PHYSICS 3926 – COMPUTER SIMULATIONS IN PHYSICS
COURSE SYLLABUS

1. COURSE DESCRIPTION

A project-oriented computation course using applications of numerical methods to problems in medical physics, science of materials, atmospheric physics and astrophysics. Projects will involve choosing a physical problem, posing scientific questions, and implementing a computer simulation. Techniques for programming, analysis, and presentation will be developed.

**Antirequisite(s):** Applied Mathematics 3911F/G.

**Prerequisite(s):** Physics 2101A/B and 2102A/B, or Physics 2128A/B and 2129A/B; Physics 2110A/B and 2910F/G, or the former Physics 2900E; Calculus 2303A/B or 2503A/B.

**Extra Information:** 3 lecture hours, 2 laboratory hours, 0.5 course.

*Note:* It is the student’s responsibility to ensure that all requisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. As per the UWO Academic Policies, “Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.”

2. COURSE OBJECTIVES

- Develop basic understanding of MATLAB and programming structure,
- Develop basic programming skills,
- Learn to model and illustrate various physics concepts through numerical simulations,
- Develop problem-solving and critical-thinking skills by developing and critically evaluating numerical solutions to different physical examples,
- Develop scientific communication skills.

This course is about using computers to do physics. Some previous experience with MATLAB is assumed from the Oscillation and Waves course and other Physics courses. After learning the basics of the MATLAB software, we will learn how to use it to analyze and present data and to investigate what is needed to solve complex physical problems. We will apply computer simulations to examples from several branches of physics. Along the way, we will learn how to develop realistic numerical models of physical systems and some of the practical aspects of how to solve and interpret these models. This is a hands-on course – there will be very little in the way of formal lectures. Rather, you will spend much of the class time working on in-class problems on the computer and assignments during labs. There is no ideal textbook, but a number of resources on different aspects (e.g. simulations, MATLAB, mathematical methods). In this course, we will create one by you as a group collectively for your own reference and for your fellow physics undergraduate students.

3. COURSE OUTLINE (Provisional)

1) Using MATLAB
   a) Arrays
   b) Calculus
   c) Plots
   d) Functions (both built-in and user defined)
2) Data analysis
   a) Curve fitting
   b) Fourier methods
3) Computer modeling
   a) Ordinary differential equations
   b) Monte Carlo techniques
   c) Partial differential equations
4. CONTACT DETAILS

Instructor: Dr. Tamie Poepping
Assistant Professor, Department of Physics and Astronomy
Physics and Astronomy Building, Office PAB236

Office Hours: Fridays 1:30-2:30 pm or by appointment
Website: http://www.physics.uwo.ca/~poepping
Email: poepping@uwo.ca Please only send email from your UWO email account. The UWO spam filter may intercept email from other sources.

Feedback & Suggestions: If you have a concern related to the course, please come to see me (Prof. Tamie Poepping), the Departmental Chair of Physics & Astronomy (Prof. Shantanu Basu) or the Associate Chair of Undergraduate Studies (Prof. Eugene Wong). I welcome and encourage your feedback at any time.

5. COURSE DELIVERY & RESOURCES

Lectures: MWF 3:30-4:20 pm.

Labs: MW 4:30-5:30 pm. Lab time will be used to work on the assignments – see below.

Room: SSC-1032 for both lectures and labs. You also have access to MATLAB at any of the GenLabs (uwo.ca/its/genlabs/) or myvlab.uwo.ca.

TAs: Amanda DiCarlo, Nirosh Getangama.

Text: There will be no assigned textbook.

Recommended books for reference (most available in Taylor Library):

- MATLAB, An Introduction with Applications, 4th ed. by A. Gilat (Wiley, New York, NY, 2011). QA297.G48 2011 This one is good to learn the nuances of MATLAB more so than physics.

Online Western Learning (OWL): Course material will be posted to the online course management system (http://owl.uwo.ca), along with images and links to useful websites. Syllabus and course material are subject to changes. Check regularly for updates and notices on the OWL Physics 3926 Home Page by logging in at http://owl.uwo.ca using your UWO username and password. Please post questions on course content or assignments on the OWL course forum, rather than emailing me directly, so that everyone can benefit from (and contribute to) the responses. Please allow 2-3 working days for a response.
6. COURSE EVALUATION

Evaluation Scheme:

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Weight (%)</th>
<th>Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignments (individual, 5-6)</td>
<td>25%</td>
<td></td>
</tr>
<tr>
<td>Project #1 (collaborative, create MATLAB learning doc)</td>
<td>5%</td>
<td>Due Oct. 9th</td>
</tr>
<tr>
<td>Midterm (open access to own programs &amp; MATLAB help)</td>
<td>20%</td>
<td>Oct. 28th</td>
</tr>
<tr>
<td>Project #2 (collaborative, create a Phys/Astr example)</td>
<td>10%</td>
<td>Due Nov. 9th</td>
</tr>
<tr>
<td>Project #3 (collaborative, create common explanations)</td>
<td>5%</td>
<td>Due Nov 30th</td>
</tr>
<tr>
<td>Project #3x (individual, detailed example)</td>
<td>25%</td>
<td>Due Dec 9th (last class)</td>
</tr>
<tr>
<td>Class participation (in-class exercises)</td>
<td>10%</td>
<td></td>
</tr>
</tbody>
</table>

There will be no final exam for this course.

