University of Sana'a
Faculty of Engineering
Department: Electrical Engineering
Title of the Program: Computer Engineering and Control Eng.

Course Specification of Introduction to Computation Theory

I. Course Identification and General Information:

1.	Course Title:	Introduction to Computation Theory				
2.	Course Code & Number:	CCE142				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr	Tr.	
		2	-	2	-	3
4.	Study level/ semester at which this course is offered:	Second level / First Semester				
5.	Pre –requisite (if any):	Programming Language II, Data Structures & Algorithms				
6.	Co –requisite (if any):					
7.	Program (s) in which the course is offered:	Computer & Control Engineering				
8.	Language of teaching the course:	English				
9.	Location of teaching the course:	Electrical Engineering Classes & Lab.				
10.	Prepared By:	Assoc. Prof. Dr. Farouk Al-Fuhaidy				
11.	Date of Approval	2020				

II. Course Description:

This course is an introductory to the theory of computation, to introduce students with basic principles pertaining to the modeling and analysis of computational problems and their solving. Topics to be covered by this course including models of computation such as Turing machines; theory of programming languages including, Automata, grammars, parsing, syntax and semantics. Upon successful completion of the course, students will be able for modeling many important kinds of hardware and software, like software for designing and checking behavior of digital circuits, lexical analyzer as a component of the Compiler, ...etc. This course supports students with basic principles

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and concepts required to study the advanced computation theory course for designing and implementing of compilers.

III. Course Intended learning outcomes (CILOs) of the course		Referenced PILOs
a1	Demonstrate knowledge of basic mathematical models for computation and describe how they relate to formal languages	A1
a2	Describe the principles of machine language modeling and analysis using Regular Expressions, Finite Automata deterministic and non-deterministic, Context Free Grammars, Pushdown Automata, and Turing Machines.	A2
b1	Formulate problems related to model of computation and theory of programming using appropriate computation and programming modelling methods.	B1
b2	Analyze computation and programming models using FA, RE, CFG, PDA, and TM.	B3
c1	Use suitable computing tools to solve/design different automata machines related to computation and programming models	C4
d1	Work effectively within team while constructing and designing computing models.	D1

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1- Demonstrate knowledge of basic mathematical models for computation and describe how they relate to formal languages	Lectures, laboratory, seminars. computer-based programs	Examinations, laboratory reports, homework presentations

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a2-	Describe and understand principles of machine language modelling and analysis using Regular Expressions, Finite Automata deterministic and non-deterministic, Context Free Grammars, Pushdown Automata, and Turing Machines.	Lectures, Laboratory work, projects, computer-based programs	Examinations, homework presentations, individual and group project reports

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
b1-	Formulate problems related to model of computation and theory of programming using appropriate computation and programming modeling methods.	Lectures, Laboratory Computing tools, , Seminars, Projects	Examinations, homework, laboratory reports presentations, individual and group project reports
b2-	Analyze computation and programming models using FA, RE, CFG, PDA, and TM.	Lectures, Laboratory Computing tools, , Seminars, Projects	Examinations, homework, laboratory reports presentations, individual and group project reports

© Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes		Teaching strategies	Assessment Strategies
c1-	Use suitable computing tools to solve/design different automata machines related to computation and programming models	Lectures, laboratory, seminars, projects, small group, computer-based programs	Examinations, laboratory reports, presentations, individual and group project reports.

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(D) Alignment Course Intended Learning Outcomes of Transferable Skills to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Work effectively within team while constructing and designing computing models.	Seminars, Laboratory Sessions, Projects.	Presentations, Reports

IV. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	Course Orientations & Introduction	a1, a2	▪ Course overview & Orientations, ▪ Introduction to Computations and discrete mathematics, basic concepts, Set theory, strings and language definitions, finite specification of languages.	1	2
2.	Language, Recursive, and Proof Techniques	a1, a2, b1	▪ Formal vs. non-formal language, Chomsky definition for language, examples of finite language ▪ Recursive definition, concepts of modeling series using recursion with examples, ▪ Proof Techniques, different proof techniques, induction and contradictions.	1 & 1/2	3
3.	Regular Expressions	a1, a2, b1	▪ Introduction to regular language and their Regular expressions	1 & 1/2	3

