Logic & Computability

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Fall 2024/25

Istanbul Technical University
Computer Engineering Department

Syllabus

W	Date	Covers	Subject	Announce	Submit
1	30th Sep	1	Introduction to Logic and Computability	TP	
2	07th Oct	1	Propositional Logic, Proof, Deduction, Induction		
3	14th Oct	1	Predicate Logic	A1	
4	21st Oct	1	Second Order Logic		
5	28th Oct		Republic Day		
6	04th Nov	1, 2	Verification with Model Checking		
7	11th Nov	2, 3	Computation with Boolean Circuits and Automata		
-	18th Nov		Fall Break		
8	25th Nov	2, 3	Turing Machine's Limit, Oracles, Reducibility	A2	A1
9	02nd Dec	1, 3	Polynomial Complexity Classes		MT
A	09th Dec	3, 4	Space and Probabilistic Complexity	$A1_G$	
B	16th Dec	3, 4	Pseudorandomness, One-Way Functions and Cryptography	MT_G	
C	23rd Dec	5	Derandomization and Cryptologic Models		A2
D	30th Dec	5	Computational Learning Theory		
E	06th Jan	7	Quantum Computing (BQP), Quantum XOR-gate, Shor's Algorithm	$A2_G$	TP

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What's the aim of this course?

This course aims to teach principals of computation.

Foundations of computability, inference and proof in common logical models, explanation of inference machines, limits of computation machines, classification and measurement of computation, computation of generalized problems, computability of learning, future of computability

Course Material Ownership

Hints for Success in This Course

Be careful about your communication, especially during written exams.

- ✔ Obey the **exam rules** and keep in mind; solely the answers that are **sound**[a], **consistent**[b] and **non-false**[c] receive points
- ✔ Comprehension is your responsibility, be concise
- ✔ Legibility of your handwriting is the key to successful written communication
- ✔ Arguing from anecdote cannot direct you to a general truth
- ✔ See exam(ple mis)communication (see class files)
- ✔ Never forget the transfer of Kevin Großkreutz to Galatasaray while submitting your assignments (see class files), do incremental uploads
- ✔ Listen, take notes, and take some rest [Hopkin, 2021]
- ✔ Ask in advance, not later!

[a] valid with true premises
[b] does not include contradictions
[c] true

Who's in charge of the course?

The course will be held on Mondays @ 1:30 local time in BBB Z-19.

Instructor Asst. Prof. Dr. Mehmet Tahir SANDIKKAYA
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Course objectives

1. Teaching inference in common logical models
2. Teaching inference machines
3. Teaching the limits of computability
4. Teaching generalized computable system design
5. Introducing novel computation proposals

Learning outcomes

1. Knowing the foundations of computability
2. Being able to infer in logical models
3. Recognizing the machines that could infer
4. Being able to classify computation from several perspectives
5. Knowing the generalized computational models

How to save the princess?

- ✔ At least 15/40 from assignments and quizzes (>15/40 or VF)
- ✔ Collect at least 21/60 in term (>21/60 or VF)
- ✔ Collect at least 40/110 during the course[a] (>40/110 or FF)

How to collect points?

Quantification	Contribution	Time
Assignment	$2 \times 10\% = 20/110$	Weeks 8 & C
Quiz	$2 \times 10\% = 20/110$	Surprise!
Mid-term	$1 \times 30\% = 20/110$	Week 9
Term-project	$1 \times 10\% = 10/110$	Week E
Final	$1 \times 50\% = 40/110$	Week F

[a] >40/110 does not necessarily indicates that your grade will not be FF

Resources

1. [Hein, 2017]
2. [Huth and Mark Ryan,]
3. [Arora and Barak, 2009]
4. [Moore and Mertens, 2011]
5. [Hromkovič, 2009]
6. Check the provided bilingual glossary among course slides

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References

[Arora and Barak, 2009] Arora, S. and Barak, B. (2009). *Computational Complexity: A Modern Approach*. Cambridge University Press. ISBN13: 978-0-521-42426-4.

[Hein, 2017] Hein, J. L. (2017). *Discrete Structures, Logic, and Computability*. Jones & Bartlett Learning. ISBN13: 978-1-284-07040-8.

[Hopkin, 2021] Hopkin, K. (2021). *Your Brain Does Something Amazing between Bouts of Intense Learning*. Accessed on 18.02.2022, https://www.scientificamerican.com/podcast/episode/your-brain-does-something-amazing-between-bouts-of-intense-learning/.

[Hromkovič, 2009] Hromkovič, J. (2009). *Algorithmic Adventures From Knowledge to Magic*. Springer. ISBN13: 978-3-642-42606-3.

[Huth and Mark Ryan,] Huth, M. and Mark Ryan, t. .

[Moore and Mertens, 2011] Moore, C. and Mertens, S. (2011). *The Nature of Computation*. Oxford University Press. ISBN13: 978-0-19-923321-2.