

HRDC  
Pt. Ravishankar Shukla University  
Raipur (C.G.)

**Refresher Course in  
Mathematics**

(ONLINE)

**07/12/2020 – 19/12/2020**

**REPORT**

Course Coordinator  
**Prof.B.S.Thakur**  
S.O.S. in Mathematics  
Pt. Ravishankar Shukla University, Raipur

HRDC, Pt. Ravishankar Shukla University, Raipur (C.G.)  
Online Refresher Course in Mathematics  
December 07-19 , 2020

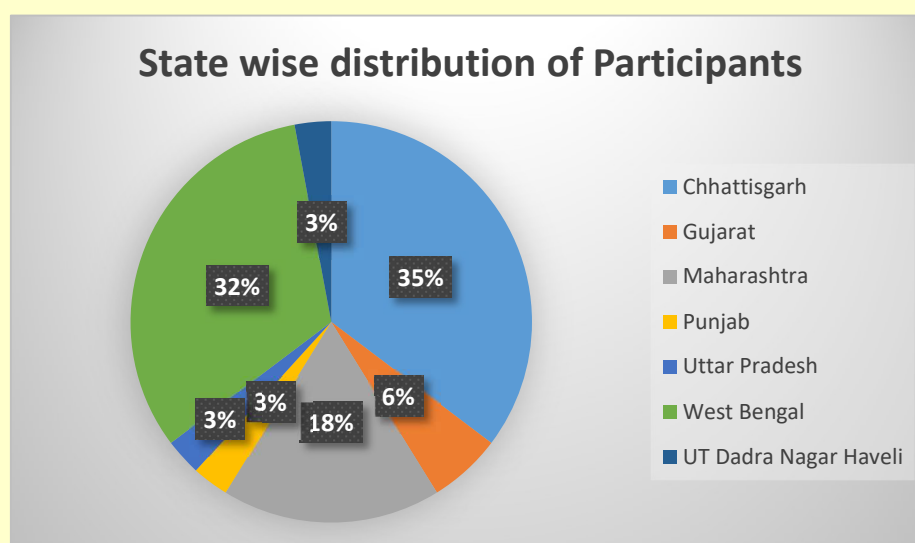
**REPORT**

The Refresher Course in Mathematics was organized in the online platform during December 07-19, 2020 under the aegis of Human Resource Development Centre, Pt. Ravishankar Shukla University, Raipur.

The course was formulated keeping in view the need to strengthen core areas of mathematics program in the undergraduate and postgraduate levels in the country. It had been designed to provide insight into a variety of interesting and meaningful topics which would be useful for teachers of Mathematics irrespective of their specialization.

Emphasis had been given to cover fundamental and advanced topics of Mathematical Analysis, Algebra, Differential equations, Functional analysis and Mathematical modeling.

34 teachers from six states, Chhattisgarh, Gujarat, Maharashtra, Punjab, Uttar Pradesh, West Bengal and Union Territory (Dadra and Nagar Haveli and Daman and Diu) attended this course. (Kindly refer to [Annexure-I](#)).



The course began with a welcome address by the Director of the HRDC, Prof. A.K. Gupta. He discussed the functions of the HRDC and other important guidelines related to this refresher course. Course coordinator, Prof. B.S. Thakur gave a brief introduction of SoS in Mathematics and outlined the framework of the course and its importance. Hon'ble Vice-Chancellor of Pt. Ravishankar Shukla University, Prof. Keshari Lal Verma addressed the participants, highlighting the contribution of India in the field of mathematics from ancient times to the present. He, further appreciated online initiatives for teaching and learning during COVID-19 scenario.

The entire course was divided into 48 Session each of 1:30 hours duration (kindly refer to [Annexure-II](#)). Chairperson and Reporter were appointed for each session, except the Opening, MCQ end test, and concluding sessions (kindly refer to [Annexure-III](#))

14 resource persons from various institutes delivered 39 lectures. Brief introduction of resource persons and abstracts of their talks may be found in the Abstract Book (kindly refer to [Annexure-IV](#)).

Each day was started with a talk by a resource person giving a brief outline of their research activities and then elaborating their respective topics (kindly refer to [Annexure-V](#) for detailed time-table). Activities viz. Seminar Presentation, ICT/Micro Teaching and Project Preparation & Presentation were also included in Refresher Course (kindly refer to [Annexure-VI to VIII](#) for details). Performance of participants in each of the activities were evaluated by external evaluators.

Some of the important topics like Banach Spaces and Fundamental Theorems, Qualitative solution of differential equation, Partial Differential Equations, Parabolic Partial Differential Equations, Galois Theory, Measure and Integration Theory, Applications of Linear Algebra, Computational Theory of Fixed Points, Algebra and its Applications to Cryptography have been covered.

Sessions were interactive, participants actively interacted with the resource persons during the sessions. Details may be found in the daily activity report (kindly refer to [Annexure-IX](#)).

All the participants enthusiastically participated in all of these activities. They also gave their Feedback on the format prescribed by the HRDC. In the concluding day of refresher course, attentiveness of the participants was assessed by MCQ test based on the questions provided by Resource Persons.

The test was followed by Valedictory session in which Prof. B.S. Thakur, Course Coordinator, presented the report for the course and discussed the various aspects of the lectures delivered in the course. He expressed his happiness over the active participation of participants and their performances in microteaching, seminars, project presentations, and test. He also expressed gratitude to Prof. A.K.Gupta, Director HRDC, and Dr. Arvind Agrawal for their co-operation.

In the valedictory function, the participants expressed the view that the online course has been a new experience for them and they got a lot to learn. It refreshed, increased their knowledge, and gave them an opportunity to be aware of recent trends of teaching and research in the field of Mathematics. They also praised the selection of proper topics, renowned and eminent Resource Persons.

Prof. A.K. Gupta in his concluding remark thanked and congratulated colleagues and especially Prof. B.S.Thakur for successfully conducting the course. He thanked all the participants for their active participation and urged them to send a SWOT analysis of the programme. He expressed his satisfaction after hearing the feedback from the participants and thanked them for choosing HRDC, PRSU for the refresher course. He wished good luck to all the participants for their future work.

## Refresher Course in Mathematics

07/12/2020 to 19/12/2020

## List of Participants

S.No.	Roll No.	Name of the Participant	Mobile number	E-mail	Designation	College/University/Institute
1	1	Dr. Niyati Gurudwan	7587068189	niyati.kuhu@gmail.com	Assistant Professor	Govt. J.Y.Chhattisgarh College, Raipur, CG
2	2	Dr Hemlal Sahu	9424332739	hemlalsahu@gmail.com	Assistant Professor	Govt. J.Y.Chhattisgarh College, Raipur, CG
3	3	Dr. Bhuneshwari Verma	9407624836	mohanverma67@gmail.com	Assistant Professor	Govt. J.Y.Chhattisgarh College, Raipur, CG
4	5	Dr. Subhajit Saha	8622980578	subhajit1729@gmail.com	Assistant Professor	Panihati Mahavidyalaya, Kolkata, WB
5	6	Dr. Saugata Mitra	9051495640	saugatamitra20@gmail.com	Assistant Professor	Ramakrishna Mission Vidyamandira, P.O. Belur Math, WB
6	7	Dr. Arnab Jyoti Das Gupta	8893901879	arnabjdg@gmail.com	Assistant Professor	Ramakrishna Mission Vidyamandira, P.O. Belur Math, WB
7	8	Dr. Tarun Maiti	8902256003	tarun.ju@gmail.com	Assistant Professor	Gurudas College, Kolkata, WB
8	9	Dr. Sugato Gupta	8240063996 / 9477070405	sguptaju@gmail.com	Assistant Professor	Vidyasagar College for Women, Kolkata, WB
9	11	Dr. Srikumar Panda	9433302908	shree.iitg.mc@gmail.com	Assistant Professor	Vidyasagar College, Kolkata, WB
10	12	Dr. Srimayee Samui	9531760965	srimayee.samui@gmail.com	Assistant Professor	Vidyasagar College, Kolkata, WB
11	13	Dr. Ritu Sen	9748237513	ritu.maths@presiuniv.ac.in	Assistant Professor	Presidency University, Kolkata, WB
12	14	Dr. Mahesh Kishanrao Kulkarni	9325056897	maheshkul111@gmail.com	Assistant Professor	Loknete Gopinathji Munde Arts, Commerce and Science College Mandangad Dist. Ratnagiri, MH
13	15	Dr. Jay Gopalbhai Mehta	9651059359	jaygmehta@gmail.com	Assistant Professor	Department of Mathematics
14	16	Mr. Kamleshkumar Ratilal Baleviya	9409509684	kamleshspu@gmail.com	Assistant Professor	Department of Mathematics
15	17	Mr. Pratap Mondal	9732914192	pratapmondal111@gmail.com	Assistant Professor	Bijoy Krishna Girls' College, Howrah, WB
16	18	Dr Samiran Banerjee	9874209951	samiran.bkgc@gmail.com	Assistant Professor	Bijoy Krishna Girls' College, Howrah, WB

S.No.	Roll No.	Name of the Participant	Mobile number	E-mail	Designation	College/University/Institute
17	19	Dr. Rupak Bhattacharyya	9239403082	mathsrup@gmail.com	Assistant Professor	Bijoy Krishna Girls' College, Howrah, WB
18	20	Mr. Chandrauday Manikpuri	9098045935, 9407908280	cdmanikpuri22@gmail.com	Assistant Professor	Govt. Ghanshyam Singh Gupt P.G. College, Balod, CG
19	21	Dr. Chandrajeet Singh Rathore	9827105314, 7999065315	rathoremaths20@gmail.com	Assistant Professor	Govt. Jajwalya Dev Naveen Girls College, Janjgir, CG
20	22	Dr. Dipti Thakur	9713877177	dipti.thakur15@gmail.com	Assistant Professor	School of Studies in Mathematics
21	23	Mr. Yashawant Jaiswal	9098499530	jjashawant@gmail.com	Assistant Professor	Government Mukut Dhar Pandey College, Katghora, CG
22	25	Mr. Dinesh Kumar	9131398987	dineshbanjare84@gmail.com	Assistant professor	S.N.A. Govt. College, Kohka-Neora, Raipur, CG
23	26	Dr. Mahantesh M. Nandeppanavar	9972082283	nandeppanavarmm@gmail.com	Assistant Professor	Government College (Autonomous), Kalaburagi, Karnataka
24	27	Mr. Hemlal Rathore	9179532768	Hemlalrathore@gmail.com	Assistant Professor	Dr. BSP Govt College, Pendra, CG
25	29	Dr. Ambrish Kumar Tiwari	7579157194	aktiwaria@gmail.com	Assistant Professor	Rajkiya Engineering College, Mainpuri, UP
26	30	Mr. Chetan Kumar Sahu	9425290168, 8871637236	ccpu123@gmail.com	Assistant Professor	Govt. Dr. Babasaheb BhimRao Ambedkar College, Dongargaon, Dist. Rajnandgaon, CG
27	32	Dr. Himanshu V. Chapani	9408292498	himanshu.chapani@gmail.com	Assistant Professor	Dr. APJ Abdul Kalam Govt. College, Silvassa, DNH
28	33	Mr. Naveen Kumar	9878831166	naveen.mlp@gmail.com	Assistant Professor	DAV College, Hoshiarpur, Punjab
29	34	Dr. Rajani A. Anturkar (Shelote)	9881551126	rajanishelote@gmail.com	Assistant Professor	Sant Gadge Maharaj Mahavidyalaya, Hingna, Dist. Nagpur, MH
30	35	Mr. Dildar Singh Tandon	9827462154	dildartandon1983@gmail.com	Assistant Professor	Dr. J.P. Mishra Govt. P.G. Science College, Mungeli, CG
31	36	Dr. Shilpa W. Samdurkar (Pahade)	7151225560	rpahade2008@gmail.com,shilpasamdurkar@gmail.com	Assistant Professor	Vidya Vikas Arts, Commerce and Science College, Samudrapur, MH
32	37	Chhatrapal Singh Sikarwar	9098596646	chhatrapal84@gmail.com	Assistant Professor	Govt. KD College, Chhura, Dist. Gariyaband, CG
33	38	Mohan D. Dhuratkar	9665103107	mohanmaths2008@gmail.com	Assistent Professor	Shivprasad Sadanand Jaiswal College, Arjuni/Morgaon, MH
34	39	Mr. Mahadeo Ganeshrao Bhujade	8983217022	mgbhujade@rediffmail.com	Assistant Professor	Lokmanya Tilak Mahavidyalaya, Wani, MH

Refresher Course in Mathematics

(07/12/2020 to 19/12/ 2020)

Time Table

	Session -I (10:30 to 12:00)	Break	Session -II (12:15 to 13:45)	Break	Session -III (14:15 to 15:45)	Break	Session -IV (16:00 to 17:30)
<b>First Week</b>							
Day 01 (07/12/2020)	Registration, Inauguration & Induction	<b>TEA Break</b>	Lecture 1 Prof. Malay Banerjee-01	<b>LUNCH Break</b>	Lecture 2 Prof. V.D.Sharma-01	<b>TEA Break</b>	Lecture 3 Prof. S.R.Ghorpade-01
Day 02 (08/12/2020)	Lecture 4 Prof. Khalil Ahmad-01		Lecture 5 Prof. Malay Banerjee-02		Lecture 6 Prof. V.D.Sharma-02		Lecture 7 Prof. S.R.Ghorpade-02
Day 03 (09/12/2020)	Lecture 8 Prof. Khalil Ahmad-02		Lecture 9 Prof. Malay Banerjee-03		Lecture 10 Prof. V.D.Sharma-03		Lecture 11 Prof. S.R.Ghorpade-03
Day 04 (10/12/2020)	Lecture 12 Prof. Khalil Ahmad-03		Lecture 13 Prof. Malay Banerjee-04		Lecture 14 Prof. V.D.Sharma-04		Lecture 15 Prof. S.R.Ghorpade-04
Day 05 (11/12/2020)	Lecture 16 Prof. Khalil Ahmad-04		Lecture 17 Prof. Sandip Banerjee-01		Lecture 18 Prof. Sandip Banerjee-02		Seminar-01
Day 06 (12/12/2020)	Lecture 19 Prof. A.S.Ranadive-01		Lecture 20 Prof. G.V.R. Babu-01		Lecture 21 Prof. G.V.R. Babu-02		Seminar-02
<b>Second Week</b>							
Day 07 (14/12/2020)	Lecture 22 Prof. M.Thamban Nair-01	<b>TEA Break</b>	Lecture 23 Prof. Mohan C. Joshi-01	<b>LUNCH Break</b>	Lecture 24 Prof. Mohan C. Joshi-02	<b>TEA Break</b>	Lecture 25 Prof. M.Thamban Nair-02
Day 08 (15/12/2020)	Lecture 26 Prof. M.Thamban Nair-03		ICT/Micro teaching-01		Lecture 27 Prof. Rafikul Alam-01		Lecture 28 Prof. M.Thamban Nair-04
Day 09 (16/12/2020)	Lecture 29 Prof. D.R.Sahu-01		Lecture 30 Dr. T.Suman Kumar-01		Lecture 31 Prof. Rafikul Alam-02		ICT/Micro teaching-02
Day 10 (17/12/2020)	Lecture 32 Prof. D.R.Sahu-02		Lecture 33 Dr. T.Suman Kumar-02		Project Presentation-01		Lecture 34 Prof. Rajendra K.Sharma-01
Day 11 (18/12/2020)	Lecture 35 Prof. D.R.Sahu-03		Lecture 36 Prof. H.K.Pathak-01		Project Presentation-02		Lecture 37 Prof. Rajendra K.Sharma-02
Day 12 (19/12/2020)	Lecture 38 Prof. A.S.Ranadive-02		Lecture 39 Prof. H.K.Pathak-02		MCQ Ending Test		Valedictory & Concluding Session

