Subject Description Form

Subject Code	AP30002
Subject Title	Computational Physics
Credit Value	3
Level	3
Pre-requisite/ Co-requisite/ Exclusion	AP20005
Objectives	To introduce basic numerical techniques and show their practical applications in some illustrative deterministic problems in physics.
Intended Learning Outcomes	Upon completion of the subject, students will be able to: (a) learn numerical techniques to deduce the most appropriate approximation solutions for some mathematical problems; (b) make use of the knowledge of numerical techniques and adapt known boundary conditions and solutions to various situations; (c) apply numerical methods to solve problem computationally in the fields of applied sciences; (d) know how to implement all the above numerical algorithms into Visual C++ program codes; and (e) undertake continuous learning.
Subject Synopsis/ Indicative Syllabus	**Solution of nonlinear equations**: bisector method, Newton-Raphson method, comparison between convergent rates, maxima of a single slit diffraction, eigen-values of a wavefucntion confined with a finite square well potential. **Approximation of functions**: linear interpolation, Lagrange interpolation polynomial, curve fitting using linear square fit, approximation of derivatives using different finite difference schemes. **Numerical integration**: rectangular, trapezoidal and Simpson methods, comparison of accuracy among these method, normalization and expectation value from a wave function, potential barrier across a PN junction. **Ordinary differential equations**: initial value problem, harmonic oscillator, forced and damped oscillation, Van der Pol oscillator, Euler's method, 2^{nd} and 4^{th} orders Runge Kutta methods (RK2 and RK4), boundary value problem using shooting method. **Heat diffusion problems**: heat diffusion under a constant and variable diffusion coefficients. **Two-dimension distribution of electrical potential**: Gauss Seidel method, Successive Over Relaxation method, Laplace and Poisson equations, Dirichlet, Cauchy and Neumann boundary conditions, distribution of electrical potential by Laplace equation, Poisson equation.

Teaching/Learning Methodology	**Lecture**: To understand the basic techniques in numerical calculations and to learn the applications of the numerical techniques to solve some general physical problems in heat and electric potential problems. **Computer laboratory**: To strengthen the students' understanding of numerical technique by solving some physical problems via computer programming. Students have opportunities to apply their knowledge gained from the lectures and to consolidate what have been learned via practical exercises.

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	d	e
(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

Paul L. DeVries and Javier E. Hasbun, "A First Course in Computational Physics", Jones and Bartlett Publishers, 2011.

Philipp O.J. Scherer, "Computational Physics - Simulation of Classical and Quantum Systems", Berlin; Heidelberg: Springer, 2010.

Andi Klein and Alexander Godunov, "Introductory Computational Physics [Electronic Resource]", Cambridge, UK; New York: Cambridge University Press, 2006.