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	(RE's) & Language		representation illustrated with many examples for empty, finite and infinite regular expressions.		
4.	Finite Automata (FA) & Language	a1, a2, b1, b2	▪ Introduction to graph theory, basic concepts, Directed and undirected graph, ▪ Finite Automata and Regular Expressions, ▪ Conversion from FA and regular expressions ▪ Deterministic finite automata (DFA), Non-deterministic finite automata (NFA), ▪ Kleene's theorem and non-determinism, ▪ Equivalence of DFA and NFA, and regular expressions, ▪ Regular expression and regular languages, ▪ Non-regular languages and pumping Lemma, and closure properties, ▪ Optimal DFA.	3	6
5.	Context Free Grammars (CFG's) and Languages	a1, a2, b1, b2	▪ Context Free Languages and Grammars; basic concepts, characteristics and applications of CFG's. ▪ Context-Free grammar; Regular grammars, leftmost derivation, and ambiguity,	2 & 1/2	5

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			▪ Parse Trees; Ambiguity in Grammars and Languages, ▪ Standard Form, Chomsky normal form and pumping lemma for context-free languages ▪ Greibach normal Forms ▪ Minimization of CFG's		
6.	Pushdown Automata (PDA)	a1, a2, b1, b2	▪ Pushdown Automata, Deterministic and Non-Deterministic (PDA); Formal definition of NPDA, ▪ Transition functions of NPDA; NPDA Execution ▪ Accepting Strings with NPDA; Equivalence of PDAs and CFG	1 & 1/2	3
7.	The Turing Machines (TM)	a1, a2, b1, b2	▪ Turing machines, Formal definition of TM's. and basic concepts, Programming Techniques for Turing Machines, ▪ TM's as acceptors; TM's as transducers; Recognizing Languages with TM's.; Sorting with TM's.; Programming in TM's. ▪ Church's thesis, and undecidable problems	2	4
8.	Introduction to Complexity Theory	a1, a2, b1, b2	▪ Introduction to complexity by distinguishing decidable problems in terms of time and space complexity ▪ Time complexity classes P and NP ▪ Reduction and NP-completeness	1	2

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			▪ Space Complexity		
Number of Weeks /and Units Per Semester				**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	contact hours	Learning Outcomes
1.	Installing Computer-based tool for construction and simulation of FA, RE, CFGs, PDA, and TM	1	2	a2, b1, b2, c1
2.	Start by introducing solved examples for Regular expressions and languages, Use Computer based simulation software to construct Regular Expressions to Languages, apply testing of different inputs (letters, words, statements) which belong or not belong to the language	2	4	a2, b1, c1, d1
3.	Finite Automata (FA) and Graph Theory; Construct some Directed & Undirected Graphs and use computer software to simulate the constructed Graphs, Construct and simulate different types of FAs the DFA, NFA to REs, Check Equivalence of DFA and NFA, and regular expressions, Use of FA to Design some Sequential Logic Circuits	3	6	a2, b1, b2, c1, d1
4.	Use of CFG's to represent Regular Expressions, FA, test Ambiguities, Tree Parsing Verify Greibach theorem,	2	4	a2, b1, b2, c1, d1

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	Chomsky Normal Form to CFG's			
5.	Pushdown Automata to CFG's DPDA, NPDA	1	2	a2, b1, b2, c1, d1
6.	Verify applications of Turing Machine (TM), Programming with TM, Recognizing language with TM, and Sorting with TMs.	2	4	a2, b1, b2, c1, d1
7.	Project Discussion	2	4	a1, a2, b1, b2, c1, d1
8.	Final Exam	1	2	a1, a2, b1, b2, c1, d1
Number of Weeks /and Units Per Semester		**14**	**28**	

V. Teaching strategies of the course:

- Active Lectures,
- Laboratory Sessions,
- Use of Information & Communication Technologies,
- Projects,
- Computer-based Programs
- Seminars
- small group

