



## Course Specification of Algorithms and analysis

Course No ( ..... )

2020/2021

Head of Department	Vise Dean for Quality Assurance	Dean of the Faculty	Dean of Academic Development center and Quality
Dr. Ahmed Al-shalabi	Dr. Anwar Al-Shamiri	Dr. Nagi Al-Shibani	Assoc. Prof. Dr.Huda Al.Emad
Rector of Sana'a University			
Prof. Dr. Qassim Mohammed Abbas			



I. Course Identification and General Information:					
1	Course Title:	Algorithms and analysis			
2	Course Code & Number:				
3	Credit hours:	C.H			
		Th.	Seminar	Pr	Tr.
		3	-	-	-
4	Study level/ semester at which this course is offered:	3 <sup>th</sup> Level -2 <sup>nd</sup> Semester			
5	Pre –requisite (if any):	None			
6	Co –requisite (if any):	None			
7	Program (s) in which the course is offered:	CS			
8	Language of teaching the course:	English/Arabic			
9	Study System	Term based system			
10	Mode of delivery:	Full time			
11	Location of teaching the course:	Faculty of Computer and Information Technology			
12	Prepared By:	Dr.Nabeel Sharaf			
13	Date of Approval				

Head of Department	Vise Dean for Quality Assurance	Dean of the Faculty	Dean of Academic Development center and Quality
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## II. Course Description:

The main goal of this course is to study the fundamental techniques to design efficient algorithms and analyze their running time. After a brief review of prerequisite material (search, sorting, asymptotic notation), we will discuss efficient algorithms for basic graph problems and solving various problems through divide and conquer algorithms, dynamic programming and greedy algorithms. We will consider also randomized algorithms, proofs of NP-completeness, approximation algorithms, partial recursive functions, and proofs of undecidability.

III. Course Intended learning outcomes (CILOs) of the course (maximum 8CILOs)		Referenced PILOs (Only write code number of referenced Program Intended learning outcomes)
a.1	Explains the concepts, theories and principles related to designing algorithms and employing them to solve software problems	A1,A3,A4,A5
a.2	Compare between different data structures. Pick an appropriate data structure for a design situation.	A1,A2,A3
b.1	Analyze the efficiency of algorithms using time and space complexity theory	B1,B2
b.2	Analyze different algorithms and their usage	B1,B2
c.1	Apply design principles and concepts to algorithm design	C1,C2,C3

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c.2	implement the algorithmic solutions in a programming language	C1,C2,C3,C6
d.1	Work effectively individually or within a team to analyze a problem and identify the algorithm appropriate for its solution	D1,D4
d.2	Argue the correctness of algorithms using inductive proofs and invariants.	D2

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

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a.1 explain the concepts, theories, and principles related to designing algorithms and employing them to solve software problems	-Lecture and presentation - Dialogue and discussion - Self and cooperative learning	- Homework /Assignments - Research Project - Midterm exam - Final exam
a.2 Compare between different data structures. Pick an appropriate data structure for a design situation.	- Brainstorming. - Problem Solving. - Labs	

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

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1. Analyze the efficiency of algorithms using time and space complexity theory	-Lecture and presentation - Dialogue and discussion	- Homework /Assignments - Research Project
b2. Apply design principles and concepts to algorithm design	- Self and cooperative learning - Brainstorming. - Problem Solving.	- Midterm exam - Final exam

**( C )Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:**

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
<b>C1.</b> Apply design principles and concepts to algorithm design	-Lecture and presentation - Dialogue and discussion	- Practical Exam and performance observation.
<b>C2.</b> implement the algorithmic solutions in a programming language	- Self and cooperative learning - Brainstorming. - Problem Solving. - Labs	- Midterm Exam - Final Exam - Project Assessment

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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 individually or within a team to analyze a problem and identify the algorithm appropriate for its solution	-Lecture and presentation - Dialogue and discussion	-Performance observation. - Project and report - assessment
d2. Argue the correctness of algorithms using inductive proofs and invariants.	- Self and cooperative learning - Brainstorming. - Problem Solving. - Labs	

IV. Course Content:					
A – Theoretical Aspect:					
Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	contact hours
1	Numeric & Matching Algorithms	a1,a2,b1	- Matrix Multiplication. - Linear Equations. - String Matching	2	4
2	Graph Algorithms	a1, a2	- Elementary Graph Algorithms - Minimum Spanning Trees - Single-Source Shortest Paths	3	4

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3	Dynamic Programming	a2, b2 c1	<ul style="list-style-type: none"> <li>- Rod cutting</li> <li>- Matrix-chain multiplication</li> <li>- Elements of dynamic programming</li> <li>- Longest common subsequence</li> <li>- Optimal binary search trees</li> </ul>	3	6
4	Greedy Algorithms	A1, a2, b2, c1	<ul style="list-style-type: none"> <li>- An activity-selection problem</li> <li>- Elements of the greedy strategy</li> <li>- Huffman codes</li> </ul>	2	4
5	NP-Completeness	a1,a2, b2, c1	<ul style="list-style-type: none"> <li>- Polynomial time</li> <li>- Typical NP Problems</li> <li>- NP-completeness and reducibility</li> <li>- NP-complete problems</li> </ul>	2	4
	Approximation Algorithms	a2, b1,b2, c1	<ul style="list-style-type: none"> <li>- The vertex-cover problem</li> <li>- The traveling-salesman problem</li> <li>- The set-covering problem</li> <li>- Randomization and linear programming</li> <li>- The subset-sum problem</li> </ul>	2	6
Number of Weeks /and Units Per Semester				14	28

