

Syllabus

Indiana Wesleyan University

PHYS-501: Mathematical Methods for Physics (Online Asynchronous)

Fall I 2022

Session Dates: 8/23/22-10/17/22

Instructor: TBD

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Course Description

This course develops a mathematical foundation to succeed in graduate level courses in classical mechanics, electrodynamics, thermodynamics/statistical physics, modern and quantum physics. It covers encompasses algorithmic skills but aims higher to develop the ability to relate mathematics and phenomena and the ability to analyze solutions for limitations and prediction of behavior.

Note: This course is designed for those seeking the credentials required by many regional accrediting bodies in order to be able to teach advanced placement, concurrent early college, and community college Physics courses.

Credit Hours: 3

Prerequisite Courses: None

Prerequisite Skills and Knowledge: A bachelor's degree with a Physics major or must be state certified (in any state) to teach Physics at a secondary school level. Undergraduate coursework must include calculus (through multivariate) and ordinary differential equations.

Course Outcomes

Upon successful completion of this course, you should be able to:

1. Demonstrate problem solving competency in the mathematical concepts and techniques used in theoretical physics.
2. Translate physical problems to mathematical formulations and mathematical solutions to physical behavior.
3. Identify recurring patterns of mathematical concepts and techniques across the areas of theoretical physics.
4. Evaluate the suitability and limitations of a range of mathematical approaches to physical problems.
5. Use technology (e.g. Mathematica, Maple) to solve differential equations and linear algebra problems and visualize Fourier, Legendre and Bessel that arise in applications to waves, heat flow and quantum mechanics using technology (e.g. Mathematica, Maple).

- Express the relevance of mathematics to the physical world in terms of creation and God's providence.

Course Textbook

Arfken, G. B., Weber, H.-J., & Harris, F. E. (2012). *Mathematical methods for physicists: A comprehensive guide*: Academic Press.

Course Technology

Each student will need to purchase a temporary site license for Mathematica Online. This can be arranged through Indiana Wesleyan.

For submitting solutions to assigned problems from the text, students may use Microsoft Equation Editor, LatEx or another text/equation editor and submit as a PDF, or scans of work written on paper.

IWU Diversity Statement

IWU, in covenant with God's reconciling work and in accordance with the Biblical principles of our historic Wesleyan tradition, commits to build a community that reflects Kingdom diversity.

We will foster an intentional environment for living, teaching, and learning, which exhibits honor, respect, and dignity. Acknowledging visible or invisible differences, our community authentically values each member's earthly and eternal worth. We refute ignorance and isolation and embrace deliberate and courageous engagement that exhibits Christ's commandment to love all humankind. (2016)

Grading Scale

NOTE: In graduate level courses, a grade of C- or below will require the course to be repeated.

Grade	Quality Points Per Credit	Percentage	Score
A	4.0	95%–100%	950–1000
A-	3.7	92%–94.9%	920–949
B+	3.3	89%–91.9%	890–919
B	3.0	85%–88.9%	850–889
B-	2.7	82%–84.9%	820–849
C+	2.3	79%–81.9%	790–819
C	2.0	75%–78.9%	750–789
C-	1.7	72%–74.9%	720–749
D+	1.3	69%–71.9%	690–719
D	1.0	65%–68.9%	650–689

F	0.0	0%–64.9%	0–649
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Grading Policies

Your grading policy for your course is dependent on your school and program. Your grading policies can be found in the [IWU Catalog](#).

Letter Grade Equivalencies

NOTE: In graduate level courses, a grade of C- or below will require the course to be repeated.

Grade	Description of Work
A	Clearly stands out as excellent performance. Has unusually sharp insights into material and initiates thoughtful questions. Sees many sides of an issue. Articulates well and writes logically and clearly. Integrates ideas previously learned from this and other disciplines. Anticipates next steps in progression of ideas. Example "A" work should be of such nature that it could be put on reserve for all cohort members to review and emulate. The "A" cohort member is, in fact, an example for others to follow.
B	Demonstrates a solid comprehension of the subject matter and always accomplishes all course requirements. Serves as an active participant and listener. Communicates orally and in writing at an acceptable level for the degree program. Work shows intuition and creativity. Example "B" work indicates good quality of performance and is given in recognition for solid work; a "B" should be considered a good grade and awarded to those who submit assignments of quality less than the exemplary work described above.
C	Quality and quantity of work in and out of class is average. Has marginal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at least minimally.
D	Quality and quantity of work is below average. Has minimal comprehension, communication skills, or initiative. Requirements of the assignments are addressed at below acceptable levels.
F	Quality and quantity of work is unacceptable and does not qualify the student to progress to a more advanced level of work.

Course Workshop Summary

Workshop	Devotion*	Guided Problem Set	Conceptual Video	Unguided Problem Set	Mathematica	Total Points per Workshop
Workshop One	10	30	20	70	20	150
Workshop Two	15	40	25	70	20	170

Workshop Three	15	40	25	70	20	170
Workshop Four	15	40	25	70	20	170
Workshop Five	15	40	25	70	20	170
Workshop Six	15	40	25	70	20	170
End of Course Survey						10 extra credit
TOTAL	85	230	145	420	120	1000

Workshop One Outline

Title	Type	Due Dates	Estimated Time	Points
1.1 Devotion: Biblical Calculation of Pi	Devotional	Video post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	1 hour	10
1.2 Conceptual Video for Taylor and Power Series, Matrices as Inverse, Transpose or Adjoint, or Vector Operators Del/Grad/Curl	Discussion	Video post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	6 hours	20
1.3 Guided Problem Set for Chapters 1-3	Dropbox	Due by the end of the fifth day of the workshop.	6 hours	30
1.4 Unguided Problem Set for Chapters 1-3	Dropbox	Due by the end of the workshop.	4 hours	70
1.5 Mathematica Activity for Series Expansion	Dropbox	Due by the end of the workshop.	1 hour	20
Totals			18 hours*	150

* These times are only estimates. Actual assignment completion times will vary.

