Department of Mathematics, IIT Bombay

Fresh Research Scholars Seminars (FRSS)

Due to the Covid pandemic, there are fewer opportunities for the research scholars who have joined the Department in the recent past to meet and interact with the faculty members and senior research scholars of the Department. Partly with this in view, a series of seminars by 15 "fresh" research scholars is being organized. This will allow the faculty and RS to "meet" these students virtually. It will also provide an opportunity to fresh research scholars to showcase the skills they have acquired in MA 792 (Communication Skills). We will have about 3 to 4 seminars each week for a period of about a month beginning Monday, 19th October 2020. An outline of the talks in this series is provided below. Further details, including abstracts and video conferencing links, will be communicated each week by the Seminar Committee. All interested are cordially invited to join.

Schedule of Talks: Mondays@11.30, Wednesdays@16.00, Saturdays@11.30 and @16.00

(Each seminar will be for about one hour, including time for questions)

1.	**Nitin Tomar**	*Pro C* algebras*	19 Oct 2020
2.	**Saad Qadri**	*Lindemann-Weierstrass theorem*	21 Oct 2020
3.	**Deep Makadiya**	*Schreier's theorem*	24 Oct 2020
4.	**Ashish Shukla**	*Representation theory of the symmetric group*	24 Oct 2020
5.	**Omkar Javadekar**	*Serre's conjecture for projective modules*	26 Oct 2020
6.	**Sai Krishna**	*Krull's Generalized Principal Ideal Theorem*	31 Oct 2020
7.	**Uttam Ojha**	*Hensel's Lemma*	31 Oct 2020
8.	**Ketan Sutar**	*Borsuk-Ulam Theorem*	2 Nov 2020
9.	**Parvez Rasul**	*Bezout's theorem for algebraic curves in plane*	4 Nov 2020
10.	**Utsav Dewan**	*Discrete Hilbert transform and L^p convergence of Fourier series*	7 Nov 2020
11.	**Shubham Niphadkar**	*Model selection consistency in linear models*	7 Nov 2020
12.	**Lovy Jain**	*Lax-Milgram lemma and its applications*	9 Nov 2020
13.	**Anik Roy**	*Testing Independence among random vectors based on Univariate Test*	18 Nov 2020
14.	**Sakshi**	*Lambert's proof of irrationality of π*	21 Nov 2020

ABSTRACTS:

Monday, 19th Oct 2020 at 11.30 am

Nitin Tomar *Pro C* algebras*

Abstract: attached.

Wednesday, 21st Oct 2020 at 4 pm

Saad Qadri *Lindemann-Weierstrass theorem*

Abstract: A (complex) number is said to be algebraic (over rationals) if it satisfies a nonzero polynomial equation with integer coefficients. A number that is not algebraic is said to be transcendental. Our goal in this talk will be to prove the Lindemann Weierstrass theorem which states that if b_j's are distinct algebraic numbers then exp(b_j)'s are linearly independent over the field of algebraic numbers (over Q). This gives as its corollary the fact that pi and e are transcendental.

Saturday, 24th Oct 2020 at 11.30 am

Deep Makadiya *Schreier's theorem*

Abstract: For any group G, Schreier theorem states that any two subnormal series of G have isomorphic refinements. This is one of the fundamental results in group theory. The proof involves another interesting lemma called Butterfly Lemma (also known as Zassenhaus Lemma). As a consequence of Schreier's theorem, we shall also outline a proof of Jordan-Hölder theorem for composition series.

Saturday, 24th Oct 2020 at 4 pm

Ashish Shukla *Representation theory of the symmetric group*

Abstract: We give a glimpse into the representation theory of the symmetric group (S_n). Here we begin by establishing the basics of representation theory by addressing questions such as: what is a representation? what is a module? how many irreducible representations are there? etc. We then answer these questions for the symmetric group. We define certain terminologies, building the basics of representation theory from introductory knowledge of linear algebra and group theory. We explore an intimate connection between Young tableaux and representations of the symmetric group. We describe the construction of Specht modules which are irreducible representations of S_n

Monday, 26th Oct 2020 at 11.30 am

Omkar Javadekar *Serre's conjecture for projective modules*

Abstract: Also known as Quillen-Suslin theorem, Serre's conjecture is a result concerning the relationship between free and projective modules over polynomial rings. It states that every finitely generated projective module over a polynomial ring over a field is free. The statement was conjectured by Serre in 1955, and the first proofs were given independently by Quillen and Suslin in 1976. In this talk we will see a proof of Serre's conjecture.

