

ENGINEERING MATHEMATICS EE2Y

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| Course code | 7LYV |
| GU Credits | 10 |
| ECTS Credits | 5 |
| Corequisite course(s) | Engineering Mathematics EE2X (7LXV) |
| Teaching staff (the first has overall responsibility) | Dr M Sorel (telephone 5229, email M.Sorel) Prof D Hutchings (telephone 6026; email D.Hutchings) |
| Approximate size of class | 60 students |
| Semester | 2 |

Description of course

20 lectures, 2 laboratories, and 5 tutorials

Notes

The course will follow the book *Engineering Mathematics* by Croft, Davison and Hargreaves.

Course Aims

To provide an introduction to the mathematical techniques and symbolism required by electronic and electrical engineers in a variety of applications.

Intended Learning Outcomes

By the end of this course the student will be able to:

- determine partial derivatives and use them in the analysis of multi-variable functions
- evaluate line integrals in a multi-dimensional space
- evaluate surface and volume integrals
- determine Fourier series for certain periodic functions
- analyse the response of a linear system to a periodic input
- use simple mathematical software (e.g. Mathematica) to analyse multi-variable and harmonic analysis problems

Syllabus**1. Calculus with many variables**

Revision of material to be used in course, particularly techniques of differentiation.

Appreciate origin of functions of many variables, e.g. robot arm, electromagnetic fields.

Define partial derivatives; understand difference between '∂' and 'd'; explain equality of mixed second derivatives. Deduce partial derivatives of simple functions from the definition. Calculate partial derivative using same methods as ordinary derivatives, including implicit differentiation, and chain rule for partial derivatives, including special cases where only one variable is involved.

Use chain rule to convert derivatives between rectangular and polar coordinates.

Use partial differentiation to derive rules for combining errors (used in first year).

Write down Taylor's theorem for functions of many variables and use it for straightforward functions.

Interpret plots of surfaces and contour diagrams for functions of two variables; identify level lines, maxima, minima, and saddle points.

Define and calculate the gradient vector and explain its magnitude and direction; understand that this is the relation between electrostatic field and potential.

Locate and identify local maxima, minima and saddle points of a function of two variables; optimize functions of two variables.

Define and evaluate integrals along a line in the plane; appreciate that the result may depend on the path as well as the endpoints.

Demonstrate that a double (area) integral may be written as two repeated single integrals; evaluate such integrals over simple areas; same for triple (volume) integrals.

Practical work:

Plot given functions of x and y to reveal their important features and locate stationary points.

Optimize functions of two variables, e.g. milk carton including seams.

2. Fourier series

Revision of material to be used in course, particularly techniques of integration. Revision of linear systems and superposition: understand why the response to a sine wave is useful.

Identify period, ordinary and angular frequency of a periodic function. Derive Fourier's theorem and the expressions for the sine and cosine coefficients. Recognise odd and even symmetry (or their absence) and know which terms in the series must be identically zero.

Calculate Fourier series for functions that may be piecewise constant, linear, parabolic, exponential or trigonometric. Know that convergence is slow if function has discontinuities.

Use special values of Fourier series to evaluate certain infinite sums. Derive complex Fourier series from real forms and know relation between coefficients. Calculate complex Fourier series for some classes of functions. Use Fourier analysis and transfer function to calculate output of a simple circuit for a periodic input (e.g. RC filter, free integrator). Define power spectrum and deduce it from Fourier series; use (but not prove) Parseval's theorem to relate integrated power spectrum to function in time.

Practical work

Calculate behaviour of a Rectifier circuit using Fourier series.

Compose Fourier series to match given waveforms; recognise effect of particular low harmonics.

Recommended books

| Authors | Title, edition | Publisher | ISBN | Code |
|-------------------------------------|--|----------------|------------|------|
| A Croft, R Davison and M Hargreaves | Engineering Mathematics (3 ed) | Addison-Wesley | 0130268585 | A |
| G James and others | Modern Engineering Mathematics (3 ed) | Addison-Wesley | 0130183199 | C |
| G James and others | Advanced Modern Engineering Mathematics (2 ed) | Addison-Wesley | 0201565196 | C |
| K A Stroud | Engineering Mathematics (4 ed) | Macmillan | 0333620224 | C |
| K A Stroud | Further Engineering Mathematics (3 ed) | Macmillan | 0333657411 | C |

Codes : A = compulsory; B = strongly recommended; C = recommended; D = wider reading

Study times

| Type | Hours |
|--------------------------------|--------------|
| Lectures and tutorials | 25 |
| Laboratory project and report | 15 |
| Tutorial sheets | 20 |
| Self study | 25 |
| Final revision and examination | 15 |

These times are a rough estimate of the work required outside formal classes by a typical student. There will be wide variations between individuals, but you will run a grave risk of failure if you spend significantly less time on this course than these guidelines suggest.

Assessment

| % | Type | Details |
|----------|--------------------|--|
| 15 | Coursework | Consolidated mark from two laboratory reports and selected tutorial questions. Attendance at laboratory session and submission of coursework is a requirement for the award of credit. |
| 85 | Degree Examination | 90 minute paper; all questions compulsory |

The degree examinations are held in week 26 onwards; a resit is available in August.