

National Program on Differential Equations-Theory, Computation & Applications (NPDE-TCA) was sanctioned by Department of Science & Technology (DST) in Feb, 2012 for a period of five year 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.

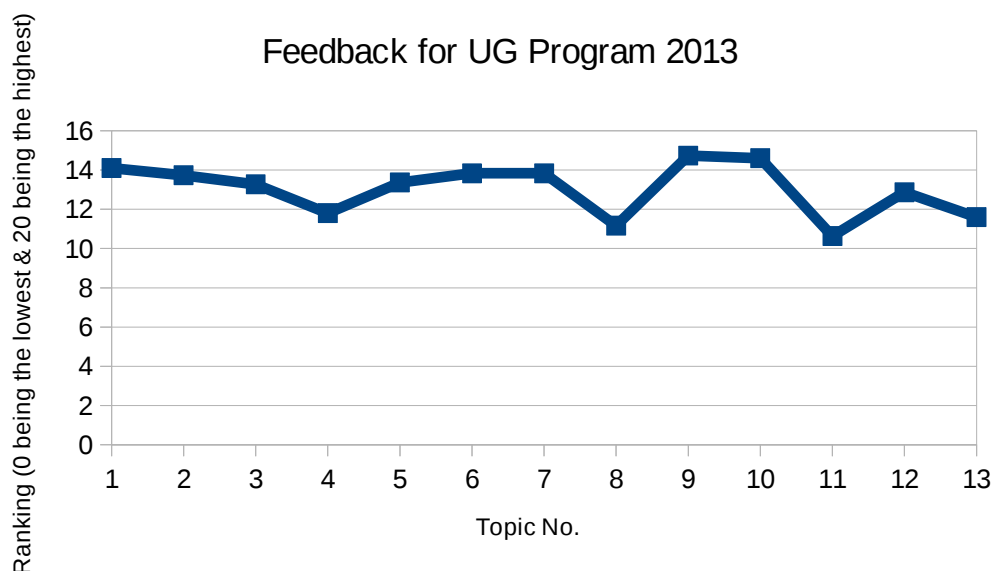
Under this national programme, the following activities were organised during 2013-2014.

A. Activities Undertaken During April, 2013 – March, 2014

ACTIVITY 1 : TRAINING PROGRAMS

1.1. Undergraduate Training Program: With a theme on “Catch them Young”, this program was held at Birla Institute Of Applied Sciences, Bhimtal, during June 3 – 22, 2013 which was coordinated by Anant Pant (BIAS, Bhimtal), M.C.Joshi (IITB), R P Pant and Mahesh Joshi (Kumaun University, Nainital). 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 helped to provide flavour of Applicable Mathematics by illustrative applications of mathematical techniques to practical problems. Advertisement for this program was done in the month of March 2013. Brochures had been sent to different universities all over India and was also displayed in NPDE-TCA website. One hundred thirty five (135) candidates from all over India applied for this program out of which fifty five (55) were selected based on their academic records and recommendations. Forty five (45) candidates covering all over India attended this program.

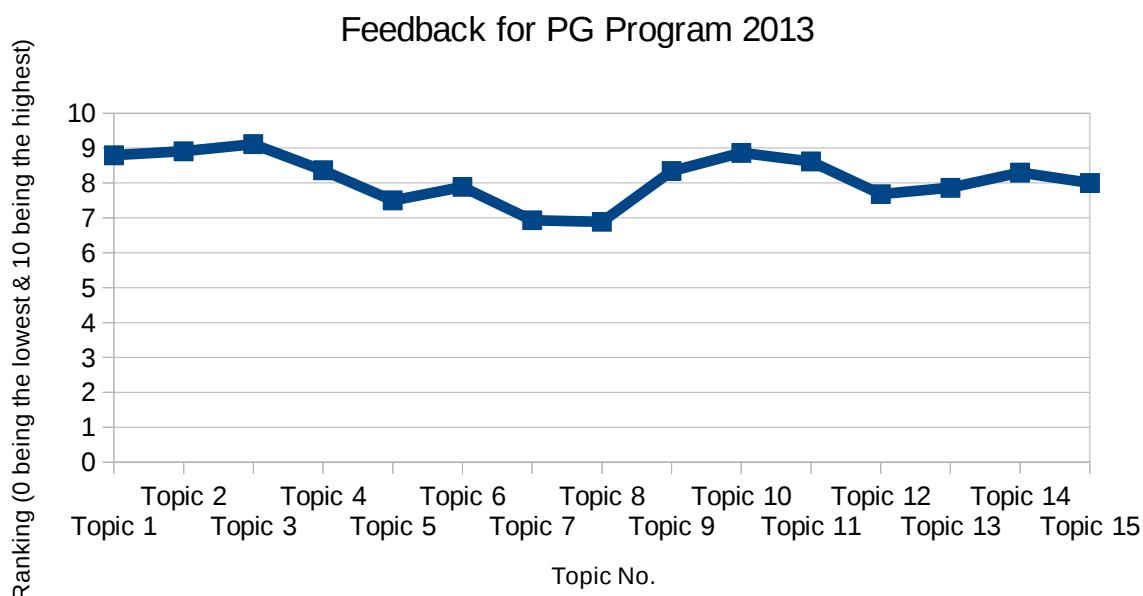
Resource Persons: Amiya Kumar Pani (IITB), Mohan C. Joshi (IITB), S. Baskar (IITB); Raju K. George (IIST, Thiruvananthapuram), A K Nandkumaran (IISc Bangalore), P. Shunmugraj (IITK), P.S. Datti (TIFR Bangalore), Peeyush Chandra (IITK), R P Pant (Kumaun University, Nainital), Mahesh Joshi (Kumaun University, Nainital) and P. Dhanumjaya (BITS-Pilani, Goa). 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 of the above program is shown below in the form of a graph with some photographs which were taken during the program.



