Subject Description Form

Subject Code	AP40008
Subject Title	Simulation Methods in Nonlinear Science
Credit Value	3
Level	4
Pre-requisite/ Co-requisite/ Exclusion	AP20005
Objectives	To provide a broad knowledge of computer simulation techniques for nonlinear systems in science and engineering.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) understand the fundamentals of random processes; (b) apply simple mathematical models to study nonlinear systems; and (c) design, implement, and operate practical algorithms to simulate and study nonlinear systems.
Subject Synopsis/ Indicative Syllabus	**Random processes**: probability; pseudo-random variables; random number generators. **Random walk**: diffusion; random walk; self avoiding walk; polymers in solvents. **Chaos**: population dynamics; logistic map; stability of periodic orbits; period doubling to chaos; chaotic circuits; Lorenz equation. **Fractals**: fractal dimension; Sierpinsky gasket; cantor set; Koch curve; coastlines; percolation. **Neural networks**: perceptrons; multilayer feedforward networks; training algorithms; time series prediction; stock prices.
Teaching/Learning Methodology	**Lecture**: the fundamentals in the computational study of nonlinear systems will be explained. Examples will be used to illustrate the main concepts and ideas. Students are encouraged to raise questions when meeting difficulties. **Computer laboratory**: students work on given problem sets either individually or through interaction among each other. They are encouraged to raise questions and discuss any issues with the instructor. These problem sets provide the opportunities to apply the knowledge gained from the lectures and to consolidate what have been learned.

Assessment Methods in Alignment with Intended Learning Outcomes

Specific assessment methods/tasks	% weighting	Intended subject learning outcomes to be assessed (Please tick as appropriate)		
		a	b	c
(1) Continuous assessment	40	✓	✓	✓
(2) Examination	60	✓	✓	✓
Total	100			

The continuous assessment is based on computer laboratories, assignments and a mid-term test. The examination is a three-hour written final examination. Various kinds of questions will be set in both components to assess the intended learning outcomes.

Student Study Effort Expected

Class contact:	
• Lecture	22 h
• Laboratory	24 h
Other student study effort:	
• Self-study	74 h
Total student study effort	120 h

Reading List and References

Textbook:

An Introduction to Computer Simulation Methods, Applications to Physical Systems, 3rd ed., H. Gould, J. Tobochnik, and W. Christian, Addision Wesley (2006).

References:

C++ How to Program, 7th Ed., P. Deitel and H.M. Deitel, Prentice Hall (2009).

Understanding Nonlinear Dynamics, D. Kaplan and L. Glass, Springer (1995).

Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, S. Strogatz, Westview Press (2001).

Machine Learning: An Algorithmic Perspective, S. Marsland, Chapman & Hall (2009).