**UGC - HRDC, PRSU, Raipur**  
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**Annexure-III**

**Time Table: First Week**

	<b>Session -I (10:30 to 12:00)</b>		<b>Session -II (12:15 to 13:45)</b>		<b>Session -III (14:15 to 15:45)</b>		<b>Session -IV (16:00 to 17:30)</b>
<b>Day 01 (07/12/2020)</b>	<b>Registration, Inauguration &amp; Induction</b>	<b>TEA Break</b>	<b>Lecture 1</b> Prof. Malay Banerjee-01 Chairperson: Dr. Niyati Gurudwan Reporter: Dr. Rupak Bhattacharyya	<b>LUNCH Break</b>	<b>Lecture 2</b> Prof. V.D.Sharma-01 Chairperson: Dr. Niyati Gurudwan Reporter: Dr. Rupak Bhattacharyya	<b>TEA Break</b>	<b>Lecture 3</b> Prof. S.R.Ghorpade-01 Chairperson: Dr. Niyati Gurudwan Reporter: Dr. Rupak Bhattacharyya
<b>Day 02 (08/12/2020)</b>	<b>Lecture 4</b> Prof. Khalil Ahmad-01 Chairperson: Dr. Rajani A. Anturkar Reporter: Mr. Hemlal Rathore		<b>Lecture 5</b> Prof. Malay Banerjee-02 Chairperson: Dr. Rajani A. Anturkar Reporter: Mr. Hemlal Rathore		<b>Lecture 6</b> Prof. V.D.Sharma-02 Chairperson: Dr. Dipti Thakur Reporter: Mr. Yashawant Jaiswal		<b>Lecture 7</b> Prof. S.R.Ghorpade-02 Chairperson: Dr. Dipti Thakur Reporter: Mr. Yashawant Jaiswal
<b>Day 03 (09/12/2020)</b>	<b>Lecture 8</b> Prof. Khalil Ahmad-02 Chairperson: Dr. Subhajit Saha Reporter: Mr. Chandrauday Manikpuri		<b>Lecture 9</b> Prof. Malay Banerjee-03 Chairperson: Dr. Subhajit Saha Reporter: Mr. Chandrauday Manikpuri		<b>Lecture 10</b> Prof. V.D.Sharma-03 Chairperson: Dr. Sugato Gupta Reporter: Mr. Kamleshkumar Ratilal Baleviya		<b>Lecture 11</b> Prof. S.R.Ghorpade-03 Chairperson: Dr. Sugato Gupta Reporter: Mr. Kamleshkumar Ratilal Baleviya
<b>Day 04 (10/12/2020)</b>	<b>Lecture 12</b> Prof. Khalil Ahmad-03 Chairperson: Dr. Arun Kumar Gali Reporter: Dr. Rupak Bhattacharyya		<b>Lecture 13</b> Prof. Malay Banerjee-04 Chairperson: Dr. Arun Kumar Gali Reporter: Dr. Rupak Bhattacharyya		<b>Lecture 14</b> Prof. V.D.Sharma-04 Chairperson: Dr. Ritu Sen Reporter: Dr. Srimayee Samui		<b>Lecture 15</b> Prof. S.R.Ghorpade-04 Chairperson: Dr. Ritu Sen Reporter: Dr. Srimayee Samui
<b>Day 05 (11/12/2020)</b>	<b>Lecture 16</b> Prof. Khalil Ahmad-04 Chairperson: Dr. Ambrish Kumar Tiwari Reporter: Mohan D. Dhuratkar		<b>Lecture 17</b> Prof. Sandip Banerjee-01 Chairperson: Dr. Ambrish Kumar Tiwari Reporter: Mohan D. Dhuratkar		<b>Lecture 18</b> Prof. Sandip Banerjee-02 Chairperson: Dr. Mahantesh M. Nandeppanavar Reporter: Dr Samiran Banerjee		<b>Seminar-01</b> Chairperson: Dr. Mahantesh M. Nandeppanavar Reporter: Dr Samiran Banerjee
<b>Day 06 (12/12/2020)</b>	<b>Lecture 19</b> Prof. A.S.Ranadive-01 Chairperson: Dr. Srikumar Panda Reporter: Chhatrapal Singh Sikarwar		<b>Lecture 20</b> Prof. G.V.R. Babu-01 Chairperson: Dr. Srikumar Panda Reporter: Chhatrapal Singh Sikarwar		<b>Lecture 21</b> Prof. G.V.R. Babu-02 Chairperson: Dr. Jay Gopalbhai Mehta Reporter: Mr. Dinesh Kumar		<b>Seminar-02</b> Chairperson: Dr. Jay Gopalbhai Mehta Reporter: Mr. Dinesh Kumar



**UGC - HRDC, PRSU, Raipur**  
**Refresher Course in Mathematics**  
**(07/12/2020 to 19/12/ 2020)**

**Time Table: Second week**

	<b>Session -I (10:30 to 12:00)</b>		<b>Session -II (12:15 to 13:45)</b>		<b>Session -III (14:15 to 15:45)</b>		<b>Session -IV (16:00 to 17:30)</b>
<b>Day 07 (14/12/2020)</b>	<b>Lecture 22</b> Prof. M.Thamban Nair-01 Chairperson: Dr. Srikumar Panda Reporter: Dr. Arnab Jyoti Das Gupta	<b>TEA Break</b>	<b>Lecture 23</b> Prof. Mohan C. Joshi-01 Chairperson: Dr. Srikumar Panda Reporter: Dr. Arnab Jyoti Das Gupta	<b>LUNCH Break</b>	<b>Lecture 24</b> Prof. Mohan C. Joshi-02 Chairperson: Dr. Bhuneshwari Verma Reporter: Dr. Jay Gopalbhai Mehta	<b>TEA Break</b>	<b>Lecture 25</b> Prof. M.Thamban Nair-02 Chairperson: Dr. Bhuneshwari Verma Reporter: Dr. Jay Gopalbhai Mehta
<b>Day 08 (15/12/2020)</b>	<b>Lecture 26</b> Prof. M.Thamban Nair-03 Chairperson: Dr. Mahesh Kishanrao Kulkarni Reporter: Dr. Saugata Mitra		<b>ICT/Micro teaching-01</b> Chairperson: Dr. Mahesh Kishanrao Kulkarni Reporter: Dr. Saugata Mitra		<b>Lecture 27</b> Prof. Rafikul Alam-01 Chairperson: Dr. Shilpa W. Samdurkar Reporter: Dr. Ambrish Kumar Tiwari		<b>Lecture 28</b> Prof. M.Thamban Nair-04 Chairperson: Dr. Shilpa W. Samdurkar Reporter: Dr. Ambrish Kumar Tiwari
<b>Day 09 (16/12/2020)</b>	<b>Lecture 29</b> Prof. D.R.Sahu-01 Chairperson: Dr. Niyati Gurudwan Reporter: Dr. Tarun Maiti		<b>Lecture 30</b> Dr. T.Suman Kumar-01 Chairperson: Dr. Niyati Gurudwan Reporter: Dr. Tarun Maiti		<b>Lecture 31</b> Prof. Rafikul Alam-02 Chairperson: Mr. Mahadeo Ganeshrao Bhujade Reporter: Mr. Mahadeo Bhujade		<b>ICT/Micro teaching-02</b> Chairperson: Mr. Mahadeo Ganeshrao Bhujade Reporter: Mr. Mahadeo Bhujade
<b>Day 10 (17/12/2020)</b>	<b>Lecture 32</b> Prof. D.R.Sahu-02 Chairperson: Mr. Naveen Kumar Reporter: Dr. Ritu Sen		<b>Lecture 33</b> Dr. T.Suman Kumar-02 Chairperson: Mr. Naveen Kumar Reporter: Dr. Ritu Sen		<b>Project Presentation-01</b> Chairperson: Dr. Rupak Bhattacharyya Reporter: Dr. Subhajit Saha		<b>Lecture 34</b> Prof. Rajendra K.Sharma-01 Chairperson: Dr. Rupak Bhattacharyya Reporter: Dr. Subhajit Saha
<b>Day 11 (18/12/2020)</b>	<b>Lecture 35</b> Prof. D.R.Sahu-03 Chairperson: Mr. Chetan Kumar Sahu Reporter: Dr. Himanshu V. Chapani		<b>Lecture 36</b> Prof. H.K.Pathak-01 Chairperson: Mr. Chetan Kumar Sahu Reporter: Dr. Himanshu V. Chapani		<b>Project Presentation-02</b> Chairperson: Mr. Pratap Mondal Reporter: Dr Hemlal Sahu		<b>Lecture 37</b> Prof. Rajendra K.Sharma-02 Chairperson: Mr. Pratap Mondal Reporter: Dr Hemlal Sahu
<b>Day 12 (19/12/2020)</b>	<b>Lecture 38</b> Prof. A.S.Ranadive-02 Chairperson: Dr. Chandrajeet Singh Rathore Reporter: Mr. Dildar Singh Tandon		<b>Lecture 39</b> Prof. H.K.Pathak-02 Chairperson: Dr. Chandrajeet Singh Rathore Reporter: Mr. Dildar Singh Tandon		<b>MCQ Ending Test</b>		<b>Valedictory &amp; Concluding Session</b>

**Refresher  
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In  
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# ABSTRACTS

**07/12/2020 -- 19/12/ 2020**

**UGC – HRDC**  
Pt. Ravishankar Shukla University  
Raipur

**Course Coordinator:**

Prof. B.S. Thakur  
SoS in Mathematics, PRSU, Raipur  
E-mail: balwantst@gmail.com



### Prof. Malay Banerjee

Department of Mathematics & Statistics  
Indian Institute of Technology, Kanpur

#### Education:

M.Sc.	University of Calcutta	1998
Ph.D.	University of Calcutta	2005

#### Research Interest:

- Nonlinear Dynamics
- Mathematical Modeling
- Analysis in Ecology and Epidemiology

#### Contact:

E-mail: malayb@iitk.ac.in

#### For details please visit:

<https://www.iitk.ac.in/new/malay-banerjee>

#### Lecture-01:

##### Solution of System of Linear Equations

In this lecture I will discuss about the structure of solution for system linear ordinary differential equations and the stability of trivial solution.

#### Lecture-05:

##### A Brief Introduction to Bifurcation Theory

Change in dynamic behaviour for the system of nonlinear ordinary differential equations are studied with the help of local and global bifurcation theory. In this talk I will discuss some standard tools to analyze saddle-node, transcritical, pitchfork and Hopf bifurcation for one and higher dimensional systems

#### Lecture-09:

##### Simple Mathematical Models for Ecology

Construction of simple mathematical models for complex ecological interactions is an challenging issue and there exists a wide range of mathematical models for ecological systems. This talk will be focused on the simple ordinary differential equation models for interacting populations.

#### Lecture-13:

##### Application of Bifurcation Theory in Mathematical Ecology

Main objective of this talk will be to explain some mathematical techniques to analyze the mathematical models (ODE models) for interacting populations and interpretation of obtained results.

**Prof. Vishnu Datt Sharma**

Department of Mathematics  
Indian Institute of Technology, Gandhinagar

**Education:**

M.Sc.	University of Allahabad	1968
Ph.D.	Banaras Hindu University	1972

**Research Interest:**

- Quasilinear systems of partial differential equations
- Conservation laws
- Nonlinear gasdynamic and shallow water waves
- Lie group invariance for solutions of PDEs

**Contact:**

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**For details please visit:**

<https://www.iitgn.ac.in/faculty/maths/fac-vsharma>

**Lecture-02, 06, 10, 14 :****Theory of Partial Differential Equations**

My lectures, in the refresher course, would be related with the theory of Partial Differential Equations (PDE), especially the first order PDEs and systems (linear and nonlinear) as they make their appearance in a large number of physical situations. In view of this, I intend to discuss, in my lectures, certain notions of linear and nonlinear scalar conservation laws, hyperbolic waves, breakdown of continuous solutions, weak solutions, Rankine-Hugoniot jump condition, Lax entropy condition, Cauchy and Riemann problems, rarefaction and shock solutions with illustrations.

**Prof. Sudhir Ramakant GHORPADE**

Department of Mathematics  
Indian Institute of Technology, Bombay  
Powai, Mumbai 400076, India

**Education:**

B.Sc.	University of Bombay	1982
M.Sc.	I.I.T. Bombay	1984
Ph.D.	Purdue University, USA	1989

**Research Interest:**

- Algebraic Geometry
- Combinatorics
- Coding Theory
- Commutative Algebra

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<http://www.math.iitb.ac.in/~srg/>

**Lecture-03, 07, 11, 15 :****Introduction to Galois Theory**

In this series of four lectures, we will give a brief introduction to rudiments of Galois theory, starting with the basics about field extensions and related notions. We hope to explain the statement and outline a proof of the Fundamental theorem of Galois theory.

A familiarity with the elementary notions of abstract algebra, such as groups, rings and fields, shall be assumed.



### Prof. Khalil Ahmad

Professor (Retd.)

Department of Mathematics  
Jamia Millia Islamia, New Delhi

#### Education:

M.Sc.	Kanpur University	1970
M.Phil.	Aligarh Muslim University	1976
Ph.D.	University of Delhi	1982

#### Research Interest:

- Functional Analysis
- Wavelet Analysis

#### Contact:

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#### For details please visit:

[https://www.jmi.ac.in/mathematics/faculty-members/Prof\\_Khalil\\_Ahmad-1939](https://www.jmi.ac.in/mathematics/faculty-members/Prof_Khalil_Ahmad-1939)

#### Lecture-04:

##### Normed and Banach Spaces

In this lecture I will discuss normed and Banach space followed by examples and counter examples. Moreover, subspace of a normed and Banach space is defined and some related theorems will be covered.

#### Lecture-08:

##### Bounded Linear Operators and Functionals

In this lecture I will discuss bounded linear operators and functionals and their continuity and boundedness. Norm of an operator and functional will also be discussed. Moreover, spaces of bounded linear operators will be defined and proved as per Banach space. Finally, equivalent norms will be discussed.

#### Lecture-12:

##### Hilbert Spaces

In this lecture I will discuss inner product space and Hilbert space followed by examples and counter examples. Subspace of Hilbert space will be discussed and related theorems will also be discussed. Moreover, orthogonality of vectors will be discussed followed by projection theorem.

#### Lecture-16:

##### Application of Wavelets

In this lecture I will discuss history and motivation of wavelets followed by existence of wavelets and construction of mother wavelet. Moreover, I will thoroughly discuss about applications of wavelets in signal and image processing.

**Prof. Sandip Banerjee**

Department of Mathematics  
Indian Institute of Technology, Roorkee

**Education:**

B.Sc.	St. Xavier's College, Calcutta	1991
M.Sc.	University of Calcutta	1993
Ph.D.	University of Calcutta	2001

**Research Interest:**

- Mathematical Biology
- Mathematical Modeling

**Contact:**

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**Lecture-17 - 18 :****Mathematical Modelling with Excel**

Mathematical modelling is an important aspect of the study of science and engineering. The importance of mathematical modelling in physics, chemistry, biology, economics, industry, and even social sciences cannot be ignored. The primary aim of my talk is to present different ways of building and analyzing mathematical models in a format that can be easily understood and to use Excel as a tool to analyze the mathematical models.



