L.079.05743
Quantum Complexity Theory (in English)
Syllabus

Course code: L.079.05743
Course Level: Masters
Instructor: Jun. Prof. Dr. Sevag Gharibian
Office: F2.313
Office hours: 14:00 – 15:00 Wednesdays
Email: sevag.gharibian@upb.de
Classroom: Online asynchronous lectures. All details shared in PANDA.
Class website: http://groups.uni-paderborn.de/fg-qc/courses/UPB_QCOMPLEXITY/2020/UPB_QCOMPLEXITY.html

Note:
All correspondence for the course will be through PANDA. Please ensure you can see course postings there.

1.0 – Major Topics Covered (tentative):

- Review of classical complexity theory
- Review of quantum circuit model and density operator formalism
- Bounded error quantum polynomial time (BQP)
- Linear systems of equations and a BQP-compete problem
- Quantum Merlin Arthur (QMA) and strong error reduction
- Quantum Cook-Levin Theorem
- Quantum-Classical Merlin Arthur (QCMA) and Ground State Connectivity
- Quantum Interactive Proofs
  - Semidefinite programming
  - Matrix Multiplicative Update Weights Method
  - QIP = PSPACE
- Potential additional topics: QMA with multiple unentangled proofs (QMA(2)), QIP with multiple provers sharing entanglement (MIP*), Boson sampling, BQP versus the Polynomial-Time Hierarchy,

2.0 – Class Schedule:
• Lectures: 9:00-12:00 Mondays. Asynchronous online format. Beginning 26.10.2020.
• Tutorial: 11:00-13:00 Tuesdays. Synchronous online format via BigBlueButton. Beginning 10.11.2020.
• Final Exam (first sitting): Either in-person oral exam or take-home written exam, depending on COVID status. Date TBA.
• Final Exam (second sitting): Either in-person oral exam or take-home written exam, depending on COVID status. Date TBA.

3.0 – Grading Scheme:

• The full grade for the course is based on the final exam, which will be oral. The grading scheme for the final exam is as follows:

<table>
<thead>
<tr>
<th>Percentage Range</th>
<th>Grade</th>
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</thead>
<tbody>
<tr>
<td>95% - 100%</td>
<td>1.0</td>
</tr>
<tr>
<td>90% - 94%</td>
<td>1.3</td>
</tr>
<tr>
<td>85% - 89%</td>
<td>1.7</td>
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<tr>
<td>80% - 84%</td>
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<tr>
<td>75% - 79%</td>
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<tr>
<td>0 – 49%</td>
<td>5.0</td>
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• Research project option: You may opt to do a research project instead of a final exam. Research project guidelines will be posted to PANDA.

• Homework: Are graded only for completeness. The bonus points for completing homeworks are as follows. Note the bonus applies only if you pass the final exam.

>= 60% of homeworks completed: 1 step bonus (eg 1.3 to 1.0)
>= 90% of homeworks completed: 2 steps bonus (eg 1.7 to 1.0)