ZPEM2302 – Mathematical Tools for Science
MVC component

Taught in Three Sections

- Differential Calculus
- Integral Calculus
- Vector Calculus

Differential Calculus

Surfaces

- Cross-sections
- Contours (data)
- Functions as a table of values (data)
- Functions of three (or more) variables

Differential Calculus

Partial derivatives

- ☐ Calculating it algebraically
- ☐ Estimating from a contour plot
- ☐ Estimating from a table of values (data)

The Gradient (vector)

- ☐ Properties
- ☐ Directional derivative

Differential Calculus

Example

The wind-chill index I is the *perceived* temperature when the *actual* temperature is T and the wind speed is v. We can thus write $I = f(T, v)$. Below is a table of values of I compiled by a meteorologist.

Wind Speed (km/h)

Actual Temperature (°C) T \ v	10	20	30	40	50	60	70	80	90	100
20	18	16	14	13	13	12	12	12	12	12
16	14	11	9	7	7	6	6	5	5	5
12	9	5	3	1	0	0	-1	-1	-1	-1
8	5	0	-3	-5	-6	-7	-7	-8	-8	-8

Integral Calculus

Double and Triple Integrals

- ☐ Finding limits – reversing the order of integration
- ☐ Estimating from a table of values (data)
- ☐ Cylindrical and Spherical Co-ordinates

Applications of Double and Triple Integrals

- ☐ Area and Volume
- ☐ Populations
- ☐ Mass, centre of mass, moments of inertia
- ☐ Calculating probabilities

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Vector Calculus

Vectors and Vector Fields

- ☐ Curves in space – Position and Velocity vector
- ☐ Parameterising curves
- ☐ Definition of a vector field and examples
- ☐ Gradient fields

Line Integrals

- ☐ Definition
- ☐ Interpretations – work and circulation
- ☐ Path independence

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Vector Calculus

Flux Integrals

- Surface element and surface integral
- Definition of flux
- Evaluation flux integrals

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Vector Calculus

Major Theorems

- Divergence Theorem
  - Divergence of a vector field
- Stokes' Theorem
  - Curl of a vector field

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Vector Calculus

Some PDEs used in Science

- ☐ Laplace's equation
- ☐ Diffusion equation
- ☐ Wave equation
- ☐ Navier-Stokes equation
- ☐ Different co-ordinate systems

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