1E1 ENGINEERING MATHEMATICS I [5 credits]

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Module organisation

The module runs for the first half (12 weeks) of the academic year and comprises of three lectures and one tutorial per week (total of 44 hours contact time).

Module description, aims and contribution to programme

Engineering Mathematics I is a half-year module taken by all Junior Freshman Engineering and Engineering with Management students. It starts with the calculus of functions of one real variable, formalising and building on Leaving Certificate mathematics. The module emphasises both theoretical foundations of calculus and application of mathematical methods and is intended to enable students to recognise mathematical structures in practical problems, to translate problems into mathematical language and to apply differentiation and integration to solve them.

Learning outcomes

Upon completion of this module, students will be able to:

1. Recognise mathematical structures in practical problems, translate problems into mathematical language, and analyse problems using methods from one-dimensional calculus;
2. Solve problems involving concepts of calculus;
3. Apply differentiation to solve practical problems and to graph a wide range of functions of one real variable;
4. Apply integration to solve geometrical problems such as computing the area or volume of solids of revolution;
5. Use standard computer input for mathematical expressions.

Module content

Functions: definition, domain and range, operations with functions, inverse function, graphs, notions of rational, algebraic, and trigonometric functions;

Limits and Continuity: Two-sided, one-sided, and infinite limits, limit at infinity and asymptotes; continuity, delta-epsilon language, intermediate-value and squeezing theorems;

Differentiation of functions of one variable: the derivative function, techniques of differentiation, implicit differentiation, related rates problems and the local linear approximation;

Derivatives in graphing and applications: Analysis of functions, graphing polynomials and rational functions, applied maximum and minimum problems and the Newton-Raphson method;

Integration: antiderivatives and introduction to integration, Riemann Sums, integration by substitution and the Fundamental Theorem of Calculus;

Applications of the Definite Integral in Geometry: area between curves, volumes and areas of solids of revolution and length of a plane curve.

Teaching strategies

The teaching strategy is a mixture of lectures and problem-solving tutorials. The format of lectures is conventional, however, the atmosphere is informal, and interaction and discussion is normal. Students are encouraged to ask questions in the lectures. In the tutorials, the students work on problems to practise and apply the methods introduced in the lectures. Discussion of problems in small groups is encouraged and facilitated.

Assessment

Weekly continuous assessment together with a team project contributes 20% towards the final grade with the end-of-year final written two-hour examination contributing 80%.

Recommended textbooks

Main text for the course:

- "*Calculus: Late Transcendentals*" Howard Anton, Irl Bivens, Stephen Davis.

There are several copies in the Hamilton library. There exist different versions and editions of the same book or parts of it, with different subtitles. Some of them only contain the first 8 or 9 chapters and are subtitled "Single Variable". This is sufficient for the course I am teaching, but some material needed for the second semester (1E2) is missing. If you intend to buy the book probably is better that you make sure to buy an edition that covers both 1E1 and 1E2.

Additional interesting reference books:

- "*Calculus - An Intuitive and Physical Approach*". Morris Kline.
- "*Calculus*". M. Spivak.
- "*Mathematics Its Content, Methods, and Meaning*". M. A. Lavrentev, A. D. Aleksandrov, A. N. Kolmogorov.