Topic 1: Analysis, Topic 2: Linear Algebra, Topic 3: Mathematical Modeling by Differential Equations, Topic 4: Metric Space & Fixed Point Theorem, Topic 5: Mathematical Modeling, Topic 6: Ordinary Differential Equations (I), Topic 7: Ordinary Differential Equations (II), Topic 8: Boundary Value Problems, Topic 9: Numerical Analysis – I, Topic 10: Numerical Analysis – II, Topic 11: Control Theory, Topic 12: Scilab Tutorials, Topic 13: Scientific Labs

1.2. Post-Graduate Training Program: This Program was held at IIT Madras during 20th May to 8th June, 2013 which was coordinated by S. Sundar and Y.V.S.S. Sanyasiraju (IIT M); S. Baskar and S. Sivaji Ganesh (IIT B). 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: S. Kesavan (IMS, Chennai); M.T. Nair (IITM); V. Raghavendra (IITK); Y.V.S.S.Sanyasiraju (IITM); A.J.Shaiju (IITM); S. Sivaji Ganesh (IITB); Ch. Srinivasa Rao (IITM); S. Sundar (IITM); B V Rathish Kumar (IITK); A.S.Vasudeva Murthy (TIFR-CAM Bangalore), R.K.Mohanty (SAU, Delhi), Manoranjan Mishra (IITRoopar), Arindama Singh (IITM). This program was also advertised in the same way as the UG Level program in the month of March 2013. More than 125 Candidates applied for this program and approximately Fifty Nine (59) had been selected. Finally fifty (50) candidates covering all over India attended the program. Participants gave a good response to the overall program, the feedback graph of which is shown below.



Topic 1: ODE: Existence & Stability, Topic 2: Multivariable Calculus, Topic 3: Measure Theory, Topic 4: First Order PDEs, Topic 5: Numerical solution of DEs Using FDM, Topic 6: Laplace Equation, Topic 7: Numerical solution of DEs Using FDM, Topic 8: FDM for Heat Equations with ADI, Topic 9: Wave Equation, Topic 10: Classification of PDEs, Separation of Variables & Energy Methods, Topic 11: Heat Equation, Topic 12: Elliptic BVP & Numerics, Topic 13: Mathematical Modeling for Chemical Engg based Problems, Topic 14: Mathematical modeling & Fluid Flow Methods, Topic 15: Scientific computing lab



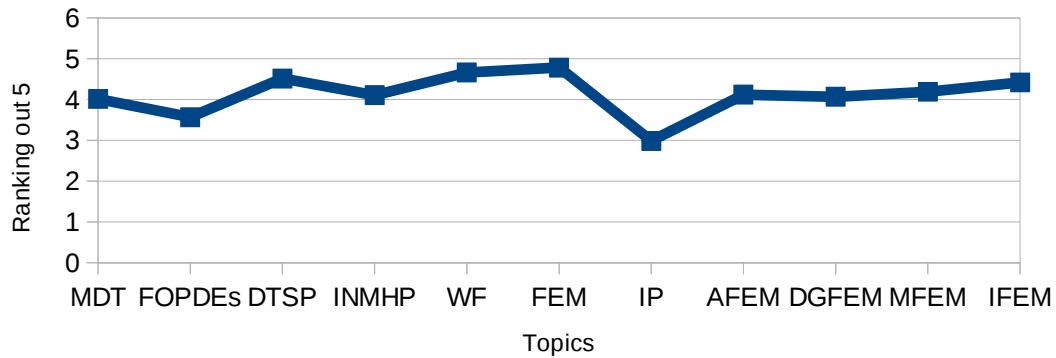
1.3. Advanced Level Training Program & CIMPA Research School: This program was held at Indian Institute of Science, Bangalore during 24th June – 19th July 2013, which was co-ordinated by Blanca Ayuso de Dios (Centre de Recerca Matematica (CRM), Spain), Sashikumar Ganesan, A.K. Nandakumaran and Thirupathi Gudi (IISc Bangalore), Amiya K.Pani and Neela Nataraj (IITB). It was focused on advanced topics in different aspects of Partial Differential Equations. The target audience comprised of Research Scholars and senior Post Graduate students. It was also open to active faculty from colleges and universities. The advanced training programme focused on a training in PDEs and FEM which was pre-requisite for the research school. The aim of the research school was to provide the participants an overview of the techniques that allow one to address the computational challenges that are encountered in different applications. It was preceded by advanced level training programme of NPDE-TCA. About 59 participants participated in the program.

Resource Persons: NPDE Advanced Training Programme : Blanca Ayuso de Dios (CRM, Barcelona, Spain); Pravir Dutt (IITK); Sashikumar Ganesan, Thirupathi Gudi, A.K. Nandakumaran, Phoolan Prasad (IISc Bangalore); G.D. Veerappa Gowda, Mythily Ramaswamy (TIFR-CAM Bangalore); Neela Nataraj, Amiya K. Pani (IITB).

CIMPA Research School : Susanne C. Brenner and Li-yeng Sung (Louisiana State University, USA); Daniele Boffi (Universita' degli Studi di Pavia, Italy); Lucia Gastaldi (Universita' degli Studi di Brescia, Italy); Andreas Veiser (Universita' degli Studi di Milano, Italy); Fabio Nobile (Ecole Polytechnique Federale de Lausanne (EPFL), Switzerland); Raul Tempone (King Abdullah University of Science and Technology (KAUST), Saudi Arabia).

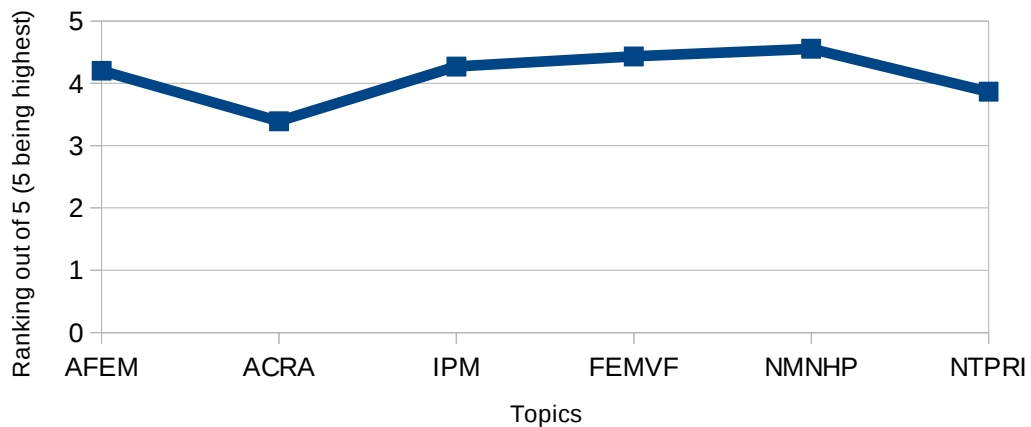
Feedback of the above program is shown below in the form of a graph with some photographs which were taken during the program.

