

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 2012-2013.

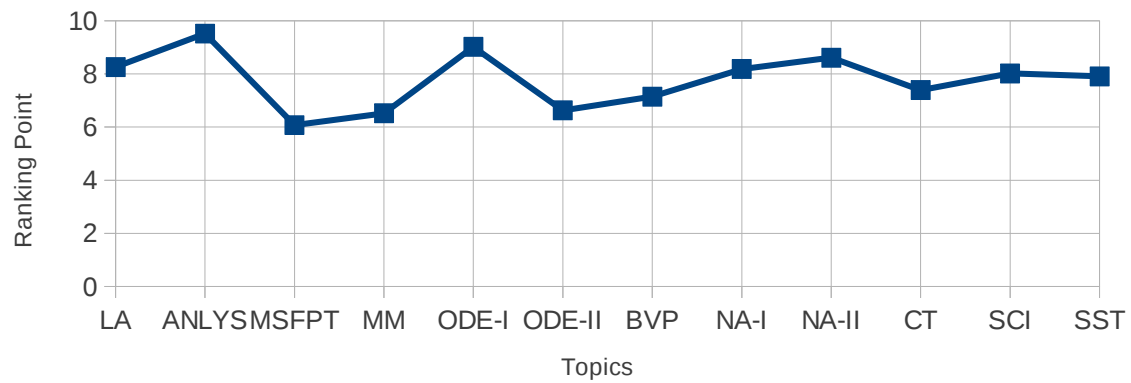
## **A. Activities Undertaken During April, 2012 – March, 2013**

### **ACTIVITY 1 : TRAINING PROGRAMS**

**1.1. Undergraduate Training Program:** With a theme on “*Catch them Young*”, this program was held at IMA, Bhubaneswar during May 7 – 26, 2012 which was coordinated by M.C.Joshi and Swadhin Pattanayak. 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 2012. Brochures had been sent to different universities all over India and was also displayed in NPDE-TCA website. Seventy Nine (79) candidates from all over India applied for this program out of which forty five (45) were selected based on their academic records and recommendations. Forty (41) candidates covering all over India attended this program.

*Resource Persons:* P.C. Das, Narhari Parhi and Krishna Kumar (NISER, Bhubaneswar); P. Dhanumjaya (BITS, Goa); Raju K. George (IIST, Trivandram); Mohan C. Joshi, Neela Nataraj and Amiya K. Pani (IITB); S. Pattanayak (IMA, Bhubaneswar); Amit Apte (TIFR, CAM, Bangalore); B. V. Rathish Kumar and P. Shunmugaraj (IITK). 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.

## Feedback for UG Level Training Program



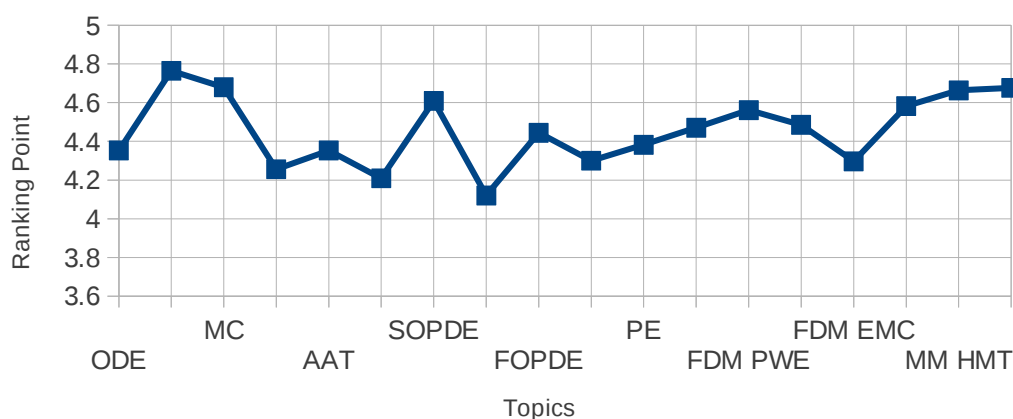
(Linear Algebra (LA), Analysis (ANLYS), Metric Space and Fixed Point Theorem (MSFT), Mathematical Modelling (MM), Ordinary Differential Equations – I (ODE I), Ordinary Differential Equations – II (ODE II), Boundary Value Problem (BVP), Numerical Analysis-I (NA), Numerical Analysis-II (NA), Control Theory (CT), Scilab (SCI), Scilab Spoken Tutorial (SST))



**1.2. Post-Graduate Training Program:** This Program was held at IIT Delhi during 13<sup>th</sup> May to 2<sup>nd</sup> June, 2012 which was coordinated by K.Sreenadh with V.V.K. Srinivas Kumar from IITD and S.Baskar with S.Sivaji Ganesh from IITB. 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:* K. Sreenadh , V.V.K.Srinivas Kumar, Girija Jayaraman and Balaji Srinivasan (IITD); M.T. Nair (IITM); R. K. Panda (University of Delhi); V. Raghavendra and B. D. Rathish Kumar (IITK) ; Amiya K. Pani, S. Baskar and S. Sivaji Ganesh (IITB); A. S. Vasudeva Murthy, K. Sandeep, P.S. Datti and G. D. Veerappa Gowda (TIFR CAM, Bangalore) and S. Kundu (IITD). This program was also advertised in the same way as the UG Level program in the month of March 2012. Eighty One (81) Candidates applied for this program and approximately forty two (42) had been selected. Finally forty two (42) candidates covering all over India attended the program. Participants gave a good response to Measure Theory,  $L^2$  spaces and Multivariable Calculus, the graph of which is shown below.

