UNIVERSITY COLLEGE OF THE FRASER VALLEY

COURSE INFORMATION

DISCIPLINE/DEPARTMENT: PHYSICS **IMPLEMENTATION DATE:** Oct. 1994

Revised:_____

PHYSICS 484	Nonlinear Physics	3
SUBJECT/NUMBER OF COURSE	**DESCRIPTIVE TITLE**	**UCFV CREDITS**

CALENDAR DESCRIPTION:
The study of nonlinear physics is important and useful because its models are used in so many disciplines, disciplines as diverse as business and ecology. This course is designed to integrate the computer's ability to perform; symbolic computations, simulations, equation solving and plotting, and model testing with the classroom theory along with the related laboratory experiments of Physics 485. The text will include a large number of computer Files which can be used to model test, and simulate the text's examples. Topics include: nonlinear mechanics, interesting nonlinear systems, methods of solving nonlinear equations, topological analysis, limit cycles, analytical methods, forced oscillations of nonlinear systems, partial nonlinear differential equations, numerical techniques, etc. Access to a home, IBM compatible computer, will assist the student in doing the problems and in understanding the text's examples.

RATIONALE:

COURSE PREREQUISITES: Physics 221, Physics 381

PRE- OR CO-REQUISITES: PHYS 485

HOURS PER TERM FOR EACH STUDENT	**Lecture**	**45**	**hrs**	**Student Directed Learning**	**15**	**hrs**
	Laboratory		**hrs**	**Other - specify:**		
	Seminar		**hrs**	_____		**hrs**
	Field Experience		**hrs**	**TOTAL**	**60**	**HRS**

MAXIMUM ENROLMENT:_____

Is transfer credit requested? ☐ **Yes** ☐ **No**

AUTHORIZATION SIGNATURES:

Course Designer(s):_____
G. McGuire

Chairperson: Art Last
Curriculum Committee

Department Head: Tim Cooper

Dean:_____
K. Wayne Welsh

PAC: Approval in Principle _____
(Date)

PAC: Final Approval: November 29, 1995
(Date)

OUTLN95/01/dd

Physics 484
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SYNONYMOUS COURSES:

(a) replaces _____
(course #)

(b) cannot take _____ for further credit
(course #)

SUPPLIES/MATERIALS:

TEXTBOOKS, REFERENCES, MATERIALS (List reading resources elsewhere)
Enns, McGuire, Tangnekar, *Nonlinear Physics with Maple*, 1st Ed., TBA (1995)

References:

1. Jackson, E.A., *Perspectives of Nonlinear Dynamics*, Vol. 1 and Vol. 2, Cambridge University Press, 1989, 1991
2. Moon, FC, *Chaotic and Fractal Dynamics, An Introduction for Applied Scientists and Engineers*, Wiley, 1992
3. Hilborn, R.C., *Chaos and Nonlinear Dynamics*, Oxford University Press. 1994

OBJECTIVES:
This course is designed to provide students with:

1. an appreciation of the importance of nonlinear phenomena in the everyday world;
2. symbolic computational skills that are needed for employment in a highly technical society;
3. useful problem solving and critical thinking skills;
4. the skills needed to tackle problems in a variety of non-scientific disciplines;
5. an understanding of the capabilities and limitations of symbolic computational software;
6. a skill which makes them employable.

METHODS:
This course will be presented using lectures demonstrations, experiments, and computer simulations. Heavy reliance will be made of the computer to simulate, mode, animate, and test the text's and the experiment's nonlinear models. The students will be introduced to models not only from the physical sciences (biology, chemistry and physics) but from the humanities, medical, and business.

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STUDENT EVALUATION PROCEDURE:

Assignments	20%
Mid-term	20%
Computer Simulations	20%
Final	40%

COURSE CONTENT:

Week 1/2: Interesting Nonlinear Systems

a. nonlinear mechanics (simple pendulum, eardrum, nonlinear damping, lattice dynamics)
b. competition phenomena (Volterra equations, fox rabies in Europe, laser beam competition)
c. nonlinear electrical phenomena
d. chemical oscillators
e. solitons
f. chaos

Week 3/4: Methods of Solutions

a. exactly solvable equations (i.e. Bernoulli, Riccati, elliptical integrals)
b. variation of parameters

Week 5/6: Topological Analysis and Graphical Solutions

a. types of singular points
b. graphical methods of solution

Week 7: Limit Cycles

a. oregonator model
b. first theorem of Bendixon
c. Poincare-Bendixon Theorem
d. Prigogine-Lefever Model

Week 8: Analysis Methods

a. Perturbation method (Poisson's & Linstedt's)
b. Krylov-Bogoliubov Method
c. Ritz method
d. Galerkin method

Week 9: Forced Nonlinear Oscillators

a. iterative solution of Duffing's equation
b. nonlinear response curve
c. nonlinear damping
d. jump phenomena and hysteresis
e. subharmonic response

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Course Content (cont)

Week 10: Partial Nonlinear Differential Equations

a. Burger's Equation-Hopf-Cole transformation
b. elementary soliton calculations

Week 11: Inverse Scattering Transformation Method

a. Lax's formulation
b. one and two soliton formulas
c. general input shapes
d. Zakharov-Shabat/AKNS Approach

Week 12: Numerical Techniques

a. finite difference approximations
b. Special Methods
   Euler, Modified Euler, Runge-Kutta, explicit method of solving PDE's

Week 13: Summary

a. review
b. summary of uses and importance of nonlinear physics
c. conclusion