Program: ECE **Faculty/College**: TGGS
Degree Level: Master

Course 090245350

Efficient Algorithms

King Mongkut's University of Technology North Bangkok
The Sirindhorn International Thai-German Graduate School of Engineering
Electrical and Computer Engineering Program

Section 1: General Information

1. **Course code and course title**

   090245350 Efficient Algorithms

2. **Total credits**

   3 credits ☐ (2-2-5) ☑ (3-0-6) ☐ (3-0-9) ☐ (2-3-7)

3. **Curriculum and course category**:

   Curriculum: *Master of Engineering in Electrical and Computer Engineering*

   Course category: Required Courses

   Course category: Required Courses

   ☐ Core Course ☐ Specific Core Course

   ☐ Industrial Internship ☐ Master Thesis

   Elective Courses

   ☑ General Elective ☐ Specific Elective ☐ Other Elective

4. **Course coordinator/ Instructors**

   Course Coordinator: _____

   Instructor(s): Dr.rer.nat. Ekkapot Charoenwanit

5. **Semester/ year of study**

   ☑ Semester 1 (Aug. to Dec.) ☐ Semester 2 (Jan. to May) Academic Year: 2021

6. **Pre-requisite (if any)**

   ☑ No ☐ Yes, please provide: .....

7. **Co-requisites (if any)**

   ☑ No ☐ Yes, please provide: .....

8. **Venue of study**

   Lecture Day/Time: Thursdays at 13.00-16.00

   ☐ On-site: Lecture Room No.:……. Floor:…….

   ☐ TGGS, KMUTNB ☐ Faculty of Engineering, CU ☐ RWTH

   ☑ Online*: Teaching Media: ☑ Microsoft Teams ☐ Google Meet

   ☐ Zoom ☐ Webex

☐ Other (specify) ……..….

9. Information for quality assurance in education

This course shows evidence of:

- ☐ Development of implementation from previous practices, e.g. the improvement of class teaching, course content, content classification and methods used for learning assessment
- ☐ Involvement from professional bodies/ external agencies in instruction; thus Enhancing student academic and professional experiences
- ☑ Integration of research or creative activities with instruction; use of research-based learning management; knowledge management practices for learning improvement
- ☐ Integration of academic services and course implementation
- ☐ Combination of cultural heritage preservation efforts into instruction or student activities

10. Date of latest revision:

28th July 2021

Section 2: Course Description and Implementation

1. Course Description

Asymptotic Notation: Big O, Big Omega, Big Theta. Proof Techniques: Direct Proof, Proof by contradiction, Proof by contrapositive, Proof by induction. Sorting: Bubble sort, Selection sort, Insertion sort, Heap sort, Merge sort, Quicksort. Searching algorithms: Linear search, Binary search. Graph Algorithms: Minimum Spanning Tree, Breadth-first search, Depth-first search, Topological Sorting, Cycle Detection, Bellman-Ford algorithm. Dijkstra's algorithm, Floyd-Warshall algorithm, Johnson's algorithm. Data structures: List, Array, Stack, Queue, Hash table, Binary tree, Heap, Priority Queue. Algorithm paradigms: Divide-and-Conquer, Greedy algorithm, Dynamic programming. Computational complexity theory: Theory of NP-completeness. Approximation algorithms. State-Space Search: Brute-Force Search, Backtracking, Branch & Bound. Randomized algorithms.

2. Number of hours per semester

Lecture	Practice	Self-study
45 hours/ semester (*3 hours/week**)	*30 hours* (*2 hours/week**)	*75 hours/ semester* (*5 hours/week**)

Remark: * *Based on 15 weeks of lecture*

Course Category: ☑ Lecture ☑ Practice ☐ Laboratory

Course Evaluation: ☑ A-F ☐ S/U ☐ P

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3. Number of hours per week for academic guidance to individual students

☑ 1. Giving academic advice (minimum number of hours per week) during the office hours

☐ 1 ☐ 2 ☑ 3 ☐ 4 ☐ 5 ☐ .....

Wednesdays at 13.00-16.00

The students can arrange to have office hours at times other than the specified office hours by telephone or email.

☑ 2. Adopting information technology-based academic advising

☑ Email: ekkapot.c@tggs.kmutnb.ac.th

☑ Phone : 0971179626

(Do not distribute this mobile number without permission.)

☐ Communication Apps: Line ID: e.wanit

(Please notify the lecturer before adding him/her.)

☐ Meeting Online: The platform will be informed to students upon request.

☐ Other (specify) .....

☐ 3. .....