### Prof. Abhay S Ranadive

Department of Applied Mathematics  
Guru Ghasidas Vishwavidyalaya, Bilaspur

#### Education:

M.Sc.	Vikram University, Ujjain
M.Phil.	Kurukshetra University, Kurukshetra
Ph.D.	Guru Ghasidas University, Bilaspur

#### Research Interest:

- Fuzzy Algebra
- Fixed Point Theory

#### Contact:

E-mail: asranadive04@yahoo.co.in

#### For details please visit:

[http://www.ggu.ac.in/RESUME/CV\\_ARanadive2.5.13.PDF](http://www.ggu.ac.in/RESUME/CV_ARanadive2.5.13.PDF)

#### Lecture-19, 38 :

#### Projective Modules & Injective Modules: A Dual Pair

One interesting and initial pair of some DUAL CONCEPTS IN MODULES is the pair Projective Modules & Injective Modules. By the word "Dual Concept" we mean to say that if  $S$  is a statement about a class of modules and module homomorphisms then its dual  $S^*$  is the statement about the same class of modules and module homomorphisms obtained by reversing the direction of each module homomorphism and replacing each composite  $A \circ B$  of module homomorphisms by  $B \circ A$ .

Though it is not necessarily true that the dual of a proposition must exist and must be a proposition but if it exists, more than often, we find that proofs of them are dual. In literature available under Dual Concepts in Modules we can find more than twenty five dual pairs. Here we will go through an introductory study of the pair "Projective Modules & Injective Modules".





### Prof. G.Venkata Ravindranadh Babu

Department of Mathematics  
Andhra University, Visakhapatnam

#### Education:

M.Sc.  
Ph.D.

#### Research Interest:

- Fixed Point Theory
- Approximation of Fixed Points

#### Contact:

E-mail: gvr\_babu@hotmail.com

#### For details please visit:

<https://www.andhrauniversity.edu.in/college/college-of-science-and-technology/science-departments/mathematics.html>

#### Lecture-20:

##### Existence and Uniqueness of Solutions of Initial Value Problem

In this talk, we discuss uniform convergence of sequence of functions and study the Weierstrass test for uniform convergence of series of functions.

Also, we consider the uniform convergence of sequence of continuous functions and show that its limit function is a continuous function.

Further, we define Lipschitz condition and study general criterion which would ensure the Lipschitz condition.

We use these preliminaries to prove the existence and uniqueness of solutions of initial value problems by the Picard's method of successive approximations. We extend it to study the existence of solutions in the large. Also we study the fixed point method.

#### Lecture-21:

##### Existence of Fixed Points and Generalization of Fixed Point Theorems

We discuss Banach contraction principle and its generalization and consequences. Further, we study a fixed point theorem for asymptotically regular mappings on a metric space using orbital continuity of a selfmap. As an application of this result, a fixed point theorem is established in T-orbitally complete metric spaces. Also, we study the existence of fixed points of a selfmap  $T$  of a metric space which is T-orbitally complete under a more general contraction type condition by using certain continuous control function.

We discuss further generalization relating to the diameter of orbits. These results extend and generalize some of the known results.



### Prof. M. Thamban Nair

Department of Mathematics

Indian Institute of Technology Madras, Chennai

#### Education:

B.Sc.	Govt. College Kasaragod, Kerala	1978
M.Sc.	University of Calicut, Kerala	1980
Ph.D.	I.I.T. Bombay, Mumbai	1986

#### Research Interest:

- Spectral Approximation of Linear Operators
- Approximation Methods for Solving Operator/Integral Equations
- Regularization and Approximation of Inverse and Ill-Posed Problems

#### Contact:

E-mail: [mtnair@iitm.ac.in](mailto:mtnair@iitm.ac.in)

#### For details please visit:

<https://home.iitm.ac.in/mtnair/index.html>

#### Lecture-22, 25:

##### Introduction to Measure and Integration

In these two talks we introduce the notion of measure and integration, a very important branch of modern mathematics, which is essential to investigate problems that are modeled by differential or integral equations. First we describe the inadequacy of Riemann integral to answer positively some of the questions that arise in the theory of Riemann integration. Thus, the need arises to consider a wider notion of integration using the notion of measure of a subset of  $\mathbf{R}$ , instead of the notion of length of an interval. Then we define the notion of integral of characteristic functions of the so called measurable sets and then the notion of integral of the so called measurable functions. We shall state some of the important useful theorems on such integral.

#### Lecture-26, 28:

##### Some Topic in Basic Operator Theory

In these two talks we discuss some basic results in Operator Theory which are useful for the investigation of problems while solving operator equations and their applications to partial differential equations. First we define the notion of a continuous (or bounded) linear operator and give some examples. Then we consider the issue of continuous invertibility of a linear operator and then discuss many results pertaining to it, including Lax-Milgram lemma in the context of Banach spaces and Hilbert spaces. In the due course, we will have occasions to refer to many of the standard theorems in Functional Analysis, such as closed graph theorem, projection theorem, and Hahn-Banach extension theorem.



### Prof. Mohan C Joshi

Department of Mathematics

Indian Institute of Technology, Gandhinagar

#### Education:

B.Sc.	Agra University	1961
M.Sc.	Delhi University	1967
M.S.	Purdue University, USA	1974
Ph.D.	Purdue University, USA	1973

#### Research Interest:

- Nonlinear Analysis
- Probabilistic Functional Analysis
- Mathematical System Theory
- Industrial Mathematics

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#### For details please visit:

<https://iitgn.ac.in/faculty/math/fac-mohan>

#### Lecture-23 - 24:

##### Solvability Analysis of Nonlinear Differential Equations and Their Application in Control Theory

We employ the tools of Fixed Point Theory and Monotone Operators to discuss the solvability of nonlinear ODE's.

We then, subsequently, introduce the concepts of Controllability and Observability of system modeled by linear and nonlinear ODE – arising in control theory while dealing with systems analysis.

By doing so, we intend to bridge the gap between theory and applications-sorely needed in doing mathematics.

**Prof. Rafikul Alam**

Department of Mathematics  
Indian Institute of Technology Guwahati

**Education:**

M.Sc.	I.I.T. Kharagpur	1991
Ph.D.	I.I.T. Bombay	1996

**Research Interest:**

- Spectral perturbation theory for matrices and operators
- Numerics of linear and nonlinear eigenvalue problems.
- Numerics of multiparameter eigenvalue problems.

**Contact:**

E-mail: rafik@iitg.ac.in

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<http://www.iitg.ac.in/rafik/>

**Lecture-27 - 31:****Applications of Linear Algebra**

Linear Algebra is not only a gateway to higher mathematics but also it provides a powerful framework for solving various problems that arise in science and engineering. Indeed, Linear Algebra plays a very important role in the development of algorithms for solving diverse problems such as design of search engines, pattern recognition, datamining and deep learning, to name only a few. Some of these problems could be introduced and taught as parts of Linear Algebra to undergraduate students, which would make the course interesting. The main purpose of the present lectures is to discuss a few applications of Linear Algebra and highlight the relevant theory from Linear Algebra.

**Prof. D R Sahu**

Department of Mathematics  
Banaras Hindu University, Varanasi

**Education:**

M.Sc.	Pt. Ravishankar Shukla Univ., Raipur	1990
Ph.D.	Pt. Ravishankar Shukla Univ., Raipur	1996

**Research Interest:**

- Fixed Point Theory
- Computational Operator Theory
- Variational Inequality Theory
- Numerical Convex Optimization
- Newton-like Methods

**Contact:**

E-mail: drsahudr@gmail.com

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<https://www.bhu.ac.in/science/mathematic/faculty.php>

**Lecture-29, 32, 35:****Computation Theory of Fixed Point and Applications**

The fixed point theory plays a fundamental role in several theoretical and applied areas, such as nonlinear analysis, integral and differential equations and inclusions, dynamic systems theory, mathematics of fractals, mathematical economics (game theory, equilibrium problems, optimization problems) and mathematical modeling. This lecture series will cover some topics of theory of fixed points and its various applications to applied and computational mathematics.

**Dr. T Suman Kumar**

School of Mathematics and Statistics  
University of Hyderabad

**Education:**

M.Sc.	University of Hyderabad	2005
Ph.D.	Universite Paris VI, Paris	2009

**Research Interest:**

- Population Dynamics
- Mathematical Biology
- Numerics of PDE

**Contact:**

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<http://mathstat.uohyd.ac.in/people/profile/suman-kumar>

**Lecture-30, 33:****Linear Partial Differential Equations**

The Laplace equation arises in different branches of mathematics ranging from mathematical physics to the theory of functions. Invariance of the Laplace operator under rotation gives the motivation to construct the fundamental solution which is a radial function.

We use Green's function methods to give existence, and the maximum principle to prove uniqueness of the solution to the Laplace equation.

On the other hand, we apply energy methods to deal with the uniqueness of the linear equations of evolution type, for instance, the heat equation. Towards the end, the maximum principle for the heat equation is introduced.

**Prof. Rajendra K Sharma**

Department of Mathematics  
Indian Institute of Technology, New Delhi

**Education:**

M.Sc.  
Ph.D.

**Research Interest:**

- Algebra
- Cryptography

**Contact:**

E-mail: rksharmaiitd@gmail.com

**For details please visit:**

<https://web.iitd.ac.in/~rksharma/index.html>

**Lecture-34, 37:****Applications of Algebra in Cryptography**

We shall discuss in this talk applications of algebra in public key cryptography



### Dr. Hemant Kumar Pathak

Professor (Retd.)

School of Studies in Mathematics  
Pt. Ravishankar Shukla University, Raipur

#### Education:

M.Sc.	Pt. Ravishankar Shukla Univ., Raipur	1977
Ph.D.	Pt. Ravishankar Shukla Univ., Raipur	1988

#### Research Interest:

- Spectral Approximation of Linear Operators
- General Topology,
- Number Theory,
- Fuzzy Set Theory & Fuzzy Logic
- Operator Theory
- Cryptography

#### Contact:

E-mail: hkpathak05@gmail.com

#### For details please visit:

#### Lecture-36:

##### Banach Spaces and Fundamental Theorems

In this lecture, we address a generalization of Euclidean space of dimension  $n$ , namely  $R^n$  (vector space of dimension  $n$ ), known as Banach space. Beginning with a historical remark that how the notion of magnitude or length of a vector introduced by Stefan Banach around 1918 led to the study of structures called normed space and special class, named Banach space. We begin with the notion of norm that was instrumental in the study of normed linear space and Banach space along with some examples of them. We also discuss some examples of structures studied by Stefan Banach, namely spaces of sequences and spaces of different classes of functions such as spaces of continuous differential integrable functions. Five fundamental results of functional analysis, namely Hahn–Banach theorem, Banach–Alaoglu theorem, uniform boundedness principle, open mapping theorem, and closed graph theorem are also discussed.

#### Lecture-39:

##### Linear Transformations and Associated Algebra

In this lecture, beginning with some fundamentals we address linear transformations and associated algebra. The notion of dual space along with dual base with an application to obtain linear independent solution of a system of linear homogeneous equations over a field  $F$  is discussed. The notion of algebra over a field is also discussed. Correspondence between linear transformation and matrices are shown in great details. The notions of minimal polynomial, eigenvalues and eigenvectors of a linear operator along with Cayley-Hamilton theorem are discussed. We also discuss the Jordan canonical form which is determined by the set of elementary divisors, determinant divisors, invariant factors etc., of a square matrix.



# UGC - HRDC

Pt. Ravishankar Shukla University  
Raipur

## Refresher Course In Mathematics

07/12/2020 -- 19/12/ 2020

TIME - TABLE

Course Coordinator:  
Prof. B.S. Thakur  
SoS in Mathematics, PRSU, Raipur  
E-mail: balwantst@gmail.com

# REFRESHER COURSE MATHEMATICS

Date: 07/12/2020, Monday

Day: 01

Week: First Week

## Schedule

Session-I  
10:30 -12:00

**Registration, Inauguration & Induction**

12:00 -12:15

**Break**

Session-II  
12:15 -13:45

**Lecture-01: Solution of system of linear equations**  
**Prof. Malay Banerjee**  
Department of Mathematics & Statistics  
Indian Institute of Technology, Kanpur  
E-mail: malayb@iitk.ac.in

13:45 -14:15

**Break**

Session-III  
14:15 -15:45

**Lecture-02: Theory of Partial Differential Equations-01**  
**Prof. V.D.Sharma**  
Department of Mathematics  
Indian Institute of Technology, Gandhinagar  
E-mail: vsharma@iitgn.ac.in

15:45 -16:00

**Break**

Session-IV  
16:00 -17:45

**Lecture-03: Introduction to Galois Theory-01**  
**Prof. S.R.Ghorpade**  
Department of Mathematics  
Indian Institute of Technology, Bombay  
Powai, Mumbai 400076, India  
E-mail: srg@math.iitb.ac.in

# REFRESHER COURSE MATHEMATICS

Date: **08/12/2020, Tuesday**

Day: **02**

Week: **First Week**

## Schedule

Session-I 10:30 -12:00	<b>Lecture-04: Normed and Banach Spaces</b> <b>Prof. Khalil Ahmad</b> Professor (Retd.) Department of Mathematics Jamia Millia Islamia, New Delhi E-mail: kahmad49@gmail.com
12:00 -12:15	<b>Break</b>
Session-II 12:15 -13:45	<b>Lecture-05: A brief introduction to bifurcation theory</b> <b>Prof. Malay Banerjee</b> Department of Mathematics & Statistics Indian Institute of Technology, Kanpur E-mail: malayb@iitk.ac.in
13:45 -14:15	<b>Break</b>
Session-III 14:15 -15:45	<b>Lecture-06: Theory of Partial Differential Equations-02</b> <b>Prof. V.D.Sharma</b> Department of Mathematics Indian Institute of Technology, Gandhinagar E-mail: vsharma@iitgn.ac.in
15:45 -16:00	<b>Break</b>
Session-IV 16:00 -17:45	<b>Lecture-07: Introduction to Galois Theory-02</b> <b>Prof. S.R.Ghorpade</b> Department of Mathematics Indian Institute of Technology, Bombay Powai, Mumbai 400076, India E-mail: srg@math.iitb.ac.in

# REFRESHER COURSE MATHEMATICS

Date: 09/12/2020, Wednesday

Day: 03

Week: First Week

## Schedule

Session-I Lecture-08: **Bounded Linear Operators and Functionals**

10:30 -12:00

**Prof. Khalil Ahmad**

Professor (Retd.)

Department of Mathematics

Jamia Millia Islamia, New Delhi

E-mail: kahmad49@gmail.com

12:00 -12:15

**Break**

Session-II

12:15 -13:45

Lecture-09: **Simple Mathematical Models for Ecology**

**Prof. Malay Banerjee**

Department of Mathematics & Statistics

Indian Institute of Technology, Kanpur

E-mail: malayb@iitk.ac.in

13:45 -14:15

**Break**

Session-III

14:15 -15:45

Lecture-10: **Theory of Partial Differential Equations-03**

**Prof. V.D.Sharma**

Department of Mathematics

Indian Institute of Technology, Gandhinagar

E-mail: vsharma@iitgn.ac.in

15:45 -16:00

**Break**

Session-IV

16:00 -17:45

Lecture-11: **Introduction to Galois Theory-03**

**Prof. S.R.Ghorpade**

Department of Mathematics

Indian Institute of Technology, Bombay

Powai, Mumbai 400076, India

E-mail: srg@math.iitb.ac.in

# REFRESHER COURSE MATHEMATICS

Date: **10/12/2020, Thursday**

Day: **04**

Week: **First Week**

## Schedule

Session-I **Lecture-12: Hilbert Spaces**

10:30 -12:00

**Prof. Khalil Ahmad**

Professor (Retd.)

