Annual Report : April 2014 – March 2015

National Program on Differential Equations-Theory, Computation & Applications (NPDE-TCA) was sanctioned by the Department of Science & Technology (DST) in February 2012 for a period of five years with a sanctioned outlay of 4.5 crores. The planning and implementation of the training programs are executed by a local executive committee which is approved from time to time by the National Scientific Organizing Committee.

With a mission "*To Create Human Resource and Generate Knowledge Source for Academia and Industry in the area of Differential Equations*", the main goal of this program is to create a work force at the national level in broad areas of Applied Mathematics, specifically, in Differential Equations, Scientific Computing and Modelling. One of the key components of the proposed activity is to form a national forum on Differential Equations: Theory, Computation & Applications for academia and industry.

Under this national programme, the following activities were organised during 2014-2015.

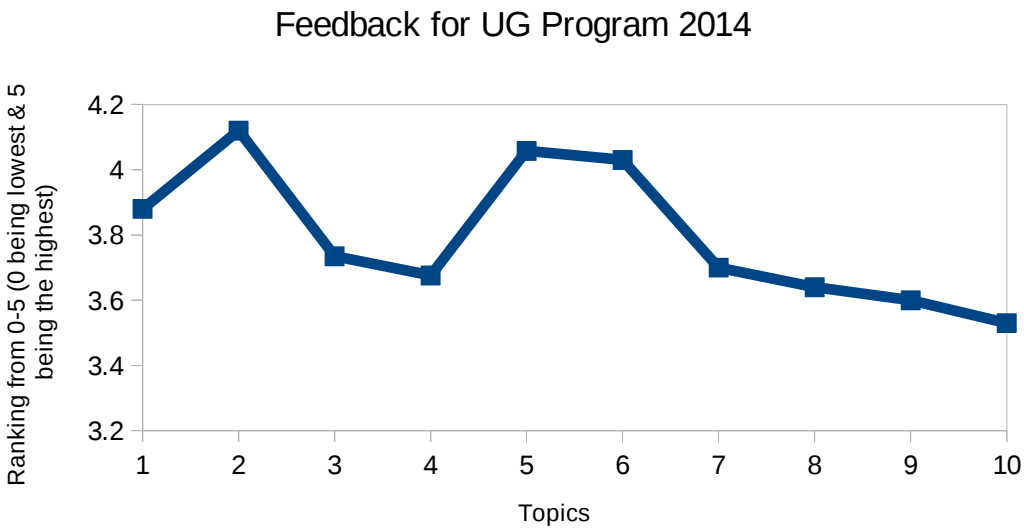
A. Activities Undertaken During April 2014 – March 2015

ACTIVITY 1 : TRAINING PROGRAMS

Undergraduate Training Program: With a theme *on "Catch them Young"*, this program was held at Maulana Azad National Institute Of Technology, Bhopal, during 26th May to 14th June, 2014 and was coordinated by Professors Peeyush Chandra, B.V. Rathish Kumar (IIT Kanpur) and Kamal Raj Pardasani (MANIT Bhopal). The main objective of this program was to introduce participants to new vistas in the area of differential equations through modelling and expose them to scientific computing lab sessions with hands on computing. It also provided a flavour of Applicable Mathematics by illustrative applications of mathematical techniques to practical problems. Advertisement for this program was done in the month of March 2014. Brochures had been sent to different universities all over India and was also displayed in NPDE-TCA website. One hundred fifty (150) candidates from all over India applied for this program out of which fifty five (55) were selected based on their academic records and recommendations.

Resource Persons: Professors P.S. Datti (TIFR-CAM, Bangalore); K. Sreenadh (IIT Delhi); Peeyush Chandra, B.V. Rathish Kumar (IIT Kanpur); Sunita Gakkhar (IITR); Prashant Srivastava (IIT Patna); Amiya K. Pani (IITBombay); A. K. Lal (); Joydip Dhar (IIITM); S. Raju (); P. Dhanumjaya (BITS-Pilani, Goa);V. Raghavendra (LNMIIT, Jaipur).