Feedback for PG Level Training Program



(ODE: Existence & Stability (ODE), Measure Theory &  $L^2$  Space(MT), Multivariable Calculus (MC), Fixed Point Theorem (FPT), Ascoli-Arzelà Theorem (AAT), Matlab (ML), Classification of Second Order PDE (SOPDE), Green Functions, Maximum Principles (GF), First Order PDE, Method of Characteristics (FOPDE), Real Analytic Solutions, CK Theorem (RAS), Parabolic Equations, Existence, Maximum Principle(PE), Second Order Wave Equations (SOWE), FDM for Parabolic & Wave Equations (FDM PWE), FDM for Hyperbolic Equations & Conservations Laws (FDM HECL), FDM for elliptic and Matrix Computations (FDM EMC), Mathematical Modelling (MM), Mathematical Models like Heat & Mass Transfer, Fluid Flows (MM HMT), On Application of Functional Analysis to Weak solutions (AFA)

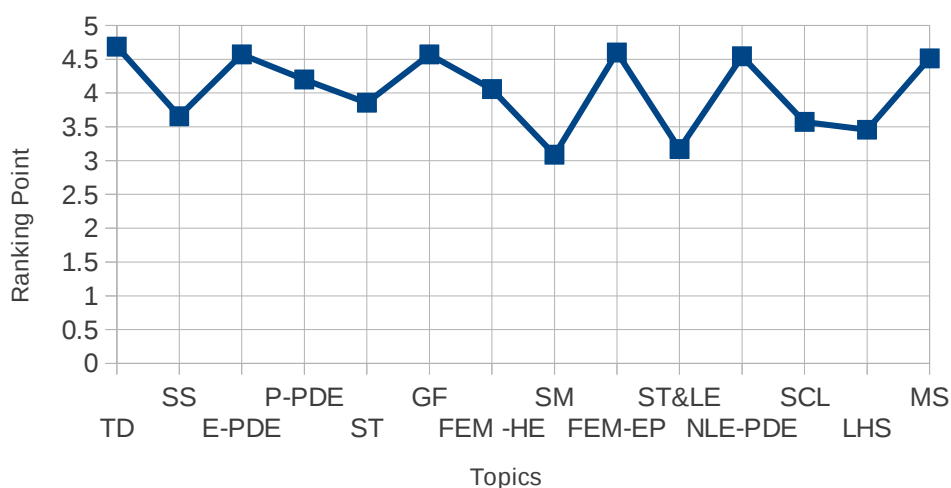




**1.3. Advanced Level Training Program:** This program was held at IIT Bombay during 10<sup>th</sup> – 30<sup>th</sup> June 2012, which was co-ordinated by Amiya K.Pani and Neela Nataraj. It was focused on advanced topics in different aspects of Partial Differential Equations. The target audience comprised of Research Scholars and senior Post Graduate students. It was also open to active faculty from colleges and universities. The main aim was to provide a sound mathematical foundation for research and expose participants to frontier areas of research on Partial Differential Equations and to create a pool of trained manpower to support advancement of science and technology in the country. About 41 participants were participated in the program.

*Resource Persons:* V. Raghavendra and Pravir Dutt (IIT Kanpur), Amiya Kumar Pani and Neela Nataraj (IIT Bombay) ; M.T. Nair (IIT Madras); R.K.Sinha (IIT Guwahati); A.S. Vasudeva Murthy, K. Sandeep , Rajib Dutt, M. Vanninathan and P.S. Datti (TIFR, Bangalore); A.K. Nandakumaran, Mythily Ramaswamy and Thirupathi Gudi (IISC, Bangalore). Many topics such as Theory of Distribution, Elliptic PDE, Galerkin Formulation and FEM, Non-linear Elliptic PDE & Matlab sessions which were covered in this program were well-appreciated by the audience. The graphical representation of the feedback data and photographs taken during the program is shown below.