## V. Teaching strategies of the course:

- Lectures
- Discussion

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▪ Brainstorming
▪ Problem solving
▪ Practical in computer (lab)
▪ Projects
▪ Self-learning
▪ Cooperative learning

## VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Assignment 1	b1,b2,c2,d2	6 <sup>th</sup>	5
2	Assignment 2	b1,b2,c2,d2	11 <sup>th</sup>	5

## 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	Homework /Projects/ Assignment	6 <sup>th</sup> ,11 <sup>th</sup>	10	10%	ALL
2	Quizzes	4 <sup>th</sup>	5	5%	a1, a2, b1, b2,c1
3	Midterm Exam	8 <sup>th</sup>	15	15%	a1, a2, b1, b2,c1,c2

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4	Final Exam (theoretical)	16 <sup>th</sup>	70	70%	a1, a2, b1,b2,c1,c2
<b>Total</b>			<b>100</b>	<b>100%</b>	

<b>VIII. Learning Resources:</b>	
<ul style="list-style-type: none"> <li>Written in the following order: ( Author - Year of publication - Title - Edition - Place of publication - Publisher).</li> </ul>	
<b>1- Required Textbook(s) ( maximum two ).</b>	
	<ol style="list-style-type: none"> <li>1. T. Cormen, C. Leiserson, R. Rivest, and C. Stein-, 2009- Introduction to Algorithms -(3rd Edition), The MIT,Press</li> <li>2. J. Kleinberg and E. Tardos, 2005 - Algorithm Design, Addison-Wesley</li> </ol>
<b>2- Essential References.</b>	
	<ol style="list-style-type: none"> <li>3. Jeffrey J. McConnell - "Analysis of Algorithms: An Active Learning Approach"- 1st edition – USA - JONES AND BARTLETT PUBLISHERS</li> <li>4. Miller, Bradley, and David Ranum. 2011, Problem Solving with Algorithms and Data Structures Using Python. 2nd ed. Franklin, Beedle &amp; Associates.</li> <li>5. Dana Vrajitoru and William Knight,2014, Practical Analysis of Algorithms, Springer International Publishing, Switzerland.</li> </ol>
<b>3- Electronic Materials and Web Sites etc.</b>	
	<ol style="list-style-type: none"> <li>1. <a href="https://www.cs.princeton.edu/~wayne/kleinberg-tardos/">https://www.cs.princeton.edu/~wayne/kleinberg-tardos/</a></li> <li>2. <a href="https://link.springer.com/article/10.1186/1471-2105-5-104">https://link.springer.com/article/10.1186/1471-2105-5-104</a></li> <li>3. <a href="https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6.006-introduction-to-algorithms-fall-2011/index.htm">https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6.006-introduction-to-algorithms-fall-2011/index.htm</a></li> </ol>

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## IX. Course Policies:

Unless otherwise stated, the normal course administration policies and rules of the Faculty of Computer and Information Technology apply. For the policy, see: -----

The University Regulations on academic misconduct will be strictly enforced. Please refer to -----

1	<b>Class Attendance:</b> 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	<b>Tardy:</b> 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	<b>Exam Attendance/Punctuality:</b> 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	<b>Assignments &amp; Project</b> The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5	<b>Cheating:</b> 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	<b>Plagiarism:</b> 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	<b>Other policies:</b> <ul style="list-style-type: none"> <li>- 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</li> <li>- Mobile phones are not allowed in class during the examination.</li> <li>- Lecture notes and assignments my given directly to students using soft or hard copy</li> </ul>

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## Faculty of Computer & Information Technology

### Department of Computer Science

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## Program of Computer Science

### Course syllabus of Algorithms and analysis

Course No ( ..... )

2020/2021

I. - Information about Faculty Member Responsible for the Course:							
Name of Faculty Member		Office Hours					
Location & Telephone No.		SAT	SUN	MON	TUE	WED	THU
E-mail							

Head of Department	Vise Dean for Quality Assurance	Dean of the Faculty	Dean of Academic Development center and Quality
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II. Course Identification and General Information:					
1-	Course Title:	Algorithms and analysis			
2-	Course Number & Code:				
3-	Credit hours:	C.H			
		Th.	Seminar	Pr.	F. Tr.
		3	-	-	-
4-	Study level/year at which this course is offered:	3 <sup>th</sup> Level -2 <sup>nd</sup> Semester			
5-	Pre –requisite (if any):	None			
6-	Co –requisite (if any):	None			
7-	Program (s) in which the course is offered	CS			
8-	Language of teaching the course:	English/Arabic			
9-	System of Study:	Term based system			
10-	Mode of delivery:	Full Time			
11-	Location of teaching the course:	Faculty of Computer and Information Technology			

### III. Course Description:

The main goal of this course is to study the fundamental techniques to design efficient algorithms and analyze their running time. After a brief review of prerequisite material (search, sorting, asymptotic notation), we will discuss efficient algorithms for basic graph problems and solving various problems through divide and conquer algorithms, dynamic programming and greedy algorithms. We will consider also randomized algorithms, proofs of NP-completeness, approximation algorithms, partial recursive functions, and proofs of undecidability.