Graph for Advanced Level Training programme - 2013



Motivation on Distribution Theory (MDT), First Order PDEs (FOPDEs), Distribution Theory and Sobolev Spaces (DTSP), Introduction to Numerical Methods for Hyperbolic Problems (INMHP), Weak Formulations (WF), Finite Element Method (FEM), Introduction to Probability (IP), Adaptive FEM (AFEM), Discountinuous Galerkin FEM (DGFEM), Mixed FEM (MFEM), Implementing FEM (IFEM).

Feedback graph for CIMPA Program 2013



Adaptive finite element methods (AFEM), A course related to applications (ACRA), C^0 interior penalty methods (IPM), Finite elements for mixed variational formulations (FEMVF), Numerical methods for nonlinear hyperbolic PDEs (NMNHP), Numerical techniques for PDEs with random input data (NTPRI)



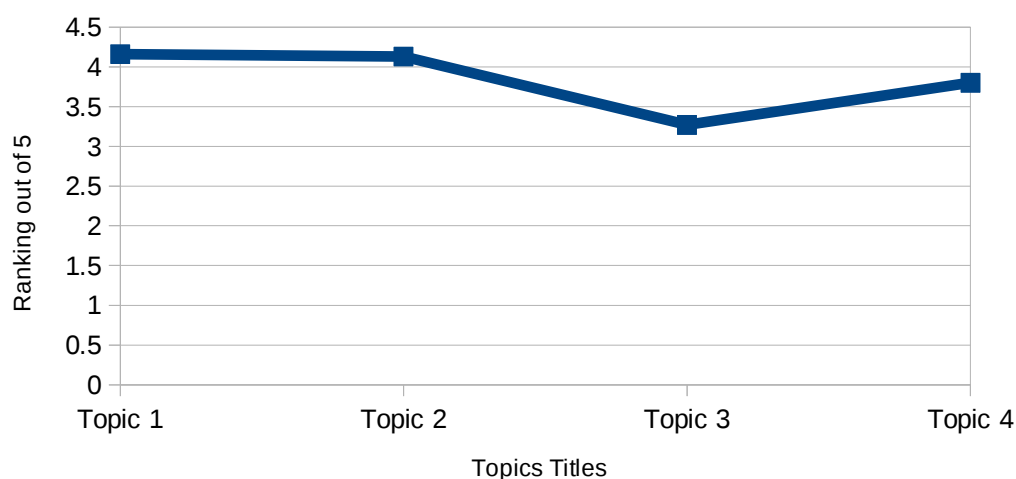
ACTIVITY 2 : ADVANCED THEMATIC PROGRAM

2.1 Advanced Level Workshop on Theoretical and Computational Aspects of Nonlinear Waves (TCANW 2013): This workshop was held at IIT Bombay during May 27th–31st, 2013 which was co-ordinated by S. Baskar and Amiya K. Pani (IITB). The main objective of this program was to train post-graduate and research students in this field by some experts from India and abroad. The workshop also aimed at bringing together researchers working on nonlinear waves and related areas and to foster interaction and collaboration with the eminent resource persons. Advertisement for this program was done in the month of August, 2013. Brochures had been sent to different universities all over India and was also displayed in NPDE-TCA website. M.Sc (Mathematics) final year, M. Tech (Aerospace, Mechanical) final year, Ph.D (Mathematics, Aerospace, Mechanical) students were selected based on recommendations and their academic records. Fifty (50) candidates from all over India applied for this program, of which thirty two (32) were selected.

Resource Persons: Philip Roe (University of Michigan), P. Prasad (IISC, Bangalore), Veerappa Gowda (TIFR, Bangalore), K. T. Joseph (TIFR, Bangalore), J. C. Mandal (IITB), Raghurama Rao (IISC, Bangalore), Ch. Srinivasa Rao (IITM), S. Baskar (IITB), Harish Kumar (IITD).

Feedback in a graphical representation and a photograph of this program is shown below.

Grap for TCANW-2013 Workshop



Topic1: Numerical Methods for Conservation Laws, Topic 2: Monotone Schemes for Conservation, Topic 3: Burgers Equations, Topic 4: Waves in Multi Dimensions & Related Developments



2.2 Advanced Workshop on Mathematical Epidemiology and Differential Equations

(AWMEDE-2013): This Program was held at Indian Institute of Technology Patna for six days during July 8th – 13th, 2013 which was coordinated by P. K. Srivastava (IITP) and Peeyush Chandra (IITK). The aim of the workshop was to provide participants an overview of mathematical techniques in ordinary, delay and partial differential equations that allow one to address the challenges in epidemiological modeling. This also gave an opportunity for the participants to interact with the resource persons in these areas. Thirty three (33) participants were selected for this program.

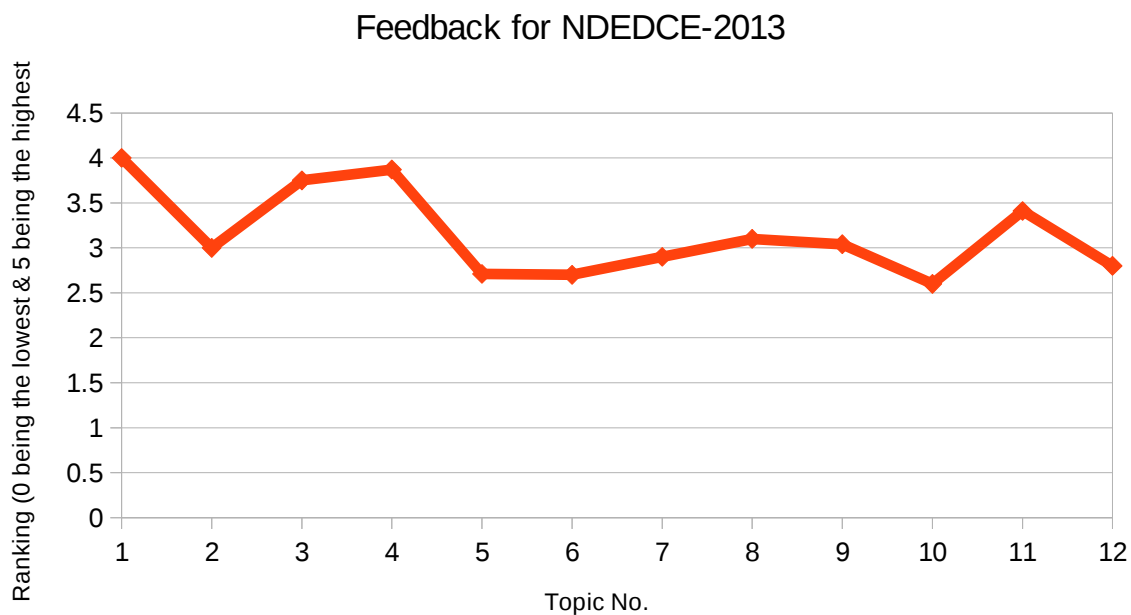
Resource Persons: M. Banerjee (IITK), P. Chandra (IITK), Pradeep Das (RMRIMS), B. Dubey (BITS), Anuj Mubayi (NEIU, USA), A. K. Misra (BHU), V. Raghavendra (IITK), A. S. Rao (GRU, USA/ ISIKol), P. K. Srivastava (IITP).



