



# SURGE 2011 Annual Report

## From the desk of DRPG

Dear SURGE Friends

SURGE program has been very popular amongst students -- it provides them access to some of the finest research facilities under personal mentoring by leading faculty.

We received about 2600 applications this year. It was a tough job to rank them, as most were good and unique in their own way. But it had to be done since the number of positions available was limited. This finalization was done by the SURGE committee based on preparedness for research, academic performance and recommendation letters. After careful consideration, the committee selected 95 excellent proposals from 122 institutes.

I would like to congratulate all the members of SURGE's extended family who made this summer so successful. The success of this program has been possible due to dedication of student participants, invaluable leadership of surge committee, 72 faculty members who took time out of their busy summers to direct the enthusiasm of students for research, excellent support provided by staff members, and donations by generous alumni to financially support SURGE.

I thank and applaud all of your generosity and effort for making this program a grand success and I also take the opportunity to remind you to continue to give your support in the future too.

Thank you!

Manindra Agrawal  
Dean Resource Planning and Generation



### **SURGE program- An overview**

SURGE is evidence of the close student-faculty collaboration opportunities, for hands on experience and quest for new knowledge that characterize IITK education. It develops the agenda of undergraduate research and promotes a culture of research and interdisciplinary education in the new generation. It promotes self-discovery, helps to bridge the gap between the class-room and the real world, and leads to the social, professional and educational development of the student. Undergraduate research at IIT Kanpur presents opportunities for students to do research under the mentorship of senior researchers at the frontiers of engineering and science.

The programme is being very well received both by students and mentors. The students experience a new non-competitive, challenging and exciting method of learning, which encompasses multiple levels of educational experience.

Allied Programs, such as Research Talks and Happy Hours provided students an opportunity to learn about research across the campus and space to interact with each other.

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### Funding SURGE

The participating students receive a stipend of Rs 12,500 for the ten-week summer program from the funds raised from external sources. The Dean Resource Planning and Generation Office raises funds to support SURGE students from a variety of sources including gifts from individuals, foundations, and corporations. SURGE depends upon the generosity of its many friends for annual gifts or for contributions to the SURGE endowment to build a robust financial base. We thank the donors who have supported SURGE 2011 and beyond! Endowments help to ensure the future of the SURGE program and provide students with unparalleled research opportunities.

#### Special Thanks to:

- Microsoft Research Lab. India
- C. P. Anil Kumar(Int. MSc./Maths/1999)
- C. S. Das (BT/ME/1977)

### Opportunities Still Available for New Endowments

Individuals or batches may support in several ways to establish endowments—they may be paid in full at creation, given in installments over a period. The contributors can be proud of the investment they have made in the future of bright and talented students, and the donors gain the personal satisfaction from playing an important part in the formation of young people, many of whom will make significant contributions to the nation and the world.

Participants of SURGE 2011 from IITK			
S. No.	Name of the participant	Project	Mentor
1	Ajinkya Desai Aerospace Engineering	Aerodynamics of a Badminton Shuttlecock using Computational Fluid Dynamics	Dr. Sanjay Mittal Aerospace Engineering
2	Himanshu Singh Aerospace Engineering	Instabilities and Bifurcations in Rectangular Lid Driven Cavity	Dr. T.K. Sengupta Aerospace Engineering
3	Sriram Ganesan Aerospace Engineering	Multi-scale analysis based study of effect of micro-level damage on macro level thermo-mechanical response of ductile material	Dr. C.S. Upadhyay Aerospace Engineering
4	Ruhi Dang Biological Sciences & Bioengineering	Syntenic relationships involving Aquaporin genes	Dr. R. Sankararamakrishnan Biological Sciences & Bioengineering
5	Aman Agarwal Chemical Engineering	Removal of pharmaceutical compounds by Ni doped phenolic beads	Dr. Nishith Verma Chemical Engineering
6	Lavanya Chemical Engineering	Solvation and inhibition studies of Kidney stones	Dr. Jayant K. Singh Chemical Engineering
7	Manish Kumar Chemical Engineering	Molecular dynamics study of atomic rearrangements in Pb on Cu(111)	Dr. Abhijit Chatterjee Chemical Engineering
8	Mayank Agrawal Chemical Engineering	General Purpose Electronic Structure Serial and Parallel Program for Atoms	Dr. Raj Ganesh S Pala Chemical Engineering
9	Pranjal Saxena Chemical Engineering	Instability in a charged cylinder	Dr. V. Shankar Chemical Engineering
10	Parichay Chakraborty Chemistry	Synthesis and characterization of Manganese doped tris (quinoline-8-olate)	Dr. S. Sundar Monohoron Chemistry
11	Premashis Manna Chemistry	Spatio-temporal modeling of Calcium Concentration in Neuronal Cell	Dr. M. Ranganathan Chemistry
12	Shubhendu Palei Chemistry	Modulators of Huntingtin Protein Aggregation	Dr. A K Thakur Biological Sciences & Bioengineering
13	Akash Gupta Civil Engineering	Non-destructive testing of flawed concrete using impact echo	Dr. Sudhir Misra Civil Engineering
14	Amit Kumar Dhankhar Civil Engineering	Aluminium Shear-Link for Seismic Energy Dissipation	Dr D C Rai Civil Engineering
15	Ujjwala Avinaw Civil Engineering	Study of primary and secondary emissions from incense	Dr. Tarun Gupta Civil Engineering
16	Vishesh Panjabi Civil Engineering	Analysis, Identification and Control of systems with Hysteresis using the Bouc-Wen model and its application in building smart structures and materials	Dr. S. K. Mishra Civil Engineering
17	Aditya Desai Computer Science & Engineering	Facilitating Loop Invariant Generation by Using Phase Patterns	Dr. Subhajit Roy Computer Science & Engineering
18	Chandra Prakash Computer Science & Engineering	Online Counseling Portal and Course Management System Using Moodle	Dr. Rajat Moona Computer Science & Engineering
19	Kritika Singh Computer Science & Engineering	Sentiment Analysis of Text Data	Dr. Anab Bhattacharya Computer Science & Engineering
20	Satvik Chauhan Computer Science & Engineering	Fingerprint identification system based on hierarchical indexing using surf features	Dr. Krithika Venkataramani Computer Science & Engineering

Note: The sequence followed in the table is in the alphabetical order of department and name of the participants.

21	Vineet Hingorani Computer Science & Engineering	Preposition Characterization using Voronoi Diagrams	Dr. Amitabh Mukherjee Computer Science & Engineering
22	Koustav Dey Electrical Engineering	Planar Near Field Measurement and its Transformation to the Far-Field	Dr. A.R.Harish Electrical Engineering
23	Rishabh Maheshwari Electrical Engineering	Detection of Direction of Radio Controlled Improvised Explosive Device's Trigger	Dr. Naren Naik Electrical Engineering
24	Rohit Sinha Electrical Engineering	Combined Approach to Source Separation Using Independent Component Analysis and Beam forming Methods	Dr. Rajesh M Hegde Electrical Engineering
25	Siddharth Sharma Electrical Engineering	Optimal Classifier Based Spectrum Sensing in Cognitive Radio Wireless Systems	Dr. A. K. Jagannatham Electrical Engineering
26	Udbhav Singh Electrical Engineering	Text Analysis for polarity assessment classification of datasets with high objective content	Dr. Arnab Bhattacharya Computer Science & Engineering
27	Aditi Gupta Humanities & Social Sciences	Price wars and tacit collusion in airline industry	Dr. Vimal Kumar Humanities & Social Sciences
28	Priya Gautam Materials and Metallurgical Engineering	Sol gel derived amorphous indium gallium zinc oxide thin films	Dr. Deepak Gupta Materials and Metallurgical Engineering
29	Poonam Kesarwani Mathematics & Statistics	A Development of Java Based GUI for Choosing Initial Guess in 3D Image Registration	Dr. R. K. S. Rathore Mathematics & Statistics
30	Arihant Bhandari Mechanical Engineering	Modeling of Electrodynamics Shakers	Dr. Nachiketa Tiwari Mechanical Engineering
31	Mrityunjay Kothari Mechanical Engineering	Studying the effect of pulsating pressure on human artery to mathematically model Aneurysm formation and growth	Dr. K. Muralidhar Mechanical Engineering
32	Nikita Jaipuria Mechanical Engineering	Determination of Heat Transfer Coefficient in slug flow using Infrared Thermograph	Dr. Sameer Khandekar Mechanical Engineering
33	Vishwas Aggarwal Mechanical Engineering	Nondestructive Testing and Reconstruction of Defects using Ultrasonic Phased Array System	Dr. N. N. Kishore Mechanical Engineering

Note: The sequence followed in the table is in the alphabetical order of department and name of the participants.

Participants of SURGE 2011 at IITK from other universities				
S.No.	Name of the participant	Name of the Institute	Project	Mentor
1	Aabhas Srivastava Aerospace Engineering	IIT Kharagpur	Computational Study of Micro Air Vehicle Aerodynamics using Velocity-Vorticity Formulation	Dr. Sengupta Aerospace Engineering
2	Gislain Aerospace Engineering	Ecole Centrale Paris	Spectroscopic Analysis of a premixed LPG-Air flame	Dr. A. Kushari Aerospace Engineering
3	Matthieu Bonneric Aerospace Engineering	Ecole Centrale Paris	DSMC method: adaptation of the code to the lid driven cavity problem	Dr. B. Esphuniyani Aerospace Engineering
4	Kunal Biotechnology	NIT Warangal	Modulating the flexibility of GImU to utilize various nucleotides as substrates and possible application of such utilization.	Dr. Balaji Prakash Biological Sciences & Bioengineering
5	Ruchi Lohia Biotechnology	Manipal University	Homology Modeling and Docking Studies of 3NTDO	Dr. R Gurunath Chemistry
6	Anjul Khadria Biotechnology and Medical Engineering	NIT Rourkela	Development of Aqueous Two Phase System (ATPS) for studying the partitioning behavior of gold nanoparticles based on their surface characteristics	Dr. Dharendra Katti Biological Sciences & Bioengineering
7	Sukriti Bhardwaj Ceramic Engineering	BHU	Microstructural and mechanical characterization of Yttria Stabilized Zirconia based composites reinforced with hydroxyapatite and carbon nanotubes	Dr. K Balani Material Science Programme
8	R Ashwin Kumar Chemical Engineering	NIT Tiruchirappalli	Assessment of the air quality in Kanpur city 2011 'impact of traffic and construction activities near major intersections'	Dr. Anubha Goel & Dr. Mukesh Sharma Environmental & Management Engineering
9	Garima Singh Chemistry	MNIT Jaipur	Low cost synthesis of water soluble graphene	Dr. S Sarkar Chemistry
10	Marianne Braun Chemistry	Rice University	Purification of Recombinant Oxygenase in E Coli	Dr. R. Gurunath Chemical Engineering
11	Mrinal Shekhar Jha Chemistry	IISER Mohali	Accurate Quantification OF THE Thermal LENS SIGNAL through Mechanical Chopper	Dr. D Goswami Chemistry
12	Himani Agrawal Civil Engineering	IIT Roorkee	An investigation on contour interval vis-à-vis data density, accuracy and ground characteristics	Dr. Bharat Lohani Civil Engineering
13	Ruchi Khetan Civil Engineering	VNIT Nagpur	A study into the approximate value of contour interval for given data density, data accuracy, terraicharacteristics	Dr. Bharat Lohani Civil Engineering
14	Sandeep Patil Civil Engineering	VNIT Nagpur	Assessment of road traffic situation in India using statistical analysis	Dr. Vinod Vasudevan Civil Engineering
15	Soumya Gupta Civil Engineering	BITS	Development of GIS based Spatially Resolved National level Emission Inventory for Reactive Nitrogen (N <sub>2</sub> O and NH <sub>3</sub> ) in India	Dr. Mukesh Sharma Environmental & Management Engineering
16	Ashish Kasera Computer Science & Engineering	LNMIIT Jaipur	Mobile application development on agropedia and vkvk website re-development	Dr. T V Prabhakar Computer Science & Engineering
17	Jahnvi Singhal Computer Science & Engineering	BHU	Task Scheduling of Distributed Heterogeneous Computer Systems	Dr. Mainak Chaudhuri Computer Science & Engineering
18	Julien Lambert Computer Science & Engineering	Ecole Centrale Paris	Semantic search engine for agropedia	Dr. T. V. Prabhakar Computer Science & Engineering

Note: The sequence followed in the table is in the alphabetical order of department and name of the participants.

19	Prithviraj Nag Computer Science & Engineering	Bengal Engineering and Science University	Detection and Location of Humans in Images	Dr. Amitabha Mukherjee Computer Science & Engineering
20	Varun Simhadri Computer Science & Engineering	IIT Hyderabad	Estimating loop bounds - For use in Compiler optimization for Database intensive applications	Dr. Amey Karkare Computer Science & Engineering
21	Jyoti Date Economics	University of Pune	Efficiency of Indian stock markets	Dr. Somesh K Mathur Humanities & Social Sciences
22	Vibhuti Awasthi Electrical & Electronics, Biological Sciences	BITS	Policy Instruments to Promote Renewable Energy in International & Indian Context	Dr. Anoop Singh Industrial & Management Engineering
23	Aneesa Kaza Electrical Engineering	NIT Durgapur	Simulation Study of Carbon nanotubes and Ferrites as Electromagnetic Absorbers	Dr. Vaibhav Srivastava & Dr. Animesh Biswas Electrical Engineering
24	Ashish Katiyar Electrical Engineering	IIT Jodhpur	Optimum AR Model based Maximum-likelihood (ML) error correction in Wireless Sensor networks (WSN)	Dr. A Jagannatham Electrical Engineering
25	Murali Krishna Nayakuni Electrical Engineering	VNIT Nagpur	Microwave molding and characterization of mixed dielectrics using x-band rectangular waveguide approach	Dr. Jaleel Akhtar Electrical Engineering
26	Shishir Nagaria Electrical Engineering	MNNIT Allahabad	Modeling of Direct Driven Synchronous Machine Based Wind Turbine	Dr. S N Singh Electrical Engineering
27	Abhimanyu Srivastava Electronics and Communication Engineering	NIT Surathkal	Enhanced gain dual band patch antenna based on complementary split-ring resonators	Dr. Vaibhav Srivastava & Dr. Animesh Biswas Electrical Engineering
28	Ananya Roychowdhury Electronics and Communication Engineering	NIT Jamshedpur	Secure Spectrum Sensing in Cognitive Radio Cooperative Sensing System	Dr. Adrish Banerjee Electrical Engineering
29	Divya Bharti Electronics and Communication Engineering	NIT Jamshedpur	RFID Reader antenna	Dr. A R Harish Electrical Engineering
30	Uma Rao Electronics and Communication Engineering	NIT Jamshedpur	Simulation of power quality events and their classification and detection using artificial intelligence	Dr. S N Singh Electrical Engineering
31	Vikas Pandey Energy Science & Engineering	IIT Bombay	Accuracy of relap 5 results for safety analysis of nuclear reactor	Dr. Prabhat Munshi Nuclear Engineering & Technology
32	Sudhanshu Kumar Singh Faculty of Science	BHU	Synthesis of functionalized cyclic peptide	Dr. S Verma & Dr. V. Chandrasekhar Chemistry
33	Harshit Mishra Information Technology	NIT Surathkal	Creating an Efficient Sorting Algorithm Using Combination of basic Sorting Methods	Dr. Manindra Agarwal Computer Science & Engineering
34	Nidhish Raj Mechanical Engineering	NIT Warangal	Design and development of flight control system for micro coaxial helicopter	Dr. Abhishek Aerospace Engineering
35	Aloona Mechanical Engineering	NIT Durgapur	Numerical Study of flow across a symmetric sudden expansion	Dr. Malay K. Das Mechanical Engineering

Note: The sequence followed in the table is in the alphabetical order of department and name of the participants.

