chapters. The first chapter introduces the function, the limit of the function, and the continuity of the function. Chapter 2 presents the calculus of one variable function and its applications. The integral of a variable as well as its application is that of the third chapter. Finally in chapter four, the numerical series theory will be introduced.

6.32. Calculus A2 (TN002)

- Number of credits: 04
- Description:

The module covers the basic knowledge of the multivariable functions such as the concept of multivariable functions, limits, continuity, differential calculus of multivariable functions, curves in space, line integrals, surface integrals and differential equations.

6.33. Probability and Statistics (TN010)

- Number of credits: 03
- Description:

The module consists of 5 chapters. Chapter 1: Probability and Probability Formula: Define Probability and the Basic Formulas of Probability. Understand what probability is and how to use it in practice. Help learners analyze problems and calculate the probability of each case in the problem. Chapter 2: Random Variables and Probability Distribution Laws. Calculate the characteristic parameters of random variables such as mean, variance, standard deviation, mode. Chapter 3: Statistics and Data. This chapter is a descriptive statistic section. Chapter 4: Parameter Estimation. The method for estimating or predicting the parameters of random variables such as mean, scaling, and variance estimation. Chapter 5: Statistical Assay Verification. Provides a method to test real-world problems such as verifying the mean (averaging against a number, comparing multiple averages, etc.), testing the ratio (proportional to some, multiple scaling), testing variance.

6.34. Linear Algebra and Analytic Geometry (TN012)

- Number of credits: 04
- Description:

The module provides basic mathematical knowledge in linear algebra, such as Linear Equation Systems, Matrices, Equations, Vector Space, Linear Mapping, Eigenvalues, Eigenvectors, Quadratic curves and Quadratic surfaces so that students have the opportunity to continue studying other Maths and specialized subjects later. In addition to equipping theoretical issues, the module also offers a variety of exercises, easy-to-do assignments, and advanced exercises to enhance students' thinking.

6.35. Study skills (CT100)

- Number of credits: 02
- Description:

The course introduces learning goals, the learning environment, active learning methods, the P.O.W.E.R. method. This module illustrates how to learn knowledges, skills, attitudes for studying and working.

6.36. Fundamentals of Information Technology (CT200)

- Number of credits: 04
- Description:

This course provides students with a relatively comprehensive knowledge of the IT background. The main contents include: Introduction to computers, computer systems, computer equipment, operating systems, communications and computer networks, database systems, information security, and specialized computing systems.

6.37. Discrete Mathematics (CT172)

- Number of credits: 04
- Description:

The main content of the course consists of 5 chapters. Chapter 1 introduces the concept of propositions and predicates, mathematical reasoning and proofing methods on propositions and predicates. Chapter 2 presents the concept of relation on set, Boolean algebra and Boolean functions, how to solve Boolean equations, Boolean functions and simple formulas. Chapter 3 presents the concept of combinatorial and probability, and methods of combining and probability. Chapter 4 presents the theory of divisible and divisible over the whole number. Chapter 5 presents congruence and related issues.

6.38. Basic Programming A (CT101)

- Number of credits: 04
- Description:

Basic Programming course provides students with basic knowledge of structured programming through the C programming language. This course is the foundation for absorbing most of the other subjects in the curriculum. On the other hand, mastering the C language is the basis for developing applications. The main contents are: Concept of programming language; The concept of data types and structured data types; The concept of algorithm and language of algorithm expression; Overview of C programming language; Data types in C; Structured commands; How to design and use functions in C; Some data structures in C.

6.39. Data Structures (CT177)

- Number of credits: 03
- Description:

This course provides students with a relatively comprehensive knowledge of data structures. The main contents include: From problem to program. Basic abstract types such as lists, stacks, queues. Tree structures such as general trees, binary trees and binary search trees. The aggregation structure includes: aggregation, dictionary and hash. Unidirectional and directional scalar graphing and some algorithms related to graphs.

6.40. Design and Analysis of Algorithms (CT174)

- Number of credits: 03
- Description:

This course provides students with a relatively comprehensive knowledge of the analysis and design of computer programming algorithms. The main contents include: Technical analysis and evaluation of algorithms through the calculation of complexity; Sort algorithms; The techniques of algorithm design, applied to solving some practical problems; Data structures to organize files and algorithms to find, insert, and delete information in a file.

