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| **Module code** | SM-4315 |
| **Module Title** | Dynamical Systems and Chaos |
| **Degree/Diploma** | Bachelor of Science (Mathematics) |
| **Type of Module** | Major Option |

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| **Modular Credits** | 4 | **Total student Workload** | 10 | hours/week |
| | | **Contact hours** | 4 | hours/week |

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| **Prerequisite** | SM-2201 Ordinary Differential Equations |
| **Anti-requisite** | None |

**Aims**

This module aims to teach students the basic concepts of dynamical systems and chaos, enabling them to analyse the behaviour of dynamical systems and investigate their stability. The module will also introduce students to the concepts of chaos, fractals and strange attractors. Each topic shall include applications from various disciplines in the social, medical, biological and physical sciences, as well as other areas.

**Learning Outcomes**

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

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| Lower order : | 40% | - understand the basic principles of dynamical systems and chaos.<br>- Understand how to apply these principles in scientific problems. |
| Middle order : | 40% | - analyse the various equations and how to use them in solving real scientific problems. |
| Higher order: | 20% | - interpret the results of analyses, and make an appropriate report for an effective communication<br>- work independently and play effectively in collaboratively in a team, especially in tutorial class. |

**Module Contents**

- Introduction to dynamical systems. Chaos, fractals, and dynamics.
- Nonlinearity, one-Dimensional Flows, geometric way of thinking, fixed points and stability, population growth, linear stability analysis, existence and uniqueness, impossibility of oscillations, potentials and solving equations using software.
- Bifurcations.
- Flows on the circle. Two-Dimensional Flows. Linear systems. Definitions and examples, classification of linear
- Systems. Phase Plane. Phase portraits, existence, uniqueness, and topological consequences, fixed points and linearisation, rabbits versus sheep, conservative systems, reversible systems, pendulum and index theory.
- Limit Cycles. Chaos.
- Fractals. Strange Attractors.

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| **Assessment** | Formative assessment | Tutorial and feedback. |
| | Summative assessment | Examination: 60% |
| | | Coursework:  40%<br>- 2 tests (30%)<br>- 1 assignment (10%) |