

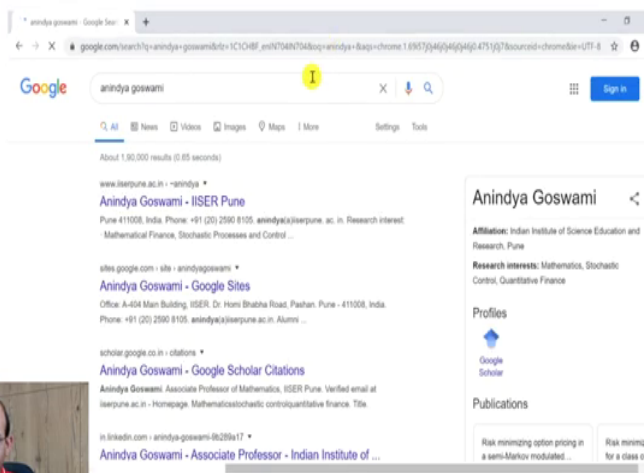
Introduction to Probabilistic Methods in PDE
Professor Dr. Anindya Goswami
Department of Mathematics
Indian Institute of Science Education and Research, Pune
Lecture 67
Conclusion

Hello, dear students. It is my pleasure to declare that the topics whatever I planned to, the lectures that I could cover. And so, we are at the end of the course. By the last lecture on semilinear evolution problems, we have concluded the course material. And I really enjoyed giving this lecture.

While lecturing, you possibly have seen some places you know some here and there typos appeared in the slides. So, what I have done is that, I have revised and corrected those slides. And those would be made available. And there is one particular course page also I have created, which would be live for the, I mean (for) I mean forever.

Because you know now whatever the modified files you would get, if I need to modify a little more further here and there, so that I might not be able to give there. But of course, surely, I would be able to do that in my own course page. So, I have a particular course page. So, I am showing you how to reach there.

(Refer Slide Time: 01:34)




The screenshot shows a Google search for "anindya goswami". The search results include:

- www.iiserpune.ac.in - anindya *
Anindya Goswami - IISER Pune
Pune 411008, India. Phone: +91 (20) 2590 8105. anindya@iiserpune.ac.in. Research interest: Mathematical Finance, Stochastic Processes and Control ...
- sites.google.com - site - anindyagoswami *
Anindya Goswami - Google Sites
Office: A-404 Man Building, IISER, Dr. Homi Bhabha Road, Pashan, Pune - 411008, India. Phone: +91 (20) 2590 8105. anindya@iiserpune.ac.in. About ...
- scholar.google.co.in - citations *
Anindya Goswami - Google Scholar Citations
Anindya Goswami, Associate Professor of Mathematics, IISER Pune. Verified email at iiserpune.ac.in - Homepage: Mathematicsstochasticcontrolquantitativefinance. Title ...
- in.linkedin.com - anindya-goswami-86289a17 *
Anindya Goswami - Associate Professor - Indian Institute of ...

On the right side, there is a profile card for **Anindya Goswami** with the following details:

- Profile:** Anindya Goswami
- Affiliation:** Indian Institute of Science Education and Research, Pune
- Research interests:** Mathematics, Stochastic Control, Quantitative Finance
- Profiles:** Google Scholar
- Publications:** Risk minimizing option pricing in a semi-Markov modulated ... Risk minimizin for a class of e



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Research interest:

- Mathematical Finance, Stochastic Processes and Control

Publication:

- A complete list by [Google Scholar Citation](#)
- Other online publications by [Zetoc](#); [ResearchGate](#); [Scopus](#); [ZIMATH](#)
- [List of recent publications](#)

Other links:

- [Teaching](#)
- [Students' thesis](#)
- [Other academic activities](#)
- [Research website](#)

[Methods in Finance 2019](#)

[Winter School on Graphs and Random Processes](#)

guided list now. Final reports of some of the projects are linked to the title. The purpose and expected nature of semester projects can be found from [here](#). Students who wish to write a report/thesis for the first time are suggested to read and understand [this](#).