6.41. Graph Theory (CT175)

- Number of credits: 03
- Description:

The graph theory module consists of six chapters. Chapter 1 introduces the basic concepts of graphs, shows how to represent graphs, and describes how to classify graph classes. Chapter 2 focuses on graph throughput, graph traversal, and applications. Chapter 3 presents the problem of finding the shortest path on the graph and the algorithms for finding the shortest path. Chapter 4 describes the topological order of the vertices in the graph, the graph ranking problem, and its application in the project management problem. Chapter 5 presents the concept of trees, the problems of finding the minimum weight tree, and the least weight tree algorithm for both undirected and directed graphs. Finally, chapter 6 presents the concept of flow in the network and algorithms to find the maximum flow in the network.

6.42. Object-Oriented Programming (CT176)

- Number of credits: 03
- Description:

The course provides background knowledge of object-oriented programming methods and uses the Java programming language to implement and illustrate this programming methodology. First, the course introduces the basic idea of object-oriented programming methodology and the important concepts of this programming method include: object, class, encapsulation, inheritance, and polymorphism. Then, the learner will be introduced to the Java programming language and use this language to illustrate the concepts of object-oriented programming. In addition, the module provides some other knowledge of the Java programming language such as exception handling, graphical programming with Swing, others., so that learners can use well-formed Java programming language to write applications according to object-oriented programming methods.

6.43. Computer Architectures (CT173)

- Number of credits: 03
- Description:

This course provides an overview of the history of computer development, information and information encoding used in the system; introduces the basic components of a computer system, computer architecture, instruction set, and basic memory address modes; provides conceptual knowledge of RISC and CISC architectures, high-level language and machine language; introduces the structure of the central processor: the organization, function and operating principle of the components inside the processor; some information processing techniques; knowledge of basic functional and operating principles of computer memory levels; introduction of some peripherals: components and interconnected systems; the method of establishing data security on external storage devices (RAID).

6.44. Principles of Operating Systems (CT178)

- Number of credits: 03
- Description:

This course provides students with a relatively comprehensive knowledge of Computer Operating Systems. The main contents include: Operating System Concepts, Operating System Structure, Process and Process Synchronization, Processor Synchronization, Memory Management, and Virtual Memory.

6.45. Computer Network (CT112)

- Number of credits: 03
- Description:

This course is intended to provide learners with the basics of computer networking. Learners will discover the problems that arise when building a computer network from the hardware, network operating system, system software and network applications and can explain how a computer network or a network application operates. The knowledge gained in this course is the foundation to study and do further research in various areas of the networking such as computer network design and installation, computer network security, network application design, others.

6.46. System Administration (CT179)

- Number of credits: 03
- Description:

The course will introduce students to the role and responsibility of a system administrator in the information technology systems. Next, components of an information technology system such as hardware, software, networks, services, users, etc. will be mentioned. Based on that knowledge, the course will continue to discuss about the security requirements for the system. Finally, the system administration documentation will be discussed. Note that this course does not cover advanced network management skills and advanced network security knowledge, which will be introduced in other courses.

6.47. Databases (CT180)

- Number of credits: 03
- Description:

The course consists of three parts: basic knowledge, theory of database design (relational database) and database programming. Since the relational model is still widespread and closely related to many other models, it will be presented as a cross-platform for the whole course. In Section A-Basic Knowledge, from the general concepts of the database, the relationship model of the database is described in more detail, and is supplemented by relational algebra. The SQL language for querying is well- defined in both grammar and usage from basic to advanced levels, primarily for the relational model of the database. Section B provides the theory of relational database design through dependency concepts and normalization rules. Part C supports in-depth programming on the database.

6.48. Unified Modeling Language (CT182)

- Number of credits: 03
- Description:

The syllabus consists of 6 chapters. Chapter 1 introduces an overview of the UML language. Chapters 2 through 5 delineate the basics of UML in turn, which are activity diagrams, class diagrams, activity diagrams, and sequence diagrams. Examples are often inserted after each concept item. And depended on the chapter, there may be general examples for the entire chapter, taken from real-world problems. Similarly for assignments, the instructor can give individual learners simple homework in the classroom after one or more items, or whole chapter assignments, and also group exercises throughout the models in order to make a report with practical value.

6.49. System Analysis and Design (CT296)

- Number of credits: 03
- Description:

The main contents taught in this course are basic concepts of system, information system, stages of information system development, data composition of a information system (including concept-level data model, logical-level data model, and physical-level data model) and processing elements (including flowchart and functional model). The two tools that can be used for this course are WinDesign, Sybase Power Designer.

6.50. Introduction to Artificial Intelligence (CT190)

- Number of credits: 02
- Description:

The course includes an overview of artificial intelligence, the goal of artificial intelligence, the tasks of artificial intelligence, artificial intelligence approaches in solving problems and applications.

6.51. Introduction to Web Programming (CT188)

- Number of credits: 03
- Description:

The course provides basic knowledge in developing web applications. Topics covered in the course include Internet introduction and architecture of the WWW service, the process of building a website, HTML language, CSS language, JavaScript programming language, DOM object modeling.