2.3 Advanced Workshop on “Nonlinear Differential Equations : Dynamics of Complex Systems (NDEDCS-2013): This program was held at University of Calcutta during September 23rd – 28th, 2013, coordinated by Susmita Sarkar. The main objective of the workshop was to bring together experts working in the field of complex systems and put in focus the essential role of differential equations in determining the collective behavior of the complex systems and acquiring an understanding thereof. More than fifty (50) participants attended this workshop.

Resource persons: Jayanta Kumar Bhattacharjee (Director, HRI), V. Balakrishnan (IIT, Chennai), M.Lakshmanan (Bharatidasan University, Tiruchirapally), Govindan Rangarajan (IISc, Bangalore), Deepak Dhar (TIFR, Mumbai), Pranay Goel (IISER, Pune), Sitabhra Sinha (IIMSc, Chennai), Soumitro Banerjee (IISER, Kolkata), B. S. Dandapat (SMIT, Sikkim), K. P. Das (Calcutta University), Anandamohan Ghosh (IISER, Kolkata), M. M. Panja (Viswabharati).

Feedback graph and photograph for this workshop is given below.



Topic 1: Introduction to Nonlinear Ordinary Differential Equations, Topic 2: Linear and Nonlinear Diffusion Equations, Topic 3: Dynamics of Coupled Nonlinear Oscillators, Topic 4: Synchronized Chaos: Stability and Pattern Formation and Nonlinear Granger Causality, Topic 5: Type I and II Dynamics in Models of Neural Spiking, Topic 6: Pattern Formation and Wave Propagation in Nonlinear Media, Topic 7: Patterns of Life and Death: Complex Spatio-Temporal Dynamics in Nonlinear Biological Systems, Topic 8: Hybrid Dynamical Systems and Border Collision Bifurcations, Topic 9: Stochastic Differential Equation: Analytical and Numerical Solutions, Topic 10: Some Perturbation Methods of Solving Nonlinear Differential Equations involving a Small Parameter, Topic 11: Modelling of Spin Coating: An Industrial Technique, Topic 12: Wavelet Based Techniques for Solutions of Differential Equations



2.4 Advanced Workshop on “Homogenization” : Department of mathematics at the Indian Institute of Space Science and Technology organized an Advanced level workshop on Homogenization from December 9th – 14th, 2013. This workshop was coordinated by N. Sabu (IIST, Trivandrum). The objective of this workshop was to introduce various techniques of homogenization to the participants. Twenty two (22) participants attended this program. *Resource Persons: A. K Nandakumaran (IISc Bangalore), M. Vanninathan (TIFR Bangalore), T. Muthukumar (IITK), Amiya K. Pani (IITB), N. Sabu (IIST, Trivandrum).*



2.5 Advanced Workshop on “Computational Methods for Integral Equations & Applications” (AWCMIEA-2014): IIT Kanpur hosted this workshop with an objective to introduce participants to a number of fundamental mathematical ideas and techniques that lie at the core of integral equation approach of problem solving. For this, the course focused on the numerical solution of integral equations as well as on solving elliptic boundary value problems by use of boundary integral methods. Accordingly, a variety of numerical techniques were discussed and analyzed for solution of linear Fredholm integral equations of the second kind with compact integral operators as well as for boundary integral equation reformulation of Laplace's equation. In addition, a series of lectures focused on some of the applications of integral equations in science and engineering. The program was co-ordinated by B.V. Rathish Kumar (IITK) and was held during January 13th – 17th, 2014. The workshop was attended by 29 participants.

2.6 Advanced Workshop & Symposium on Stability Analysis of Differential Equations with Application to Fluid Flow Problems (SADEAFFP-2014) : A four day workshop & symposium was held at IIT Kanpur during March 20th – 24th, 2014. The aim of the workshop was to introduce participants to the concepts of fluid flow instability. At the end of the workshop participants will be able to identify a flow stability phenomenon associated with a flow, formulate the flow stability problem, select appropriate method to solve it and finally interpret the results. The workshop addressed topics associated with instability of fluid flows such as thermal instability, centrifugal instability, weakly nonlinear theory, nonlinear stability, turbulence, etc. Applications of flow instability to problems in porous media, biofluid, MHD, etc.. were also discussed. The symposium covered some of the recent research works on the topics discussed in the workshop. This program was co-ordinated by B.V. Rathish Kumar and S. Ghorai (IITK).

2.7 Advanced Level Workshop on “Stabilization Methods for Singularly Perturbed Differential Equations” (SPDE-2013). This program was conducted at IISc Bangalore during October 3rd – 5th, 2013 which was coordinated by Dr. Sashikumar Ganesan (IISc Bangalore). The workshop was attended by 37 participants (20 outstation + 17 local).

Topics covered in this workshop: FDM for Singularly Perturbed Problems, Stabilization Methods etc.

Resource Persons: Lutz Tobiska (Uni-Magdeburg, Germany), Roddam Narasimha (JNCASR), M. K. Kadalbajoo (IITK), Rama Govindarajan (TIFR-CIS), Sashikumaar Ganesan (IISc Bangalore)

2.8 “Advanced Level Workshop On Orthogonal Spline Collocation Methods (OSCM-2014) For Partial Differential Equations”. South Asian University hosted this four day workshop during March 21st – 24th, 2014. Thirty three participants attended this workshop. The program was coordinated by Kapil K. Sharma (SAU, Delhi). Forty (40) participants which were selected out of 110 applicants attended this workshop.

Topics covered in this workshop: OSCM for elliptic, parabolic PDE, ADI OSCM and Matrix decomposition methods.

Resource Persons: Amiya K. Pani (IITB), Graeme fairweather (Colorado School of Mines USA) and P. Dhanumjaya (BITS-Pilani, Goa).

