University of Engineering and Technology
School of Computer Science
Syllabus of Course
Academic Period 2018-II

1. **Code and Name:** CS3102. Advanced Data Structures
2. **Credits:** 4
3. **Hours of theory and Lab:** 2 HT; 4 HL;
4. **Professor(s)**

   Meetings after coordination with the professor
5. **Bibliography**

[Chá+01] E. Chávez et al. "Proximity Searching in Metric Spaces". In: *ACM Computing Surveys* 33.3 (Sept. 2001), pp. 273–321.

[Cua+04] Ernesto Cuadros-Vargas et al. "Implementing data structures: An incremental approach". http://socios.spc.org.pe/ecuadros/cursos/pdfs/. 2004.

[Gam+94] Erich Gamma et al. *Design Patterns: Elements of Reusable Object-Oriented Software*. Computing Series. ISBN-10: 0201633612. Addison-Wesley Professional, Nov. 1994.

[GG98] Volker Gaede and Oliver Günther. "Multidimensional Access Methods". In: *ACM Computing Surveys* 30.2 (1998), pp. 170–231.

[Knu07a] Donald Ervin Knuth. *The Art of Computer Programming, Fundamental Algorithms*. 3rd. Vol. I. 0-201-89683-4. Addison-Wesley, Feb. 2007.

[Knu07b] Donald Ervin Knuth. *The Art of Computer Programming, Sorting and Searching*. 2nd. Vol. II. 0-201-89685-0. Addison-Wesley, Feb. 2007.

[PI06] Trevor Darrell PGregory Shakhnarovich and Piotr Indyk. *Nearest-Neighbor Methods in Learning and Vision: Theory and Practice*. 1st. ISBN 0-262-19547-X. MIT Press, Mar. 2006.

[Sam06] Hanan Samet. *Foundations of Multidimensional and Metric Data Structures*. Illustrated. Elsevier/Morgan Kaufmann, 2006. ISBN: 9780123694461. URL: `http://books.google.com.pe/books?id=vO-NRRKHG84C`.

[Tra+00] C. Traina Jr et al. "Slim-Trees: High Performance Metric Trees Minimizing Overlap between Nodes". In: *Advances in Database Technology - EDBT 2000, 6th International Conference on Extending Database Technology*. Vol. 1777. Lecture Notes in Computer Science. Konstanz, Germany: Springer, Mar. 2000, pp. 51–65.

[Zez+07] Pavel Zezula et al. *Similarity Search: The Metric Space Approach*. 1st. ISBN-10: 0387291466. Springer, Nov. 2007.

6. **Information about the course**

   (a) **Brief description about the course** Algorithms and data structures are a fundamental part of computer science that allow us to organize information in a more efficient way, so it is important for every professional in the area to have a solid background in this regard.

   In the course of advanced data structures our goal is for the student to know and analyze complex structures, such as Multidimensional Access Methods, Space-Time Access Methods and Metric Access Methods, etc.

   (b) **Prerrequisites:** CS2102. Analysis and Design of Algorithms. (5^{th} Sem)

   (c) **Type of Course:** Mandatory

   (d) **Modality:** Face to face

7. Specific goals of the Course

- That the student understands, designs, implements, applies and Propose innovative data structures to solve problems related to the handling of multidimensional data, retrieval of information by similarity, search engines and other computational problems.

8. Contribution to Outcomes

a) An ability to apply knowledge of mathematics, science. (**Familiarity**)

b) An ability to design and conduct experiments, as well as to analyze and interpret data. (**Usage**)

c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. (**Familiarity**)

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9. Competences (IEEE)

C1. An intellectual understanding and the ability to apply mathematical foundations and computer science theory.⇒ **Outcome a**

C20. Ability to connect theory and skills learned in academia to real-world occurrences explaining their relevance and utility.⇒ **Outcome b**

CS2. Identify and analyze criteria and specifications appropriate to specific problems, and plan strategies for their solution.⇒ **Outcome c**

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10. List of topics

1. Técnicas Básicas de Implementación de Estructuras de Datos
2. Métodos de Acceso Multidimensionales
3. Métodos de Acceso Métrico
4. Métodos de Acceso Aproximados
5. Seminarios

11. Methodology and Evaluation
Methodology:

Theory Sessions:
The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

Lab Sessions:
In order to verify their competences, several activities including active learning and roleplay will be developed during lab sessions.

Oral Presentations:
Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

Reading:
Throughout the course different readings are provided, which are evaluated. The average of the notes in the readings is considered as the mark of a qualified practice. The use of the UTEC Online virtual campus allows each student to access the course information, and interact outside the classroom with the teacher and with the other students.
Evaluation System:

12. Content

Unit 1: Técnicas Básicas de Implementación de Estructuras de Datos (16)	
Competences Expected: C1	
Learning Outcomes	**Topics**
• That the student understands the basic differences that involve the different techniques of implementation of data structures[Usage] • That the student analyze the advantages and disadvantages of each of the existing techniques[Usage]	• Structured Programming • Object-oriented programming • Abstract Data Types • Independence of the user programming language of the structure • Platform Independence • Concurrency control • Data Protection • Encapsulation levels (struct, class, namespace, etc)
Readings : [Cua+04], [Knu07a], [Knu07b], [Gam+94]	

Unit 2: Métodos de Acceso Multidimensionales (16)	
Competences Expected: C20	
Learning Outcomes	**Topics**
• That the student understands to know and implement some Access Methods for multidimensional data and temporal space[Usage] • That the student understands the potential of these Access Methods in the future of commercial databases[Usage]	• Access Methods for Point Data • Access Methods for non-point data • Problems with dimension enhancement
Readings : [Sam06], [GG98]	

Unit 3: Métodos de Acceso Métrico (20)	
Competences Expected: C24	
Learning Outcomes	**Topics**
• That the student understands to know and implement some methods of metric access[Usage] • That the student understands the importance of these Access Methods for Information Retrieval by similarity[Usage]	• Metric Access Methods for discrete distances • Metric Access Methods for Continuous Distances
Readings : [Sam06], [Chá+01], [Tra+00], [Zez+07]	

Unit 4: Métodos de Acceso Aproximados (20)	
Competences Expected: C1	
Learning Outcomes	**Topics**
• That the student understands to know and implement some approximate access methods[Usage] • That the student understands the importance of these Access Methods for Information Retrieval by Similarity in environments where Scalability is a very important factor [Usage]	• Space Filling Curves • Locality Sensitive Hashing
Readings : [PI06], [Zez+07], [Sam06]	

Unit 5: Seminarios (8)	
Competences Expected: C20	
Learning Outcomes	**Topics**
• That the student can discuss the latest advances in access methods for different domains of knowledge [Usage]	• Access Methods Temporary Space • Generic Data Structures
Readings : [Sam06], [Chá+01]	