Department of Mathematics

Jamia Millia Islamia, New Delhi

E-mail: kahmad49@gmail.com

12:00 -12:15

**Break**

Session-II

12:15 -13:45

**Lecture-13: Application of Bifurcation Theory in  
Mathematical Ecology**

**Prof. Malay Banerjee**

Department of Mathematics & Statistics

Indian Institute of Technology, Kanpur

E-mail: malayb@iitk.ac.in

13:45 -14:15

**Break**

Session-III

14:15 -15:45

**Lecture-14: Theory of Partial Differential Equations-04**

**Prof. V.D.Sharma**

Department of Mathematics

Indian Institute of Technology, Gandhinagar

E-mail: vsharma@iitgn.ac.in

15:45 -16:00

**Break**

Session-IV

16:00 -17:45

**Lecture-15: Introduction to Galois Theory-04**

**Prof. S.R.Ghorpade**

Department of Mathematics

Indian Institute of Technology, Bombay

Powai, Mumbai 400076, India

E-mail: srg@math.iitb.ac.in

# REFRESHER COURSE MATHEMATICS

Date: **11/12/2020, Friday**

Day: **05**

Week: **First Week**

## Schedule

Session-I 10:30 -12:00	<b>Lecture-16: Topological Spaces</b> <b>Prof. Khalil Ahmad</b> Professor (Retd.) Department of Mathematics Jamia Millia Islamia, New Delhi E-mail: kahmad49@gmail.com
12:00 -12:15	<b>Break</b>
Session-II 12:15 -13:45	<b>Lecture-17: Mathematical Modeling with Excel-01</b> <b>Prof. Sandip Banerjee</b> Department of Mathematics Indian Institute of Technology, Roorkee E-mail: sandip.banerjee@ma.iitr.ac.in
13:45 -14:15	<b>Break</b>
Session-III 14:15 -15:45	<b>Lecture-18: Mathematical Modeling with Excel-02</b> <b>Prof. Sandip Banerjee</b> Department of Mathematics Indian Institute of Technology, Roorkee E-mail: sandip.banerjee@ma.iitr.ac.in
15:45 -16:00	<b>Break</b>
Session-IV 16:00 -17:45	<b>Seminar Presentation-01</b> <b>Dr. Sahadeo Padhye</b> Department of Mathematics Mohtilal Nehru National Institute of Technology Allahabad, Prayagraj E-mail: sahadeo@mnnit.ac.in

# REFRESHER COURSE MATHEMATICS

Date: **12/12/2020, Saturday**

Day: **06**

Week: **First Week**

## Schedule

Session-I  
10:30 -12:00 **Lecture-19: Projective Modules & Injective Modules : A Dual Pair-01**

**Prof. Abhay S Ranadive**

Guru Ghasidas Vishwavidyalaya (A Central University)  
Bilaspur, Chhattisgarh  
E-mail: asranadive04@hotmail.com

**12:00 -12:15 Break**

Session-II  
12:15 -13:45 **Lecture-20: Existence and Uniqueness of Solutions of Initial Value Problem**

**Prof. G. Venkata Ravindranadh Babu**

Department of Mathematics  
Andhra University, Visakhapatnam  
E-mail: gvr\_babu@hotmail.com

**13:45 -14:15 Break**

Session-III  
14:15 -15:45 **Lecture-21: Existence of Fixed Points and Generalization of Fixed Point Theorems**

**Prof. G.Venkata Ravindranadh Babu**

Department of Mathematics  
Andhra University, Visakhapatnam  
E-mail: gvr\_babu@hotmail.com

**15:45 -16:00 Break**

Session-IV  
16:00 -17:45 **Seminar Presentation-02**

**Dr. Sahadeo Padhye**

Department of Mathematics  
Motilal Nehru National Institute of Technology Allahabad,  
Prayagraj  
E-mail: sahadeo@mnnit.ac.in

# REFRESHER COURSE MATHEMATICS

Date: **14/12/2020, Monday**

Day: **07**

Week: **Second Week**

## Schedule

**Session-I**  
10:30 -12:00 **Lecture-22: Introduction to Measure and Integration -01**  
**Prof. M. Thamban Nair**  
Department of Mathematics  
Indian Institute of Technology Madras, Chennai 600036, India  
E-mail: mtnair@iitm.ac.in

**12:00 -12:15** **Break**

**Session-II**  
12:15 -13:45 **Lecture-23: Solvability Analysis of Nonlinear Differential Equations and Their Application in Control Theory-01**

**Prof. Mohan C Joshi**  
Department of Mathematics  
Indian Institute of Technology, Gandhinagar  
E-mail: mcj@iitgn.ac.in

**13:45 -14:15** **Break**

**Session-III**  
14:15 -15:45 **Lecture-24: Solvability Analysis of Nonlinear Differential Equations and Their Application in Control Theory-02**

**Prof. Mohan C Joshi**  
Department of Mathematics  
Indian Institute of Technology, Gandhinagar  
E-mail: mcj@iitgn.ac.in

**15:45 -16:00** **Break**

**Session-IV**  
16:00 -17:45 **Lecture-25: Introduction to Measure and Integration -02**

**Prof. M. Thamban Nair**  
Department of Mathematics  
Indian Institute of Technology Madras, Chennai 600036, India  
E-mail: mtnair@iitm.ac.in



# REFRESHER COURSE MATHEMATICS

Date: **15/12/2020, Tuesday**

Day: **08**

Week: **Second Week**

## Schedule

**Session-I**  
10:30 -12:00

**Lecture-26: Some Topics in Basic Operator Theory-01**  
**Prof. M. Thamban Nair**  
Department of Mathematics  
Indian Institute of Technology Madras, Chennai 600036, India  
E-mail: mtnair@iitm.ac.in

**12:00 -12:15** **Break**

**Session-II**  
12:15 -13:45

**ICT/Micro teaching-01**  
**Prof. Amitabh Banerjee**  
Principal,  
Govt. J.Yoganandam Chhattisgarh College,  
Raipur, Chhattisgarh  
E-mail: amitabh101961@gmail.com

**13:45 -14:15** **Break**

**Session-III**  
14:15 -15:45

**Lecture-27: Applications of Linear Algebra-01**  
**Prof. Rafikul Alam**  
Department of Mathematics  
Indian Institute of Technology Guwahati, Guwahati  
E-mail: rafik@iitg.ac.in

**15:45 -16:00** **Break**

**Session-IV**  
16:00 -17:45

**Lecture-28: Some Topics in Basic Operator Theory -02**  
**Prof. M. Thamban Nair**  
Department of Mathematics  
Indian Institute of Technology Madras, Chennai 600036, India  
E-mail: mtnair@iitm.ac.in

# REFRESHER COURSE MATHEMATICS

Date: **16/12/2020, Wednesday**

Day: **09**

Week: **Second Week**

## Schedule

Session-I  
10:30 -12:00      **Lecture-29: Computation Theory of Fixed Point and Applications-01**

**Prof. D.R.Sahu**

Department of Mathematics

Banaras Hindu University, Varanasi

E-mail: drsahudr@gmail.com

**12:00 -12:15      Break**

Session-II  
12:15 -13:45      **Lecture-30: Linear Partial Differential Equations –01**

**Dr. T. Suman Kumar**

School of Mathematics and Statistics

University of Hyderabad

E-mail: suman.hcu@gmail.com

**13:45 -14:15      Break**

Session-III  
14:15 -15:45      **Lecture-31: Applications of Linear Algebra-02**

**Prof. Rafikul Alam**

Department of Mathematics

Indian Institute of Technology Guwahati, Guwahati

E-mail: rafik@iitg.ac.in

**15:45 -16:00      Break**

Session-IV  
16:00 -17:45      **ICT/Micro teaching-02**

**Prof. Amitabh Banerjee**

Principal,

Govt. J.Yoganandam Chhattisgarh College,

Raipur, Chhattisgarh

E-mail: amitabh101961@gmail.com

# REFRESHER COURSE MATHEMATICS

Date: 17/12/2020, Thursday

Day: 10

Week: Second Week

## Schedule

Session-I  
10:30 -12:00      **Lecture-32: Computation Theory of Fixed Point and Applications-02**

**Prof. D.R.Sahu**

Department of Mathematics

Banaras Hindu University, Varanasi

E-mail: drsahudr@gmail.com

12:00 -12:15      **Break**

Session-II  
12:15 -13:45      **Lecture-33: Linear Partial Differential Equations -02**

**Dr. T. Suman Kumar**

School of Mathematics and Statistics

University of Hyderabad

E-mail: suman.hcu@gmail.com

13:45 -14:15      **Break**

Session-III  
14:15 -15:45      **Project Presentation-01**

**Prof. B.K.Sharma**

Former Head

School of Studies in Mathematics,

Pt.Ravishankar Shukla University, Raipur

E-mail: sharmabk07@gmail.com

15:45 -16:00      **Break**

Session-IV  
16:00 -17:45      **Lecture-34: Applications of Algebra in Cryptography-01**

**Prof. Rajendra K.Sharma**

Department of Mathematics

Indian Institute of Technology Delhi, New Delhi

E-mail: rksharmaiitd@gmail.com

# REFRESHER COURSE MATHEMATICS

Date: **18/12/2020, Friday**

Day: **11**

Week: **Second Week**

## Schedule

Session-I  
10:30 -12:00      **Lecture-35: Computation Theory of Fixed Point and Applications-03**

**Prof. D.R.Sahu**

Department of Mathematics  
Banaras Hindu University, Varanasi  
E-mail: drsahudr@gmail.com

**12:00 -12:15      Break**

Session-II  
12:15 -13:45      **Lecture-36: Banach Spaces and Fundamental Theorems**

**Prof. H.K.Pathak**

Former Head  
School of Studies in Mathematics,  
Pt.Ravishankar Shukla University, Raipur  
E-mail: hkpathak05@gmail.com

**13:45 -14:15      Break**

Session-III  
14:15 -15:45      **Project Presentation-02**

**Prof. B.K.Sharma**

Former Head  
School of Studies in Mathematics,  
Pt.Ravishankar Shukla University, Raipur  
E-mail: sharmabk07@gmail.com

**15:45 -16:00      Break**

Session-IV  
16:00 -17:45      **Lecture-37: Applications of Algebra in Cryptography-02**

**Prof. Rajendra K.Sharma**

Department of Mathematics  
Indian Institute of Technology Delhi, New Delhi  
E-mail: rksharmaiitd@gmail.com

# REFRESHER COURSE MATHEMATICS

Date: **19/12/2020, Saturday**

Day: **12**

Week: **Second Week**

## Schedule

Session-I  
10:30 -12:00      **Lecture-38: Projective Modules & Injective Modules :  
A Dual Pair-02**

**Prof. Abhay S Ranadive**

Guru Ghasidas Vishwavidyalaya (A Central University)

Bilaspur, Chhattisgarh

E-mail: asranadive04@hotmail.com

**12:00 -12:15      Break**

Session-II  
12:15 -13:45      **Lecture-39: Linear Transformations and Associated Algebra**

**Prof. H.K.Pathak**

Former Head

School of Studies in Mathematics,

Pt.Ravishankar Shukla University, Raipur

E-mail: hkpathak05@gmail.com

**13:45 -14:15      Break**

Session-III  
14:15 -15:45      **MCQ Ending Test**

**15:45 -16:00      Break**

Session-IV  
16:00 -17:45      **Valedictory & Concluding Session**

## Refresher Course in Mathematics

07/12/2020 to 19/12/2020

## Topics of ICT/Microteaching

S.No.	Roll Number	Name of the Participant	Title/Topic	Day/ Session
1	1	Dr. Niyati Gurudwan	Accretive Operators and Fixed Point Theorems	Day-05 Session-IV
2	2	Dr Hemlal Sahu	Block Chain	Day-05 Session-IV
3	3	Dr. Bhuneshwari Verma	Finite State Machine	Day-05 Session-IV
4	5	Dr. Subhajit Saha	A Very Brief Introduction to Modern Cosmology	Day-05 Session-IV
5	6	Dr. Saugata Mitra	Wormhole solutions in f(R) gravity theory	Day-05 Session-IV
6	7	Dr. Arnab Jyoti Das Gupta	An Asymptotically Stable IMEX Runge-Kutta Scheme for the Wave Equation System in Low Mach Number Limit	Day-05 Session-IV
7	8	Dr. Tarun Maiti	Two-way product recovery in a closed-loop supply chain	Day-05 Session-IV
8	9	Dr. Sugato Gupta	Does power functor preserve Morita equivalence?	Day-05 Session-IV
9	11	Dr. Srikumar Panda	An alternative approach for solving Cauchy type singular integral equation	Day-05 Session-IV
10	12	Dr. Srimayee Samui	Straight lines which are not Straight	Day-05 Session-IV
11	13	Dr. Ritu Sen	A study of Ideals in $C(X)$ with $\beta X$	Day-05 Session-IV
12	14	Dr. Mahesh Kishanrao Kulkarni	Identification & verification of different types of numbers by Programming	Day-05 Session-IV
13	15	Dr. Jay Gopalbhai Mehta	Group Law on Elliptic Curves	Day-05 Session-IV
14	16	Mr. Kamleshkumar Ratilal Baleviya	Module in Algebras	Day-05 Session-IV
15	17	Mr. Pratap Mondal	Hyers-Ulam-Rassias Stability of a Pexider Type Functional Equation in Banach Spaces	Day-05 Session-IV
16	18	Dr Samiran Banerjee	A Short Note on Graphs of Alternating Knots	Day-05 Session-IV
17	19	Dr. Rupak Bhattacharyya	Probabilistic Portfolio Selection	Day-05 Session-IV

S.No.	Roll Number	Name of the Participant	Title/Topic	Day/ Session
18	20	Mr. Chandrauday Manikpuri	Pell's Equation with integer solution	Day-06 Session-IV
19	21	Dr. Chandrajeet Singh Rathore	A brief introduction to summability theory	Day-06 Session-IV
20	22	Dr. Dipti Thakur	Introduction to CAT(0) spaces	Day-06 Session-IV
21	23	Mr. Yashawant Jaiswal	Bhaskaracharya: A great Indian Mathematician	Day-06 Session-IV
22	25	Mr. Dinesh Kumar	Metric Spaces	Day-06 Session-IV
23	26	Dr. Mahantesh M. Nandeppanavar	Importance of Non-dimensionalization in Research	Day-06 Session-IV
24	27	Mr. Hemlal Rathore	Fourier series and its applications	Day-06 Session-IV
25	29	Dr. Ambrish Kumar Tiwari	Combined Effect of magnetic field and ramped temperature in a porous medium bounded by a vertical wall	Day-06 Session-IV
26	30	Mr. Chetan Kumar Sahu	Ramanujan: A Man who knew Infinity	Day-06 Session-IV
27	32	Dr. Himanshu V. Chapani	B Spline Finite Element Method for Solving Nonlinear Infiltration Equation	Day-06 Session-IV
28	33	Mr. Naveen Kumar	Simple Harmonic Motion	Day-06 Session-IV
29	34	Dr. Rajani A. Anturkar (Shelote)	The phenomenon of length contraction in Special theory of Relativity	Day-06 Session-IV
30	35	Mr. Dildar Singh Tandon	Fuzzy Module	Day-06 Session-IV
31	36	Dr. Shilpa W. Samdurkar (Pahade)	Group Theory	Day-06 Session-IV
32	37	Chhatrapal Singh Sikarwar	Stability and bifurcation analysis of a prey-predator model with age based predation	Day-06 Session-IV
33	38	Mohan D. Dhuratkar	Limits of Sequences of Real Numbers	Day-06 Session-IV
34	39	Mr. Mahadeo Ganeshrao Bhujade	Introduction to Number Theory	Day-06 Session-IV