Computational labs with hands on computation using public domain software package "SCILAB" were taken in collaboration with Spoken Tutorials, IIT Bombay. Analysis and Ordinary Differential Equations were the topics which reached the students at a high level. Feedback and some photographs which were taken during the programme are shown below.

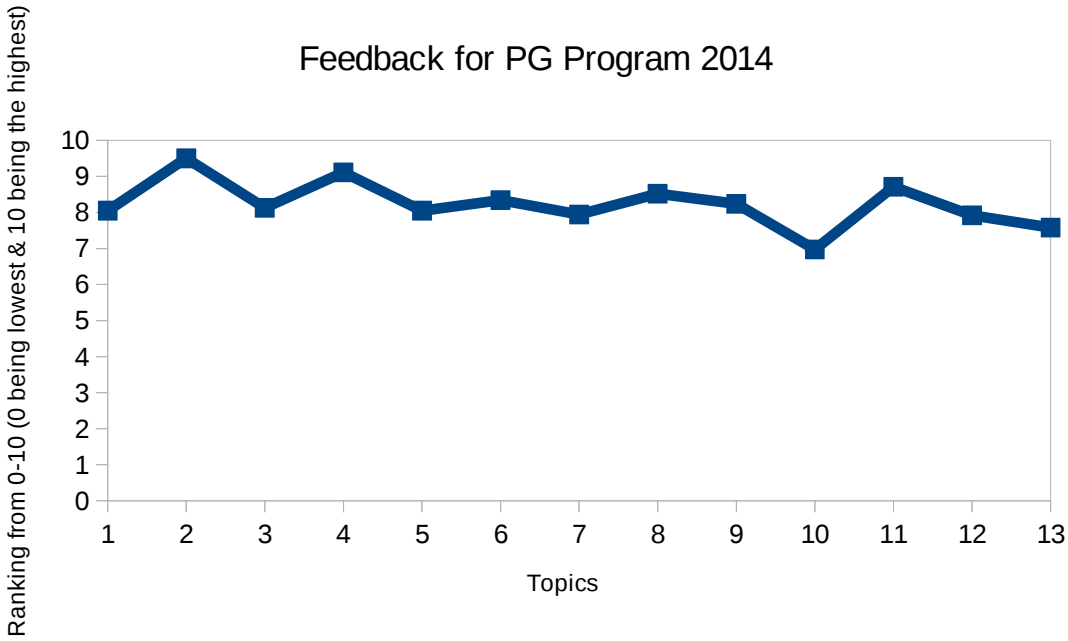


Analysis, Linear Algebra, Math Modeling , First Order ODE, Second Order ODE, System of ODE, Mathematical Models using ODE – I, Mathematical Models using ODE – II, Scilab software and Solution of ODE using SCILAB, Introductory SCILAB Sessions

1.2. Post-Graduate Training Program: This Program was held at IIT Guwahati during 2nd to 21st June, 2014 and was coordinated by Professors Rajen K. Sinha, Bhupen Deka (IIT Guwahati); S. Baskar and S. Sivaji Ganesh (IIT Bombay). The main objective of this program was to provide linkage between theory and practice through real life problems and generate manpower to support academia, scientific organizations and industry by providing appropriate training and also to expose participants to high end mathematical software like MATLAB. Training components include dynamical systems, classical PDE, multivariable analysis, PDE modelings and scientific computing with hands on computation through lab sessions.

Resource Persons: Professors Anjan K. Chakrabarty , P. A. S. Sree Krishna (IIT Guwahati); Phoolan Prasad (IISc, Bangalore); P. Shunmugaraj(IIT Kanpur); V. Sree Hari Rao (JNTU, Hyderabad); P. C. Das (IIT Kanpur (ret'd)); Bhupen Deka (IIT Guwahati); Amiya K. Pani, S. Sivaji Ganesh, S. Baskar (IIT Bombay); R . K. Mohanty (SAU, Delhi); S. Sundar (IIT Madras); B. V. Rathish Kumar (IIT Kanpur).

