Module Title: 2E11 Computational Engineering

Code: EEU22E11

Level: Senior Freshman

Credits: 5

Lecturer(s): Prof. Anil Kokaram (akokaram@tcd.ie)

Module Organisation
The module runs for 12 weeks of the academic year and comprises three lectures per week. An assisted assignment is given every week. Total contact time is 44 hours.

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<th>Semester</th>
<th>Start Week</th>
<th>End Week</th>
<th>Lectures per week</th>
<th>Lectures total</th>
<th>Tutorials per week</th>
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<td>1</td>
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Module Description
This is a module on the application of mathematical methods to gain approximate solutions to real world engineering problems. This module demonstrates why there is frequently a need for numerical solutions to real-world problems, and introduces the high level programming environments of Excel, Matlab (and optionally Python) to code basic solutions to Engineering problems. The module also introduces best practice Engineering coding methodology used in companies like Google and YouTube. The Mathematics which underpin this module have been largely covered in previous Mathematics modules. This module therefore provides a link between pure Mathematics and Engineering applications encountered in industry and in research.

Learning Outcomes
On successful completion of this module, students will (be able to):

1. Understand the need for numerical solutions to engineering problems.
2. Understand how numerical methods incur errors.
3. Use Matlab and Excel or Python to implement solutions to Engineering problems.
4. Perform basic statistical analysis.
5. Use the Taylor Series as a basis for error estimation.
6. Find numerical solutions to systems of equations.
7. Perform basic optimization.
8. Program curve fitting methods.
10. Find numerical solutions to differential equations.
11. Apply the finite element method to basic engineering problems.
Module Syllabus

- The need for numerical methods
- Machine representation of numbers and associated errors
- Review of the Taylor Series
- Roots of non-linear equations
- Numerical Methods for Linear Matrix Solutions
- Optimization
- Curve fitting and basic statistics
- Numerical integration
- Numerical differentiation
- Differential equations
- The finite element method

Lab/Assignments
Each topic is covered in podium lectures which include a practical demonstration showing the techniques implemented in Excel or Matlab, and one computer based tutorial which students submit for grading.

Teaching Strategies
Lectures: The teaching strategy broadly follows a single text book [1] for the core material, to assist in student revision. Examples from the lecturers’ research experience are frequently introduced to demonstrate the need for the methods covered.

Tutorials: there are weekly assignments using either Excel or Matlab or Python to implement each numerical method. These are guided by teaching assistants who are recruited from the postgraduate student body in the School of Engineering.

Assessment Modes
The assessment is by a 2 hour examination which is held at the end of the Trinity term and by grading the submitted assignments done on a weekly basis. The written examination carries 70% of the total marks and the graded assignments together carry 30% of the marks.

Recommended Texts