



SHIV NADAR UNIVERSITY

DEPARTMENT OF MATHEMATICS

SCHOOL OF NATURAL SCIENCES

GRADUATE PROSPECTUS

M.Sc. and Ph.D. in Mathematics

2019–20

www.snu.edu.in

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Overview

The Department of Mathematics at SNU offers programs and courses that highlight the interdisciplinary and the multidisciplinary nature of the university. Its academic programs provide a solid base for careers in both academia and industry. There is a great demand for mathematicians in various sectors: investment banks, insurance companies, financial institutions, engineering consultancies, medical research, bioinformatics, software, computer security, and defense. Well trained students are also sought by universities all over the world for their research programs.

The following distinguishing features are common to all our programs:

- Accessibility to students from diverse backgrounds
- Melting of the artificial barriers between pure and applied mathematics and between mathematics and other disciplines.
- Exposure to leading mathematicians, scientists and thinkers from India and abroad.

The department offers the following degree programs at the graduate level:

- **M.Sc. in Mathematics**
- **Ph.D. in Mathematics**

The department has a close relationship with research centers at SNU; especially the **Institute for Innovations and Inventions with Mathematics and IT (IIIMIT)** and the **Big Data Analytics Center (BDAC)** which are currently headed by mathematics faculty. We have regular seminars, and have hosted national conferences and programs such as

- *Northern Regional Conference of the National Initiative in Mathematics Education (2011, co-hosted with Ambedkar University, Delhi).*
- *27th Annual Conference of the Ramanujan Mathematical Society (2012)*
- *Annual Foundation School for Ph.D. students (2015, sponsored by the National Centre for Mathematics).*
- *Mathematical Training and Talent Search program (2015 and 2016, sponsored by the National Board for Higher Mathematics).*
- *Advanced Instructional School on Matrix Analysis (2016, sponsored by the National Centre for Mathematics).*
- *National Conference on Cross-disciplinary Applications of Complex Networks (2018, sponsored by Science and Engineering Research Board, India).*
- *Annual Conference of Indian Women and Mathematics (June 2018, sponsored by National Board for Higher Mathematics).*

Research is further supported by facilities such as individual laptops/desktops for faculty, a 30-PC computer lab with Mathematica and Matlab, a generous library budget for books, and subscriptions to diverse journals. In 2015, we were awarded a five-year

grant under the **DST-FIST** scheme for developing a Research Computer Lab and a Department Library.

All graduate programs at SNU are managed and coordinated by the office of the **Dean of Research and Graduate Studies**. The overall goals of graduate study at SNU are:

1. Provide scholars with a discovery-driven intellectual environment
2. Develop scholars for leadership positions in academic and research focused organizations
3. Encourage the development of interdisciplinary research orientation focused on tackling intellectually and socially relevant problems
4. Train scholars in academic and research publishing processes
5. Hone scholars' teaching abilities



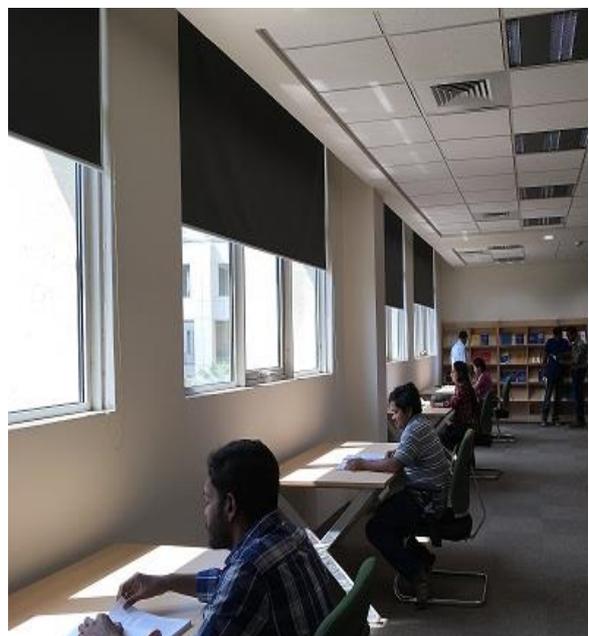
Department faculty, staff and graduate students in front of the Library in December 2015.