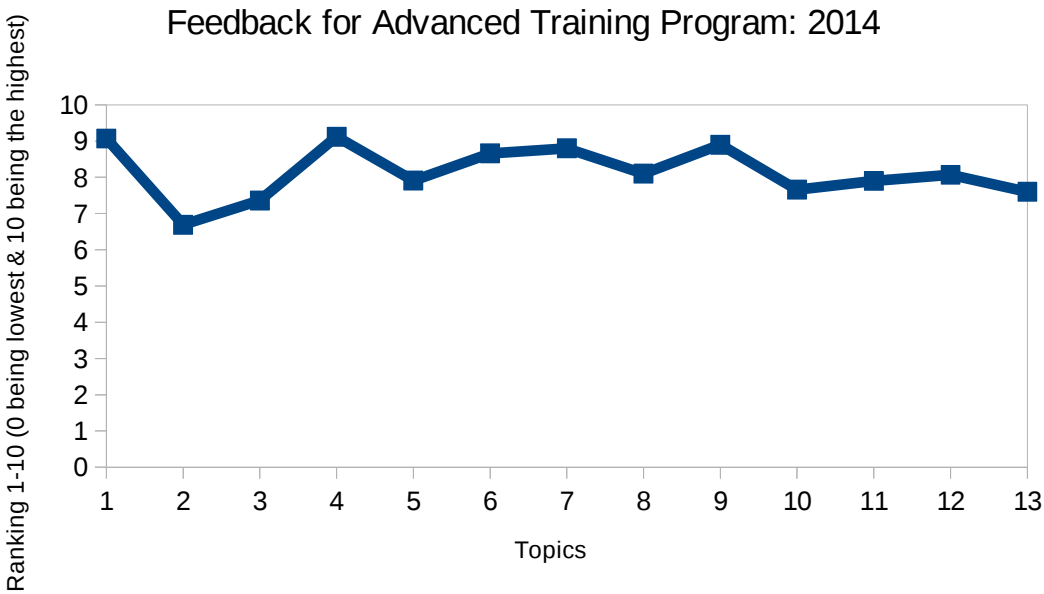
This program was also advertised in the same way as the UG Level program in the month of March 2014. More than 120 candidates appplied for this program and approximately fifty five (55) had been selected. Participants gave a good response to the overall program, the feedback graph of which is shown below.



Topic 1: Multivariate Calculus, Topic 2: Analysis, Topic 3: First Order PDEs, Topic 4: Measure Theory, Topic 5:Advanced ODEs, Topic 6: Classifications and Methods of Solutions for PDEs, Topic 7: Elliptic PDEs, Topic 8: Heat Equations, Topic 9: Wave Equations, Topic 10: FDM for Heat Equations, Topic 11: FDM for Elliptic and Wave Equations, Topic 12: Mathematical Modeling, Topic 13: Variational Methods

1.3. Advanced Level Training Program: This program was held at Indian Institute of Science Education And Research, Thiruvananthapuram during May 26th–June 13th 2014 and was co-ordinated by Professors K. R. Arun (IISER, Trivandrum); Raju K. George (IIST Trivandrum); Amiya K. Pani and Neela Nataraj (IIT, Bombay). The target audience comprised of Research Scholars and senior Post Graduate students. The main aim of this program was to provide a sound mathematical foundation for research in Applied Mathematics specially in Partial Differential Equations (PDE) and Computational PDEs to create a pool of trained manpower for academic jobs, research and development organizations and industry and expose participants to scientific lab sessions with hands on computing.

Resource Persons: Professors S. Kesavan (IMSc, Chennai); M. Vanninathan, K.T. Joseph, A. Adimurthi, G.D.V. Gowda, Mythily Ramaswamy (TIFR-CAM, Bangalore); Amiya K. Pani, Neela Nataraj (IIT, Bombay); Raju K. George, N. Sabu (IIST, Trivandrum); A.K. Nandakumaran (IISc, Bangalore). The program was well appreciated as seen from the feedback response of the participants (see the graph).