## Refresher Course in Mathematics

07/12/2020 to 19/12/2020

Topics of ICT/Microteaching

S.No.	Roll Number	Name of the Participant	Title/Topic	Day/ Session
1	1	Dr. Niyati Gurudwan	Laplace equation and Mean Value Property	Day-08 Session-II
2	2	Dr Hemlal Sahu	Continuous function is Riemann Integrable	Day-08 Session-II
3	3	Dr. Bhuneshwari Verma	Euler's Formula	Day-09 Session-IV
4	5	Dr. Subhajit Saha	Group Homomorphism	Day-08 Session-II
5	6	Dr. Saugata Mitra	Liouville's theorem	Day-08 Session-II
6	7	Dr. Arnab Jyoti Das Gupta	Relation between gradient and directional derivatives of a scalar valued function	Day-08 Session-II
7	8	Dr. Tarun Maiti	Newton-Raphson Method	Day-08 Session-II
8	9	Dr. Sugato Gupta	Linear Transformation	Day-08 Session-II
9	11	Dr. Srikumar Panda	Solution of Linear Systems using Matrix Method	Day-08 Session-II
10	12	Dr. Srimayee Samui	Ring Homomorphism	Day-08 Session-II
11	13	Dr. Ritu Sen	An introduction to Measure theory	Day-08 Session-II
12	14	Dr. Mahesh Kishanrao Kulkarni	G.C.D. by using Euclidean Algorithm	Day-08 Session-II
13	15	Dr. Jay Gopalbhai Mehta	Simultaneous solution of a system of linear equations and motivation for the definition of vector space	Day-08 Session-II
14	16	Mr. Kamleshkumar Ratilal Baleviya	Cauchy Goursat Theorem.	Day-09 Session-I
15	17	Mr. Pratap Mondal	Introduction of Partial Differential Equations	Day-09 Session-I
16	18	Dr Samiran Banerjee	Sequence of Functions	Day-09 Session-I
17	19	Dr. Rupak Bhattacharyya	Introduction to Probability	Day-09 Session-I
18	20	Mr. Chandrauday Manikpuri	Symmetric Group	Day-09 Session-IV
19	21	Dr. Chandrajeet Singh Rathore	Metric Space	Day-09 Session-IV
20	22	Dr. Dipti Thakur	Measurable function	Day-09 Session-IV
21	23	Mr. Yashawant Jaiswal	VECTOR SUBSPACE	Day-09 Session-IV
22	25	Mr. Dinesh Kumar	Ring theory	Day-09 Session-IV



S.No.	Roll Number	Name of the Participant	Title/Topic	Day/ Session
23	26	Dr. Mahantesh M. Nandeppanavar	Regula falsi method to solve non linear equation (False Position Method)	Day-09 Session-IV
24	27	Mr. Hemlal Rathore	Matrix- change in normal form and its find Rank.	Day-09 Session-IV
25	29	Dr. Ambrish Kumar Tiwari	Differential Equations	Day-09 Session-IV
26	30	Mr. Chetan Kumar Sahu	Group Theory	Day-09 Session-IV
27	32	Dr. Himanshu V. Chapani	Cantor's theorem	Day-09 Session-IV
28	33	Mr. Naveen Kumar	Pair of straight lines	Day-09 Session-IV
29	34	Dr. Rajani A. Anturkar (Shelote)	Ordinary Differential Equation in Two or more Variables	Day-09 Session-IV
30	35	Mr. Dildar Singh Tandon	Analytic function	Day-09 Session-IV
31	36	Dr. Shilpa W. Samdurkar (Pahade)	Example on Leibnitz theorem	Day-09 Session-IV
32	37	Chhatrapal Singh Sikarwar	System of linear equations	Day-09 Session-IV
33	38	Mohan D. Dhuratkar	Indeterminate Forms	Day-09 Session-IV
34	39	Mr. Mahadeo Ganeshrao Bhujade	Gamma Function	Day-09 Session-IV

## Refresher Course in Mathematics

07/12/2020 to 19/12/2020

### Title/Topic of Projects Prepared and Presented by Participants

Group	S.No.	Name of the Participant	Title/ Topic	Day & Session
Group-01	11	Dr. Srikumar Panda	Application of water wave theory in the protection of coastal areas	Day-10 Session-III
	37	Chhatrapal Singh Sikarwar		
	34	Dr. Rajani A. Anturkar (Shelote)		
	7	Dr. Arnab Jyoti Das Gupta		
Group-02	8	Dr. Tarun Maiti	Supply Chain Coordination through Forward and Reverse Logistics	Day-10 Session-III
	23	Mr. Yashawant Jaiswal		
	22	Dr. Dipti Thakur		
Group-03	18	Dr Samiran Banerjee	Blockchain-Enabled E-voting system	Day-10 Session-III
	35	Mr. Dildar Singh Tandon		
	16	Mr. Kamleshkumar Ratilal Baleviya		
	2	Dr Hemlal Sahu		
Group-04	6	Dr. Saugata Mitra	Applications of Topology in Wormhole Geometry	Day-10 Session-III
	25	Mr. Dinesh Kumar		
	15	Dr. Jay Gopalbhai Mehta		
Group-05	13	Dr. Ritu Sen	Study of the approximation of in nite series by using different Summability methods	Day-10 Session-III
	21	Dr. Chandrajeet Singh Rathore		
	33	Mr. Naveen Kumar		
	1	Dr. Niyati Gurudwan		

Group	S.No.	Name of the Participant	Title/ Topic	Day & Session
Group-06	9	Dr. Sugato Gupta	On some aspects of Morita equivalence of semigroups and semirings and its connection with $\Gamma$ -structures	Day-11 Session-III
	20	Mr. Chandraday Manikpuri		
	32	Dr. Himanshu V. Chapani		
	39	Mr. Mahadeo Ganeshrao Bhujade		
Group-07	19	Dr. Rupak Bhattacharyya	Computational Treatment of Transient Free Convection in a Porous Medium Saturated by a Nanofluid	Day-11 Session-III
	27	Mr. Hemlal Rathore		
	29	Dr. Ambrish Kumar Tiwari		
	17	Mr. Pratap Mondal		
Group-08	12	Dr. Srimayee Samui	Some Investigation of the Cosmological Models with Inhomogeneous Equation of State	Day-11 Session-III
	36	Dr. Shilpa W. Samdurkar (Pahade)		
	38	Mohan D. Dhuratkar		
	3	Dr. Bhuneshwari Verma		
Group-09	5	Dr. Subhajit Saha	Study of possible solutions of nonlinear equations arising in flow and heat transfer of Newtonian and non-Newtonian fluids	Day-11 Session-III
	30	Mr. Chetan Kumar Sahu		
	26	Dr. Mahantesh M. Nandeppanavar		
	14	Dr. Mahesh Kishanrao Kulkarni		

**Refresher Course in Mathematics**

(ONLINE)

**07/12/2020 – 19/12/2020**

*Daily Activity Report*

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 07/12/2020

**Day:** 01

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Session: II

Time: 12:15 -13:45

Lecture: 01

Title: Solution of system of linear equations

Speaker: **Prof. Malay Banerjee**

Department of Mathematics & Statistics

Indian Institute of Technology, Kanpur

E-mail: [malayb@iitk.ac.in](mailto:malayb@iitk.ac.in)

Chairperson: Dr. Niyati Gurudwan

Reporter: Dr. Rupak Bhattacharyya

Prof. Banerjee started his lecture with some introductory concept on ordinary differential equations. The engrossing lecture could be divided into five parts. Firstly, he discussed a system of two linear ordinary differential equations. Next, he generalized the concept into a general system of linear ODE. Related to the second part, Prof. Banerjee then discussed the Putzar algorithm to find  $e^{At}$ . After this, he discussed on equilibrium points and the stability of equilibrium. Finally, he demonstrated different types of phase portrait in 2D diagrammatically for different type of eigen values.

The session was interactive and the participants enjoyed the lecture of Prof. Banerjee very much. Prof. Banerjee will continue the lecture on day 2.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Session: III  
Time: 14:15 -15:45  
Lecture: 02  
Title: Partial Differential Equations-01  
Speaker: **Prof. V. D. Sharma**  
Department of Mathematics  
Indian Institute of Technology, Gandhinagar  
E-mail: [vsharma@iitgn.ac.in](mailto:vsharma@iitgn.ac.in)  
Chairperson: Dr. Niyati Gurudwan  
Reporter: Dr. Rupak Bhattacharyya

Prof. V. D. Sharma started his lecture on basic idea of linear Partial Differential Equations in daily life. Then he defined a simple form of Quasi-linear equation. After that he discussed on the Cauchy problem, its characteristic equations and its solutions. He also diagrammatically showed the solution curve and characteristic equations. Also, he explained the explicit and implicit function theorems. After that, he explained the expansion phase and compressive phase of partial differential equations diagrammatically. At last, he prescribed some reference books for further study.

The session was interactive and the participants enjoyed the lecture of Prof. Sharma very much.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Session: IV  
Time: 16:00 -17:45  
Lecture: 03  
Title: Introduction to Galois Theory-01  
Speaker: **Prof. S. R. Ghorpade**  
Department of Mathematics  
Indian Institute of Technology, Bombay  
Powai, Mumbai 400076, India  
E-mail: srg@math.iitb.ac.in  
Chairperson: Dr. Niyati Gurudwan  
Reporter: Dr. Rupak Bhattacharyya

Prof. S. R. Ghorpade started his lecture with brief historical introduction of Galois theory. He explained the basic of the theory in a very lucid manner. Then he given the definitions of finite extension, field extension, degree of the extension, algebraic numbers, transcendental numbers etc. with appropriate examples. Some important theorems with proof were discussed. The later part of todays discussion was mainly focused on the ideas ‘The notion of a solvable group in group theory allows one to determine whether a polynomial is solvable in radicals, depending on whether its Galois group has the property of solvability’ and ‘Each field extension  $L/K$  corresponds to a factor group in a composition series of the Galois group’.

The session was interactive and the participants enjoyed the lecture of Prof. Sharma very much. Prof. Ghorpade will continue the lecture on day 2.

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## **UGC – HRDC, PRSU, RAIPUR**

### **REFRESHER COURSE: MATHEMATICS**

**07/12/2020 to 19/12/2020**

Chairperson: Dr. Rajani A. Aturkar

Reporter: Dr. Hemlal Rathore

Session: I Lecture : 04

Time : 10:30-12:00 Speaker: Prof. Khalil Ahmad

Lecture-4 by Prof. Khalil Ahmed has given very valuable lecture and include useful topic in Normed and Banach Spaces. His lecture for all spaces like vector spaces ,Banach spaces,normed spaces,subspaces is very nice and interesting. His lecture also defined Functional analysis,Linear Algebra,Topology and also all algebra and analysis covered in lecture and its application of Banach spaces. His talking skill is very clear and also presentation is very nice.

Session: II Lecture : 05

Time : 12:15-13:45 Speaker: Prof. Malay Banerjee

Lecture-5 by Prof. Malay Banerjee was talking about Introduction to Bifurcation theory which is related to system of nonlinear ordinary differential equations . His lecture about stability of equilibrium point, Linear stability analysis, Bifurcation in 1D and 2 D autonomous system is also very remarkable. He also includes useful topic and there is some example from graph of stability and bifurcation in 1 &2 dimensional. His talking skill have sufficient clarity and presentation is very nice.



**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 08/12/2020

**Day:** 01

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**Session:** III

**Time:** 14:15 -15:45

**Lecture:** 06

**Title:** Theory of Partial Differential Equations

**Speaker:** **Prof. V.D. Sharma**

Department of Mathematics

Indian Institute of Technology, Gandhinagar

E-mail: vsharma@iitgn.ac.in

**Chairperson:** Dr. Dipti Thakur

**Reporter:** Mr. Yashwant Jaiswal

Prof. V.D. Sharma started his lecture with near partial differential equation at first order with some special cases. Then he discuss at its hyperbolic equation and explain hyperbolic waves with diagrammatically. After that he also discuss about cauty problem with its Implicit form. Also he explained Berger's equation, breakdown of continuous function, quasi linear equation, weak solution conservation law and ramekin Condition.

The session was interactive and the participant enjoyed the lecture of Prof. Sharma very much.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 08/12/2020

**Day:** 01

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**Session:** IV

**Time:** 16:00 -17:90

**Lecture:** 07

**Title:** Introduction to Galois Theory - 02

**Speaker:** **Prof. S.R. Ghorpade**

Department of Mathematics

Indian Institute of Technology, Bombay

Powai Mumbai 400076, India

E-mail: srg@matho.iitb.ac.in

**Chairperson:** Dr. Dipti Thakur

**Reporter:** Mr. Yashwant Jaiswal

Prof. S.R. Ghorpade started his lecture with a lemma and its proof. He again discuss about a lemma – “Algebraic over algebraic is algebraic” and given its proof also. After this he solve a exercise to find explicit polynomial in  $k[x]$  satisfied by  $\alpha + \beta$  and by  $\alpha.\beta$ . where  $\alpha \beta$  are algebraic over  $k$ . Then he explain splitting fields and Normal extension and related lemmas’s with its proof. At last he discuss about symmetric polynomial.

The session was interactive and the participant enjoyed the lecture of Prof. Ghorpade very much.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Date 09/12/2020

Day 3

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Session: I

Time: 10:30 -12:00

Lecture: 08

Title: Bounded Linear Operators and Functionals

Speaker: **Prof. Khali Ahamad**

**Professor (Retd.)**

Department of Mathematics

Jamiya Millia Islamia, New Delhi

E-mail: [kahamd49@gmail.com](mailto:kahamd49@gmail.com)

Chairperson: Dr. Subhajit Saha

Reporter Prof. Chandraday Das  
Manikpuri

Prof. Ahamad started his lecture with some introductory concept on Linear operator defined on normed linear spaces & Banach spaces and its continuity as well as boundedness. Then he given the definitions of Bounded Linear Operator, Norm of bounded Linear operator, Null space of linear operator, Spaces of bounded linear operators. Some important theorems discuss which asserts that for linear operator, continuity and boundedness are equivalent. Some theorems on equivalent norms, isometric isomorphism and Topological isomorphism were discussed. Finally he ended his lecture with brief historical introduction of Wavelets and its application.

The session was interactive and the participants enjoyed the lecture of prof. Ahamad very much. Prof. Ahmad will continue the lecture on day 4.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Date 09/12/2020

Day 3

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 09/12/2020

**Day:** 03

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Session: II

Time: 12:15 -13:45

Lecture: 09

Title: Simple Mathematical Models For Ecology

Speaker: **Prof. Malay Banerjee**

Department of Mathematics & Statistics

Indian Institute of Technology, Kanpur

E-mail: [malayb@iitk.ac.in](mailto:malayb@iitk.ac.in)

Chairperson Dr. Subhajit Saha

Reporter Prof. Chandraday Das  
Manikpuri

Prof. Banerjee started his lecture with newly topic simple mathematical models for ecology. Complete lecture could be divided into two parts. Firstly, he discussed about single species population growth models. In this model he discussed on Exponential growth model, Logistic growth model, Dimensionless model. Secondly, he discussed on two species population Growth Models. In this model he discussed on Competition model, Cooperation model and Pre-predator model. Prof. Banerjee then discussed Lotka-volterra competition model. After this, he discussed on equilibrium points and the Rosenzweig-MacArthur models. He demonstrated different types of model in 2D diagrammatically.

The session was interactive and the participants enjoyed very much. Prof. Banerjee will continue the lecture on day 4.

**Report of the Session-III & IV**  
**Refresher Course in Mathematics (7-19 December, 2020)**  
**UGC HRDC, Pt. Ravishankar Shukla University, Raipur**

**Report by: Mr. Kamleshkumar Ratilal Baleviya**  
**Chair Person: Dr.Sugato Gupta**  
**Date: 09-12-2020 (Wednesday)**

The third session of the 3rd day (09-12-2020) was started on 02:15 PM. Our speaker was Prof. V. D. Sharma, Department of Mathematics, Indian Institute of Technology, Gandhinagar. His lecture was on Partial Differential Equations. Third session was delivered by him. In his lecture, he enlightened the audience about the following topics

1. Solution of  $u_t + c(u) + u_x = 0$ .
2. Solution of Riemann Problem.
3. Weak Solution.
4. How to ensure uniqueness of the solution.
5. Peter D. Lax Theorem.