6.52. Project – Fundamental Topics (CT201)

- Number of credits: 03
- Description:

The supervisor will describe the requirements of the project. Next, students apply the basic knowledge of the industry to select appropriate models and tools to develop specific applications. Next, students must plan the work to be performed. The main tasks include understanding requirements (understanding the needs of the topic and researching related to the topic), analyzing requirements, and designing and developing applications. Finally, students write a scientific report and present the results.

6.53. Linear programming (CT199)

- Number of credits: 03
- Description:

The linear programming module covers the primary contents for real-world modeling problems into linear programming problems and approaches to solving linear programming problems, such as the simplex method, the monomorphic method, the duality method, and the degenerate case of the problem. Simultaneously, applications of linear programmings, such as methods to solve game problems and transport problems, are also presented in this module.

6.54. Numerical Analysis (CT479)

- Number of credits: 03
- Description:

The module provides knowledge of the approximation, solving equations and system of linear equations, the approximation of function values, polynomial interpolation of functions. Namely, the module introduces methods for approximating equations and systems of linear equations, approximating function values, and determining interpolated polynomials of functions. The first content presents approximate numbers, error types, error calculation formulas, and error inverse problems. Numerical analysis methods introduce an approximate solution to the equation $f(x) = 0$, the polynomial solution method, and two ways of approximating the function value, including the power series method and the iterative method. Interpolation theory introduces general interpolation polynomials, interpolation polynomial formulas, Sline interpolation functions, Hermite interpolation polynomials, and island interpolation. The following content is on derivatives and integrals. This section introduces ways to approximate derivatives and definite integrals, including the Lagrange interpolation polynomial method, the case of equidistant interpolation datums, and interpolation

functions. Spline level 3; formulas for approximating definite integrals; definite integrals accurate to a given $\varepsilon>0$; and quadrature formulas. The final content of the course is numerical methods in linear algebra, which introduces methods for correct and approximate solutions to systems of linear equations and how to calculate determinants of inverse matrices.

6.55. Information theory (CT292)

- Number of credits: 03
- Description:

This module overviews information theory fundamentals such as entropy concepts, information quantification, code generation methods, and channel types. The content of basic concepts includes entropy properties and computing quantification methods. In the problem of separable code generation, the concepts of separable code, the relationship between separable code and code length, and the optimization of code length are introduced, in which two methods of Kraft and Huffman code generation are typical. Discrete communication channel without memory is one of the essential contents of this module, introducing the types of transmission channels as well as how to calculate the capacity of each type and the method of building the optimal decoding scheme and calculation method. Types of false propagation probabilities on the channel. The final content of the module introduces the self-correcting problem of encodings, including parity-checking codes, Hamming codes, and rotation codes.

6.56. Theory of Computation (CT121)

- Number of credits: 03
- Description:

The module provides knowledges of languages, formal languages, language classification, formal languages, finite automats, context-free languages, pushdown automata, Turing machines, and von Neumann machine model.

6.57. Artificial Intelligence (CT332)

- Number of credits: 03
- Description:

The course includes: an overview of artificial intelligence such as the goal of artificial intelligence, the tasks of artificial intelligence, artificial intelligence approaches in solving problems (problem modeling in the state space, analysis of the problems in the direction of divide-and-conquer and the And-Or graphical model, etc.), techniques for finding solutions to the modeled problem, the role of knowledge in problem solving, methods of knowledge representation and reasoning.

6.58. Applied Machine Learning (CT294)

- Number of credits: 03
- Description:

The Applied Machine Learning module will provide learners with an overview of machine learning and its application areas. The module will introduce standard machine learning techniques such as k nearest neighbors, naive Bayes, decision trees, model aggregation methods, artificial neural networks, support vector machine learning, and data clustering techniques for this overview. The course also helps learners to solidify the principles of setting up the environment, practice, and test the machine mentioned above learning models, from practicing skills in using modern tools and settings to designing and implementing, and testing machine learning-related systems against the standards of the field of machine learning.

6.59. Data Management (CT467)

- Number of credits: 03
- Description:

The Data Management module provides fundamental knowledge in the design of database management systems. The course is designed into six chapters. Chapter 1 introduces the database management system, including the basic concepts of the database environment. Advantages of managing data with DBMSs and DBMS architectures. Chapter 2 presents methods for storing data on storage devices and strategies to improve data retrieval performance, such as indexes and hashes. Chapter 3 presents the concept of transactions and transaction management in DBMSs. Chapter 4 presents the concept of competition and the protocols that control competition between transactions. Chapter 5 presents recovery algorithms to ensure the atomicity and stability of transactions. Finally, chapter 6 introduces methods for managing large, structurally heterogeneous data types.

