

Instructional School for Lecturers (Galois Theory)

December 01-13, 2014.



Sponsored by

National Centre of Mathematics

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(A joint centre of TIFR and IIT Bombay)



Venue: Department of Mathematics,
SGGS Institute of Engineering & Technology, Nanded

Organizers

Prof. Sudhir R. Ghorpade (Department of Mathematics, IIT Mumbai)
Prof. Arunkumar R. Patil (SGGS Institute of Engineering & Technology,
Nanded)

SGGSIE and T, Nanded conducted a Two Week's NCM sponsored Instructional School for Lecturers on Galois Theory during December 01-13, 2014. Usually, NCM study the profile of institute and then invites the institute to organize such a instructional school. Till date this programme was organized at IIT's, IISC, IISER's, TIFR, and reputed universities such as UOP and UOM, This is the honor to SGGS Institute for inviting us to organize such a prestigious school. Eminent Mathematicians across the country gave their talks in this course.

Inaugural Session



For the inaugural function of this school (held on 01/12/14) Dr. L. M. Waghmare (Director, SGGS IE and T, Nanded) was Chief Guest. Prof. Sudhir R. Ghorpade (IIT, Mumbai) and Prof. Arunkumar Patil (SGGSIE and T) were the organizers of this course. Prof. A. S. Sontakke (Head, Department of Mathematics, SGGS IE and T, Nanded) was also present for the inaugural ceremony.



Dr. L. M. Waghmare, in his inaugural talk remarked upon the importance of these instructional schools to update the knowledge of the subject. He also thanked to NCM for giving an opportunity to SGGS for the first time to organize such kind of school in this region. The inaugural function was attended by all participants and teachers from the neighboring colleges and Institutes.

Resource Persons:

Five resource persons from reputed institutions of India delivered lectures in the school. These resource persons were as follows:

1. Prof. Sudhir R Ghorpade, IIT Mumbai.
2. Prof. Arunkumar R. Patil, SGGS IE and T, Nanded
3. Prof. Indranath Sengupta, IIT Gandhinagar.
4. Prof. Jugal K. Verma, IIT Mumbai.
5. Prof. Balwant Singh, CEBS, Mumbai.

These speakers together delivered 24 lectures of one-and-half hour duration spread over two weeks.

In addition, four lectures on Unity in Mathematics were arranged. These lectures were given by following two eminent speakers:

1. Prof. V. Srinivas, School of Mathematics, TIFR, Mumbai had delivered a talk on *Connection of Galois Theory with fundamental groups* on December 11, 2014.

2. Prof. T. N. Venkataramana, School of Mathematics, TIFR, Mumbai had delivered a talk on *connection of Galois Theory with monodromy groups* on December 12, 2014.

Tutorials:

Two hours tutorials were conducted on every day. Along with instructors following three persons assisted as a tutor to conduct tutorial sessions:

1. Mrinmoy Datta, Reserach Scholar, IIT Bombay, Mumbai

2. Joydip Saha, RKM Vivekananda University, Belur Math, Howrah, Kolkatta

3. Gaurab Tripathi, Research Scholar, Jadhavpur University

Report on the School

- In the first week of the school, five lectures were delivered by Prof. S. R. Ghorpade on Permutations, Cycles, transpositions, Symmetric Functions and Fundamental Theorem for Symmetric Polynomials.



- Prof. A. R. Patil delivered two lectures in the school on Sylow's theorems and Structure Theorem for finite abelian groups.
- Prof. Indranath Sengupta delivered four lectures on Simple groups, Field extensions and its basic properties.