Last session was conducted by Prof.S.R.Ghorpade, Department of Mathematics, Indian Institute of Technology, Bombay. He delivered the last sessions on Introduction to Galois Theory. In the last lecture, he showed the existence of splitting field. In this lecture, he proved the uniqueness of splitting field. The lecture begin with the doubt of Dr.Sugato Gupta which Prof.S.R.Ghorpade clarified. He gave definition of normal extension. He showed that normal extension, splitting field and  $k$ -homomorphism are equivalent.

Both the sessions were wonderful and all the participants were interacted with each other and with the expert. Finally, the chair of the last to session Dr.Sugato Gupta thanked the resource person on behalf of all the participants.

I am thankful to UGC HRDC, Pt.Ravishankar Shukla University, Raipur for giving the opportunity to act as an reporter for the day.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 10/12/2020

**Day:** 04

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Session: I

Time: 10:30 -12:00

Lecture: 01

Title: **Hilbert Spaces**

Speaker: **Prof. Khalil Ahmad**

Professor (Retd.)

Department of Mathematics

Jamia Millia Islamia, New Delhi

E-mail: [kahmad49@gmail.com](mailto:kahmad49@gmail.com)

Chairperson: **Absent**

Reporter: Dr. Rupak Bhattacharyya

Prof. Ahmad started his lecture from where he left on day 3. In the engrossing lecture he discussed on Hilbert space. A Hilbert space is a vector space equipped with an inner product, an operation that allows defining lengths and angles. Furthermore, Hilbert spaces are complete, which means that there are enough limits in the space to allow the techniques of calculus to be used. The success of Hilbert space methods ushered in a very fruitful era for functional analysis.

The session was interactive and the participants enjoyed the lecture of Prof. Ahmad very much. Prof. Ahmad will continue the lecture on day 5.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Session: II  
Time: 12:15 -13:45  
Lecture: 02  
Title: Application of Bifurcation Theory in Mathematical Ecology  
Speaker: **Prof. Malay Banerjee**  
Department of Mathematics & Statistics  
Indian Institute of Technology, Kanpur  
E-mail: [malayb@iitk.ac.in](mailto:malayb@iitk.ac.in)  
Chairperson: **Absent**  
Reporter: Dr. Rupak Bhattacharyya

Prof. M. Banerjee started his lecture on basic idea of bifurcation theory. His lecture could be divided into four parts, namely Bifurcation in RM model, Bifurcation in a model with Allee effect, Simple model with complex dynamics, and an example of three species models including 2-prey 1-predator model.

The session was interactive and the participants enjoyed the lecture of Prof. Banerjee very much.

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**UGC-HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

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Date: 10/12/2020

Day: 04

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Session: III

Time: 14:15 - 15:45

Lecture: 03

Title: Partial differential Equation - 04

Speaker: Prof. V.D. Sharma

Reporter: Dr. Srimayee Samui

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It was the last lecture of Prof. Sharma. In this lecture, various types of *Initial boundary value problems* were discussed beautifully by diagrams. He introduced some useful tools for solving problems, for example, finding the characteristic equations and solutions of Initial Value Problems. Also, along the way, the idea of the Conservation law was explained with one example. The importance of initial value conditions was explained by showing the dependence of the characteristic equation associated to a partial differential equation and hence the solution on the initial value of same equation. Finally, we have got to know about some elegant books from him which are really helpful to understand the content covered by Prof. Sharma in these lectures.

This Session was very interactive and fruitful. We acquired a preliminary knowledge of partial differential equation from him.

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Session: IV

Time: 16:00 - 17:30

Lecture: 04

Title: Introduction to Galois Theory - 04

Speaker: Prof. S. R. Ghorpade

Reporter: Dr. Srimayee Samui

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In this lecture, after giving a quick overview of previous lectures, Prof. Ghorpade introduced the concept of *Galois Theory*. He started with some elementary definitions and lemmas which were inevitable to explain the *Galois Theory*. Also, some exercises based on previous lectures were discussed which would be helpful for understanding the theory. In short, these elegant lectures of Prof. Ghorpade on the *Galois Theory* really helped us to make a better understanding on the theory of *Galois*. Finally, a number of problems in this theory were given.

This lecture was very informative and useful to us.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Session: I  
Time: 10:30 -12:00  
Lecture: 16  
Title: Applications of Wavelets  
Speaker: **Prof. Khalil Ahmad**  
Professor (Retd.)  
Department of Mathematics  
Jamia Millia Islamia, New Delhi  
E-mail: [kahmad49@gmail.com](mailto:kahmad49@gmail.com)  
Chairperson: Dr. Ambrish Kumar  
Tiwari  
Reporter: Mr. Mohan D. Dhuratkar

Prof. Khalil Ahmad started his lecture with some introductory concept on Topology. The engrossing lecture could be divided into two parts. Firstly, he discussed the Topological spaces. Next, he had focused on broad application of wavelets. Related to the first part, Prof. Ahmad discussed the definition and properties of topological spaces with appropriate examples, further he discussed the definition, properties on Discrete topology, Usual topology, Closed sets in topological spaces, Neighbourhood in topological spaces with appropriate examples, further he also illustrate the concepts of Limit points, Closure of a set, Interior points and Boundry points of a Set with appropriate examples. Related to second, Prof Ahmad with keen interest emphasis the application of parabola in dish antenna, numerous application of wavelets such as in fix point theory in big data, turbulence, removing of noise to build picture quality, noise control in ECG, Geo-Physics, Stock Market, Quality Control, MRI, Nuclear Magnetic Field, Quantum Mechanics, etc. The session was interactive and the participants enjoyed the lecture of Prof. Ahmad very much.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Session: II  
Time: 12:15 -13:45  
Lecture: 17  
Title: Mathematical Modeling with Excel-01  
Speaker: **Prof. Sandip Banerjee**  
Department of Mathematics  
Indian Institute of Technology, Roorkee  
E-mail: [sandip.banerjee@ma.iitr.ac.in](mailto:sandip.banerjee@ma.iitr.ac.in)  
Chairperson: Dr. Ambrish Kumar Tiwari  
Reporter: Mr. Mohan D. Dhuratkar

Prof. Sandip Banerjee started his lecture on basic idea of how Mathematical Modeling is a Process. Then he given a very insightful and brief lecture on mathematical model for Prey-Predator, where he explained the graphical representation using software mathematica, he further explained the mathematical Lazy Student Model, Rumor Spread Model, SI Model, SIR Model, Hepatitis C virus mathematical model, further he also talk on the treatment aspect and mechanism of Hipatitis C virus work. Lastly he concluded his talk on Cancer Model where he emphasis the Tumor, Hunting and Resting Model.

The session was interactive and the participants enjoyed the lecture of Prof. Sandip Banerjee very much.

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**UGC – HRDC, PRSU,  
RAIPUR REFRESHER COURSE: MATHEMATICS  
07/12/2020 to 19/12/2020**

**Date:** 11/12/2020

**Day :** 05

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**Session:** III

**Time:** 13:45 -16:00

**Lecture:** 18

**Title:** Mathematical Modeling with Excel-02

**Speaker:** Prof. Sandip Banerjee

Department of Mathematics Indian Institute of Technology,

Roorkee

E-mail: sandip.banerjee@ma.iitr.ac.in

**Chairperson:** Dr. Mahantesh M. Nandeppanavar

**Reporter:** Dr Samiran Banerjee

In his first lecturer (in morning session), Prof. Banerjee presented different mathematical model related to mathematical, medical, social etc fields. In afternoon session he has started his lecture with practical demonstration using the Microsoft Excel for computing and plotting several mathematical problems. At the very beginning he demonstrated to solve the system of equations through matrix method. Finally, he discussed and showed how to plot a linear ordinary differential equations, by Euler method. He completed his lecture at around 3:10pm but again returned at 3:25pm with some more demonstration.

The session was interactive and the participants enjoyed the lecture of Prof. Banerjee.

**UGC – HRDC, PRSU,  
RAIPUR REFRESHER COURSE: MATHEMATICS  
07/12/2020 to 19/12/2020**

**Date:** 11/12/2020

**Day :** 05

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**Session:** IV

**Time:** 16:05 -18:15

**Topic:** Seminar 1

**Examiner:** Dr. Sahadeo Padhye

Department of Mathematics Mohtilal Nehru National Institute of  
Technology Allahabad, Prayagraj

E-mail: [sahadeo@mnnit.ac.in](mailto:sahadeo@mnnit.ac.in)

**Chairperson:** Dr. Mahantesh M. Nandeppanavar

**Reporter:** Dr Samiran Banerjee

In this session total 17 participants delivered their talk on different topics with PPT presentations.

UGC-HRDC, PRSU, RAIPUR  
REFRESHER COURSE, MATHEMATICS

07/12/2020 TO 19/12/2020

Date: 12/12/2020

Day: 06

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Session: I

Time : 10:30-12:00

Lecture : 19

Title: Projective module and injective module :- a dual pair

Speaker: Prof. A S Ranadive

Dept of Applied Mathematics

Guru Ghasidas Vishwavidyalaya , Bilaspur CG

E-mail: [asranadive04@yahoo.co.in](mailto:asranadive04@yahoo.co.in)

Chairperson: Dr Srikumar Panda

Reporter: Dr chhatrapal Singh Sikarwar

Prof . A S Ranadive started his lecture by defining the meaning of dual pair of modules. He defined the direct product of module and duality in the statement of universal and co-universal problem. After that he discussed free module, exact sequence, long exact sequence, short exact sequence using some propositions like every module is a homomorphic image of free module etc..he explained some concepts on exact sequence and discussed equivalent conditions to define a split exact sequence. At the end of the lecture he also explained splitting homomorphism and projective module. The session was very interactive and participants enjoyed the lecture of Prof. Ranadive very much.

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**UGC-HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE, MATHEMATICS**

07/12/2020 TO 19/12/2020

Session: II  
Time : 12:15-13:45  
Lecture : 20  
Title: Existence & uniqueness of solutions of initial value problems  
Speaker: Prof. G. V. R. Babu  
Dept of Mathematics  
Andhra University, Vishakapatnam  
E-mail: gvr\_babu@hotmail.com  
Chairperson: Dr Srikumar Panda  
Reporter: Dr chhatrapal Singh Sikarwar

Prof. G V R Babu started his lecture by defining some basic of differential equations . He discussed uniform convergence of sequence of functions and explained the Weierstrass test for uniform convergence of series of functions. Also, he considered the uniform convergence of sequence of continuous functions and show that its limit function is a continuous function. After that, he defined Lipschitz condition and explained general criterion which would ensure the Lipschitz condition. He also proved the existence and uniqueness of solutions of initial value problems by the Picard's method of successive approximations. At the end of the lecture he also explained the fixed point method. The session was very interactive and participants enjoyed the lecture of Prof. Babu very much.

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**UGC – HRDC, PRSU,  
RAIPUR REFRESHER COURSE: MATHEMATICS  
07/12/2020 to 19/12/2020**

**Date:** 12/12/2020  
**Day :** 06

**Session:** III  
**Time:** 14:15 -16:00  
**Lecture:** 21  
**Title:** Existence of Fixed Points and Generalization of Fixed Point Theorems.

**Speaker:** Prof. G.Venkata Ravindranath Babu  
Department of Mathematics  
Andhra University, Visakhapatnam

**E-mail:** gvr- abu@hotmail.com  
**Chairperson:** Dr. Jay Gopalbhai Mehta  
**Reporter:** Mr. Dinesh Kumar

In his first lecturer (in morning session), Prof. G. Venkata Ravindranath Babu presented Existence and Uniqueness of Solutions of Initial Value Problem. In afternoon session he has started his lecture with **Existence of Fixed Points and Generalization of Fixed Point Theorems**. At the very beginning he demonstrated to solve the system of this talk consists of five sections (1) Introduction. (2) Banach Contraction Principle. (3) Consequences of Banach Contraction Principle. (4) Fixed Point Theorem relating to the orbital continuity. (5) Generalization of fixed point theorems relating to the diameter of orbits by using a control function. He completed his lecture at around 3:45pm but again returned at 3:50 pm with some more demonstration.

The session was interactive and the participants enjoyed the lecture of Prof. G.V.R.BABU.

**UGC – HRDC, PRSU,  
RAIPUR REFRESHER COURSE: MATHEMATICS  
07/12/2020 to 19/12/2020**

**Date:** 12/12/2020  
**Day :** 06

**Session:** IV  
**Time:** 16:00 - 18:15  
**Topic:** Seminar  
**Examiner:** Dr. Sahadeo Padhye  
Department of Mathematics Mohtilal Nehru National  
Institute of Technology Allahabad, Prayagraj  
E-mail: [sahadeo@mnnit.ac.in](mailto:sahadeo@mnnit.ac.in)  
**Chairperson:** Dr. Jay Gopalbhai Mehta  
**Reporter:** Mr. Dinesh Kumar

In this session total 17 participants delivered their talk on different topics with PPT presentations.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**  
**Report**

**Date :** 14/12/2020  
**Day :** 07

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Session : I

Time : 10:30 am – 12 noon

Lecture : 22

Title : Introduction to Measure and Integration

Speaker : Prof. M. Thamban Nair  
Department of Mathematics  
Indian Institute of Technology Madras, Chennai

Chairperson : Dr. Srikumar Panda

Reporter : Dr. Arnab Jyoti Das Gupta

**Report**

The session started with the coordinator of the course, Prof. B.S. Thakur, welcoming the speaker Prof. M. Thamban Nair. This was followed by a brief introduction of the speaker by the chairperson of the session, Dr. Srikumar Panda.

Prof. Nair, started his lecture with some basic facts about the inadequacy of the Reimann Integration in several situations in Real analysis and highlighted the requirement of alternative theories of Integration. He supported this point by showing explicit examples of bounded functions not being Reimann Integrable, sequence of Reimann integrable functions converging point wise to non-Reimann integrable functions and Integrals of a sequence of Reimann integrable functions not converging to the integral of their point wise limit. He emphasised that the last example existed as the sequence of functions were not uniformly bounded. With this motivation he stated the Arzela's theorem for the convergence of integrals of an uniformly bounded sequence of Riemann Integrable functions.

The speaker then went on to introduce the characteristic function on an open interval and built the necessary foundation required for the alternative treatment of the integration theory. He highlighted the requirement of measure of sets in the real line. At this point he gave the names of several reference books including the book

*Measure Theory and Integration: A First Course* by M. T. Nair, CRC press.

He then went on to set the foundations of the Lebesgue measure, starting with simple examples of measures of a singleton set, finite set, rationals, etc. He highlighted how measure of open sets is invariant of how many sub intervals it is decomposed into, thus highlighting the reason of usage of open intervals in the definition of measure.

Prof, Nair then listed out some results involving the measures of subsets, disjoint union of sets and countable union of sets. He then introduced the outer measure of a set in real line and discussed its properties and gave the relationship between the measure and outer measure of various sets in real line.

He concluded his first of two lectures by discussing a problem – whether the outer measure of the union of two disjoint sets in the real line is equal to the sum of their individual outer measures? He gave the answer to be “NO” and said that many such examples exist.

Overall, the lecture was very conducive and interesting and many participants discussed enthusiastically ideas with the speaker during the lecture session.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**  
**Report**

**Date :** 14/12/2020  
**Day :** 07

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Session : II

Time : 12:15 pm – 1:45 pm

Lecture : 23

Title : Solvability Analysis of Nonlinear Differential Equations and Their Application in Control Theory

Speaker : Prof. Mohan C. Joshi  
Department of Mathematics  
Indian Institute of Technology, Gandhinagar

Chairperson : Dr. Srikumar Panda

Reporter : Dr. Arnab Jyoti Das Gupta

**Report**

The session started with the coordinator of the course, Prof. B.S. Thakur, welcoming the speaker Prof. Mohan C. Joshi. This was followed by a brief introduction of the speaker by the chairperson of the session, Dr. Srikumar Panda.