Feedback for Advanced Level Training Programme



(Theory of Distribution (TD), Sobolev Spaces (SS), Elliptic PDE (E-PDE), Parabolic PDE (P-PDE), Spectral Theory (ST), Galerkin Formulation (GF), FEM for Heat Equation (FEM-HE), Spectral Methods (SM), FEM for Elliptic Problems (FEM-EP), Semigroup Theory and Linear Evolution Equations (ST&LE), Non-Linear Elliptic PDE (NLE-PDE), Scalar Conservation Lab (SCL), Linear Hyperbolic System (LHS), Matlab Session (MS))





## ACTIVITY 2 : ADVANCED THEMATIC PROGRAM

**2.1 Advanced Level Workshop on Differential Equations in Ecology & Epidemiology (AWDEEE 2012):** This workshop was held at IIT Roorkee during 10<sup>th</sup> – 14<sup>th</sup> October, 2012 which was co-ordinated by Sunita Gakkhar. The main objective of this program was to expose participants to the advanced topics, current trends & future directions in these areas and deliver the state of the art lectures dealing with Mathematical Models in Ecology and Epidemiology by the domain experts. This program also focused to bring together the researchers working on ecological & epidemiological systems and to form a working group at National level in order to chalk out a plan for future activity. As a result a second workshop is proposed in IIT Patna during July 8<sup>th</sup> to 13<sup>th</sup>, 2013. Advertisement for this program was done in the month of August, 2012. Brochures had been sent to different universities all over India and was also displayed in NPDE-TCA website. Post-graduate (Mathematics) students and Researchers working in ecology and epidemiology were selected based on recommendations and their academic records. Fifty Four (54) candidates from all over India applied for this program, of which thirty seven (37) were selected.

*Resource Persons: Sunita Gakkhar (IITR); Karmeshu (JNU, Delhi); Arni S.R. Srinivasa Rao (ISI, Kolkata); V. Srihari Rao (JNTU); Malay Banerjee (IITK); Vishwesh Guttal (ISC Bangalore); P.D. Srinivasu (Vishakhapatnam); and Ram Naresh (HBTI, Kanpur).*



**2.2 Advanced Workshop on Mathematical Theory of Control and Numerics (MTCN-2012):** This Program was held at IIST Thiruvananthapuram for ten days during 21<sup>st</sup> – 30<sup>th</sup> November, 2012 which was coordinated by K. Saktivel and Raju K. George. This ten days long workshop was also partially supported by Indian Space Organisation through IIST. The main objective of this workshop was to explore the concepts of linear and nonlinear control systems mathematically as well as numerically by interacting with a group of eminent scholars from all over India. Apart from the theory, hands-on-computation and exposure to problems in space research organisation were a part of this workshop.

*Resource Persons: Amiya K. Pani (IITB), K. Balachandran (Bharathiyar University, Coimbatore); M.V. Dhekane (VSSC, Thiruvananthapuram), A.K. Nandakumaran (IISc, Bangalore), N. Sukavanam (IIT Roorkee); M. Thamban Nair (IIT Madras); V. Raghavendra (IITK); N. Parhi (NISER, BBSR), K. Saktivel, Raju K George and Sam K. Zachariah (IIST, Thiruvananthapuram).* Topics covered under this program were Solution of Linear Systems using Transition Matrix, Controllability and Observability of ODE & DAE, Stability and Stabilizability, Optimal Control Problems, Computation of Steering Controls in Matlab and Frequency Domain as well as Spatial Approach to Control Systems.



**2.3 Advanced Workshop on Evolution Equations: Theory, Methods & Applications (AWEETMA-2012):** This program was held at IIT Kanpur during 2<sup>nd</sup> – 6<sup>th</sup> December, 2012, coordinated by Rathish Kumar and D. Bahuguna. The workshop aimed at familiarizing researchers working in India with the current trends in evolution equations and motivate them to take up challenging problems in this and related areas of research.

*Resource persons:* N. Sukavanam (IITR); Amiya K. Pani (IITB); Rajen K. Sinha (IITG); V. Raghavendra, D. Bahuguna, B.V. Rathish Kumar, Pravir Dutt (IITK) and P. Veeramani (IITM). Topics covered were Fixed Point Theorem & Applications, Monotone Operators, Semi-Group Theory Based Methods, Applications to Diffusion and Sub-diffusion Problems, Galerkin Methods, Control Theory and Time Discretization. This workshop was followed by a National Conference.

**2.4 Advanced Workshop on “Non-Standard Finite Element Methods” (AWNSFEM 2013) :**

This program was held during February 11-15, 2013 at IIT Bombay, co-ordinated by Neela Nataraj and Amiya K Pani. Objective was to expose research scholars to the broad area of non-standard finite element methods, which may be superior to the standard finite element methods in specific applications. The participants were provided with an overview of the methodologies of discontinuous Galerkin finite element methods and non-conforming finite element methods. The workshop also aimed at bringing together researchers working on computational partial differential equations in India and foster interaction and collaboration with the eminent resource persons. Brochures had been sent to different universities all over India and was also displayed in NPDE-TCA website. Participants were selected based on their academic records and recommendations. Thirty two (32) participants participated in this program.

*Resource Persons:* Susanne C. Brenner (Louisiana State University, Baton Rouge), Carsten Carstensen (Humboldt University, Berlin), Amiya K Pani (IIT Bombay) Thirupathi Gudi (IISc, Bangalore), Li-yeng Sung (Louisiana State University, Baton Rouge). 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.