Sobolev spaces, Theory of hyperbolic conservation laws, FD/FV methods for conservation laws, Distribution Theory, Elliptic PDE, Finite dimensional control theory, Heat equation and semigroup theory, Controllability and Observability, FEM for control problems, Optimal control and dynamic programming, Viscocity solutions, Control of heat equation, FEM and approximation theory

ACTIVITY 2 : ADVANCED THEMATIC PROGRAM

2.1 Advanced Level Workshop on "Finite element methods for Navier-Stokes equations: This workshop was held at SERC, IISc Bangalore during September 8th–12th, 2014 which was co-ordinated by Dr. Sashikumar Ganesan (IISc Bangalore). The main objective of this program was to introduce mathematical models for fluid flows using compressible and incompressible Navier-Stokes equations (NSE) (laminar and turbulent), deliberate about the current trends in computations of CFD models, discuss FE formulation for the NSE with different types of boundary conditions, provide FE algorithms for large scale scientific computing, and hands-on training in the use of the in-house FE package, MooNMD. Forty One (41) candidates were selected for this program.

Resource Persons: Professors Tanmay Basak (IITM); Sashikumaar Ganesan (IISc Bangalore); John Volker, (WIAS, Germany); B.V. Rathish Kumar (IITK); C. Praveen (TIFR-CAM, Bangalore); Lutz Tobiska, Uni-Magdeburg, Germany.

2.2 Advanced Workshop on "Variational Analysis And Optimization": IIT Gandhinagar will be hosting this six days workshop during March 2nd – 7th, 2015 and was coordinated by Professors Amiya Pani (IIT Bombay); Mohan Joshi, Narendra Ladhawala, Chetan Pahlajani, Indranath Sengupta, Jagmohan Tyagi (IIT Gandhinagar). Forty two (42) participants are selected for this program.

Resource Persons: Professors Joydeep Dutta (IIT Kanpur); Neela Nataraj, Amiya Pani (IIT Bombay); Mohan Joshi, D V Pai, Jagmohan Tyagi (IIT Gandhinagar); V. Raghavendra (LNMIIT Jaipur); Mythily Ramaswamy (TIFR-CAM Bengaluru).

2.3 Advanced Workshop on "Computational Methods For Control Problems": This program will be held at Mar Ivanios College, Trivandrum (Autonomous) during March 16th – 21st, 2015, and was coordinated by Dr. Sarvesh Kumar (IIST, Trivandrum) and Prof. Mary George (Mar Ivanios

College, Trivandrum). The main objective of the workshop is to expose young researchers to different computational aspects of control problems, to focus on recent developments in the computational algorithms which are used for control problems, to provide a common platform for exchanging of ideas and results pertaining to the challenges in this area as well as some related areas to expose to hands-on-computation through computational Lab Sessions.

Resource persons: Professors Amiya Kumar Pani, Neela Nataraj (IIT Bombay); Raju. K. George, Harsha Simha M.S., Priyadarshnam, Sarvesh Kumar. (IIST Trivandrum); Mohan C. Joshi (IIT Gandhinagar); A. K. Nandakumaran (IISc Bangalore); Mythily Ramaswamy (TIFR Bangalore); K. Balachandran (Bharathiar University, Coimbatore), N. Sukavanam (IIT Roorkee); Anil Kumar, P. Dhanumjaya (BITS-Goa)

2.4 Advanced Workshop on "Finite Difference Methods For Differential Equations": Department of Mathematics, South Asian University will be hosting this advanced workshop during March 13th – 17th , 2015. The program is coordinated by Prof. Kapil Sharma, Prof. R.K.Mohanty and Prof. Navnit Jha (SAU, Delhi). The primary goal of the workshop is to expose the participants to the latest developments and various mathematical concepts in the field of finite difference methods for differential equations and applications in various research areas. The workshop will provide a platform for the interaction of the researchers working in this field.

Resource persons: Professors M.K.Kadalbajoo, B.V. Rathish Kumar (IIT Kanpur); Amiya K. Pani (IIT Bombay); YVSS Sanyasiraju (IIT Madras); SCS Rao (IIT Delhi); V.S.Hari Rao (JNTU, Hyderabad); Sirj-ul-islam (UET Pakistan); Kapil Sharma, R.K.Mohanty, Navnit Jha (SAU, Delhi).

