# Simulation modelling 780 (BUY 780)

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| **Qualification** | Postgraduate |
| **Faculty** | Faculty of Engineering, Built Environment and Information Technology |
| **Module credits** | 16.00 |
| **NQF Level** | 08 |
| **Programmes** | BEngHons *Industrial Engineering* |
| | BScHons (Applied Science) *Industrial Systems* |
| **Prerequisites** | BUY 321 or BAN 780 |
| **Contact time** | 24 contact hours |
| **Language of tuition** | Module is presented in English |
| **Department** | Industrial and Systems Engineering |
| **Period of presentation** | Semester 1 or Semester 2 |

## Module content

In recent years, the boundaries between different simulation paradigms such as discrete event simulation, system dynamics and agent-based models have become less distinct. Improvements in computational efficiency also allow much richer and complex models to be built. This module introduces system dynamics (SD) and agent-based models (ABM) as a class of computational models. While SD is concerned with understanding the dynamical interactions amongst the elements of a system covering (man, machine, materials, methods, money and management) in a bid to gain a measurable insight into a system's local and/or global behaviour over a given horizon time for effective decision making, ABS on the other hand is concerned with deploying a collection of autonomous decision-making entities called agents. Inhere, each agent, individually assesses its situation and makes decisions on the basis of a set of rules. ABS addresses autonomous agents and their interactions with other agents, and their surrounding environments. The module content covers basic theoretical foundations of ABM and then focuses on a few specific application areas where ABM is used for decision-making covering: pedestrian and transport models; production and logistics; as well as biology.

Theme 1: **System Dynamics Modelling**

**Block Week1:**

1. **System Behavioural Patterns***:* Exponential growth, goal seeking, s-shaped growth, oscillatory growth.
2. **Delays, Smoothing and Averaging:** Pipeline material flow delays, third order exponential delays, information averaging (moving average, exponential smoothing, information delays).
3. **Representing Decision Processes:** Modelling Decision Processes (Types of Decision Models)-- weighted-average decision models, floating goals, multiplicative decision rules
4. **Nonlinearities***:* Nonlinear responses.
5. **Initial Conditions:** Initialising a model to equilibrium, Simultaneous initial conditions.
6. **Vensim Software Hands-on Demo**: Creating and converting causal loop diagrams to stock and flow diagrams, and conduct of simulations.

Theme 2: **Agent-Based Simulation**

**Block Week 2:**

1. Discrete event simulation overview.
2. Introduction to agent-based simulation and modelling philosophy premised on (routine deployment of human interaction).
3. Agent-based simulation modelling as a decision support tool (based on the principle presented in Macal (2016)).
4. Research in agent-based modelling covering (Design Research Methodology- (as an appropriate methodology for simulation).

**Block Week 3:**

1. Java for AnyLogic
2. Agent-based modelling in AnyLogic

**General Academic Regulations and Student Rules**
The General Academic Regulations (G Regulations) and General Student Rules apply to all faculties and registered students of the University, as well as all prospective students who have accepted an offer of a place at

the University of Pretoria. On registering for a programme, the student bears the responsibility of ensuring that they familiarise themselves with the General Academic Regulations applicable to their registration, as well as the relevant faculty-specific and programme-specific regulations and information as stipulated in the relevant yearbook. Ignorance concerning these regulations will not be accepted as an excuse for any transgression, or basis for an exception to any of the aforementioned regulations. The G Regulations are updated annually and may be amended after the publication of this information.

## Regulations, degree requirements and information
The faculty regulations, information on and requirements for the degrees published here are subject to change and may be amended after the publication of this information.

## University of Pretoria Programme Qualification Mix (PQM) verification project
The higher education sector has undergone an extensive alignment to the Higher Education Qualification Sub-Framework (HEQSF) across all institutions in South Africa. In order to comply with the HEQSF, all institutions are legally required to participate in a national initiative led by regulatory bodies such as the Department of Higher Education and Training (DHET), the Council on Higher Education (CHE), and the South African Qualifications Authority (SAQA). The University of Pretoria is presently engaged in an ongoing effort to align its qualifications and programmes with the HEQSF criteria. Current and prospective students should take note that changes to UP qualification and programme names, may occur as a result of the HEQSF initiative. Students are advised to contact their faculties if they have any questions.