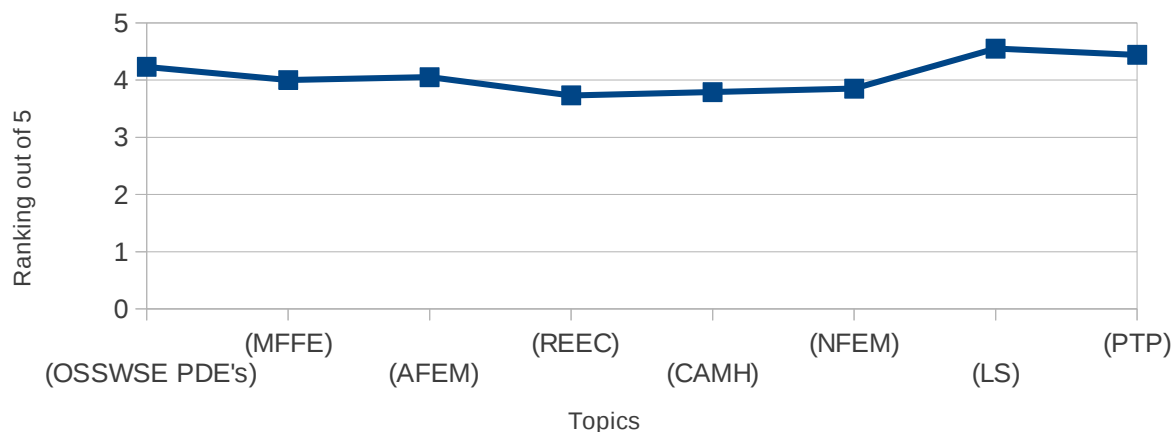
## 2.5. 3rd Indo-German Workshop on “Adaptive Finite Element Methods”

**(AWAFEM-2013):** IMA Bhubaneswar hosted this program during February 22 – March 2, 2013. This program was coordinated by C. Carstensen (Humbolt University of Berlin), Amiya K Pani (IITB) and S. Padhy (IMA Bhubaneswar). The aim of the program was to expose young researchers particularly from India to efficient and reliable algorithms related to adaptivity feedback and a posteriori error control, to bring together and to provide a common platform for exchanging ideas and results pertaining to the challenges in these front line areas of FEM. and to expose the participants to hands-on-computing through Computational Lab Sessions. Research Scholars and Researchers working on Computational PDE in various Indian Universities, Institutes and Research & Development Organizations were the targeted audience. Total 24 participants were selected based on their biodata and recommendation letter. One of the distinctive feature of this workshop was students participation through group projects in the last couple of days. This nine (9) days long workshop was also partially supported by IMA, BBSR.

*Resource Persons:* Ph. Brinkmann (Humboldt University, Berlin), Carsten Carstensen (Humboldt University, Berlin), D. Gallistl (Humboldt University, Berlin), Thirupathi Gudi (IISc, Bangalore), Amiya K. Pani (IITB), Susanne C. Brenner & Li Yeng Sung (Louisiana State University). From the feedback: Overview of sobolev spaces and weak solution to elliptics PDEs, Lab sessions and Participation through project were well received. The graphical representation of the feedback data and photographs taken during the program is shown below.

### AWAFEM - 2013

Feedback Graph



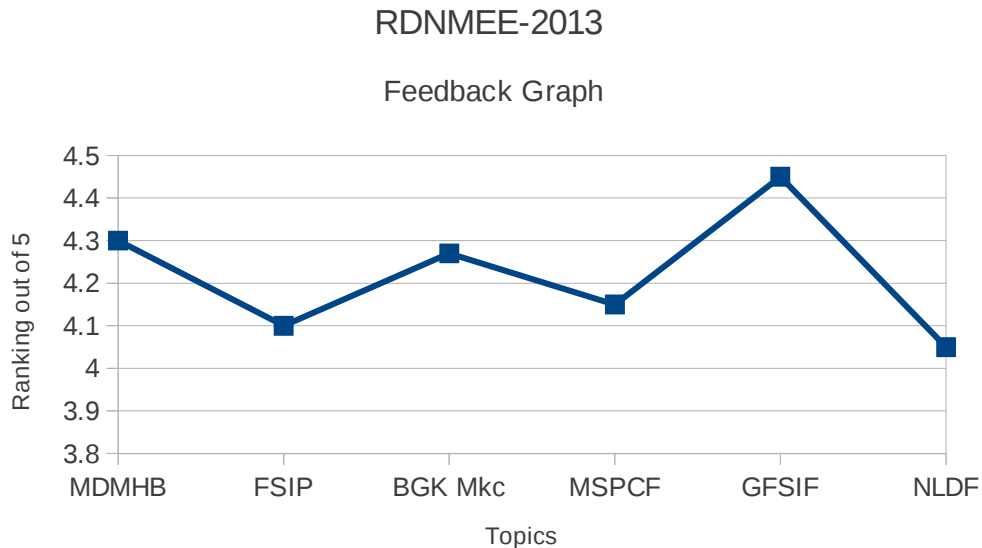


Overview of Sobolev Spaces and Weak solution to elliptics PDEs (OSSWSE PDE's), Mathematical Foundation of Finite Element (MFFE), Adaptive Finite Element Methods (AFEM), Reliable and Efficient Error Control (REEC), Convergence of Adaptive Methods with Hands on Computation (CAMH), Nonstandard FEM (NFEM), Lab classes (LS), Participation Through Projects (PTP)