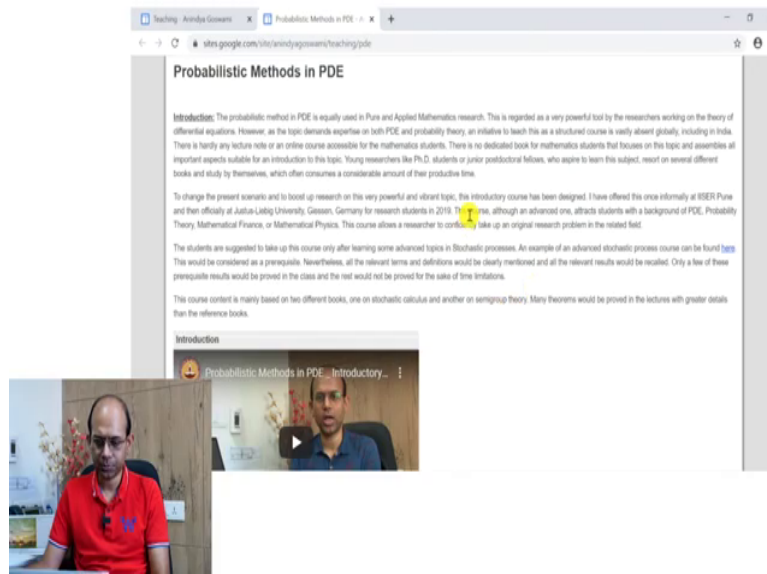
If you are a student, willing to learn math-finance and seeking a guidance how to start with, check if you find [this link](#) useful and write me your opinion, if you wish.

Showing 78 items.

when	what	type	for (size)
Sort -	Sort -	Sort -	Sort -
January 1, 2020	Probabilities in PDE	NPTEL Online Course	Research students
January 1, 2020	Stochastic process	Elective course	BS-MS 4th year (16)
December 2, 2019	Exoticly stock chain and arbitrage	Winter project	for 3rd and 4th year BS-MS
August 1, 2019	Probability Theory	Elective Course	BS-MS, PhD, PhD (20)
August 1, 2019	Computational Techniques in Math Finance	Semester Project	Individual (2)
April 18, 2019	Probabilistic Methods in PDE	at J.U Gießen, Germany	Research students
January 8, 2019	Mathematical Finance	2nd credit course	BS-MS, PhD, PhD
January 1, 2019	Risk Management in Financial Markets	Semester Project	Individual (1)
January 1, 2019	Existence and uniqueness of SDEs of jump diffusion processes	Semester Project	Individual (1)
January 1, 2019	Sections of Markovs Theory and Computation	Semester Project	Individual (1)
January 1, 2019	Investment Science	Semester Project	Individual(3)
	Support and Resistance Trend Lines	Semester project	Individual (3)
	Numerical Analysis	Elective course	BS-MS, PhD, MSc (76)
	Option pricing in volatile markets model	Semester Project	Individual (1)
	Summer 2018	Summer Project	external and internal (21)
	Detection of Regime Switching using the Intraday Volatility of a Financial Time Series	MS Project	BS-MS 4th yr - Sanjay N S

If you just search by my name, you would be able to get this website. And here, you would be able to see a link, teaching link. In the teaching link, so, there I generally update all the courses that I teach in the present or whatever or the past semester whatever I taught. So, here, this appears at the top, because this is the present semester, okay. So over time it would go below to, in the list.

(Refer Slide Time: 02:04)



The screenshot shows a web browser window with the URL sites.google.com/site/andygossens/teaching/pde. The page title is "Probabilistic Methods in PDE". The main content is an introduction paragraph explaining the course's focus on the probabilistic method in PDE research. Below the text is a video player showing a man in a red shirt speaking.

Probabilistic Methods in PDE

Introduction: The probabilistic method in PDE is equally used in Pure and Applied Mathematics research. This is regarded as a very powerful tool by the researchers working on the theory of differential equations. However, as the topic demands expertise on both PDE and probability theory, an initiative to teach this as a structured course is vastly absent globally, including in India. There is hardly any lecture note or an online course accessible for the mathematics students. There is no dedicated book for mathematics students that focuses on this topic and assembles all important aspects suitable for an introduction to this topic. Young researchers like Ph.D. students or junior postdoctoral fellows, who aspire to learn this subject, resort on several different books and study by themselves, which often consumes a considerable amount of their productive time.

