

Module code

SPM-3415

Type of module

Undergraduate: Mathematical Sciences – Elective

Integral Equations



Modular credits

4

Total student
engagement

56 hours

Prerequisite

**SPM-2202 (Linear
Algebra and its
Applications)**

Anti-requisite

None

Aims

To develop students' ability to analyse, solve, and prove results involving Volterra and Fredholm integral equations using concepts from functional analysis and operator theory.

Module learning outcomes (MLO)

On successful completion of this module, a student will be expected to be able to:

MLO 1

Analyse the fundamental concepts of normed spaces, Banach spaces, inner product spaces, and Hilbert spaces.

MLO 2

Analyse the properties of linear operators, including boundedness and continuity, and apply the Banach theorem and spectral radius formula.

MLO 3

Solve Volterra integral equations and evaluate the conditions for solvability and uniqueness, including their relationship with Fredholm integral equations.

MLO 4

Evaluate resolvent kernels and iterated kernels for Fredholm equations with bounded and degenerate kernels.

MLO 5

Construct and prove results on the solvability of Fredholm integral equations with summable and degenerate kernels.

Module contents

Normed spaces. Completeness. Banach Spaces. Spaces with inner product. Hilbert Spaces

Linear operators. Boundedness and continuity. Space of bounded linear operators $B(X)$

Series in $B(X)$. Invertibility. Banach theorem. Spectral radius. Integral operators and their norms

Fixed point theorem. Volterra integral equations. Solvability and uniqueness of solutions

Connections between Volterra and Fredholm integral equations

Fredholm equations with bounded kernels. Resolvent and iterated kernels. Equations with square summable kernels. Equations with degenerate kernels. Solution of Fredholm equations with degenerate kernels

Fredholm theory for equations with degenerate kernels. Summable kernels. Hilbert-Schmidt theory. Integral equations with weakly singular kernels

Assessment

60%

Examination

40%

Coursework



■ Examination — 60% ■ Class tests — 30% ■ Assignment — 5% ■ Tutorial Participation — 5%

Formative assessment

Weekly discussion and feedback

Summative assessment

COMPONENT	WEIGHTING
Examination	60%
Coursework	40%
Individual	40%
Class tests	30%
Assignment	5%
Tutorial Participation	5%

Graduate attributes and skills

Programme learning objectives (PLO) addressed

- 1** PLO 1 (Core Mathematical Knowledge)
- 4** PLO 4 (Mathematical Communication)

- 2** PLO 2 (Analytical Problem-Solving)

Sustainability concept addressed

- 4** SDG 4 Quality Education

Digital skills/software used (not limited to)

- Organisational tools (e.g. Outlook calendar)
- Mathematical and computational software (e.g. MATLAB, Mathematica)
- Learning management and collaboration platforms (e.g. Canvas)

Micro-credentialling option

No

Stackable towards GenBESTARI Undergraduate Degree Programme or other relevant Lifelong Learning Programmes

No

Document details

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