4. Course Learning Outcomes (CLOs): Students should be able to:

CLO 1. To explain key mathematical concepts, namely, proof techniques and asymptotic notation, etc. as well as key algorithm design paradigms, namely, divide-and-conquer, dynamic programming, greedy algorithm, brute-force search, backtracking, and branch & bound, etc.

CLO 2. To analyze the temporal and the spatial complexity of any given algorithm using the knowledge of algebra, probabilistic analysis, and asymptotic notation

CLO 3. To apply the knowledge of algorithms learned in the lectures to solve relevant computational problems

CLO 4. To analyze the correctness of algorithms using proof techniques such as proof by contradiction and induction

CLO 5. To design efficient algorithms and complex data structures to efficiently solve computational problems

Remark: 1. Guidelines according to Bloom's Taxonomy is available at https://courses.dcs.wisc.edu/design-teaching/PlanDesign_Fall2016/2-Online-Course-Design/2_Learning-Objectives-Alignment/6_objectives_blooms-taxonomy.html

2. For the master level course, CLOs should be "apply" and "analyze" or possibly consider the doctoral CLOs "evaluate" and "create". "Remember" and "Understand" are for the undergraduate level courses, however, they can be implemented only at the beginning of the course.

3. CLOs can be defined as many as appropriate for the course.

5. The mapping between Expected Learning Outcomes (ELOs) from the curriculum and Course Learning Outcomes (CLOs)

Table 5.1 ELOs-CLOs Consistency *(for a subject-specific course/ a specific curriculum)*

Remark: All ELOs and ELOs for the course (highlighted row) are as written in the Official Approved Curriculum.

ELOs/CLOs consistency	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
ELO1	✓	✓	✓	✓	
ELO2	✓	✓	✓	✓	
ELO3	✓	✓			✓
ELO4	✓	✓			✓
ELO5					
ELO6					
ELO7					
ELO8					
ELO9					
ELO10					

Table 5.2 Mapping desirable characteristics of KMUTNB graduates and CLOs *(for non-specific courses designed for various curriculums)*

Consistency between desirable characteristics of KMUTNB Graduates- CLOs	CLO 1	CLO 2	CLO 3	CLO 4	CLO 5
1. **Professional credentials with critical thinking skills**	✓	✓	✓	✓	✓
2. **Integrity and social responsibility**					
3. **Innovative and technopreneur mindset**	✓	✓			✓
4. **Global Competence**	✓	✓			✓

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Section 3: Student Improvement in relation to Course Learning Outcomes (CLOs)

Organizing learning to develop skills/ knowledge; evaluation of CLOs in accordance with the ones identified in Section 2.4

Course Learning Outcomes (CLOs)	Teaching Methods compliant with CLOs	Evaluation Methods compliant with CLOs
CLO 1	• Lectures • Examples • In-class exercises • Individual assignments	• Assignment evaluation • Assessment of assigned exercises • Exams****
CLO 2	• Lectures • Examples • In-class exercises • Individual assignments	• Assignment evaluation • Assessment of assigned exercises • Exams****
CLO 3	• Lectures • Examples • In-class exercises • Individual assignments • Supervision sessions	• Assignment evaluation • Assessment of assigned exercise • Exams ****
CLO 4	• Lectures • Examples • In-class exercises • Individual assignments • Supervision sessions	• Assignment evaluation • Assessment of assigned exercise • Exams****
CLO 5	• Lectures • Examples • In-class exercises • Individual assignments • Supervision sessions	• Assignment evaluation • Assessment of assigned exercise • Exams****

*Remark: * Lecture on the concept of the topic is introduced with basic or fundamental definitions, visualization, and correlations. For the complicated equation, the derivation from the basic laws can be shown to students. So, the students do not memorize the equations but understand the basic concept and basic equation. The lecturer will introduce the advanced*

and new concepts, technologies, and findings to students from publications such as journals and websites and from the research and industrial experiences.

*** Active learning by asking questions related to the topic in the lecture and encouraging the students to respond to the questions. If the students cannot respond with answers, then the lecturer will give some guidance until the students can respond.*

**** Quiz in the closed-book format on the basic concepts and equations with simple problem solving to evaluate their learning. The solution will be given to students after grading, so they can identify their mistakes and weakness.*

***** Exam on the basic concepts and equations with simple problem-solving in the closed-book format as a review, whereas the complicated/integrated problem solving will be worked in the open-book format.*

