

# Quantum error correction and its relations to statistical physics

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## Overview

Quantum error correction is indispensable to building a quantum computer and protecting quantum information. This rapidly growing field has deep and fruitful connexions to many areas of physics, specifically statistical physics, which lead to new insights and applications. For example, these connexions have enabled the constructions of efficient decoders, the characterization of channel capacity in terms of phase transition, and the discovery of new phases of matter. After a general introduction to the topic of quantum error correction, this course will cover advanced topics, with a special emphasis on its relations to statistical physics. It will present landmark results as well as state-of-the-art current research topics. Although familiarity with either classical linear codes and/or statistical physics could be useful, neither are necessary. Some familiarity with quantum mechanics will be assumed (state vector, matrix algebra, etc.)

The primary objectives of the course are as follows:

- i) Become familiar with modern and advanced research topics in the field of quantum error correction
- ii) Learn how to apply some of the tools of statistical physics to this setting.

<b>Modules/Brief Syllabus</b>	<ul style="list-style-type: none"><li>• Quantum codes, stabilizer formalism &amp; the decoding problem</li><li>• The surface code &amp; topological quantum order</li><li>• Surface code decoding: renormalization, mapping to Ising model, fault tolerance</li><li>• LDPC codes, belief propagation, free-energy and mean-field theory</li><li>• Relations to tensor networks, polar codes and beyond</li></ul>
<b>Course schedule</b>	22-26 Jan, 2018 at IIT Madras (Tentative dates)
<b>Credits</b>	1
<b>Participants</b>	Limited to 50
<b>You may consider attending if you are ...</b>	<ul style="list-style-type: none"><li>• Researchers from industry, R&amp;D laboratories</li><li>• Students (BTech/MSc/MTech/PhD) or Faculty from reputed academic/technical institutions</li></ul> with a background in Electrical Engineering or Physics and are interested in the field of quantum error correction.
<b>Fees</b>	The participation fees for taking the course are as follows. Fees include all instructional materials. <b>Students: Rs. 1000</b> <b>Faculty : Rs. 5000</b> <b>Govt. Research Organizations: Rs. 5000</b>

	<p><b>Industry participants: Rs. 10000</b></p> <p><b>Modes of payment:</b></p> <p>Online transfer:  Account Name: CCE IIT Madras Acc. No.: 36401111110  Branch: SBI, IIT Madras Branch, Chennai , IFSC Code: SBIN0001055</p> <p>OR</p> <p>Demand draft in favour of "Registrar, IIT Madras" payable at Chennai. The demand draft is to be sent to the Course Coordinator at the address given below.</p>
<b>Accommodation</b>	<p>The participants may be provided with hostel accommodation, depending on availability, on payment basis. Request for hostel accommodation may be submitted through the link: <a href="http://hosteldine.iitm.ac.in/iitmhostel/">http://hosteldine.iitm.ac.in/iitmhostel/</a></p>

## Course Faculty

**Prof. David Poulin** is a Professor of Physics at the Université de Sherbrooke since 2008 where he heads the quantum information research center EPIQ. He specializes in theoretical quantum information, with particular interest in fault-tolerant quantum computation and quantum algorithms. He received a MSc from the Université de Montréal under the supervision of Prof. Gilles Brassard and a PhD from the University of Waterloo under the supervision of Prof. Raymond Laflamme. He was a postdoc in the group of Gerard Milburn and Michael Nielsen in Queensland and in the group of John Preskill at Caltech.

## Course Coordinator

**Dr. Pradeep Kiran Sarvepalli** is an Assistant Professor in the Department of Electrical Engineering at the Indian Institute of Technology Madras. His research interests are classical and quantum error correcting codes, quantum cryptography, and quantum computation. He graduated with a PhD. in Computer Science from Texas A&M University. His doctoral dissertation was completed under the supervision of Andreas Klappenecker. He held Postdoctoral Fellowships in the groups of Ken Brown at the Georgia Institute of Technology and Robert Raussendorf at the University of British Columbia.

## Course Coordinator

**Dr. Pradeep Kiran Sarvepalli**

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