2.5 Advanced Workshop on "Mimetic Spectral Element Methods": The one week long workshop is coordinated by Profs. Pravir Dutt and B.V.Rathish Kumar (IIT Kanpur) and is scheduled to be held at IIT Kanpur in the end of March 2015. The content of the lectures will cover (1) a brief introduction on differential geometry and algebraic topology (2) The way to go from a continuous representation to a discrete representation (3) the introduction of spectral basis functions which preserve properties from the continuous level at the discrete level (4) Illustration of techniques with examples(5) Finite Volume Method, Finite Element Method, Spectral Element Method and Least Square Formulations, (6) Applications of this approach to elliptic and eigenvalue problems, Generalized Laplace equations, Stokes operator and Maxwell equations.

Resource persons: Professors Marc Gerristma, TU/Delft; M. K. Kadalbajoo, Pravir Dutt, C.S. Upadyay, B.V. Rathish Kumar, M.K.Verma (IIT Kanpur); Aklaq Hussain (LNMIIT Jaipur), Subhashree Mohapatra, Kishore Kumar, Subir Singh Lamba, Arbaz Khan, Lokendra Bilaiyan, Pankaj Biswas, Nagaraju

2.6 Advanced Workshop on "Biomathematics": The workshop will be held at Banaras Hindu University, Varanasi in the month of March 2015. The aim of this workshop is to initiate an interdisciplinary dialogue and motivate young researchers to tackle the challenges arising in the modeling of the biological and medical systems. The workshop will also provide a platform for the researchers of various disciplines to interact with the experts and among themselves, and motivate them to do some fruitful research in the area of biomathematics. In this workshop, the main focus will be on the modeling of epidemic systems using differential equations. A special focus will be made on the transmission dynamics of the infectious diseases, like HIV, cholera, malaria, kala azar, influenza, etc. The resource persons will be chosen from core disciplines, like mathematics, medicine and engineering. This program is coordinated by Professors Peeyush Chandra (IITK) and Arvind K. Mishra (BHU, Varanasi).

2.7 Advanced Workshop on "Theoretical and Numerical Aspects of Inverse Problems" (Partially supported): An advanced instructional school on the theoretical and numerical aspects of Inverse Problems from June 16 – 28, 2014, was held at Tata Institute of Fundamental Research, Centre for Applicable Mathematics (TIFR-CAM) Bangalore. The goal was an advanced school devoted to an introduction to various types of inverse problems and methods for studying them to researchers and advanced graduate students who may or may not have worked on inverse problems. While this workshop was primarily directed towards mathematicians, it planned to invite researchers from the associated areas of applications at research institutes and universities, government research organizations and industries.

Resource persons: Professors Gaik Ambartsoumian (University of Texas at Arlington, USA); Jan Boman (Stockholm University, Sweden); Kim Knudsen (Technical University of Denmark, Denmark); Peter Kuchment (Texas A&M University, USA); Yaroslav Kurylev (University College, London, UK); Matti Lassas (University of Helsinki, Finland); Clifford Nolan (University of Limerick, Ireland); Rakesh (University of Delaware, USA); Vladimir Sharafutdinov (Novosibirsk State University, Russia); Bastian von Harrach (University of Stuttgart, Germany).

2.8 Advanced Workshop on "Hyperbolic PDEs: Theory, Numerics and Applications" (HPTNA-2014): The LNM Institute of Information Technology, Jaipur organised this workshop from December 1st – 9th, 2015. The workshop brochure was sent by emails and hard copies to different leading universities and institutions across the country. There were 40 participants spread over all over India. The lectures delivered during the workshop encompassed basics and advanced topics on: Basics of first order conservation laws, method of Characteristics; advection equations, Weak solutions and Entropy, Bicharacteristic Based Genuinely Multidimensional Schemes for Hyperbolic Systems of Conservation Laws: the wave equation system, the Euler equations of gas dynamics, and the equations of ideal magnetohydrodynamics (MHD), introduction to the classical multidimensional characteristic theory, especially aimed at systems of conservation laws, state and flux decompositions, Fey's method of transport (MOT) and finite volume volume evolution Galerkin (FVEG) Scheme, Discontinuous Galerkin Methods (DGM) for conservation laws: theory and computation, Review of basic numerical concepts for hyperbolic equations, Finite volume schemes for scalar conservation laws, Godunov method, Approximate Riemann Solvers, Stability and Convergence of the schemes, Second order finite volume methods for scalar conservation laws, REA Algorithms, Limiters, TVD Reconstructions, Time Discretizations, 2nd order Hyperbolic problems in higher dimension, Linear Hyperbolic Systems etc. There were MATLAB hands on practice sessions for implementing some of these methods on computers.