6.60. Information Safety and Security (CT204)

- Number of credits: 03
- Description:

The module introduces an overview of the risks that lead to information insecurity, creating opportunities for cyber-attacks. Since then, security policies, security checks, and solutions to ensure information safety have been proposed to improve reliability in storing and exchanging information. Information security solutions include cryptographic methods, trust models, public key security infrastructure, and secret protocols for OSI network layers.

6.61. Embedded Software Development (CT234)

- Number of credits: 03
- Description:

The course provides knowledges of embedded systems, devices, operating systems. The content focusses on skills for developing embedded applications on Arduino, Raspberry Pi.

6.62. Open-Source Software Development (CT207)

- Number of credits: 03
- Description:

This course aims to introduce students to the following issues: the concept of free software, open-source software, some popular open-source software licenses, the benefits of using open-source software; the development history and architecture of Linux; proficiency in Linux (Ubuntu Desktop); knowledge of the open-source software development model and familiarity with the environments and utilities used to develop open-source software.

6.63. Web Application Development (CT449)

- Number of credits: 03
- Description:

This module is intended to provide students with knowledge of web application development, with the primary language being JavaScript. The technologies introduced in the chapters revolve around the MEAN Stack solution suite (MongoDB, Express, Angular, NodeJS) favored by modern web applications. Besides, there are other contents such as JSON data format, REST API, template creation with Handlebars, and user authentication with OAuth2.

6.64. Project – Specialized Topics (CT208)

- Number of credits: 03
- Description:

The instructor will describe the requirements for the topic. Then, students apply specialized knowledge to select appropriate models and tools to develop applications or provide a solution to a problem. Students must plan the work to be performed. The main tasks include understanding requirements (understanding the requirements of the topic and researching related to the topic), analyzing requirements, and designing and developing applications. Finally, students write a scientific report and present their results.

6.65. Image Processing (CT316)

- Number of credits: 03
- Description:

The module introduces learners to digitizing images and the different structures when representing an image. From this, they can identify basic image processing methods to clarify images and identify information on images. , which separates the important objects on the image and represents their borders in terms of the encoding method.

6.66. Computer Graphics (CT203)

- Number of credits: 03
- Description:

The computer graphics course provides an overview of computer graphics, basic graphic objects, transformations in 2D and 3D graphics, and 2D and 3D image display processes, drawing algorithms, coloring algorithms, cutting algorithms, and Basic knowledge of 3D graphics.

6.67. Advanced Graphics (CT209)

- Number of credits: 03
- Description:

In this module, learners will be supplemented with in-depth knowledge of graphics on computers and devices that use graphics: smartphones, tablets, and professional support systems using graphics. The module updates new knowledge, hardware, and software techniques in computer graphics and entertainment areas such as movies, games, simulation programs, and other emulators. The module focuses on theory and practice to help students create advanced effects, simulate “realistic” effects, delight users, and achieve the goals of the advanced graphics program.

6.68. Computer Animation (CT220)

- Number of credits: 03
- Description:

This module will provide students with the basic concepts of computer animation and help them understand the purpose and meaning of conveying information about the animation to the viewer. First, students will learn about the steps in the computer-animated graphic design process. Then you will learn about the fundamental techniques used in creating computer animation, such as space and spatial transformations, fundamental transformations in 3D space, and interpolation. In the following content, students will apply interpolation and transformations in 3D space to make characters/objects move. Students will then learn about skeleton animation, movement hierarchy, and some other knowledge to build a complete short animation by themselves.

6.69. Computer Vision (CT210)

- Number of credits: 03

- Description:

Computer vision is a branch of artificial intelligence that includes theory and related techniques to create an artificial system that can receive information from images. Computer vision is the science and technology that makes computers "see". Computer vision course provides the foundation knowledge and applications in the field of computer vision, including cameras, projections, image reconstruction, low-level image processing methods such as filters, middle level like edge detection, advanced topics like segmentation, clustering, and high level like object recognition, scene recognition, human face recognition.

6.70. Data Mining (CT312)

- Number of credits: 03
- Description:

The data mining module provides knowledge about the process and methods to transform collected raw data into useful information and knowledge. Apply popular data mining algorithms such as K neighbors, naive Bayes, decision trees, random forests, model collection methods, clustering algorithms, and association rules to solve problems concrete in practice.

