OFFICIAL UNDERGRADUATE COURSE OUTLINE (page 1)

COURSE IMPLEMENTATION DATE:	September 2001
COURSE REVISED IMPLEMENTATION DATE:	September 2012
COURSE TO BE REVIEWED: *(six years after UEC approval)*	May 2018 *(month, year)*

OFFICIAL UNDERGRADUATE 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 – see course syllabus available from instructor

PHYS 481	Science	3
COURSE NAME/NUMBER	FACULTY/DEPARTMENT	UFV CREDITS

Advanced Mathematical Methods of Physics

COURSE DESCRIPTIVE TITLE

CALENDAR DESCRIPTION:

Working physicists analyze physical systems and model them mathematically. The equations that arise are often complicated, so specific mathematical techniques have been developed over the years to solve them. These solutions then predict the future behaviour of that physical system. This course includes: Bessel functions and associated Legendre polynomials and their applications in mechanics, electromagnetism, and the hydrogen atom; the calculus of variations, with applications in classical mechanics, optics, and classical field theory, (with attention to coupled systems); Green function techniques; and applications to strings, electromagnetism, and heat. Students will work many problems initially using pen and paper, and then with Maple and/or C or FORTRAN. Computers will be used to generate numerical and/or graphical solutions.

PREREQUISITES: PHYS 381/MATH 381/ENGR 257.
COREQUISITES:
PRE or COREQUISITES:

SYNONYMOUS COURSE(S):

(a) Replaces: **n/a**
(b) Cross-listed with: **n/a**
(c) Cannot take: **n/a** for further credit.

SERVICE COURSE TO: *(department/program)*

TOTAL HOURS PER TERM: **75**

STRUCTURE OF HOURS:

Lectures:	**75**	Hrs
Seminar:		Hrs
Laboratory:		Hrs
Field experience:		Hrs
Student directed learning:		Hrs
Other (specify):		Hrs

TRAINING DAY-BASED INSTRUCTION:
Length of course:
Hours per day:

OTHER:
Maximum enrolment: **36**
Expected frequency of course offerings: On student demand, never two years consecutively
(every semester, annually, every other year, etc.)

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

Course designer(s):	Tim Cooper; revised Derek Harnett		
Department Head:	Norm Taylor	Date approved:	**Dec. 6, 2012**
Supporting area consultation (Pre-UEC)		Date of meeting:	**March 2, 2012**
Curriculum Committee chair:	Norm Taylor	Date approved:	**April 20, 2012**
Dean/Associate VP:	Ora Steyn	Date approved:	**May 4, 2012**
Undergraduate Education Committee (UEC) approval		Date of meeting:	**May 23, 2012**

LEARNING OUTCOMES:

Upon successful completion of this course, the student will be able to (among other things):

- Use separation of variables to solve a variety of boundary-value problems involving:
  - diffusion, wave, Laplace, and Helmholtz equations in 1-3 spatial dimensions;
  - Dirichlet, Neumann, and Robin boundary conditions; and
  - Cartesian, cylindrical, and spherical coordinates.
- Calculate generalized Fourier coefficients corresponding to several important series representations including Bessel series, spherical Bessel series, and series of associated Legendre functions.
- Employ the eigenfunction expansion technique to solve forced boundary-value problems (Poisson problems, for instance).
- Use the Fourier transform to solve initial-value problems on unbounded spatial regions.
- Compute Green functions using the division of region method, the Fourier transform, and/or the eigenfunction expansion method.

METHODS: *(Guest lecturers, presentations, online instruction, field trips, etc.)*

- Lecture on theory and examples, followed by homework problems on the same material completed in a timely manner.
- Computer demonstration, followed by students developing their own computer solutions.

METHODS OF OBTAINING PRIOR LEARNING ASSESSMENT RECOGNITION (PLAR):

☒ Examination(s) ☐ Portfolio assessment ☐ Interview(s) ☐ Other (specify):

☐ PLAR cannot be awarded for this course for the following reason(s):

TEXTBOOKS, REFERENCES, MATERIALS: *[Textbook selection varies by instructor. Examples for this course might be:]*

Text will be the same as for PHYS 381, supplemented by instructor's notes. Other texts on mathematical physics will be recommended, such as:
Advanced Engineering Mathematics (Wyie and Barrett OR Kreyszig)
A First Course in Computational Physics (DeVries)
Mathematical Physics (Butkov)
Mathematical Methods of Physics (Mathews and Walker)
Advanced Mathematics for Scientists and Engineers (Spiegel)

SUPPLIES / MATERIALS:

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

Midterm	20%
Final	40%
Assignments	30%
Computer solutions	10%

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

Students will be expected to use both Maple and either C++ or Fortran to solve problems.
The start of this course has a small overlap with PHYS 381 to help ease students in to the new material.

1. Bessel Functions
2. Applications of Bessel Functions
3. Associated Legendre Functions
4. Applications of Associated Legendre Functions (H-atom,)
5. Calculus of Variations (with and without constraints)
6. Applications of the Calculus of Variations, Rayleigh Ritz, Variational method for He.
7. Minimum Action Principles in Physics (mechanics, optics, Classical Field Theory)
8. Green Functions
9. Applications of Green Functions

10-11. Advanced Partial Differential Equations, numerous examples, applications.

12. Numerical Solutions of ordinary and partial differential equations.
13. Integral Equations, numerical and analytic techniques.
14. (week 14 may not be offered if time is short).
15. Perturbation theory, analytic and numerical.