KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DEPARTMENT OF PHYSICS

COURSE SYLLABUS

Term	:	Fall Semester 2013 – 2013 (131)
Course Title	:	**Advanced Methods of Theoretical Physics I**
Course Code	:	Phys 571
Credit Hours	:	3
Prerequisites	:	PHYS 371 or Consent of the Instructor
Schedule	:	**Lecture**: UTR 1:00 – 02:00 pm. Building 6, Room 201

Instructor	:	Dr. Ibraheem Nasser, Prof.
Phone	:	2234
Email	:	imnasser@kfupm.edu.sa
Web	:	http://faculty.kfupm.edu.sa/phys/imnasser/
Office	:	Building 6, Room 217
Office Hours	:	Daily 10:30 – 12:00 am, or by appointment

Course Description:

Phys 571 is designed to provide first-year graduate students with the mathematical background for subsequent studies of advanced mechanics, electrodynamics and quantum theory. Topics treated include: Partial differential equations, Separation of variables; Eigenfunctions and Eigenvalues; Linear vector spaces and linear operators; Green functions; Integral equations; Integral transforms.

Objectives:

This course will introduce fundamental concepts and techniques of differential equations and demonstrate their relevance to physics and research applications.

Main Textbook:

G. Arfken and H. Weber, "***Mathematical Methods for Physicists***". 6th Edition (2005) (ALSEVIER Academic Press)

Homework:

A homework assignment will be given every week on each of the chapters covered in the text book. Solutions should hand in for grading not later than one week after completing the chapter. Problems may be set from the textbook or from the other sources.

Late Policy: Homework is due by 5 PM on the due date. If you need an extension, email me by the day before the homework is due. Extensions will be granted quite freely, but you must include: Why you need the extension, and when you will turn it in. You can have an extension of up to one week. If you do not get an extension, the policy is 50% credit up to one week late, and zero credit after that. Also, note that late homework may not be graded in a timely manner.

Extra credit will be given for computer solving problems.

Examinations:

Two major exams and one final will be announced during classes. The exams will be closed book but with given formula sheet.

Attendance:

Attendance will be evaluated according to the University regulations.

Assessment

Activity	Weight
Homework	30%
Exam #1	20%
Exam #2	20%
Final Exam (Comprehensive)	30%

Grading

$A^{+}\geq 89$ $89>A\geq 82$ $82>B^{+}\geq 75$ $75>B\geq 68$ $68>C^{+}\geq 61$ $61>C\geq 54$ $54>D^{+}\geq 47$ $47>D\geq 40$ $F<40$

Homework & Tests:

This course will be your opportunity to work lots of homework problems. Usually one set for each topic (or chapter) will be assigned. The instructor's written solutions will be passed out when the set is due. The homework turned in will be spot-graded and returned. It is each student's responsibility to study and understand the solution.

There will be a quiz on each chapter or topic, and a final, with no exemptions. Homework and tests should look professional. All work turned in should be on good paper and be neat and easily read. Use of good, standard notation is required. The presentation will be reflected in the grade.

On the homework and tests, you are expected to show all your work. You must solve everything by hand (no calculators, no symbolic manipulators), unless specifically stated otherwise. The work must be yours alone.

On the homework, it is acceptable to discuss homework problems with others, but each student must turn in work that he did on his own. On tests, any collaboration at all is unacceptable.

Course Delivery

1 Coverage of Planned Program

Topics	Planned Contact Hours	Actual Contact Hours	Reason for Variations if there is a difference of more than 25% of the hours planned
Linear vector spaces and linear operators	**6**	**6**	
Eigenfunctions and Eigenvalues	**5**	**5**	
Differential equations and special functions	**6**	**6**	
Separation of variables	**5**	**5**	
Partial differential equations	**5**	**5**	
Green functions	**5**	**5**	
Integral equations	**4**	**4**	
Integral transforms	**2**	**2**	
Vector, transformation and General coordinates	**4**	**4**	