6.71. Principles of Machine Learning (CT202)

- Number of credits: 03
- Description:

Machine learning is one of the fast-growing areas of computer science, with far-reaching applications. This module aims to introduce the theoretical basis of machine learning and deeply analyze the principles of algorithmic models. Machine learning theories, such as the gradient reduction method, regression method, back-propagation algorithm, probability model, and reinforcement learning, are analyzed in depth. Besides, students can apply this knowledge to solve real-life problems through practice with small illustrative examples.

6.72. Deep Learning (CT282)

- Number of credits: 03
- Description:

The deep learning module consists of 4 chapters. Chapter 1 introduces the basic concepts of neural networks and deep learning models. Chapter 2 focuses on issues that need to be taken care of in building a deep learning project and techniques to improve deep neural networks. Chapter 3 presents a typical deep learning model: a convolutional neural network. Finally, chapter 4 describes the string models used to process sequential data, including the word embedding and string-to-string translation models.

6.73. Visual Data Analysis (CT217)

- Number of credits: 03
- Description:

The data visualization module provides students with knowledge of commonly used data visualization methods in statistics and multidimensional data visualization methods in knowledge discovery and data mining. In the preprocessing step, the display helps the user to understand the data at a glance. Data mining step, data display method, interactive tools, visualization, support users in building models to create knowledge. Finally, the display also supports the interpretation and interpretation of the results generated from the data mining step, helping users avoid risk when making decisions.

6.74. Natural Language Processing (CT219)

- Number of credits: 03
- Description:

The Natural Language Processing Module provides the foundational knowledge of natural language processing, focusing on human language applications. The content of the course only focuses on language processing in the form of text and does not discuss language processing in the form of audio (speech). In the module, students learn about Vietnamese language processing. This module also equips learners with the necessary knowledge and skills to help learners be able to self-study, adapt to changes in technology, and develop future directions of natural language processing models.

6.75. Internship in Computer Science (CT516)

- Number of credits: 05
- Description:

Students will spend eight weeks of internship in a real working environment. The purpose of this internship is to help students: (1) Consolidating knowledge already equipped in the academy and apply that knowledge in a real-life environment; (2) Training the sense of compliance with labor discipline, attitude to communicate with people, and promote learning, initiative, and creativity in work.

6.76. Graduation Thesis – Computer Science (CT552)

- Number of credits: 15
- Description:

The main aim of the thesis is for students to demonstrate their ability to solve a complex problem in computer science or applied fields independently in a limited time (one semester) by using scientific approaches and knowledge provided in the training program. In a scientific report, students must describe the problem, problem-solving history, concepts, proposed solutions, implementation steps, results and benefit assessments, conclusions, and future work. The jury will evaluate the students' final results based on the plan and content of the work done, the report book, the program demo, the speech, and the ability to criticize and defend the previous views jury.

6.77. Graduation Project – Computer Science (CT504)

- Number of credits: 06
- Description:

Graduation projects are an important part of the Computer Science program. It allows students to apply and implement a range of skills, theories, and concepts they have learned in various modules. Students also discover how these apply to create products that meet the requirements of the problem posed. Therefore, students are offered the opportunity to test their knowledge and skills before graduation. In order to complete the Graduation Essay, students must have active and experiential learning. It requires students to put considerable effort into planning, analyzing, designing, implementing, and preparing a final report document.

The student/group of students will complete the graduation project within one semester. The instructor provides project requirements. Students must plan projects, specify requirements, and analyze and understand algorithms' feasibility, application, and optimization based on which to design, develop, and write reports project.

6.78. English for Information Technology (CT198)

- Number of credits: 03

- Description:

This module allows students to use English at a basic level for short and straightforward communication situations in an Information Technology work environment.

6.79. Knowledge Base System (CT216)

- Number of credits: 03
- Description:

The module includes an overview of a knowledge-based system, components of a knowledge-based system (knowledge engineering, knowledge base, inference engine, user interface), roles, and the task of each component. Knowledge representation methods, advantages, and disadvantages of each technique. Deductive methods. Problems with inference engine design. The process of designing an expert system.

6.80. Network Programming (CT221)

- Number of credits: 03
- Description:

This course is to deliver relatively complete knowledge of network programming principles and skills with use of Java. Main contents include: inter-process communication mechanism; TCP/IP networking model; types of program architecture; several standard protocols of Internet; method to build a protocol for certain network application; concept of port of a network application; concept of socket; method of socket programming under TCP connection-oriented and UDP connectionless approach; multicast programming; RPC; building distributed application using Java with RMI utility; introduction to some Java classes for dealing with network service.

6.81. System Security (CT222)

- Number of credits: 03
- Description:

This course provides students with a relatively comprehensive knowledge of Computer System Security. Key contents include: Basic concepts of information and computer security, Operating system security, Malware, Network security, Web services security, Data encryption, Information security models.