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Recursion & Proof Techniques	a1, a2, b1, d1	3rd	1
2.	Regular Expressions	a1, a2, b1, b2, d1	4th	1
3.	Finite Automata	a1, a2, b1, b2, d1	5th to 7th	2
4.	Context Free Grammars	a1, a2, b1, b2, d1	9th to 11th	2 .5

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5.	PDA	a1, a2, b1, b2, d1	12th	1.5
6.	Turing Machine	a1, a2, b1, b2, c1, d1	13th & 14th	2
	Total			**10**

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	HomeWorks & Assignments	3rd to 14th	15	10%	a1, a2, b1, b2, c1, d1
2.	Laboratory Work	3rd to 11th	15	10%	a2, b1, b2, c1, d1
3.	Mid-Term Exam (Th.)	8th	15	10%	a1, a2, b1, b2
4.	Project Work & Presentations	12th & 13th	15	10%	a1, a2, b1, b2, c1, d1
5.	Final Exam (Pr.)	14th	15	10%	a1, a2, b1, b2, c1, d1
6.	Final Exam (Th.)	16th	75	50%	a1, a2, b1, b2
	Total		**150**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1- Thomas A. Sudkamp (2006). An Introduction to the Theory of Computer Science Languages and Machines. Third Edition, Addison Wesley.
2- Daniel I. A. Cohen- 1997- Introduction to Computer Theory- Second Edition - Prentice-Hall.
3- Dexter C. Kozen- (2006-05-08) - Theory of Computation- 1st Edition- Springer Science & Business Media- ISBN-13 9781846282973

2- Essential References.

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	1- J. E. Hopcroft., R. Motwani, and J. D. Ullman -2007- Introduction to Automata Theory, Languages, and Computation, Third Edition, Addison Wesley. 2- Peter Linz- 2001- An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett. 3- M. Sipser -2003- Introduction to the Theory of Computation- 2nd Edition- Prentice Hall.
3- Electronic Materials and Web Sites *etc*.	
	1- Sites and Other learning material such as computer-based programs, professional standards/regulations Will be specified at the course time as needed.

IX. Course Policies:

1.	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic.
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:** A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Project** The assignment is given to the students after each chapter; the student must submit all the assignments for checking on time.
5.	Cheating: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.

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6.	**Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments my given directly to students using soft or hard copy

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University of Sana'a
Faculty of Engineering
Department: Electrical Engineering
Title of the Program: Computer Engineering and Control Eng.

Template for Course Plan of Introduction to Computation

Theory

I. Information about Faculty Member Responsible for the Course:							
Name of Faculty Member	Assoc. Prof. Dr. Farouk AL-Fuhaidy	**Office Hours**					
Location& Telephone No.	777909815	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	farouqakh@gmail.com						

II. Course Identification and General Information:						
1.	Course Title:	Introduction to Computation Theory				
2.	Course Number & Code:	CCE142				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	-	2	-	3
4.	Study level/year at which this course is offered:	Second level / First Semester				
5.	Pre –requisite (if any):	Computer Programming II, Data Structures & Algorithms				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Computer Engineering and Control				
8.	Language of teaching the course:	English				
9.	System of Study:	Semester System				
10.	Mode of delivery:	Lecture				
11.	Location of teaching the course:	Electrical Eng. Dep.				

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III. Course Description:

This course is an introductory to the theory of computation, to introduce students with basic principles pertaining to the modeling and analysis of computational problems and their solving. Topics to be covered by this course including models of computation such as Turing machines; theory of programming languages including, Automata, grammars, parsing, syntax and semantics. Upon successful completion of the course, students will be able for modeling many important kinds of hardware and software, like software for designing and checking behavior of digital circuits, lexical analyzer as a component of the Compiler, ...etc. This course supports students with basic principles and concepts required to study the advanced computation theory course for designing and implementing of compilers.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Demonstrate knowledge of basic mathematical models for computation and describe how they relate to formal languages
2. Describe the principles of machine language modeling and analysis using Regular Expressions, Finite Automata deterministic and non-deterministic, Context Free Grammars, Pushdown Automata, and Turing Machines.
3. Formulate problems related to model of computation and theory of programming using appropriate computation and programming modelling methods.
4. Analyze computation and programming models using FA, RE, CFG, PDA, and TM .
5. Use suitable computing tools to solve/design different automata machines related to computation and programming models
6. Work effectively within team while constructing and designing computing models.

