The Hebrew University of Jerusalem

Syllabus

Mathematical Methods II - 80157

Last update 15-10-2024

HU Credits: 6

Degree/Cycle: 1st degree (Bachelor)

Responsible Department: Mathematics

Academic year: 0

Semester: 2nd Semester

Teaching Languages: Hebrew

Campus: E. Safra

Course/Module Coordinator: Prof. Ruth Lawrence-Naimark

Coordinator Email: ruthel.naimark@mail.huji.ac.il

Coordinator Office Hours: By prior arrangement

Teaching Staff:

Prof. Ruth Lawrence-Naimark,
Dr. Miriam Bank,
Mr. Dotan Halevi,
Mr. Daniel Rosenblatt,
Mr. Morris Bar David

Course/Module description:

The aim of the course, along with its first semester companion (Mathematical Methods I), is to supply all the basic mathematical tools (apart from linear algebra) for science students (primarily physics, engineering and computer engineering) for first degree studies. This course covers vector analysis, recurrence relations, ordinary differential equations, Laplace transforms, convergence of sequences and series of functions, power series, Fourier series and Fourier transforms, with an emphasis on intuitive understanding and use rather than rigor.

Course/Module aims:

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Learning outcomes - On successful completion of this module, students should be able to:

An understanding of and ability to apply the material and techniques taught in the course.

Ability to understand some of the deeper analytic techniques behind constructions used in the first semester companion course (Mathematical Methods I) such as convergence and manipulations of power series.

Familiarity with basic notions in mathematics.

Familiarity with some of the mathematical tools used in the exact sciences.

Attendance requirements(%):

none

Teaching arrangement and method of instruction: The core material is methodically

presented in frontal lectures, with minimal examples only in order to illustrate the ideas as presented. The student is expected to read the lecture summaries both before and after classes and then do the recommended homework examples, on their own or with the help of solutions provided. It is expected that the student spend around 2 hours out of class for each hour of frontal presentation, working with the material and doing problems. Exercise classes are active problem solving sessions (once a week).

Course/Module Content:

1: Vector analysis (integration over surfaces. Integration of scalar and vector fields over surfaces; integral theorems of Gauss/Stokes/Green; scalar and vector potentials of a vector field; vector analysis identities amongst curl, div, grad; Laplacian, curl, div, grad in planar/cylindrical/spherical polar coordinates)
[Not this year 2: Recurrence relations (sequences, definition of recurrence relation, linear homogeneous recurrence relations, fundamental system of solutions, linear inhomogeneous recurrence relations and particular solutions)]
3: Ordinary differential equations
3.1: General definitions
3.2 First order ODEs and methods of solution
3.3 Picard's theorem and Euler method for first order ODEs
3.4 First order systems of ODEs, higher order ODEs
3.5 Homogeneous linear ODES (general theory, finding a fundamental system of solutions to an nth order ODE, constant coefficient ODEs, ODEs of type Euler, reduction of order, finding a fundamental set of solutions for a first order system of ODEs, fundamental matrices)
3.6: Inhomogeneous linear ODEs (general theory, method of undetermined coefficients, method of variation of parameters, finding particular solutions for a first order inhomogeneous linear system of ODEs)
4: Laplace transforms (definition, properties, Heaviside and delta functions, use to solve ODEs with constant coefficients)
5: Convergence (limits, sequences and series of numbers, absolute and conditional convergence, convergence tests for sequences and series of numbers, comments on improper integrals, general metric spaces, completeness, sequences and series of functions, uniform/pointwise/in-the-mean/L^2 convergence of sequences/series of functions, continuity of limit, Weierstrass test)
6. Power series (definition, radius of convergence, multiplication of power series, term-by-term differentiation and integration of power series, introduction to power series solutions of ODEs)
7. Fourier series and transforms (projections and general Fourier series, Bessel inequality, convergence and Parseval equality, introduction to Fourier transforms, properties, examples and applications)
8. Introduction to functions of a complex variable (differentiability of a complex-valued function of a complex variable, Cauchy-Riemann equations, contour integrals, Cauchy integral theorem, residues, Cauchy residue theorem)

Chapters 2 and/or 8 will be included if time permits.

Required Reading:
Book of lecture notes and book of exercises and solutions, both available electronically on the MOODLE page of the course and directly from the coordinator in printed form.

Additional Reading Material:
Any book on mathematical methods for science students and/or calculus for science students.

Grading Scheme:
Written Exam % 70
Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 30 %

Additional information:
The bohanim (untimed individualised online assignments) contribute 10% regularly and an additional 10% magen to the final grade. There are also computer-graded online timed quizzes which can be repeated and from which 10% of the final graded is assigned.
Other or additional topics may be studied.