PHY370 Advanced Mathematical Methods of Physics

Gustavus Adolphus College Spring 2019

Instructor: Dr. Steven Mellema

Office: Olin Hall 210 **Office Hours:** MTWRF 11:30am-12:20pm

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Textbooks:

Mathematical Methods for Scientists and Engineers, by Donald McQuarrie, University Science Books, ©2003

Mathematical Handbook of Formulas and Tables, by Murray R. Spiegel (Schaum's Outline Series)

Course Description and Objectives:

In this course we extend the development of mathematics to topics essential in advanced physics and engineering. The course includes topics in linear algebra, differential equations, Sturm-Liouville theory, and special functions, and explores both analytical and numerical techniques. Practical objectives are:

1. to expose the student to the formalism of the theories and involve them in handling the operational techniques of problem solving;

2. to prepare students for the study of quantum mechanics in their senior year, using Dirac notation to connect both the matrix and eigenfunction representations; and

3. to build upon the mathematical techniques introduced in previous mathematics and physics courses, and to prepare the student for the mathematical level of introductory graduate courses in physics and engineering.

Course Policy and Evaluation:

1. **Class Meetings and Reading Assignments**: The class will meet five days a week from 9:00-9:50AM for lecture, small-group problem solving, homework review and, occasionally, for exams. Attached is a daily calendar of activities for the course. When reading assignments are made for a class session, the reading is expected to be completed **before** coming to the class.

2. **Homework**: Homework problems will be assigned according to topics from the textbook, and are due at the beginning of class on the due date listed on the calendar. Late homework may be accepted at the discretion of the instructor with a reduction in credit.

3. **Use of Computers for Homework**: Occasionally homework problems will be assigned which require a numerical solution. These problems will be specifically assigned as computer problems. For the solutions of these computer problems, you may use any computational tools with which you are familiar, including Mathematica, Python, MATLAB, etc. However, for non-numerical problems involving algebra and calculus, the use of Mathematica or other Computer Algebra/Calculus Systems is **forbidden**. No credit for such problems will be given for solutions done by Mathematica.

4. **Group Problems**: Frequently in class, students will work together, in assigned groups of 3-4 members, to cooperatively solve problems. A group solution will be submitted, with all group members receiving the same grade. There will be no make-up for group problems missed due to absence.

5. **Problem Presentations**: After completing the lectures for each topic in the textbook, we will take one day to have example problem solutions presented to and discussed by the class. These problems will be assigned to specific student presenters approximately one week in advance, and all students will take turns to present problem solutions. Students will earn credit both for their presentations and for their thoughtful discussion of others' presentations.

6. **Attendance** : Regular attendance at all class meetings is expected. Students will be held responsible for informing themselves of all announcements/assignments made in class.

7. **Use of Electronic Devices in Class:** The use of cellular phones, tablets, and laptop computers during the lectures is prohibited. Exceptions may be made to accommodate student disabilities.

8. **Exams :** There will be four hour exams and a two-hour final exam (see the calendar below). Students must arrange **in advance** to take an exam at other than the scheduled time, and may do so **only** for a valid health or school-related reason. (It is the responsibility of the student to inform the instructor during the first week of the semester regarding any anticipated absences due to required field trips, athletic events, musical performances, or other extra-curricular activities.) Exams missed without pre-arrangement are entered as zero credit and cannot be made up.

9. **Evaluation** :

Homework	25%
Group Problems	7.5%
In-Class Problem Presentations	7.5%
Hour Exams	10% each
Final Exam	20%

Assignment of final letter grades will be based upon the following guidelines:

	B+ = 86-90%	C+ = 74-78%	D+ = 62-66%
A = 94-100%	B = 82-86%	C = 70-74%	D = 58-62%
A- = 90-94%	B- = 78-82%	C- = 66-70%	

10. **Incompletes** : A grade of incomplete will **only** be given for work not completed due to circumstances beyond the control of the student (*this is the College policy*).

11. **Academic Honesty**: Having signed and agreed to abide by the College's Honor Code, students thereby pledge that, in all academic exercises, examinations, papers, and reports, they shall submit their own work. In the context of this course, students are expected to collaborate and to discuss their out-of-class assignments. However, submitting under one's own name work that is merely copied from another is a violation of the Honor Code. (The full text of the Gustavus Academic Honor Code Policy may be found at: https://gustavus.edu/general_catalog/current/acainfo).

12. **Help for Multilingual Students:**
Support for English learners and multilingual students is available through the Academic Support Center's English Learning Specialist (www.gustavus.edu/advising/). The ELS can meet individually with students for tutoring in writing, consulting about academic tasks, and helping students connect with the College's support systems. When requested, the ELS can consult with faculty regarding effective classroom strategies for English learners and multilingual students. The ELS can provide students with a letter to a professor that explains and supports appropriate academic arrangements (e.g., additional time on tests, additional revisions for papers). Professors make decisions based on those recommendations at their own discretion. In addition, English learners and multilingual students can seek help from peer tutors in the Writing Center (www.gustavus.edu/writingcenter/).

