



सत्यमेव जयते
Ministry of Education
Government of India

REPORT

ON

REFRESHER COURSE IN MATHEMATICS

(16 March - 30 March 2021)

ORGANIZED BY

TEACHING LEARNING CENTRE

Ramanujan College

under the aegis of

MINISTRY OF EDUCATION

PANDIT MADAN MOHAN MALAVIYA

NATIONAL MISSION ON TEACHERS AND TEACHING

IN

COLLABORATION WITH

DEPARTMENT OF MATHEMATICS

Ramanujan College

(Accredited Grade 'A' by NAAC)

(University of Delhi)

A REPORT ON REFRESHER COURSE IN MATHEMATICS (16th – 30th MARCH 2021)

ABOUT THE REFRESHER COURSE

With the advent of technology, e-learning is rapidly gaining importance and momentum. With the government aiming at digitizing India with its “Digital India” Initiative, educational institutions are also working in tandem to help fulfill the goal.

The Refresher Course in Mathematics was an attempt in this direction to impart quality education in Mathematics to the undergraduate teachers of the country in the online mode. It was of two weeks duration (16th – 30th March 2021) with 12 working days (excluding Sundays and Gazetted Holidays). The course was consist of minimum of 20 hours of video content (in the form of pre-recorded videos and live lectures) and 20 hours of non-video content. The course was offered in a highly flexible format. There was built-in assessment exercises and activities as part of the academic progression in the course. At the end of the course, there was a terminal assessment conducted online. Successful participants of the online refresher course were given participation certificate.

The main objective of the refresher course was to equip and motivate the participants with basic as well as advanced knowledge of various topics in the field of Mathematics for quality teaching and research. The Programme was discipline specific and provided a forum to participants to keep themselves abreast of the latest advances in various areas of Mathematics with experienced and eminent resource persons from reputed institutions like Indian Institute of Science (IISc), Indian Institute of Technology (IIT), Indian Statistical Institute (ISI), National Institute of Technology (NIT), Shiv Nadar University, University of Kashmir, University of Jammu, Delhi Technological University, South Asian University, TERI School of Advanced Studies and University of Delhi.

PARTICIPANTS

The Refresher Course had a diverse participation with 1342 registered participants from all over India (33 States/Union Territories).

TOPICS COVERED

S. No.	TOPICS
1	Teaching Pedagogies in Mathematics: Innovative Pedagogy
2	The Baire Category Theorem and its Applications
3	An Insight into MathSciNet and other Mathematical Databases
4	Brief introduction to Measure Theory
5	The Fundamental Theorem of Algebra
6	History of Complex Numbers
7	Real Analysis and Complex Analysis: A Comparison
8	Complex Integration
9	Singularities of a Complex Function
10	Nature Inspired Optimization
11	Random Walk and Electrical Networks
12	Introduction to Mathematical Modeling
13	Solution to Mathematical Models using Matlab
14	Introduction to Graph Theory
15	Applications of Graph Theory
16	Network Science and its Applications to Biology
17	Domination in Graphs
18	Signed Network Application for Network Security
19	Existence Theorems and Optimality Conditions for Minimization Problems
20	Research Paper: How Not to Write Badly?
21	Tora Software
22	LaTeX: The Mathematical Typesetting Software
23	Mathematica: An Introduction
24	R Software: An Introduction
25	Google Scholar
26	ResearchGate: A Social Networking Website for Researchers
27	Orcid
28	Web Tools for Mathematics
29	Mathematical Software: Some Hidden Tools

RESOURCE PERSONS

The following 23 resource persons delivered online and pre-recorded sessions on the above mentioned 12 modules:



PROF. AMBER HABIB
Shiv Nadar University



PROF. C. S. LALITHA
UNIVERSITY OF DELHI



PROF. DEEPA SINHA
SOUTH ASIAN
UNIVERSITY



PROF. E. K. NARAYANAN
IISc Bangalore



PROF. JAGDISH CHAND BANSAL
SOUTH ASIAN UNIVERSITY



PROF. K.S. CHARAK
University of Jammu



PROF. PURNIMA GUPTA
STATE BANK OF INDIA



PROF. RAHUL ROY
ISI Delhi



PROF. S. ARUMUGAM
Amrita Vishwa
Vidyapeetham



PROF. S. SIVAPRASAD KUMAR
Delhi Technological
University



PROF. SHARIEFUDDIN PIRZADA
University of Kashmir



PROF. SHOBHA BAGAI
University of Delhi



PROF. V. RAVICHANDRAN
NIT Trichy



PROF. ARVIND AYYER
IISc Bangalore



PROF. SANJAY PANT
University of Delhi



PROF. NILAM
Delhi Technological
University



PROF. SURUCHI SINGH
University of Delhi



PROF. VAMSI PRITHAM PINGAL
IISc Bangalore



PROF. VIVEK KUMAR AGGARWAL
Delhi Technological
University



DR. RAJESH SINGH
Ramanujan College
University of Delhi



DR. DEEPAKSHI SHARMA
Ramanujan College
University of Delhi



MR. SANYAM GUPTA
Ramanujan College
University of Delhi



DR. VIRENDRA KUMAR
Ramanujan College
University of Delhi

SCHEDULE

Tuesday March 16, 2021 (DAY-1)	LIVE: INAUGURATION (10.30 AM Onwards) Dr. Geetha Venketaraman Ambedkar University	Teaching Pedagogies in Mathematics Prof. Shobha Bagai Cluster Innovation Centre, University of Delhi		Quiz-1
Wednesday March 17, 2021 (DAY-2)	The Baire Category Theorem and its Applications (Part 1-3) Prof. Amber Habib Shiv Nadar University	An insight into MathSciNet and other Mathematical Databases Prof. V. Ravichandran National Institute of Technology Tiruchirappalli		Quiz-2
Thursday March 18, 2021 (DAY-3)	Brief introduction to Measure Theory Prof. E. K. Narayanan Indian Institute of Science Bangalore	The Fundamental Theorem of Algebra Prof. K.S. Charak University of Jammu		Quiz-3
Friday March 19, 2021 (DAY-4)	History of Complex Numbers Prof. V. Ravichandran National Institute of Technology Tiruchirappalli	Real Analysis and Complex Analysis: A Comparison Prof. Vamsi Pritham Pingali Indian Institute of Science Bangalore	TORA Software Mr. Sanyam Gupta Ramanujan College	Quiz-4
Saturday March 20, 2021 (DAY-5)	Nature Inspired Optimization Prof. Jagdish Chand Bansal South Asian University	LaTeX: The Typesetting Software Dr. Virendra Kumar Ramanujan College		Quiz-5 Assignment-1
Monday March 22, 2021 (DAY-6)	Session 1: Interesting Paradoxes in Probability Session 2: Random Walk and Electrical Networks Prof. Rahul Roy Indian Statistical Institute Delhi	LIVE: An Introduction to Graph Theory and Applications Prof. Shariefuddin Pirzada University of Kashmir	LIVE: Applications of Graph Theory Prof. S. Arumugam Adjunct Professor Amrita Vishwa Vidyapeetham, Coimbatore	Quiz-6
Tuesday March 23, 2021 (DAY-7)	Mathematica: An Introduction Prof. Suruchi Singh Aditi Mahavidyalaya University of Delhi	Complex Integration Prof. S. Sivaprasad Kumar Delhi Technological University	Singularities of a Complex Function Prof. Sanjay Pant Deen Dayal Upadhyaya College, University of Delhi	Quiz-7