We begin by defining unimodular extension property. We then show that polynomial rings have unimodular extension property. Finally, appealing to the result that finitely generated projective modules over polynomial rings are stably free, we conclude the proof of Serre's conjecture by showing that stably free modules over a ring having unimodular extension property are free.

Saturday, 31st Oct 2020 at 11.30 am

Sai Krishna *Krull's Generalized Principal Ideal Theorem*

Abstract: In this talk, we will discuss the proof of Krull's Generalized Principal Ideal Theorem without using the the Dimension theorem. We will briefly introduce the notion of Krull dimension and prove the Principal ideal theorem and the generalized version. We will look at a few consequences of this result.

Saturday, 31st Oct 2020 at 4 pm

Uttam Ojha *Hensel's Lemma*

Abstract: We begin with the notions of completion of a module and completeness. Then we prove Hensel's Lemma for a complete ring and deduce the Implicit function theorem as a Corollary.

Monday, 2nd Nov 2020 at 11.30 am

Ketan Sutar *Borsuk-Ulam Theorem*

Abstract: The Borsuk-Ulam theorem is a nice result in Algebraic Topology. It states that every continuous function from a sphere to a plane acts as antipode preserving for a point on sphere. In this talk we will discuss some basic definitions and concepts in Algebraic Topology. Then we will prove some theorems which will be helpful for the proof the Borsuk-Ulam theorem. We will also discuss its generalisation to plane known as The Bisection theorem.

Wednesday, 4th Nov 2020 at 7 pm

Parvez Rasul *Bezout's theorem for algebraic curves in plane*

Abstract: Algebraic geometry is concerned with the study of the properties of certain geometric objects (which are mainly solution sets of systems of polynomial equations) using abstract algebra. One of the earliest results to this end is Bézout's theorem, which relates the number of points at which two polynomial curves intersect to the degrees of the generating polynomials. Here we reproduce an elementary proof of Bézout's theorem for algebraic curves in plane. It states that if we have two algebraic plane curves, defined over an algebraically closed field and given by zero sets of polynomials of degrees n and m, then the number of points where these curves intersect is exactly nm if we count "multiple intersections" and "intersections at infinity". To formulate and prove the theorem rigorously we go through some concepts which lie at the heart of algebraic geometry like projective space and intersection multiplicities at a common point of two curves.

Saturday, 7th Nov 2020 at 11.30 am

Utsav Dewan *Discrete Hilbert transform and L^p convergence of Fourier series*

Abstract: We investigate the convergence of Fourier series of various $L^p(\mathbb{T})$ functions via the discrete Hilbert transform.

Saturday, 7th Nov 2020 at 4 pm

Shubham Niphadkar *Model selection consistency in linear models*

Abstract: This short note studies the effects of model selection in a linear regression model with two covariates. We study the effect of including redundant covariate and effect of excluding useful covariate. We explore consistency and uniform consistency of model selection.

Monday, 9th Nov 2020 at 11.30 am

Lovy Jain *Lax-Milgram lemma and its applications*

Abstract: Lax-Milgram lemma is an effective tool in checking the well-posedness of a weak formulation. Derived from basic theorems of functional analysis, it saves hectic calculations that serves the purpose otherwise in differential equations' analysis.

Wednesday, 18th Nov 2020 at 4 pm

Anik Roy *Testing Independence among random vectors based on Univariate Test*

Abstract: The problem of testing independence of random vectors has received increased attention in recent years. There are lots of method for testing independence among univariate random variables and also random vectors. In this presentation we carry out a test of Independence for random vectors based on univariate test.

Saturday, 21st Nov 2020 at 11.30 am

Sakshi *Lambert's proof of irrationality of π*

Abstract: In the 1760s, Johann Heinrich Lambert proved that the number π (pi) is irrational. It was the very first proof of irrationality of π and was proved using the continued fraction expression of $\tan x$. This talk includes a brief introduction to continued fractions and focuses on a simplified version of Lambert's proof given by M. Laczkovich in 1997.