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V. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact hours
1.	Course Orientations & Introduction	▪ Course overview & Orientations, ▪ Introduction to Computations and discrete mathematics, basic concepts, set theory, strings and language definitions, finite specification of languages.	1st	2
2.	Language, Recursive, and Proof Techniques	▪ Formal vs. non-formal language, Chomsky definition for language, examples of finite language ▪ Recursive definition, concepts of modeling series using recursion with examples, ▪ Proof Techniques, different proof techniques, induction and contradictions.	2nd ,3rd	3
3.	Regular Expressions (RE's) & Language	▪ Introduction to regular language and their Regular expressions representation illustrated with many examples for empty, finite and infinite regular expressions.	3rd ,4th	3
4.	Finite Automata (FA) & Language	▪ Introduction to graph theory, basic concepts, Directed and undirected graph, ▪ Finite Automata and Regular Expressions, ▪ Conversion from FA and regular expressions ▪ Deterministic finite automata (DFA), Non-deterministic finite automata (NFA), ▪ Kleene's theorem and non-determinism,	5th ,6th ,7th	6

		▪ Equivalence of DFA and NFA, and regular expressions, ▪ Regular expression and regular languages, ▪ Non-regular languages and pumping Lemma, and closure properties, ▪ Optimal DFA.		
5.	Mid-Term Exam	▪ All Previous Topics	8th	2
6.	Context Free Grammars (CFG's) and Languages	▪ Context Free Languages and Grammars; basic concepts, characteristics and applications of CFG's. ▪ Context-Free grammar; Regular grammars, leftmost derivation, and ambiguity, ▪ Parse Trees; Ambiguity in Grammars and Languages, ▪ Standard Form, Chomsky normal form and pumping lemma for context-free languages ▪ Greibach normal Forms ▪ Minimization of CFG's	9th ,10th ,11th	5
7.	Pushdown Automata (PDA)	▪ Pushdown Automata, Deterministic and Non-Deterministic (PDA); Formal definition of NPDA, ▪ Transition functions of NPDA; NPDA Execution ▪ Accepting Strings with NPDA; Equivalence of PDAs and CFG	11th ,12th	3

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8.	The Turing Machines (TM)	▪ Turing machines, Formal definition of TM's. and basic concepts, Programming Techniques for Turing Machines, ▪ TM's as acceptors; TM's as transducers; Recognizing Languages with TM's.; Sorting with TM's.; Programming in TM's. ▪ Church's thesis, and undecidable problems	13th ,14th	4
9.	Introduction to Complexity Theory	▪ Introduction to complexity by distinguishing decidable problems in terms of time and space complexity ▪ Time complexity classes P and NP ▪ Reduction and NP-completeness ▪ Space Complexity	15th	2
10.	Final Exam	All Topics	16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours
1.	Installing Computer-based tool for construction and simulation of FA, RE, CFGs, PDA, and TM	1st	2
2.	Start by introducing solved examples for Regular expressions and languages, Use Computer based simulation software to construct Regular Expressions to Languages, apply testing of different inputs (letters, words, statements) which belong or not belong to the language	2nd ,3rd	4
3.	Finite Automata (FA) and Graph Theory;	4th ,5th ,6th	6

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	Construct some Directed & Undirected Graphs and use computer software to simulate the constructed Graphs, Construct and simulate different types of FAs the DFA, NFA to REs, Check Equivalence of DFA and NFA, and regular expressions, Use of FA to Design some Sequential Logic Circuits		
4.	Use of CFG's to represent Regular Expressions, FA, test Ambiguities, Tree Parsing Verify Greibach theorem, Chomsky Normal Form to CFG's	7^{th} ,8^{th}	4
5.	Pushdown Automata to CFG's DPDA, NPDA	9^{th}	2
6.	Verify applications of Turing Machine (TM), Programming with TM, Recognizing language with TM, and Sorting with TMs.	10^{th} ,11^{th}	4
7.	Project Discussion	12^{th} ,13^{th}	4
8.	Final Exam	14^{th}	2
Number of Weeks /and Units Per Semester		**14**	**28**