Wednesday March 24, 2021 (DAY-8)	Introduction to Mathematical Modeling Prof. Nilam Delhi Technological University	MATLAB: An Introduction Mr. Sanyam Gupta Ramanujan College	Solution to Mathematical Models using Matlab Prof. Vivek Kumar Aggarwal Delhi Technological University	Quiz-8
Thursday March 25, 2021 (DAY-9)	R Software: An Introduction Dr. Rajesh Singh Ramanujan College	Research Tools: ORCID and Google Scholar ResearchGate: A Social Networking Website for Researchers Dr. Rajesh Singh & Dr. Virendra Kumar Ramanujan College	LIVE: Network Science and its Application to Biology' in the "Refresher Course in Mathematics Prof. S. Arumugam Adjunct Professor Amrita Vishwa Vidyapeetham Coimbatore	Quiz-9 Assignment-2
Friday March 26, 2021 (DAY-10)	Counting and Tiling Prof. Arvind Ayyer Indian Institute of Science Bangalore	Web Tools for Mathematics Dr. Rajesh Singh Ramanujan College, University of Delhi	Mathematical Software: Some Hidden Tools Dr. Deepakshi Sharma Ramanujan College	Quiz-10
Saturday March 27, 2021 (DAY-11)	Existence Theorems and Optimality Conditions for Minimality Problems Prof. C. S. Lalitha University of Delhi	LIVE: Domination in Graphs Prof. Purnima Gupta Director, Central Board of Directors, SBI	Discrete Mathematics and Allied Topics Prof. Deepa Sinha South Asian University	Quiz-11
Tuesday March 30, 2021 (DAY-12)	The Baire Category Theorem and its Applications (Part 4) Prof. Amber Habib Shiv Nadar University	Research Paper: How not to write badly? Prof. V. Ravichandran National Institute of Technology Tiruchirappalli	LIVE: Valedictory Session (3 PM onwards) Prof. Shobha Bagai Cluster Innovation Centre, University of Delhi	

HIGHLIGHTS

Live Sessions: 4

Recorded Sessions: 23

Total Videos: 63

Quizzes: 11

Assignments: 2

Feedback Form: 31

Portal Based Day Wise Discussion Forum

DAY-WISE REPORTS

DAY 1 (16 MARCH 2021)

Inauguration

Prof. Geetha Venkataraman, Ambedkar University, Delhi (**Chief Guest**)

Prof. S.P. Aggarwal (**Principal, Ramanujan College, University of Delhi**)

Dr. Rajesh Singh (**Programme Convener**)

Dr. Virendra Kumar (**Programme Co-convener**)

All Faculty Members of the Department of Mathematics, Ramanujan College, University of Delhi

Participants joined live via Streaming on the YouTube Channel of College

Link for the Inaugural Ssession:

<https://youtu.be/padi17LgLy0>

Media Coverage for Inaugural Session

INAUGURATION OF REFRESHER COURSE IN MATHEMATICS (16-30 March 2021)



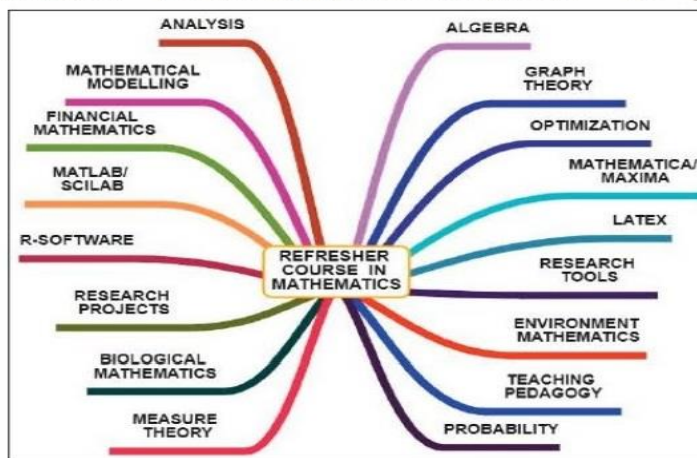
New Delhi, Focus News, The Teaching Learning Centre (under PMMMNMTT Scheme) and Department of Mathematics, Ramanujan College is conducting an Online Refresher Course in Mathematics during 16-30 March 2021. It is an attempt to impart quality education in Mathematics to the undergraduate teachers of the country in the online mode. The course is being offered in a highly flexible format and can be done at own pace and within stipulated time. There are built-in assessment exercises and activities as part of the academic progression in the course. The formal inaugural event of the Refresher Course took place online through Zoom

platform and was telecasted live on YouTube in the morning of 16th March. The event was graced by Dr. Geetha Venkataraman, Professor, Ambedkar University, Delhi as the Chief Guest.

Dr. Deepakshi Sharma, Assistant Professor, Department of Mathematics, Ramanujan College, commenced the inaugural ceremony with a warm welcome of the Chief Guest, Resource Persons and more than 1300 participants from all over India. She specifically highlighted the programmes rolled by the Teaching Learning Centre, Ramanujan College in the online mode during Covid-19 Pandemic, which catered to the knowledge and skill deficit of the

academics of the entire country. The centre has trained more than 1 Lakh teachers across India and is compelling evidence of quality training programmes.

The Principal of Ramanujan College, Prof. S. P. Aggarwal, addressed the participants and focused on the need of interdis-



plinary education/research in institutions. He also emphasized that the Mathematics, being the central point of allied area of Mathematics, is much needed for all. He concluded speech with wishes to the organizing team. The Chief Guest, Prof. Geetha Venkataraman, appreciated the efforts of organizing team and highlighted that the real values of this kind of refresher course lies in the Resource Persons and curious participants from the top institutions across India. She also emphasized the importance of the learning and teaching in a right way. She told that along with how to teach it is equally important to know how not to teach.

Dr. Rajesh Singh, Convener of the

Refresher Course in Mathematics, conveyed that the objectives of the refresher course is to equip and motivate the participants with basic as well as advanced knowledge of various topics in the field of Mathematics for quality teaching and research. He informed that the program has received a tremendous response with more than 1300 participants from most of the states and union territories of India. He also made the participants acquainted with the rules regarding assessment and certification during the two weeks programme. The formal vote of thank was given by Dr. Virendra Kumar, Co-convenor of the Refresher Course in Mathematics.

The event was concluded with the formal announcement of opening the Refresher Course by the Chief Guest Prof. Geeta Venkataraman. It is worth to remark that Refresher course is discipline specific and will provide a forum to participants to keep themselves abreast of the latest advances in various areas of Mathematics with experienced and eminent resource persons from reputed institutions like Indian Institute of Science (IISc), Indian Statistical Institute (ISI), National Institute of Technology (NIT), Shiv Nadar University, University of Kashmir, University of Jammu, Delhi Technological University, South Asian University, TERI School of Advanced Studies and University of Delhi.

Session 1: Teaching Pedagogies in Mathematics: Innovative Pedagogy

Abstract: The lecture highlights the need to change the teaching pedagogy in mathematics and then goes on to introduce the Inductive – Deductive Approach; Use of Heuristics in teaching, Analytic – Synthetic Method, Contextual Based Teaching. The methods have been described and differentiated using problems from undergraduate mathematics.

Resource Person: Prof. Shobha Bagai, Cluster Innovation Centre, University of Delhi

Link of Lecture: <https://youtu.be/DtMMKL0ovml>

Session 2: Teaching Pedagogies in Mathematics: Project Based Learning

Abstract: The lecture starts by defining what is learning. Based on Bloom's taxonomy the three learning domains are explained. The speaker uses three examples of project-based learning (PBL) that she had experimented with her students to illustrate the key features of PBL. The session is concluded by summarizing the desirable goals of Mathematics Curriculum.

Resource Person: Prof. Shobha Bagai, Cluster Innovation Centre, University of Delhi

Link of Lecture: <https://youtu.be/ibRq5MITM60>

DAY 2 (17 MARCH 2021)

Session 1: The Baire Category Theorem and its Applications

Abstract: The role of the Baire Category Theorem is somewhat analogous to the Pigeonhole Principle in Number Theory. It provides a way of arranging facts that makes them more amenable to producing results. We will look at how the Theorem arises out of some very elementary questions involving the rational numbers, and then take up applications to various parts of real analysis.