Resource persons: Professors P. S. Datti, C. Praveen, Imran Biswas (TIFR-CAM, Bangalore); Prof. V. Raghavendra, (LNMIIT Jaipur); Prof. Amiya K. Pani, Sivaji Ganesh (IIT Bombay); Harish Kumar (IIT Kanpur); K. R. Arun (ISER, Trivandrum).

ACTIVITY 3 : MODELING WEEK & STUDY GROUP MEETING

3.1 Modeling Week and Study Group Meeting on Industrial Problems (MWSGMIP-2015): Department of Applied Mathematics at MSU in collaboration with industrial Mathematics Group at IITB, Powai-Mumbai, will be hosting Study Group Meeting (SGM) during March, 23rd - 27th , 2015 and as a precursor to SGM a Modeling Week (MW) has been organized during March 17th - 21st 2015. One of the objectives of the SGM & MW is to give exposure to Research Scholars and young faculty members to live industrial problems requiring mathematical solutions.

Scientists, Engineers, Economists, Managers, Financial Analysts and other user community will be invited to present their technical problems. It will be the endeavor of the participants to provide useful directions toward visible solutions for problems through intense sessions of brainstorming. Program of the meeting will involve Problem presentation by industry participants. Formation of working groups, problem solving sessions, preparation of mid-term progress report by each group, feedback analysis, presentation of final solution. The program is coordinated by Professors D. C.Vakaskar and B.M. Shah (MSU, Baroda).

Resource Persons: Professors M. C. Joshi (IITB), A. K. Pani (IITB), V. D. Pathak (MSU), S. Ramamohan (MSU), Sukavanam (IITR), R. K. George (IIST - Trivendrum), B. V. Ratish Kumar (IITK), A. S. Vasudeva Murthy (TIFR - CAM Bangalore), Nandakumar (IISc - Bangalore), S. Sundar (IITM), J. Tyagi (IITGn), Shree Hari Rao (JNTU - Hyderabad), J. J. Patel (Consultant), Mahajani (Deputy General Manager, Amtech Electronics), S. Panda (NIT Kalicut), M. N. Mehta (NIT - Surat), V. H. Pradhan (NIT - Surat), D. C. Vakaskar (MSU), D. P. Patel (MSU), B. M. Shah (MSU), Nitin Bhate (MSU), Milind Koranne (MSU).

3.2 Indo-European Study Group Meeting on Industrial Problems (IESGMIP2015) January, 5-9 2015 (Partially supported): This meeting held in M.S. University which is jointly organized by M.S University of Baroda in collaboration with Lappeenranta University of Technology during January 5-9,2015.

Resource Persons: Prof.(Dr.)W.H.A.(Wil) Schilders (TUE, Netherlands); Colin Please (University of Oxford, U.K.); Christian Veje (USD, Denmark); Marko Laine (FMI, Finland); Matti Heilio (LUT, Finland); Simo Ali-Löytty (TUT, Finland); Tuomo Kauranne (LUT, Finland); Agus Yodi Gunawan (ITB, Indonesia); Trinh Khanh Duy (Kyushu University Japan); K.K. Viswanathan (UTM, Malaysia); M. K. Abeyratne and P. A. Jayantha (UOR, Sri Lanka); N.G.A. Karunathilake, D.K. Mallawa Arachchi (UOK, Sri Lanka); S. Krishnakumar (Open Univ., Sri Lanka) and senior professors from prestigious institutes across India like IIT, NIT and other institutes made the study Group Meeting a great success.

Around 90 participants including PG students in Engineerring/Applied Mathematics, research scholars & faculty, scientists and engineers from industry across India and several countries of Europe and Asia were present during the event. Industries like Larsen & Tuobro Ltd., GETCO, Crompton Greaves Ltd. and ERDA posed few problems and also sent 10 participants.