PROGRAMS PARTIALLY SUPPORTED BY NPDE

1. Advanced Workshop on “Nonlinear Functional Analysis & Its Applications” (NFAA-2013) : This program was held during October 21-29, 2013 at University of Kashmir, Srinagar, co-ordinated by N.A. Rather and S. Pirzada.

Nonlinearity is eminently visible in problems of practical importance in many inter-disciplinary areas of science and engineering. The investigations of these problems require exposition on development of a common theory of nonlinear analysis, which has already acquired enormous proportion.

The subsequent decades saw applicability of prime results in this study for the solvability analysis of nonlinear ordinary and partial differential equations as well as integral equations. These equations model real life problems in many fields like space science, financial engineering, control engineering, structural dynamics and information technology. The task of analyzing these models is simplified if readily available technology of nonlinear functional analysis is properly understood. The workshop aimed to spread the working knowledge of this technology by bringing together an expert group of functional analysts to expand on various aspects of its salient features, covering the following topics. More than 65 candidates applied for this program out of which 45 were selected.

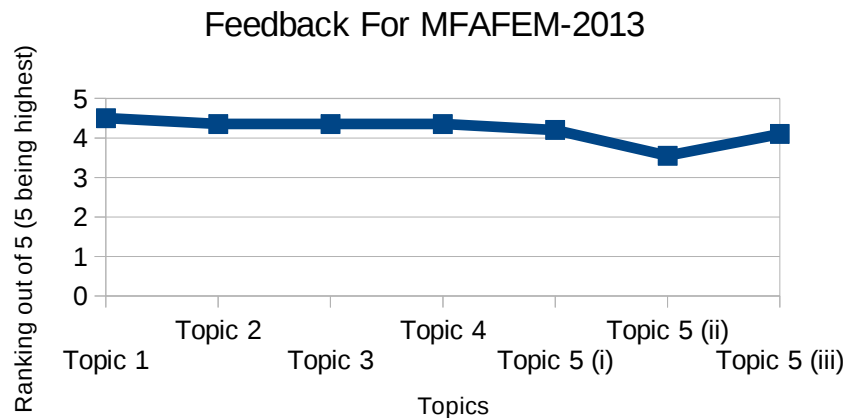
Resource Persons: Mohan C Joshi, D V Pai (IIT, Gandhinagar); Amiya K Pani (IITB), P N Srikanth (TIFR, Bangalore), Raju K George (IIST, Thiruvananthapuram), S Kesavan (IMS, Chennai), Amin Sofi (University of Kashmir), N Sukavanam (IIT Roorkee). Overall the workshop was very well appreciated because of its interactive sessions and the lecture series. The photographs taken during the programme is shown below.



2. Advanced Workshop on Mathematical Foundation of Advanced Finite Element Methods (MFAFEM-2013) : A nine day workshop was held at BITS-Pilani, Goa during 26th Dec. 2013 – 3rd Jan 2014 which was co-ordinated by Carsten Carstensen (Humboldt University of Berlin, Germany), P. Dhanumjaya (BITS-Pilani), Neela Nataraj and Amiya K. Pani (IITB).. The aim of this workshop was to motivate research students towards a career in computational mathematics

through the lectures from the national & international experts in this area, to provide an overview of the techniques that allow one to address the computational challenges that are encountered in different applications, to provide a common platform for exchanging ideas and results pertaining to the challenges in these front line areas of FEMs. and to expose participants to hands-in-computing through Computational Lab Sessions. More than 30 participants attended this workshop.

Resource Persons: Amiya K. Pani, Neela Nataraj (IIT Bombay); P. Dhanumjaya (BITS-Pilani); Thirupati Gudi (IISc Bangalore); Carsten Carstensen, Mira Schedensack, Dietmar Gallistl (Humboldt University of Berlin, Germany); Jay Gopalakrishnan (Portland State University, U.S.). The graphical representation of the feedback data and photographs taken during the program is shown below.



Topic 1: A quick introduction to Sobolev spaces, Lax-Milgram Lemma; Review of Elliptic PDE: existence of unique weak solution, regularity, Mixed FEM.

Topic 2: Basic FEM: Cea's Lemma Mixed FEM, Aubin-Nitsche duality technique, convergence rates, Discontinuous Galerkin Finite Element Methods.

Topic 3: A posteriori error analysis, reliability, efficiency, adaptive mesh refinement, contraction property, discrete reliability, optimality of closure algorithm, approximation classes, optimality of adaptive finite element algorithms. Adaptive finite element methods for elliptic PDEs: basic concepts and a posteriori estimators, Adaptive Galerkin Discretization of mixed finite element methods.

Topic 4: Discontinuous Petrov Galerkin Methods (DPG): Introduction of the DPG method as a Petrov-Galerkin method, connection to least squares methods, a mixed method reformulation, theory of a priori error estimates for the DPG method, Application to the Laplace operator

Topic 5(i): FEM, Topic 5(ii): FeniCS, Topic 5(iii): Adaptive FEM



ACTIVITY 3 : MODELING WEEK & STUDY GROUP MEETING

3.1 Modeling Week and Study Group Meeting on Industrial Problems (MWSGMIP-2013):

This program was hosted at NIT Calicut in collaboration with Industrial Mathematics Group at IITB (Modeling Week: 2nd – 7th, December 2013, Study Group Meeting: 9th – 14th, December 2013) which was coordinated by Satyananda Panda and Suresh Kumar Nadupuri (NIT Calicut) and Amiya K. Pani (IITB). One of the objectives of the MW & SGM was to give exposure to research scholars and young faculty members to study industrial problems requiring mathematical solutions. Emphasis was given on generating ideas which will eventually lead to a tangible methodology for problem solving as a short term objective, evolving long term interaction between academic and industry with respect to research & development perspective and developing a network of mathematicians and computational scientists dealing with industrial problems. Information regarding this program was advertised in the month of October, 2013. Forty five (academic) covering all over India were selected for this programme.

Resource Persons: Keijo Ruotsalainen (University of Oulu, Finland), N.G.A. Karunathilake (University of Kelaniya, Sri Lanka), A Grm (C3M, Slovenia), S. Perera (University of Colombo, Sri Lanka), Amiya Kumar Pani (IITB), N G A Karunathilake (University of Kelaniya, Srilanka), Neela Nataraj (IITB), Mohan C Joshi (IITB), S Sundar (IITM), Raju K George (IIST, Trivandrum), L Chandra (IIT, Rajasthan), Dhanesh Patel (MS University, Baroda), S Panda (NIT, Calicut), Jagadeesha T (NIT Calicut), Suresh Kumar Nadupuri (NIT, Calicut).