Resource Person: Prof. Amber Habib, Department of Mathematics & Dean Undergraduate Studies, Shiv Nadar University

Link of Lecture:

Part 1: <https://youtu.be/sSb-1q8crhc>

Part 2: <https://youtu.be/wkkP7DLd4m4>

Part 3: <https://youtu.be/Xv2u6j3Pykc>

Session 2: An Insight into MathSciNet and other Mathematical Databases

Abstract: In this session, various features of the online bibliographic database MathSciNet are illustrated through a hands-on session. In addition, various other digital libraries and databases like zbMATH, Electronic Library of Mathematics, Project Euclid, JStor, EuDML etc. are discussed.

Resource Person: Prof. V. Ravichandran, Department of Mathematics, National Institute of Technology, Tiruchirappalli.

Link of Lecture:

PART 1: <https://youtu.be/HbIYzIPTs8E>

PART 2: <https://youtu.be/f1fuWYv6oYc>

DAY 3 (18 MARCH 2021)

Session 1: Brief introduction to Measure Theory

Abstract: In these short lectures we will give a brief overview of Lebesgue's theory of integration on the real line (without any proofs). After a quick recap of Riemann integration, we will explain Lebesgue measure and then go on to describe the integration theory. Main results will be stated. We end with a comparison of Riemann and Lebesgue integration.

Resource Person: Prof E. K. Narayanan, Department of Mathematics, Indian Institute of Science, Bangalore

Link of Lecture:

Part 1 : <https://youtu.be/E0FGNtEuh8c>

Part 2 : <https://youtu.be/C4aOVaa8YNY>

Part 3 : <https://youtu.be/MIEz1pVuziU>

NOTES

PART 1 NOTES: https://drive.google.com/file/d/1o5N2sQGpzdwM61DC_E3uiG3lf5zh4n2-/view

PART 2 NOTES: https://drive.google.com/file/d/1Y36VCJ1rxZDQPiqTStf5kFybj_YgdhGL/view

PART 3 NOTES: https://drive.google.com/file/d/1peoeLRHEif_y7kCNyiQn-CWbE-kVApDp/view

Session 2: The Fundamental Theorem of Algebra

Abstract: The fundamental Theorem of Algebra is really a fundamental result in all of Mathematics. The first encounter of a student with its statement is at High school level with a remark that the proof of this result is beyond the scope of that book. The first proof that a student comes across is by Liouville's theorem which can't be presented to High School level students. The main purpose of these lectures on the Fundamental Theorem of Algebra is to present its proof which uses only simple facts from calculus. Also, some other interesting and recent proofs shall be discussed.

Resource Person: Prof. Kuldeep Singh Charak, Department of Mathematics, University of Jammu.

Link of Lecture:

Part 1 : <https://youtu.be/OUmsmiwRXxc>

Part 2 : https://youtu.be/CuKwoy4el_c

Part 3 : <https://youtu.be/zO7o0V0sNsw>

DAY 4 (19 MARCH 2021)

Session 1: History of Complex Numbers

Abstract: In this lecture, the speaker discussed historical facts about complex numbers in context of an essay "A Short History of Complex Numbers" written in 2016. He narrated several stories about various well-known mathematicians connected with the birth of complex numbers. At the end, he discussed the method of finding the roots of cubic and biquadratic equations under certain conditions.

Resource Person: Prof. V. Ravichandran, Department of Mathematics, National Institute of Technology, Tiruchirappalli.

Link of Lecture: <https://youtu.be/OGpDUDJd378>

Session 2: Real Analysis and Complex Analysis: A Comparison

Abstract: In this series of lectures, I shall go over some concepts of real and complex analysis and point out the similarities as well as differences between them. In particular, I shall discuss the algebraic aspects of both fields, real multivariable differentiability, holomorphicity of complex functions, real and complex analyticity, and real and complex integration.

Resource Person: Dr. Vamsi Pritham Pingali, Assistant Professor, Department of Mathematics, IISc, Bangalore.

Link of Lecture:

Part 1 : <https://youtu.be/8rkFaLJW6w>

Part 2 : <https://youtu.be/9rRkggxgWr4>

Part 3 : <https://youtu.be/CuB7TVSZBfA>

Session 3: TORA Software

Abstract: Temporary-Ordered Routing Algorithm (TORA) — An Operations Research Software
TORA is an algorithm i.e., a mathematical set of instructions or programs (mathematical-software). It is an optimization system in the area of operations research which is very easy to use. Further, TORA is a menu-driven and Windows-based which makes it very user friendly.

Resource Person: Mr. Sanyam Gupta, Assistant Professor in Department of Mathematics, Ramanujan College, University of Delhi

Link of Lecture:

Part 1 : <https://youtu.be/DJp-b2-W8YY>

Part 2 : <https://youtu.be/jwhVa3DvpC0>

Part 3 : <https://youtu.be/W9oDsHe69pY>

DAY 5 (20 MARCH 2021)

Session 1: Nature Inspired Optimization

Abstract: Nature Inspired Optimization algorithm is one of the most sought research fields of the time. The artificial intelligence emerged from iterative computation is usually referred to as computational intelligence. In the computational intelligence, we study the design of intelligent systems. Artificial Neural Network Systems, evolutionary computation, swarm intelligence and fuzzy logic are significant components of the computational intelligence. Out of these fields, Swarm and Evolutionary algorithms are also referred to as nature inspired algorithms for optimization. His lecture will be an introduction of the Nature Inspired Optimization.

Resource Person: Prof. Jagdish Chand Bansal, Department of Mathematics, South Asian University, New Delhi and Visiting Faculty at Mathematics and Computer Science, Liverpool Hope University UK

Link of Lecture: <https://youtu.be/E2dJOYDz7b0>

Session 2: LaTeX : The Typesetting Software

Abstract: The first part is an introductory video on LaTeX in which the download and installation process are explained. How to use LaTeX both online and offline uses are also discussed in the video. In the second part, producing/typesetting a simple document in LaTeX is explained in this video. In the third part, typesetting of a document along with some mathematical expressions is described. In fourth and fifth parts, typesetting a scientific document is described. Adding title, author name, sections, equation numbers, references and their citation, acknowledgement, cross checking the citations, including graphics into document, geometry package and margin setting etc. are all explained in the video. Use of online

Resource Person: Dr. Virendra Kumar, Assistant Professor, Department of Mathematics, Ramanujan College, University of Delhi

Link of Lecture:

Part 1 : <https://youtu.be/zrPLMjInudI>

Part 2 : <https://youtu.be/iWZZDRU8kQw>

Part 3 : <https://youtu.be/9FuPz9MIhms>

Part 4 : https://youtu.be/s3o_1Rj53Sg

Part 5 : <https://youtu.be/-LO3vgIgSOI>

DAY 6 (22 MARCH 2021)

Session 1: Interesting Paradoxes in Probability

Abstract: We discuss some problems in probability. The problems are chosen because they have some non-intuitive solutions and also to emphasize how the statement and the set-up of the problem leads to different answers. In particular, questions in probability, like other branches of mathematics have to be formulated with total precision, otherwise they may lead to non-sensical answers.

Resource Person: Dr. Rahul Roy, Professor at Indian Statistical Institute, Delhi

Link of Lecture:

Part 1 : <https://youtu.be/GZkEsgxR9KE>

Part 2 : <https://youtu.be/kbsuE6HehLs>

Session 2: Random Walk and Electrical Networks

Abstract: A classical result of Polya (1928) is that the random walk on Z^d is recurrent for $d = 1, 2$, i.e. it returns to the origin with probability one, and transient for $d \geq 3$, i.e. it never returns to the origin with positive probability. We establish this result by using notions like Kirchoff's law, Ohm's law in electrical networks.

Resource Person: Dr. Rahul Roy, Professor at Indian Statistical Institute, Delhi

Link of Lecture:

Part 1 : <https://youtu.be/YkRVAYzGdm4>

Part 2 : <https://youtu.be/BTO0cHOKQIA>

Session 3 (LIVE): An Introduction to Graph Theory and its Applications

Abstract: Graph theory has always attracted the attention of mathematicians and has a glorious history. The subject has evolved rapidly under the growing interest evinced by mathematicians, scientists and engineers in the past several decades. In this talk, we will discuss the origin of graph theory, its development and some applications.