The Department of Mathematics is housed in the School of Natural Sciences.



Graduate students at Research Computer Lab in the department. It is funded by DST under the FIST scheme.



The department library. It is funded by DST under the FIST scheme.

Faculty

The members of the faculty of mathematics at SNU have studied or worked at leading institutions. Their mathematical interests vary across areas such as functional and harmonic analysis, representation theory, differential geometry, number theory, encryption, game theory, graph theory, category theory, differential equations, signal processing, computational methods, statistics, mathematical finance, mathematical biology, and medical imaging.

Faculty Member	Qualifications	Areas of Interest
Sanjeev Agrawal Professor	Ph.D. Delhi M.A. Oxford	Functional Analysis, Operator Theory, Error Correcting Codes, Encryption
Sudepto Bhattacharya Associate Professor	Ph.D. Nagpur M.Sc. Nagpur	Complexity, Game theory, Network Theory, Mathematical Modeling
Samit Bhattacharyya Assistant Professor	Ph.D. Univ. of Calcutta M.Sc. Univ. of Calcutta	Applied Mathematics and Computational Biology
Debashish Bose Assistant Professor	Ph.D. IIT Kanpur M.Sc. IIT Kanpur	Harmonic Analysis, Number Theory, Combinatorics, Percolation
Priyanka Grover Assistant Professor, DST-Inspire Faculty	Ph.D. ISI Delhi M.Sc. Univ. of Delhi	Matrix Analysis, Operator Theory
Neha Gupta Assistant Professor	Ph.D. Univ. of Warwick M.Sc. Univ. of Warwick	Quantum Groups, Category Theory
Amber Habib Professor & Head	Ph.D. Berkeley M.S. (Int) IIT Kanpur	Representation Theory, Mathematical Finance
Ajit Kumar Assistant Professor	Ph.D. Univ. of Houston M.S. Univ. of Houston	Partial Differential Equations, Finite Element Method
Pradip Kumar Assistant Professor	Ph.D. HRI M.Sc. IIT Kanpur	Differential Geometry, Global Analysis
Sneh Lata Assistant Professor; Graduate Advisor	Ph.D. Univ. of Houston M.S. Univ. of Houston	Frame theory, Operator Theory and Function Theory
A Satyanarayana Reddy Assistant Professor	Ph.D. IIT Kanpur M.Sc. Andhra University	Algebraic Graph Theory, Discrete Mathematics, Algebraic Number Theory
Niteesh Sahni Assistant Professor; Undergraduate Advisor	Ph.D. Delhi University M.Sc. Delhi University	Functional Analysis, Operator Theory, Dynamical Systems
Charu Sharma Assistant Professor	M.S. Univ. of Houston	Bioinformatics, Computational Finance
Santosh Singh Associate Professor; Director BDAC	Ph.D. IIT Kanpur M.A. Agra University	Medical image analysis, Image reconstruction, Computational

		photography, Light field and Optimization techniques
L. M. Saha Professor; at IIIMIT	Fellow Ph.D. Univ. of Calcutta M.Sc. Patna University	Dynamical Systems & Chaos Theory, Celestial Mechanics & Astrophysics, Application of Nonlinear Dynamics to Bio-Science & other areas of science

Some major journals in which our faculty members have published:

- Proceedings of the American Mathematical Society
- Proceedings of the National Academy of Sciences, USA
- Studia Mathematica
- Journal of Functional Analysis
- Linear Algebra and its Applications
- Forum Mathematicum
- Indiana University Mathematics Journal
- Journal of Theoretical Biology
- Bulletin of Mathematical Biology
- Stochastic Analysis and Applications
- Proceedings of the Indian Academy of Sciences
- Journal of Mathematical Analysis and Applications
- Journal of Ramanujan Mathematical Society
- Houston Journal of Mathematics

M.Sc. in Mathematics

Our two-year M.Sc. program epitomizes SNU's development of innovative offerings that open new avenues for students. Our students acquire the training, the exposure, and the creative thinking needed to develop new mathematics and to take on challenges such as detecting cancer, managing financial risk, modeling complex systems, etc. At the same time our students are well exposed to the rigour of mathematics. The M.Sc. degree can be used to provide the base for a Ph.D. in mathematics and its applications, or a career in industry. In support of our argument a few concrete examples of what our M.Sc. graduates can do are given on Page 6.