List of Industrial Participants:

Dr. S. Velmurugan, Scientific officer H+, Head, Water and Chemistry Division, BARC, Kalpakkam; Mr. P. Madasamy, Scientific officer E, Engineering Simulation Studies Section, Water and Chemistry Division, BARC, Kalpakkam; Dr. Madhu Sankar G. Senior Research Analyst, Mellon Capital, Pune; Mr. Sachin Pagnis, Senior Technology Specialist, Advanced Engineering Group Ingersoll Rand Engineering & Technology Center (IRETC) Bangalore; Mr. Josin Tom, CFD Engineer, Advanced Engineering Group Ingersoll Rand Engineering & Technology Center (IRETC) Bangalore.



ACTIVITY 4 : INTERNSHIP PROGRAM

This program aimed to give 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, 2013. More than 140 Candidates from all over India applied for this Internship Program. Out of which fourteen candidates from various institutes were selected. Six Candidates did their Internship at IIT Bombay one candidate did the internship at Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram, Kerala, four did at IIT Kanpur, Two candidates did at Tezpur University and one at IISc Bangalore. At the end of their internship, each of them submitted a report. This program helped the students to acquire the skills needed for quality research work.

4.2 Winternship Program: Two hundred candidates from all over India applied for this Winternship Programme 2013 held in the month of December. Out of which eight (8) candidates from various institutes were selected. Five Candidates did their Winternship at IIT Bombay, two at IIT Kanpur and one candidate at IITB and TIFR-CAM Bangalore. At the end of their winternship each of them submitted a report. The response was tremendous as compare to last year.

ACTIVITY 5 : VISITORS PROGRAM

1. Prof. Philip L. Roe (University of Michigan): visited India during 15th May to 14th June (roughly), 2013 as an INSA visiting professor. His visit was funded by INSA, whereas the local hospitality for his stay in IIT Bombay during the period of 22nd May to 1st June was taken care by NPDE-TCA (with partial support from NPDE-TCA). During this period, Prof. Roe took part as a resource person in the advanced level workshop on Theoretical and Computational Aspects of Nonlinear Waves and gave 5 lectures each of 90 minutes duration.
2. Prof. Daniele Boffi (University of Pavia, Italy) visited the Department of Mathematics, IISc Bangalore during the period July 6th-20th, 2013 (with a partial support from NPDE-TCA). Prof. Boffi is one of the resource persons in the CIMPA-NPDE-NBHM research school on "Current Trends in Computational Methods for PDEs" which held during July 8-19, 2013 at the Department of Mathematics, IISc Bangalore. Prof. Boffi delivered a series of lectures on mixed finite element formulations and eigen value problems. The research school has been a great success because of the renowned speakers like Prof. Boffi. There were several discussions and interactions between the participants and Prof. Boffi. Prof. Chandrasekhar S. Jog from the Department of Mechanical Engineering, IISc Bangalore had discussed some of his research problems with Prof. Boffi.
3. Prof. Lucia Gastaldi (University of Brescia, Italy) visited the Department of Mathematics, IISc Bangalore during July 6th-20th, 2013 (with a partial support from NPDE-TCA). Prof. Gastaldi delivered a series of lectures on mixed variational problems and mixed eigen problems in the CIMPA-NPDE-NBHM research school on "Current Trends in Computational Methods for PDEs" held at the Department of Mathematics, IISc Bangalore during July 8th-19th, 2013. There were a total of 60 participants in the research school out of which 40 are from India. All the participants have benefitted by the lectures of Prof. Gastaldi.
4. Prof. C. Carstensen visited BITS, Goa to give a series of lectures in the Advanced Workshop on "Mathematical Foundation of Advanced Finite Element Methods" (MFAFEM-2013) and IITB for research collaboration during 28th Dec. - 6th Jan, 2014. Following is the publication.

- C Carstensen, AK Dond, N Nataraj, AK Pani (2014), Error analysis of nonconforming and mixed FEMs for second-order linear non-selfadjoint and indefinite elliptic problems, arXiv preprint arXiv:1401.4810, Submitted to Numer. Math. (Under Revision)
- C Carstensen, N Nataraj, AK Pani (2014), Comparison Results and Unified Analysis for First-Order Finite Volume Methods in a Poisson Model Problem. Submitted to under (revision) SIAM J. Numer Anal
- C Carstensen, D Gallistl and N Nataraj, Comparison Result of Non Standard P_2 Finite element Methods for the Biharmonic Problems”(submitted).

5. Prof. Gudo Kanschat (University of Heidelberg) visited IITB during 24th Feb to 6th March, 2014. He was here for research collaboration and to give a series of lectures in the workshop on “FEM using Deal.II”. Topics covered: Introduction: why software, overview of deal.II, short description, example 1 (generating meshes), Brief review of FEM, 4 steps towards an adaptive Poisson solver, An elliptic system (Lamé-Navier-eqns), DG and multi-grid methods, Laplacian in mixed form, Stokes problems.

6. Prof. Luca Pavarino (Department of Mathematics, Univ. Milano, Italy) visited IIT Kanpur from February 14th-23rd, 2014 (with full support from NPDE-TCA) . He had given a series of talks on following topics:

- Non-overlapping domain decomposition methods based on Finite Element Method for partial differential equations.
- Overlapping schwarz domain decomposition methods based on Finite Element Method for partial differential equations.
- Abstract schwarz domain decomposition theory for Partial Differential Equations
- Application of parallel finite element based domain decomposition method to computational cardiac electric activity.

He has also visited BHU, Varanasi and delivered an invited talk on “Current Trends in DDM for PDEs & Development of Parallel DD based FE solver for large scale problems from CEA.” We have also had research discussions on Modeling & Simulation in Computational Biology. Especially the topic related to Cardiac Electric Activity has been the focus of the discussion. Future research collaborative work and joint projects have been discussed and envisaged.

7. Prof. Daniele Boffi (Department of Mathematics, Univ. Pavia, Italy) visited IIT Kanpur from February 23rd to March 3rd, 2014 (with full support from NPDE-TCA). He had given a series of talks on following topics:

- An introduction to Mixed Finite Elements
- The immersed Boundary Element Method: Mathematical Formulation & Numerical Approximation
- On the Discrete Compactness of hp Finite Elements & Application to Maxwell Equations
- Approximation of Quadrilateral Finite Elements

Research discussions on Mixed FEM and IBM for fluid-Structure interactions. Further there were also few discussions on Mixed FEM for problems from Hydrodynamics in porous media. Few collaborative works along these lines were envisaged.