ACTIVITY 4 : INTERNSHIP PROGRAM

This program aimed to give an opportunity to both under graduate and postgraduate students to participate in short term projects. Based on theme "*Learning Mathematics while working on a project*", a few bright participants from both Basic Level Programme and PG Level Programme were selected to do their internship with eminent researchers.

4.1 Summer Internship: This program was in the month of May and June, 2014. Around 345 applications were received out of which 27 applicants were selected, and they did their internship in institutes like IIT Bombay, IIT Kanpur, SAU Delhi, IIT Delhi, IIT Madras, IIT Guwahati, IIT Gandhinagar, IIT Kharagpur, BHU Varanasi, TIFR-CAM Bangalore and IIST Trivandrum, Kerala.

4.2 Winternship Program: Two hundred and fifty candidates from all over India applied for this Winternship Programme 2014 held in the month of December, out of which twelve (12) candidates from various institutes were selected. At the end of their winternship each of them submitted a report. The response was tremendous as compared to last year.

ACTIVITY 5 : VISITORS PROGRAM

1. Prof. Rakesh from Department of Mathematical Sciences, University of Delaware, Newark, DE19808, USA had been invited at Tata Institute of Fundamental Research, Centre for Applicable Mathematics, Bangalore, (TIFR-CAM) India. An advanced instructional school on the theoretical and numerical aspects of Inverse Problems was organized from June 16 – 28, 2014 at TIFR-CAM, Bangalore. Prof. Rakesh gave a series of lectures in the workshop held in TIFR-CAM and had discussed with Prof. Venky Krishnan on Inverse Problems. The lecture & research topics included were Electrical impedance tomography (EIT), Cloaking, Hybrid imaging, Tensor tomography, Spherical Radon transform, Inverse problems for Einstein equations. As a result of his vist, a joint research collaboration started with Professor Venky's research group on inverse problems for the wave equation.

2. Prof. Lutz Tobiska from Uni-Magdeburg, Germany was invited for the advanced workshop on "Finite element methods for Navier-Stokes eqautions" during September 8 th – 12 th 2014 at SERC, IISc Bangalore to give a series of lectures in the workshop. Professor Tobiska is collaborating with Sashikumar Ganesh, the host in IISc on an ongoing research programme on stabilized methods.

3. Prof. Jeffrey Ovall, Portland State University visited to the Department of Mathematics and Statistics at the Indian Institute of Technology Kanpur during November - December, 2014. During his visit, he gave a series of research talks on a posteriori error estimation for finite element methods and interacted with departmental faculty members and research scholars working in the broad areas of Computational Mathematics so as to explore joint collaborative research projects.

4. Prof. Roberta Musina visited IIT Delhi during January 13th – 26th , 2015. During the visit at the Mathematics Department of the Indian Institute of Technology Delhi, some open problems in a research field of current and international interest were discussed. In particular, they dealt with classes of variational problems driven by nonlocal differential. During her visit she also gave two seminars in the department. In the first one she surveyed the classical theory of variational

inequalities driven by the conventional Laplace operator. In the second one she reported about some recent results about the Dirichlet and the Navier Laplace operators. Those include noncompact Dirichlet problems of Brezis-Nirenber type for the fractional Laplace operator, Kirchoff equations, and singular problems involving the Heaviside functions.

5. Prof. Samir Karaa visited IIT Bombay during February 2nd – 10th , 2015 for a research discussion and collaboration with Prof. Amiya K. Pani. He had also visited South Asian University for their gave a talk. During his visit, they worked on an ongoing research project on *Finite volume methods for fractional-diffusion problems and also on posteriori analysis for a second order wave equation.*

6. Professor G. Fairweather from Colorado School of Mines, Golden is presently visiting IIT Bombay and later on will be visiting BITS, Goa for few days. During his visit (14th Feb-28th Feb,2015), he will be collaborating with Professor Pani from IITB on an ongoing project Orthogonal spline collocation methods for Schrodinger equations and also on qualocation method. At BITS, Goa, he will be collaborating with Professor P. Dhanumjaya and his group on numerical solution to Helmohltz equation.