- **Duration:** Four semesters, extendable by two semesters.
- **Eligibility:** A B.A./B.Sc./B.S./B.Tech. Degree in Mathematics/Physics/Science/ Engineering or similar disciplines with overall marks of at least 50% (or equivalent grade). Final year students can apply on the basis of their earlier marks. Please write to us in case you have a different background or are uncertain about your eligibility for any reason. (Contact details are given at the end of this prospectus)

- **Admission:** Admission is through a written test. The syllabus for the test is described in the **Admission Process** section.

- **Course Structure:**

Semester I	Analysis I	Algebra I	Linear Algebra	Numerical Analysis & Computer Programming
Semester II	Complex Analysis	Algebra II	Functional Analysis	ODE
Semester III	Lebesgue Measure Theory	Topology	Elective	Project/Elective
Semester IV	Elective	Elective	Elective	Project/Elective

- **Electives:** The department offers a wide range of elective courses such as – Number Theory, Error Correcting Codes, Commutative Algebra, Non-Negative Matrices, Graph Theory, Algebraic Graph Theory, Topological Graph Theory, Representation Theory, Lie Groups, Matrix Analysis, Fourier Analysis, Hardy-Hilbert Spaces and Applications, Algebra of Operators, General Measure Theory, Differential Geometry, Dynamical Systems, Numerical Differential Equations, Computational Economics, Formal Languages and Automata Theory, Game Theory, Evolutionary Game Theory, Biomathematics, Statistics, Probabilistic Models and Statistical Inference, Complex Networks, etc.
- **Project:** In semester III and IV, students can choose to do a project, spread over 2 semesters, where they work with a faculty to develop a master's thesis.
- **Degree Requirements:** The student must
 1. Complete 16 graduate courses of level 600 and above, totaling a minimum of 64 credits. Up to two of the elective courses may be replaced by level 500 courses, or by courses from other departments. All exceptions require the prior approval of the Graduate Advisor.
 2. Maintain a CGPA of 5.0 (i.e. an average grade of C-). A student who does not have a CGPA of at least 5.0 at the start of the 3rd semester will be asked to leave the program.
- **Fees and Financial Aid:** All students of M.Sc. Mathematics receive financial aid in the form of a teaching assistantship. Continuation of the assistantship is contingent on maintaining a minimum CGPA of 7.0, and compliance with all university regulations. Further, it is only offered for the regular duration of the M.Sc. program (i.e. four semesters). The details of fees and the teaching assistantship can be found on SNU website. **Please see the university's Policy for Retention of Tuition Fee Waivers.**

Examples of career options for a M.Sc. (Mathematics) graduate from SNU:

1. Once a student has a thorough understanding of our core courses like Linear Algebra, Analysis I, Functional analysis, Complex analysis, Lebesgue Measure Theory, he/she

can do advanced courses in areas like Complex Analysis, Functional Analysis or Harmonic Analysis and go for a Ph.D. in these areas.

2. A Ph. D. in Biomathematics or a job in an industry that manages Weather Prediction/Biomedical Modelling & Simulation - This requires a thorough understanding of our core courses like Analysis, ODE and Numerical Analysis & Computer Programming. After this the student can take up electives like Biomathematics, Complex Networks, etc. to start a Ph. D. in Biomathematics or apply in industries that manage Weather Predictions, Biomedical Modelling & Simulations, Traffic Modelling, etc.
3. A Ph.D. in Computational Finance or a job in Finance industry – This requires thorough understanding of our core courses like Linear algebra, Analysis I, and Lebesgue Measure Theory. After this student can take up advanced courses in Computational Finance as electives and is ready to do a Ph.D. in Computational Finance or join a research team in a firm who manages Mutual Funds and Hedge Funds. Suppose a student chooses to go for Ph.D. first, he/she can directly apply for higher posts in similar firms.
4. Core courses like Analysis, Linear Algebra, ODE, Numerical Analysis & Computer Programming and Functional Analysis also prepare a student for applied areas like CFD. Interested student can take electives such as Numerical PDE and few other advanced courses in CFD and can choose either go for a Ph.D. in CFD or apply in industries such as Aeronautic, Automobile, Product Design & Optimization, etc.

