Network Dynamics
M4A38 Advanced Dynamical Systems
Autumn, 2015

Brief notes on the course content.

More details (assessment etc) will be provided separately. Any questions to mikefield@gmail.com. Provisional schedule is at the end.

The course will be about *dynamics on networks*. We consider various approaches: from physics, engineering, and mathematics and their range (and lack) of applicability to real problems in the physical sciences, and technology. The basic question is that of understanding the *function* of a complex network — how it works and figuring out why it works well.

This is a hard problem.

Topics covered will include:

1. The concept of a network and basic examples (mainly without dynamics). *Invariants* (adjacency matrices, degrees, network graph, etc) and some key definitions (all-to-all coupled, scale free network, hubs, etc).

2. Dynamics (continuous, discrete, hybrid, random). Mainly a review.

3. Reduction to phase oscillator dynamics. Kuramoto systems. Mean field approach.
    (**Physics** viewpoint.) Some mathematics but concentration on the ideas.

4. Synchronization and Synchrony in networks. Chimeras.
    (What can and cannot — yet — be proved.) What is hard.

5. Coupled cell systems. Heterogeneous systems, heteroclinic cycles and networks, bifurcation.

6. Control and delay. (Surprises.)

7. Spike timing dependent plasticity: relative timings.
    (Biology problems: applicability of physics & mathematics viewpoints. Local time.) Unravelling the complexity.

8. Asynchronous networks and event driven dynamics I: motivation and examples.
    (**Engineering** viewpoint.)

9. Asynchronous networks and event driven dynamics II: Functional networks; theory and reductionism revisited. Results.

Extensive notes will be (and were) provided.

Provisional schedule and rooms

October 14	13:00—15:00 Room 139	
October 21	13:00—15:00 Room 139	
October 28	13:00—15:00 Room 139	
November 4	13:00—15:00 Room 642	[*Note room change*]
November 11	13:00—14:00 Room 139	[*Note time*]
November 18	13:00—15:00 Room 642	
November 25	13:00—15:00 Room 642	
December 2	13:00—15:00 Room 130	[*Note room change*]
December 9	13:00—15:00 Room 130	
December 16	13:00—15:00 Room 642	

Prof Michael Field, October 7, 2015.