Section 4: Lesson Plan and Evaluation

1. Lesson Plan

Week	Topics/Details	CLOs	Hours	Learning and teaching activities; teaching media (if any)	Lecturer
1	Chapter 1: Asymptotic Notation	CLO 1	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 1	Ekkapot
2	Chapter 2: Mathematical Induction	CLO 1	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 2	Ekkapot
3	Chapter 3: Data Structures (Part I): Stack, Queue, Heap Priority Queue	CLO 1 CLO 2 CLO 3	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 3	Ekkapot
4	Chapter 4: Data Structures (Part II): Hash Table and Hashing Techniques	CLO 1 CLO 2 CLO 3	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 4	Ekkapot
5	Chapter 5:	CLO 1	3.0	• Lecture presentation slides • Q&A	Ekkapot

	Searching and Sorting Algorithms	CLO 2 CLO 3 CLO 4 CLO 5		• Examples • Problem Set 5	
6	Chapter 6: Divide-and-Conquer Algorithms	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 5	Ekkapot
7	Chapter 7: Dynamic Programming	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 6	Ekkapot
8	Chapter 8: Greedy Algorithms	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 7	Ekkapot
9	Midterm Exam	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Written Exam	Ekkapot
10	Chapter 9: Graph Algorithms (Part I): Graph Traversal Techniques (DFS and BFS), Topological Sorting, Cycle Detection	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 8	Ekkapot
11	Chapter 10: Graph Algorithms (Part II):	CLO 1 CLO 2 CLO 3	3.0	• Lecture presentation slides • Q&A • Examples	Ekkapot

	Djikstra's algorithm, The Bellman-Ford algorithm	CLO 4 CLO 5		• Problem Set 8	
12	Chapter 11: Graph Algorithms (Part III): Floyd-Warshall algorithm, Johnson's algorithm	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 8	Ekkapot
13	Chapter 12: Theory of NP-Completeness: Optimization and Decision Problems, Karp Reduction, NP-Completeness Proof	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 9	Ekkapot
14	Chapter 13: Approximation Algorithms	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 9	Ekkapot
15	Chapter 14: State-Space Search: Brute-Force Search, Backtracking, Branch & Bound	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 10	Ekkapot
16	Chapter 15: Randomized Algorithms	CLO 1 CLO 2 CLO 3 CLO 4 CLO 5	3.0	• Lecture presentation slides • Q&A • Examples • Problem Set 10	Ekkapot
17	Final Exam	CLO 1 CLO 2 CLO 3	3.0	• Written Exam	Ekkapot

		CLO 4 CLO 5			
		Total	51.0		

2. **Evaluation Plan (in accordance with OBE 2 mapping framework)**

Course Learning Outcomes (CLOs)	Evaluation Methods	Week of Evaluation	Percentage of Evaluation
CLO 1, 2, 3, 4, 5	10 Assignments	1-16	50%
CLO 1, 2, 3, 4, 5	2 Exams: Midterm 20% and Final 30%	9,17	50%

Section 5 Teaching/Learning Resources

Textbooks and materials

1. E. Charoenwanit. Efficient Algorithms (Presentation Slides)
2. Cormen, T. H., & Cormen, T. H. 2001. Introduction to algorithms. Cambridge, Mass: MIT Press.
3. Jon Kleinberg and Eva Tardos. 2005. Algorithm Design. Addison-Wesley Longman Publishing Co., Inc., USA.
4. Anany V. Levitin. 2002. Introduction to the Design and Analysis of Algorithms. Addison-Wesley Longman Publishing Co., Inc., USA.

Section 6 Course Evaluation and Improvement

1. **Course evaluation by students**

The students will have an opportunity to evaluate the effectiveness of the course in the form of paper-based surveys and group interviews at the end of each semester. The results of the survey and the interview including the grading will be reviewed by the curriculum committee to evaluate the course's effectiveness.

2. **Strategies for assessing learning management**

The students will have an opportunity to evaluate the teaching in the form of paper-based surveys and group interviews at the end of each semester. The results of the survey and the interview including

the grading will be reviewed by the curriculum committee to evaluate the teaching. The lecturer will be informed of the evaluation for future improvements.

3. **Improvement schemes of course implementation**

The evaluation from the students including the grading will be submitted to the curriculum committee for reviewing and brainstorming to improve the teaching of each course. Comments and suggestions given by the curriculum committee will be informed to the responsible lecturer of each course.

4. **Verification of students' learning outcomes, referred to OBE 2 and 3**

The grading of this course will be evaluated and reviewed by the Department meeting and the TGGS executive board meeting in order to verify its appropriateness before the final approval.

5. Course review and improvement plans

The results of the grading evaluation and student evaluation will be submitted to the curriculum committee for reviewing and brainstorming to improve the effectiveness of the offered courses. Comments and suggestions will be informed to the responsible lecturer of each course.