**Marshall University**

**PHY 645 Syllabus**

**Methods for Mathematical Physics**

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| Course Title/Number | Mathematical Methods for Physicists |
| Semester/Year | Fall 2018 |
| Days/Time | Monday and Thursday from 1:05 pm to 2:45 pm |
| Location | SCI 281 and TBA |
| Instructor | Maria Babiuc Hamilton |
| Office | SCI 257 |
| Phone/Email | 304-696-2754 / babiuc@marshall.edu |
| E-Mail | TBA |
| Office Hours | Monday and Thursday from 3 pm to 4 pm |
| University Policies | By enrolling in this course, you agree to the University Policies listed below. Please read the full text of each policy be going to [www.marshall.edu/academic-affairs](http://www.marshall.edu/academic-affairs) and clicking on “Marshall University Policies.” Or, you can access the policies directly by going to <http://www.marshall.edu/academic-affairs/?page_id=802>  Academic Dishonesty/ Excused Absence Policy for Undergraduates/ Computing Services Acceptable Use/ Inclement Weather/ Dead Week/ Students with Disabilities/ Academic Forgiveness/ Academic Probation and Suspension/ Academic Rights and Responsibilities of Students/ Affirmative Action/ Sexual Harassment |

**Course Description: From Catalog**

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| This course on advanced methods of mathematical physics, will review and develop theories of real and complex analysis, group theory, tensors, special functions, differential and integral transforms, emphasizing their application to problems in electrodynamics, quantum, statistical mechanics, etc. |

The table below shows the following relationships: How each student learning outcomes will be practiced and assessed in the course.

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| **Course Student Learning Outcomes** | **How students will practice each outcome in this Course** | **How student achievement of each outcome will be assessed in this Course** |
| Students will learn the mathematical methods needed to solve advanced physics problems. | Understanding concepts of curved coordinates and tensors, determinants and matrices, group theory, infinite series, Complex functions, differential equations, orthogonal and special functions, Fourier series, integral transforms and equations. | Attendance to lecture homework, examinations and project. |
| Students will demonstrate fluency in comprehending various methods in mathematical physics. | Interpret the mathematical methods found in the textbook, and properly chose the correct mathematical methods to solve complex physical problems. | Attendance to lecture homework, examinations and project. |
| Students will apply the mathematical methods to physics problems at a level commensurate with graduate level standards. | Apply varied mathematical methods to physics problems, and employ critical thinking skills to find specific solutions. | Attendance to lecture homework, examinations and project. |
| * Students will conduct primary research literature in physics and identify the mathematical methods used. | Explore the scientific literature, choose a paper and summarize the mathematical methods used to solve specific physics problems. | Attendance to lecture homework, examinations and project. |
| Students will apply theoretical and experimental tools, as appropriate, to make progress in solving a complex physics problem. | Demonstrate the ability to work effectively with Mathematica, and develop solutions to solve problems. | Attendance to lecture homework, examinations and project. |

**Required Materials**

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| 1. Mathematical Methods for Physicists – A Comprehensive Guide (Seventh edition), by G.B. Arfken, H.J. Weber, and F. E. Harris (@2013 Elsevier Inc.) ISBN: 978-0-12-384654-9 2. Access to Mathematica (http://www.marshall.edu/cosweb/math/mathematica/) |

**Additional Reading, and Other Materials**

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| 1. *Essential Mathematical Methods for Physicists (1st edition)*, by H.J. Weber and G.B. Arfken (Harcourt Academic Press, 2003) 2. Numerical Recipes, by W.H. Press, B.P. Flannery, S.A. Teukolsky, and W.T. Vetterling (Cambridge University Press) |

**Course Requirements / Due Dates**

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| 1. **Group Work:** Students are expected to come to class and get involved in group work. Students will receive 10% of the grade for presence, and **notebook** documenting in-class note taking and group work. 2. **Homework** is an important component of the course and must be completed as close to the due date as possible. The problems given as homework **will not be graded**.  After the due date, students will have access to the solutions. Students should attempt the homework, without looking at the solutions, because this is the best way to learn the material. The material given as homework will be on exams. 3. **Exams:** There will be two **open book** exams: one midterm and one final. Each will be two hours long, and will include only material covered up to the exam. No electronic devices can be used during the exam. The exact dates of the midterm and the final will be determined during the course. Make-up exams will be given only when pre-arranged with the instructor or for unavoidable absences. 4. **Project:** The project will consist inwriting a **4-5 pages paper** documenting an interesting physics problem from the material covered, illustrating a mathematical method, and using Mathematica solving it. |

**Grading Policy**

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| The grade will be weighted using the following scale:   |  |  |  | | --- | --- | --- | | Class Presence and Group Work | Exams (Midterm + Final) | Project (Paper and Mathematica ) | | 10% | 60% | 30% |   Letter grades are based upon the following distribution of numerical scores:   * A: For 85% or higher score in the course. * B: For 70% or higher score the course. * C: For 55% or higher score in the course.   *Homework is not part of the grade in this course, the students are responsible of covering this material*. |

**Course Outline**

For some of you, much of this course may be review, but it is important to make sure that all students have a solid foundation in basic mathematical manipulations in order to proceed through advanced

Physics courses. Here is a rough outline of what will be covered in the course. This plan may be modified according to student interests, preparation, the general pace of the course, and/or questions that may arise during the course.

Schedule

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| Date | Material |
| Week 01 (Aug. 20 - 23) | Chapter 1 Mathematical Preliminaries |
| Week 02 (Aug. 27 - 30) | Chapter 2 Determinants and Matrices |
| Week 03 (Sep. 03 - 06) | Chapter 6 Eigenvalue Problems |
| Week 04 (Sep. 10 - 13) | Chapter 8 Sturm-Liouville Theory |
| Week 05 (Sep. 17 - 20) | Chapter 9 Partial Differential Equations |
| Week 06 (Sep. 24 - 27) | Chapter 11 Complex Variable Theory |
| Week 07 (Oct. 01 - 08) | Chapter 11 Complex Variable Theory |
| **Week 08 (Oct. 08 - 11** | Review/Exam |
| Week 09 (Oct. 15 - 18) | Chapter 10 Green’s Functions |
| Week 10 (Oct. 22 - 25) | Chapter 13 Gamma Function |
| Week 11 (Oct.29/Nov01) | Chapter 14 Bessel Function |
| Week 12 (Nov. 05 - 08) | Chapter 14 Bessel Function |
| Week 13 (Nov. 12 - 15) | Chapter 15 Legendre Function |
| Week 14 (Nov. 26 - 29) | Chapter 15 Legendre Function |
| **Week 15 (Dec. 12 - 14)** | Review for Exam/ Project |

Note: Wolfram Mathematica software will be used throughout this course and has to be installed.

In order to share material in a straightforward way, please make a Dropbox account and a Google Drive account.