6.82. Programming for Mobile Devices (CT274)

- Number of credits: 03
- Description:

This course provides principles and fundamental concepts for wireless communication technology and mobile software technology. The course introduces methods to setup a development environment and to use tools for programming and developing applications on the top mobile application development platforms such as Android, iOS and Windows. The course helps students to setup development environment for mobile devices (e.g., smart phone and tablet), do application development process, test and release applications on Android, iOS and Windows phones. The course also helps students train network programming skills, create user interface, handle user interaction, save data and develop some network applications and simple games on Android platform.

6.83. Programming for Mobile Devices (CT290)

- Number of credits: 03
- Description:

The Game Programming module provides students with knowledge about the group of computer

game software. The course content includes learning about game software's characteristics and general requirements; skills in requirements analysis, planning, game software development process according to given requirements; programming, game software development, and evaluation.

6.84. Question and Answering System (Chatbot) (CT284)

- Number of credits: 03
- Description:

The question-and-answering system module provides students with basic knowledge about the question and answer system. The course content includes concepts related to the question-and-answering system, approaches to building a question-and-answering system, construction methods, and how to evaluate a question-and-answering system. This module also equips the learners with the necessary knowledge and skills to help them do their research and adapt to changes in technology and the future development direction of the Q&A system.

6.85. Introduction to Simulation (CT189)

- Number of credits: 03
- Description:

This module provides students with a relatively complete body of knowledge about multi-agent systems and multi-agent applications in simulation. The main contents include an introduction to agents and multi-agent systems. Smart agent. Interaction in a multi-agent system. Communication in a multi-agent system. Multi-agent simulation and GAML simulation programming language.

6.86. Principles of IoT and Embedded Software (CT295)

- Number of credits: 03
- Description:

The Internet of Things (IoT) is a technology that allows hardware components (sensors, devices, computers) to connect and interact with each other through the Internet, thereby performing remote control and monitoring for a specific system. This module provides students with foundational knowledge in the IoT field, thereby helping them apply what they have learned to practical exercises and practical applications. The main content of this module includes basic concepts, the architecture of IoT, sensors and actuators, communication networks, data visualization, and analysis.

6.87. Cloud Computing (CT233)

- Number of credits: 03
- Description:

Cloud computing is a technology that helps organize and manage a large number of computing resources (including hardware and software) to provide information technology services to become more accessible and more efficient. This module will provide students with a complete overview of cloud computing technology's effectiveness, benefits, and challenges. Students will learn about the history of the development of cloud computing technology, as well as the techniques and underlying mechanisms that make this technology a reality. In addition, students learn a full range of concepts, models, and architectures that can be used to build the features of a cloud computing system. Finally, learners study how to exploit popular cloud platforms worldwide.

PART 4. STUDENT ASSESSMENT

The assessment of students is done through the learning process and the final evaluation throughout the training program to determine their achieved level of knowledge and competency in comparison with the objectives and learning outcomes of the program. The student assessment is undertaken based on the academic regulations of Can Tho University. The academic regulations are publicly available on the University website and provided directly to students in the form of a student handbook. The evaluation includes assessing the sense of learning (not absent more than 1 practical session), study records (writing reports, presentations, post-harvest assignments, project-based assignments), mid-term test (short essay in class or practical exercises), and final exam (in the form of multiple choice or essay). The percentages of the assessment sections will depend on each subject, but the final score should be at least 50%.

Lecturers can choose the appropriate assessment methods for their courses to accurately reflect the level of achievement of the objectives and expected learning outcomes of the course. The assessment forms and scores of the module are shown in the course outline and are announced directly in the classroom as well as on the college's e-learning website (elcit.cict.ctu.edu.vn). The questions in the test must follow the content of the module to assess the learners' level of understanding and synchronize with the standard outcomes of the module and the curriculum. The transition between grades as well as the student's understanding of the course is described in Table:

Rank	**10-point scale**	**4-point scale**		**Meaning**
		Letter	**Number**	
Excellent	9.0– 10.0	A	4.0	Learners fully understand and apply the knowledge of the subject and successfully complete the requirements of the course.
Good	8.0 – 8.9	B+	3.5	Learners have a firm grasp of the basics of the subject and fulfill the requirements of the course.
Fair	7.0 – 7.9	B	3.0	
Fair average	6.5 – 6.9	C+	2.5	Learners understand part of the module knowledge and complete most of the requirements of the module.
Average	5.5 – 6.4	C	2.0	
Pass	5.0 – 5.4	D+	1.5	Learner understands very little about the subject and completes a portion of the course requirements.
Pass	4.0 – 4.9	D	1.0	
Fail	< 4.0	F	0.0	Learners do not understand the course content and complete very few requirements of the course.

