

Module code

SPM-3404

Type of module

Undergraduate: Mathematical Sciences – Elective

Dynamical Systems and Chaos



Modular credits

4

Total student engagement

56 hours

Prerequisite

SPM-2205 (Ordinary Differential Equations)

Anti-requisite

None

Aims

To develop students' ability to analyse nonlinear dynamical systems and chaotic behaviour using analytical and computational techniques, and to interpret stability, bifurcations, fractals, and strange attractors in natural and applied science contexts.

Module learning outcomes (MLO)

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

MLO 1

Analyse and classify one- and two-dimensional dynamical systems, assessing stability and long-term behaviour.

MLO 2

Apply and interpret bifurcation theory, limit cycles, and chaos to explain complex system dynamics.

MLO 3

Utilise computational and software tools to simulate nonlinear systems and evaluate their qualitative behaviour.

MLO 4

Critically communicate and evaluate mathematical findings effectively through clear reports and presentations.

Module contents

Introduction to dynamical systems: Chaos, fractals, and dynamics

One-dimensional flows: Nonlinearity, fixed points and stability, population growth, linear stability analysis, existence and uniqueness, impossibility of oscillations, potentials, and computational solutions

Bifurcations: Types and examples

Flows on the circle and two-dimensional systems: Linear systems, classification, phase plane and phase portraits, fixed points and linearisation, conservative and reversible systems, pendulum models, index theory

Limit cycles and chaos: Existence, stability, and examples

Fractals and strange attractors: Properties and applications

Assessment

60%

Examination

40%

Coursework

Examination
60%

Class tests
30%

10%

■ Examination — 60% ■ Class tests — 30% ■ Assignment — 10%

Formative assessment

Weekly discussion
and feedback

Summative assessment

COMPONENT

WEIGHTING

Examination

60%

Coursework

40%

Individual

40%

Class tests

30%

Assignment

10%

Graduate attributes and skills

Programme learning objectives (PLO) addressed

1

PLO 1 (Core Mathematical Knowledge)

2

PLO 2 (Analytical Problem-Solving)

3

PLO 3 (Computational And Digital Tools)

4

PLO 4 (Mathematical Communication)

Sustainability concept addressed

4

SDG 4 Quality Education

9

SDG 9 Industry, Innovation and Infrastructure

Digital skills/software used (not limited to)

■ Computational and programming software (Python, MATLAB, Mathematica)

Micro-credentialling option

No

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

No

Document details

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