36	Ayush Kumar Mechanical Engineering	NIT Surathkal	Suppression of vortex shedding	Dr. A K Saha Mechanical Engineering
37	Deleep Kumar Chandar Mechanical Engineering	NIT Tiruchirappalli	Aerodynamic shape optimization of wing using adjoint based method	Dr. S. Mittal Aerospace Engineering
38	Manish Kandpal Mechanical Engineering	VNIT Nagpur	Working of tail rotor controller futaba gy611of mini helicopter and modal analysis of cantilever beam with sweep, anhedral and point mass	Dr. Venkatesan Aerospace Engineering
39	Raj Deep Gupta Mechanical Engineering	NIT Warangal	Effect of moduli ratio & aspect ratio on the variation of energy of interfacial misfit edge dislocation along interface using FEM	Dr. Anandh Subramaniam Material Science Programme
40	Shamayita Mukherjee Mechanical Engineering	NIT Durgapur	Design and Modeling of Coaxial Micro Air Vehicle	Dr. Abhishek Aerospace Engineering
41	Sourayon Chanda Mechanical Engineering	NIT Durgapur	Natural convection in a pin-fin heat exchanger having multiple arrays of square cylinders with constant wall temperature	Dr. A K Saha Mechanical Engineering
42	Vishu Vishal Mechanical Engineering	KIIT Bhubaneswar	Dynamic Analysis of Composite Beam with Randomly Aligned Natural Fiber Reinforcement	Dr. B Bhattacharya Mechanical Engineering
43	Sagnik Sarkar Metallurgical and Materials Engineering	NIT Durgapur	Study of Crystallization Kinetics Of Bulk Metallic Glasses	Dr. K Mondal Materials and Metallurgical Engineering
44	Soumitra Sulekar Metallurgical and Materials Engineering	VNIT Nagpur	Tape Casting of Electrolyte for Solid Oxide Fuel Cell	Dr. K Balani Materials and Metallurgical Engineering
45	Aradhana Chopra Nanotechnology	IIT Roorkee	Translation of ds-DNA molecules on polymerized silicone elastomer surface with different liquid state viscosities	Dr. S Bhattacharya Mechanical Engineering
46	Luna Bhowmick Physics	NIT Rourkela	Tomographic reconstruction from Lamb Wave Tomography Data	Dr. Prabhat Munshi Nuclear Engineering & Technology
47	Nishtha Sachdeva Physics and Astrophysics	Delhi University	Weyl Vector Meson in Local Scale Invariant Standard Model	Dr. Pankaj Jain Physics
48	Ashish Production Engineering	NIT Tiruchirappalli	Experimental Investigation and Simulation of Single Discharge on Silicon in Micro Electric Discharge Machining ( $\mu$ -EDM)	Dr. J Ramkumar Mechanical Engineering
49	Hariharan Pappil Kothandapani Production Engineering	NIT Tiruchirappalli	Online evaluation and numerical comparison of electro thermal models in $\mu$ -edm	Dr. J Ramkumar Mechanical Engineering
50	Mouluka Mandal Psychology	BHU	Visual Stimuli and Bio-behavioral Indicators: The Stress and Premorbidity Imperative	Dr. A K Sinha, Dr. Braj Bhusan & Dr. Ravi Priya Humanities & Social Sciences

Note: The sequence followed in the table is in the alphabetical order of department and name of the participants.

## Participants of SURGE 2010 from IITK to Overseas Universities

S. No.	Name of the participant	Name of the Institute	Project	Mentor
1	Kartikey Asthana Aerospace Engineering	Ecole Polytechnique	Finger formation in Hele-Shaw flow captured using a Lagrangian particle level set method	Peter Schmid Hydrodynamics Laboratory
2	Sidharth GS Aerospace Engineering	Ecole CentraleParis	Building Systems Energy efficiency and Fault Detection using Recursive Deterministic Perceptron Neural Network	Prof. Frederic Magoules High Performance Computing, Laboratory of Applied Mathematics
3	Shourya Sonkar Roy Burman Biological Sciences & Bioengineering	Caltech	Investigating the Expression Patterns of Potential Regulators and Homologues of FoxD3	Marianne Bronner and Marcos Simões-Costa
4	Aditya Huddedar Computer Science & Engineering	Caltech	Linear Programming and Clustering	Dr. Leonard Schulman
5	Anindya Jyoti Roy Computer Science & Engineering	Ecole Polytechnique	Development of new support vector machines techniques for the analysis of RNA motifs	Prof. Julie Bernauer Laboratoire d'Informatique
6	Tej Pratap Electrical Engineering	Rice University	High Level Synthesis of Trellis Search Based Detector Using AutoESL	Prof. Joseph R. Cavallaro Electrical and Computer Engineering and Computer Science
7	Keerti Choudhary Mathematics & Statistics	Rice University	Dominating Set Problem	Dr. Illya V. Hicks Computational and Applied Mathematics
8	Abhimanyu Banerjee Physics	Ecole Polytechnique	Theoretical Study of Bose Einstein Condensation in Gaussian Random Fields	Prof. Philippe Mounaix, CPHI
10	Sanchit Singh Mechanical Engineering	The University of Melbourne	Modeling of Zero Emission Vehicles for Australian Driving Condition	A/Prof. Michael Brear Mechanical Engineering
11	Narendra Chaudhary Biological Sciences & Bioengineering	The University of Melbourne	Investigation of neuronal network activity in response to spatiotemporal input patterns	Prof. David Grayden Department of Electrical and Electronic Engineering
12	Rishab Raj Material Science and Engineering	The University of Melbourne	Phase Transformation in Ti-20Mo alloys	Dr. Kenong Xia

Note: The sequence followed in the table is in the alphabetical order of department and name of the participants.

## Abstracts: SURGE 2011 Research Projects Done at IIT Kanpur

**Aerodynamics of a Badminton Shuttlecock using Computational Fluid Dynamics**

Ajinkya Desai  
Dr. Sanjay Mittal

The objective of this work is the computational aerodynamic analysis of a synthetic shuttlecock. Software including *GAMBIT* would be used for generating a mesh to solve for the flow. The solver would give us values of drag and moment coefficients. Flow at different Reynolds numbers (by varying the inlet velocity) shall be analysed and the corresponding variations will be plotted. Mostly turbulent flows shall be taken into account. The results will be compared to available experimental results and an average drag coefficient for the synthetic shuttlecock is to be found and compared to the experimentally determined range of 0.58 to 0.65.

**Instabilities and Bifurcations in Rectangular Lid Driven Cavity**

Himanshu Singh  
Dr. T.K.Sengupta

We have studied flow inside rectangular lid driven cavities (RLDC) of Aspect Ratio (AR) 2 and 3. We have investigated flow transition in a RLDC with AR=2, where we see multiple bifurcations. It is important to study the effects of Reynolds number and aspect ratio on the flow transition in RLDC and compare these results with those of SLDC as lid driven cavities form canonical problem to study the basic fluid dynamics of internal flows and is often used for computational methods' validation owing to its unambiguous initial and boundary conditions. Similarities and differences between SLDC and RLDC flows have been highlighted using the spectrum of time series of vorticity at discrete points in the domain. Additional features of RLDC flow and their dependence on the Reynolds number are obtained using high accuracy computational methods as discussed in Sengupta et al. (2009,2009a). These features have been further explained using proper orthogonal decomposition (POD) of the vorticity field in the full domain of RLDC. In the end, effect of aspect ratio on the bifurcation sequences have also been discussed with reference to results for RLDC with aspect ratio of 3 at four different Reynolds number.

**Multi-scale analysis based study of effect of micro-level damage on macro level thermo-mechanical response of ductile material**

Sriram G  
Dr. C. S. Upadhyay

Constitutive descriptions for deterioration of material strength capacity due to separation or rupture of material have been the focus of numerous investigations in the field of continuum damage mechanics. Presently, empirical scalar-based damage descriptions are used in practical numerical simulations of impact and failure. For ductile metals, the model introduces a damage parameter—the cumulative scalar plastic strain at failure—whose instantaneous value may depend upon the strain rate, temperature, deviatoric stress, and/or hydrostatic pressure. The broader aim of the investigation is to develop a framework for describing the deformation and failure responses of ductile materials from micromechanical considerations and volume averaging techniques in a computationally efficient way and for a broad range of load conditions. Two dimensional micromechanical model based simulations were conducted to study influence of interacting flows. Also the microscopic structure of 9 Cr-1 Mo Steel, which is being used in Nuclear applications was studied both in undamaged and damaged state and the results were assimilated into simulations.

**Syntenic relationships involving Aquaporin genes**

Ruhi Dang

Dr. R. Sankararamakrishnan

Cell contents are separated from extracellular fluids by a barrier of selectively permeable cell membranes. The intracellular and extracellular compartments differ in the composition and concentration of ions, small solutes and proteins, but not overall osmolality. Maintenance of the osmolality of body fluids within a very narrow physiological range (280 to 296 mOsm kg-1H<sub>2</sub>O) is made possible by complex homeostatic mechanisms such as: the intake and excretion of water; as well as the movement between the intracellular and extracellular fluid compartments through Aquaporin water channels. These channels are widely distributed in all kingdoms of life, including bacteria, plants, and mammals. They form tetramers in the cell membrane, and facilitate the transport of water and, in some cases, other small solutes across the membrane. To speculate the possible protein-protein interactions and involvement of aquaporins and their neighboring proteins in signaling pathways, syntenic analysis of aquaporin genes has been carried out. A generic tool (code written in python) was developed and used to create a database. This database consists of the gene order surrounding aquaporin genes of different mammals along with their gene ontology information. This database was analyzed and conserved synteny was observed among closely related mammals.

**Removal of pharmaceutical compounds by Ni doped phenolic beads**

Aman Agarwal

Dr. Nishith Verma

The objective of this summer project is to do the fixed bed column study of the Ni doped phenolic nanoparticles and Vit B-12. In this column the nanoparticles will act as a adsorbent and vit B-12 as a tracer material. The reason behind Ni beads is that Vit B-12 contains Co so may be Ni can form bond with Co thus acting as a good adsorbent. The main focus of the project is on designing the column so that there is no leakage, mal-distribution or channelling. Once the column design is completed the next job is to run the column. There may be many problems with the column like agglomeration or blocking of membrane.

**Solvation and inhibition studies of Kidney stones**

Lavanya

Dr. Jayant K.Singh

We have considered the problem of determining the most efficient solvent for dissolving Calcium Oxalate crystal (major component of kidney stones). In vitro studies of Kidney stones in citrates, pyrophosphates and some other common salt solutions have been done in great detail. But we propose to do a molecular dynamics study and list the solvents in increasing order of their solubility of Calcium oxalate and in doing so find a solvent which is most effective and if it can be administered orally as a drug for Kidney stones treatment.

We have used classical molecular dynamics for the bulk study of Calcium Oxalate crystal in different solvents. Using LAMMPS software, the system was equilibrated and potential energy calculated for

□ G calculation using Thermodynamic Integration and Gaussian Quadrature integration technique.

The results we got for calcium oxalate – water system and calcium oxalate - ethanol system clearly indicates that water helps dissolving the crystal better than alcohol. Also a study comparing different sizes of the crystal in water was done. It reemphasizes on the fact that □ G is an extensive function.

**Molecular dynamics study of atomic rearrangements in Pb on Cu(111)**

Manish Kumar

Dr. Abhijit Chatterjee

Using Molecular simulation approach on a system containing about 20000 atoms, we find that Cu and Pb arranged in single atomic layers on Cu(111) surface, self assemble into nanoscale domain patterns. With the deposition of 1 Monolayer of Pb on Cu surface the formation of a 4\*4 repeating pattern of deposited Pb being formed has been observed which is similar to that observed by experimentalists. With the MD data the value of diffusion coefficient(D) for Pb on Cu(111) and Cu on Cu(111) is calculated and from the comparison of diffusion coefficient of both system we deduce that Pb diffuses faster on the surface as compared to Cu. Potential energy barrier for displacement of Cu and Pb on Cu surface has been calculated. Pb atom getting embedded has also been observed along with the vacancy creation from Molecular simulations.

**General Purpose Electronic Structure Serial and Parallel Program for Atoms**

Mayank Agrawal

Dr. Raj Pala

Our overall objective is to develop an elementary serial and parallel program to find the numerical solution to the Schrödinger equation of atoms. The program was for Helium atom and the ground state obtained for Helium atom using Hartree-Fock approach compared well with previous results. We have restricted the electronic wave function to a simple form by making Born-Oppenheimer and independent-particle approximations to the Hamiltonian. We then further parameterize the uncorrelated wave function by a linear combination of basic functions (four Gaussian basis functions in our case). The equation is thus converted to a Generalized Eigenvalue Problem which is solved for the coefficients of basic functions we used.

MPI (Message Passing Interface) libraries were used to parallelize the sequential code, and various measures of efficiency of parallelization were tested. We find that when the run time is very low, the communication time between cores dominates, which vitiates the utility of parallelizing the program. In other case, like factorizing very large number (high run time), parallelizing with MPI resulted in increase in efficiency.

**Instability in a charged cylinder**

Pranjal Saxena

Dr. V Shankar

The objective of this work is to predict the capillary instability of a soft elastic filament( example agar gel) in a charged solution using the basics of Rayleigh-Plateau instability for a capillary of jet. This work includes study of basic cases of instability ranging from Rayleigh instability for a capillary to instabilities in a soft solid gel. Counter ions and charges are known to modify existing instabilities due to electro hydrodynamic coupling between the fluid flow and electrostatics.

The analysis influenced from RPI instability may be relevant to soft solids often found in biology, and thus may play a role in biological processes as generation of filaments, formation of beaded forms in myelinated nerve fibres, etc. Fundamental building blocks of self assemble are typically charged ex. Lipids, molecules and proteins.

### Synthesis and characterization of Manganese doped tris(quinoline-8-olate)

Parichay Chakraborty

Dr. S. Sundar Monoharan

In our present work we synthesized Manganese doped tris-(quinoline-8-olate) preparation was carried out in ether medium for 8 hours. It was purified by vacuum sublimation.

We studied the structure of the complexes and it indicates mer isomer. SEM micrograph suggests that the particle sizes are almost 150 nm in diameter and no phase separation is taking place. The most important feature is the ferromagnetism of so prepared complexes. It can be explained by Mn:Mn interaction in the crystal structures which is also evident from the broadened EPR spectra of the complexes. On irradiation with 390nm UV light these give intense peak at around 530 nm. To study electroluminescence we prepared an OLED device employing so prepared compound as the emissive layer. It was seen that electroluminescence starts at 10 volt. It gives peak maxima at 530nm. The so prepared complexes may be used as spin OLED materials with high electron mobility.

### Spatio-temporal modeling of Calcium Concentration in Neuronal Cell

Premashis Manna

Dr. Madhav Ranganathan

Calcium plays a very important role in many biochemical and physiological processes in the living organisms. Experiments show that it has also profound effect in the formation of many important proteins like bend in the neuronal cell which helps in neuronal plasticity and neuronal growth. Exact spatio-temporal modeling of the calcium in the neuronal cell can elucidate the mechanism of the transcription of the corresponding gene (BDNF). In our model, we have assumed that calcium enters into the cell through various voltage-gated channels. The probability of closing and opening of these channels is regulated by membrane potential which is described by the Hodgkin-Huxley equations. We have used the Hodgkin-Huxley equations to generate voltage fluctuation across the cell membrane. Along with this, we have included the gating variables due to calcium channels which are related to the incoming calcium flux. The temporal fluctuation of calcium concentration from our model exactly matches with the experimental one.