**2.6 Workshop on Recent Developments on Numerical Methods for Evolution Equations (RDNMEE-2013) :** A four day workshop was held at IIT Bombay during March 18-21, 2013 which was co-ordinated by S. Baskar, Amiya K Pani (IITB) and Phoolan Prasad (IISc Bangalore). The main objective of this program was to give a flavor of advanced topics, current trends and future directions in the area of numerical methods to evolution partial differential equations (PDEs) and deliver some state of the art lectures on the topic by experts. Also this programme aimed to be an initiator to bring together the researchers working in this field. The target audience comprised of applicants with Post-graduate (Mathematics), final year, M.Tech (Aerospace, Mechanical) final year, Ph.D (Mathematics, Aerospace, Mechanical) background. More than 30 participants attended this workshop.

*Resource Persons:* K.R. Arun (IISER, Thiruvananthapuram), Maria Lukacova (Johannes Gutenberg University), Phoolan Prasad (IISc, Bangalore), M.K.Kadalbajoo (IIT Kanpur), S.Sundar (IIT Madras), Y.V.S.S. Sanyasiraju (IIT Madras). The graphical representation of the feedback data and photographs taken during the program is shown below.



Multi-dimensional methods for hyperbolic balance laws (MDMHB), Fluid-structure interaction problems (FSIP), BGK model and kinetic schemes (BGKMKC), Multi-scale problems in compressible flows (MSPCF), Grid free schemes for incompressible flows(GFSIF), Non-linear diffusion filtering (NLDF).



### ACTIVITY 3 : MODELING WEEK & STUDY GROUP MEETING

**3.1 Indo-European Modeling Week and Study Group Meeting on Industrial Problems (IEMWSGMIP-2012):** This program was hosted at M.S. University of Baroda, (MSU) Vadodara in collaboration with Industrial Mathematics Group at IITB and Lapeenranta University of Technology of Technology, Finland (Modeling Week: 3<sup>rd</sup> – 8<sup>th</sup>, December 2012, Study Group Meeting – 10<sup>th</sup> – 15<sup>th</sup>, December 2012) which was coordinated by Dhanesh Patel from M.S. University of Baroda and Amiya K. Pani from IITB. Additionally, the interaction with participating industries in our country would bring new opportunities in terms of jobs and long-term project associations. In order to make it more effective for the student participants, it had a Modelling Week just before Study Group Meeting. It was proposed to hunt for sizable number of real life problems from industry, spread all across India. Information regarding this program was advertised in the month of October, 2012.

*Resource Persons: M.K.Abeyratne (University of Ruhuna, Sri Lanka); Bhathawala P.H.(SGU, Surat) Dhanesh Patel, D.C.Vakaskar, V.D.Pathak, S.Ramamohan (M.S.University of Baroda); Ewald H. Lindner (Johannes Kepler University, Austria; Matti Heilio, Tuomo Kauranne (Lappeenranta University of Technology, Finland); Mohan C. Joshi (IITB); Federico Liberatore (Rey Juan Carlos University, Madrid, Spain); S. Panda (NIT, Calicut); Peregrina Quintela (Santiago De Compostela, Spain); Raju K. George (IIST, Trivandrum); Keijo Ruotsalainen (University of Oulu, Finland); Russell Davies (Cardiff University, United Kingdom); Susana Serna (Universitat Autònoma De Barcelona, Spain); Wil H.A. Schilders (Eindhoven University of Technology, Netherlands). Sixty Eight( academic) covering all over India, and Mr. L.W. Somathilake and Mrs. M.H.M.R.S. Dilhani (University of Ruhuna, Srilanka) from Srilanka were selected for this programme.*

***For Modelling Week, the following Industries participated***

*Banco Products (I) Ltd Vadodara; Chemical Engineering Division, Research Centre Indian Petrochemicals Corporation Limited, Vadodara; ABB Limited, Vadodara ; Birla Century; GERI, Baroda; Department of Botany The M. S. University of Baroda Forest Department Project.*

***For Study Group Meeting, the following industries participated***

*Suzlon Energy Ltd. One Earth, Opp. Magarpatta City, Hadapsar, Pune; Global R & D Centre, Crompton Greaves Ltd., Mumbai; ATR-Asahi Glass Process Systems (P) Ltd., GIDC, Vadodara; Department of Plant Molecular Biology & Biotechnology, Navsari Agricultural University, Gujarat ; Shri Dinesh Mills Ltd., Vadodara; Gujarat Alkalies and Chemicals Limited, Vadodara; RRS Shares and Stock Brokers Private Limited, Baroda; Sun Pharmaceuticals and Department of Pharmacy Faculty of Technology & Engineering The Maharaja Sayajirao University of Baroda Gujarat ; Global R&D Centre, Crompton Greaves, Ltd. Mumbai; GERI, Vadodara.*

*Photographs taken during the program is shown below.*







## 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 were selected to do their internship with eminent researchers.

**4.1 Summer Internship:** This program was in the month of May and June, 2012. Thirty Seven Candidates from all over India applied for this Internship Program. Out of which five candidates from various institutes like Calicut University, ICT Mumbai, SVNIT Surat, IITKGP and IITR were selected. Four Candidates did their Internship at IIT Bombay and one candidate did the internship at Indian Institute of Space Science and Technology (IIST), Thiruvananthapuram, Kerala. 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 :

Forty Two (42) candidates from all over India applied for this Winternship Programme. Out of which Eight candidates from various institutes like IIT Kanpur, IIT Delhi, IIT Guwahati, NIT Surathkal and NIT Rourkela were selected. Seven Candidates did their Winternship at IIT Bombay and one candidate at IIT Roorkee. At the end of their winternship each of them submitted a report.