Alumni Feedback

- ❖ Harman Kour (2017 batch).
UG degree: B.Sc. Physical Sciences

“An eclectic mix of pure and applied courses as well as TA opportunities at SNU not only helped me learn the fundamentals in mathematics but also laid the foundations for me to grow and flourish in myriad ways. The faculty members are immensely supportive and encouraged me to integrate learnings in math with my interests in ecology. Following masters, I pursued research on the predator-prey dynamics of snow leopards at the Nature Conservation Foundation. Thanks to the enriching time at SNU, I am now starting a Ph.D. in Ecology/Evolution at Stanford University, with a full scholarship.”

- ❖ Nipun Thakurele (2017 batch)
UG degree: B.Sc. Mathematics

"I found life-long mentors among SNU faculty members who are not only great teachers but also top researchers, working in diverse areas. The training in theoretical courses, as well as computational methods based courses, prepared me well for my higher studies at the

University of Chicago. The Master's thesis and Teaching Assistantship provided me with a unique opportunity to implement my classroom learning and played a pivotal role in obtaining Merit Scholarship at the UChicago."

- ❖ Kumar Ashutosh (2017 batch)
UG degree: B.Sc. Economics

"Coming from the economics background, I was skeptical about my decision to pursue a Masters in Mathematics. However, apart from the rigorous training in various subjects, viz, Topology, Measure Theory, Analysis, Algebra and so forth, the extensive and continuous support of faculty was amazing. The freedom to choose electives and research thesis helped me in the job market to a great extent. In condensed terms, I would say that mathematics department at SNU is a great place for anyone who is looking to gain meaningful mathematical training in order to pursue a gratifying career in the field of research as well as corporates."

- ❖ Sushil Singla (2016 batch)
UG degree: B. Sc. Physical Sciences

"I did my B.Sc. in Physical Sciences from Stephen's College before joining M.Sc. Mathematics at SNU. The support from the department made me truly enjoy the subject so that I am currently pursuing Ph.D. in Mathematics at SNU with a CSIR fellowship."

- ❖ Himanshu Sharma (2016 batch)
UG degree: B.Tech.

"The two years I spent here were by far the most rewarding in terms of satisfying my intellectual curiosity. The department offers a host of courses and the best part is that they do it after personal consultation with students. The mathematics department at SNU provides a really healthy and interactive environment. The kind of support extended by faculties outside the classroom was a really grateful experience that I will remember for life. And ofcourse, the campus is really beautiful!"

- ❖ Mayank Roy (2015 batch)
UG degree: B.Tech.

" I completed my masters from Cornell as Mechanical Engineer with Specialization in Robotics in May of 2018. After completion of my course I was hired as a Robotics Software Engineer at Trimble Navigation in the Alpharetta office. Here at Trimble, I am working in designing autonomous systems and intelligent sensors. My work requires me to program specific behavior in the sensors and my knowledge of mathematics serves me well to that end.

Common areas that I apply include optimization, numerical analysis, numerical integration and differentiation, differential equations, probability, statistics, graph theory and formal

language. These are all courses I did while at SNU and my understanding of these areas helps me work independently and perform well.”

Ph.D. in Mathematics

The faculty members of the Department of Mathematics at SNU have research interests over wide areas of pure and applied mathematics. The broad areas of interest of our individual faculty have been listed earlier.

Ph.D. students can also carry out their research in collaboration with faculty in other departments or research centres such as IIIMIT, BDAC and the Centre for Informatics.