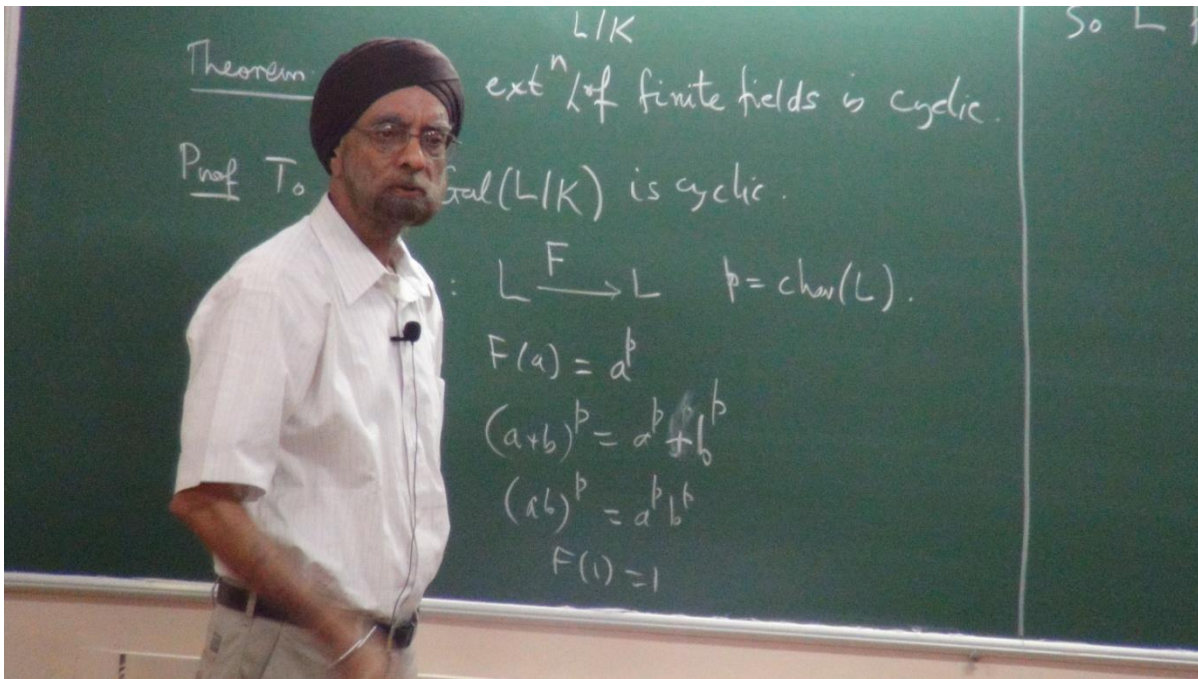


These lectures were arranged to let the participants get acquainted with basics of Galois Theory i.e. Field Theory.

- In the second week of the school, Prof. J. K. Verma delivered six lectures on Fundamental Theorem of Galois Theory, Galois group etc.



- Prof. Balwant Singh delivered four lectures on finite fields and Cyclic extensions



- Dr. Indranath Sengupta had delivered one lecture on Ruler and compass constructions.



Tutorials sessions were conducted by instructors and three tutors every day for two hours.



Participants:

The school was attended by 27 participants including 19 participants from outside Nanded. This school was largely attended by young faculty members who are working in the areas of Algebra, Algebraic Geometry, and related areas of research etc. We observed active participation from participants during lectures and tutorials, and each participant availed of best opportunities to discuss their queries with experts of the subjects. A total of around 51 applications were received to participate in ISL-2014(Galois Theory). At the end, only 28 participants were participated in the school. The details of these 28 selected participants for ISL-2014 in Galois Theory are given in Table 1.

Table 1: List of selected participants in ISL-Galois Theory (2014)

