LTCC Basic Course

Title: Morse theory, Topology and Robotics.

Basic Details:

- Core Audience: Pure and Applied, 2nd/3rdyr
- Course Format: Extended: 5 x 2hr lectures

Course Description:

- Keywords: Morse functions, Morse inequalities, configuration spaces of mechanisms, mechanical linkages, Betti numbers of configuration spaces, topological problems inspired by robotics.
- Syllabus:

  Lecture 1. Topology of sublevel sets, operation of attaching cells, Morse functions, Morse Lemma, existence of Morse functions, crossing a Morse critical value. Main theorem of Morse theory. Morse inequalities. Examples: spheres, complex projective spaces, etc.

  Lecture 2. Smale's solution of Generalised Poincare Conjecture. H-cobordism theorem. Ideas and techniques of the proof.

  Lecture 3. Planar linkages and their configuration spaces. Formula for their Betti numbers. Walker's Conjecture.

  Lecture 4. Spaces of polygons in high dimensions, classification of these spaces in combinatorial terms.

  Lecture 5. Robot motion planning and topology. Schwarz genus of a fibration. Lusternik-Schnirelmann theory. Topological complexity.

- Recommended reading:
  - J. Milnor, Morse theory. 1963
  - J. Milnor, Lectures on the h-cobordism theorem. 1965.
  - M. Farber, Invitation to topological robotics, EMS, 2008.

- Additional Optional reading:
  - M. Farber and V. Fromm, The topology of spaces of polygons**.** Trans. Amer. Math. Soc. 365 (2013), no. 6, 3097–3114.

- Prerequisites: Basic homology theory of cell complexes, basic knowledge smooth manifolds.

Format:

- No of discussion/problem sheets: 4

- Electronic lecture notes: yes

Lecturer Details:

- Lecturer: Professor Michael Farber
- Lecturer home institution: Queen Mary University of London
- Lecturer e-mail: M.Farber@qmul.ac.uk
- Lecturer telephone number: 07906345551