8. Prof. D.A.S.Rees (University of Bath, UK) visited IIT Kanpur during March 18th – 26th , 2014 (with full support from NPDE-TCA). The lectures were attended by 60 faculty/Ph.D. students of SADEAFFP-2014 and IITK. The series of lectures included following topics:

- Linear Stability Analysis of Fluid Flows.
- Weakly Nonlinear Stability Analysis of Fluid Flows.
- Nonlinear Stability Analysis of Fluid Flows.

- Stability Analysis of Mixed Convection process in a fluid saturated porous media.
- Flow and convection of a Bingham fluid in a porous medium.

He interacted with different researchers who were the participants of SADEAFFP-20014 and had sorted out quite few of their difficulties with their research problems. Prof. Bera, IIT R also had research discussion with him and they seem to have come up with some collaborative project work. The group also had discussions on research projects related to a) stability analysis of convection in multi-layer porous media and b) The onset and development of convection in semi-infinite porous region heated from below with uniform suction.

9. Prof. Matin Bees (York University, UK) visited IIT Kanpur during March 19- April 4, 2014 (with full support from NPDE-TCA). He has given a series of Four 90 minute talks in IIT Kanpur on the following topics:

- Stability of Gyrotactic Bio-Convection.
- Chemo-Convection: Linear and Weakly Nonlinear Stability Analysis.
- Photo-Gyrotactic Bio-Convection.
- Taylor Dispersion of swimming cells in tube.

10. Prof. Graeme fairweather (Colorado School of Mines USA) visited IIT Bombay, LNMIIT Jaipur and SAU, Delhi for “ Advanced Level Workshop On Orthogonal Spline Collocation Methods for Partial Differential Equations” (OSCM-2014) . During his visit, he gave two lectures in IITB and two lectures in LNMIIT Jaipur. Prof. Graeme visited SAU, Delhi during March 21st – 24th , 2014 (with a partial support from NPDE-TCA).to give series of lectures in OSCM-2014 workshop. Following is the publication.

- M. Khebchareon, A.K. Pani and Graeme Fairweather (2013), Alternating direction implicit Galerkin methods for an evolution equation with a positive-type memory, (to be submitted)

11. Prof. Jacques Henry visited SAU Delhi during March 9th – 24th , 2014 (with full support from NPDE-TCA). During his visit at SAU, he has given four lectures at different Indian Universities . Details of seminar and discussion with research scholars are as follows:

- During his stay at SAU, he interacted with the students and faculty member, particularly he worked with Dr. Kapil Kumar Sharma, Associate professor, Department of Mathematics and his research scholar Mr. Pankaj Mishra. They worked on the topics “Computing Zooming Technique in Simulation of Linear Elliptic type Differential Equation” and did computation on numerical approximation to the solution of elliptic problems using computing zooming technique. He also explored the areas especially in Surgery, where computing zooming technique may be very useful. Generally in surgery doctors need fast result with maximum accuracy in a certain region of interest. So this method could be explored. This renew the collaboration of Dr. Kapil Sharma and planning to submit a joint proposal.
- He has given two seminars at Department of Mathematics , SAU. On 10 March,2014 he has given talk on “Factorization of Linear Elliptic Boundary Value Problems” and on 11 March,2014, he has given seminar on “Inverse ECG problem Using Factorization Methods” . Both talks were very motivating and gave a chance for further study.
- He delivered ML Gogana Memorial lecture at the Kurukshetra University, Kurukshetra (Haryana), India on 15 March,2014. Title of his talk was “Inverse ECG problem Using Factorization Methods”. Talk was very successful and had a good interaction with the faculty members and students over there.
- He visited Department of Mathematics , Panjab University, Chandigarh on 21 March, 2014 where he has given seminar on “Factorization of Linear Elliptic Boundary Value Problems”.

12. Prof. Samir Kaara from Sultan Qaboos University, Sultanate of Oman has visited IIT Bombay during 1st – 10th June, 2014 (with a partial support from NPDE-TCA).for research collaboration and discussions. Following are the publications :

- 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. (submitted). (Minor Revision)
- S Karaa, AK Pani (2014), Optimal error estimates of mixed FEMs for second order hyperbolic integro-differential equations with minimal smoothness on initial data, arXiv preprint arXiv:1401.5134, Journal of Computational and Applied Mathematics (Minor Revision).
- S Karaa, AK Pani (2014), A priori error estimates for finite volume element approximations to second order linear hyperbolic integro-differential equations, arXiv preprint arXiv:1401.5139, IJNAM (Minor Revision)

13. Dr. Soumaya Bajpai visited IITB from March 3rd – 10th , 2014. She was here for research discussion and collaboration. Following is the publication.

- S Bajpai, AK Pani (2014), On a three level two-grid finite element method for the 2D-transient Navier-Stokes equations, arXiv preprint arXiv:1401.5540

14. Dr. Anil Kumar Pundir visited SAU Delhi from February 10th – 17th , 2014 for a research collaboration and discussion on Controllability of PDE (under preparation) with Prof. AK Pani.

B. Proposed and Already Committed Programs in the Year 2013-2014

ACTIVITY 1 : TRAINING PROGRAM

Due to tremendous response for the training programmes the National Scientific Organising committee suggested to increase the members of candidates from 40 to 50 in each training program without an increase in the budget.

1. PG Level Training Program from June 2nd - 21st, 2014 at IIT Guwahati. This Program is co-ordinated by Rajen K. Sinha, Bhupen Deka (IIT Guwahati); S. Baskar and S. Sivaji Ganesh (IIT Bombay). Around 115 candidates had applied and around 50 + local candidates were selected.
2. UG Level Training Program from May 26th–June 14th, 2014 at Maulana Azad National Institute Of Technology, Bhopal. This Program is co-ordinated by Peeyush Chandra, B.V. Rathish Kumar (IIT Kanpur) and Kamal Raj Pardasani (MANIT Bhopal). More than 145 applications were received for this program, out of which 55 + local candidates were selected for the programme.
3. Advanced Level Training Program from May 26th– June 13th, 2014 jointly organised by IISER, Thiruvananthapuram and IIST at Indian Institute Of Science Education and Research, Thiruvananthapuram coordinated by K. R. Arun (IISER, Trivandrum); Raju K. George (IIST Trivandrum); Amiya K. Pani and Neela Nataraj (IIT, Bombay). Around 110 candidates applied and 55 + some local candidates were selected.