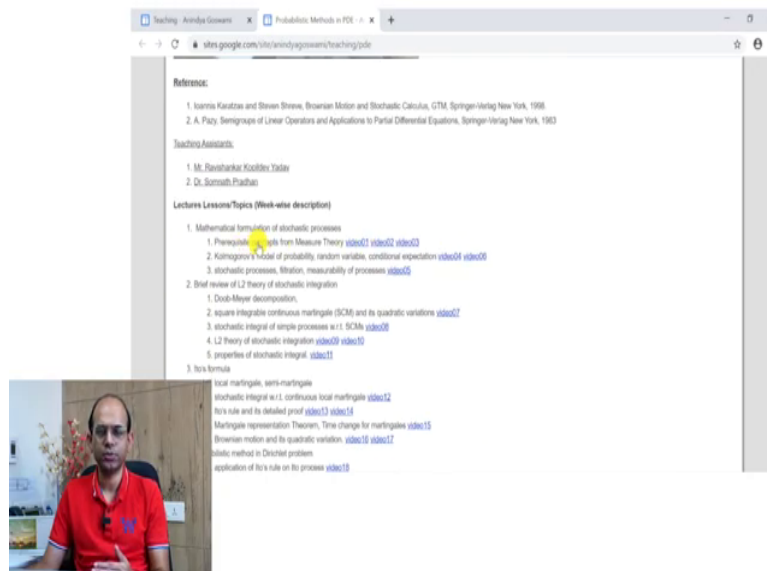
To change the present scenario and to boost up research on this very powerful and vibrant topic, this introductory course has been designed. I have offered this once informally at BIER Pure and then officially at Justus-Liebig University, Gießen, Germany for research students in 2019. To **think**, although an advanced one, attracts students with a background of PDE, Probability Theory, Mathematical Finance, or Mathematical Physics. This course allows a researcher to confidently **take** up an original research problem in the related field.

The students are suggested to take up this course only after learning some advanced topics in Stochastic processes. An example of an advanced stochastic process course can be found [here](#). This would be considered as a prerequisite. Nevertheless, all the relevant terms and definitions would be clearly mentioned and all the relevant results would be recalled. Only a few of these prerequisite results would be proved in the class and the rest would not be proved for the sake of time limitations.

This course content is mainly based on two different books, one on stochastic calculus and another on semigroup theory. Many theorems would be proved in the lectures with greater details than the reference books.

Introduction

Probabilistic Methods in PDE - Introductory...



The screenshot shows the lower part of the course page, including a list of references, teaching assistants, and a detailed list of lecture topics with corresponding video links.

References:

1. Ioannis Karatzas and Steven Shreve, Brownian Motion and Stochastic Calculus, GTM, Springer-Verlag New York, 1998.
2. A. Pazy, Semigroups of Linear Operators and Applications to Partial Differential Equations, Springer-Verlag New York, 1983.

Teaching Assistants:

1. Mr. Ravishanker Koolikar Yashir
2. Dr. Sumath Pradhan

Lectures Lessons/Topics (Week-wise description)

1. Mathematical formulation of stochastic processes
 1. Probabilistic **split** from Measure Theory [video01](#) [video02](#) [video03](#)
 2. Kolmogorov's model of probability, random variables, conditional expectation [video04](#) [video05](#)
 3. stochastic processes, filtration, measurability of processes [video06](#)
2. Brief review of L2 theory of stochastic integration
 1. Doob-Meyer decomposition,
 2. square integrable continuous martingale (SICM) and its quadratic variations [video07](#)
 3. stochastic integral of simple processes w.r.t. SICM [video08](#)
 4. L2 theory of stochastic integration [video09](#) [video10](#)
 5. properties of stochastic integral, [video11](#)
3. Itô's formula
 - local martingale, semi-martingale
 - stochastic integral w.r.t. continuous local martingale [video12](#)
 - Itô's rule and its detailed proof [video13](#) [video14](#)
 - Martingale representation Theorem, Time change for martingale [video15](#)
 - Brownian motion and its quadratic variation, [video16](#) [video17](#)
 - Itô's method in Dirichlet problem
 - application of Itô's rule on Itô process [video18](#)

And in that course page, what you can see now here I have the list of all the topics and then I have mapped the video numbers, corresponding to those topics also here.