Workshop Two Outline

Title	Type	Due Dates	Estimated Time	Points
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2.1 Devotion: Unity	Discussion	Post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	1:30 hours	15
2.2 Conceptual Video for Tensors, Vector Space, Eigenvalues and Eigenvectors	Discussion	Post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	5 hours	25
2.3 Guided Problem Set for Chapters 4-6	Dropbox	Due by the end of the fifth day of the workshop.	5 hours	40
2.4 Unguided Problem Set for Chapters 4-6	Dropbox	Due by the end of the seventh day of the workshop.	3 hours	70
2.5 Mathematica Activity for Matrix Properties	Dropbox	Due by the end of the seventh day of the workshop.	30 minutes	20
Totals			15 hours*	170

* These times are only estimates. Actual assignment completion times will vary.

Workshop Three Outline

Title	Type	Due Dates	Estimated Time	Points
3.1 Devotion: Mathematics and the Natural Sciences	Discussion	Post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	1:15 hours	15
3.2 Conceptual Video for Ordinary Differential Equations, Vector Space and Hilbert Space	Discussion	Video post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	5 hours	25
3.3 Guided Problem Set for Chapters 7-8	Dropbox	Due by the end of the fifth day of the workshop.	5 hours	40
3.4 Unguided Problem Set for Chapters 7-8	Dropbox	Due by the end of the seventh day of the workshop.	3 hours	70
3.5 Mathematica Activity for Using ODEs to Estimate Population Growth	Dropbox	Due by the end of the seventh day of the workshop.	45 minutes	20
Totals			15 hours*	170

* These times are only estimates. Actual assignment completion times will vary.

Workshop Four Outline

Title	Type	Due Dates	Estimated Time	Points
4.1 Devotion: The Nature of Mathematics	Discussion	Post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	1:30 hours	15
4.2 Conceptual Video for Partial Differential Equations, Green's Function	Discussion	Video post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	4 hours	25
4.3 Guided Problem Set for Chapters 9-10	Dropbox	Due by the end of the fifth day of the workshop.	5:30 hours	40
4.4 Unguided Problem Set for Chapters 9-10	Dropbox	Due by the end of the seventh day of the workshop.	3 hours	70
4.5 Mathematica Activity for Using PDEs to Model Heat Conduction	Dropbox	Due by the end of the seventh day of the workshop.	45 minutes	20
Totals			14:45 hours	170

* These times are only estimates. Actual assignment completion times will vary.

Workshop Five Outline

Title	Type	Due Dates	Estimated Time	Points
5.1 Devotion: The Nature of Mathematics	Discussion	Post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	1:15 hours	15
5.2 Conceptual Video for Complex Variables and Functions, Generating Functions, Gamma Function, Bessel Functions	Discussion	Video post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	5 hours	25
5.3 Guided Problem Set for Chapters 11-14	Dropbox	Due by the end of the fifth day of the workshop.	5 hours	40
5.4 Unguided Problem Set for Chapters 11-14	Dropbox	Due by the end of the seventh day of the workshop.	3:30 hours	70

5.5 Mathematica Activity for General Solutions to Bessel's Equation	Dropbox	Due by the end of the seventh day of the workshop.	30 minutes	20
Totals			15:15 hours*	170

* These times are only estimates. Actual assignment completion times will vary.

Workshop Six Outline

Title	Type	Due Dates	Estimated Time	Points
6.1 Devotion: The Purpose of Mathematics	Discussion	Post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	1:15 hours	15
6.2 Conceptual Video for Legendre Polynomials, Fourier Series, Fourier and Laplace Transform	Discussion	Video post due by the end of the third day of the workshop; one response due by the end of the fifth day of the workshop.	5 hours	25
6.3 Guided Problem Set for Chapters 15; 19-20	Dropbox	Due by the end of the fifth day of the workshop.	5 hours	40
6.4 Unguided Problem Set for Chapters 15; 19-20	Dropbox	Due by the end of the seventh day of the workshop.	2:45 hours	70
6.5 Mathematica Activity for Using PDEs to Solve the Wave Equation	Dropbox	Due by the end of the seventh day of the workshop.	1 hour	20
6.6 End of Course Survey	Dropbox	Due by the end of the seventh day of the workshop.	30 minutes	10 extra credit
Totals			15:30 hours*	170

* These times are only estimates. Actual assignment completion times will vary.

Course Assignments

TOTALS 93.5 hours* 1000

* These timings are based on estimations of average times to complete each assignment. Actual assignment completion times will vary.

Course Development Resources

Arfken, G. B., Weber, H.-J., & Harris, F. E. (2012). *Mathematical methods for physicists: A comprehensive guide*: Academic Press.

Abell, M. L., & Braselton, J. P. (2016). *Differential equations with mathematica*: Academic Press.

Nave, C. R. (2010). Hyperphysics. Department of physics and astronomy, Georgia State University, GA. Retrieved from <http://hyperphysics.phyastr.gsu.edu/hbase/index.html>

Expectations, Policies, and Important Student Information

School/Division	Link
DeVoe School of Business Division of Liberal Arts School of Services and Leadership	View School/Division Expectations, Policies, and Student Information
School of Educational Leadership	View School/Division Expectations, Policies, and Student Information
Wesley Seminary @ IWU	View School/Division Expectations, Policies, and Student Information
Nursing - Undergraduate	View School/Division Expectations, Policies, and Student Information
Nursing - Graduate	View School/Division Expectations, Policies, and Student Information