LTCC Proposed Course

Title: Methods of Industrial Mathematics

Basic Details:

- Core Audience (1st yr mathematicians should manage the maths without difficulty; 2nd/3rdyr may find it helpful to career considerations: app.):
- Course Format (extended or intensive): **Extended**

Course Description:

- Keywords: Industrial Mathematics, Applications, Mechanics, Diffusion, Numerical Methods, Optimisation

Overview

The course will contain mathematics I have used myself or have seen used, and gained a good understanding of including through reviewing and consultancy, in the course of my career as an industrial mathematician. For each topic, introductions of the basic theory will be given, followed by some analytical solutions and numerical methods. The emphasis is very much on how the mathematics has been applied in practice, rather than on the rigorous development of theory, though reference to key textbooks and papers will be made. The course should be accessible to physicists and engineers with a strong mathematical background.

The course will be of duration 10 hours, divided into five two hour sessions. The likely date of the course will be autumn 2017.

Session1

Overview of where mathematics is applied in industry. Some problems of applied dynamics resulting in ordinary differential equations. Solution by explicit Runge-Kutta methods (the algorithm will be presented briefly with reference to its' derivation). Modelling friction.

Session 2

A reminder of the diffusion equation and description of some of its applications. Common boundary conditions. Some analytical solutions in steady state and time-dependent cases. Numerical solution schemes including finite differences in some detail and a very brief introduction to the finite element method describing the huge role of the latter in engineering.

Session 3

A reminder of the equations of fluid flow. Boundary conditions. Some useful analytical solutions used in industry. Jets and their applications and stability. An associated application of Bernoulli's law. An introduction to the concept of a shock.

Session 4

A brief survey of optimisation methods: single variable, multiple variables. Some dangers of applying optimisation methods. Nelder-Mead, genetic algorithms, simulated annealing.

Session 5

Scoping a mathematical modelling problem - specifying the requirements. Designing and writing modelling software to meet the requirements. There are no prerequisites in terms of programming skills in a specific language. The content is intended to be relevant no matter what language is being used. Final thoughts and advice.

- **Recommended reading**: To be extended and confirmed. Certain parts only.

1. Abramovitz and Stegun *Handbook of Mathematical Functions.*
2. Carslaw and Jaeger *Heat Conduction*, Crank *Diffusion*, Davies *Introduction to the Finite Element Method* or more accessible equivalent.
3. Batchelor *Fluid Mechanics*, Chadwick *Continuum Mechanics*
4. Textbook on Optimisation TBD – want to make sure choice is accessible.
5. Probably a textbook on Software Development TBD

Additional Optional reading: Zienkiewicz *The Finite Element Method,* Courant and Friedrichs *Shock Waves*, Hill *Plasticity.*

- Prerequisites: Mathematics or alternatively a strong mathematical background from Physics or Engineering ideally with some fluid and/or continuum mechanics.

Format:

- No of problem sheets (4):
- Electronic copies of slides including some supporting notes. Handouts on certain aspects.
- Necessary support facilities None
- Necessary software requirements for computing facilities. None.
- Lecture/computer session/tutorial/discussion split (hours of each): **10 hours of lectures**

Lecturer Details:

- Lecturer: Dr John Curtis
- Lecturer home institution:UCL
- Lecturer e-mail: John.Curtis@ucl.ac.uk