(Refer Slide Time: 02:24)

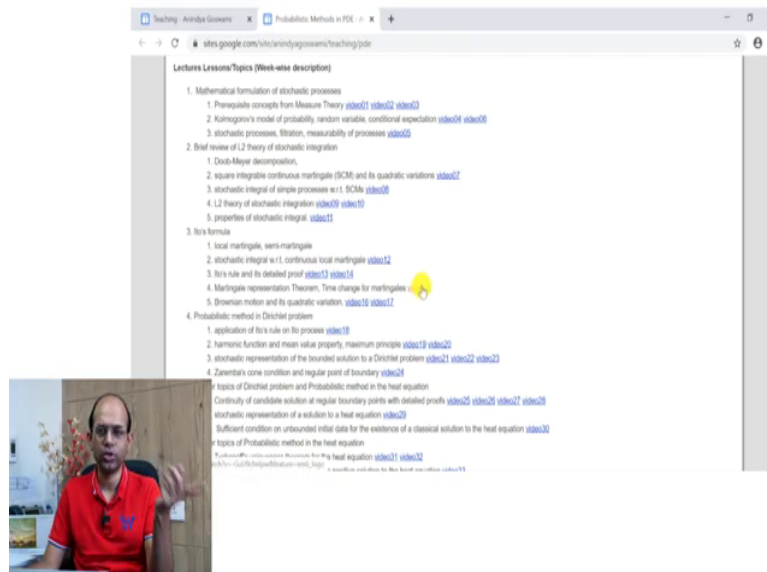
The screenshot shows a Google Drive folder named 'slides' containing a list of presentation files. The files are listed in a table with columns for file name, description, date, and owner. A yellow circle highlights the file 'presentation18.pdf'. A video inset in the bottom-left corner shows a man in a red shirt speaking.

File Name	Description	Date	Owner
presentation11.pdf	Nonnegative solution. Solution to the mixed Initial boundary value problem	Feb 24, 2020, 8:28 PM	Anshya Goswami
presentation12.pdf	The Feynman-Kac formula	Jan 20, 2020, 8:28 PM	Anshya Goswami
presentation13A.pdf	Tutorial: GBM, Mean-reverting process, and Brownian Bridge	Mar 3, 2020, 8:38 PM	Anshya Goswami
presentation13.pdf	A second order linear ODE	Jan 31, 2020, 8:28 PM	Anshya Goswami
presentation14.pdf	Existence and uniqueness of SDE solution	Feb 16, 2020, 4:59 PM	Anshya Goswami
presentation15.pdf	Weak Solution and Operator associated to that	Feb 28, 2020, 2:31 PM	Anshya Goswami
presentation16.pdf	Operator associated with Weak Solution to PDE, Statement of Feynman-Kac formula	Mar 30, 2020, 12:51 PM	Anshya Goswami
presentation17.pdf	Cauchy Problem with variable coefficients. Proof of Feynman-Kac formula	Mar 30, 2020, 12:51 PM	Anshya Goswami
presentation18.pdf	Definition, examples and growth of C, C_1 semigroups	Mar 30, 2020, 12:55 PM	Anshya Goswami
presentation19.pdf	Classical & Mild solution to homogeneous IVP. Hille-Yosida Theorem. Yosida Approximation	Apr 2, 2020, 8:48 PM	Anshya Goswami
Probabilistic approach in PDE.pdf		Jul 24, 2016, 9:58 PM	Anshya Goswami

The screenshot shows a Google Drive folder containing a list of presentation files. A text block at the top provides instructions on how the files are organized. The files are listed in a table with columns for file name, description, date, and owner. A yellow circle highlights the file 'Lecture07.pdf'. A video inset in the bottom-left corner shows a man in a red shirt speaking.

The slides used in the video recordings have been revised and improved with occasionally more written clarifications and also by eliminating typographical errors. These slides are saved as presentationx.pdf and numbered sequentially and can be viewed or downloaded from the following file cabinet. The presentations are not numbered according to the video lecture number. These are rather arranged topics-wise. The TA and some other students have kindly agreed to prepare printable files from the materials in the presentation file. They would also mention the video numbers corresponding to each file. So, these would serve the purpose of lecture notes. Some notes may have additional examples or clarifications.