The detailed SNU Ph.D. Regulations can be obtained from the SNU website. A summary of the Mathematics Ph.D. program is given below:

- **Duration:** Six to ten semesters.
- **Admission:** Admission is through a written test and interview. The written test is described in the **Admission Process** section.
- **Course-Work:** The student must register for the following, in consultation with the Graduate Advisor:
 - Three courses of 4 credits each in the first semester.
 - Research Methodology course.
 - Coursework in the second semester will depend on performance in the first semester.
 - Retention of fellowship requires a minimum CGPA of 7.0. For more details, see **SNU Policy for Retention of Tuition Fee Waivers**.
- **Degree Requirements:** To earn a Ph.D. degree the student must:
 - Complete the required course-work.
 - Pass the Comprehensive Examination, which consists of Qualifying Examinations and a Research Seminar, by the end of the 4th semester.
 - Publish one research paper in a refereed journal before thesis submission.
 - Submit and defend the doctoral thesis.
- **Eligibility:** A Master’s Degree in Mathematics or related disciplines with overall marks of at least 60% (or equivalent grade). Please enquire in case you are uncertain about your eligibility for any reason. Candidates who have qualified for CSIR-UGC NET-JRF, GATE-JRF, JEST or NBHM Fellowship are preferred.
- **Fees and Financial Aid:** All students admitted to our Ph.D. program receive a Teaching Assistantship as well as significant Tuition and Hostel Fee waivers. **Please see SNU website for details.**

Continuation of the assistantship is contingent on satisfactory performance in the program evaluated continuously, and compliance with all University regulations. Further,

the scholarship is only offered for the regular duration of the Ph.D. program (i.e. eight semesters).

Admission Process

All interested candidates should apply online at www.snu.edu.in. After online submission and payment of application fee, print the completed form and send by speed post to the University at the following address:

Ms. Lakshmi Arya
EA to the Head
Department of Mathematics
School of Natural Sciences
Shiv Nadar University P.O.
NH-91, Tehsil Dadri
District Gautam Buddha Nagar, UP 201314, India.

The printed form should be accompanied by the following documents:

- At least one sealed reference letter in support of the application.
- Demand Draft for application fee (If online fee payment mode is not used).

Admissions to the M.Sc. program is through a written exam, and admission to the Ph.D. program is through an exam comprising of a written test and an interview. The key dates for both M.Sc. and Ph.D. admission exams are:

Exam	Last date for receipt of application form by SNU	Announcement of shortlist for written test and interview
July 2, 2019	June 17, 2019	June 21, 2019

The written tests are described below.

Written Test for Admission to M.Sc.

The written test will consist of both multiple-choice and descriptive questions. There will be an element of choice available. The questions will range over the following topics:

Real analysis: Elementary set theory, real number system, sequences and series, monotone sequences, convergence, Cauchy sequences and completeness, Bolzano-Weierstrass

theorem, continuity, uniform continuity, differentiability, Taylor expansions, mean value theorems, Riemann integration, and Fundamental theorem of Calculus.

Linear algebra: Vector spaces, subspaces, basis, dimension, direct sum, matrices, determinants, linear transformations, rank, nullity, systems of linear equations, eigenvalues and eigenvectors.

Algebra: Groups, Lagrange's theorem, normal subgroups, cyclic groups, homomorphism and isomorphism of groups.

Ordinary differential equations: General and particular solutions of a differential equation, formation of differential equations, first order first degree differential equations and their classification, separation of variables, integrating factors, and linear equations.

Probability: Permutations and combinations, principle of inclusion and exclusion, mathematical induction, combinatorial probability, independent events, total probability, conditional probability, Bayes' theorem, binomial, Poisson, normal distributions, mean and variance, Chebyshev's inequality, and joint distribution.

Written Test for Admission to Ph.D.

The written test will be in two parts, consisting of multiple-choice and descriptive questions respectively.

The multiple-choice portion will contain Masters level questions from the fundamental areas of Linear Algebra, Algebra, Real Analysis, Metric Spaces, Complex Analysis, Numerical Analysis, Ordinary Differential Equations, Combinatorics, and Probability.

The descriptive questions will be selected from the above as well as specialized topics such as Functional Analysis, Harmonic Analysis, Differential Geometry, Partial Differential Equations, Graph Theory. As these may not have been studied by all students, the applicant will be allowed to choose between questions.

Contact Us

For further details, please write to one of the following:

Prof. Amber Habib
Head
Department of Mathematics
amber.habib@snu.edu.in

Prof. Priyanka Grover
Department of Mathematics
priyanka.grover@snu.edu.in

The SNU website is www.snu.edu.in.

