Syllabus for Foundations of Mathematical Physics I and II

(CAS-100311 Foundations of Mathematical Physics I,
CAS-100312 Foundations of Mathematical Physics II)

Spring Semester 2018

Up-to-date course information can be found on the course website
http://math.jacobs-university.de/petrat/teaching/2018_spring_mathematical_physics/index.html

1 Official Course Description

Physics and mathematics have a very intimate relationship. On the one hand, big discoveries in physics have often lead to interesting new mathematics, and on the other hand, new developments in mathematics have made new discoveries in physics possible. The goal of this course is to look at some examples of that, and to get an insight into which role rigorous mathematics has played and plays nowadays in explaining physical phenomena. This class focuses mainly on quantum mechanics and statistical mechanics, and is accessible to both physics and math students. Part I puts the emphasis on the mathematical foundations. Part II puts the emphasis on applications in physics.

2 Contact Information

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3 Time and Place

Wed 15:45 – 17:00, Lecture Hall Research I
Fri 14:15 – 15:30, East Hall 4 (until March 16), East Hall 8 (starting March 23)

First class: February 2, 2018; last class: May 16, 2018
No classes on March 28, March 30 (Spring Break)

4 Textbooks

TBA

5 Exercises

Each week on Wednesday (except the first and exam weeks) there will be a homework assignment. These are an integral part of the coursework and working on the exercise sheets consistently is the best preparation for the exams.

- The solutions have to be handed in at the beginning of class.
- No late submissions are accepted.
- The two worst homework sheets are not considered for grading.
- It is encouraged to discuss the homework sheets with your classmates (e.g., discuss how to come up with the solution or what the right way of approaching the problem is). On the other hand, the solutions must be written down and handed in individually! Copying the solutions from somebody else is a violation of Academic Integrity.

6 Exams

There will be two exams, a midterm and a final. More details will be announced. Note that this class uses gradescope for grading exams, see https://gradescope.com for more information.

7 Parts I and II

This course is officially split into two parts, part I from February 2 until March 21, and part II from March 23 until May 16. It is recommended to take both parts.

8 Grading

The final grade is weighted as follows:

Homework:	20%
Midterm:	30%
Final:	50%

Students who take both part I and II receive the same grade for part I and II according to the above scheme. For students who take only part I the final grade for part I is weighted 20% homework and 80% midterm.

9 Tentative Class Schedule

Session	Date	Topic
1	Feb 2	Fourier transform
2	Feb 7	Fourier transform
3	Feb 9	Fourier transform
4	Feb 14	Tempered distributions
5	Feb 16	Long-time asymptotics of the free Schrödinger equation and the momentum operator
6	Feb 21	Hilbert and Banach spaces
7	Feb 23	Hilbert and Banach spaces
8	Feb 28	Unitary groups
9	Mar 2	Guest lecture?
10	Mar 7	Self-adjoint operators
11	Mar 9	Self-adjoint operators
12	Mar 14	Self-adjoint operators
13	Mar 16	Self-adjoint operators
14	Mar 21	Self-adjoint operators
15	Mar 23	**Midterm**
	Mar 28	**Spring Break, no class**
	Mar 30	**Spring Break, no class**
16	Apr 4	Spectral Theorem
17	Apr 6	Spectral Theorem
18	Apr 11	Spectral Theorem
19	Apr 13	Spectral Theorem
20	Apr 18	Spectral Theorem
21	Apr 20	Tensor-products and spin
22	Apr 25	PVMs and POVMs
23	Apr 27	PVMs and POVMs
24	May 2	PVMs and POVMs
25	May 4	Long-time behavior of unitary groups
26	May 9	Long-time behavior of unitary groups
27	May 11	Scattering Theory
28	May 16	Scattering Theory
	TBA	**Final Exam**