ACTIVITY 3 : MODELING WEEK & STUDY GROUP MEETING:

ACTIVITY 4 : INTERNSHIP PROGRAM

Summer Internship Program during May-July 2014. Around 345 applications were received out of which 30 applicants are selected, who will be doing 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. Four candidates will be doing their internship at IIT Bombay, four at SAU Delhi, four at IIT Delhi, three at IIT Guwahati, three at IIT Kharagpur, two at IIST Trivandrum, one at IIT Madras, one at IIT Kanpur, Two candidates at BHU Varanasi, three at IIT Gandhinagar and three at IITB and TIFR-CAM Bangalore.

ACTIVITY 5 : VISITORS PROGRAM

Five international visitors are already proposed and discussions as well as approvals by Scientific Organising Committee are yet to be taken

C. Summary :

C.1 Activities Undertaken During April, 2012 – March, 2013

TRAINING PROGRAM			
Sr. No.	Training Program/Workshop	Date & Venue	Total Participants & Resource Person
1	UG Training Program	June 3 rd – 22 nd , 2013, BIAS, Bhimtal	45 & 10
2	PG Training Program	May 20 th – June 8 th , 2013, IIT M	50 & 12
3	Advanced Level Training Program	June 24 th – July 19 th , 2013, IISc Bangalore	59 & 18
THEMATIC PROGRAM			
1	TCANW-2013	May 27 th – 31 st , 2013, IIT B	35 & 8
2	AWMEDE-2013	July 8 th – 13 th , 2013, IIT Patna	28 & 8
3	NDEDCS-2013	Sept. 23 rd – 28 th , 2013, University of Calcutta	55 & 10
4	NFAA-2013	Oct. 21 st – 29 th , 2013, University of Kashmir, Srinagar	45 & 12
5	Advance workshop on Homogenization-2013	Dec. 9 th – 14 th , 2013, IIST Thiruvananthapuram	22 & 6
6	MFAFEM-2013	Dec. 26 th – Jan. 3 rd , 2014, BITS-Pilani, Goa	28 & 9
7	SPDE-2013	Oct 3 rd – 5 th , 2013, IISc Bangalore	37 & 5
8	OSCM for PDE	March 21 st – 24 th , 2014, SAU Delhi	33 & 3
9	AWCMIEA-2014	Jan 13 th – 17 th , 2014, IIT Kanpur	29 & 10
10	SADEEFF-2014	March 20 th – 24 th , 2014, IIT Kanpur	30 & 8
11	Modeling Week and Study Group Meeting	Modeling Week: Dec. 2 nd – 7 th , 2013, Study Group Meeting: Dec. 9 th –14 th ,	45 & 18

	MWSGMIP-2013	2013, NIT Calicut	
INTERNSHIP PROGRAM			
1	Summer Internship	May and June, 2013 Six Candidates at IITB, one at IIST, Thiruvananthapuram, two at IITK and two at Tezpur University.	14 participants
2	Winternship	December 2013 Four Candidates at IITB, two at IITK and one at IITB and TIFR-CAM	8 participants
VISITORS PROGRAM			
Sr.No.	Visitor's Name	Institute/University	Period of Visit
1	Prof. Phillip L. Roe	University of Michigan	15 th May to 14 th June, 2013 at IITB
2	Prof. Samir Karra	Sultan Qaboos University, Oman	4 th to 9 th June, 2013 at IITB
3	Prof. Boffi Daniele	University of Pavia, Italy	6 th to 20 th July, 2013 at IISc Bangalore
4	Prof. Lucia Gastaldi	University of Brescia, Italy	6 th to 20 th July, 2013 at IISc Bangalore
5	Prof. Carsten Carstensen	University of Humboldt, Germany	20 th Dec – 5 th Jan, 2014 at IITB & BITS Goa
6	Prof. Luca Franco Pavarino	University of Milano, Italy	14 th – 23 rd February, 2014 at IITK
7	Prof. Jean Pierre Raymond	University of Paul Sabatier, France	4 th – 8 th February, 2014 at IITB
8	Dr. Anil Kumar Pundir	BITS-Pilani, Goa	10 th – 17 th February, 2014 at SAU Delhi
9	Prof. Gudo Kanschat	University of Heidelberg	24 th Feb – 6 th March, 2014 at IITB
10	Prof. Mythily Ramaswamy	TIFR-CAM, Bangalore	3 rd – 10 th March, 2014 at IITB
11	Prof. Thirupathi Gudi	TIFR-CAM, Bangalore	3 rd – 10 th March, 2014 at IITB
12	Dr. Soumaya Bajpai	TIFR-CAM, Bangalore	3 rd – 10 th March, 2014 at IITB
13	Prof. Jacques Henry	Universite de Bordeaux, France	9 th – 24 th March, 2014 at SAU Delhi

14	Prof. D.A.S Rees	University of Bath, UK	18 th to 26 th March, 2014 at IITK
15	Prof. Martin Alan Bees	University of Glasgow, UK	20 th March to 4 th April, 2014 at IITK
16	Prof. Dhanumjaya Palla	BITS-Pilani, Goa	21 st – 24 th March, 2014 at SAU Delhi
17	Prof. Graema Fairweather	American Mathematical Society, US	14 th – 29 th March, 2014 at IITB

C.2 PROPOSED ACTIVITY

TRAINING PROGRAM

Sr. No.	Training Program/Workshop	Date & Venue	Total Participants & Resource Person
1	PG Training Program	June 2 nd - 21 st , 2014 at IIT Guwahati	50 + local candidates & 14
2	UG Training Program	May 26 th – June 14 th , 2014 at MANIT Bhopal.	55 + local candidates & 13
3	Advanced Level Training Program	May 26 th – June 13 th , 2014 at IISER Thiruvananthapuram	55 + local candidates & 11

THEMATIC PROGRAM

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

INTERNSHIP PROGRAM

1	Summer Internship 2014	May-July 2013 Four candidates will be doing their internship at IIT Bombay, four at SAU Delhi, four at IIT Delhi, three at IIT Guwahati, three at IIT Kharagpur, two at IIST Trivandrum, one at IIT Madras, one at IIT Kanpur, Two candidates at BHU Varanasi, three at IIT Gandhinagar and three at IITB and TIFR-CAM Bangalore.	30 participants
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