Sr. No	Name of the Participant	Status	Affiliation
1	Nitin Shridhar Darkunde	Assistant Professor	SRTM University, Nanded
2	Uday Subhash Divyaveer	Assistant Professor	SRTM University, Nanded
3	Surendranath Reddy	Assistant Professor	SRTM University, Nanded
4	Mahesh Sahebrao Wavare	Assistant Professor	Shahu College, Latur
5	Sharad Bhagwanrao Kadam	Assistant Professor	Anandibai Raorane Arts, Commerce & Science College, Vaibhavwadi
6	Dipak Sandu Jadhav	Assistant Professor	Smt. Chandibai Himathmal Mansukhani College, Mumbai
7	Rupali Jain	Assistant Professor	SRTM University, Nanded
8	Subhash Krishnan	Assistant Professor	K. J. Somaiya College of Science and Commerce, Mumbai
9	Amol Khandagale	Assistant Professor	BAMU, Aurangabad
10	Jita Parida	Assistant Professor	Priyadarshini Indira Mahavidyalaya , Sambalpur University
11	Bhairunath Shivaji Satpute	Assistant Professor	Vaidyanath College,Parli-V.
12	Syed Zarqua Mohammedi	Lecturer	SGGSIE & T, Nanded
13	Prashant Gurulingayya Swami	Assistant Professor	SJCET, Palghar
14	Sudeshna Roy	Research Scholar	IIT Bombay
15	Samriddho Roy	Research Scholar	IIT Bombay
16	Arindam Jana	Research Scholar	IIT Bombay

17	AvijitPanja	Research Scholar	IIT Bombay
18	Sachin Pandurang Basude	Research Scholar	SRTM University, Nanded
19	Gobinda Rakshit	Research Scholar	IIT Bombay
20	Tripti Dahiya	Research Scholar	Maharaja Sayajirao Univ Baroda
21	Pasham Narasimha Swamy	Assistant Professor	GIATAM University
22	Umanath S	M.Sc. student	Jamal Mhd. Autonomous College, Tiruchirapalli
23	Jyoti Singh Siwach	Research Scholar	Maharaja Sayajirao Univ Baroda
24	Amit Sharma	Assistant Professor	Pratap Institute of Technology, Sikar
25	Sharmishtha Sunil Deshmukh	Assistant Professor	GR Patil College ,Mumbai
26	Rajesh Digambarrao Sonkamble	Teacher	Eklavya Residential School, Nanded.
27	Raju A. Muneshwar	Assistant Professor	Science College, Nanded.

Infrastructure and other facilities:

The institute infrastructure did help the participants and resource persons to work in this ISL comfortably. The resource persons were facilitated with smart boards, LCD projectors for smooth delivery of the lectures. The Internet facility was provided from day one through wi-fi / wired technologies to all the participants and resource persons. Comfortable places were allotted to reside in Atithi Hotel, Nanded and City Pride, Nanded. All rooms allotted to the participants and resource persons were equipped with air conditioners.

In addition, we conducted few activities like group photograph, discussions during lunch, short trip etc. We firmly believe that participants and resource

persons find this ISL 2014 to remember forever with pleasant memories. Also, we believe that interaction of participants and resource persons will continue even after this course and this course will give a great impetus to young participants in their research and teaching works.

Acknowledgement:

At last, I on behalf of the organizers and institute wish to thank the National Centre for Mathematics for providing financial support and giving us the opportunity to hold this prestigious school at SGGS IE and T, Nanded. I am also thankful to my staff members for all best efforts to make this course a big success.

Exact Time Table

Week 1						
Time	December 1 Monday	December 2 Tuesday	December 3 Wednesday	December 4 Thursday	December 5 Friday	December 6 Saturday
9:30 - 11:00	SRG	SRG	SRG	IS	SRG	IS
11:00 - 11:30	Tea/coffee					
11:30 - 1:00	ARP	ARP	SRG	IS	IS	IS
Lunch						
2:30 - 4:30	Tutorial (SRG + Tutors)	Tutorial (SRG + Tutors)	Tutorial (ARP+ Tutors)	Tutorial (IS + Tutors)	Tutorial (IS + Tutors)	Tutorial (IS + Tutors)
4:30 - 5:00	Tea/ coffee/ Snacks					