7. Professor C. Carstensen from Humboldt University, Berlin is presently visiting IIT B and subsequently he also visited IISc, Bangalore. During his visit (Feb 14- March 3, 2015), he will be collaborating with the research gorup in IITB and the research group in IISc, Bangalore on adaptive finite element methods. He will give a Departmental Colloquium in IITB.

8. Professor Vidar Thomee from Chalmerse Univ. Technology, Sweden will be visiting TIFR (CAM) and also IITB. During his visit (Feb 18- March 4,2015), he will collaborate on an on going project with Professor Vasudeva Murthy on nonlocal parabolic problems and in IIT B, a part from collaborating on mixed finite element methods for parabolic problem in nonconvex polygonal domain, Professor Thomee will give a Departmental colloquium.

LIST OF PUBLICATIONS

1. S Karaa, AK Pani (2014), A priori error estimates for finite volume element approxi-mations to second order linear hyperbolic integro-di erential equations IJNAM (Accepted)

2. Carsten Carstensen, Dietmar Gallistl and Neela Nataraj, Comparison Results of non-standard P_2 Finite Element Methods for the Biharmonic Problem, Paper accepted for publication in M^2AN.

3. S Karaa, AK Pani (2015), Optimal error estimates of mixed FEMs for second order hyperbolic, integro-differential equations with minimal smoothness on initial data. Journal of Computational and Applied Mathematics 275, 113-13.

4. M. Khebchareon, Amiya K. Pani and Graeme Fairweather (2015), ADI Galerkin methods for and evolution equation of positive type memory (Revised version submitted)

5. S Karaa, AK Pani, S Yadav (2014), A Priori hp-estimates for Discontinuous Galerkin Approximations to Linear Hyperbolic Integro-Differential Equations, arXiv preprint arXiv:1401.5539, Appl. Numer. Math. (Revised version submitted).

6. Carsten Carstensen, Asha K. Dond, Neela Nataraj and Amiya K. Pani, A posteriori mixed finite element error analysis for non-self adjoint and indefinite elliptic problems, Revised version submitted.
7. Carsten Carstensen, Neela Nataraj and Amiya K. Pani, Unified Analysis and Comparison Results for First Order FVM, submitted.

8. A.K.Pani, K.Sharma, N. Sharma (Submitted), Finite Element Galerkin Approximations to a Class of Nonlinear Nonlocal Parabolic Problems.

9. S. Kundu and A.K. Pani (Submitted), On Numerical Approximation to Kirchhoff's Model of Parabolic Type.

10. S. Karaa, K. Mustapha and A.K.Pani , Finite Volume Element Methods for a Class of Sub-Diffusion Problems (paper under preparation).

11. S.Karaa and A.K. Pani, On a posteriori error analysis of a mixed finite element Galerkin approximation to second order hyperbolic problems (paper under preparation).

12. Gouranga Mallik & Neela Nataraj: A nonconforming finite element approximation for the Von {K\'{a}rm\'{a}n} Equations

13. K. Asha Dond, Thirupathi Gudi and Neela Nataraj: On a non-conforming finite element approximation for optimal control of the obstacle problem. (paper under preparation)

14. Anil Kumar, Amiya K. Pani and Mohan C. Joshi, Approximate Controllability of a class of Parabolic Integro--Differential Equations (under preparation)

15. J. Henry, Kapil K. Sharma and Pankaj Mishra: Computing Zoom in the Simulation of Linear Elliptic Type Partial Differential Equations (paper under preparattion)

PROPOSED ACTIVITY

TRAINING PROGRAM

Sr. No.	Training Program/Workshop	Date & Venue	Total Participants & Resource Person
1	UG Training Program	May 18 th - June 06 th, 2015 The LNM Institute of information Technology, Jaipur	61 , 18
2	PG Training Program	18 th May - 4 th June, 2015 Indian Institute Of Technology Kanpur	63 , 16
3	Advanced Level Taining Program	May 25 th -June 14th, 2015 BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI – K. K. BIRLA GOA CAMPUS	57 , 12

THEMATIC PROGRAM

Advanced Level programmes are proposed and their approvals are yet to be taken**.**

INTERNSHIP PROGRAM

1	Summer Internship 2015	Held in various Institutes all over India	21