The notification of student registration and information related to training and test-exam activities are regularly and continuously updated through personal accounts to help students understand the content and assessment methods, regulations of evaluation processes, request for re-score.

The course is only cumulative when scores are from D or higher.

Before completing the training program, students must take part in graduation internship at an agency or a company related to information technology such as network management positions. This module is to collect practical experiences and get acquainted with the working environment in agencies and businesses. The assessment of the internship will be conducted by an officer in charge at the company and an instructor assigned by the College. During the internship, the instructor will call or visit the company to check the working conditions, the internship process of the students, and receive opinions from the officer in the company. At the end of the practical internship, the instructors will evaluate the students' internship results based on their reports, tracking internship activities sheet, and the officer's assessment.

In addition, students must do a 15-credit graduation thesis (final project) or study some modules to achieve the equivalent knowledge block. The thesis will help students further develop their own activeness, creativity, and self-research. Thesis-making students must defend their research results in front of an evaluation board. The defense will be publicized with a 3-member board to overall evaluate the skills and knowledge of the program learning outcomes. If a student does an essay rather than a graduation thesis, he must submit his research results to two members of the essay evaluation board. The essay evaluation board is assigned by the department of Computer Networks, in which one member is the instructor.

PART 5. STUDY ENVIRONMENT

1 Infrastructure to support education and research

CTU has a total area of 2,249,773. 47 m^2, of which the total construction area for training purposes is nearly double the minimum requirement of the Ministry of Education and Training. Since April 2020, CTU has 290 classrooms and lecture halls with a total area of 61,007.70 m^2. The teaching facilities such as televisions, projectors, and microphones are fully equipped. All classrooms have televisions or projectors.

The CICT uses the classrooms of the university, accommodating from 40 to 160 students/room. The CICT currently manages 3 thesis/project rooms, 26 lab rooms, and 15 function rooms including working offices and main halls. The CICT's facilities and equipment are regularly updated, maintained, invested in upgrading, purchased, used, and exploited very effectively. They fully meet the needs of teaching, learning, research, and other activities of staff and students. Each year, the CICT conducts activities to receive the equipment procurement and repair needs from the lecturers and laboratory managers.

In addition, the CICT has an open, clean, and beautiful self-study space with 24/24 wifi coverage, which is one of the favorite places of students for self-studying. This self-study space meets the needs of students' self-study, and group activities.

2 Library and learning resources

The library system of the CTU consists of the Learning Resource Center (LRC) and 14 libraries in colleges and institutes. The construction floor area of the LRC is 7,560 m^2, including 23 reading rooms with 1,000 seats. The LRC is equipped with modern facilities, computer labs, discussion rooms, training rooms, private classrooms, multimedia rooms, and a variety of globally connected modern technology facilities. The LRC provides a professional, and comfortable learning and working environment. As of May 2020, the information resources of the LRC have 62,823 electronic collections; resources in the field of knowledge in the print form includes 139,289 book copies and 306,117 books in many different languages. The LRC provides a variety of books, textbooks, references in Vietnamese and foreign languages and is regularly updated.

The LRC provides a variety of electronic databases such as registered online databases (SpringerLink, IEEE, Scopus, …), open-access online database (DSpace@Cambridge, Elsevier Open Access Journals, …), nation and international open learning materials (MIT, OpenCoursewave, Coursera, edX, Udemy và FutureLearn). The LRC materials are in almost

all areas of teaching and research.

The users can access these materials from both inside and outside the University, which effectively responds to user requirements. Users can easily register online for cards or register directly at the center.

