MATH36022 - 2012/2013

General Information

- Title: Numerical Analysis 2
- Unit code: MATH36022
- Credits: 10
- Prerequisites: MATH20602 (Numerical Analysis 1)
- Co-requisite units: None
- School responsible: Mathematics
- Members of staff responsible: Dr. C. Powell.

Specification

Aims

To introduce students to theoretical and practical aspects of best approximation, quadrature, and the numerical solution of ordinary differential equations.

Brief Description of the unit

This module introduces numerical methods for approximating functions and data, evaluating integrals and solving ordinary differential equations. It continues the introduction to numerical analysis begun in MATH20602. It provides theoretical analysis of the problems along with algorithms for their solution. Insight into the algorithms will be given through MATLAB illustrations, but the course does not require any programming.

Learning Outcomes

On completion of the module, students will be familiar with

- the theory of best approximation and how to compute best polynomial approximations in the 2- and ∞-norms,
- the theory and practice of numerical integration,
- the theory and practice of numerical methods for solving ordinary differential equations.

They will also recognize some of the difficulties that can occur in the numerical solution of problems arising in science and engineering.

Future topics requiring this course unit

None.

Syllabus

1. Approximation and Curve Fitting. Best approximation in the 1-norm. Weierstrass' theorem, equioscillation theorem, Chebyshev polynomials. Best approximation in the 2-norm. Orthogonal polynomials. Rational approximation; Padé approximants. [6]
2. Numerical Integration Interpolatory rules. The Romberg scheme: extrapolation using the Euler-Maclaurin summation formula. Gaussian quadrature. Adaptive quadrature. [6]
3. Initial Value Problems for ODEs Introduction and existence theorem. Numerical methods: one step methods and multistep methods. Euler's method. Local truncation error, convergence, local error. Taylor series method. Runge-Kutta methods. Trapezium rule. Functional iteration and predictor-corrector PE(CE)m implementations. Absolute stability. Linear multistep methods. Higher order systems. [10]

Textbooks

1. Endre Süli and David F. Mayers. An Introduction to Numerical Analysis. Cambridge University Press, Cambridge, UK, 2003. ISBN 0-521-00794-1. x+433 pp.

2. Richard L. Burden and J. Douglas Faires. Numerical Analysis. Brooks/Cole, Pacific Grove, CA, USA, seventh edition, 2001. ISBN 0-534-38216-9. xiii+841 pp.
3. James L. Buchanan and Peter R. Turner. Numerical Methods and Analysis. McGraw-Hill, New York, 1992. ISBN 0-07-008717-2, 0-07-112922-7 (international paperback edition). xv+751 pp.
4. David Kincaid and Ward Cheney. *Numerical Analysis: Mathematics of Scientific Computing*. Brooks/Cole, Pacific Grove, CA, USA, third edition, 2002. ISBN 0-534-38905-8. xiv+788 pp.
5. David Nelson, editor. *The Penguin Dictionary of Mathematics*. Penguin, London, fourth edition, 2008. ISBN 978-0-141-03023-4. 480 pp.

Teaching and learning methods

Two lectures and one examples class each week. In addition students should expect to spend at least four hours each week on private study for this course unit.

Assessment

Mid-semester test: weighting 20%
End of semester examination: two hours weighting 80%

Arrangements