Resource Person: Prof. Shariefuddin Pirzada, Department of Mathematics, University of Kashmir, India

Link of Lecture: https://youtu.be/eQCs_98LIAM

Session 4 (LIVE): Basic Concepts in Graph Theory with Applications

Abstract: In our day to day life, we are surrounded by various connections and networks for example we may consider the networks of roads and railways, communication lines, the internet, circuits in any electronic system and even molecular bonds. In fact, we also have social networks that represents connections between friends and families. All these examples can be represented by a mathematical structure called Graphs. Thus graphs are at the very foundation of many objects, concepts and processes in everyday life. In this lecture we will learn how graph theory is applied to solve various real life problems.

Resource Person: Prof. S. Arumugam, Adjunct Professor, Department of Mathematics, Amrita Vishwa Vidyapeetham, Tamil Nadu, India.

Link of Lecture: https://youtu.be/eQCs_98LIAM

DAY 7 (23 MARCH 2021)

Session 1: Mathematica: An Introduction

Abstract: Through these videos, we'll be learning the basics of the software MATHEMATICA. Using the free online version of MATHEMATICA, we'll learn plotting of 2D, 3D, polar and parametric curves, manipulate command, finding limit, differentiation and integration of functions, solving differential equations, operations on matrices, vectors, simple programming skills and applications of these in writing simple programs in Numerical Analysis

Resource Person: Dr. Suruchi Singh, Assistant Professor, Department of Mathematics, Aditi Mahavidyalaya, University of Delhi

Link of Lecture:

Part 1 : <https://youtu.be/Z1hON9oh2Zo>

Part 2 : <https://youtu.be/8drsppMdM6o>

Part 3 : <https://youtu.be/BM3Z3CZZGVg>

Session 2: Complex Integration

Abstract: In this lecture the following concepts of complex analysis are explained; line integral, contour integral, Cauchy integral formula and its special cases, power series expansion of an analytic function, Cauchy's estimate, fundamental theorem of algebra, Liouville's theorem, Cauchy's theorem, winding number, Morera's theorem, homotopic version of Cauchy's theorem, the concept of counting zeros of analytic functions.

Resource Person: Prof. S. Sivaprasad Kumar, Head, Department of Applied Mathematics, Delhi Technological University, Delhi.

Link of Lecture: <https://youtu.be/A61jvAur8pY>

Session 3: Singularities of a Complex Function

Abstract: We will explore the local behaviour of an analytic function at a singular point. In first part, we will see the classification of isolated singular points and will give some characterising properties of these different kind of singularities, namely, removable, pole and essential. The second part will classify these singularities in terms of singular part (part with negative exponents) of Laurent series centred at these isolated singularities. We also give application in calculating residues.

Resource Person: Prof. Sanjay Pant, Associate Professor, Department of Mathematics, Deen Dayal Upadhyaya College, University of Delhi

Link of Lecture:

Part 1 : <https://youtu.be/rP7wegVqA90>

Part 2 : <https://youtu.be/ycEy4TDfrfl>

DAY 8 (24 MARCH 2021)

Session 1: Introduction to Mathematical Modeling

Abstract: In the first part, the principles of Mathematical models, their types and uses are explained with help of some examples. Apart from that the limitations of mathematical modeling are also pointed out. In part 2, the process of development of mathematical models of diabetes are described. Part 3, the methods of developing model for infectious disease are explained in the video lecture.

Resource Person: Dr. Nilam, Assistant Professor, Department of Applied Mathematics, Delhi Technological University, Delhi.

Link of Lecture:

Part 1 : <https://youtu.be/uZEDdq-Nh7U>

Part 2 : <https://youtu.be/noR1ktVTRes>

Part 3 : https://youtu.be/cCNR-FI_clk

Session 2: MATLAB: An Introduction

Abstract: MATLAB (Matrix Laboratory) is a programming language and numeric computing environment developed by MathWorks. MATLAB allows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages. In this video you will learn how to use MATLAB on web. Some basic and important commands that are used in MATLAB will be discussed. There will also be session on how to perform matrix calculations using MATLAB.

Resource Person: Mr. Sanyam Gupta, Assistant Professor, Department of Mathematics, Ramanujan College, University of Delhi.

Link of Lecture:

Part 1 : <https://youtu.be/x6AssezJsj8>

Part 2 : <https://youtu.be/J8m5kXkMAeU>

Part 3 : <https://youtu.be/zkp7jdk6wzo>

Session 3: Solution to Mathematical Models using MATLAB

Abstract: In the first part some basics about the Euler's method for solving first order ODE are explained. In the second part, a population model has been discussed and then its MATLAB/Octave code is written to demonstrate the solution of the model. A comparison can also be shown with the help of this code. In part 3, SIR model has been discussed along with the MATLAB/Octave code. The graphs for two different sets of parameters have also been shown.

Resource Person: Dr. Vivek Kumar Aggarwal, Assistant Professor, Department of Applied Mathematics Delhi Technological University, Delhi.

Link of Lecture:

Part 1 : <https://youtu.be/AIW44OOZJ0I>

Part 2 : <https://youtu.be/zB3VS3fLp1g>

Part 3 : <https://youtu.be/rIdenRDLbYU>

DAY 9 (25 MARCH 2021)

Session 1: R Software: An Introduction

Abstract: In these three lectures, we learn about R, which is a programming language and software environment for statistical analysis, graphics representation and reporting. We learn how to download and install both R Software and R Studio. We will see how we can use help command in R to keep learning while practicing R. We do some basic mathematical calculations using R. We will learn how to assign value or vector to some variable in R and then how to use the same for further purpose like plotting, finding statistical parameters etc. In the end we will learn how to use data frames to manage any given data in R and how to do analysis of that data using R.

Resource Person: Dr. Rajesh Singh, Assistant Professor, Department of Mathematics, Ramanujan College, University of Delhi

Link of Lecture:

Part 1 : <https://youtu.be/TfZP4DNdCJk>

Part 2 : https://youtu.be/Yw2tjU-g_oU

Part 3 : <https://youtu.be/Vadshtz79TA>

Session 2: Session on Research Tools

Abstract:

[Google Scholar](#)

In this video, we will learn about a freely accessible web search engine and a database for scholarly/ academic documents which is developed by Google and is called Google Scholar. Google Scholar indexes the full text or metadata of scholarly literature across various publishing formats and disciplines. The Google Scholar index includes peer-reviewed online academic journals and books, conference papers, theses and dissertations, preprints, abstracts, technical reports, and other scholarly literature, including court opinions and patents. Here we will learn how to create our profile on Google Scholar, how to add our contributions, how to search papers/profiles, how to use Google Scholar to create references etc.

[ResearchGate: A Social Networking Website for Researchers](#)

Getting updates of recent works in the field of research is an important factor for a quality research. ResearchGate provides such a platform where one can get recent updates and even contact researchers across the globe and have a collaborative research work. In this video, creating account on ResearchGate and managing the account in it have been explained.

[ORCID](#)

In this video we will learn about an open registry called ORCID. ORCID stands for Open Researcher and Contributor ID. It provides an ORCID iD, a unique, 16-digit identifier that researchers can use to clearly distinguish themselves from other researchers and reliably connect with their own professional affiliations and contributions. We will learn how to register on ORCID platform to acquire a unique 16 digit identifier.

Resource Person: Dr. Rajesh Singh & Dr. Virendra Kumar, Assistant Professor, Department of Mathematics, Ramanujan College, University of Delhi

Link of Lecture:

Google Scholar (Dr. Rajesh Singh): <https://youtu.be/ooM6efKydvY>

ORCID (Dr. Rajesh Singh): <https://youtu.be/S-eYEdLpYr0>

ResearchGate: A Social Networking Website for Researchers (Dr. Virendra Kumar):
https://youtu.be/r_nkFOJ8gKs

Session 3 (LIVE): Network Science-Structure, Dynamism, Stability, Emergence and Applications

Abstract: Network science helps you design faster, more resilient communication networks; revise infrastructure systems such as electrical power grids, telecommunications networks, and airline routes; model market dynamics; understand synchronization in biological systems; and analyze social interactions among people. In this lecture we examine various kinds of networks (regular, random, small-world, influence, scale-free, and social) and applies network processes and behaviors to emergence, epidemics, synchrony, and risk.