In-class exercises can be found at the end of each lesson document. In your OWL course dropbox, create a folder called ‘Exercises’ and upload your files there at the end of each lesson. Name your files according to each lesson with your initials, e.g. L1abc_script1.m. Exercises must be completed and uploaded before the start of the next class.

Assignments will be computer-based and will focus on using the material and techniques learned in class. You can work on them – with help from me or a TA – during the scheduled lab periods or at any other time. Again, these will be uploaded to your OWL dropbox. Assignments are due before midnight on the due date.

There will be three projects, with increasing weights, which form a major component of the course, with accompanying contributions to the course textbook, as follows:

• **Project 1** will be worth 5% of your grade. You will be asked to participate in a collaborative Google doc, summarizing and explaining one feature of MATLAB that you wished someone had explained to you and you wanted it documented so that you can always go back to it, making it a useful resource. While you can contribute to other’s explanations or examples, you need to identify one command/feature of your own.

• **Project 2** is to apply what you have learned up to and including ordinary differential equations to create a Physics or Astronomy problem/example. This will be done collaboratively on Google docs in groups of 3.

• **Project 3** will be worth 30% and will be due on the last day of class. You will be required to choose a system or problem of interest to you and investigate it by means of partial differential equations (PDE) or Monte Carlo simulations (MC). You must get into groups and work on the common theme within the PDE or MC groups (5%), again using Google doc. You will have to choose a specific example in PDE or MC to work on as your final project to work independently, and a one-page proposal must be assessed for suitability and approved before its due date.

• You will be expected to write up your projects in the form of a section within a chapter of a book.

Your “class participation” grade will be based on attendance and participation in the in-class assignments.

The Department of Physics and Astronomy may, in exceptional cases, adjust the final course marks in order to conform to Departmental policy.

**Marks will be deducted (10% per day) on late assignments or projects.** Contact me beforehand regarding any late submissions, as no submissions will be accepted once the solutions are posted.
7. ADMINISTRATIVE POLICIES

Please refer to the UWO Academic Policies http://www.uwo.ca/univsec/academic_policies/ for further details on the policies in practice here.

1. Accommodations: The only acceptable excuses for missing an examination are serious personal illness, immediate-family bereavement, or approved religious conflicts.

Absences & Illness—If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's office as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Dean's Office immediately. For further information please see: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medical.pdf.

A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Record's Release Form (located in the Dean's Office) for visits to Student Health Services. The form can be found here: https://studentservices.uwo.ca/secure/medical_document.pdf. Students who are in emotional or mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

Accommodations for Religious Holidays—When scheduling unavoidably conflicts with religious holidays which a) require an absence from the University or b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate department chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

A student who, for either of the situations outlined in paragraph one above (a or b), is unable to write examinations and term tests on a Sabbath or Holy Day in a particular term shall give notice of this fact in writing to his or her Dean as early as possible, but not later than November 15 for mid-year examinations and March 1 for final examinations, i.e., approximately two weeks after the posting of the mid-year and final examination schedule respectively. In the case of mid-term tests, such notification is to be given in writing to the instructor within 48 hours of the announcement of the date of the mid-term test. If a Special Examination is offered as an alternative means to satisfy the academic requirements, the instructor(s) in the case of mid-term tests and the dean in the case of mid-year and Spring final examinations will arrange for special examination(s) to be written at another time. In the case of mid-year and Spring final examinations, the accommodation must occur no later than one month after the end of the examination period involved. It is mandatory that students seeking accommodations under this policy give notification before the deadlines and that the Faculty accommodates these requests.

For purposes of this policy the University has approved a list of dates which are recognized religious holidays which require members of those religions to be absent from the University; this list is updated annually and is available at Departmental, Deans' and Faculty advising offices.

Accessibility—Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.
2. **Make-up Policy for Final Examinations:** In accordance with Senate Policy, a Special Examination will be held within thirty days of the regular final examination for students who are unable to write the regular examination for medical or other documented reasons. Requests for such a Special Examination must be made to the Associate Dean, Faculty of Science. Note that if you fail to write a scheduled Special Examination, permission to write another Special Examination will be granted only with the permission of the Dean in exceptional circumstances and with appropriate supporting documents. In such a case, the date of this Special Examination normally will be the scheduled date for the final exam the next time the course is offered.

3. **Cheating and Plagiarism:** University Policy states that cheating, including plagiarism, is a major scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

   As per the UWO Academic Policies, “Plagiarism: Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing, such as footnotes or citations.” All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com ([http://www.turnitin.com](http://www.turnitin.com))."