ENGINEERING MATHEMATICS FOR THE 1990's
REPORT OF IMS/SEFI MWG JOINT MEETING,
University College, Dublin
September 3rd and 4th 1990

This meeting was organised by the Irish Mathematical Society and the Mathematics Working Group of S.E.F.I. (Société Européan pour la Formation de Ingénieurs) to coincide with and complement the S.E.F.I. Annual Conference, hosted this year by the Engineering Faculty of University College, Dublin.

The meeting was held in UCD's new Engineering Building and the delegates were welcomed by the Dean of Engineering, Professor V. McCabe. Then the chairman of the S.E.F.I. Mathematics Working Group (S.M.W.G.), Professor L. Rade (Gothenburg) formally opened the meeting. The papers can be divided into three (related) themes:

- curriculum and teaching developments
- current research in mathematics related to engineering
- use of computers in engineering mathematics

Curriculum and Teaching

A major reason for holding the meeting was to air the (nearly completed) S.M.W.G. report on a core curriculum in engineering mathematics.

P. Nuesch (Lausanne) (S.E.F.I.'s next president) spoke about the need for mathematicians to adapt to the newer types of engineering, for co-operation between universities in Western Europe and in Eastern Europe, for S.E.F.I. and S.M.W.G. to address the issue of mutual recognition of qualifications, as required by the E.C. from 1993.

E. Murphy (Limerick) addressed the issue of the role of statistics in engineering education but with particular reference to quality and reliability. He quoted a 1989 report by American Management Association which said that engineering students must study more statistics to enable them to cope with these issues. Attempts to reduce statistics to a black box package should be resisted, rather we should ensure that our graduates have a good scientific base, to enable them to benefit fully from the rest of their 'formation'.

G. James (Coventry), former chairman of the S.M.W.G. presented the report on the curriculum. Among the factors listed were:

- need to balance theory and applications, analytic and numerical methods
- need to provide coverage of mathematical ideas and techniques of current applicability
- need to provide coverage of mathematical ideas that will provide a foundation for future study

The document caused much discussion, and although generally welcomed, there were reservations about some its recommendations. For example D. McHale (Cork) agreed that one role of mathematics was to improve an engineer's creativity, whereas F. Hodnett (Limerick) was disappointed to see that special functions had been squeezed out.

Addressing pedagogical issues, M. Attenborough (London) argued that the concept of a system is fundamental to engineering, as it is to applied mathematics. And J. Kennedy (Dublin) discussed the integration of numerical methods and computing into mathematics teaching, and he illustrated some of the problems that packages implementing standard numerical methods can give rise to if used without understanding.

Mathematics Related to Engineering

The papers presented on this theme were designed to illustrate the type of mathematics that is currently used by mathematicians when addressing engineering problems, and so may reflect back on the engineering mathematics curriculum

P. Fitzpatrick (Cork) gave an illuminating talk showing how aspects of abstract algebra and number theory are now finding application in computer engineering. For example in coding theory, cyclic codes draw on the rich algebraic structure of ideals,

and convolution codes use an extended version of the familiar Euclidean algorithm. Similarly in the study of IIR filters algebraists have introduced a "signed binary redundant number system" to ensure that the most significant digits in a calculation are those that are calculated first.

A. Wood (Dublin) described a problem which originated in the real engineering requirement of estimating leakage at bends in optical fibres. His approach to this modern problem showed how some very classical ideas in Applied Mathematics (Sturm-Liouville problems, Airy functions, contour integration, Stoke's phenomenon) retain their relevance to engineering.

M. Newman and A. Roberts (Belfast) jointly described a stochastic feedback control problem where the approach to the solution depends on a spectral decomposition of polynomial matrices.

P. Boland (Dublin) gave a brief review of reliability—a topic that uses probability, statistics and calculus.

Also on the topic of reliability, L. Rade (Gothenburg) described his use of the symbolic algebra package MATHEMATICA for doing calculations that arise in reliability theory.

Rade was followed by C. Wolfram from Wolfram Research, the designers of MATHEMATICA. He gave an overview of the package.

Computing in Mathematics Teaching

A number of case studies relating to this theme were presented. In Eindhoven, computing is fully integrated into the early calculus and linear algebra courses. J. Smits described how PC-MATLAB is used as the vehicle to teach a first linear algebra course which has matrix decomposition as its core. At present the course is still examined in the traditional way, but they are moving to a situation in which computing will be involved in that process too.

D. Sprevak (Belfast) described two programs (FLIP and NAN-OPT) that he uses to teach numerical optimisation to engineering students.

In separate talks P. Boieri (Turin) and C. Mate (Madrid) described their approaches to the introduction of computing into engineering mathematics courses.

The concluding paper of the meeting was a well illustrated talk by W. Schauffelberger (Zürich) who described the Project-

Zentrum IDA in the ETH in Zürich. This government financed centre is concerned with integrating computers, especially workstations, into engineering and scientific education. Its aim is to equip ETH with one workstation per five students by 1991 so that students can spend roughly one day per week on computer driven tasks.

R. H. Critchley
Department of Mathematics
University of Limerick

D. W. Lewis
Department of Mathematics
University College, Dublin