## ACTIVITY 5 : VISITOR PROGRAMME

1. Prof. Carsten Carstensen, Department of Mathematics from Humboldt University of Berlin visited Department of Mathematics, IIT Bombay as a distinguished professor (supported by the Department) for a period of one month from Feb.-March, 2012 for the on-going research collaboration on adaptive FEM. During his visit, we had organised an advanced level workshop on Adaptive finite element methods in IIST, Trivandrum with full financial support from IIST.

- *C. Carstensen, A. Dond, Neela Nataraj and A.K. Pani have worked on “Aposteriori mixed finite element error analysis for non-symmetric and indefinite elliptic problems”.*

2. Prof. Sussane C. Brenner (Department of Mathematics Louisiana State University of LA) visited Department of Mathematics, IIT Bombay as a distinguished professor (supported by the Department) for a period of one month from Feb–March, 2013 for the on-going research collaboration. During her visit, we had organised an advanced level workshop on “Non Standard Finite Element Methods” at IIT Bombay and 3<sup>rd</sup> Indo-German Workshop on “Adaptive Finite Element Methods” at IMA, Bhubaneswar.

3. Prof. Carsten Carstensen (Humboldt University of Berlin) visited the Department for a period of one month during Feb-March, 2013. Apart from being a resource person in the Advanced Workshop on Non-Standard Finite Element Methods during February 11-15, 2013, he was one of the main organizer of 3<sup>rd</sup> Indo-German Workshop on Adaptive Finite Element Methods which was held in IMA, BBSR during Feb 22-March 2, 2013. During his visit he collaborated with Amiya K. Pani and Neela Nataraj (IITB) on Adaptive Finite Volume Methods and Adaptive Finite Element Methods. As a result, a research manuscript entitled Unified Analysis and Comparison Results for First Order FVM is in its final stage of completion.

4. Prof. Li-Yeng Sung (Department of Mathematics Louisiana State University of LA) visited Department of Mathematics, IIT Bombay (partially supported) for a period of one month from Feb–March, 2013 for the on-going research collaboration. During his visit, we had organised an advanced level workshop on “Non Standard Finite Element Methods” at IIT Bombay and 3<sup>rd</sup> Indo-German Workshop on “Adaptive Finite Element Methods” at IMA, Bhubaneswar.

5. Dr. Samir Karaa, Department of Mathematics and Statistics from Sultan Qaboos University, Sultanate of Oman, visited IIT Bombay under the NPDE-TCA Program from June 03–09, 2012 and only a partial support in terms of honorarium is provided by NPDE-TCA. During his visit he collaborated with Amiya K. Pani an on-going research program on FEM for hyperbolic PDE.

- *Samir Karaa, Amiya K.Pani and S.Yadav have worked on “An hp-estimates for linear hyperbolic Integro differential equations”. (Submitted)*
- *Samir Karaa (with a partial support from NPDE-TCA) visited also during 11<sup>th</sup> to 16<sup>th</sup> Feb, 2013 and collaborated with Amiya K Pani on Mixed FEM for Hyperbolic Integro Differential Equations. (manuscript is almost ready for submission).*

6. Dietmar Gallistl, Institute of Mathematics from Humboldt-Universitat of Berlin had been invited to Department of Mathematics, IIT Bombay during the period 7<sup>th</sup>-13<sup>th</sup> October, 2012 and collaborated with our on-going research program under NPDE-TCA. A nominal support was provided through NPDE-TCA.

- *C.Carstensen, D. Gallistl and Neela Nataraj worked on “Comparison result of non-standard  $P_2$  Finite element Methods for the Biharmonic Problems”.*

7. Prof. Maria Lukacova of Institut für Mathematik, Johannes Gutenberg – Universität visited Department of Mathematics, IIT Bombay for a period of one month March, 2013. She had also visited IISc, Bangalore. During her visit at IIT Bombay, we had organised an advanced workshop on “Recent Developments on Numerical Methods for Evolution Equations” (RDNMEE-2013). Further she also participated in an ongoing research collaboration on hyperbolic PDE with Phoolan Prasad (IISc Bangalore), S. Baskar (IITB) and K.R.Arun (IISER, Thiruvananthapuram).