VI. Teaching strategies of the course:

- Active Lectures,
- Laboratory Sessions,
- Use of Information & Communication Technologies,
- Projects,
- Computer-based Programs
- Seminars
- small group

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VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Recursion & Proof Techniques	a1, a2, b1, d1	3rd	1
2.	Regular Expressions	a1, a2, b1, b2, d1	4th	1
3.	Finite Automata	a1, a2, b1, b2, d1	5th to 7th	2
4.	Context Free Grammars	a1, a2, b1, b2, d1	9th to 11th	2 .5
5.	PDA	a1, a2, b1, b2, d1	12th	1.5
6.	Turing Machine	a1, a2, b1, b2, c1, d1	13th & 14th	2
	Total			**10**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	HomeWorks & Assignments	3rd to 14th	15	10%	a1, a2, b1, b2, c1, d1
2.	Laboratory Work	3rd to 11th	15	10%	a2, b1, b2, c1, d1
3.	Mid-Term Exam (Th.)	8th	15	10%	a1, a2, b1, b2
4.	Project Work & Presentations	12th & 13th	15	10%	a1, a2, b1, b2, c1, d1
5.	Final Exam (Pr.)	14th	15	10%	a1, a2, b1, b2, c1, d1
6.	Final Exam (Th.)	16th	75	50%	a1, a2, b1, b2
	Total		**150**	**100%**	

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Academic Development Center & Quality Assurance
Assoc. Prof. Dr. Huda Al-Emad

Rector of Sana'a University
Prof. Dr. Al-Qassim Mohammed Abbas

IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. Thomas A. Sudkamp (2006). An Introduction to the Theory of Computer Science Languages and Machines. Third Edition, Addison Wesley.
2. Daniel I. A. Cohen- 1997- Introduction to Computer Theory- Second Edition - Prentice-Hall.
3. Dexter C. Kozen- (2006-05-08) - Theory of Computation- 1st Edition- Springer Science & Business Media- ISBN-13 9781846282973

2- Essential References.

1. J. E. Hopcroft., R. Motwani, and J. D. Ullman -2007- Introduction to Automata Theory, Languages, and Computation, Third Edition, Addison Wesley.
2. Peter Linz- 2001- An Introduction to Formal Languages and Automata, Third Edition, Jones and Bartlett.
3. M. Sipser -2003- Introduction to the Theory of Computation- 2nd Edition- Prentice Hall.

3- Electronic Materials and Web Sites *etc*.

1. Sites and Other learning material such as computer-based programs, professional standards/regulations Will be specified at the course time as needed.

X. Course Policies:

1.	**Class Attendance:** A student should attend not less than 75 % of total hours of the subject; otherwise he will not be able to take the exam and will be considered as exam failure. If the student is absent due to illness, he/she should bring a proof statement from university Clinic.
2.	**Tardy:** For late in attending the class, the student will be initially notified. If he repeated lateness in attending class he will be considered as absent.
3.	**Exam Attendance/Punctuality:**

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	A student should attend the exam on time. He is Permitted to attend an exam half one hour from exam beginning, after that he/she will not be permitted to take the exam and he/she will be considered as absent in exam.
4.	**Assignments & Project** The assignment is given to the students after each chapter; the student must submit all the assignments for checking on time.
5.	Cheating: For cheating in exam, a student will be considered as fail. In case the cheating is repeated three times during his/her study the student will be disengaged from the Faculty.
6.	**Plagiarism:** Plagiarism is the attending of a student the exam of a course instead of another student. If the examination committee proofed a plagiarism of a student, he will be disengaged from the Faculty. The final disengagement of the student from the Faculty should be confirmed from the Student Council Affair of the university.
7.	**Other policies:** - Mobile phones are not allowed to use during a class lecture. It must be closed, otherwise the student will be asked to leave the lecture room - Mobile phones are not allowed in class during the examination. - Lecture notes and assignments my given directly to students using soft or hard copy

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