Course Outline

School / Portfolio: Faculty of Science and Technology

Course Title: MODELLING THE ENVIRONMENT

Course ID: MATHS3004

Credit Points: 15.00

Prerequisite(s): (MATHS2001)

Co-requisite(s): Nil

Exclusion(s): Nil

ASCED Code: 010101

Program Level:

<table>
<thead>
<tr>
<th>AQF Level of Program</th>
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<tbody>
<tr>
<td>5</td>
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<tr>
<td>Introductory</td>
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<tr>
<td>Intermediate</td>
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<tr>
<td>Advanced</td>
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Learning Outcomes:

Knowledge:

K1. Model natural processes with mathematical and stochastic methods.

Skills:

S1. Apply the modelling cycle and understand the components of a model.
S2. Compute analytical solutions to systems of ordinary and partial differential equations.
S3. Solve models using matrices and time series analysis.

Application of knowledge and skills:

A1. Use methods of calculus, including numerical approximation by software, for predicting natural phenomena.
A2. Predict outcomes of evolving environmental systems by applying probabilistic methods.

Course Content:

Modelling of environmental systems, through conceptual models showing linkages of variables, and full mathematical models. Using discrete and continuous models of biological, chemical and physical processes, the ecology and physical behaviour of environmental systems is represented by models with analytic or numerical solutions. A range of mathematical methods including: analytic and approximate methods (through spreadsheets) for ordinary differential equations, Fourier series solutions for partial differential
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equations, matrix models and simple difference equations; elementary systems analysis; are used to explore models, and their use in depicting the behaviour of simple physical systems.

Topics may include:

- Introduction and overview of modelling, empirical, dimensional analysis, ordinary differential equations (ODE’s).
- Population like models, development of terms, Von Bertalanffy fish model, Bernoulli differential equations (DE’s).
- Systems of ODE’s: analytical and numerical solution, decomposition of high order DE’s.
- Markov chains, classification and long-run behavior.
- Time Series, Markov annual stream flow.
- Modelling with partial differential equations (PDE’s), directly integrable, advection and method of characteristics.
- Method of separation of variables, Fourier series, Euler’s formulas.
- Dirichlet, Gibbs and Parseval phenomenon, odd and even extensions.
- Diffusion equation with numerical methods.
- Wave equation with numerical methods.

Values and Graduate Attributes:

Values:

V1. Appreciate the roles of mathematics and statistics for finding solution to real world problems.

Graduate Attributes:

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Brief Description</th>
<th>Focus</th>
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</thead>
<tbody>
<tr>
<td>Continuous Learning</td>
<td>The course extracts, from familiar environmental examples, applications for concepts and methods previously learnt, such as ordinary differential equations and calculation of eigenvalues and vectors. Prior knowledge is also generalised for solution of partial differential equations, including advection and diffusion, and construction of Fourier series. Moreover, the ground up development of models will give new perspectives on previous learning and will further develop problem solving skills.</td>
<td>High</td>
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<tr>
<td>Self Reliance</td>
<td>The course provides demonstration of personal achievement through tutorial/laboratory exercises and assignments. Independent, in-depth study of topics summarised in lectures is supported by additional learning materials in the Study Guide.</td>
<td>Medium</td>
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<tr>
<td>Engaged Citizenship</td>
<td>The course develops understanding of mechanisms behind community issues such as water management and multiple populations in support or conflict. The models and processes learned can be used to inform future management of environmental systems.</td>
<td>Medium</td>
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<tr>
<td>Social Responsibility</td>
<td>The course develops ethical communication by including the analysis of assumption in model construction.</td>
<td>Medium</td>
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</table>

Learning Task and Assessment:
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<table>
<thead>
<tr>
<th>Learning Outcomes Assessed</th>
<th>Assessment Task</th>
<th>Assessment Type</th>
<th>Weighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>K1, S1 - S4, A1, A2</td>
<td>Problem solving and modelling techniques, analytical and numerical solution of</td>
<td>Written assignments</td>
<td>30% - 50%</td>
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<tr>
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<td>models involving ordinary and partial differential equations, use of software,</td>
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<td>applied matrix methods, time series analysis.</td>
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<td></td>
<td>Demonstrate knowledge of solution and interpretation of mathematical models.</td>
<td>Written examination</td>
<td>50% - 70%</td>
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**Adopted Reference Style:**