Resource Person: Prof. Arumugam, Adjunct Professor, Department of Mathematics, Amrita Vishwa Vidyapeetham, Tamil Nadu, India.

Link of Lecture: <https://youtu.be/wJAAX7bHjA>

DAY 10 (26 MARCH 2021)

Session 1: Counting and Tiling

Abstract: In the first lecture, he introduced a powerful technique for enumeration known as generating functions. In the second lecture, he applied it to count tilings of regions of the two-dimensional chessboard with dominos. The material will be self-contained.

Resource Person: Dr. Arvind Ayyer, Associate Professor, Department of Mathematics, Indian Institute of Science Bangalore.

Link of Lecture:

Part 1 : https://youtu.be/Z_eHBSyu-Y

Part 2 : <https://youtu.be/QqCVlimNSzA>

Session 2: Web Tools for Mathematics

Abstract: In this video we will learn about four highly efficient web tools for Mathematics. The main idea is to make you all familiar with the features of these tools and to show their efficacy and helpfulness in getting solutions to many mathematical problems. Firstly, we consider the Matrix Calculator using which one can perform all the basic matrix operations as well as

methods for solving systems of simultaneous linear equations, decomposition of matrix using various methods. One of the key feature of this tool is that detailed solution of each problem is available for better understanding of the problem.

Next we consider Symbolab, which is an advanced math education tool. It allows users to learn, practice and discover math topics using mathematical symbols and scientific notations as well as text. Symbolab provides automated step by step solutions to algebraic, trigonometric and calculus topics covering from middle school through college. Symbolab offers a wealth of smart calculators including: equations, simultaneous equations, inequalities, integrals, derivatives, limits, tangent line, trigonometric equations, functions and more. The stated goal of the site is to make scientific content universally accessible by expanding the searchable data space onto scientific notations, expressions, equations and formulas. This is done by applying proprietary machine learning algorithms in order to understand the meaning and context of the queries. Symbolab, making math simpler.

The next tool we consider is Graph Online, which can be used to create graph manually or using adjacency or incidence matrices. There are some inbuilt algorithms available like find the shortest path, find adjacency matrix, find minimum spanning tree, find eulerian path etc. which helps in deeper analysis of the given graph or network.

Finally we consider live.amcharts, which can be used to obtain animated pie-charts, bar graphs, line graphs etc. corresponding to any given data. It also gives HTML coding for the same, which one can incorporate in their webpage to attract the audience.

Resource Person: Dr. Rajesh Singh, Assistant Professor, Department of Mathematics, Ramanujan College, University of Delhi.

Link of Lecture: https://youtu.be/Jh_RZL3okl0

Session 3: Mathematical Software: Some Hidden Tools

Abstract: In this lecture we discuss a few software which are hidden from most of the people but are very useful in mathematics. These software are called CAS. A computer algebra system (CAS) or symbolic algebra system (SAS) is any mathematical software with the ability to manipulate mathematical expressions in a way similar to the traditional manual computations of mathematicians and scientists. The software discussed are all open source and free. A free software is a software which is free to use. An open source software is one whose source code is available to all. We discuss the following software:

- Microsoft Mathematics
- Photo math
- Geogebra

- Sagemath
- Cadabra
- Maxima
- Gap

Resource Person: Dr. Deepakshi Sharma, Assistant Professor, Department of Mathematics, Ramanujan College, University of Delhi

Link of Lecture: <https://youtu.be/-OZ1l1Q1Y4M>

DAY 11 (27 MARCH 2021)

Session 1: Existence Theorems and Optimality Conditions for Minimization Problems

Abstract: In this lecture, we discuss three existence theorems of minimization of real-valued continuous functions of several variables. An alternate proof of the Fundamental Theorem of Algebra follows from an existence theorem. In the lecture, we further discuss first and second-order necessary optimality conditions for minimization of real-valued functions of several variables. Second-order sufficient optimality conditions for the existence of local minimizers, global minimizers, and saddle points are also discussed further in this lecture.

Resource Person: Prof. C. S. Lalitha, Head & Dean, Department of Mathematics, University of Delhi.

Link of Lecture:

Part 1 : <https://youtu.be/lofKdnaEChQ>

Part 2 : https://youtu.be/QoWk_VBdxUA

Session 2: Signed Network Application for Network Security

Abstract: Data in the social sciences can often be modeled using a signed graph therefore it has emerged as one of the major area of research in Graph Theory. In this video the concept of signed graphs with example is explained. Further its applications in the network security are discussed. More specifically, it is elaborated that with signed graphs, the characteristics of a portfolio from a risk management perspective can be uncovered for analysis purpose. Line sigraphs and its characteristics and similar other concepts are also explained.

Resource Person: Prof. Deepa Sinha, Department of Mathematics, South Asian University

Link of Lecture: <https://youtu.be/DqGvmWwzpVE>

Session 3 (LIVE): Domination in Graphs

Abstract: Around 1850, people interested in Chess gave thought to a question that what will be the least number of queens that can be placed on a chess board with a goal that each one of the blocks are either occupied by a queen or is attacked by a queen. The idea of Domination came into existence with this problem. It was found that five is the answer for an 8 by 8 chess board. In a graph G , a subset S of the vertex V is called a dominating set of G if for every vertex v in $V-S$, there exists a vertex u in S adjacent to v . The domination number of G is the minimum cardinality of a dominating set in G . In this lecture graphs satisfying the equality of the parameters domination number and independent domination number are discussed.

Resource Person: Prof. Purnima Gupta, Former Professor of Mathematics, University of Delhi

Link of Lecture: <https://youtu.be/ce-PGtndAYQ>

DAY 12 (30 MARCH 2021)

Session 1: The Baire Category Theorem and Its Applications (Part 4)

Abstract: The role of the Baire Category Theorem is somewhat analogous to the Pigeonhole Principle in Number Theory. It provides a way of arranging facts that makes them more amenable to producing results. We will look at how the Theorem arises out of some very elementary questions involving the rational numbers, and then take up applications to various parts of real analysis.

Resource Person: Prof. Amber Habib, Dean Undergraduate Studies, Head, Department of Mathematics, Director IIIMIT Department of Mathematics, Institute for Innovations & Inventions with Mathematics and IT (IIIMIT), School of Natural Sciences (SoNS)

Link of Lecture: <https://youtu.be/INgBzuU31x8>

Session 2: Research Paper: How not to write badly?

Abstract: The participants must have encountered the talks and sessions on writing a good research article. However, the present speaker focusses on the aspect of how to not write a research paper badly. The talk will contain the suggestions on preparing the manuscript for a journal, the key factors which are taken into account by the reviewers and the editors of a journal while reviewing the article and how to choose a best journal for your research work.

Resource Person: Prof. V. Ravichandran, Department of Mathematics, National Institute of Technology, Tiruchirappalli.