### Modulators of Huntingtin Protein Aggregation

Shubhendu Palei

Dr. Ashwani Kumar Thakur

Huntington's Disease(HD) is one of the fatal Neurodegenerative genetic disorder characterised by chorea and involuntary muscular action. It results from the misfolding and aggregation of the mutated Huntingtin protein in neuronal cells of the Brain. In recent years many methods were developed to study its mechanism and find a suitable therapeutic. But till now, none of them has been proved fruitful. Our work focuses on study of some "Modulator Molecules" which may delays or fastens the aggregation process, thus reducing the concentration of Oligomeric Peptides which is believed to be the sole cause of Neuronal toxicity in HD. We have studied effect two molecules Trehalose and Calmidazolium Chloride(CLC) on kinetics of Exon1 and PolyQ aggregation. We found that Trehalose has an inhibitory effect on PolyQ aggregation, thus increasing the concentration of monomers, which was measured by HPLC, where as CLC accelerated the aggregation kinetic. A good amount of healthy PolyQ aggregates began to appear just after 1 hour of reaction. This was in accordance with the fact that CLC fastens aggregation kinetic of Abeta peptide(Williams et al,PNAS,2005,102,7115). But surprisingly in Exon1, though CLC accelerated the aggregation during initial hours, it seemed to have a peculiar kinetics. At first Exon1 monomer concentration fell down abruptly, but then it increased and became stable. This stable critical concentration prevailed for even upto 7 days unlike normal Exon1 aggregation which almost completes in 200 hours(Thakur et al,NSMB 2009 Apr;16(4):380-9). Thus CLC showed a inhibitory effect on Exon1 aggregation unlike Abeta.

### Non-destructive testing of flawed concrete using impact echo

Akash Gupta

Dr. Sudhir Misra

Non Destructive methods which are based on propagation of stress waves are frequently used in testing of concrete structures. Many ultrasonic methods are used for testing same. Impact Echo is also one of the non-destructive methods based on the impact-generated stress waves. The objective of this study is to test the flawed specimens prepared in lab using Impact Echo and check the accuracy of results with respect to the actual results. Test were performed on various types of flaws like surface opening crack in a beam, horizontal cracks of varying size in a box like specimen to check the versatility of impact echo. Impact Echo was also performed on the concrete cube before and after failure to see the change in responses. The shift in dominant frequency in frequency response predicts the presence of flaw. Same experiments were also done with UPV (ultra-sonic pulse velocity) and the results obtained were compared with that of impact echo.

### Aluminium Shear-Link for Seismic Energy Dissipation

Amit Kumar Dhankhar

Dr. D.C. RAI

An aluminum beam shear-link is developed for earthquake-resistant structures. In the present study application of AL-SYD has been studied for improving the seismic behavior of truss moment frame and improving the stiffness of the AL-SYD frame by using it in several configurations. Shear link was designed for a typical truss moment frame in several configurations-one in which shear link was employed in horizontal configuration and when shear link was employed at some angle with horizontal. Performance of the link was observed by using rigid joint as well as pin joint at the chord where link is to be employed. Two designed methodologies were used-force based design and energy based design. Dynamics of the frame was observed in SAP2000, general purpose software for structural analysis and performance of the link was noted. Pushover analysis and time history analysis were performed. For time history analysis N21E component of the 1952 Kern County earthquake recorded at Taft was used at PGA level ranging from 0.05g to 0.9g. The reduction of base shear was observed in AL-SYD frames and the frame gained stiffness when link was oriented at some angle with horizontal, henceforth taking more lateral load for a given roof drift(29.44% for 2% roof drift), in this case area of the shear link designed (energy based design) showed a 27.12% reduction in area of web of the link used, taking 10.76% more lateral load(2%drift). Pin connection case showed higher values of shear force in the link for all roof drift values.

### Study of primary and secondary emissions from incense

Ujjwala S. Avinaw

Dr. Tarun Gupta

---This study is focussed towards measuring the particle size distribution of primary and secondary particulate matter from incense, which is an indoor combustion source. This study was done with the help of a photochemical chamber which simulated the atmospheric conditions. Experiments were conducted for different UV light exposure times and particle size distribution was obtained for 0.1 micron > size > 0.01 micron and for size > 0.3 micron. The experiments showed that significant amount of secondary products are formed. 0.1 micron > size > 0.01 micron had a peak number concentration when UV exposure time was 20 mins and size > 0.3 micron had a peak number concentration when UV light exposure time was 30 mins.



### **Analysis, Identification and Control of systems with Hysteresis using the Bouc-Wen model and its application in building smart structures and materials**

Vishesh Kumar Panjabi

Dr. S.K Mishra

Here we are trying to deal with a special class of systems with hysteresis. This nonlinear behavior is encountered in wide variety of processes in which the input-output dynamic relations involve memory effects. In mechanical and structural systems, hysteresis appears as a natural mechanism of materials to supply restoring forces against movements and dissipate energy. In these systems, hysteresis refers to the memory nature of inelastic behavior where the restoring force depends not only on the instantaneous deformation but also on the history of the deformation. Within this context, a hysteretic semi-physical model was proposed initially by Bouc in 1971 and subsequently generalized by Wen in 1976.

The basic aim of our project could be sub-divided into 5 different sections:

1. Analysis of the compatibility of model with some laws of physics.
2. Relationship between the model parameters and the hysteresis loop.
3. Identification of the model parameters.
4. Control of systems that include a Bouc-Wen hysteresis.
5. Applying all of these developed concepts for developing models of smart structures.

### **Facilitating Loop Invariant Generation by Using Phase Patterns**

Aditya Desai

Dr. Subhajit Roy

Generation of invariants which are conjunctive is much better understood problem than inferring disjunctive invariants. Though there are sophisticated tools which are available in today's date to generate good disjunctive invariants, it is possible to avoid this problem of disjunctive invariants in a skill full manner. Disjunctive invariants arise from the usage of a conditional statement inside the loop though not all conditionals imply requirement of disjunctive invariants. Previously there has been effort to modify the program code (belonging to a certain domain of codes) into a semantically equivalent code which does not require disjunctive invariants. This way we can use the simple and existing invariant generators to come up with strong enough invariants. We propose a innovative method of program conversions for a different domain of loops. In this project we propose the use of theorem proves to discover a relation between iteration counter and the conditional statement inside the loop. We try to come up with a periodic relation, if it exists, implying the existence of the pattern in the behavior of the conditional statement present in the loop. We then plan on unrolling the loop to successfully eliminate the conditional statement and thus acquiring a code which does not require disjunctive invariants to be inferred.

### **Online Counseling Portal and Course Management System Using Moodle**

Chandra Prakash

Dr. Dheeraj Sanghi and Dr. Rajat Moona

The project is about studying the JEE counseling online portal, testing the seat allocation software and website to check for errors, adding more functionality and find solutions to problems that arise during the online counseling procedure.

The JEE counseling online portal (JCOP) is a unified portal which has come up with a solution to the difficulty faced by candidates in the counseling. Earlier candidates had to report to the zonal IITs for the counseling which causes inconvenience to both candidates and administration. The administration has to enter the choice sheets of the student manually which was prone to human error and wastage of time. Using online counseling candidates are allowed to enter their choices directly to the JEE database. Also, the candidate is allowed to enter their choices over a period of time instead of reporting to IITs on specified date and time. The website is integrated with payment portal and seat allocation software to allot seats to the candidates. The later phase of project include setting up

a Course Management System using Moodle for the administration, documentation, tracking, and reporting of training programs, classroom and online events, e-learning programs, and training content and add suitable modules to further enhance the system.

### **Sentiment Analysis of Text Data**

Kritika Singh

Dr. Arnab Bhattacharya

We consider the problem of classifying documents not by topic, but by overall sentiment, e.g., by their polarity -determining whether a review is positive or negative. We evaluated the performance of various classifiers like multi-variate Naive Bayes, multinomial Naive Bayes, Support Vector Machine (SMO method), IB1, J48, and ID3 on three data sets. WEKA[2] implementation of these classifiers were used for this purpose. Comparing the results obtained, we found that Multinomial Naive Bayes and SMO are good classifiers for sentiment analysis giving satisfactory results for most of the data sets. We conclude by examining factors that make the sentiment classification problem more challenging.

### **Fingerprint identification system based on hierarchical indexing using surf features**

Satvik Chauhan

Dr. Krithika Venkataramani

Among all the biometric techniques, fingerprint-based identification is the oldest method which has been successfully used in numerous applications and the recent advancement in technology has led to a wide range of systems which require reliable recognition schemes to determine the users identity. The goal of these schemes is to allow only authorized persons to use the service like access to computer systems, buildings, laptops, mobile phones etc. This has led to the development of many biometric and fingerprint identification systems to confirm a persons' identity. Everyone is said to have unique fingerprint and thus can be used as to identify the identity of a person. Current fingerprint identification systems use texture and minutiae based features for identification but these approaches take too much time if one desires very good accuracy. In this work we have explored application of another feature extraction scheme called SURF for extracting and proposed a fingerprint matching system based on hierarchical indexing.

### **Preposition Characterization using Voronoi Diagrams**

Vineet Hingorani

Dr. Amitabha Mukerjee

In this work we present our approach for the characterization of spatial related terms. Being inside an enclosure causes a reduction in area of initial Voronoi cells. This idea is used to capture a cognitive model for how a baby (below 6 months) may learn the aspects of containment prior to language. We have used Voronoi Diagrams' concept in our work. Here we consider how the area of the Voronoi Regions is reduced by the introduction of an object and use this to construct a measure of Degree of Intrusion. The idea of voronoi diagrams is used to implement the concept of proximity (degree of closeness). We assume the learner to have a capability of perception of notions of proximity. A pre-verbal notion of containment can be obtained by the notion of proximity.

### **Planar Near Field Measurement and its Transformation to the Far-Field**

Koustav Dey

Dr. A.R.Harish

Antenna measurement refers to the actual testing of an antenna to meet certain specifications which include gain, directivity, polarization, impedance etc. Field pattern measurement is a method to allow the measurement of relative power density of an antenna. We are interested in knowing the behavior of an antenna at far-off distances (say infinity). However in case of antennas having large aperture or operating at small wavelengths, it is not feasible for us to measure their far field pattern directly. We have considered the problem of measuring the near field pattern of an antenna first and then its transformation to find the far-field pattern of the antenna.

In this experiment we used a micro-controller connected to stepper motors which in turn are connected to a platform capable of moving in the X-Z Plane. The probe is mounted on this platform and the Antenna Under Test (AUT) is kept at a fixed distance from this plane and they are connected to a Vector Network Analyzer using serial cables. We use a computer which is interfaced with the micro-controller through a serial port and with the Network Analyzer using Ethernet programming. We have designed an Interface in MATLAB that positions the X-Z Controller corresponding to the input from the user, and for every relative position extracts the  $s_{21}$  values from the Network Analyzer and saves them in the form of Near-Field Data. We have also designed another User Interface that transforms the near field data (works with data collected from the previous interface and also that obtained through any simulator) to the far field pattern by an inverse fast fourier transformation. Thus the main course of action was to develop an automated interface for measuring the Near Field pattern first and then process it to give the far-field pattern. This if done manually would require manually positioning the AUT and probe on the X-Z Plane, noting the values from the VNA and then mathematically evaluate the far field pattern from it.

#### **Detection of Direction of Radio Controlled Improvised Explosive Device's Trigger**

Rishabh Maheshwari  
Dr. Naren Naik

The objective of the work is to find the direction of Radio Controlled Improvised Explosive Device (RCIED)'s trigger, working in a typical range of 136 – 174 MHz, and jamming the communication, as soon as the signal is detected. Current equipment locate the presence of a malicious signal in the remote area, but location of the transmitter of RCIED is still unknown by them as these technologies require an appreciable amount of time to track the source, whereas signal of the RCIED trigger is active only for a time interval of 2-3 milliseconds.

The work is broadly divided into two parts. The first part focuses on study of directional antennas and antenna arrays, in VHF range, to develop an understanding of antennas and thus choosing the appropriate antenna as per the required case. The second part focuses on interpolation techniques. It involves analysis of discrete data, taken from an antenna array, as continuous curves, to get direction of the source signal.

#### **Combined Approach to Source Separation Using Independent Component Analysis and Beam forming Methods**

Rohit Kumar Sinha  
Dr. Rajesh M. Hegde

We propose a modified algorithm for blind source separation (BSS), in which independent component analysis (ICA) and beam forming are combined to resolve the slow-convergence problem through optimization in ICA. The proposed method consists of the following three parts: (a) ICA with direction-of-arrival (DOA) estimation from it. (b) MVDR beam forming based on the estimated DOA, and (c) integration of (a) and (b) on the basis of an objective function. The unmixing matrix obtained by ICA is temporally substituted by the matrix based on MVDR beam forming through iterative optimization, and the temporal alternation between ICA and beam forming realizes faster and higher convergence. The results of the signal separation experiments reveal that the signal separation performance of the proposed algorithm is superior to that of the conventional ICA-based BSS method and Beam forming techniques.

#### **Optimal Classifier Based Spectrum Sensing in Cognitive Radio Wireless Systems**

Siddharth Sharma  
Dr. Aditya K. Jagannatham

The growing success of new wireless applications and services has led to overcrowded licensed radio spectrum bands, inducing governmental regulatory agencies to consider flexible strategies to improve its utilization.

To this end, cognitive radio (CR) is a promising technology as it allows the secondary users to communicate over the spectrum licensed to the primary users, when the latter are not using it. This is achieved through dynamic spectrum sharing. Spectrum sensing, that is, detecting the presence of the primary users in a licensed spectrum, is a fundamental part of the cognitive radio paradigm. We investigate the performance of classification based schemes for spectrum sensing. Three different optimal classification techniques for spectrum sensing, namely Support Vector Classifiers (SVC), Logistic Regression (LR) and Quadratic Discrimination (QD) have been discussed. These classification techniques do not require any estimate of the channel coefficients, or knowledge of the noise variance. They have been compared in terms of detection performances, in co-operative sensing scenarios. The techniques discussed offer significant advantage in situations where a malicious user is present as compared to the optimal detector. We propose a novel QD based classifier for blind spectrum sensing in MIMO cooperative wireless scenarios. It has also been shown through simulations that QD is a better candidate for spectrum sensing when there is a carrier frequency offset at the receiver.

#### **Text Analysis for polarity assessment classification of datasets with high objective content**

Udbhav Singh  
Dr. Arnab Bhattacharya

The objective of this work is to identify a polarity assessment classifier for text documents with high objective content. The present work in the end of text classification has dealt with datasets comprised of personal opinions and reviews such as movie reviews and posts from use net discussion groups. We seek to build a classifier for accurate classification of news articles on the Iraq War and the Indo US Nuclear Deal. These articles have a large content of objective data which remains same for articles which report favors as well as opposition. We compare six classifiers on movie review data collected by Pang & Lee. The results from these tests give us an estimate of the relative performance of these classifier on a subjective dataset. We identify Naive Bayes, Multinomial Naive Bayes and Support Vector Machines as the most accurate ones. Tests with the War and Nuclear Deal datasets on these classifier present us with a few anomalies from those documented in referenced papers. We seek to explain these results. In further work, we aim at improving these classifier by building another classifier for removing objective data within our documents.

#### **Price wars and tacit collusion in airline industry**

Aditi Gupta  
Dr. Vimal Kumar

Airlines are frequently engaged in 'price wars'. A 'price war' means continuous lowering of ticket prices. The idea behind such a strategy is that it helps an airline capture a larger market share which can get translated into higher profit in the present as well as in the future. Certainly, customers get benefitted from such price wars. Tacit collusion- where firms, without meeting their competitors try to untangle their competitors hoping that they will untangle them back, occurs quite commonly among oligopolists of our economy, and airline industry is among one of the top oligopolists to show such behaviour. Analysis of various aviation markets help us to find out the certain situations where price wars and collusion can occur. In this project we study the history of the Indian Aviation industry and analyze the various fluctuations experienced by it. We look at the aviation market of another developing country as India- 'China' and also at a developed country- 'Australia' which faced the liberalization and the entry of new competitors at the same time as India. This research concludes certain factors responsible for the occurrence of price wars and collusion. They are basically demand shocks (external) and financial situation (internal) of the firm. The data which has been used in this project has been collected from the site of Directorate General of Civil Aviation (DGCA). The monthly unavailability of airfares of various airlines in India is one of the biggest limitations of the research. Price wars and collusions are very short lived hence the quarterly or yearly data which is available will be insufficient.

