UNIVERSITY COLLEGE of the FRASER VALLEY

COURSE IMPLEMENTATION DATE: September 1995
COURSE REVISED IMPLEMENTATION DATE: January 2001
COURSE TO BE REVIEWED: January 2005
(Four years after implementation date) (MONTH YEAR)

OFFICIAL COURSE OUTLINE INFORMATION

Students are advised to keep course outlines in personal files for future use.
Shaded headings are subject to change at the discretion of the department and the material will vary - see course syllabus available from instructor

FACULTY/DEPARTMENT: **NATURAL SCIENCES**

PHYSICS 484		**3**
COURSE NAME/NUMBER	FORMER COURSE NUMBER	UCFV CREDITS

NONLINEAR PHYSICS
COURSE DESCRIPTIVE TITLE

CALENDAR DESCRIPTION:

Physics 484 is an integrated physics course designed to introduce the students to the exciting world of nonlinear phenomena. Nonlinear physics is at the cutting edge of physics and it may be the penultimate branch of physics. 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.

PREREQUISITES: **Physics 221, Physics 381**
COREQUISITES: **PRE or COREQUISITES: PHYS 485**

SYNONYMOUS COURSE(S)
(a) Replaces: _____ *(Course #)*
(b) Cannot take: _____ *(Course #)* for further credit.

SERVICE COURSE TO: _____ *(Department/Program)* _____ *(Department/Program)*

TOTAL HOURS PER TERM: **60**
STRUCTURE OF HOURS:

Lectures:	**45**	Hrs
Seminar:		Hrs
Laboratory:		Hrs
Field Experience:		Hrs
Student Directed Learning:	**15**	Hrs
Other (Specify):		Hrs

TRAINING DAY-BASED INSTRUCTION
LENGTH OF COURSE: _____
HOURS PER DAY: _____

MAXIMUM ENROLLMENT: _____
EXPECTED FREQUENCY OF COURSE OFFERINGS: _____

WILL TRANSFER CREDIT BE REQUESTED? (lower-level courses only)	☐ Yes	☐ No
WILL TRANSFER CREDIT BE REQUESTED? (upper-level requested by department)	☒ Yes	☐ No
TRANSFER CREDIT EXISTS IN BCCAT TRANSFER GUIDE:	☐ Yes	☐ No

AUTHORIZATION SIGNATURES:

Course Designer(s): George McGuire
Chairperson: *(Curriculum Committee)*
Department Head:
Dean: J.D. Tunstall, Ph.D.
PAC Approval in Principle Date:
PAC Final Approval Date: December 13, 2000

LEARNING OBJECTIVES / GOALS / OUTCOMES / LEARNING OUTCOMES:

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, model, 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.

PRIOR LEARNING ASSESSMENT RECOGNITION (PLAR):

Credit can be awarded for this course through PLAR (Please check:) ☐ Yes ☐ No

METHODS OF OBTAINING PLAR:

TEXTBOOKS, REFERENCES, MATERIALS:

[Textbook selection varies by instructor. An example of texts for this course might be:]

TEXT: Enns, McGuire, Rangnekar, 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, F.C., 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

SUPPLIES / MATERIALS:

STUDENT EVALUATION:

[An example of student evaluation for this course might be:]

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

COURSE CONTENT:

[Course content varies by instructor. An example of course content might be:]

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

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