## **B. Proposed and Already Committed Programmes in the Year 2013-2014**

*(2013 has been declared as the year of “Computational PDE”)*

### **ACTIVITY 1 : TRAINING PROGRAM**

Due to tremendous reponse 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 20<sup>th</sup> May 2013 – 8<sup>th</sup> June 2013 at IIT Madras. This Program is co-ordinated by S. Sundar, Y.V.S.S. Sanyasiraju (IITM); S. Baskar and S. Sivaji Ganesh (IITB). Around 150 candidates had applied and around 50 + local candidates were selected.
2. UG Level Training Program from 3<sup>rd</sup> – 22<sup>nd</sup> June 2013, Uttarakhand Technical University. This Program is co-ordinated by Anant K Pant (Director, BIAS, Bhimtal); R.P. Pant, Mahesh Joshi (Kumaun University, Nainital); Mohan C Joshi (IITB). More than 140 applications were received for this program, out of which 55 + local candidates were selected for the programme.
3. Advanced Level Training Program in IISc Bangalore combined with CIMPA School.  
Advanced Level Training Program: June 24<sup>th</sup>-July 7<sup>th</sup>, 2013 coordinated by Thirupathi Gudi & A.K. Nandakumaran (IISc Bangalore) and Neela Nataraj (IITB).  
CIMPA Research school: July 8<sup>th</sup>-19<sup>th</sup>, 2013. coordinated by Dr. Thirupathi Gudi (IISc Bangalore) and Dr. Blanca Ayuso de Dios (Centre de Recerca Matematica (CRM), Spain).  
Around 200 candidates applied and 40 + some from abroad candidates were selected.

CIMPA-NPDE Research School is titled as “Current Trends in Computational Methods for PDEs”. In the first part topics related to our advanced level training program will be covered. In the second part, the aim of the summer school is to provide students an overview of the techniques that allow one to address the computational challenges that are encountered in different applications. Some of these methodologies include: high order approximation, mixed finite elements, discontinuous Galerkin (DG) methods, domain decomposition and mul-tilevel techniques, adaptivity, a-posteriori error analysis, approximation by sampling methods, sparse grids, ENO and WENO schemes and TVD-reconstructions. *Resource Persons* : Prof. Mark Ainsworth (University of Strathclyde, UK); Prof. Daniele Boffi (Universita' degli Studi di Pavia, Italy); Prof. Lucia Gastaldi (Universita' di Brescia, Italy); Prof. Susanne Brenner and Prof. Li-yeng Sung (Louisiana State University, USA); Prof. Siddhartha Mishra (Seminar f' r Angewandte Mathematik (SAM-ETH); Prof. Fabio Nobile (Mathematics Institute of Computational Science and Engineering (MATHICSE); Ecole Polytechnique (Fdrale de Lausanne (EPFL); Lausanne (Switzerland); Prof. Raul Tempone, King Abdullah (University of Science and Technology (KAUST) Saudi Arabia); Prof. Andreas Veeser (Universit` degli Studi di Milano, Italy).



## ACTIVITY 2 : ADVANCED THEMATIC PROGRAM

1. Advanced Level Workshop on "Theoretical and Computational Aspects of Nonlinear Waves" (TCANW-2013) during May 27<sup>th</sup> – 31<sup>st</sup>, 2013 at IITB. This program is co-ordinated by S. Baskar and Amiya K. Pani (IITB).
2. Advanced Level Workshop on “Mathematical Epidemiology and Differential Equations” during July 8<sup>th</sup> - 13<sup>th</sup>, 2013 at IIT Patna. This program is co-ordinated by P.K.Srivastava (IIT Patna) and Peeyush Chandra (IIT Kanpur).
3. Advanced Level Workshop on “Non-Linear differential Equations” during September 23<sup>rd</sup> -28<sup>th</sup>, 2013 at Department of Applied Mathematics, University of Calcutta. The program is co-ordinated by Dr. Susmita Sarkar (University of Calcutta).
4. Advanced Level Workshop on entitled “Stability Analysis of Differential Equations with emphasis on Fluid Flow Problems”. This program is co-ordinated by S. Ghorai and B.V. Rathish Kumar (IIT Kanpur). Advanced Workshop: 2nd – 6<sup>th</sup> Dec., 2013 and National Symposium: 7<sup>th</sup> – 8<sup>th</sup> Dec., 2013.
5. Advanced Level Workshop on "Computational Methods for Integral Equations & Applications" during January, 2014 at Department of Mathematics , IIT Kanpur. This program is co-ordinated by Prof. Akash Anand and Prof. B.V. Rathish Kumar (IIT, Kanpur).

## ACTIVITY 3 : MODELING WEEK & STUDY GROUP MEETING:

1. NIT Calicut will be organizing this program in the month on December, 2013.

## ACTIVITY 4 : INTERNSHIP PROGRAM

Summer Internship Program during May-July 2013. Around 145 applications were received out of which 18 applicants are selected, who will be doing their internship in institutes like IIT Bombay, IIT Kanpur, IIST Trivandrum, IISc Bangalore and Tezpur University. Eight candidates will be doing their internship at IIT Bombay, five at IIT Kanpur, two at Tezpur University, Assam, two at IIST Trivandrum and one at IISc Bangalore.

## ACTIVITY 5 : Visitor's Program

Possible International Visitors.

Sr. no.	Visitor's Name	Month
1	Prof. Philip L. Roe (Michigan University)	May 15 – June 30, 2013
2	Prof. Daniele Boffi (Universita degli Studi di Pavia, Italy)	June 23 – July 20, 2013
3	Prof. Lucia Gastaldi (Universita di Brescia, Italy)	June 23 – July 20, 2013
4	Prof. Fernando Reitich (University Minnesota, Minneapolis)	January, 2014
5	Dr. Andrew Rees (University of Bath,UK)	Dec 2013 - Jan 2014

## 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	May 7 <sup>th</sup> – 26 <sup>th</sup> , 2012, IMA, BBSR	41 & 12
2	PG Training Program	May 13 <sup>th</sup> – June 2 <sup>nd</sup> , 2012, IIT D	42 & 16
3	Advanced Level Training Program	June 10 <sup>th</sup> - 30 <sup>th</sup> , 2012, IIT B	41 & 14

#### THEMATIC PROGRAM

1	AWDEE-2012	Oct. 10 <sup>th</sup> – 14 <sup>th</sup> , 2012, IIT R	37 & 8
2	MTCN-2012	Nov. 21 <sup>st</sup> – 30 <sup>th</sup> , 2012, IIST Thiruvananthapuram	38 & 11
3	AWEETMA-2012	Dec. 2 <sup>nd</sup> – 6 <sup>th</sup> , 2012, IIT K	30 & 8
4	AWNSFEM 2013	Feb. 11 <sup>th</sup> -15 <sup>th</sup> , 2013, IIT B	32 & 5
5	3rd Indo-German Workshop on AWAFFEM-2013	Feb.22 <sup>nd</sup> – March 2 <sup>nd</sup> , 2013, IMA BBSR	24 & 7
6	RDNMEE-2013	March 18 <sup>th</sup> -21 <sup>st</sup> , 2013, IIT B	30 & 6
7	Modeling Week and Study Group Meeting IEMWSGMIP-2012	Modeling Week: Dec. 3 <sup>rd</sup> – 8 <sup>th</sup> , 2012, Study Group Meeting: Dec. 10 <sup>th</sup> –15 <sup>th</sup> , 2012, M.S. University of Baroda	70 & 18

#### INTERNSHIP PROGRAM

1	Summer Internship	May and June, 2012 Four Candidates IITB and one at IIST, Thiruvananthapuram, Kerala.	5 participants
2	Wintership	December 2012 Seven Candidates at IITB and one at IITR	8 participants

#### VISITORS PROGRAM

Sr. No.	Visitor's Name	Institute/University	Period of Visit
1	Prof. Carsten Carstensen	Humbolt University of Berlin	Feb-March, 2012 Feb 11-15, 2013
2	Prof. Sussane C. Brenner	Louisiana State University of LA	Feb-March, 2013
3	Prof. Li-Yeng Sung	Louisiana State University of LA	Feb-March, 2013
4	Dr. Samir Karaa	Sultan Qaboos University	June 3–9, 2012 Feb 11-16, 2013
5	Dietmar Gallistl	Humbolt University of Berlin	Oct 7-13, 2012
6	Prof. Maria Lukacova	Institut für Mathematik, Johannes Gutenberg – Universität	March 2013

## C.2 PROPOSED ACTIVITY

### TRAINING PROGRAM

Sr. No.	Training Program/Workshop	Date & Venue	Total Participants & Resource Person
1	PG Training Program	May 20 <sup>th</sup> – June 8 <sup>th</sup> , 2013, IIT M	50 + local candidates & 12
2	UG Training Program	June 3 <sup>rd</sup> – 22 <sup>nd</sup> , 2013, Bhimtal	55 + local candidates & 10
3	Advanced Level Taining Program with CIMPA School	Advanced Level Training Program: June 24th-July 7th, 2013 CIMPA Research school: July 8th-19th, 2013 IISc Bangalore	40 + some abroad candidates & 19

### THEMATIC PROGRAM

1	TCANW-2013	May 27 <sup>th</sup> – 31 <sup>st</sup> , 2013, IIT B	9 resoucer persons
2	MEDE-2013	July 8 <sup>th</sup> - 13 <sup>th</sup> , 2013, IIT P	10 resource persons
3	NLDE-2013	Sept. 23 <sup>rd</sup> -28 <sup>th</sup> , 2013, University of Calcutta.	12 resource persons
4	SADE-2013	Advanced Workshop: 2 <sup>nd</sup> – 6 <sup>th</sup> Dec, 2013 National Symposium: 7 <sup>th</sup> – 8 <sup>th</sup> Dec, 2013, IIT K	
5	CMIEA	Jan., 2014 at IIT K	
6	Modeling Week & Study Group Meeting	Dec., 2013 at NIT Calicut	

### INTERNSHIP PROGRAM

1	Summer Internship 2013	May-July 2013 Eight candidates at IIT B, five at IITK, two at Tezpur University, Assam, two at IIST Trivandrum and one at IISc Bangalore.	18 participants
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