EXTRA REFERENCES TEXTS FOR MATH 371/571

1. **Arfken,** George, and Weber, Hans, "Mathematical Methods for Physicists" Second Edition, Academic Press, New York, 2001, 5th Edition.This is a good book for review and reference. Vector analysis, coordinate systems, tensor analysis, determinants, matrices, infinite series, Green's functions.
2. **Cushing**, J.T. "Applied Analytical Mathematics for Physical Scientists" John Wiley and Sons, Inc., New York, 1975. This book is more theoretically than practically oriented -- but it should provide background for the class notes and some extra explanations. QA300.C87.
3. **Mathews**, Jon and Walker, R.L. "Mathematical Methods of Physics" W.A. Benjamin, Inc., N.Y., 1970 This book treats a broad range of advanced topics: ordinary differential equations; infinite series, evaluation of integrals, integral transforms; complex variables, vectors and matrices, special functions; partial differential equations; eigenfunctions, eigenvalues, Green's function perturbation theory, integral equations; calculus of variations probability and statistics, tensor analysis; group theory. This book covers these subjects with very few details. It was meant as an outline for students to follow in pursuing these topics on their own.
4. **Courant**, R. and Hilbert, D. "Methods of Mathematical Physics", Vol. I. Interscience Publishers, Inc. N.Y., 1937. Has good treatment of n-dimensional vectors, orthogonal systems, norms, unitary transformations and eigenvalue problems.
5. **Hermann**, R. "Lectures in Mathematical Physics", Vol. I. W.A. Benjamin, Inc., N.Y., 1970 Vector spaces, linear transformations, tensors, matrices, linear ordinary differential equations, eigenvectors, Green's functions; Hilbert Space.
6. **Boas**, Mary L. "Mathematical Methods in the Physical Sciences" John Wiley and Sons, Inc., N.Y., 1966 Elementary book (Undergraduate)- good for review.
7. **Harper, Charlie, "**Introduction to Mathematical Physics", Printec-Hall, 1976. Good undergraduate book.
8. **Eisele, John and Mason, Robert** "Applied Matrix and Tensor Analysis" Wiley - Interscience, N.Y., 1970 Good book for study of tensors.
9. **Fano**, Guido "Mathematical Methods of Quantum Mechanics" Mc-Graw Hill, N.Y., 1971 Finite dimensional linear space and matrices measure theory, Hilbert Space, brief survey of quantum mechanics.
10. **Morse**, Philip M. and Feshbach, Herman "Methods of Theoretical Physics" Mc-Graw Hill, N.Y., 1953, Volumes I and II Good reference book; some material for course will be taken from these books - but not enough to warrant buying either volume.
11. **Korn,** Granino A. and Korn, Theresa M. "Mathematical Handbook for Scientists and Engineers" Contains an excellent, concise, and detailed summary of just about any mathematical topic you are likely to encounter in classwork or research. This is a very good reference book! Consider buying this book for your library (not required or advised for this course specifically).
12. **Abramowitz,** Milton and Stegun, Irene A. "Handbook of Mathematical Functions" National Bureau of Standards Applied Mathematics Series 55, Washington, D.C., 1964 Gamma functions, error functions, Fresnel integrals, Bessel functions, confluent hypergeometric functions, elliptic integrals, Coulomb wave functions. This book has formulas, graphs and tables. A very good and inexpensive reference book!
13. **Watson**, G.N. "A Treatise on the Theory of Bessel Functions" University Press, Cambridge, 1958 All about Bessel Functions - good reference.
14. **Bergmann,** Peter Gabriel "Introduction to the Theory of Relativity" Dover, New York 1976. Chapter V has a very good (and complete) discussion of Vector and Tensor Calculus....you should find this useful.

15. **Wrede**, R.C. "Introduction to Vector and Tensor Analysis" Dover Publications, New York, 1972.
16. **Lovelock**, David and Rund, Hanno "Tensors, Differential Forms and Variational Principles".
17. **Spain,** B. and Smith, M.G. "Functions of Mathematical Physics" Van Nostrand Reinhold Company, New York, 1970. This is a good reference for Chapter V of class notes: Differential Eqs. This book takes a little different approach to special functions, but you will find it complements material in notes.
18. **Andrews**, Larry C. "Special Function for Engineers and Applied Mathematicians" Macmillan, New York, 1985.Has nice discussion of special functions including the Digamma function, Beta function, fractional derivatives, Gegenbauer polynomials, Jacobi polynomials, incomplete gamma function, Packhammer symbol,.....
19. **Hassani**, Sadri, "Foundations of Mathematical Physics", Allyn and Bacon, Boston 1991. A good reference book.
20. **Dennery** and Krzywicki, *Mathematics for Physicists*, by Dover (1996)
21. 0. S. **Hassani**, *Mathematical Physics: A modern introduction to its foundation* (Springer-Verlag, New York, 1999)
22. **Hassani**, Mathematical Physics. Springer (2002).
23. **Bender** and Orszag, Advanced Mathematical Methods for Scientists and Engineers, McGraw Hill, 1978
24. **Lea,** S. M.: "Mathematics for Physicists", (2004, Thomson Brooks/Cole) (Undergraduate)
25. **Lea, S. M.**: Student solutions Manual for "**Mathematics for Physicists**", (2004, Thomson Brooks/Cole) **Undergraduate**
26. Chow, Tai L. **Mathematical Methods for Physicists**, Cambridge University Press, July 2000. Intermediate level.
27. **Kelly, James J**. **Graduate Mathematical Physics,** With MATHEMATICA Supplements, Wiley-VCH, Berlin (2006). http://www.physics.umd.edu/courses/CourseWare/EssentialMathematica/
28. **Murray Spiegel**, Schaum's outline of "Theory and problems of Advanced Mathematics for Engineering and Scientists" McGraw-Hill, 1971. Q 111, s3, A49 c.4.

MATHEMATICA Books

1- Mathematica, Demystified, by Jim Hoste, McGraw Hill (2009)
2- Mathematica, Schaum's outlines, by Eugene Don, McGraw-Hill (2009)
3- Mathematica by examples, by M. L. Abell and J. P. Braselton, AP Professional (1994)
4- Mathematica for Physics, by R. Zimmerman and F. Olness, Addison-Wesley (1995)
5-

Q. M. Books

1- **Nouredine Zettili**, "Quantum mechanics, Concepts and Applications", Second edition, (John Wiley, 2009).

E.M. Books

1- Jackson, J. D. "Classical Electrodynamics", Third edition, 1999, (J. Wiley).
2- Griffiths "*Introduction to Electrodynamics Theory*", (3rd Edition Prentice-Hall, 1999).

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