### Sol gel derived amorphous indium gallium zinc oxide thin films

Priya Gautam  
Dr. Deepak Gupta

The objective of this research project is to synthesize the indium gallium zinc oxide (IGZO) thin films via sol gel method and characterize them for the properties like transparency, resistivity, crystalline, thickness and refractive index.

IGZO thin films were successfully synthesized via sol-gel technique using nitrates and acetate based precursors. We investigated the effect of annealing temperature and annealing time on the IGZO (2:1:10) thin films. Films were found to amorphous in nature but some crystallization starts when annealed at higher annealing temperatures. Films' thickness was found to be about 60 nm and resistivity was of the order of  $10^5 \Omega\text{cm}$ . Films were highly transparent with transparency more than 85% when annealed for 2 hours.

### A Development of Java Based GUI for Choosing Initial Guess in 3D Image Registration

Poonam Kesarwani  
Dr. R.K.S. Rathore

The purpose of this work is to avoid the subject head movement problem in brain functional MRI. Patient motion during data acquisition could become one of the major problems in the any voxel wise analysis of MRI data such as DCE-MRI etc. In such cases, as indicated, it may be imperative to do registration before taking up a voxel wise analysis. The objective of this work is to develop a GUI for initial affine guesses in image-volume registration including the shear parameters.

### Modeling of Electrodynamics Shakers

Arihant Bhandari  
Dr. Nachiketa Tiwari

An electrodynamic shaker functions to deliver a force proportional to the current applied in its voice coil. These devices are used in diverse activities such as product evaluation, stress screening, squeak-and-rattle testing and modal analysis. These shakers may be driven by sinusoidal, random or transient signals based upon the application. Problem Statement: To know the response of system in presence of load and make a model for the system.

Solution Approach:

1. Lumped Parameter Modelling of shaker table.
2. Experiments to verify theoretical results and correct the model.
3. Develop a final predictable model based on data from 1 and 2.

### Studying the effect of pulsating pressure on human artery to mathematically model Aneurysm formation and growth

Mrityunjay Kothari  
Dr. K. Muralidhar

Human body contains a large number of blood vessels made up of complex biological materials. These undergo pulsating pressures as the heart pumps the blood to the body. This loading of the arteries may lead to their weakening in due course of time. ANEURYSM is a blood filled swelling or bulge developed in arteries. Once it forms, as a result of the FLUID LOADING it continues to deform and a stage comes when the eventual failure of the artery takes place and it can lead to immediate death. Questions like what causes an aneurysm, how fast they grow, when do they rupture still remain unanswered? Clinical progress in this direction is impeded by the absence of specific mathematic models which describe aneurysm. (The biomechanics of Arterial Aneurysms, Annu.Rev.Fluid Mech. 2007). A mathematical model will be able to address these issues and predict the aneurysm formation so that preventive measures can be taken. The important thing here is dealing with complex biological materials in arteries whose properties are a combination of various behaviors like visco elasticity etc. I have studied the response of elastic and visco elastic materials on the application of pulsating pressure. The study of deformation of arteries to application of load is crucial to development of a mathematical model.

### Determination of Heat Transfer Coefficient in slug flow using Infrared Thermograph

Nikita Jaipuria  
Dr. Sameer Khandekar

The main objective of the study is to determine the heat transfer coefficient in hydro dynamically developed but thermally developing laminar flow (single phase as well as two phase) in a square channel. The bubble train in case of two phase axial steady flow is injected from the transverse direction. Bubbles disturb the flow i.e. thermal and hydrodynamic boundary layers can be disturbed and as a result, heat transfer is affected. The heat transfer coefficient is determined in an aluminium test section of square cross section 5mm x 5 mm (hydraulic diameter 5.0 mm), with 140 mm as the length of the channel. Deionized water is used as the working fluid which flows horizontally and the test section is heated by a cartridge heater (constant heat flux boundary condition applied at the bottom of the substrate). The different parameters like Reynolds Number (Re), Prandtl Number (Pr), frequency of the pulsations - Womersley number (Wo) and the amplitude of pulsations play significant role in characterizing this kind of phenomenon. This study will be mainly focused to analyze the effect of the abovementioned parameters on the heat transfer. Infra-Red Thermography will be employed to obtain the temperature field and the local heat flux and the heat transfer coefficient will be calculated from the captured thermographs.

### Nondestructive Testing and Reconstruction of Defects using Ultrasonic Phased Array System

Vishwas Aggarwal  
Dr. N. N. Kishore

For quality assurance of structural member during manufacturing stage and operational life, NDT is a vital tool to confirm that. Among number of NDT methods, Ultrasonic has been the tool of choice to inspect, since the likely defects and important material properties are most easily, and inexpensively, uncovered in ultrasonic NDT. Manual ultrasonic is much better than radiography for planar defects, but due to slow and the results are highly operator-dependent phased array technique used as it offers speed and flexibility. Due to hazardous nature of x-rays, ultrasonic testing methods gained importance in medical and NDT. Due to physical constraints of accessing other side of structure and immeasurability of transmitted signal (like cardiovascular imaging), we have taken into account the reflections coming from various interfaces and tried to develop a technique for the reconstruction of defects in an isotropic material using phased array system.

### Computational Study of Micro Air Vehicle Aerodynamics using Velocity-Vorticity Formulation

Aabhas Srivastava  
Dr. T. K. Sengupta

Recent times have seen a large interest in development of Micro Air Vehicles which are characterized by small Reynolds number aerodynamics. As at Low Reynolds number, unsteady effects are dominant, the airfoil is needed to be such on which the flow separates at a larger distance from the leading edge than conventional airfoils. As such flows suffer from aliasing problem originating from dissipation term and the thick boundary layer experiences large unsteadiness, available commercial softwares fail badly in predicting MAV aerodynamics problem and there is no alternative to developing our own high accuracy methods based on compact schemes. The objective of the work was to develop velocity-vorticity formulation for an orthogonal grid which can produce accurate solutions for flow past airfoils at Reynolds number relevant to MAV's. The results obtained by this solver need to be compared with results already available. No such formulation has been earlier developed which uses the velocity-vorticity formulation and its development offers a new area in Computational Fluid Dynamics to work upon in future.

### Spectroscopic Analysis of a premixed LPG-Air flame

Gislain

Dr. A. Kushari

This study aims at establishing a new method to have access to the equivalent ratio of a flame, without using a thermocouple. Several experiments were made on a LPG-Air flame, using rotameters to measure flow rates and a Constant Deviation Spectrometer (CDS) to measure radical emission intensities. These emissions, by taking their ratio, were then related with the equivalence ratio. The first experiment's purpose was to find the proper relation between each radical intensity ratio and the equivalence ratio. These relations appeared to be linear. A second experiment was conducted, using the linear relations just previously found to compute the equivalence ratio at different points of the flame. Thus, a horizontal equivalence ratio profile of the flame and a vertical one were obtained for the lean and the rich burning region. Comparison with measured equivalence ratio values frequently produces a relative error smaller than 3%, which highlights the reliability of this method. The flame profile convexity for the lean region and the flame profile concavity for the rich region were also described. The vertical equivalence ratio profile was also studied, also with relative errors around 3%.

### DSMC method: adaptation of the code to the lid driven cavity problem

Matthieu Bonneric

Dr. Brijesh Eshpuniyani

If one works in the lower atmosphere, the number density is very high and most often the continuum approximation is valid. The study of aerodynamic flows often requires the resolution of Euler equations or Navier-Stokes equations (most often with numerical tools). Thanks to the continuum approximation, we can solve these problems using the finite elements method (for instance). The Computational Fluid Dynamics method (CFD method) is based on this principle. But when we work in the higher atmosphere, the air becomes scarce, and the continuum approximation is no longer valid. This means we can't use the CFD method to solve our problems properly. In the High Speed Aerodynamics laboratory, people work on Direct Simulation Monte Carlo method (DSMC method), which uses a particle approach. This method allows simulating hypersonic flows in the higher atmosphere. After spending some times to understand the principle of DSMC method, and to understand how the FORTRAN code used at the lab was built, I worked on adapting the code used at the lab to simulate the lid driven cavity problem. The lid driven cavity problem had already been solved for cases where the continuum approximation is valid. But implementing the DSMC code for this problem enables one to solve it for rarefied flows. I had to work on adapting the program to the particular geometry of the problem. I wrote two codes, each one implementing one kind of reflection. Eventually, I could compare the two models, and to observe the impact of Knudsen number and the moving plate's velocity on the simulated profiles.

### Modulating the flexibility of GlnU to utilize various nucleotides as substrates and possible application of such utilization.

Kunal

Dr. Balaji Prakash

The objective of this work is to analyze the ability of GlnU to utilize various nucleotides as substrates and possible application of such a utilization. GlnU is a nucleotidyltransferase which catalyses the production of UDP-GlcNAc, which is a precursor to peptidoglycan synthesis. The uridine ring of the substrate UTP is stabilized by Gln 83 which provides specificity towards uridine nucleotides. We proposed here to alter the specificity of the nucleotide by mutating the Gln 83 residue using the technique of the overlap extension PCR and then performed malachite green assay to check the nucleotidyltransfer activity of mutants. Such an approach was extended to GlnU with reference to thymidyltransferaseRmlA which was engineered in 2007 and brought forward the change in efficiency several fold of guanylyltransferase and adenylyltransferase by performing such mutation. In this study we mutated Gln 83 to Ala and Ser with the objective of enhancing the bias towards purine nucleotides. Our results shows that Wild type GlnU can utilize all the four nucleotides with varying

efficiency but substitution of Gln to small side chain residue does not show significant increase in the adenylyltransferase activity. This shows that, though a nucleotidyltransferase, GlnU cannot be utilised for glycorandomization, like RmlA.

### Homology Modeling and Docking Studies of 3NTDO

Ruchi Lohia

Dr. R. Gurunath

3Nitro toluene dioxygenase (3NTDO) is a microbial enzyme of the Rieske Oxygenase family which catalyzes the stereospecific dioxygenation of aromatic rings of especially nitroarenes, which is a serious environmental contaminant. It shows high sequence identity with Nitro benzene dioxygenase (NBDO) and has only difference of five amino acids at the active site. In the present study, the homology modelling of  $\alpha\beta$  subunit of 3NTDO from *Diaphorobacter* sp. strain DS2 has been constructed using NBDO as template in order to get a depth idea of its structural and functional aspects. After validating the consistency of the model it was further analyzed for changes in the structure with respect to the NBDO and NDO. It was observed that the size of the pocket at the active site is bigger in 3NTDO as compared to NBDO especially due to presence of Val350 instead of Ile350. Also the entrance of the pocket seems to be less sterically hindered due to Met251 instead of Phe251. This shows that 3NTDO may also degrade polyaromatic compounds and might have different substrate specificity. Further, in future docking studies with wide range of substrates need to be done using AUTODOCK and GOLD. The binding properties of these compounds need to be studied for identification of critical active site residues which could be used as potential targets for site directed mutagenesis leading to novel mutants with enhanced activity.

### Development of Aqueous Two Phase System (ATPS) for studying the partitioning behavior of gold nanoparticles based on their surface characteristics

Anjul Khadria

Dr. Dharendra S. Katti

The study of surface characteristics of gold nanoparticles such as surface charge and surface hydrophobicity becomes imperative as gold nanoparticles have found to be of extensive use in the field of biological sciences owing to its optical and chemical properties. In this work we are developing partitioning based method for determining size based changes in surface characteristics. We have proposed the use of Aqueous Two Phase Systems (ATPS) to study the partitioning behavior of gold nanoparticles. We have used Polyethylene glycol-Dextran two phase systems for this purpose. Phase diagram for these systems were studied using conventional approach employing polarimeter and refractometer. We also developed a novel approach based on colorimetric analysis of polymers in ATPS to determine phase diagram. To best of our knowledge this kind of approach has not been used till now. We further synthesized gold nanoparticles of two sizes (~15 and ~40 nm) using citrate reduction methods. These particles were then partitioned into two different ATPS which differ in their phase composition. We observed that change in phase composition significantly affects the partitioning behavior of gold nanoparticles. This approach has shown potential to be developed into a new method for determining surface characteristics of gold nanoparticles. Further research is going on to determine effect of charge based and non-charge based interactions in partitioning behavior demonstrated by gold nanoparticles in said ATPS.

### Microstructural and mechanical characterization of Ytria Stabilized Zirconia based composites reinforced with hydroxyapatite and carbon nanotubes

Sukriti Bhardwaj

Dr. Kantesh Balani

The objective of this work is to prepare a material which is best suited as a bone graft substitute in bone and dental implants. The material used for a dental implant must have high strength, fracture toughness and biocompatible. Ytria Stabilized Zirconia is known for its hardness and fracture toughness but it is bioinert therefore hydroxyapatite is added to make the implant bioactive. Now, mechanical properties degrade on adding hydroxyapatite due to low values of hardness, fracture

toughness of hydroxyapatite. Density increases by 2% but hardness and fracture toughness decreases by 47 and 61% respectively for nYSZ-10HAp. Due to high hardness and toughness values of Carbon nanotubes, 10% by weight Hydroxyapatite doped zirconia is reinforced with CNT. It is therefore expected that on the addition of CNT the mechanical properties will improve but due to CNT agglomeration and poor cohesion between CNT and matrix. Also CNT prevents the transformation of tetragonal zirconia to monoclinic which reduces transformation toughening and hence the hardness and toughness values of YSZ-HAp-CNT composites degrade further.

#### Assessment of the air quality in Kanpur city 2011 'impact of traffic and construction activities near major intersections'

R. Ashwin Kumar  
Dr. Anubha Goel

According to a recent summary report on Air Quality in Indian cities (2010-11) by Ministry Of Environment And Forest, Kanpur is the most polluted city in India in terms of the air pollution levels related to the particulate matter (PM). Knowledge of the adverse health effects due to exposure to PM combined to the fact that currently extensive construction work on underground sewage and highway construction activity is underway in the city raises concern about impact on human health. This study was undertaken to characterize the air quality of Kanpur city, with emphasis on major railroad intersections and in the regions where extensive construction activity is underway. Air samples at six different locations (with multiple sites at each location) were collected during the peak traffic and construction activity hours using the Optical Particle Counter (OPC) in both count and mass mode. Data reveal that average levels of coarse and fine particles are around 6-8 times higher than the national as well as international air quality standards ( $60-150 \mu\text{g}/\text{m}^3$ ). As expected, an inverse correlation between particle size and particle count was observed for data from different locations. Health parameters (lung capacity) of people at each sampling location were measured using a Peak Flow (PF) meter. One of the research goals was also to examine the correlation between particle concentrations in count mode with health parameters. As expected, particle concentrations in the  $\text{PM}_{2.5}$  size range were found to be more significant than the mass of the particles, in affecting the lung capacity of the subjects under health evaluation.

#### Low cost synthesis of water soluble graphene

Garima Singh  
Dr. Sabyasachi Sarkar

This report contains the synthesis of a water soluble graphene oxide sheet which is a new rising hero on the horizon of nanotechnology. Till the methods known are not eco-friendly as well as they require harsh conditions and very costly. A simple idea that how can we write on paper with pencil gives a sight to work. Bilayer graphene was synthesized by using pencil as source with some oxidizing agent and results obtained are very positive and further work is needed. FESEM image of bilayer water soluble graphene oxide sheet synthesized from pencil



#### Purification of Recombinant Oxygenase in E Coli

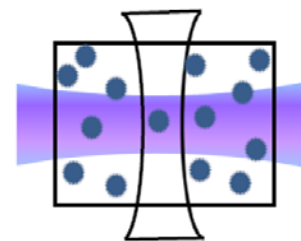
Marianne Braun  
Dr. R. Gurunath

The successful purification of the oxygenase subunit from cloned E Coli cells was the primary purpose of this project. The enzyme from which the oxygenase was purified has the ability to catalyze the conversion of indole or tryptophan to indigo, and is thus of very relevant importance in the industrial world. However, then enzyme must first be characterized and understood properly. Starting from a cell culture, numerous techniques and protocols were performed in order to attain an acceptable specific activity. Not many enzymes are known to catalyze the formation of a dihydroxylate aromatic ring. With purification of this recombinant oxygenase, further analysis and characterization of such a promising enzyme can be performed.

#### Accurate Quantification OF THE Thermal LENS SIGNAL through Mechanical Chopper

Mrinal Shekhar  
Dr. Debrata Goswami

It has been widely reported in the literature that the thermal lens signal attenuates with the increase of chopper frequency. My objective in this experiment is to find out is this really true? In order to investigate this problem, two kinds of experiments were performed. One was the dual beam mode mismatched experiment and the other is single beam experiment. For both these experiments a femtosecond Er:doped fiber laser was used. This laser generated a pulse, centered at 1560 nm (fundamental) and a second pulse centered at 780 nm (second harmonics). The 1560 nm beam acted as the pump beam and the 780 nm beam acted as the probe beam. After the experiment is performed, it is observed that the mean and peak-to-peak measurements are different in the dual beam mode-mismatch experimental setup. We then performed the single beam experiment and found out that the mean and peak-to-peak measurement behaves similarly. Since it has been reported in the literature that thermal lens should attenuate with the increase of chopper frequency, both the experiments should have shown the same trend, i.e. attenuation of the mean and peak-to-peak measurements with the increase of the chopper frequency. Since the results were different, my objective was to investigate the reason for such an observation



#### An investigation on contour interval vis-à-vis data density, accuracy and ground characteristics

Himani Agrawal  
Dr. Bharat Lohani

Contours are extensively used to show 3D topography on a 2D map. The correct choice of contour-interval (CI) is very important for map accuracy. The thumb rules available today take into account only few factors while calculating CI. In this research we have tried to find out the numerical relationship of CI with data density, data accuracy and average slope of terrain.

#### **A study into the approximate value of contour interval for given data density, data accuracy, terrain characteristics**

Ruchi Khetan

Dr. Bharat Lohani

Topographic data collection methods have moved from the selective mode of the theodolites and Total Stations to the non-selective and redundant mode of laser scanning of the terrain. This modern process of 3D data collection has posed major challenges for the scientific community in order to generate topographic maps or contours. We make an attempt to understand the relationship between the sampling density and the errors thus produced in the generation of contours. Simulated terrains are generated, and sampled for fine to coarse spatial resolutions. Normally distributed random errors are added to the sampled data as per the error budget properties of the collecting instrument. This data is interpolated to generate the terrain and compared with the "true" one. Plots for varying data density, errors and terrain types are compared, analyzed and guidelines have been framed. Using these graphs, optimum data density requirements for given accuracy can be estimated.

#### **Assessment of road traffic situation in India using statistical analysis**

Sandeep Patil

Dr. Vinod Vasudevan

The objective of this work is to develop a model to predict the deaths due to road traffic crashes in India using regression analysis. The model developed is a data intensive statistical model based on the concept of total harm. The work involved reviewing the previous studies to build up a knowledge base and understanding of the concept of road safety. Road safety is described as a public health problem requiring multi-sectoral collaborative efforts to react to the situation. The data is an essential component in the development of such a model. The model incorporates the exposure and risk dimensions of the road safety problem. The work done is a macro level study and identifies the reasons responsible for the rising traffic fatalities.

#### **Development of GIS based Spatially Resolved National level Emission Inventory for Reactive Nitrogen ( $N_2O$ and $NH_3$ ) in India**

Soumya Gupta

Dr. Mukesh Sharma

Reactive Nitrogen is trace N components that are biologically-active, photochemically-reactive, and radiatively-active nitrogen compounds in the atmosphere, hydrosphere and biosphere. Although nitrogen (N) is a major nutrient that governs growth and reproduction of organisms, however, accumulations of reactive nitrogen from various sources have a profound effect on air and water quality. It leads to air pollution, acidification and eutrophication of eco-systems, bio-diversity impacts, leaching of nitrates into groundwater and global warming.  $N_2O$  and  $NH_3$  play important roles in local, regional and global environments in terms of global warming, fine particulate matter formation, atmospheric. The objective of this work is to prepare a spatially resolved national emission inventory of India for Reactive Nitrogen, specifically,  $N_2O$  and  $NH_3$ . The grid wise inventory will provide information for a 55km x 55km grid emission data. ArcGIS is used to get grid-wise data which is later analyzed to identify the major polluting sources for  $N_2O$  and  $NH_3$ . Distribution of these sources is also developed to identify the critical grid points.

#### **Mobile application development on agropedia and vkvk website re-development**

Ashish Kasera

Dr. T.V. Prabhakar

Agropedia is a digital knowledge repository with the open platform for learning and sharing information related to Indian agriculture. It includes universal meta models and localized content for a variety of users with appropriate interfaces built in collaborative mode in multiple languages. The content is semantically catalogued and easy to find. Agropedia contains a module called Package Of Practices (POP). We here aim at developing a mobile application using HTML and Javascript that displays the contents of POP in substitute of an Android application because Android applications can run only on Android OS and Android phones are too expensive for the target users like farmers. We also aim to re-develop the VKVK website using the Open Source CMS called DRUPAL. VKVK supports services like sending alerts from scientists on different crops in the form of text messages, emails and voice calls to farmers across India.

#### **Task Scheduling of Distributed Heterogeneous Computer Systems**

Jahnvi Singhal

Dr. Mainak Chaudhuri

The objective is to schedule a task on distributed heterogeneous computer systems in order to reduce the time to complete the task. I have considered the problem of scheduling Matrix-Multiplication problem optimally on CPU and GPU. The task is distributed on the systems so that they both work simultaneously. Some portion of the task is being done on CPU and the rest is being done on GPU with heavy parallelism in such a manner that both end up doing their respective portions of task at same time.

#### **Semantic search engine for agropedia**

Julien Lambert

Dr. TV Prabhakar

The aim of this project was to build a search tool adapted to Agropedia website's strong content organization. We have defined a search algorithm that uses the articles' tags as reference (semantic) rather than searching for the keywords in the textual content of each articles (syntactic). The algorithm also takes into account the existing hierarchy between tags (taxonomy) to get all the relevant content. Once the precise mechanism of this algorithm has been designed, it has been implemented as a Drupal module, fully tested and optimized, and is now part of Agropedia website.

#### **Detection and Location of Humans in Images**

Prithviraj Nag

Dr. Amitabha Mukerjee

The objective of this work is to implement a human detector from images using the PHOG (Pyramidal Histogram of Oriented Gradients) as a feature descriptor of the image and SVM (Support Vector Machine) classifier to classify the generated feature descriptions and testing it on a human image database like the INRIA dataset. PHOG as a feature descriptor has been found to be best suited performance-wise for such tasks as human detection. 3 level image PHOGs of positive and negative training set images are constructed and used to train an SVM and create a data model. Various sub-images of many sizes are created from test case images and their resulting PHOGs are passed onto the SVM which classifies them as containing or not containing a human, based on the trained data model. This way, the presence of a human can be detected in any part of an image and its location known. The work describes the procedure of creation of the PHOG, generation of sub-images from test cases, training of the SVM and ends with the results.

### Estimating loop bounds - For use in Compiler optimization for Database intensive applications

Varun Simhadri

Dr. Amey Karkare

Applications invoke database queries repeatedly (no sharing of work) and synchronously (blocking on every request). Naive iterative execution of such queries is inefficient – no sharing of work, network round trip delays. The loop transformation technique, called batching in [1] which is based on query decorrelation technique has been proposed to automatically replace iterative invocation of query with its set oriented execution. But, if there are very few iterations of loop, application of this technique may not be beneficial - overhead of transformation (memory for creating batch, etc.) may be high. In such case, conditional execution of transformed code based on an estimate of number (n) of executions of query inside the loop would bring in efficiency. In this project, an approach to estimate number of executions of query inside loops has been proposed and implemented in a standalone tool in Java, using JDBC for database connectivity.

### Efficiency of Indian stock markets

Jyoti Date

Dr. Somesh Kumar Mathur

The study is about estimating the efficiency on Indian Stock Markets. In this project Nifty and Defty, two indices of National Stock Exchange India were tested for efficiency with the basis of random walk hypothesis. Random walk hypothesis state the prices move randomly and the past prices are not helpful in predicting future prices. Many researches so far have been conducted to prove that hypothesis using different models and approaches. The results of these studies are contradictory. The problem of unit root was tested using two parametric methods Augmented Dickey Fuller test and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test along with one non parametric method, Phillip Perron test. Further another parametric test was performed in order to maintain accuracy; auto-correlation test was done on the given data series of closing prices. The projects describe the unit root problem and also test the data series at a first difference level in order to reject the null hypothesis. The results of the four alternate tests revealed that the Indian Stock Market is inefficient in the weak form and therefore does not follow the random walk process. Thus, the opportunity of making excess returns in the market is ruled out.

### Policy Instruments to Promote Renewable Energy in International & Indian Context

Vibhuti Awasthi

Dr. Anoop Singh

Modern Society is chiefly reliant on fossil fuels to satisfy its energy needs. Today, one of the primary concerns associated with such fuels is that of energy independence as these fuels have a limited presence in nature. Also environmental degradation due to their excessive use is posing great danger to our planet. In this context renewable energy is of utmost significance and is rapidly gaining acceptance within the society. The aim of this study is to review policy and regulatory instruments implemented to promote renewable energy including assess the development of voluntary green markets and roof-top PV programs. Implementation of policy instruments like Feed-In-Tariffs, Cash Subsidies and Tax Credits across different countries as well as India has been studied. Specific provisions under these policies for supporting roof-top programs have also been discussed under each section. Voluntary green markets in various countries have been examined with respect to green power labeling schemes, suppliers and products being sold as green electricity. Finally some suggestions for the development of roof top programs and voluntary green markets in India have been provided.

### Simulation Study of Carbon nanotubes and Ferrites as Electromagnetic Absorbers

Kaza Aneesha

Dr. K.V. Srivastava

Of late, we have seen the development of increasingly hostile detection systems, threatening the effectiveness with which the weaponry platforms carry out their activities. Therefore, Radar Cross Section Reduction (RCSR) becomes important in stealth technology for aircraft, missiles and other military vehicles. RCSR can be realized in various ways, of which, the method of using radar absorbing materials (RAMs) has been discussed here from application point of view. Two very common objects, a metallic rectangular plate and a circular disc, are chosen here as targets and RCS have been calculated for them, and compared with available literatures. The RCS have been calculated also for doped carbon nanotube (CNT) and ferrites and it has been found with the coating, RCS has been reduced, signifying them as absorbers.

### Optimum AR Model based Maximum-likelihood (ML) error correction in Wireless Sensor networks (WSN)

Ashish Katiyar

Dr. Aditya K. Jagannatham

Wireless Sensor Networks (WSN) have many applications such as environment and habitat monitoring, healthcare applications, and traffic control, etc. Two important factors in the practical implementation of WSN are reliability and cost. These two factors are interdependent. As the reliability increases, the cost also increases and vice versa. Due to the cost constraints, there are errors due to hardware noise, communication errors, errors in sensors, etc. To address this problem we have proposed a new error correction algorithm, Optimum AR Model based Maximum-likelihood (ML) error correction. This algorithm uses the temporal correlation of the data and the channel information to detect and correct errors of the data received over a wireless channel.

### Microwave molding and characterization of mixed dielectrics using x-band rectangular waveguide approach

Nayakuni Murali Krishna

Dr. Jaleel Akhtar

The model for measuring of electromagnetic properties of mixed dielectrics and composite materials using the rectangular waveguide includes the assumptions that the material under measurement is homogenous and the electric field is uniform throughout the waveguide. We have considered the problem of molding and characterization of mixed dielectrics and n-layer composite material which is not homogenous using x-band rectangular waveguide approach technique. We have considered the non-uniform electric field in waveguide which varies in sinusoidal form along the broader dimension of the waveguide. We have shown taking into account the effect of sinusoidal electric field provides better results in properties measurement compared to the volumetric formula or any other formulae in case of rectangular waveguide technique.

### Modeling of Direct Driven Synchronous Machine Based Wind Turbine

Shishir Nagaria

Dr. S.N. Singh

2 MW electrical power conversion system is developed for a variable speed wind turbine system. In the wind energy conversion system (WECS) a synchronous generator converts the mechanical energy into electrical energy. As the voltage and frequency of generator output vary along the wind speed change, a DC-DC boosting chopper is utilized to maintain constant DC link voltage. Line side PWM inverter supply currents into the utility line by regulating the DC link voltage. The active power is controlled by q-axis current whereas the reactive power can be controlled by d-axis current. The phase angle of utility voltage is detected using software PLL (phased locked loop) in d-q synchronous reference frame.

### Enhanced gain dual band patch antenna based on complementary split-ring resonators

Abhimanyu Srivastava

Dr. Kumar Vaibhav Srivastava

There is a lot of research going on in the area of antenna design to meet the requirements set by the tremendous growth of wireless communication technology. Great efforts are especially being made for the reduction in size of antenna. In this project a simple dual band patch vertical polarized rectangular antenna is simulated. The dual band antenna is designed to be used in the WLAN applications (around 5 GHz frequencies). The dual band antenna is designed by etching a complementary rectangular split ring resonator in the patch of a conventional rectangular patch antenna. The dual band antenna design has been made feasible due to the quasi-static resonance property of the complementary split ring resonators. A miniaturization of the conventional rectangular patch antenna is achieved.

### Secure Spectrum Sensing in Cognitive Radio Cooperative Sensing System

Ananya Roychowdhury

Dr. Adrish Banerjee

Cognitive Radio is an emerging technology that senses its environment and changes its transmission or reception parameters to communicate efficiently avoiding interference with licensed or unlicensed users. Spectrum sensing is one of the important mechanisms of cognitive radio and is an active area of research. The operational aspects of spectrum sensing are being studied actively, but its security aspects have garnered very little attention till now. Although cooperation among multiple secondary users improves the system performance, the presence of malicious secondary users severely degrades the same. In this report, we study the detection and elimination of these malicious users in a cooperative sensing system by using outlier detection techniques. We introduce two new techniques and show that they significantly outperform the existing outlier detection technique in the presence of a single malicious secondary user.

### RFID Reader antenna

Divya Bharti

Dr. A.R. Harish

We have considered an RFID reader designed to radiate circularly polarized waves on both sides of the antenna to track tags situated on its either side. The model was an annular slot antenna loaded with a meander slot. We studied its properties and made changes to the antenna model that caused optimization in terms of reflection coefficient bandwidth and the axial ratio bandwidth. The study of several variations regarding the structure of the antenna as well as the feed has been carried out, thus changing the reflection coefficient bandwidth of the antenna from about 10% to 21%. The small size of the antenna makes it very suitable for use in modern wireless systems which require compact, low cost, and high performance circuits. Moreover, its circular polarization makes it more attractive for various applications in other RFID systems. Also, attempts were made to make the antenna resonate between some interval of frequencies to increase the axial ratio bandwidth it did not yield desirable results. Some further work is required in this regard.

### Simulation of power quality events and their classification and detection using artificial intelligence

Uma Rao

Dr. S.N.Singh

The classification of the disturbances is an important task for monitoring and protection of power system. This work presents an approach for fault detection and classification in the distribution system for two events occurring simultaneously in the system. This work is based on wavelet Multi Resolution Analysis (MRA) and Feed Forward Neural Network. The objective is achieved in three steps. In the first step, various kinds of double events possible in a practical system are simulated in IITK distribution system using simulink. In the second step, the disturbance power in each level is calculated using Discrete Wavelet Transform (DWT). In the last step, an algorithm has been proposed for fault classification and detection. Fault type, whether single or mixed fault is identified

using Feed Forward Neural Network (FFNN).

### Accuracy of relap 5 results for safety analysis of nuclear reactor

Vikas Pandey

Dr. Prabhat Munshi

RELAP 5 system codes is developed by Idaho national lab, U.S. and is used in various countries for the safety analysis, rulemaking and licensing of nuclear reactors nuclear power plants. The RELAP5 model is based on the one dimensional two fluid models for analysis of two phase flow phenomena in nuclear reactor core. The two phase flow is known to be highly unstable in nature. To stability check of the conservation equations we can use method of characteristics. The instability in two phase flow is correlated with the ill posed problem. The system will stable only when solution has well posedness. The solution has well posedness only when the equations are hyperbolic in nature and characteristics are real and distinct. At the pressure 7 bar, 70 bar and 140 bar the analysis of the governing equations are carried out. The code is written in the MATLAB 2010. These results can be also extended to the other hydraulic systems.

### Synthesis of functionalized cyclic peptide

Sudhanshu Kumar Singh

Dr. Sandeep Verma

Cyclic-(GSG)<sub>2</sub>, a cyclic hexapeptide which has been previously synthesized in our lab self-assembles into nanotubular structure. These nanostructures show bending phenomenon upon interaction with electron beam or ion beam. In continuation we wanted to functionalize cyclic-(GSG)<sub>2</sub> to diversify its application. We have derived a method so that we can substitute additional functional groups on it. Propargyl substituted cyclic hexapeptide was synthesized by using solution phase synthesis. Further fictionalization with mannose, cholesterol etc is possible by using click chemistry. As the first example we were able to attach mannose groups on propargyl substituted cyclic hexapeptide using click chemistry. These compounds may be used in nanotechnology.

### Creating an Efficient Sorting Algorithm Using Combination of basic Sorting Methods

Harshit Mishra

Dr. Manindra Agarwal

The problem undertaken is to generate a time-efficient algorithm that performs the fundamental task of sorting numbers using a combination of basic sorting techniques. In this project, we analyzed six sorting methods Bubble sort, Selection sort, Insertion sort, Mergesort, Heapsort and Quicksort. Each sorting algorithm has some range in which it exhibits efficiency per se. We considered large number of randomly generated arrays of various sizes which served as fixed-memory inputs. In this regard, we collected a plethora of readings for each size for each algorithm and plotted their graphs using the average of the readings. Graphically, we identified the most efficient algorithms and noted their ranges. The recursive algorithm created checks the array size in each run and selects the appropriate algorithm for that range. We then moved on to evaluate time constants for these  $O(n^2)$  and  $O(n \log n)$  using the Least Squares method and also established the best fit curve for the newly created optimized algorithm. This research initiative finds widespread application and can be immoderately extended to include more than 6 basic methods and yield an even more fruitful result.

### Design and development of flight control system for micro coaxial helicopter

Nidhish Raj

Dr. Abhishek

The objective of this work is to design and implement a flight control system for a micro coaxial counter rotating helicopter. The flight control system basically controls the attitude of the vehicle. For this purpose three independent PID controller each for roll, pitch and yaw is implemented in Atmega328 microcontroller in Arduino development board. An accelerometer and gyro are used to give roll, pitch and yaw rate feedback to the PID controllers. The angular rate data from gyro is converted from body frame to earth fixed navigation frame using Euler angle transformation.



The attitude data from gyro and accelerometer are merged together using complementary filter to get a better estimate. Two servos are used to control the tilt of swash plate, thereby controlling the roll and pitch moment of the vehicle. Two dc brushed motors are used to rotate the upper and lower rotor in opposite direction. To produce a yaw moment, the difference between the speeds of two rotors is increased. Finally a test stand with three degrees of freedom (roll, pitch and yaw) was built to tune the gains of PID controllers.

#### Numerical Study of flow across a symmetric sudden expansion

Aloona

Dr. Malay K. Das

This study deals with two - dimensional, incompressible, laminar flow in a symmetric plane sudden expansion. This type of flow exhibits a stable symmetric solution up to a critical Reynolds number above which a symmetry breaking bifurcation occurs. The governing equations (Continuity and Navier Stokes equation) are written in the primitive variable form and are solved using second order spatial and temporal discretizations for Reynolds number ranging from 50 to 150. The expansion ratio has been fixed as 3:1. The explicit Marker and Cell (MAC) method and a staggered grid is used to obtain the solution. We have run two cases for ascending and descending Reynolds number, for both uniform and parabolic inflow profiles. The results show that this problem has multiple solutions as we have obtained different values of the critical Reynolds number for different cases. It is also seen that uniform inflow delays the critical Reynolds number to a higher value. The length of the recirculation zone was also found to increase with an increase in Reynolds number.

#### Suppression of vortex shedding

Ayush Kumar

Dr. Arun K. Saha

A computational study of flow over a bluff body (square cylinder) in a finite flow domain was done. The main objective of the study was to suppress the vortex shedding using the passive control elements. The control square cylinders of size 15% of that of the main cylinder were used and placed upstream and downstream to the main cylinder. The cases for two square cylinders and a single cylinder were run for Reynolds Numbers range 55-100. Unsteady Navier Stokes equations were solved. A simulation was run without control cylinder just to confirm vortex shedding for the same flow domain and boundary condition the Strouhal Number for this case is equal to 0.15143. Initially single control cylinder simulation was run but no suppression could be seen. Then two control cylinders were placed upstream and the simulation was run for Reynolds Number 100. The flow is steady there is no vortex shedding and the simulation is still running also the total drag coefficient including the drag of control cylinders decreases continuously with time. Also two control cylinders were placed downstream the time is very less no vortex shedding is seen till now. For  $Re=55$  the simulation was run for the control cylinder placed downstream to the main cylinder there is no suppression of vortex shedding in this case either.

#### Aerodynamic shape optimization of wing using adjoint based method

Deleep Kumar Chandar

Dr. Sanjay Mittal

The tools for aerodynamic shape optimization of a finite wing and an infinite wing are developed separately and implemented. A method is proposed for determination of control points in parameterization of airfoils. An airfoil is parameterized using 13 control points with 4<sup>th</sup> order NURBS curve. The control polygon for airfoil is stacked along the span to generate a wing surface. Suitable design variables are proposed for the representation of the plan form shapes. A parallel code for solving 3D adjoint equations for a finite wing is developed. Similarly a code for solving 3D adjoint equations for an infinite wing is developed. The results obtained by solving 3D codes for maximizing

$C_L$  (Co-efficient of lift) of an infinite wing (considering 2 slices) is compared with the results of the 2D airfoil problem obtained for the same bounds on the variables. The 3D parallel code is then solved for both symmetric and asymmetric plan forms separately for

minimizing  $C_D$  (Co-efficient of drag) problem at  $Re = 500$  and  $1000$ . It is found that greater the number of variables greater is the change in the value of drag to lift during optimization. Interesting wing geometry is observed.

#### Working of tail rotor controller futaba gy611 of mini helicopter and modal analysis of cantilever beam with sweep, anhedral and point mass

Manish Kandpal

Dr. C Venkatesan

In this project we have tried to analyze the working of FUTABA GY 611 controller to be able to better use it for atomization of mini helicopter. The aim of this project is to understand how the controller receives all the inputs regarding the yaw rate and the output it sends the S9256 servo to control the yaw rate. We have tried to establish a relation between these inputs and output. A relation between the tail input and controller settings was derived. Also a working logic of the controller is developed. In the second phase of project, a cantilever beam was simulated to obtain natural frequencies and thus better understand the structural significance of tip variations in the helicopter rotor blades. The natural frequencies of various types of cantilever beams were calculated along with mode shapes.

#### Effect of modulli ratio & aspect ratio on the variation of energy of interfacial misfit edge dislocation along interface using FEM

Raj Deep Gupta

Dr. Anandh Subramaniam

In an epitaxially grown film, the misfit strains present at the interface can be relieved by the formation of an interfacial misfit edge dislocation. The energy associated with the formation of interfacial misfit dislocation depends on the modulli ratio and the aspect ratio of the thickness of the epitaxial film and substrate. In the present work, this is analyzed by simulating the state of stress of the epitaxially grown film in the presence of an interfacial misfit dislocation, using Finite Element Method. Thermal strains (stress-free strains) are fed in appropriate regions to simulate the coherency stresses of the epitaxial film and also the stress state of an interfacial misfit dislocation. The energy of the whole system is obtained for misfit dislocation at different positions along the interface varying from centre of the domain towards the free surface by using ABAQUS/STANDARD software. The effect on the variation of energy is done for different modulli ratio and aspect ratio.

#### Design and Modeling of Coaxial Micro Air Vehicle

Shamayita Mukherjee

Dr. Abhishek

This project involved of two phases. First, a 3D CAD model of a hover test stand was built with the goal of testing the performance of a hover capable counter rotating coaxial rotor. Based on literature review initial span of the blade, camber, taper, and shape of the airfoil was chosen for optimum hover performance. A swash plate was designed to control the lower rotor blade pitch while upper rotor was connected to a stabilizer bar. Transmission system designed consists of a simple gear train with reduction ratio 4:1. A detailed 3D model of the Micro Air Vehicle was also made. In the second phase, an existing trim code for conventional helicopter configuration was modified successively, first for calculating trim for a full scale coaxial, and then for a MAV scale coaxial helicopter. For simplicity the two rotors were assumed to have same inflow. The expressions for rotor collective and cyclic pitch angles, coning angles and shaft angles were formulated by solving the force and moment balance equations, which were solved iteratively for inflow and control angles. The results obtained were compared and analyzed for conventional vs. full scale coaxial helicopters and full scale coaxial vs. MAV scale coaxial configurations to understand the effect of modeling changes.

### Natural convection in a pin-fin heat exchanger having multiple arrays of square cylinders with constant wall temperature

Sourayon Chanda

Dr. Arun K. Saha

The present study deals with the two-dimensional analysis of natural convection in a pin-fin heat-exchanger with in-line arrays of periodically mounted square cylinders. The effect of variation in geometric configurations on the fluid flow and heat transfer has been investigated for different Grashof number. The Navier-Stokes and energy equation have been solved using higher order spatial and temporal discretizations. Periodic boundary conditions have been assumed for velocity, temperature and pressure. Numerical simulation has been carried out using MAC algorithm the range of non-dimensional pitch under study is 1.5 - 3.0, and a Prandtl number of 0.7 (corresponding to air) has been used. The results show that the flow becomes unsteady and periodic above a critical Grashof number. This critical value of Grashof number is strongly dependent on the fin spacing. In cases of unsteady flow, the Strouhal number is found to decrease by a very small value with increase in Grashof number. The Nusselt number is found to increase almost linearly with increase in Grashof number, for a particular pitch. The rate of increase of Nusselt number is also increases with higher value of pitch. A decrease in the value of Nusselt number is observed with increase in pitch at constant Grashof number.

### Dynamic Analysis of Composite Beam with Randomly Aligned Natural Fiber Reinforcement

Vishu Vishal

Dr. Bishakh Bhattacharya

In this proposed work dynamic Analysis on composite beams were carried out using Laser Doppler Vibrometer (LDV). Two composite beams of different compositions are used for study and comparison of the dynamic behaviors.

Composite beam of pure epoxy.

Composite beam with 90% epoxy and 10% natural fiber.

The experimental set up consists of the composite beam clamped as a cantilever beam. A shaker imparts a given range of excitation frequency (0-2000 Hz) to the cantilever composite beam. LDV uses three He-Ne LASER beams to generate the frequency response function (FRF) of the vibrating composite beam in a tri-axial mode. Mesh is defined by using PSV software on the composite beam for scanning. LDV uses the principle of Doppler Effect and phenomenon of interference to generate frequency response function of composite plate corresponding to a given excitation frequency. Frequency response function gives the amplitude and phase of vibration for the range of frequencies corresponding to displacement and velocity field. Different modes of vibration were obtained from the frequency response function. The FRF data for composite beams are exported from LDV to MATLAB and Dynamic parameters are obtained by using half power bandwidth method.

### Study of Crystallization Kinetics Of Bulk Metallic Glasses

Sagnik Sarkar

Dr. K. Mondal

Crystallisation kinetics of five Zr-based bulk metallic glasses has been studied. The samples have been heated non-isothermally in differential scanning calorimeter (DSC) with different heating rates viz. 10, 20, 30, 40, 50, 60, 70, 150 and 200 K.min<sup>-1</sup>. The onset and peak temperatures for crystallisation and fraction of material transformed are obtained from the DSC traces. Activation energy for crystallisation has been computed via three different routes using Johnson-Mehl-

Avrami-Kolmogorov (JMAK) equation as the basis. The main objective of the present work is to find out isothermal transformation plot as a function of time from the non-isothermal transformation data and subsequently, the activation energy for the isothermal transformation has been calculated. It is observed that the present process shows very good matching between the activation energy for crystallization as determined from non-isothermal data and simulated isothermal data.

### Tape Casting of Electrolyte for Solid Oxide Fuel Cell

Soumitra Sulekar

Dr. Kantesh Balani

To optimize the slurry formulation for tape casting of Yttria Stabilized Zirconia (YSZ) electrolyte for Solid Oxide Fuel Cells (SOFCs). SOFCs convert chemical energy to electrical energy with an efficiency of 40-60% in the 800-1000°C temperature range. The thickness and the material used for the electrolyte play a crucial role in determining the ionic conductivity and the operating temperature of the cell. YSZ is used as an electrolyte material owing to its stability and ionic conductivity of 0.1 S/cm at 1000°C. A lower operating temperature calls for a thin electrolyte. The aim is to obtain enhanced ionic conductivity at lower operating temperature. Tape casting is a low cost process well suited for fabrication of thin films with different morphologies from highly porous to fully dense. The process can be easily upgraded for large scale production and multiple layers can also be cast. The slurry was prepared using nano sized 8 mol % YSZ. Tapes of varying thickness have been cast with a Doctor's blade. Pure or doped ceria (CeO<sub>2</sub>) is an attractive alternative to YSZ electrolyte due to its high ionic conductivity in the intermediate temperature range (600-800°C), but it also has a high electronic conductivity. It would be advantageous to make ceria doped YSZ and exploit both the components in terms of stability and conductivity. Structural analysis of Ceria doped YSZ has been done and it has been found that the lattice parameter increases from 5.13Å<sup>0</sup> to 5.15Å<sup>0</sup> with an increase in the ceria content (0-10 %). X-ray diffraction reveals that ceria forms a solid solution with YSZ.

### Translation of ds-DNA molecules on polymerized silicone elastomer surface with different liquid state viscosities

Aradhana Chopra

Dr. Shantanu Bhattacharya

Fractionation of ds-DNA based on different molecular lengths by passing them through a sieving medium has been regularly explored for all diagnostics. Surface electrophoresis is a good substitute for capillary or gel electrophoresis for the separation of large DNA. The separation efficiency of surface electrophoresis, e.g., resolution, is a complicated function of the surface structure and chemical state. Although some previous work has reported the movement of ds-DNA strands within surfaces with heterogenous nanostructures none have them have looked at the impact that surfaces which have a thin layer of viscous fluids on them play in affecting the mobility of these molecules. This movement is very important from a physiological standpoint as within the human body, fluids like blood flowing over the vasculature tend to flow proteins and DNA on the outer surface of gelatinous cells (lipid bilayer) in the extracellular region. In order to study the influence of jelly like surfaces to mobility to DNA, we have fabricated gel free micro channel devices made up of polydimethyl siloxane (PDMS) with different curing agent to silicone rubber ratios resulting in higher or lower surface stiction of the molecules of different viscosities for the for performing surface based electrophoresis of ds-DNA molecules. In the presence of electric field, it was found that the translation of DNA was faster in the device with the lowest composition corresponding to the lowest curing agent %age i.e. 35:1 and fractionation was observed at in time scales running in minutes whereas as the composition of the curing agent was reduced it resulted in a device increased the decrease in DNA mobilities translation and fractionation. Preliminary studies indicate that there may be an added surface force to the molecule causing this change in mobilities and we are further trying to explore the molecular level modeling of this phenomenon. Thus it may be thought of as the surface viscosity of the device plays a significant role in translation and fractionation of ds-DNA.

### Tomographic reconstruction from Lamb Wave Tomography Data

Luna Bhowmick

Dr. Prabhat Munshi

The objective of this work is to reconstruct images from simulated and real lamb wave data. Ultrasonic or Lamb wave testing of materials is an easier, faster, cost effective and time efficient method of Non-Destructive Evaluation (NDE). Lamb waves travel faster in plate like thin media and are reflected at the interface of medium change. Scanning is done to obtain projection data. Tomographic images are reconstructed from simulated data and real lamb wave measured data using the cross borehole scanning technique. The results are thus compared with the obtained results of cross-borehole geometry and application of MART algorithm with that of cross-borehole geometry and MART algorithm inspection of Saurabh khare's paper on Defect Detection in Carbon-Fiber Composites using Lamb Wave Tomographic Methods and one finds that the cross-borehole geometry of arrangement of sensors is more capable of providing clear images of defects. It has been shown that this approach leads to better reconstruction. Thus the MART algorithm for tomographic reconstruction was investigated. Optimization code was finally applied to simulated and real data for examining defects.

### Weyl Vector Meson in Local Scale Invariant Standard Model

Nishtha Sachdeva

Dr. Pankaj Jain

The generalization of the local scale invariant standard model leads to the existence of a new particle called the Weyl vector meson. Scale symmetry suggests the invariance under change in magnitude. We consider this theory with real scalar field, higgs field and gravity to study the interaction of the Weyl meson with Higgs boson in the Large Hadron Collider and calculate the cross-section for this process.

### Experimental Investigation and Simulation of Single Discharge on Silicon in Micro Electric Discharge Machining ( $\mu$ -EDM)

Ashish

Dr. J. Ramkumar

Micro Electric Discharge Machining ( $\mu$ -EDM) is a machining process in which the material is eroded due to the thermal effect. It is used in every field like Aerospace, Automobiles, Medical instruments & Communication due to requirement of miniaturization. Several studies have been done on  $\mu$ -EDM and many models have been developed, but we have concentrated only on five highly accepted models which deals with the material removal. The models are Dibitonto's Model, Jilani's Model, Snoey's Model, Beck's Model & Van Dijk's Model out of which Dibitonto gives accurate result for point heat source while Snoey gives accurate result for disk heat source. This project is related only with the material removal for a single spark with Tungsten as tool, Si(100) & Si(111) as workpiece and air as dielectric. In EDM, the material is removed by a series of discharges occurring one after another. It is a very complex process, so it is better to study the process for a single spark to get more accurate result. Crater diameter & depth were calculated using Scanning Electron Microscope, Olympus Microscope & Profilometer. The erosion efficiency was then calculated using Energy Balance Equation with assumption that only 39% of the total energy is transferred to the anode. In the equation "K" factor is considered which is equal to the percentage of vaporized material. Crater depth & diameter and Efficiency for Si(111) was found to be more because of different plane. Simulation of temperature distribution was performed on Silicon for point & line heat source using time dependent heat transfer equation. Crater size was obtained for both the heat sources and it was observed that the depth & diameter for point heat source was smaller in comparison to line heat source.

### Online evaluation and numerical comparison of electro thermal models in $\mu$ -edm

Hariharan PK

Dr. J. Ramkumar

The objective of this work is to develop an online monitoring system for Micro-EDM process in order to determine the characteristics of micro electric discharge machining ( $\mu$ -EDM) plasma systematically by using optical emission spectroscopy and to determine the elements/ions present in the electrode surface during the Electric Discharge Machining Process. In order to characterize the plasma and its parameters such as plasma temperature and electron density, the optical spectra were recorded for different energies. From the recorded spectra, using line pair method and modified Saha equation, plasma temperature and electron density, respectively were calculated. The Plasma Temperature was calculated for every possible combination of the peaks present in the spectra. Similarly the Electron Density was also calculated for all combinations of Atomic and Ionic peaks. The Atomic and Ionic lines in the spectra were identified by matching the observed wavelength of the peaks present in the spectra with the NIST database. In order to analyze the Temperature Distribution and Crater Geometry, four EDM models from Snoeys, Van Dijk, Beck and DiBintonto were used to simulate the heat input into the cathode surface. The Temperature Distribution and Crater Geometry with respect to depth and Radial Distance from the centre were obtained. The results from each model were numerically compared.

### Visual Stimuli and Bio-behavioral Indicators: The Stress and Premorbidity Imperative

Moulika Mandal

Dr. Braj Bhushan, Dr. Kumar Ravi Priya, Dr. Arvind K Sinha

The study attempted to explore the relationship between subjective emotional arousal and physiological arousal as a consequence of exposure to five kinds of visual stimuli with general stress and premorbidity as predisposing factors. Twenty female post-graduate students of an engineering institution located in north India participated in the study. Bio-feedback machine was used to record physiological arousal (GRS, pulse rate, breath rate) whereas questionnaires were used for stress levels, premorbidity, subjective arousal level, and biographical information. Data were analyzed using one-way analysis of variance (ANOVA), t-test, and multiple regressions. The qualitative analysis of responses to open ended questions and semi-structured interviews was interpreted using content analysis and initial coding for grounded theory. The results suggested that the psychological measurement may be used with profit together with machine diagnostic to arrive at a holistic interpretation and understanding of the stress phenomena, and human arousal states and experiences.

## Abstracts: SURGE 2011 Research Projects Done in Overseas Universities

### Finger formation in Hele-Shaw flow captured using a Lagrangian particle level set method

Kartikey Asthana

Peter Schmid, Hydrodynamics Laboratory.

This work is based on the numerical simulation of a Hele-Shaw cell (Stokes flow in narrow gap between two parallel plates) with the ultimate objective of actively controlling the instabilities known as finger formation. The interface between the two fluids is modelled using level sets, such that the level set information is carried by evolving particles instead of grid nodes. The level set formulation allows topological changes such as pinching of fingers and the merging of interfaces. Moreover, the particle based implementation of the level sets circumvents several limitations associated with the standard Eulerian level set approach. The Lagrangian particle level set scheme has been successfully established and applied to fluid injection as well as ejection in a numerically modelled Hele-Shaw cell consisting of two fluids. The assembly is qualitatively consistent in regard to the pinching of fingers during suction, merging of fragments and the identification of instabilities in general. The present focus of the work is concerned with the most important task of active control.

### Building Systems Energy Inefficiency and Fault Detection using Recursive Deterministic Perceptron Neural Network

Sidharth GS

Prof. Frederic Magoules, High Performance Computing, Laboratory of Applied Mathematics

The objective of this study is to demonstrate the application of Recursive Deterministic Perceptron (RDP) Classification technique in detection of degradation faults of building systems. System faults lead to inefficient control operations and consequently excessive energy consumption. In order to maximize energy savings and occupant comfort, it becomes imperative to devise cost effective online-fault detection technology. The study comprises of three sections. In the first section, classification models are developed and tested for different building models with varied faults. The second section focuses on diagnostics and builds models for faults localized in building HVAC sub-components. In the third section, we aim to train a RDP classification model with data fed from multiple buildings with near-similar features and test the model on another building. The classification models have shown successful performance with fast convergence and high accuracy of fault prediction.

### Investigating the Expression Patterns of Potential Regulators and Homologues of FoxD3

Shourya Sonkar Roy Burman

Marianne Bronner, Co-mentor: Marcos Simões-Costa

Neural crest cells are a population of transient migratory cells unique to the vertebrate embryos, which give rise to a wide variety of derivatives like the peripheral nervous system and the facial skeleton. They serve as a model to study multipotency, epithelial to mesenchymal transition, cell migration, embryonic induction and cell-fate determination. Of specific interest to this project is a transcriptional repressor in the gene regulatory network governing these processes, FoxD3. FoxD3 is expressed early in the presumptive neural crest region, and changes the adhesion properties of these cells leading to their epithelial to mesenchymal transition and migration. The first part of this project involves identification of potential regulators of FoxD3 in the chicken embryo using a candidate gene approach. A set of transcription factors was identified based on binding site studies on an enhancer element of FoxD3. The expression patterns of these genes were compared to the region where the enhancer is activated, and a refined list of candidates was prepared. In the second part of the project, differences in the formation of neural crest between an early vertebrate, the lamprey and other vertebrates was explored by studying the expression pattern of FoxD3 and a related homologue, FoxD1.

### Linear Programming and Clustering

Aditya Huddedar

Dr. Leonard Schulman

We study an affine invariant approach to strongly polynomial algorithm for linear programming by Vempala- Barasz. We prove that the method of combination of the improving rays (with non-negative coefficients) in a particular step does not matter as far as the analysis of the algorithm for Klee-Minty and Goldfarb-Sit cubes is considered. We present a counter-example in which a weaker version of their algorithm is forced to visit some facets of the polytope more than once, unlike in Klee-Minty or Goldfarb-Sit cases. We implement and analyze the efficiency of the seeding algorithm described in "The effectiveness of Lloyd-type Methods for the k-Means Problem" by Ostrovsky, Rabani, Schulman and Swamy.

### Development of new support vector machines techniques for the analysis of RNA motifs

Anindya Jyoti Roy

Prof. Julie Bernauer, Laboratoire d'Informatique

Non coding RNAs are known to perform various roles in the cell. To better understand the function of these molecules, we try to understand the link between their sequence and their structure. The folding of the molecules in both 2 and 3D depends largely on the motifs their sequence contains. To study these motifs and be able to distinguish between various types of RNA, machine learning and support vector machines in particular can be used [1]. By being able to define well suited new triplet kernels for support vector machines [2] and apply these to well-chosen datasets, we would be able to identify new potential therapeutic targets. The work is performed in collaboration with Peter Clote (Boston College, USA and Diteo Chair). During the Internship period we have studied features of various Machine Learning packages available along with their licenses and benefits, implemented a flexible support vector machine module that works as a flexible base of further development in the field. This not only used the existing literature, but also tried different methods to increase the efficiency of the support vector machine in this field.

### High Level Synthesis of Trellis Search Based Detector Using AutoESL

Tej Pratap

Prof. Joseph R. Cavallaro, Professor of Electrical and Computer Engineering and Computer Science

The objective of this work is to do the high level synthesis of a high throughput trellis search based detector algorithm using Xilinx AutoESL High level Synthesis design tool and then test the design on a Virtex 4 FPGA board for proper functioning. Secondary objective is to provide feedback on the AutoESL HLS tool to Xilinx Inc. The work describes a high throughput MIMO detection Architecture for a 4X4 16 QAM system and the parallel method used for detection of the received signals, in a manner so that the soft information for every possible symbol on every antenna is preserved. We will then use this soft information to make hard decisions on the received signals. The synthesis, simulation and implementation of the algorithm has been done and results have been produced. Finally, the results of FPGA implementation of the design have been produced.

### Dominating Set Problem

Keerti Choudhary

Dr. Ilya V. Hicks, Computational and Applied Mathematics

A dominating set for a graph  $G = (V, E)$  is a subset  $D$  of  $V$  such that every vertex not in  $D$  is adjacent to a member of  $D$ . The domination number  $\gamma(G)$  is the size of a minimal dominating set for  $G$ . Finding a minimum dominating set is NP-hard in general. In the computational part of this project we apply the reduction rules given by Alber that explores the local structure of the graph, and then apply Branch and Bound Algorithm to compute minimum dominating set for graphs. In the theoretical part - (i) we study 3-critical and domination perfect graphs; (ii) we extend the result given by Ho on the total domination number of Cartesian product of graphs to general n-case product, and improve the result for paired domination number of Cartesian product of graphs.

### Theoretical Study of Bose Einstein Condensation in Gaussian Random Fields

Abhimanyu Banerjee

Prof. Philippe Mounaix, CPHT, Ecole Polytechnique

This project deals with the structure of a Gaussian Random field in the infinite volume limit. Motivated by the Laser plasma interaction in spatially smoothed Laser beams, this problem has been dealt with earlier in the works of Mounaix and Collet. It is proved that the probability distribution of the field concentrates onto the eigenspace associated with the largest eigenvalue of the covariance of the field as the norm of the field gets large. It is tempting to interpret this in terms of Bose Einstein Condensation. But of course, like for any system a phase transition is not possible in the case of a finite system. We must study the system in the infinite volume limit to analyze if a phase transition occurs. We have found that if the dimension of the system is large enough and if the norm of the field is greater than a critical value ( $u_c$ ), then there is a concentration of the field to the  $k=0$  mode, which again corresponds to concentration to the eigenspace with the largest eigenvalue. It must be noted that the problem is formally (mathematically) similar to that of the spherical model of the ferro-magnet, where the total sum of squares of the spins is fixed, which corresponds to keeping the norm of the field to be a fixed quantity. In this report we first demonstrate the existence of a phase transition by showing the non-analyticity of the partition function analog. We have then found the "structure" of the condensate that forms (the concentration of the field to the  $k=0$  eigenspace). In 1D, we have exact results from numerical methods. The general case (of any other dimension) is difficult and is only partially solved (analytically).

### Modeling of Zero Emission Vehicles for Australian Driving Condition

Sanchit Kumar Singh

A/Prof. Michael Brear, Mechanical Engineering

The aim of the project was to analyze different Zero emission vehicles (ZEVs) for Australian driving conditions in terms of lifetime cost, energy efficiency and carbon emission.

In this project the following three models of Ford Falcon (a very common ICE car in Australian market) were modeled in Powertrain System Analysis Toolkit (PSAT):

- Electric Vehicle (EV)
- Fuel cell Vehicle (FCV)
- Hydrogen ICE Vehicle (H-ICV)

PSAT (Version 6.2 SP1) provides a Graphical User Interface (GUI) for creating simulations in MATLAB Simulink. This software is a very useful toolkit and provides extensive library of vehicle component models, vehicle configurations, drive cycles, vehicle controller strategies and simulation setups.

The three vehicles were modeled to give similar performance in terms of acceleration, torque and power output to the conventional model of Ford Falcon with carefully analyzed choice of components. Also, minimizing the energy consumption was equally important criteria for choosing different components. The simulations were run on PSAT using Australian Urban Drive Cycle (AUDC) to obtain results on fuel/energy consumption and carbon emission. The final versions of the vehicle model created were compared with the corresponding commercially available models to verify their credibility.

In the next part of the project, the energy data from PSAT simulation results were used to convert it into equivalent carbon emission by using Green house equivalent factor for Electricity and Hydrogen for Australia accounting for the generation both from renewable (wind, solar etc) and non-renewable sources (coal, natural gas etc).

In the Economic analysis, the component-wise costing including a final mark-up factor to account for development, retail and profit margin was used to calculate the total vehicle price for each of the model. Based on the hydrogen/electricity consumption data collected from PSAT and current price of hydrogen and electricity, the lifetime cost of the each vehicle was calculated (also includes the service cost). Comparative study under fluctuating price of electricity and hydrogen indicated the conditions in which a particular model becomes economically favourable. The results were

presented in the graphical manner to account for the fluctuating cost of energy and for easy interpretation of the data.

### Investigation of neuronal network activity in response to spatiotemporal input patterns

Narendra Chaudhary

Prof. David Grayden, Department of Electrical and Electronic engineering

Recurrent neural network show different types of dynamics, ranging from totally ordered to totally chaotic. We have studied the network activity in response to spatiotemporal input pattern and how it changes as these are gradually modified. As the network dynamics (ordered or chaotic) is very important in the processing capability of the recurrent neural network, our study is expected to further improve our understanding of the effect of spatiotemporal pattern on the network.

### Phase Transformation in Ti-20Mo alloys

Rishabh Raj

Dr. Kenong Xia, University of Melbourne

This project titled was a part of the bigger project "Ti Alloy development" going on at University of Melbourne under the ARC (Australian Research Council). This project primarily deals with formulating a research plan based on Ti-20Mo samples to be used for Ti-5 5 5 3 alloys. The main motive was to analyze the application of Ti-5 5 5 3 alloys as the second generation landing gears. Work was done only on the Ti-20Mo samples during the period of the project. This was an individual project with Dr. Wei Xu, assisting supervisor of the project. Our main objective was to achieve a well dispersed  $\alpha$  phase in  $\beta$  phase in Ti-20Mo alloys which is a necessity for better mechanical properties. No testing of the mechanical properties was done during this project. We were trying to achieve  $\beta$  grain refinement through ECAP (Equal Channel Angular Pressing). Ti-20Mo with ECAP at 200 °C followed by direct ageing for 1 hour at 550 °C was the last sample to be analyzed during this project. It showed some promising results as a well dispersed second phase was found. This was followed by FIB (Focused Ion Beam) technique carried out on the sample.

### Feedback of Mentors and Students of 2011 SURGE Program

#### Mentor Feedback

The statistics of the responses to the quantitative questions of the Mentor Feedback form are given in Table below.

**Table:** Quantitative Responses in Mentor Feedback for SURGE 2011 Program

#	Question	Average score
<b>Student</b>		<b>2011</b>
3	Did the student measure up to your expectations? (1: Well below expectations; 5: Beyond expectations)	3.99
4	How much supervision did the student require? (1: A lot; 5: Not much)	3.00
5	Did the student work when you expected him/her to? (1: Never; 5: Always)	3.89
6	Did the student observe guidelines you set forth? (1: Never; 5: Always)	4.00
7	Did the student work well with your research group? (1: No; 5: Yes)	3.50
8	Did the student participate in department seminars or discussion groups? (1: No; 5: Yes)	2.78
9	How well suited was the student for the research in terms of: (1: Low; 3: Medium; 5: High)	
	(a) Enthusiasm for the work	4.32
	(b) Preparatory Coursework	3.40
	(c) Skills or abilities, etc.	3.90
	(d) Background knowledge	3.00
10	Would you recommend this student for the SURGE 2012 Program? (1: No; 5: Yes)	2.89
11	Would you like to work with this student again? (1: No; 5: Yes)	3.00
12	If your student was a non-IIT Kanpur student, would you consider taking him/her on as a graduate student? (1: No; 5: Yes)	4.56
13	Please give us your overall evaluation of the student. (1: Poor; 5: Excellent)	3.99

<b>Research</b>		
14	Did the research you expected from the SURGE research project get done in the 10 weeks? (1: No; 5: Yes)	4.15
15	Is the work worth publishing in a refereed Journal? (1: No; 5: Yes)	3.01
<b>Overall</b>		
16	Were you satisfied with the assistance and administrative support provided by the Office of the DRPG hosting the SURGE Program? (1: Poor; 5: Excellent)	4.53

#### Student Feedback

The statistics of the responses to the quantitative questions of the Student Feedback form are given in Table below.

**Table:** Quantitative Responses in Student Feedback for SURGE 2011 Program

#	Question	
<b>Research</b>		<b>2011</b>
3	On an average, how many hours per week did you interact with your Mentor and/or Co-Mentor? (1: 25 hours or more; 5: 5 hours or less)	3.09
4	Did you get the required equipment & facilities needed to carry out your research? (1: No; 5: Yes)	4.49
5	Did you attend research group meetings or participate in discussions with your research group members? (1: No; 5: Yes)	2.83
6	Did you feel comfortable asking questions of your Mentors and Co-Mentors? (1: No; 5: Yes)	
	(a) Mentor	3.87
	(b) Co-Mentor	3.56

7	What was the benefit you received from your summer research experience in terms of (1: Low; 3: Medium; 5: High)	
	(a) Clarification of career path	3.94
	(b) Skill in interpretation of results	3.62
	(c) Tolerance for obstacles faced in research process	3.99
	(d) Readiness for more demanding research	4.41
	(e) Understanding how knowledge is constructed	4.70
	(f) Understanding of the research process in your field	4.61
	(g) Ability to integrate theory and practice	4.27
	(h) Learning ethical conduct in your field	3.54
	(i) Learning laboratory techniques	3.76
	(j) Skill in how to give an effective oral presentation	4.87
	(k) Skill in science writing	4.09
	(l) Self-confidence	4.45
	(m) Learning to work independently	4.60
	(n) Others (please state):	3.09
8	How does your undergraduate research experience compare with the expectations you held before you began your project? (1: Well below expectations; 5: Well above expectations)	4.00
9	Evaluate the overall performance of your Mentor or Co-Mentor: (1: Poor; 5: Excellent)	
	(a) Mentor	4.06
	(b) Co-Mentor	4.09
<b>Overview</b>		
10	Please comment on the effectiveness of the following: (1: Low; 3: Medium; 5: High)	
	(a) Writing the research proposal or project plan before coming to IIT Kanpur	3.62
	(b) Oral presentations	4.00
	(c) Writing your final technical paper	4.18

### Reviews from Students-“Impact of SURGE”

I, Deleeeep Kumar Chandar currently doing my third year in Department of Mechanical Engineering at National Institute of Technology Tiruchirappalli. I was part of SURGE 2011 program. This program was a great experience for me. It was the first time I was introduced into research. Working with Dr. Sanjay Mittal, Nikhil Kumar and others from the CFD group taught me a lot. With the help of the my experience at IIT Kanpur I have got an invite from the Universtat Stuttgart to spend the summer of 2012 for doing a project at their esteemed Institute of Aerodynamics and Gas Dynamics.

My aim in professional life, is to become a well known aerospace design engineer and Surge 2011 had truly been the guiding light for me in pursuing this dream.

Deleeeep

Well frankly saying SURGE was one of the best thing happened to me in my academic life, not only because its the program of IITK but because of the things I learned there. I was ever determined to pursue research as my career though I was a dilettante in the field of research but SURGE helped me to strengthen that determination. Through this program I really came across some world class faculty and facility. I would seriously like to thank my mentor Dr. Dharendra Katti of Biological Sciences and Bio Engineering Department for providing me this opportunity. I really had an awesome and memorable 10 weeks which I will cherish through out my life. I really made some great friends too during the SURGE program. To me SURGE was not a summer fellowship program but a gift which really helped me to shape up my future goals and career.

Anjul Khadria

I still cherish the memories of the Surge-days and the friends I made at that time. I have contact with most of them on social networking sites.

The good thing is I am at present an MTech student in IITK. My specialization is RF, Microwaves and Photonics, Electrical Engineering Dept. In this semester I am TA under my Surge-2010 guide Dr. K V Srivastava which is a great plus point. So I am not missing the campus as such.

Debdeep Sarkar

First of all, thank you very much for remembering us and giving a chance to share our beautiful memories of SURGE-2011.

"SURGE program was the first ever research experience in my life. I feel I was lucky enough to get a chance to explore my dreams through SURGE. I involved in active research working on sophisticated instruments in the lab. This ten week training has really projected my carrier in ambitious way. I was never exposed to such environment before. Before SURGE I was in a complete dilemma in which area I would do my PhD. But after SURGE programe I feel like as if I've got my lost thread. More over with out the help of Faculties and Coordinator of SURGE program it would be impossible. So thank you all again."

with regards.....  
Shubhendu Palei

Thanks for giving me a chance to put forth my SURGE experience once again..I attended SURGE once in 2010..I am a IV yr student of Civil Engineering at NIT Surathkal, Karnataka.

The summer which I spent in IITK for SURGE was truly one of best I could get.. Apart from the research work, I had lot of other things to learn...The atmosphere in the campus is really conducive for studies and keeps the spark for learning enlightened. During our stay, we all fellow students, had developed a great bond with each other.. Now, being at different places, we are still in touch. With this program, we could develop a network through out India...All thanks to SURGE. During this program, we got the feel of how research is done...truly speaking- how much "hard work and dedication " research requires. It all helped me to identify my goal and gave me an opportunity to work in an atmosphere which always was a dream for me. I still miss those day. I wish SURGE program all the success in the coming future. I would like to thanks all those who are working behind the stage to make "SURGE" a reality. I would also like to thanks to you (Āparna Mitra) for extending all the support throughout, for periodically being in touch and for giving us the opportunity to express our experience there...

Tariq Zyad

### Achievements of Students-"Accepted Papers in Journals "

Here are few abstracts of articles which have been recently published a review article in which some of the results were generated by SURGE students, Manon Pelletier, Sria Mujumdar, Anjani Varshney and K.G. Kavitha . We acknowledge their SURGE contribution in the paper.

#### Local hydrodynamics of flow in a pulsating heat pipe: a review

Sameer Khandekar,\* , Pradipta K. Panigrahi, Frédéric Lefèvre, Jocelyn Bonjour

Global thermal performance modeling of Pulsating Heat Pipes (PHPs) requires local, spatio-temporally coupled, flow and heat transfer information during the characteristic, self-sustained thermally driven oscillating Taylor bubble flow, under different operating conditions. Local hydrodynamic characteristics such as velocities, lengths, shapes and profiles of bubbles and slugs, their dynamic contact angles, thickness of the liquid film that surrounds the bubbles, enhanced mixing/ flow circulation within the liquid slugs and net pressure drop along the flow, etc., are needed to predict local heat transfer and thus, the global thermal performance. In this paper, we systematically review the experimental, theoretical/analytical, and modeling methodologies to predict these hydrodynamic properties in unidirectional two-phase Taylor bubble flows, in the context of Pulsating Heat Pipes. Indeed, there is little literature available for oscillating Taylor bubbles flows. In view of the state-of-the-art, we therefore recommend some directions and perspectives for furthering research on understanding and modeling PHPs.

#### Thermal radiators with embedded pulsating heat pipes: Infra-red thermography and simulations

Vadiraj A. Hemadri, Ashish Gupta, Sameer Khandekar\*

With the aim of exploring potential applications of Pulsating Heat Pipes (PHP), for space/terrestrial sectors, experimental study of embedded PHP thermal radiators, having two different effective Biot numbers respectively, and subjected to conjugate heat transfer conditions on their surface, i.e., natural convection and radiation, has been carried out under different thermo-mechanical boundary conditions. High resolution infrared camera is used to obtain spatial temperature profiles of the radiators. To complement the experimental study, detailed 3D computational heat transfer simulation has also been undertaken. By embedding PHP structures, it was possible to make the net thermal resistance of the mild steel radiator plate equivalent to the aluminum radiator plate, in spite of the large difference in their respective thermal conductivities ( $k_{Al}$  w  $4k_{MS}$ ). The study reveals that embedded PHP structures can be beneficial only under certain boundary conditions.



The degree of isothermalization achieved in these structures strongly depends on its effective Biot number. The relative advantage of embedded PHP is appreciably higher if the thermal conductivity of the radiator plate material itself is low. The study indicates that the effective thermal conductivity of embedded PHP structure is of the order of 400 W/mK to 2300 W/mK, depending on the operating conditions.

#### --Interfacial Edge Dislocation Interactions with Free-Surfaces in nanocrystals

Arun Kumar<sup>1</sup>, K.G. Kavitha<sup>2</sup> and Anandh Subramaniam<sup>1\*</sup>

The configurational force experienced by a dislocation towards a free-surface is termed as the image force. In this work we consider a combination of two cases, wherein the image force experienced by an edge dislocation is considerably altered with respect to an edge dislocation in a semi-infinite body: (i) interfacial misfit edge dislocation in an epitaxial system and (ii) edge dislocation in a 2D nanocrystal. The interaction of an edge dislocation with a free-surface in a 2D nanocrystal can be: (i) attractive with a considerably altered magnitude and direction (as compared to the theoretically calculated value), (ii) neither attractive nor repulsive or (iii) even repulsive. To compute the image force on a misfit edge dislocation in a 2D nanocrystalline epitaxial system, a finite element model is constructed and stress-free strains are imposed in appropriate regions of the domain, to simulate an epitaxial system (Nb/Sapphire) and an interfacial dislocation. The results of the simulation are contrasted with the standard theoretical formulations, which are shown to be highly inadequate to handle such cases which involve epitaxial strains, two materials in the system and considerable domain deformations.

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- The generous donors who made contributions to support the programme.
- Members of the Advisory Committee, Implementation Committee, Departmental Representatives and numerous other faculty members who helped in the programme.
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**Advisory Committee**

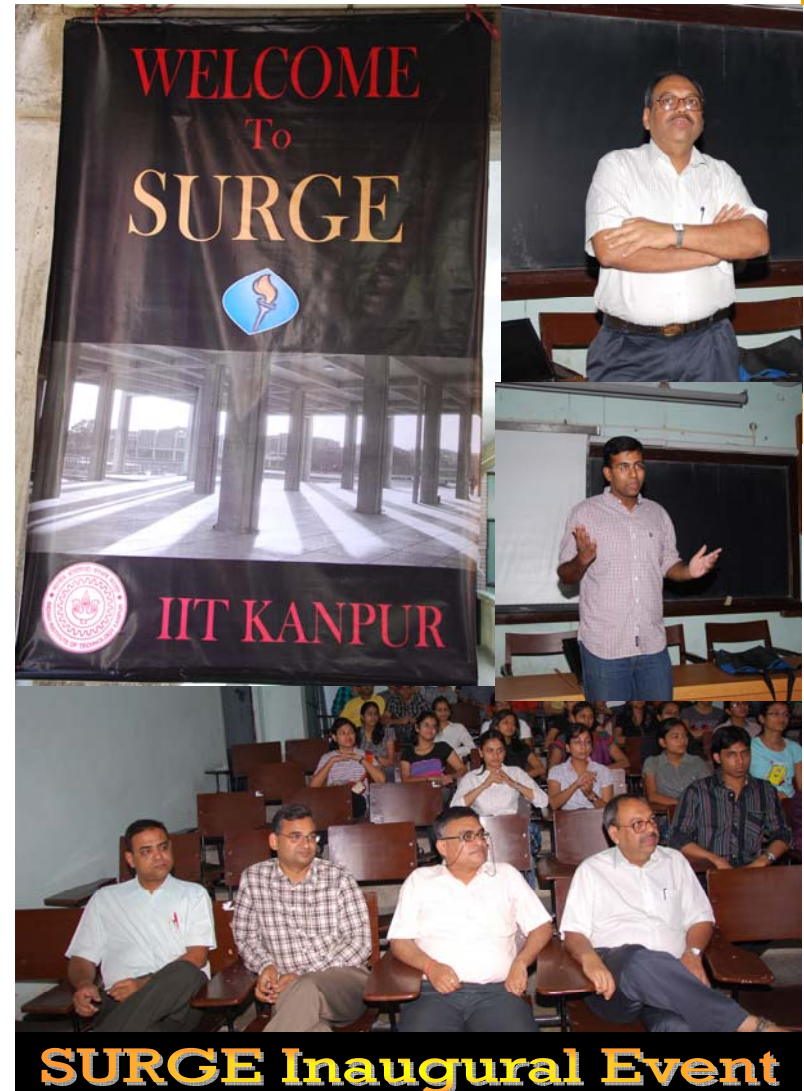
Sanjay G. Dhande (Director)  
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 Madhav Ranganathan (Chemistry)  
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 Ashwani Thakur (Biological Sciences and Bioengineering)  
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## SURGE Poster Presentation



**SURGE 2011 TEAM**

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