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

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

a1.Explains the concepts, theories, principles, and principles related to designing algorithms and employing them to solve software problems

a2. Compare between different data structures. Pick an appropriate data structure for a design situation.

b1.Analyze the efficiency of algorithms using time and space complexity theory

b2.Ability to compare and analyze different algorithms and their usage

c1.Apply design principles and concepts to algorithm design

c2.Implement the algorithmic solutions in a programming language

d1.Work effectively individually or within a team to analyze a problem and identify the algorithm appropriate for its solution

d2.Argue the correctness of algorithms using inductive proofs and invariants.

#### V. Course Content:

##### A – Theoretical Aspect:

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Order	Units/Topics List	Sub Topics List	Week Due	contact hours
1	Numeric & Matching Algorithms	<ul style="list-style-type: none"> <li>- Matrix Multiplication.</li> <li>- Linear Equations.</li> <li>- String Matching</li> </ul>	1 <sup>st</sup> , 2 <sup>nd</sup>	4
2	Graph Algorithms	<ul style="list-style-type: none"> <li>- Elementary Graph Algorithms</li> <li>- Minimum Spanning Trees</li> <li>- Single-Source Shortest Paths</li> </ul>	3 <sup>th</sup> , 4 <sup>th</sup>	4
3	Dynamic Programming	<ul style="list-style-type: none"> <li>- Rod cutting</li> <li>- Matrix-chain multiplication</li> <li>- Elements of dynamic programming</li> <li>- Longest common subsequence</li> <li>- Optimal binary search trees</li> </ul>	5 <sup>th</sup> - 7 <sup>th</sup>	6
4	Mid Term Exam	-	8 <sup>th</sup>	2
5	Greedy Algorithms	<ul style="list-style-type: none"> <li>- An activity-selection problem</li> <li>- Elements of the greedy strategy</li> <li>- Huffman codes</li> </ul>	9 <sup>th</sup> , 10 <sup>th</sup>	4
6	NP-Completeness	<ul style="list-style-type: none"> <li>- Polynomial time</li> <li>- Typical NP Problems</li> <li>- NP-completeness and reducibility</li> <li>- NP-complete problems</li> </ul>	11 <sup>th</sup> , 12 <sup>th</sup>	4
7	Approximation Algorithms	<ul style="list-style-type: none"> <li>- The vertex-cover problem</li> <li>- The traveling-salesman problem</li> <li>- The set-covering problem</li> <li>- Randomization and linear programming</li> <li>- The subset-sum problem</li> </ul>	13 <sup>th</sup> - 15 <sup>th</sup>	6
	Final Exam	-	16 <sup>th</sup>	
Number of Weeks /and Units Per Semester			16	32

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## VI. Teaching strategies of the course:

- Lectures
- Discussion
- Brainstorming
- Problem solving
- Practical in computer (lab)
- Projects
- Self-learning
- Brain storm

## X. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1	Assignment 1	b1,b2,c2,d2	6 <sup>th</sup>	5
2	Assignment 2	b1,b2,c2,d2	11 <sup>th</sup>	5

## I. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1	Homework /Projects/ Assignment	6 <sup>th</sup> ,11 <sup>th</sup>	10	10%	ALL
2	Quizzes	4 <sup>th</sup>	5	5%	a1, a2, b1, b2,c1
3	Midterm Exam	8 <sup>th</sup>	15	15%	a1, a2, b1, b2,c1,c2
4	Final Exam (theoretical)	16 <sup>th</sup>	70	70%	a1, a2, b1,b2,c1,c2

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<b>Total</b>	<b>100</b>	<b>100%</b>	
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<b>XI. Learning Resources:</b>	
<ul style="list-style-type: none"> <li>Written in the following order: ( Author - Year of publication – Title – Edition – Place of publication – Publisher).</li> </ul>	
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### اللجنة الإشرافية

م.	الاسم	الصفة	التوقيع
١	أ.م.د. عبد الماجد الخليدي	نائب عميد الكلية للشؤون الأكاديمية	
٢	أ.م.د. احمد مجاهد	نائب عميد مركز التطوير الأكاديمي وضمان الجودة	
٣	د. حسين الأشول	ممثل المركز في الكلية	
٤	أ.د. إبراهيم المطاع	نائب رئيس الجامعة للشؤون الأكاديمية	

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