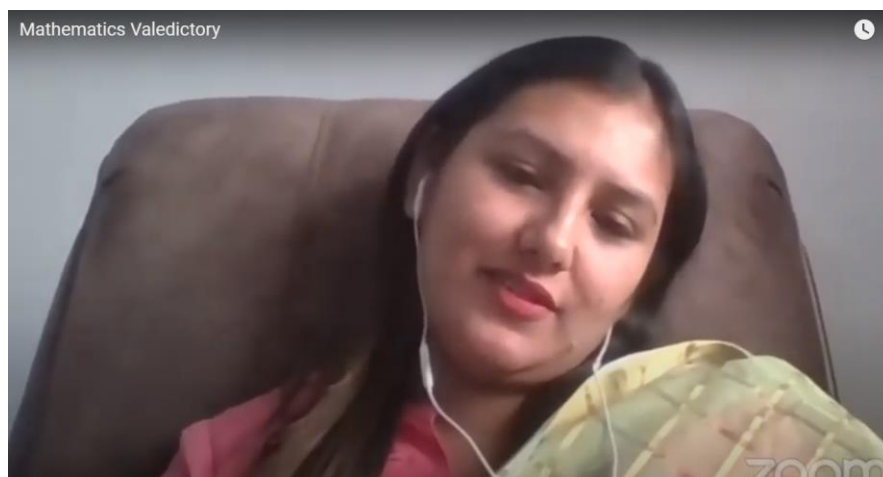
Link of Lecture: https://youtu.be/29_qUe62gAw

VALEDICTORY SESSION

**CHIEF GUEST: PROF. SHOBHA BAGAI, A PROFESSOR AT THE CLUSTER INNOVATION CENTRE,
UNIVERSITY OF DELHI**

Link for Valedictory Session

<https://youtu.be/g2zyl4PZUFk>



Dr. Deepakshi Sharma hosting the Valedictory Session



Convenor, Dr. Rajesh Singh presenting the final report of the programme

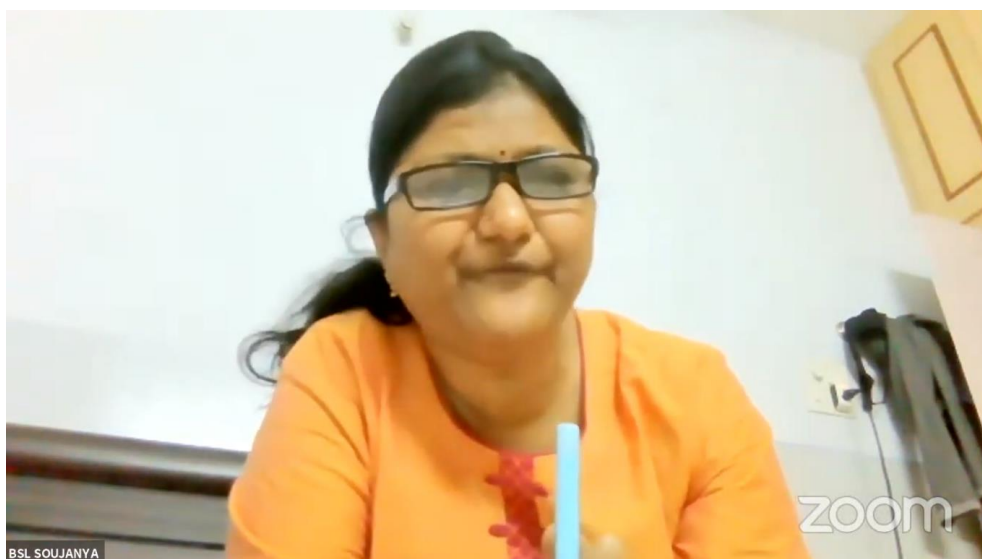
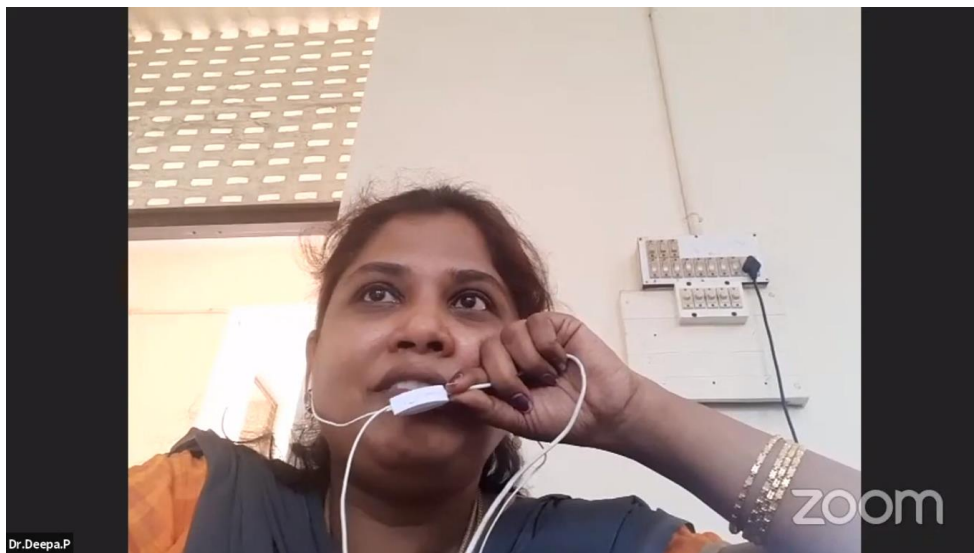


Address by the TLC Director and Principal, Prof. S.P. Aggarwal



Chief Guest, Prof. Shobha Bagai addressing the audience

Live Feedback by Participants in Valedictory Session

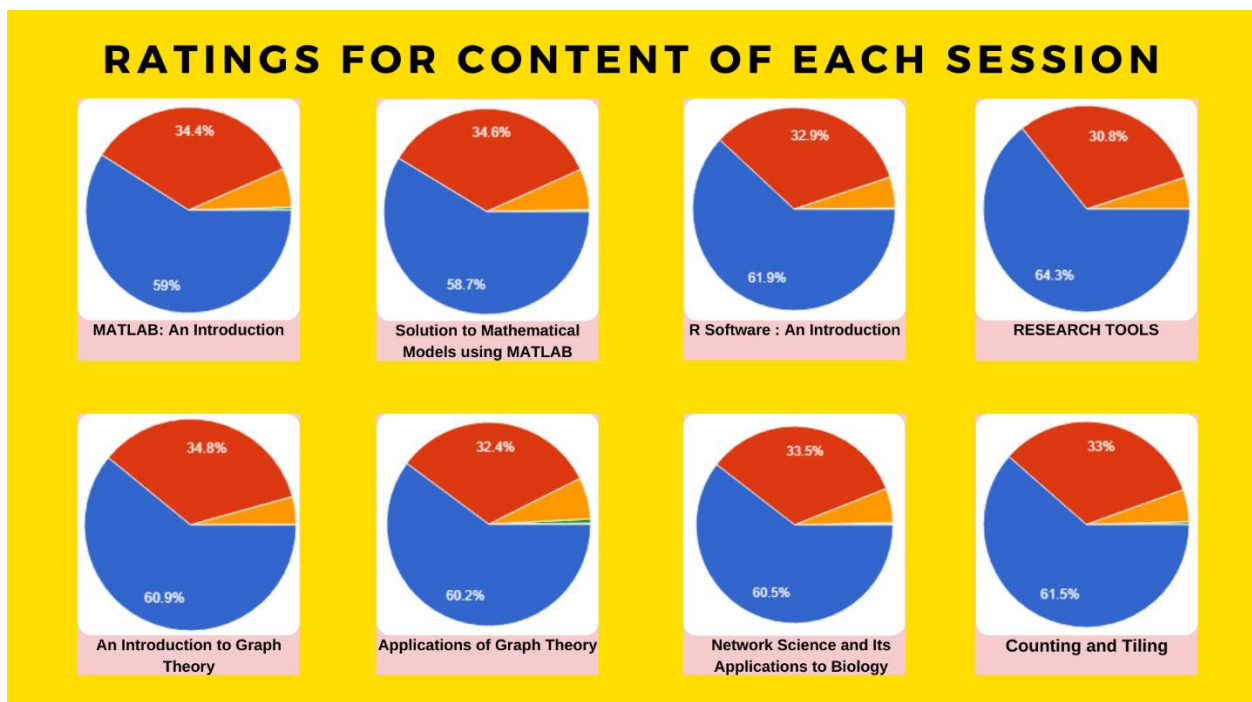
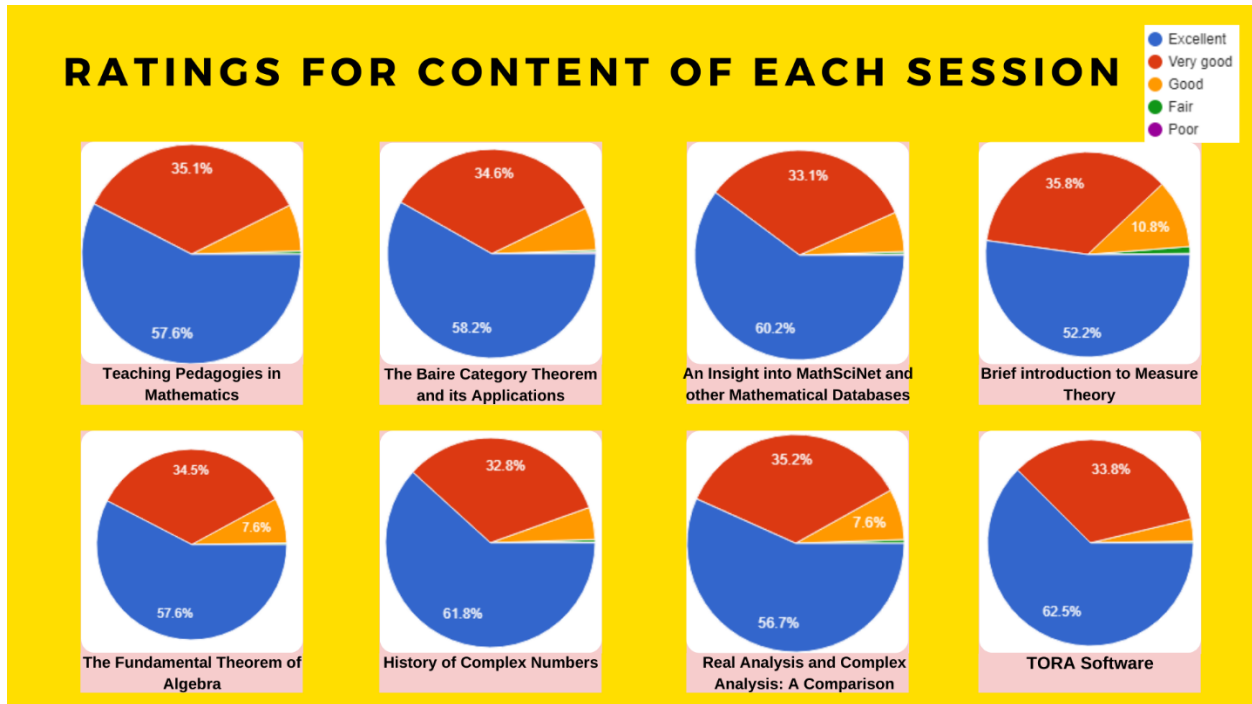