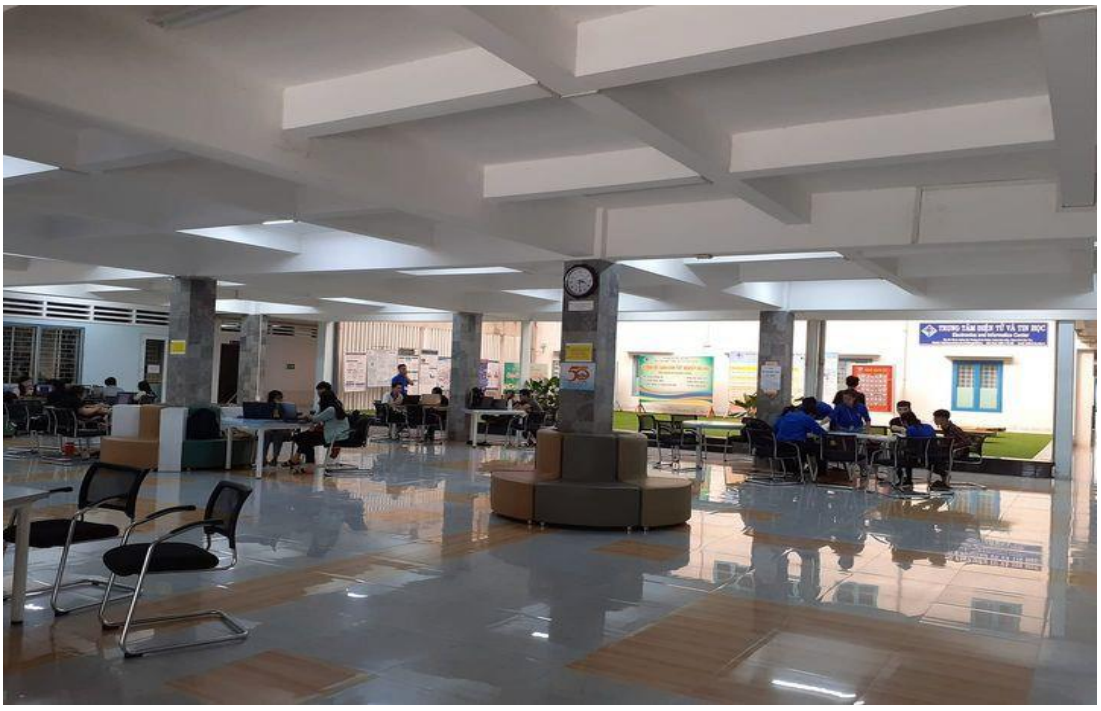
In order to make good use of resources, the center usually opens LRC tours and training courses showing how to use resources. Survey results show that the level of student satisfaction with the LRC is very high in both resources and services provided; specifically, in the most recent survey results, the LRC has a total rate of very satisfied and satisfied at 89.6%.

The library of the CICT is built on an area of 180m^2 with 54 seats. The CICT library has 3,431 books, magazines, eBooks, and electronic databases. The CICT library uses the resources of the LRC, ensures a complete and up-to-date provision of specialized resources. Every year, the CICT library updates and orders new resources through additional requests, books, and references of lecturers in the College. The CICT students can also refer to resources from other colleges and institutes within the University. The CICT annually buys and repairs equipment and facilities for the library.

3 Laboratories and equipment

The total number of laboratories, practice rooms, computer labs, and veterinary clinics of CTU is 141 (with 277 sub-divisions), 15 lab rooms for learning foreign languages, multimedia rooms, and interpretation booth.

Due to typical features of the field, the laboratories at CICT are served for both scientific research and training activities. At present, the College has 1 big computer lab and 3 laboratories with 36 subordinate rooms. Each subordinate room has an area from 36 to 96m2, and is equipped with 36 to 61 computers. CICT totally has 1,453 computers (106 computers in the function rooms and 1,347 computers in the computer labs and laboratories), 2 robots, 21 projectors, 26 televisions and 23 printers for teaching and research activities. To ensure the facilities are fully equipped and updated, CICT regularly has plans for renovating lab rooms, purchasing new computers, and equipment for training and research activities. Besides that, all practice rooms are fully furnished with essential stationery



To ensure the equipment is complete and up to date, the CICT regularly plans and renovates rooms and facilities, purchases new computers and equipment for training and research activities.

PART 6. CAREER OPPORTUNITIES

- Administrator in computer science, working at companies, organizations, enterprises, in the information technology field,
- Consultant, supervisor, and leader in the field of information technology for organizations, businesses, or individuals; IT system administrator for organizations, companies, or individuals.
- Experts in the research and development of technologies, especially knowledge technology and intelligent products or products related to natural language processing such as virtual assistants, dictionaries, and automatic translation software, among others; specialists in developing technologies for image processing, computer vision, virtual reality, augmented reality, graphics, game programming, and animation.
- Research staff, analysts in the field of information technology at research institutes and universities
- Lecturers teach computer science-related subjects at colleges, professional secondary schools, and high schools.
- Programmers in companies in the information technology field.

In addition, Computer Science engineers can also improve their professional qualifications, develop their skills in an intensive, academic direction, or study postgraduate education programs (masters, doctorates), becoming experts in information technology.

MINISTRY OF EDUCATION AND TRAINING CAN THO UNIVERSITY

DEPARMENT OF COMPUTER SCIENCE

COLLEGE OF INFORMATION AND COMMUNICATION TECHNOLOGY

Address: Campus 2, 3/2 Street, Ninh Kieu District, Can Tho City

Website: http://www.cit.ctu.edu.vn

Email: office@cit.ctu.edu.vn

Phone: 84 0292 3 734713 - 0292 3 831301