13. **Disability Services**:
Gustavus Adolphus College is committed to ensuring the full participation of all students in its programs. If you have a documented disability (or you think you may have a disability of any nature) and, as a result, need reasonable academic accommodation to participate in class, take tests or benefit from the College's services, then you should speak with the Disability Services staff, for a confidential discussion of your needs and appropriate plans. Course requirements cannot be waived, but reasonable accommodations may be provided based on disability documentation and course outcomes. Accommodations cannot be made retroactively; therefore, to maximize your academic success at Gustavus, please contact Disability Services as early as possible. Disability Services (www.gustavus.edu/advising/disability/) is located in the Academic Support Center.

February 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
10	**11** Classes begin; Syllabus and Introduction Infinite Series Sections 2.1-2.3	**12** Alternating Series Sections 2.4-2.5	**13** Power Series Sections 2.6-2.8	**14** Gamma and Beta Functions Sections 3.1-3.2	**15** Error Function and Elliptic Integrals Sections 3.3, 3.5	**16**
17	**18** Dirac Delta Function Section 3.6	**19** Problem Presentations: Chapters 2&3	**20** Determinants Sections 9.1 Chapters 2-3 Homework due	**21** Gaussian Elimination Section 9.2	**22** Matrices Section 9.3	**23**
24	**25** Rank of a Matrix Section 9.4	**26** Vector Spaces Sections 9.5-9.7	**27** Problem Presentations: Chapter 9	**28** Transformations Section 10.1 Chapter 9 Homework Due		

March 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1 Eigenvalues and Eigenvectors Section 10.2	**2**
3	**4** Applied Eigenvalue Problems Section 10.3	**5** Hour Exam #1 (Ch. 2,3,9)	**6** Change of Basis Section 10.4	**7** Diagonalization Section 10.5	**8** Quadratic Forms Section 10.6	**9**
10	**11** Problem Presentations: Chapter 10	**12** 1st-Order ODE's Section 11.1 Chapter 10 Homework due	**13** 1st-Order ODE's Section 11.2	**14** 2nd-Order ODE's w/ Constant Coefficients Section 11.3-11.4	**15** Systems of Linear Diff. Eqs. Section 11.6	**16**
17	**18** Numerical Solutions to Ordinary Differential Equations	**19** Problem Presentations: Chapter 11	**20** Frobenius' Method Sections 12.1-12.2 Chapter 11 Homework due	**21** Legendre's Equation Section 12.3	**22** Singularities Section 12.4	**23**
24	**25** Hour Exam #2 (Ch. 10-11)	**26** Bessel's Equation Section 12.5	**27** Bessel Functions Section 12.6	**28** Problem Presentations: Chapter 12	**29** Phase Plane Sections 13.1 Chapter 12 Homework due	**30**
31						

April 2019

	Mon	Tue	Wed	Thu	Fri	Sat
	1 No class – Spring Break	**2** No class – Spring Break	**3** No class – Spring Break	**4** No class – Spring Break	**5** No class – Spring Break	**6**
7	**8** Critical Points Section 13.2	**9** Stability of Critical Points Section 13.3	**10** Nonlinear Oscillators Section 13.4	**11** Population Dynamics Section 13.5	**12** Problem Presentations: Chapter 13	**13**
14	**15** Legendre Polynomials Section 14.1 Chapter 13 Homework due	**16** Orthogonal Polynomials Section 14.2	**17** Sturm-Liouville Theory Section 14.3	**18** Hour Exam #3 (Ch. 12-13)	**19** No class – Easter Break	**20**
21	**22** No class – Easter Break	**23** Eigenfunction Expansions Section 14.4	**24** Green's Functions Section 14.5	**25** Problem Presentations: Chapter 14	**26** Fourier Series Section 15.1 Chapter 14 Homework due	**27**
28	**29** Fourier Sine/Cosine Series Section 15.2	**30** Convergence of Fourier Series Section 15.3				

May 2019

Sun	Mon	Tue	Wed	Thu	Fri	Sat
			1 Mayday Schedule: Fourier Series and ODE's Section 15.4	**2** Problem Presentations: Chapter 15	**3** Partial Diff. Eqs. Sections 16.1-16.2 Chapter 15 Homework due	**4**
5	**6** 1D Wave Equation Section 16.3	**7** 2D Wave Equation Section 16.4	**8** Heat Equation Section 16.5	**9** Schrodinger Equation Section 16.6	**10** Problem Presentations: Chapter 16	**11**
12	**13** Laplace Transforms Section 17.1 Chapter 16 Homework due	**14** Laplace Inverse Transforms Section 17.2	**15** Laplace Transforms and ODE's Section 17.3	**16** Hour Exam #4 (Ch. 14-16)	**17** Laplace Transforms and PDE's Section 17.4	**18**
19	**20** Fourier Transforms Section 17.5	**21** Fourier Transforms and PDE's Section 17.6	**22** Problem Presentations: Chapter 17	**23** No class – Reading Day	**24**	**25** Final Exam 8-10 am (20% Ch. 17; 80% Comprehensive)
26	**27**	**28**	**29**	**30**	**31**	