Prof. Mohan C. Joshi started his lecture by sharing his plans of covering 3 broad topics for the two talks, scheduled today. He then started with his first topic – Existence and Uniqueness of solutions. His other two broad topics being two qualitative properties, viz. Phase portrait and Controllability. He plans to spend 1hour on each of these 3 topics.

He began his first topic– Existence and Uniqueness of solutions of Initial Value problems of ordinary differential equations by emphasising on the existence of the largest interval of existence, uniqueness of solutions depending on nature of functions involved as well as on the initial conditions. He demonstrated these points using explicit worked out examples. From these examples he concluded that it is essential to discuss the solvability issues concerning initial value problems of ordinary differential equations.

Prof. Joshi, then gave the definition of solution of an initial value problems (IVP) of ordinary differential equations (ODE) and proved the existence and uniqueness theorem for such problems satisfying the Lipschitz condition. He, then went on to introduce the Banach contraction mapping principle for complete metric spaces and said when we look into the solution of IVP of ODEs, we generally look into the function space of continuously differentiable functions on the given interval with respect to the supremum norm, thus making the space a complete metric space.

To obtain the fixed point for the IVP case, Prof. Joshi transformed the given IVP into an equivalent integral equation and introduced the Picard's iterative process for the construction of the solution of the given IVP.

The speaker then moved onto his second broad topic of Qualitative property- Phase portrait. He introduced the term phase portrait, what it means to obtain a phase portrait about an equilibrium point. He stopped here and said will continue from here in his next lecture, scheduled today in the post lunch session.

To summarise, the lecture was very interesting. The speaker started with very basic theory, keeping in mind the diverse background of all participants, and he plans to move deeper into the qualitative properties of the solutions of the ordinary differential equations in the upcoming session.

# REPORT OF THE DAY

## REFRESHER COURSE IN MATHEMATICS

### (07-19 DECEMBER, 2020)

#### UGC-HRDC, PRSU, RAIPUR

Monday, December 14, 2020 (Post-Lunch Sessions)

**BY: DR. JAY GOPALBHAI MEHTA (ROLL NO. 15)**

I feel pleasure in writing the report of the first day in the second week of the Refresher Course in Mathematics. We had lunch break at 01:45 p.m. and we gather again in the Google Meet session at 02:15 p.m. for the post-lunch sessions. The Google Meet ID for today is **tyj-mora-inw**. Prof. Bhuneshwari Verma, who is chairing the session for the second half of today, dropped a message in the whatsapp group requesting all the participants to join the google meet soon.

### Session 3: 02:15 p.m. to 03:45 p.m.

**i Resource Person: Prof. Mohan Joshi**  
Department of Mathematics  
Indian Institute of Technology (IIT), Gandhinagar

**Title of the Session: Solvability and Qualitative Analysis of Ordinary Differential Equations – 02**

This is Lecture No. 24 of the two-week program. Dr. Bhuneshwari Verma is the chair for the post-lunch sessions today. She welcomed Prof. Mohan Joshi who had already joined the session and invited him to conduct the session. Prof. Joshi was the speaker for the pre-lunch session too. He resumed his topic from his earlier talk by sharing his slides along with the white board work.

Prof. Joshi explained Phase Portrait, which is a qualitative property, by drawing it on a white board. He then defined equilibrium state of a system, which is the state where  $\frac{dy}{dt} = 0$ , and explained the saddle point by an example. He explained all the cases where the equilibrium points are stable and unstable by some examples and by plotting the graph on his slides.

The speaker then explained the third and the most important qualitative property of a system which is Controllability. He considered the following linear system for the controllability problem.

$$\frac{d\bar{x}}{dt} = A(t)\bar{x}(t) + B(t)\bar{u}(t)$$

$$\bar{x}(t) = \bar{x}_0$$

He stated that our infinite-dimensional problem reduces to finite-dimensional if the controllability Grammian matrix  $W(t_0, t_f)$  is invertible. He stated some important theorems and gave a sketch of their proofs and he explained the theory nicely by giving a few examples. Prof. Joshi gave an application of it in the satellite problem relating it to the Apollo Mission.

He ended his session at 03:45 p.m. and then some of the participants asked their queries and requested him to share the slides of his talk. The chair of the session, Dr. Verma expressed her gratitude to Prof. Joshi on behalf of all the participants of the refresher course. Finally, Dr. Balwant Thakur thanked Prof. Mohan Joshi for sparing his time and giving two nice sessions in our refresher course.

It is 03:45 p.m. now and we have a tea break for 15 minutes before the next session. We are back into the google meet before 04:00 p.m. for the last lecture of the day. The chair of the session Dr. Verma and the resource person Prof. Thumban Nair, who gave his first talk in the course earlier this morning, have already joined the meet. Dr. Bhuneshwari sent a message to all the participants in the whatsapp group to join the session soon.

#### **Session 4: 04:00 p.m. to 05:30 p.m.**

**i Resource Person: Prof. M. Thumban Nair**  
**Department of Mathematics**  
**Indian Institute of Technology (IIT Madras), Chennai**

#### **Title of the Session: Introduction to Measure and Integration - 02**

This is Lecture No. 25 of the two-week refresher course. The chair-person Dr. Bhuneshwari Verma invited Prof. Nair to conduct the final session of the day. Prof. M. T. Nair already started his course of four lectures in the refresher course this morning on Measure Theory. He resumes his course by presenting his slides. Earlier this morning, at the end of his session, he had posed a question that whether for two disjoint sets  $A$  and  $B$ , the outer measure of their union is equal to the sum of their outer measures, i.e.,

$$\mu^*(A \cup B) = \mu^*(A) + \mu^*(B).$$

The answer to this question is negative which he explained by proving a theorem. This explains why the outer measure  $\mu^*$  is not an appropriate candidate for defining a measure. Prof. Nair defined *Lebesgue measurable* set and defined *Lebesgue measure* to be the outer measure restricted to the family of measurable sets. He



showed that the family of measurable sets contains all the closed sets, all open sets, all  $G_\delta$  and all  $F_\sigma$  sets and this property is called *completeness*. The speaker then defined a collection  $\mathcal{A}$  of subsets of a set  $\Omega$ , called a  $\sigma$ -algebra which defines a measure space  $(\mathcal{A}, \sigma)$  after which he defined a Borel  $\sigma$ -algebra denoted by  $\mathcal{B}_{\mathbb{R}}$  on  $\mathbb{R}$ . Later on, sir introduced the *counting measure*  $\mu$  and the *Dirac measure*.

We learned integration of so called measurable functions on the measure space  $(\Omega, \mathcal{A}, \mu)$ . For this first we understand it on *simple functions*. We then see the definition of *measurable function* and the Lebesgue integration of measurable functions. The resource person proved one of the most important theorem in Measure Theory, the Dominated Convergence Theorem as a consequence of which we get Arzela's theorem. Finally we see some more nice consequences of the Dominated Convergence theorem and the property called *almost everywhere* (a.e.) on a set  $\Omega$ .

During the last 5 minutes, the participants reported in the WhatsApp group that they were out of the ongoing google meet. It seems that the Google is down at present. The program coordinator Dr. Balwant Thakur informed the participants in the WhatsApp group that Prof. Nair will continue his lecture tomorrow. That's all for today. It was a great session giving a revision of almost the entire Measure Theory, indeed refreshing the participants of the topics in measure theory.

It was 5:25 p.m. when the google went down. We called it a day then. This completes the Day 7 of this two-week program.

This report is a part of the task assigned to me for the Online Refresher Course in Mathematics (07-19 December, 2020) organized by the UGC-HRDC, Pt. Ravishankar Shukla University, Raipur.

- Jay Mehta.

**UGC-HRDC, PRSU, Raipur**  
**Refresher Course in Mathematics**  
**07/12/2020-19/12/2020**

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Date: 15/12/2020

Day: 08

Session: I

Time: 10:30am-12noon

Title: Some Topic in Basic Operator Theory-01

Speaker: Prof. M. Thamban Nair

Department of Mathematics

Indian Institute of Technology Madras, Chennai

Chairperson: Dr. Mahesh Kishanrao Kulkarni

Reporter: Dr. Saugata Mitra

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Prof. Nair started his lecture with some introductory concept of bounded linear operators. He first explained continuity of linear operators elaborately. Then he described bounded linear operators with many examples. After that he linked his example with initial value problem and then he explained continuity of inverse, closed linear operator. Finally he ends his lecture in this session by discussing closed graph theorem and bounded inverse theorem.

The session was interactive and all the participants enjoyed the lecture of Prof. Nair very much. Prof. Nair will continue his lecture today at 4pm.

**UGC-HRDC, PRSU, Raipur**  
**Refresher Course in Mathematics**  
**07/12/2020-19/12/2020**

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Date: 15/12/2020

Day: 08

Session: II

Time: 12:15pm-1:45pm

**ICT/ Micro teaching 01**

Examiner: Prof. Amitabh Banerjee

Principal,

Govt. J.Yoganandam Chhattisgarh College,

Raipur, Chhattisgarh

Chairperson: Dr. Mahesh Kishanrao Kulkarni

Reporter: Dr. Saugata Mitra

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The session started after the introduction of Prof. A. Banerjee by the chairperson. Following participants are scheduled to perform micro teaching today:

Roll	Name	Title	Mode of presentation/ <b>status</b>
1	Dr. Niyati Gurudwan	Laplace equation and mean value property	Recorded and completed
2	Dr. Hemlal Sahu	Riemann integration	Recorded and completed
3	Dr. Bhneswari Verma	Eulers formula	not completed, rescheduled for tomorrow
5	Dr. Subhajit Saha	Group homomorphism	Recorded and completed
6	Dr. Saugata Mitra	Liouville's theorem	Live and completed
7	Dr. Arnab Jyoti Das Gupta	Relation between gradient and directional derivatives	Live and completed
8	Dr. Tarun maiti	Newton Raphson Method	Recorded and completed
9	Dr. Sugato Gupta	Linear transformation	Live and completed
11	Dr. Srikumar Panda	Solution of linear system of equations using matrix method	Recorded and completed
12	Dr. Srimayee Samui	Ring homomorphism	Live and completed
13	Dr. Ritu Sen	Measure theory	Live and completed

14	Dr. Mahesh Kishanrao Kulkarni	g.c.d. by using Euclidean Algorithm	Recorded and completed
15	Dr. Jay Gopalbhai Mehta	Simultaneous Solution of a System of Linear Equations and Motivation to the Definition of Vector Spaces	Live and completed
16	Mr. Kamleshkumar Ratilal Beleviya	Cauchy Goursat Theorem	not completed, rescheduled for tomorrow
17	Mr. Pratap Mondal	Introduction of partial differential equation	not completed, rescheduled for tomorrow
18	Dr. Samiran Banerjee	Sequence of functions	not completed, rescheduled for tomorrow
19	Dr. Rupak Bhattacharya	Introduction to probability	not completed, rescheduled for tomorrow

UGC –HRDC, PRSU, RAIPUR  
REFRESHER COURSE: MATHEMATICS  
07/12/2020 to 19/12/2020

Date: 15/12/2020

Day: 08

Session: III

Time: 14:15 -15:45

Lecture No.: 27

Title: Applications of linear Algebra-01

Speaker: **Prof. Rafikul Alam**

Department of Mathematics

Indian Institute of Technology, Guwahati

E-mail: [rafik@iitg.ac.in](mailto:rafik@iitg.ac.in)

Chairperson: Dr. Shilpa W. Samdurkar

Reporter: Dr. Ambrish Kumar Tiwari

Prof. Rafikul Alam started his lecture with some important applications of linear Algebra. First he discussed the pagerank problem which is very useful to find task of extracting information from all the webpages. For this connection, he nicely defined basic concepts related to n-dimensional vector space as data matrix, eigen value problem, eigen space, geometric and algebraic multiplicities by giving various examples. He linked his contains with Google search engine and ranking of webpages described by graph. After that, he explained World Wide Web as a hyperlink matrix, non-unique ranking, Adjustment of hyperlink matrix. At last, he defined Google matrix by describing teleportation matrix and power method that all necessary for findings of pagerank problem.

The session was very interactive and the participants enjoyed the lecture of Prof. Rafikul Alam very much. Prof. Rafikul Alam will continue the lecture on day 09.

## UGC –HRDC, PRSU, RAIPUR

REFRESHER COURSE: MATHEMATICS

07/12/2020 to 19/12/2020

Date: 15/12/2020  
Day: 08  
Session: IV  
Time: 16:00 -17:45  
Lecture No.: 28  
Title: Some topics in Basic Operator theory-02  
Speaker: **Prof. M. Thamban Nair**  
Department of Mathematics  
Indian Institute of Technology, Madras, Chennai  
E-mail: [mtnair@iitm.ac.in](mailto:mtnair@iitm.ac.in)  
Chairperson: Dr. Shilpa W. Samdurkar  
Reporter: Dr. Ambrish Kumar Tiwari

Prof. M. Thamban Nair started his lecture with connecting the facts which was delivered in the last lecture (Lecture No. 26). It was last lecture of Prof. Nair in the series of four lectures of him in which first two was based on introduction to measure and integration and last two on some topics in basic operator theory. This lecture was the continuation of lecture third. He nicely defined bounded linear operator and its properties. He also discussed various important theorems based on several operators. He also discussed bounded inverse theorem and closed graph theorem. He gave proof of Lax Milgram lemma based on coercive linear operator and Reisz representation theorem with example. At last, he frankly discussed almost all the participants and gave the answer the questions which are asked by participants.

The session was very interactive and the participants enjoyed the lecture of Prof Prof. M. Thamban Nair very much.

# **UGC – HRDC, PRSU, RAIPUR**

## **Refresher Course in Mathematics**

**07/12/2020 to 19/12/2020**

**Date:** 16/12/2020

**Day:** 09

**Session:** I (10.30am – 12.00pm)

**Title:** Computation Theory of Fixed Point and Applications-01

**Speaker:** Prof. D. R. Sahu

**Department of Mathematics**

**Banaras Hindu University, Varanasi**

**Chairperson:** Dr. Niyati Gurudwan

**Reporter:** Dr. Tarun Maiti

Due to some network issue Prof. D.R. Sahu has disconnected and delayed his lecture for half hour. In the meantime, our coordinator and chairperson decided to continue our microteaching lecture of our participants which is pause yesterday. First, Dr. Kamlesh Beleviya gives his microteaching on Cauchy Goursat Theorem through live teaching. Then Dr. C D Manikpuri played his recorded microteaching on Symmetric Group. Later, Dr. Pratap Mondal delivered his microteaching through PPT presentation on Introduction of Partial Differential Equations.

Now, Prof. Sahu has joined and started his talk with brief introduction on fixed point. Then, he discussed successive approximation and application through some questions and their elaboration. He gave some overview concept on semi metric space, Lipschitz continuous mapping, contraction mapping and Banach contraction principle though some examples. Later, he introduced some examples of linear and non-linear problem to find the roots of algebraic equation, solution of systems of linear equation and solutions of system of nonlinear equations. Prof. Sahu has concluded his lecture with many problems arising in different areas of science, social science and engineering such as: differential equations, Integral equations, Operator equation, Operator inclusions etc.

The lecture was very informative and participate are enriched many new aspects about fixed point theory. He will continue his lecture on tomorrow in same session with more topics which are not discussed today.

**Date:** 16/12/2020  
**Day:** 09  
**Session:** II (12.15pm – 1.45pm)  
**Title:** Linear Partial Differential Equations-01  
**Speaker:** Dr. T. Suman Kumar  
School of Mathematics and Statistics  
University of Hyderabad  
**Chairperson:** Dr. Niyati Gurudwan  
**Reporter:** Dr. Tarun Maiti

Dr. Kumar started his lecture with Laplace equation and derived it very convenient way. Next, he elaborately developed Fundamental solution for Laplace equation. He also shown the invariance of the Laplace operator under rotation which motivated to construct the radial solution, is also a fundamental solution. This solution is also shown by the radial solution of Laplace equation. Then, he illustrated Mean Value formula very elaborately. After improvement of Mean Value formula, he discussed its applications on Strong Maximal principle with extravagant way.