Week 2						
Time	December 8 Monday	December 9 Tuesday	December 10 Wednesday	December 11 Thursday	December 12 Friday	December 13 Saturday
9:00 - 10:30	JKV	JKV	BS	JKV	UiMT - TNV	BS
10:30 - 11:00	Tea/coffee					
11:00 - 12:30	IS	SRG	JKV	UiMT - VS	UiMT - TNV	Tutorial (BS + Tutors)
Lunch						
2:00 - 3:30	JKV	JKV	BS	UiMT - VS	BS	
3:30 - 4:00	Tea/ coffee/ Snacks					
4:00 - 6:00	Tutorial (IS + Tutors)	Tutorial (JKV + Tutors)	Tutorial (JKV + Tutors)	Tutorial (BS + Tutors)	Tutorial (JKV + Tutors)	

Speakers	Unity in Mathematics Talks	Tutors
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SRG - Sudhir R. Ghorpade IIT Bombay	VS - V. Srinivas TIFR, Mumbai	Mrinmoy Datta
ARP - Arunkumar R. Patil SGGS, Nanded	TNV - T. N. Venkataramana TIFR, Mumbai	Joydip Saha
IS - Indranath Sengupta IIT Gandhinagar		Gaurab Tripathi
JKV - Jugal K. Verma IIT Bombay		
BS - Balwant Singh CEBS, Mumbai		

Exact Syllabus Covered in ISL-Galois Theory

Prof. Sudhir R Ghorpade (SRG)

- Evolution of the theory of equations and a historical overview of Galois theory
- Permutations, Cycles and transpositions, Symmetric Functions
- Fundamental Theorem for Symmetric Polynomials, Newton's identities
- Polynomials and their roots, Fundamental Theorem of Algebra, Irreducibility criteria for polynomials over \mathbb{Q}
- Resultants and Discriminants
- Norm, Trace and Discriminant

Prof. Arunkumar R. Patil (ARP)

- Group actions, Cauchy's theorem
- Sylow's theorems and Structure Theorem for finite abelian groups
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Prof. Indranath Sengupta (IS)

- Simple groups: simplicity of A_n and $PSL(2, p)$
- Solvable groups, Composition series and Jordan-Holder Theorem
- Field extensions; basic properties
- Splitting fields and normal extensions
- Separable extensions, Primitive element theorem
- Construction by ruler and compass, classical Greek problems (in Week 2)

Prof. Jugal K.Verma (JKV)

- Galois groups and Galois extensions
- Fundamental Theorem of Galois Theory
- Applications to: Regular polygons, Fundamental theorem of algebra, Cubic equations
- Calculating Galois groups of cubics and quartics
- Solvable extensions and Galois' criteria for solvability

Prof. Balwant Singh (BS)

- Finite fields
- Construction of algebraic closure of a field, Examples
- Roots of unity, cyclotomic extensions
- Cyclic extensions, Hilbert's Theorem 90

Unity in Mathematics Talks

- **VS V. Srinivas** : Connection with fundamental groups
- **TNV T. N. Venkataramana** : Connection with monodromy groups

Financial Support:

Financial Support: An amount of Rs. 7,35, 137 was sanctioned and transferred to Institutes account before program me by NCM.

Feedback

From the feedback of the participants, we understand that the program was a success in achieving its goals. Participants felt that local facilities are excellent, e.g. food, hospitality and AC accommodation. Also most of the participants were able to follow the course in-spite of their not so good background.

According to the feedbacks teaching was excellent and rated the school overall 9 out of 10.

However, there was only one comment: *Every day is very long. so we do not have enough time to solved tutorial problems left in sessions. If possible, one of the middle day of a week can be given as holiday.*

Evaluation report of lecture courses and Programme Feedback given by participants is send to the NCM office along with this report.

Acknowledgements

The organizers wish to thank National Centre for Mathematics for financial support and the encouragement. We are also extremely grateful to all the eminent mathematicians of who readily accepted our request for their talks. they stayed here and shared their knowledge and experiences with participants generously. They even involved in tutorials, which was one of the success of this school. Also, we are thankful to SGGS Institute of Engineering & Technology, Nanded for providing excellent infrastructure and full cooperation in smooth conducting the school. Especially, we are grateful to Dr. L. M. Waghmare (Director, SGGS IE and T, Nanded) and

faculty of Mathematics for providing full support for smooth conduct of this School.

Group Photo:

