Centre for Mathematical sciences (CMS)
Apaji Institute of Mathematics & Applied Computer Technology
Banasthali University
Banasthali 304022 (Rajasthan)

National Workshop
on
Linear and Non-Linear Systems

December 15-19, 2011
Sponsored
by
Department of Science & Technology
Government of India, New Delhi

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ABOUT THE WORKSHOP

A linear system is a mathematical model of a system based on the use of a linear operator and nonlinear system is a model where the variable(s) to be solved for cannot be written as a linear combination of independent variables. Linear systems typically exhibit features and properties that are much simpler than the general, nonlinear case. But, nonlinear problems are of more interest to engineers, physicists and mathematicians because most physical systems are inherently non-linear in nature. As a mathematical abstraction or idealization, linear systems find important applications in automatic control theory, signal processing, and telecommunications. Other way, nonlinear systems are difficult to solve but provide to interesting phenomena such as chaos, dynamical systems etc. A wide variety of application areas exist, where linear and nonlinear systems are used extensively: fluid mechanics, elasticity, relativity, biology etc. The Seminar was intended for young faculty and researchers from Mathematical Sciences, Computer Science and Biological Sciences. The participants were required to be familiar with non-linear partial differential equations.

Eminent speakers in the field of who have consented tentatively are:

1. Prof. Karmeshu, JNU, Delhi
2. Prof. K.N. Rai, IT-BHU, Varanasi
3. Prof. Balram Dubey, BITS-Pilani
4. Prof. B.D. Sharma, JIIT, Noida
5. Prof. P.G. Siddheshwar, Bangalore University
6. Dr. Ashok Jangid, Dayalbagh Educational Institute, Agra (MATLAB Instructor)
7. Dr. Phool Singh, ITM University, Gurgaon (MATLAB Instructor)

Participants: Participation was invited from all over the country by sending invitation to the Heads of the Departments of Mathematics/Statistics/Computer Science of various Institutes/Universities and Research Organizations and also by announcing on the website of Banasthali University www.banasthali.org. The advisory committee scrutinized the applications received and short-listed based on the relevance of the area of specialization with their research interest. The application of sixty-five candidates from all over India was received and out of them thirty-five candidates was shortlisted and invited. In addition to this, faculty members and students from Banasthali Vidyapith also participated.

Programme: The programme comprised of theory and Lab sessions in addition to Inaugural and Valedictory session. The detailed Program Schedule was as follows:

Centre for Mathematical Sciences (CMS)
Apaji Institute of Mathematics & Applied Computer Technology
Banasthali University
PROGRAM SCHEDULE

National Workshop on Linear and Nonlinear Systems

(December 15-19, 2011)

Sessions Date	**09:30 AM to 11.15 AM**	**11.15 AM to 11:45 AM**	**11.45 AM to 01:00 PM**	**01.00 PM to 02:30 PM**	**02.30 PM to 3.45 PM**	**03.45 PM to 04.15 PM**	**04.15PM to 05.15 PM**	**05.15 PM to 06.15 PM**
Dec.15, 2011	Registration (**09:30 AM to 10:30 AM**) Inaugural Session (**10:30 AM to 11:15 AM**)	High Tea	PGS	Lunch	PGS	Tea	Matlab Session	

Sessions Date	**10:00 AM to 11.00 AM**	**11.00 AM to 11:30 AM**	**11.30 AM to 12:30 PM**	**12:30 PM to 01:30 PM**	**01.30 PM to 3.00 PM**	**03.00 PM to 04.00 PM**	**04.00 PM to 04.15 PM**	**04.15 PM to 05.15 PM**	**05.15 PM to 06.15 PM**
Dec.16, 2011	PGS	Tea	PGS	Matlab Session	Lunch	Matlab Session	Tea	BD	BD
Dec.17, 2011	BDS	Tea	BDS	BD	Lunch	BDS	Tea	Matlab Session	Matlab Session
Dec.18, 2011	KAR	Tea	KAR	KAR	Lunch	KNR	Tea	--	--
Dec.19, 2011	KNR	Tea	KNR	Valedictory	Lunch				