File Name	Description	Date	Owner
Lecture03.pdf	video01 video02 video03	Mar 7, 2020, 7:04 PM	Anshya Goswami
Lecture04.pdf	video04 video05 video06	Mar 7, 2020, 7:04 PM	Anshya Goswami
Lecture07.pdf	video07 video08	Mar 7, 2020, 7:05 PM	Anshya Goswami
presentation00.pdf	Prerequisite concepts from Measure Theory	Mar 9, 2020, 3:54 PM	Anshya Goswami
presentation01.pdf	Mathematical formulation of stochastic processes	Jan 20, 2020, 5:10 PM	Anshya Goswami
presentation02.pdf	Preliminary relations for defining Stochastic Integration	Jan 20, 2020, 5:30 PM	Anshya Goswami
presentation03.pdf	L2 theory of stochastic integration and its properties.	Jan 20, 2020, 5:34 PM	Anshya Goswami
presentation04.pdf	Stochastic Integral w.r.t. continuous local martingales	Jan 20, 2020, 5:13 PM	Anshya Goswami
presentation05.pdf	Brownian motion and its quadratic variation	Jan 20, 2020, 5:12 PM	Anshya Goswami
presentation06.pdf	Harmonic function and mean value property. Maximum Principle	Jan 20, 2020, 5:36 PM	Anshya Goswami
presentation07.pdf	Dirichlet problem: part 1 - Bounded solution	Jan 20, 2020, 5:33 PM	Anshya Goswami
presentation08.pdf	Dirichlet Problem: part 2 - Continuity of	Jan 20, 2020, 5:33 PM	Anshya Goswami



And at the end of this list, there is a file cabinet. It is a Google Drive file cabinet. So, here, in this file cabinet, you would be able to get all the slides, okay. And these slides are the same thing what you would be able to get for my course which are modified, not possibly 0, but less error, less typing error. So, these are, these files are written in the names of like presentation 0, 1, 2, 3, 4, 5, 6, etc okay.

And you can read this; you know blue things here which explains the arrangement of the files here. And also, I want to get help from TA and other students, to make one printable version of the slides, okay, so like a lecture note, okay. And those lecture notes not a full 1 single lecture note for the whole course lectures, but separate different files, okay.

So, there I would try to mention the video numbers also which are associated with these lectures. So, one would be able to get that, you know given a topic which one can find out. Say for example, here; given the week number, one can see what are the lecture topics and for these lecture topics, which is the video number.

And one can also see here, say particular topic, for this particular topic, what is the corresponding slide, okay. And also, here, whatever the video number, considering that whatever, what is the corresponding lecture note. Okay so, this lecture note I have not prepared yet. So, this for this I need help from TA or some other students, who are going to compile just you know reconstruct the slide content into a printable version.

So, till now, only 3 lectures, I mean notes are appearing here, till video 8. But some more would appear very soon. Okay wish you all the best, I really encourage you to take this

course seriously and whatever is taught here are basically from 2 books. Both the books are very good.

And I really found, those are easy to self-study also. Okay, students can actually learn more details than whatever I have delivered in the course, okay. Those are fantastic books. So, it was, my work was much easier because those books were anyways written very nicely. And the only thing what I just did is that, you know, just you know removed some parts and included the things to make a course here.

And I really believe that if you are confident about this course, if you think that you have learned all the concepts, delivered in the course, then I think you are ready to start actually taking up a research problem in this direction. And you would be able to confidently, you know work in this direction seriously.

Okay I hope that this really, you know becomes useful for many of you and many of you find it useful. Not only now but in future also, many future students also should get benefited from this course. And if you find any more content in any part of the course which you think that I could improve better by giving more details or by having different approach or you think that some things are really vague I did not do it properly.

So, whatever you feel like, you can give me, you can send me an email. You can write to me. And I would make sure that, those suggestions would be, you know reflected in the lecture notes. Okay so, this page would be, you know is basically maintained by me. If I find that some very good point, what I have missed or what I could have included, okay.

So not by you know making the length abruptly long, but it can fit very well. So, those parts or those, you know explanations I would really love to include and I would like to keep it. And I would like to improve the present course material over time.

Okay, thank you very much for registering for this course, attending this, asking questions in the forum, solving assignments, etc I am really happy to see the enthusiasm among the students. Okay, wish you all the best. Thank you very much.