RESULTS

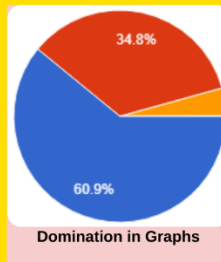
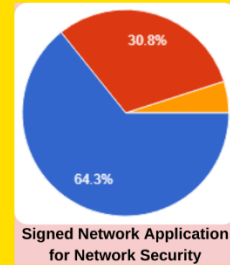
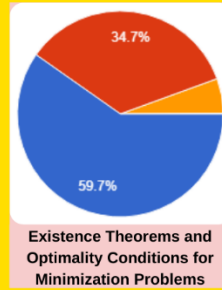
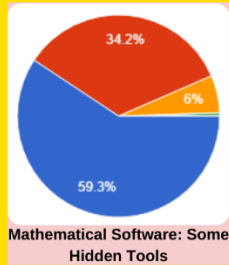
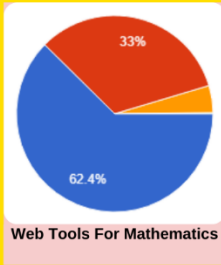
The result was announced and certificates to the successful participants (1284) were distributed on 11 April 2021 via link:

<http://certificatex.io/RC/MATHFDP/>

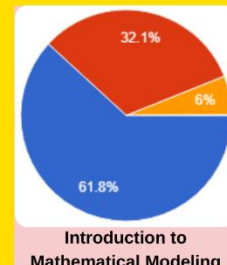
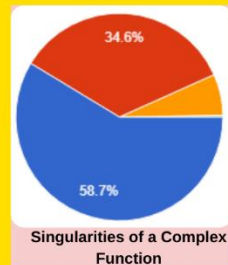
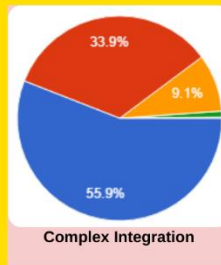
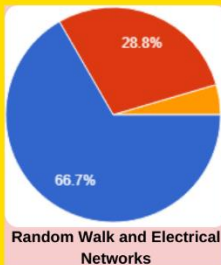
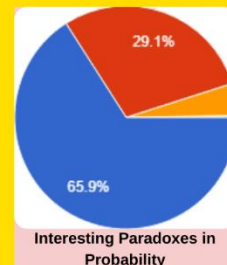
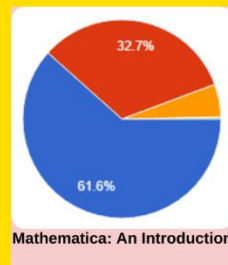
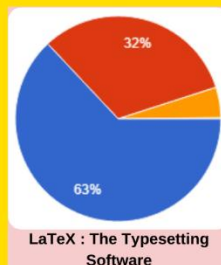
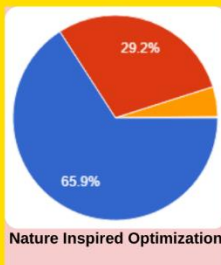
RATINGS FOR CONTENTS OF EACH SESSION