Prof. P. G. Sidheshwar (PGS):	1.Differential transform methods for nonlinear differential equations, 2. *Finite element methods for nonlinear ordinary differential equations and* 3. Homotopy methods for nonlinear equations
Prof. K.N. Rai (KNR):	1. Linear system. 2. Critical points and stability in linear system. 3. Autonomous systems and stability.
Prof. Karmeshu (KAR):	Stochastic linear and nonlinear models
Prof. B. D. Sharma (BDS):	Modelling skills and some illustrative problems of mathematical modelling involving, various mathematical & stochastic techniques.
Prof. Balram Dubey (BD):	1. Linear system: phase portrait analysis 2. Liapunov's Direct Method to analyse nonlinear models 3. Some nonlinear mathematical models
Dr. Ashok Jangid (AJ):	Matlab Session
Dr. Phool Singh (PS):	Matlab Session

Venue for lectures: CMS Lecture Theatre

Report of the Program

The inaugural ceremony commenced with the lightning of the lamp by a group of dignified persons- Prof. Pradeep G. Siddheshwar (Bangalore University, Bangalore), Prof. D. Kishore (Secretary, Banasthali University), Prof. G.N. Purohit (Dean & Convenor), Prof. J.L. Arora (Department of Mathematics and Statistics, Banasthali University), Prof. Sarla Pareek (Head, Department of Mathematics and Statistics, Banasthali University), Dr. Deepa Sinha (Coordinator) and Dr. Ashok Jangid (Department of Physics and Computer Science, Dayalbagh University, Agra), and the program was followed by Saraswati-Vandana.

Prof. Sarla Pareek formally welcomed to all the dignitaries on the dias and participants from the various parts of the country, colleagues, guests and students. She introduced about the project CMS and various institute in all over the country running this project. She discussed the objectives of CMS and its activities. She revealed origin and evaluation of CMS right from the beginning to till date, the activities of CMS, regarding the collaboration between DST, New Delhi and Banasthali University and how this centre is helping and promoting the young researchers. She told that this is the 14^{th} workshop organized by CMS and also spoke about some aspects of Mathematical Modelling, linear and non-linear systems and how the participants will be benefited from this workshop. She requested everyone to utilize his/her valuable timings by attending all the sessions during the workshop.

Prof. G.N. Purohit first gave the statistics of the Workshop that 65 applications from all over India were received within 3 days and 35 were short-listed. After that he explained about linear and non-linear systems and discussed its applications in many branches like Fluid Mechanics, Relativity, Signal processing, Bifurcation, Chaos theory, Biology, Ecology, and many more areas.

On this great occasion, Prof. Pradeep G. Siddheshwar, first praised the beautiful campus of Banasthali University and also appreciated the education system of our university. He guided and motivated the young researchers as how to proceed for a quality research work. He motivated the participants for the discussion and said few words about the Bangalore University. He also said that the Centre for Advance Studies has been established at Bangalore University and a large group of persons are working in the field of Non-Linear systems.

Then, Prof. D. Kishore, Secretary of Banasthali University welcomed all the dignitaries who were part of the workshop. He showered his blessing for the success of the workshop.

Dr. Deepa Sinha offered a vote of thanks to all including Prof. Aditya Shastri, Director of CMS and Vice Chancellor, Banasthali University without whom this event wouldn't have

been possible. She thanked all the dignitaries for gracing the occasion by their presence and to all the participants of the workshop who were the main ingredient of this workshop. She also thanked DST for providing all kind of facility to conduct such workshops in the centre.

In the first day of the workshop, Prof. Pradeep G. Siddheshwar talked on the topic 'Differential Transform Method, Homotopy methods to solve the linear and non-linear differential equations'. He started with basic theory of transformation (Laplace and Differential Transforms) and homotopy (HPM, HAM) and said that these techniques can be assembled with the numerical schemes where we can not find exact solution and named it as "Hybrid scheme". These hybrid schemes can be applied on linear and non-linear systems such as Diffusion equation, Burger's equation, Telegraph equation, etc.