The participants appreciated this session for his pen-book elaborated method and truly participate and interact with Dr. Kumar. He will continue his lecture with Green function, and some its property on tomorrow in the same session.



**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Date: 16/12/2020  
Session: III  
Time: 02:15 -03:45  
Lecture: 31  
Title: Applications of Linear Algebra-02  
(Eigenfaces and SVD with application to Face Recognition and Information Retrieval)  
Speaker: **Prof. Rafikul Alam**  
Department of Mathematics  
Indian Institute of Technology, Guwahati  
E-mail: [rafik@iitg.ac.in](mailto:rafik@iitg.ac.in)  
Chairperson: Mr. Mahadeo G. Bhujade  
Reporter: Mr. Mahadeo G. Bhujade

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Prof. Rafikul Alam started his lecture with Matrix as an image. Then he discusses how picture can be viewed as a matrix, and matrices can be viewed as images to gain insight into the data. Next, he had focused on Data as a Matrix and four fundamental subspaces. He discussed some basic concepts which are Eigenvalue problem, Diagonalization with appropriate examples, further he discussed the most important topics such as Schur triangularization theorem, Spectral theorem for Hermitian matrices, Eigenvectors of triangular matrix and Block upper triangular form. Then after he come back towards application of linear algebra which includes how image represents as a vector, Face recognition, Mean subtracted faces, Eigenfaces, Computation of Eigenfaces with suitable example of 12 ex-Presidents of America, further he discussed Singular Value Decomposition (SVD), Properties of SVD, Existence of SVD with appropriate examples. At last, he discussed Low rank approximation, Eckart-Young theorem, Information retrieval, Term-document matrix, Query vector, Mathematical Problem, Latent semantic indexing with examples.

The session was interactive and the participants enjoyed the lecture of Prof. Rafikul Alam very much.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

Date: 16/12/2020  
Session: IV  
Time: 04:00 -05:30  
Lecture: 32

**ICT/ Micro teaching 02**

Examiner: Prof. Amitabh Banerjee  
Principal  
Govt. J. Yoganandam Chhattisgarh college,  
Raipur, Chhattisgarh

Chairperson: Mr. Mahadeo G. Bhujade  
Reporter: Mr. Mahadeo G. Bhujade

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The session started after the permission of Prof. Balwant Singh Thakur. Following participants are scheduled to perform micro teaching today:

Roll No.	Name of Participants	Title	Mode of Presentation
18	Dr. Samiran Banerjee	Sequence of functions	Live
19	Dr. Rupak Bhattacharya	Introduction to probability	Live
21	Dr. Chandrajeet Singh Rathore	Metric Space	Recorded Video
22	Dr. Dipti Thakur	Measurable function	Recorded Video
23	Mr. Yashawant Jaiswal	Vector Space	Recorded Video
25	Mr. Dinesh Kumar	Ring Theory	Recorded Video

26	Dr. Mahantesh M. Nandeppanavar	Regula Falsi Method	Recorded Video
27	Mr. Hemlal Rathore	Matrix	Recorded Video
29	Dr. Ambrish Kumar Tiwari	Recorded Video	Recorded Video
30	Mr. Chetan Kumar Sahu	Group Theory	Recorded Video
32	Dr. Himanshu V. Chapani	Cantor's Theorem	Live
33	Mr. Naveen Kumar	Pair of straight lines	Recorded Video
34	Dr. Rajani A. Anturkar (Shelote)	ODE in two or more variables	Live
35	Mr. Dildar Singh Tandon	Analytic function	Recorded Video
36	Dr. Shilpa W. Samdurkar (Pahade)	Total Differential Equation	Recorded Video
37	Chhatrapal Singh Sikarwar	System of Linear Equation	Recorded Video
38	Mohan D. Dhuratkar	Indeterminate form	Recorded Video
39	Mr. Mahadeo G. Bhujade	Gamma Function	Recorded Video
03	Dr. Bhmeshwari Verma	Euler's formula	Live

**UGC - HRDC, PRSU, RAIPUR**  
**Refresher Course in Mathematics**  
**07.12.2020 to 19.12.2020**

**Date - 17.12.2020**

**Day - 10**

**Session- 32**

**Time : 10.30-12.00**

**Title - Computational Theory of Fixed Points and Applications**

**Speaker - Prof. D.R.Sahu**

**Chairperson - Mr. Naveen Kumar**

**Reporter - Dr. Ritu Sen**

The speaker discussed on “Some more Linear and non-linear problems as fixed point models”. Prof. Sahu started with different problems arising in different areas of Science, Social Science and Engineering such as Differential equations, Integral equations, Operator equations, Operator inclusions, Generalized inclusions, Variational inequality etc. He covered examples of linear and non-linear problems as fixed point models, non-linear Fredholm integral equations of the second kind, linear and non-linear Volterra integral equations of the second kind, non-linear Volterra -Fredholm integral equations etc. The session was an interactive one and the participants enjoyed this session.

**Session- 33**

**Time : 12.15-13.45**

**Title - Linear Partial Differential Equations**

**Speaker - Dr. T. Suman Kumar**

**Chairperson - Mr. Naveen Kumar**

**Reporter - Dr. Ritu Sen**

The speaker explained the basic concepts related to the formula “Integral by parts”, which is frequently used and is the key formula for the different topics in linear PDE. He then explained the uniqueness of the solution of Poisson’s equation using Maximum Principle. Then he proved the famous Liouville’s theorem. At the end, he explained the

importance of Green's function and gave the derivation of representation formula using Green's function. The session was an interactive one and the participants enjoyed this session.

**Project Presentation-01**  
**Prof. Birendra Kumar Sharma**

**Date: 17/12/2020**

**Day 10 Session III: 14:15 - 15:45**

**Reporter: Dr. Subhajit Saha**

This Session was dedicated to presentation of Project Proposals which were developed by the participants during the course of this Refresher Course. Participants were divided into 9 groups of 4 each. In this session, Groups 1-5 presented their proposals. The details are as follows:

Group 1: Dr. Rajani A. Anturkar (Shelote), Dr. Arnab Jyoti Das Gupta, Dr. Srikumar Panda, Chhatrapal Singh Sikarwar. They presented their proposal on “Application of water wave theory in the protection of coastal areas” to be investigated over a period of 2 years.

Group 2: Dr. Tarun Maiti, Dr. Dipti Thakur, Mr. Yashawant Jaiswal, Dr. Arun Kumar Gali. They presented their proposal on “Supply Chain Coordination through Forward and Reverse Logistics” to be investigated over a period of 3 years.

Group 3: Dr. Hemlal Sahu, Mr. Dildar Singh Tandon, Mr. Kamleshkumar Ratilal Baleviya, Dr Samiran Banerjee. They presented their proposal on “Blockchain-Enabled E-voting system” to be investigated over a period of 2 years.

Group 4: Mr. Dinesh Kumar, Dr. Saugata Mitra, Dr. Jay Gopalbhai Mehta. They presented their proposal on “Application of Topology in Wormhole Geometry” to be investigated over a period of 1 year.

Group 5: Dr. Ritu Sen, Dr. Niyati Gurudwan, Dr. Chandrajeet Singh Rathore, Mr. Naveen Kumar. They presented their proposal on “Study of the approximation of infinite series by using different Summability methods” to be investigated over a period of 1 year.

The Session was very fruitful for all the participants. The Evaluator of the Project Proposals, Prof. Birendra Kumar Sharma interacted with the investigators and provided them with many useful comments and suggestions. The 2nd Session of Project Presentation will continue on 18/12/2020 when Groups 6-9 will present their project proposals.

**Lecture 34: Applications of Algebra in Cryptography**  
**Prof. Rajendra K. Sharma**

**Date: 17/12/2020**

**Day 10 Session IV: 16:00 - 17:30**

**Reporter: Dr. Subhajit Saha**

This lecture was based on Applications of Algebra in Cryptography. Prof. Sharma started his lecture with the discussion of the Silver-Pohlig Exponentiation Cipher (1976) and explained the application of the Fermat's Little Theorem and the Division Algorithm in the process. He then demonstrated the cipher with some rigorous examples. He stressed upon the fact that the above cipher cannot be used as a Public Key Cryptosystem. In the next part of his lecture, Prof. Sharma discussed the Rivest Shamir Adleman (RSA) Cryptosystem and again demonstrated it with rigorous examples. He then mentioned about the very interesting Little Challenge (1977) which was to decrypt the integer  $c = 9689\ 9613\ 7546\ 2206\ 1477\ 1409\ 2225\ 4355\ 8829\ 0575\ 9991\ 1245\ 7431\ 9874\ 6951\ 2093\ 0816\ 2982\ 2514\ 5708\ 3569\ 3147\ 6622\ 8839\ 8962\ 8013\ 3919\ 9055\ 1829\ 9451\ 5781\ 5154$ . He mentioned the Prize Money of 100 USD that was offered to anyone who would be successful in decrypting the message within April 1, 1985. He then briefly described the outline of the solution which was finally given in 1994 by Atkins, Graff, Lenstra, and Leyland who used Quadratic Sieve and inputs from 600 persons around the globe to finally decrypt the message. He ended his lecture with an exercise which was to decrypt the message HK XP KN RH FT YV HE AF WT DJ JU. In this connection, he discussed Fermat's Numbers.

The Session was a very enjoyable one and all the participants were enthralled by the wonderful lecture given by Prof. Rajendra K. Sharma. He will deliver his second and final lecture on 18/12/2020.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date: 18th December, 2020**

**Day: 11**

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Session: I  
Time: 10:30 - 12:00  
Lecture: 03  
Title: Computational Theory of Fixed Point and Applications  
Speaker: **Prof. D. R. Sahu**  
Department of Mathematics  
Banaras Hindu University  
E-mail: drsahudr@gmail.com  
Chairperson: Mr. Chetankumar Sahu  
Reporter: Dr. Himanshu V. Chapani

Prof. D. R. Sahu started his lecture with continuation of previous lecture-02 based on Fixed Point Theory and its Applications. Firstly, he discussed the applications of Fixed point theory to integral equations with reference to nonlinear Volterra integral equation of first kind and nonlinear Volterra integral equation of second kind. Next, he applied the concept of fixed point theory to the Fredholm integral equation of the second kind and proved basic theorems on it in a lucid manner. Uniqueness of solution was also established in the theorem on nonlinear Fredholm integral equations. Finally, he discussed the solution of nonlinear Volterra-Fredholm integral equations as an application of fixed point theory. This was the last lecture of it. His sessions were interactive and participants enjoyed.



**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date: 18th December, 2020**

**Day: 11**

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Session: II  
Time: 12:15 - 13:45  
Lecture: 01  
Title: Banach Spaces and Fundamental Theorems  
Speaker: **Prof. H. K. Pathak**  
Professor (Retired)  
PRSU, Raipur  
E-mail: [hkpathak05@gmail.com](mailto:hkpathak05@gmail.com)  
Chairperson: Mr. Chetankumar Sahu  
Reporter: Dr. Himanshu V. Chapani

Prof. H. K. Pathak began with the norm that was instrumental with the study of normed linear space and Banach space. Schur property of normed spaces is defined in a systematic way. He also discussed spaces of sequences spaces of different classes of functions. Bounded linear operators (functionals) are described with examples. The space  $B(X,Y)$  was defined. At the end of the lecture, dual space is defined with an adequate number of illustrations. Prof. H. K. Pathak will continue his talk on the next day.

## Refresher Course in Mathematics

Report of the date 18 December 2020

Reporter- Dr Hemlal Sahu

### Third session

Third session started at 2:15 pm. It was the second session of project presentation. The Chairperson of that session was Dr Pratap Mondal and resource person was Dr B K Sharma, former head department of mathematics pandit Ravishankar Shukla University Raipur. In previous project presentation session five groups have presented their projects, so session started with the presentation of group 6. Project title of the group 6 was on "Some aspects of morita equivalence of semigroups and semirings and its connection with gamma structures". Presenter explained introduction, expected outcomes, methodology and year wise plan of their project and evaluator asked questions related to their presentation. Followed by group 7 presented their project on the title "Computational treatment of transient free convection in a porous saturated nanofluid". Post After that presentation group 8 presented their project on the title "Some investigation of the cosmological models with inhomogeneous equation of state" . It is followed by the project presentation of the group 9 on the title "Study of possible solutions of nonlinear equations arising in flow and heat transfer of Newtonian and non-Newtonian fluids". It was the last project presentation. Chairperson thanked the resource person Dr BK Sharma for evaluating the projects and invited him to say some words on presentation. Prof Sharma suggested that use bar diagram in project to make project understandable and clearly explained what Mathematics involved in project.

### Forth session

Last academic session of that day started at 4:22pm with the lecture of Prof. R K Sharma on the topic Application of algebra in cryptography. It was second lecture of Prof Sharma on cryptography in the refresher course. He started lecture by explaining alphabets repeated in ciphertext. He showed that how can we guess plaintext by the knowledge of ciphertext. He also explained Kroneker operation and kernel which applied on numbers to find plaintext. After completion of lecture chairperson asked participant for any query and thanked Prof Sharma for nice and interesting lecture.

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 19/12/2020

**Day:** 12

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Session: I

Time: 10:30 -12:00

Lecture: 38

Title: PROJECTIVE & INJECTIVE MODULE: A DUAL PAIR -02

Speaker: **Prof. A. S. RANDIVE**

GURU GHASIDAS  
VISHWAVIDYALAYA (A CENTRAL  
UNIVERSITY), BILASPUR (C.G.)

E-mail: asrandive04@hotmail.com

Chairperson: Dr. C. S. RATHORE

Reporter: Mr. DILDAR TANDON

Prof. A. S. RANDIVE started his lecture with recall of some definition, theorem & lemma from his previous lecture. After this he discussed about injective modules. Then he constructed some Theorems and give its proof. He also explained some lemma & give its proof. At last, he discussed about Zorn's lemma.

The session was interactive and the participant enjoyed the lecture of Prof. Randive very much. They feel a great honor & pleasure in his presence.

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**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

**Date:** 19/12/2020

**Day:** 12

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Session: 02

Time: 12:15-13:45

Lecture: 39

Title: Linear Transformation & Associated Algebra

Speaker: **Prof. H. K. PATHAK**

FORMER HEAD

School of studies

Pt. Ravishankar Shukla University, Raipur(c.g.)

E-mail-hkpathak05@gmail.com

Chairperson: Dr. C.S. RATHORE

Reporter: Mr. DILDAR TANDON

Prof. H. K. PATHAK started his lecture with some Historical Remark on Quadratic form, algebra etc. Then he started Fundamental part. In this part he gave definitions, examples & related theorems of Integral domain, Field, Ring, Ideal, Polynomial Ring, Modules, linear independent & dependent vectors, sufficient condition to check L.I & L.D of vector, Basis of vector space. After this he explain the main part of lecture i.e. Linear transformation, its Kernel, Isomorphism, Rank & Nullity, Sylvester theorem of nullity. After this he also explain composite of two linear transformation, Annihilator, Application of dual space, Algebra over a Field, Matrix representation of linear transformation, Eigenvalues & Eigenvectors, molecular orbitals. Then he discussed principal components analysis, Eigen faces, Biology optimization theory, stability analysis, Minimal polynomials, invariant subspace, Jordan l form, Jordan blocks, Jordan form theorem. at last, he explained an

**UGC – HRDC, PRSU, RAIPUR**  
**REFRESHER COURSE: MATHEMATICS**  
**07/12/2020 to 19/12/2020**

application to Jordan canonical form

The session was interactive and the participants enjoyed the lecture of Prof. H. K . PATHAK very much. all participants learnt a lot from prof. H.K. PATHAK

THANK YOU

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