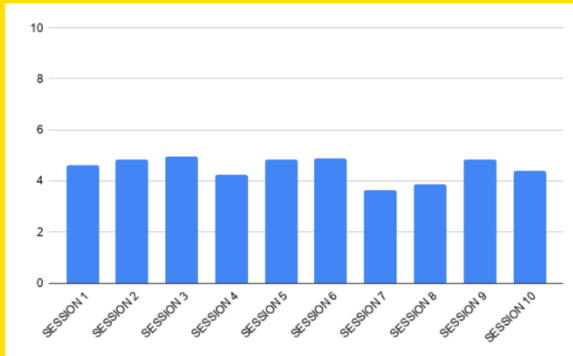
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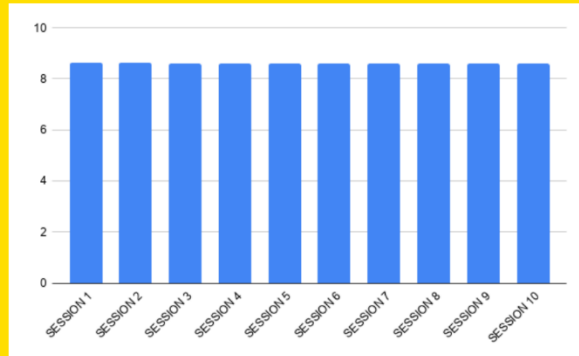
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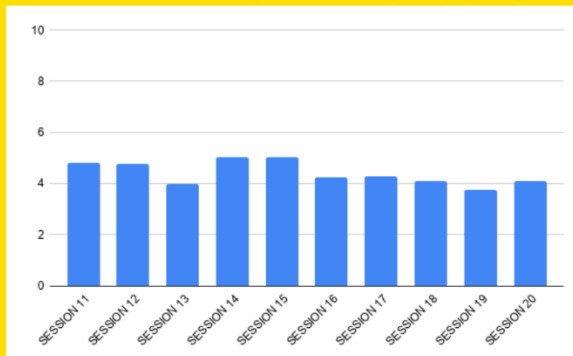
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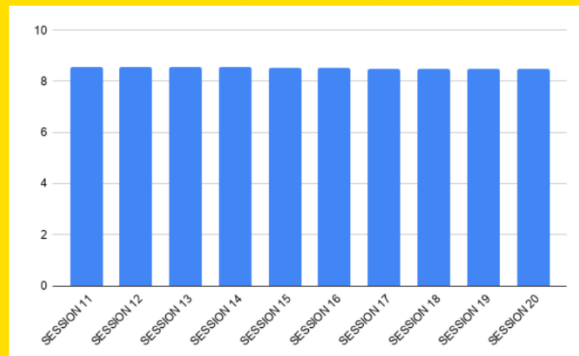
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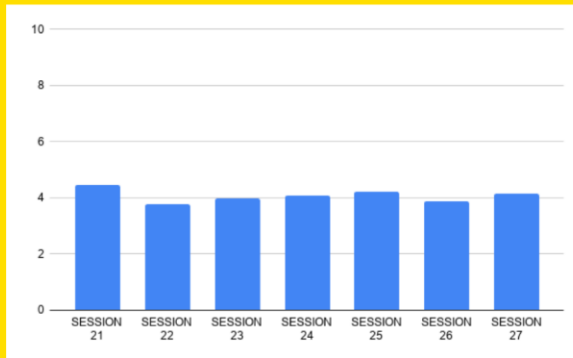
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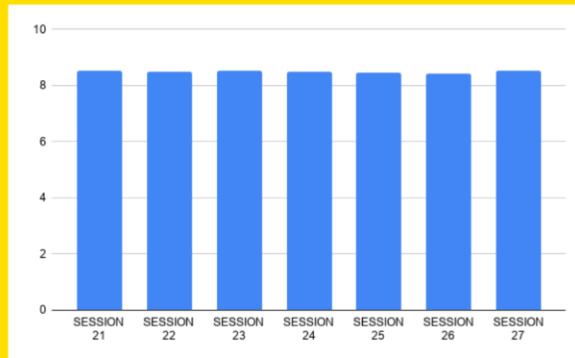
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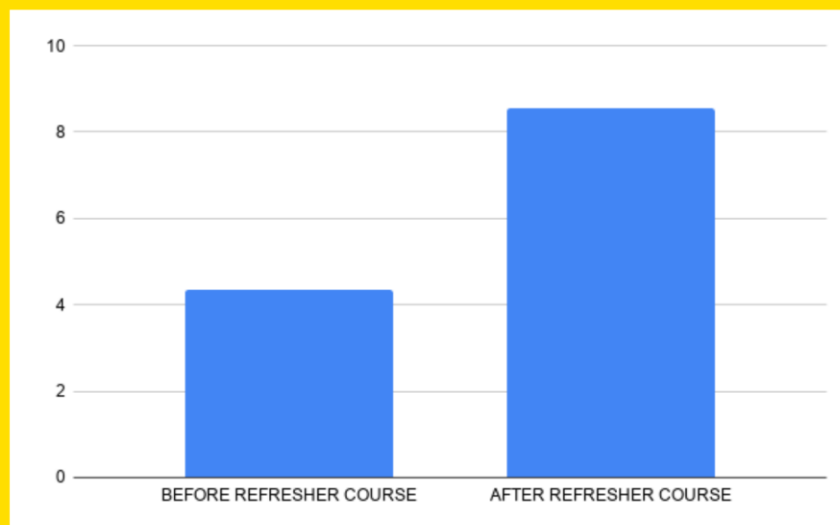
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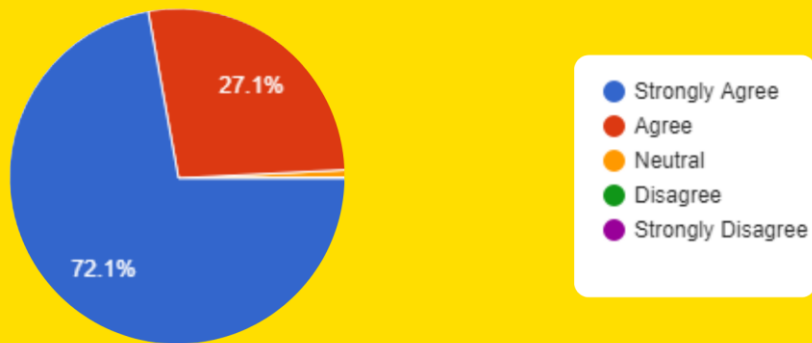


OVERALL KNOWLEDGE

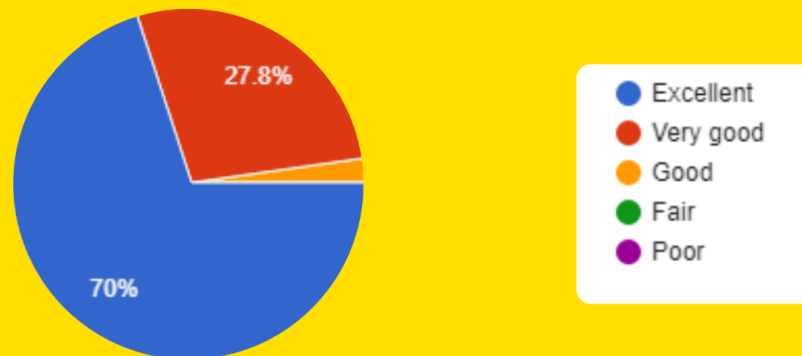


USER FRIENDLY INTERFACE OF THE LEARNING MANAGEMENT SYSTEM(LMS)

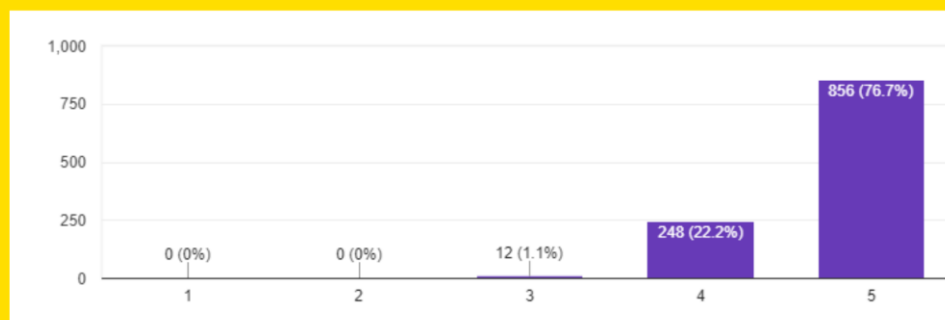
<http://math.rcmoocs.in>



QUALITY OF THE RESOURCE PERSONS



OVERALL EXPERIENCE WITH THE ORGANIZING COMMITTEE



LOWEST - 1 & HIGHEST - 5

PARTICIPANTS FEEDBACK

Well structured refresher course and organised in very informative manner. Detailed descriptions given in prior for how to handle the online course and instructions for each sessions is very useful

---Jagadeesan S

Well organized , excellent eminent personalities. If possible provide ppt of all sessions so that We can share with our students. Thanks for organizing this refresher course.

-----Babita

Without any physical interaction, I found the all saved and live sessions are very knowledgeable and remarkable. Functioning of LMS used in this programme had a user friendly interface. All members of organizing committee have tried with their best specially Dr. Rajesh Singh & Dr. Virender Kumar. Thanks a lot !!!

-----SATYENDER SINGH

New or different that you have learnt in this Refresher Course

I have learnt many things through this refresher course. The sessions on programming R, Counting and Tiling and the Mathematical tools were completely new to me. I got a good exposure to these topics the sessions on Complex Analysis, Probability and Graph Theory were excellent. It helped to refresh things which I had learned before and also learn the new developments in those areas.

-----Maria Thomas

lots information, new ideas, I don't have to comment on the course or lectures because it is much much better than I expected but I have to comment on the courses. The course not only teach us about the subject but what it teach more is how to teach and learn a better way. Every act depicts sincerity, dedication and hard work. This is the best course that I have taken till. Everything was covered very methodically. Little snippets of new research in the field was very interesting. The confidence while teaching was very appreciable.

-----SANJAY SARKAR

Many softwares and web tools for Mathematics Mathematica, Sagemath, Geogebra, R, Latex etc.,

-----S.MANIKANDAN

We learnt Mathematical Modelling, MatLab, R software, Counting & tiling, Random Walks and Tora software which are very useful in Mathematics and new concepts. Thanks

-----Babita

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Singh, Rimjhim Chakraverty, Devesh Tewari

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