In the evening session, Dr. Ashok Jangid (Dayalbagh Educational Institute, Agra) and Dr. Phool Singh (ITM University, Gurgaon) started the session on MATLAB software, in which they explained about the fundamental commands needful for programming.

In the first session of second day of the workshop, Prof. Pradeep G. Siddheshwar talked on the topic 'Homotopy Continuation Method and Finite Element Method', to solve the linear and non-linear differential equations'. He discussed one of his papers titled Computer assisted solution of the "DARCY-BRINKMAN-FORCHHEIMER" equation using the continuation method for flow through rectangular porous channels and cylindrical porous annulus. He explained the mathematical formulation of cylindrical porous tube and annulus occupied by a Newtonian liquid. In his concluding lecture he discussed the Homotopy method for finding solutions of linear and non-linear differential equations. He also discussed about matrix differential method.

In the MATLAB session, Dr. Ashok Jangid discussed about plotting the graphs (plot, subplot, figure, subfigure) and Dr. Phool Singh showed that how we have to write a program in MATLAB like Bisection Method, Newton-Raphson method etc, and also he defined some flowcharts of these type of problems.

In the evening session, Prof. Balram Dubey (BITS, Pilani) delivered two lectures. He started with the basics of Linear Systems (homogeneous, non-homogeneous, autonomous, non-autonomous) and phase portrait analysis. In addition he discussed Liapunov's Direct Method to analyse non-linear models.

In the third day of the workshop Prof. Bhu Dev Sharma (JIIT, Noida) delivered three lectures. He discussed about Modelling skills and some illustrative problems of mathematical modelling involving, various mathematical & stochastic techniques.

In the next lecture of Prof. Balram Dubey, he described the stability analysis of both linear and nonlinear systems with various examples.

In the MATLAB session, both instructors defined the ode45 command for Runge-Kutta techniques, bvp4c for shooting technique and some other commands which are used in real physical models (e.g., simple and coupled ODE's).

The fourth day morning session started with the lecture of Prof. Karmeshu. He gave the conceptual idea of simple harmonic motion and different type of oscillations and he also discussed about new emerging field like System science, Neuro Science, Brain Computing etc. In the last lecture he defined some applications of 'Stochastic linear and nonlinear Models' in the physical problems. In all three lectures he also gave many versatile areas of research and which brought interest to the participants in versatile directions.

The second session of the day was started after tea break and Prof. K.N. Rai (IT-BHU) talked on the topic of linear systems. He explained some basic theorems which are used in our linear and nonlinear systems.

Prof. K.N. Rai devoted the session of **the last day** with two interesting lectures about different types of initial, boundary and moving boundary value problems and after that he explained some biological applications like Application of porous media for flow in biological tissues, single and two-phase problems geometrically.

The program ended with the valedictory session.

Valedictory Session: Beginning with the cordinator, Dr. Deepa Sinha giving a brief of the proceedings and seminar statistics, the session had expressions and feelings from all the experts and the participants. Prof. G.N. Purohit expressed his satisfaction on the arrangements of the seminar and cooperation from the participants from outside instrumental in the success of the academic activity. He appreciated the fact that Banasthali University enthusiastically participates in research activities necessary for the promotion of research in Mathematical Sciences. Participants presented their views on behalf of all, where they expressed that the quality of all the lectures was par excellence and they were benefited by new techniques to solve the linear and nonlinear problems required in modelling.

At last, Dr. Deepa Sinha on behalf of organizing committee thanked the university staff, DST and all other involved in the managing of the workshop.

Lecture notes: The hard copy as well as soft copy in CD of the lectures notes procured from experts has been provided to the participants.

Conclusion: The seminar, sponsored by DST, under CMS had very positive outcomes as follows:

It has given a chance to the faculty and students to interact with the distinguished experts from the field of Linear and Nonlinear systems.

It established the fact that Centre for Mathematical Sciences, Banasthali University organizes activities for the promotion of research in Mathematical Sciences thereby providing a platform for the researchers. It introduced and exposed the participants to the range of support for various academic initiatives by DST.

Glimpses at a Glance: