SURGE - 2008

Summer Undergraduate Research Grant for Excellence

Annual Report

Office of Dean, Resource Planning & Generation
Indian Institute of Technology Kanpur
Kanpur 208 016

Executive Summary

To develop the agenda of undergraduate research and to promote a culture of research and interdisciplinary education in the new generation, an undergraduate research initiative was formally launched at the Indian Institute of Technology, Kanpur, during the summer of 2006. For this purpose, active help was sought from the California Institute of Technology (Caltech), a pioneer in undergraduate research.

The Summer Undergraduate Research Grant for Excellence (SURGE) programme of IIT Kanpur has the following vision:

> *Undergraduate research fosters collegiality and welcomes students into the community of researchers and scholars. 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 must present opportunities for students to do research under the mentorship of senior researchers at the frontiers of engineering and science.*

The SURGE Programme selects students from within the Institute and from different National Institutes of Technology (NITs) for a 10-week research experience at IIT Kanpur during the summer. In addition, under exchange arrangements with some overseas universities, some overseas students work at IITK and vice versa. Guidelines and markers are laid down well before the start of the programme and the students (under the guidance of their faculty mentors) develop a research proposal well before they start work in the summer so as to have an effective lead time. The Office of the Dean, Resource Planning and Generation at IIT Kanpur coordinates this activity and provides infrastructure support.

The programme is being received very well 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. The mentors from IIT Kanpur are impressed by the enthusiasm displayed and the rigor adopted by the young researchers. By the end of the programme, a surprising number of these young minds show an inclination towards seeking research and development as their career, and almost all students experience enhanced and holistic learning as opposed to the "*chalk and talk method*".

54 students have participated in the progamme in the summer of 2008 as compared to 27 in the summer of 2006. Also, in addition to the ongoing exchange with Caltech and Ecole Centrale Paris, Ecole Polytechniqe Paris too has joined the programme this year. This report summarizes the work carried out by the 54 undergraduate students and gives an overall assessment of the programme.

Acknowledgements

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Dr. Siddharth Dasgupta (MSc5/CHM/1980), Associate Director for Industrial Relations & Tech Transfer, NSE Center for Science and Engineering of Materials, Caltech for relationship building between IIT Kanpur and Caltech.

Members of the Advisory Committee, Implementation Committee, Departmental Representatives and numerous other faculty members who helped in the programme.

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The entire staff of the Office, Resource Planning and Generation for their support and assistance.

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1. Introduction

IIT Kanpur launched a 10-week programme entitled Summer Undergraduate Research Grant for Excellence (SURGE) in the summer, of 2006. The programme aims to promote a culture of research amongst undergraduate students of not just IIT Kanpur but also at some other select academic institutes in the country. This programme was developed in collaboration with the California Institute of Technology (USA), which has been running the highly acclaimed Summer Undergraduate Research Fellowship (SURF) programme for over 25 years (www.surf.caltech.edu). In its second year, SURGE was expanded to cover a much larger number of students, and it now included an exchange arrangement with Ecole Centrale Paris Ecole Polytechnique Paris as well.

2. Inception of SURGE Programme

The concept of a summer undergraduate research programme emerged through various discussions in February 2005 between Professor Sudhir K. Jain (Dean Resource Planning & Generation, IIT Kanpur), Ms. Carolyn Ash (Director, Student-Faculty Programme, Caltech), and Dr. Siddharth Dasgupta (MSc5/CHM/1989) (Associate Director, NSF Center for Science and Engineering of materials, Caltech). This concept was developed further through e-mail discussions and a subsequent visit of Professor Jain to Caltech in the summer of 2005. A memorandum of understanding was signed in October 2005 between Caltech and IIT Kanpur under which Caltech agreed to help IIT Kanpur in jumpstarting an undergraduate research programme. Caltech and IIT Kanpur also agreed to exchange three students each for undergraduate research.

In the fall of 2005, the concept of SURGE was debated and finalized at IIT Kanpur. Applications were invited from students of IIT Kanpur who were desirous of participating in Caltech's 2006 SURF Programme. A rigorous procedure of selection was put in place. Applications from students of all 17 National Institutes of Technology in the country and from IIT Kanpur were invited in December 2005. The selection criteria included that the best applicant should be taken even at the cost of not having an equitable distribution across different NITs and across different specializations.

Professor Sanjay G. Dhande, Director, IIT Kanpur inaugurated IIT Kanpur's SURGE programme on 8 May 2006. In the inaugural year 2006, 10 students from IIT Kanpur, and 11 students from different NITs across the country participated in the programme. The 3 students from Caltech came for 10-weeks in the summer to do research at IIT Kanpur and 3 IIT Kanpur students went to Caltech.

The students benefited greatly from the experience and learned not only science but also interpersonal skills (please see the SURGE Annual Report 2006 at http://www.iitk.ac.in/surge/SurgeReport.pdf). Excellent feedback was received from students and faculty members and it was decided to further expand the programme.

In its second year, 18 students from IIT Kanpur, 29 students from different NITs, 5 students from Ecole Centrale Paris, and 2 students from Caltech did their summer research at IIT Kanpur. Two IITK students went to Ecole Centrale Paris and three students went to Caltech. Details of the students may be seen in the Tables 1-2.

3. The SURGE Programme

Under the SURGE programme, second and third year undergraduate students (including those in the Dual Degree programmes) undertake short duration, but focused research projects and push their intellectual abilities beyond those driven by the classroom. The duration is a period of 10 weeks from early-May to end-July of each year. Selected students receive a stipend of Rs.10,000 for the entire 10-week duration; an award of Rs.10,000 plus a commendation certificate is also given to those SURGE students who produce exceptional quality research during the 10 weeks.

The candidates are selected on the basis of their academic record, involvement in extra-curricular technical activities, recognition at the national student level competitions, and their technical proposal for

the research to be undertaken. Two faculty members from the concerned departments and the Implementation Committee scrutinize the applications. Details of the information sought from the aspiring students in their applications are given on the SURGE website (www.iitk.ac.in/surge). As the SURGE programme involves students from different categories of universities, the selection procedure is not the same.

An IIT Kanpur student wishing to apply for summer research at the partner overseas universities is shortlisted on the basis of his/her application. He/She is then asked to give a small presentation highlighting his/her area of interest and his proposed research. The names of the further short-listed students are then sent to the overseas institutes where these students are matched with appropriate mentors. IIT Kanpur students then need to fulfill the formalities of the overseas institute for which they have been chosen. They also develop more detailed proposals in consultation with their mentors at the respective institutes.

An IIT Kanpur student wishing to be considered for the SURGE programme in the campus is required to identify a faculty member on the campus who may be her/his potential research mentor, discuss with her/him the research work to be undertaken (clearly outlining the scope), and then submit an application along with the research proposal. Short-listed students are asked to give a small presentation. The final candidates are chosen on the basis of the clarity and coherence of their project proposal. They are required to submit a revised four-page research proposal before the commencement of the programme.

An interested NIT student is required to submit the application along with a research proposal, and his choice of names of possible mentors from IIT Kanpur. The applications are sorted out and then sent to the heads of respective departments for scrutiny and for allocation of faculty members. The selected students are then invited to correspond with their mentors and submit a quality four-page proposal before the commencement of the programme.

The overseas students are chosen by the concerned overseas university on the basis of the student's interest and interviews. The applications and areas of interest of the selected students are received at the SURGE office, which then matches appropriate mentors and invites the international students to correspond with the mentors at IIT Kanpur.

The SURGE participants are required to give a mid-term presentation after four weeks, to a small review committee consisting of a group of academic staff members. The review committee gives feedback and suggests possible improvements in the work. The candidates prepare a final technical report at the end of 10 weeks. The culmination of the summer research is the oral and/or poster presentation of the work and the feedback of student experiences.

Care is taken to ensure that SURGE focuses not only on "research" but also on a multifaceted personality development of the student. Thus, weekly social and cultural activities are interlaced with the research programme. While these meetings allow the students to socialize and share their enthusiasm with each other, they also help SURGE coordinators to group mentor the students and get regular feedback. As a bonus, these activities win strong loyalty from the students for the programme.

4. SURGE 2008 Programme

In the SURGE 2008 Programme, as many as 54 undergraduate students (14 from IIT Kanpur, 29 from National Institutes of Technology across India, 3 from Ecole Centrale Paris and 1 from Caltech), who had completed II/III year of the undergraduate programme of any branch of engineering and sciences, were chosen based on a very competitive search, for their strong academic background and for their aptitude to do high quality research. These young researchers spent 10 weeks of their summer vacation at IIT Kanpur doing research at the frontiers of engineering and science under the mentorship of IIT Kanpur faculty members. Moreover, in the SURGE 2008 Programme, 3 IIT Kanpur students participated in a 10 weeks research program at Caltech, 2 students participated in a 10 weeks research program at Ecole Centrale Paris and 3 students did likewise at Ecole Polytechnique Paris. Please see Tables 1 and 2 for details of these students and their summer research work.

In order to maintain the non-academic facets of this programme, the students were introduced to Kanpur city and to its history during several visits which were planned and executed by the students themselves. There were extra-curricular activities during evenings. Also, faculty members and students got together every Wednesday evening for a “happy hour”. An idea of “Wednesday-Talks” by faculty members for SURGE students was introduced this year and it was a success. Often, the mentors joined students for non–academic programmes as well. This mentor-student interaction is rated as one of the high-points of the SURGE Programme.

Abstracts of the research undertaken by students during the 2007 SURGE Programme are given in Appendices A and B, and an analysis of the surveys undertaken by the SURGE office is given in Tables 3 and 4.

5. Feedback of Mentors and Students of 2007 SURGE Programme

5.1 Mentor Feedback

The statistics of the responses to the quantitative questions of the Mentor Feedback form are given in Table 3. Some of the salient points that emerged from the qualitative responses to the other questions of the Mentor Feedback form are:

(a) All the mentors have very much appreciated the idea as well as the organization of the Programme.
(b) Many mentors felt that 10 weeks in summer was too short a time for meaningful research; they plan to invite their students again to wind up the work.
(c) It was suggested that another informal research programme should be run for IIT Kanpur students during the regular semesters.
(d) It was also suggested that the number of students be increased, in particular from the NITs.

5.2 Student Feedback

The statistics of the responses to the quantitative questions of the Student Feedback form are given in Table 4. The salient points from the qualitative responses to the other questions of the Student Feedback form are:

(a) Students were very grateful for the opportunity that IIT Kanpur presented them with almost 80% of them showed interest in continuing in research.
(b)The atmosphere provided by IIT Kanpur to the SURGE students was appreciated. Many students felt that the time was too short for them to tie up with the project properly, though it was enough for them to taste the flavor of research.
(c) A number of students felt that the mid-term report was done when they were still inadequately prepared. They suggested that the mid-term report might be replaced by informal discussions.

Table 1: Participants in SURGE 2008 at IIT Kanpur

Sl. No.	Name of the Institute	Name	Project	Mentors
1.	From IIT Kanpur	Anant Raj BTech /ME/II Yr	Tomographic Reconstruction	Prabhat Munshi *Mechanical Engineering*
2.		Dhawal Kumar Buaria BTech-MTech(Dual)/AE/IV Yr	Linear Global stability Analysis of a Flat Plate Boundary Layer	Sanjay Mittal *Aerospace Engineering*
3.		Jyoti Wadhwani BTech /EE/II Yr	A Telephone-Based Indian English Digit Recognition System	S. Umesh *Electrical Engineering*
4.		Lokesh Tayal BTech/CHE/II Yr	Designing and Fabrication of Humidity Sensor Based on Conducting Polymer	Siddhartha Panda *Chemical Engineering*
5.		Mohit Kumar Jolly BTech/BSBE/II Yr	Human mRNA Sequences with their Translation Initiation Sites (TIS) in weak Kozak context: Analysis using Gene Ontology Terms	R. Sankararamakrishnan *Biological Science & Bio-Engineering*
6.		Mudit Srivastava BTech/CE/II Yr	Study on Some Important Aspects of Fly-ash Cement Concrete	S. K. Chakrabarti *Civil Engineering*
7.		Neelu Singh BTech-MTech(Dual)/AE/IV Yr	Dynamical System Approach to Bluff-Body Flow Transition	T. K. Sengupta *Aerospace Engineering*
8.		Neeti Birla BTech/BSBE/II Yr	Developmental Metabolomics	Amitabha Bandyopadhyay *Biological Science & Bio-Engineering*
9.		Rahul Jhanwar BTech /ME/II Yr	Non Destructive Evaluation of Fibre Composites Using Ultrasonic Rays	N. N. Kishore *Mechanical Engineering*
10.		Sandip Kumar Gupta BTech /CSE/II Yr	Named Entity Recognition for Hindi	Harish Karnick *Computer Science & Engineering*
11.		Sonam Srivastava BTech-MTech(Dual) /CHE/II Yr	Design and Fabrication of A Conducting Polymer Based Temperature Sensor	Siddhartha Panda *Chemical Engineering*
12.		Tanya Gupta BTech /CHE/II Yr	A Simple Robust Algorithm for Rigorous Design of Multi-Component Distillation Columns	Nitin Kaistha *Chemical Engineering*
13.		Vaibhav Sethi BTech /EE/II Yr	Improvement of Swarm Intelligence Based Routing Algorithms for Mobile Ad-Hoc Networks and Using Simulation to test the Improvements Made	Animesh Biswas *Electrical Engineering*
14.		Vikas Trivedi BTech/BSBE/II Yr	Molecular Characterization of Development of Fovea in Vertebrate Retina	Jonaki Sen *Biological Science & Bio-Engineering*
15.	From Different NITS	Ajay Singh M.Sc./CHM/II Yr, Dr. B. R. Ambedkar NIT, Jalandhar	Synthesis and Characterization of Water Soluble Carbon Nanotube (CNTs) from Industrial Waste	S. Sarkar *Chemistry*
16.		Amrendra BTech /CE/II Yr, MNNIT, Allahabad	Strengthening of Unreinforced Masonry Walls For Out-Of-Plane Loading Using FRP	K. K. Bajpai *Civil Engineering*
17.		Arpan Kusari BTech /CE/II Yr, NIT, Tiruchirapalli	Comparison of the Various Plane Extraction Methods on the Basis of Simulated LiDAR Data and Making Assessment of their Accuracy, Efficiency and Sensitivity	Bharat Lohani *Civil Engineering*
18.		A. Sri Krishna Rao, BTech/CE/II Yr, NIT, Warangal	Permeability of Fly Ash Under Stress	Amit Prashant *Civil Engineering*
19.		Avanti Dahiwadkar BTech /CHE/II Yr, NITK, Surathkal	A Simple Robust Algorithm for Rigorous Design of Multi-Component Distillation Columns	Nitin Kaistha *Chemical Engineering*
20.		Deeksha Bhatia	Studies Towards The Synthesis of Constrained Chiral Amino Acids Using	Y. D. Vankar

		M.Sc./CHM/II Yr, Dr. B. R. Ambedkar NIT, Jalandhar	Diels-Alder Reaction	*Chemistry*
21.		Gaurav Mishra BTech /ME/III Yr, NIT, Durgapur	Effect of Buoyancy on the Flow Structure and Heat Transfer Characteristics in a Periodic Array of Cubic Pin-Fins	A. K. Saha *Mechanical Engineering*
22.		Govinda Kamath BTech /EE/II Yr, NITK, Surathkal	Phone Based Train-Name Recognition System	S. Umesh *Electrical Engineering*
23.		G. Parithi BTech /ME/II Yr, NIT, Tiruchirapalli	Design and Analysis of Landing Skid and Avionics Box of Mini Autonomous Helicopter	C. Venkatesan *Aerospace Engineering*
24.		Hemant Kumar BTech /CE/II Yr, NIT, Warangal	Identification of Source in Groundwater Pollution by Using Artificial Neural Network	Rajesh Srivastava and Ashu Jain *Civil Engineering*
25.		Indu Pridarshini BTech /CE/II Yr, NIT Patna	Preparation of GIS database for Archeological Studies	Onkar Dikshit *Civil Engineering*
26.		Jagdeep Singh M.Sc./CHM/I Yr, Dr. B. R. Ambedkar NIT, Jalandhar	Synthesis and Characterization of Carbon Nanotube Formed from Leather Industrial Waste	S. Sarkar *Chemistry*
27.		Jyoti Chaubey BTech /CE/III Yr, NIT, Silchar	Identification of Groundwater Pollution Using Artificial Neural Network	Rajesh Srivastava and Ashu Jain *Civil Engineering*
28.		Jyoti Kumar BTech /CE/III Yr, NIT, Silchar	Design of Pavement with Non-Uniform Thickness	Animesh Das *Civil Engineering*
29.	**From Different NITS**	Mandira Pandey BTech /CE/III Yr, NIT, Tiruchirapalli	Measurement of Inhalable Ambient Particles Present in Microenvironment within IIT-K	Tarun Gupta *Civil Engineering*
30.		Manish Kumar Gupta BTech /CE/III Yr, NIT, Durgapur	Flow Past an Erodible Island in a Natural Stream	Pranab K. Mohapatra *Civil Engineering*
31.		Manoj Krishna K. N. BTech /CHE/III Yr, NITK, Surathkal	A Simple Robust Algorithm for Rigorous Design of Multi-Component Distillation Columns	Nitin Kaistha *Chemical Engineering*
32.		Marun Dutta BTech /CHE/II Yr, MNIT, Jaipur	Development of an Efficient and a Low Cost Methodology for Analyzing Polycyclic Aromatic Hydrocarbon	Mukesh Sharma *Civil Engineering*
33.		Navdeep Kaur M.Sc./CHM/II Yr, Dr. B. R. Ambedkar NIT, Jalandhar	Study Towards The Synthesis of Sugar Carbasugar Hybrid as a New Class of Glycosidase Inhibitors	Y. D. Vankar *Chemistry*
34.		Neethu R. Nair BTech /CE/III Yr, NIT, Durgapur	Analysis of Multiple Dam Break Flow	Pranab K. Mohapatra *Civil Engineering*
35.		Preeti Bende BTech /CE/III Yr, NIT, Durgapur	Eco-Friendly Toilets with “Zero Discharge”	Vinod Tare *Civil Engineering*
36.		Pullagura Pavani BTech /CE/III Yr, NIT, Tiruchirapalli	Construction of Combined Dispersion Curve in Spectral Analysis of Surface Waves (SASW) Technique	Amit Prashant *Civil Engineering*
37.		Saurabh Chandra BTech /EE/III Yr, MNNIT, Allahabad	Optimising P3HT:PCBM organic solar cells to achieve higher efficiency	S. S. K. Iyer *Electrical Engineering*
38.		Sravya Vallabhaneni BTech /CHE/II Yr, NIT Warangal	Membraneless Microfluidic Fuel Cells	Animangsu Ghatak *Chemical Engineering*
39.		Sria Majumdar BTech /ME/II Yr, VNIT, Nagpur	Study of the Hydrodynamics of Oscillating Slug Flow in Capillary Tubes	Sameer Khandekar *Mechanical Engineering*
40.		Sucharitha Rajendran BTech /ME/II Yr, NIT, Durgapur	Fluid Flow Along a Horizontal Wavy Surface	A. K. Saha *Mechanical Engineering*
41.		T. Durgalakshmi BTech /ICE/II Yr, NIT, Tiruchirapalli	Online Monitoring of Surface Roughness During Grinding Using Acoustic Emission	J. RamKumar *Mechanical Engineering*
42.		Udit Gupta BTech /ICE/II Yr, Dr. B. R. Ambedkar NIT, Jalandhar	DC Motor Speed Control Methods, Including A Feedback Control System, for DC Motor Drives using Malab	P. K. Kalra *Electrical Engineering*

43.		Vishwnath Karthik M. BTech /CHE/II Yr, NIT Warangal	Micro Fabrication of a pH Meter	Siddartha Panda *Chemical Engineering*
44.	Caltech	Saurabh Kumar Pandey *(BEM/APh),* Caltech, USA	A Probabilistic approach to the Random Matching Problem	Neeraj Mishra *Mathematics & Statistics*
45.	Ecole Centrale Paris	Pierre Amstutz (Ecole Centrale Paris), Computer Science & Engineering	Searching with Semantics	T. V. Prabhakar *Computer Science & Engineering*
46.		Quentin de Chabot de Tramecourt (Ecole Centrale Paris), Electrical Engineering	Studying the influence of drying time and chlorobenzene's vaporization temperature on the performances of a P3HT: PCBM based Solar Cell	S. S. K. Iyer *Electrical Engineering*

Table 2: IIT Kanpur Students in SURGE 2008 at Overseas Universities

Sl. No.	Name of the Institute	Name	Project	Mentors
1.	*At Caltech*	ParajTitum BTech /PHY/III Yr	Renormalization Group Approach to Solving 1D Random SU(2)5 Anyon Chains	Gil Refael *Theoretical Physics*
2.		Saurabh Chatterjee BTech /CSE/III Yr	Asteroid detection in the DR1 region of the Palomar Quest Sky Survey	George Djorgovski *Astronomy*
3.		Subhonmesh Bose BTech /EE/III Yr	Studying Entropic Vectors	Babak Hassibi *Electrical Engineering*
4.	*At Ecole Central*	Ashish Agrawal BTech /EE/II Yr	A mutual information and entropy based approach to feature selection and Image clustering	Nikos PARAGIOS *Electrical Engineering*
5.		Kapil Mathur BTech /CE/III Yr	Soil-Structure Interaction Analysis in time Domain	Didier CLOUTEAU *Civil Engineering*
6.	*At Ecole Polytechnique*	Abhishek Bhowmik BTech /CSE/II Yr	Bounds on the leakage of the input's distribution in information - hiding protocols	Catuscia Palamidessi, INRIA Saclay and LIX *ComputerScience& Engineering*
7.		Ananda Roy BTech /PHY/III Yr	Perturbative Renormalization of the phi-fourth interaction in 2 and 3 dimensions and that of polynomial field interaction in 2 dimensions	Christoph KOPPER *Physics*
8.		Rohan Nag BTech /EE/III Yr	Construction of a Kelvin Probe and to use it to observe the changes in TCO workfunctions under different treatments and conditions	Pere Roca i Cabarrocas *Electrical Engineering*

Table 3: Quantitative Responses in Mentor Feedback to SURGE2008-09 Programme

#	Question	Average score
Student		***2008***
3	Did the student measure up to your expectations? (1: Well below expectations; 5: Beyond expectations)	4.00
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)	4.37
6	Did the student observe guidelines you set forth? (1: Never; 5: Always)	4.11
7	Did the student work well with your research group? (1: No; 5: Yes)	3.84
8	Did the student participate in department seminars or discussion groups? (1: No; 5: Yes)	3.29
9	How well suited was the student for the research in terms of: (1: Low; 3: Medium; 5: High)	
	(a) Enthusiasm for the work	4.21
	(b) Preparatory Coursework	3.33
	(c) Skills or abilities, etc.	3.63
	(d) Background knowledge	3.16
10	Would you recommend this student for the SURGE 2008 Program? (1: No; 5: Yes)	4.11
11	Would you like to work with this student again? (1: No; 5: Yes)	4.37
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)	4.06
13	Please give us your overall evaluation of the student. (1: Poor; 5: Excellent)	3.95
Research		
14	Did the research you expected from the SURGE research project get done in the 10 weeks? (1: No; 5: Yes)	3.63
15	Is the work worth publishing in a refereed Journal? (1: No; 5: Yes)	3.11
Overall		
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)	4.42

Table 4: Quantitative Responses in Student Feedback to SURGE 2008-09 Programme

#	Question	
Research		***2008***
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)	2.70
4	Did you get the required equipment & facilities needed to carry out your research? (1: No; 5: Yes)	4.40
5	Did you attend research group meetings or participate in discussions with your research group members? (1: No; 5: Yes)	3.87
6	Did you feel comfortable asking questions of your Mentors and Co-Mentors? (1: No; 5: Yes)	
	(a) Mentor	4.49
	(b) Co-Mentor	4.82
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	3.84
	(b) Skill in interpretation of results	3.87
	(c) Tolerance for obstacles faced in research process	4.02
	(d) Readiness for more demanding research	3.96
	(e) Understanding how knowledge is constructed	4.11
	(f) Understanding of the research process in your field	4.11
	(g) Ability to integrate theory and practice	3.87
	(h) Learning ethical conduct in your field	3.72
	(i) Learning laboratory techniques	3.59
	(j) Skill in how to give an effective oral presentation	4.09
	(k) Skill in science writing	3.91
	(l) Self-confidence	4.27
	(m) Learning to work independently	4.16
	(n) Others (please state):	4.43
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)	3.70
9	Evaluate the overall performance of your Mentor or Co-Mentor: (1: Poor; 5: Excellent)	
	(a) Mentor	4.42
	(b) Co-Mentor	4.64
Overview		
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	3.36
	(b) Oral presentations	3.93
	(c) Writing your final technical paper	3.96

2008/IITK/1
Tomographic Reconstruction
Anant Raj, *Mechanical Engineering, IIT Kanpur*
Mentor: *Prabhat Munshi, Department of Mechanical Engineering*

Tomography is cross-sectional imaging of an object from either transmission or reflection data collected by illuminating the object from many different directions. Thus it is a method of reconstructing a function from a set of its projections .Different techniques are used for reconstruction .In the present study we have considered reconstruction from the transmission data using a family of iterative techniques called algebraic reconstruction techniques for three different data collection geometries 1. Fan beam geometry: used in CT-scans 2. Cross hole geometry: used in SHM 3. Cone beam geometry: used in 3D imaging. The project begins with development of the weight matrix for the three geometries. A simulation study was done for four different algorithms and the algorithms were studied for different parameters. The purpose of the study was to compare the performance of the algorithms, reducing the time and space complexities, to speed up the reconstruction and increasing the display size while reducing the computational cost and to come up with new smarter algorithms. The 2D reconstruction approach is also extended to 3D circular cone beam reconstruction. We also intend to extend our 3D reconstruction algorithms of helical cone beam geometry

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2008/IITK/2
Linear Global Stability Analysis of a Flat Plate Boundary Layer
Dhawal Buaria, Aerospace Engineering, IIT Kanpur
Mentor: *Sanjay Mittal, Department of Aerospace Engineering*

The stability of a two-dimensional flat plate boundary layer is studied by means of global linear stability analysis. The flow over a flat plate is known to change from laminar to turbulent at around Reynolds number 50000 (based on downstream distance). Stability analysis is carried out at this and lower Reynolds numbers to search for the unstable eigenmodes which may be responsible for the onset of first turbulence. Further this analysis can be extended to find out computationally, without any parallel flow approximation, the critical Reynolds number for change of flow from laminar to turbulent. All computations have been carried out using a stabilized finite-element formulation of the incompressible flow equations.

2008/IITK/3
A TELEPHONE-BASED INDIAN ENGLISH DIGIT RECOGNITION SYSTEM
Jyoti Wadhwani, Electrical Engineering, IIT Kanpur
Mentor: *S. Umesh, Department of Electrical Engineering*

With the remarkable evolution of telecommunications, it becomes clear that speech recognition via the telephone network will play an increasingly important role, mainly due to the widespread use of both cellular and non-cellular telephones. For many applications of automatic speech recognition over the telephone, such as credit card and account number validation, train and flight enquiry, catalogue ordering, and many interactive voice response systems, digit recognition is fundamental. This kind of application demands a high level of accuracy in order to be of any use. However, speaker independent recognition of telephone speech is more difficult than clean speech recognition because besides speaker variability problems, we also have to deal with a potentially very large variability in channels. A study of the speech data that we had, showed that many of the word pronunciations was not linguistically predictable and that the intrusion of non-speech sounds both from the speakers in the form of coughs and throat noise and from the environment in the form of background noise was widespread. The goal of the project was to develop methods for speech processing that is robust to such environmental distortions and speaker

variability that lead to the degradation of speaker independent systems. In this project we present an acoustic training system for building acoustic models (HMM models) for a speaker-independent and continuous speech telephone-based digit recognition system. The system was built using a portable HMM toolkit called HTK. A sufficiently large speech database (around 3000 utterances) was collected to train the acoustic models. The acoustic models for all digits were constructed and trained. Separate models were built for non-speech sounds like background noise and channel noise, false-starts and throat. A test set database having 1000 utterances was constructed to test the accuracy of the acoustic models. Our results show a word level accuracy of 96.83% and 71.74% sentence correct. Using Asterisk, the system was then built to work online for the students of IITK to know their Room No. and Hall of Residence by uttering their respective Roll No. on telephone.

2008/IITK/4

DESIGNING AND FABRICATION OF HUMIDITY SENSOR BASED ON CONDUCTING POLYMER

Lokesh Tayal, Chemical Engineering, IIT Kanpur
Mentor: *Siddharta Panda, Department of Chemical Engineering*

Hygrometer has been developed using Polyaniline doped with acids as thin film..Hydrochloric acid, phosphoric acid, sulphuric acid, camphor sulphonic acid, iodine have been characterized as sensing material to determine relative humidity in the range of 25-80%. Each thin film is obtained on glass substrate. Polyaniline is prepared with oxidative polymerization of aniline with ammonium peroxydisulfate in acid medium. For sensing purpose interdigitated electrode system is formed over the film to get better admittance of sensing material using Vaccum Box coater. Thin film is formed with spin coating at various RPM's and later on surface profilometry and FTIR is done for characterization purpose.Keithley4200 and Keithley 2400 is used for resistance measurement and calibration purpose. Linear Regression relation is obtained for variation of resistance with temperature and humidity. It shows the decrement in resistance with increase in humidty as well as temperature. It is found that with decrease in concentration of acids resistance is found decreasing and hence increase in conductivity. The response of sample doped with organic acids have been found to be more sensitive compared to inorganic dopants. Signal processing is done using the Psoc kit and 8-bit microcontroller is used for the memory and analog to digital conversion. Psoc is programmed according to the circuit for LED display.

2008/IITK/5

Analysis of human mRNA sequences with their Translation Initiation Sites (TIS) in weak Kozak context: Analysis using Gene Ontology terms

Mohit Kumar Jolly, Biological Sciences and Bioengineering, IIT Kanpur
Mentor: *R. Sankararamakrishnan, Department of Biological Sciences and Bioengineering*

Three steps are involved in the transmission and expression of an organism's genetic information- DNA replication, transcription and translation. A tri-nucleotide sequence (codon) in a mRNA (messenger RNA) sequence specifies a particular amino acid during protein synthesis in translation. The initiation of translation plays a critical role in understanding what part of the sequence is translated and what protein is synthesized. The prediction of translation initiation site (TIS) in eukaryotic mRNAs has always been a challenging problem in gene prediction algorithms and computational molecular biology. In most cases, TIS is an AUG codon with strong Kozak context- (-3)RNNAUGG(+4), where R is a purine(A/G) and N is any nucleotide. In this report, We have compared the success rate or efficiency of two existing algorithms which predict TIS in a given mRNA sequence- NetStart and weakAUG, when tested specifically on around 500 human mRNA sequences having TIS as AUG with weak context. The efficiency of weak AUG is found to be much better than that of NetStart. I have also analyzed the gene products of human mRNA sequences having their TIS in weak Kozak context in terms of Gene Ontology- a vocabulary of gene and its products in terms of the molecular function, biological process and cellular localization. Majority of such mRNA sequences is found involved in signaling processes and an important conclusion has been drawn explaining why such processes are prominent with these sequences.

Presently, the authentic start codon of any mRNA sequence has to be known through experiments, which consume much money and time. Looking specifically into the sequences whose TIS are correctly predicted by one algorithm but not the other, a more efficient algorithm than the existing ones can be designed. This will also help in a better understanding of the mechanism of translation initiation. A similar analysis of Gene Ontology of mRNA sequences having their TIS in moderate Kozak context can also be done.

2008/IITK/6

Study on some important aspects of Flyash cement concrete

Mudit Srivastava, Civil Engineering, IIT Kanpur
Mentor: *S. K. Chakrabarti, Department of Civil Engineering*

Cement concrete is the most widely used construction material in the world. The primary constituent of it is Ordinary Portland Cement (OPC). But OPC has some drawbacks: It is costly, requires large energy for production and creates pollution. If Fly-ash is used as a partial replacement of cement in concrete it can solve these problems as well as improve some properties of concrete like lowering the rate of liberation of heat, increasing durability towards acidic environment and enhancement of impermeability. This report presents the results of a laboratory study done on the Split-Tensile strength and Setting time of concrete and cement with various replacements (0%, 10%, 20%, 30%, 40%, and 50%) of cement with Fly-ash. All the results are obtained at different ages (3days, 7days, 14days and 28days) and comparisons are made. Results for key properties of Fly-ash used in the experiments are also obtained (as specified under IS: 1727). Further the 28 day compressive Strength and Slump results have been obtained for same replacements. The results show that although initial split-tensile strength of concrete with high replacement is less than 0% replacement but the 28day split tensile strengths nearly equals that of 0% replaced concrete. The 28day compressive strength of samples with fly-ash replacement reached 80% to 90% of that of concrete with no replacement. Also quantitative increases in setting times have been documented with the increasing percentage of replacements.

2008/IITK/7

Dynamical System Approach to Bluff – Body Flow Transition

Neelu Singh, Aerospace Engineering, IIT Kanpur
Mentor: *T. K. Sengupta, Department of Aerospace Engineering*

For the external flow around cylinders at very small Reynolds numbers, the separation is not present. At higher Re, the separation appears and the wake grows. At a certain value of Re, called the critical Reynolds number, an unsteady motion develops resulting in alternate shedding of vortices known as the Karman –Vortex Street. In this project, firstly we have explained the vortex shedding behind a bluff body (circular cylinder) due to Hopf Bifurcation using the theoretical Landau's Model. Different values of critical Reynolds number for the flow past a circular cylinder reported by different investigators shows the importance of the background disturbances. We have modeled the freestream turbulence (FST) computationally and then studied the flow past a circular cylinder in the presence of noise (background disturbances) and the effect of the noise level on the flow and saturation amplitude for Reynolds number, Re = 60. As FST level increases, in addition to the most dominant mode excited, other modes also become important and therefore inter-mode interaction should also be considered. We have also obtained the time variation of vorticity at different streamline positions of the cylinder for different levels of freestream turbulence for Re = 60, which gives the spatial dependence of the most dominant excited frequency due to absolute instability. We have also shown that frequencies are excited far downstream showing the onset of convective instability in addition to the absolute instability which is already present in the flow in the near downstream position also. Finally, the vorticity contours at Re = 60 are compared for different FST levels when flow has reached the equilibrium for each case.

2008/IITK/8

Developmental Metabolomics

Neeti Birla, Biological Sciences and Bioengineering, IIT Kanpur
Mentor: *Amitabha Bandyopadhyay, Department of Biological Sciences and Bio-Engineering*

Organs and tissues have characteristic chemical and physical properties commensurate with their functions. The unique characteristic of any tissue develops early during embryonic development. What remains an enigma is despite having the same DNA (responsible for the genetic content), how do cells in different tissues have distinct properties. This gives rise to the hypothesis that the tissues must differ in the repertoire of the gene expression. While oranogenesis is primarily controlled at the level of signal transduction and tissue specific regulation of gene transcription, the physical and chemical properties of a tissue is imparted by the metabolites it produces. The production of these metabolites is not template driven rather it is stochastic, meaning a metabolite may be synthesized if and only if the substrate and the enzymes are present in the tissue. In our project, we are trying to establish a relation between metabolic networks and the development of an embryo. We are studying the expression pattern of thousands of metabolic enzymes in chick embryos at various stages of development. Through the result obtained from this, we will find the coordinately expressed genes and also see if we can discover some new metabolic pathways.

2008/IITK/9

NON DESTRUCTIVE EVALUATION OF FIBRE COMPOSITES USING ULTRASONIC RAYS

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Use of fibre reinforced composite materials is growing at a rapid pace due to their unmatched properties like high strength and stiffness to weight ratio, dimensional stability, electrical insulation, smooth outer surface etc. Since composite materials are used widely in sophisticated applications such as aerospace industry, there is a strong need for reliable inspection procedure to assess the integrity of the structure during service life and estimate its residual life. Non Destructive Evaluation (NDE), in particular ultrasonic technique, is an obvious choice for such inspection due to its low cost and high reliability. However, NDE of composite materials is complicated due to the simultaneous existence of different damage modes in them. Directional anisotropy and local heterogeneity also provide considerable constraints to the NDE procedure. The real challenge in the NDE of composite materials is to identify different damage mode(s) and to characterize the role played by them. The project begins with the target to obtain the correct contour plots (both peak value as well as energy) for the pulse echo mode of NDE. It has been demonstrated that we need to cut off the water-born reflection part in the echo signal to get the expected contour plots according to the damage of the specimen plate. In the second half, concentration was built on producing the images simultaneously while the scanning was going on. Use of Matlab was avoided due to its incompatibility with the older platform of the computer performing scanning. GNU Plot came as a solution but was avoided due to certain issues. Now, work is presently going on with the C library functions to achieve this task.

2008/IITK/10

Named Entity Recognition for Hindi

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Mentor: *Harish Karnick, Department of Computer Science and Engineering*

Named entity recognition (NER) is a subtask of information extraction that seeks to locate and classify atomic elements in text into predefined categories such as the names of persons, organizations, locations, expressions of times, quantities, monetary values, percentages, etc. Two basic approaches adopted for Named Entity Recognition (NER): 1) Rule based – NER on the basis of grammatical rules 2) Using Machine Learning – It involves using a machine learning algorithm to train a classifier using annotated dataset. The work on NER for English and other foreign languages has given very good results. But the

situation for Hindi and other Indian Languages is not that good. The reason may be attributed to structural (capitalization, etc.) and grammatical differences. We would like to explore methods and techniques to augment the machine learning approach to achieve better results for Hindi. Among the probabilistic automata like HMM, MEMM, etc CRF has advantages in its ability to handle contextual information and thus addresses limitations of the other approaches. We use CRFs for building a machine learning classifier to recognize named entities.

2008/IITK/11

Design and Fabrication of a Conducting Polymer based Temperature Sensor

Sonam Srivastava, Chemical Engineering, IIT Kanpur
Mentor: *Siddharta Panda, Department of Chemical Engineering*

The study of conductive polymers and modulation of their properties for various electronic applications is a an interesting research topic with a vast potential. Conducting polymers combine the property of conduction with the typical properties of strength, flexibility, elasticity, stability, mouldability and ease of handling of polymer, thus providing a new dimension to the advantages and functionalities of polymeric materials. Here the temperature dependant conductivity of polymers is utilized to monitor the temperature and fabricate a temperature sensor. Polyaniline has been chosen for this purpose from the vast classes of conductive polymers because of its ease of synthesis, huge range of conductivity, good temperature coefficient of resistivity (TCR) and easy mouldability. The effect of various dopants on the conductivity has been studied and increase in the conductivity by the order of 106 has been reported. Polyaniline doped with H2SO4 and blended in polystyrene has been used or the fabrication due to its optimum conductivity and TCR. Interdigitated electrodes on the polymer film coated on a glass substrate form the basic design of the sensor. The films have been physically characterized. Polyaniline thin film sensors promise diverse future applications such as in large surface area multifunctional sensors.

2008/IITK/12

A Simple Robust Algorithm for Rigorous Design of Multicomponent Distillation Columns

Tanya Gupta, Chemical Engineering, IIT Kanpur
Mentor: *Nitin Kaistha, Department of Chemical Engineering*

A robust tray-by tray algorithm for the rigorous design of simple multicomponent distillation columns is presented. The algorithm is applicable for ideal as well as mildly non-ideal systems. A major advantage is its ability to handle column design problems with any type of split i.e. direct splits, indirect splits and intermediate splits where both the light key and heavy key components are intermediate boilers. A spectrum of column designs for specified key component recoveries can be generated by varying the recoveries of either the lighter than light key component or heavier than heavy key component. This provides a direct means for obtaining the “best” column design as the one with the minimum number of trays. The proposed approach is similar to the Lewis-Matheson method of tray-by-tray calculations that proceed from the two ends of the column towards the feed tray. The discrepancy in the component flows at the feed tray is driven to zero using Newton-Raphson corrections on the iteration variables. The method is simple, rigorous and the same formalism applies to both rating and design problems. A range of problems with different number of components and various types of splits are studied to demonstrate the efficacy of the method.

2008/IITK/13

IMPROVEMENT OF SWARM INTELLIGENCE BASED ROUTING ALGORITHMS FOR MOBILE AD-HOC NETWORKS AND USING SIMULATION TO TEST THE IMPROVEMENTS MADE

Vaibhav Sethi, Electrical Engineering, IIT Kanpur
Mentor: *Animesh Biswas, Department of Electrical Engineering*

A mobile ad hoc network (MANET) is a kind of wireless Ad Hoc network, and is a self configuring network of mobile routers (and associated hosts) connected by wireless links – the union of which form an arbitrary topology. Such a network may operate in a standalone fashion, or may be connected to the larger Internet. In this project We investigated Swarm Intelligence based routing protocols for routing in mobile Ad Hoc networks. Swarm intelligence (SI) is artificial intelligence based on the collective behavior of decentralized, self-organized systems. More particularly Ant colony inspired optimization algorithms (which are a part of SI) were inquired into. We have come with a new/modified Swarm Intelligence algorithm for routing, which builds on the framework of an existing algorithm, AntHocNet. Various features have been added like pheromone decay, local congestion awareness and Power aware routing (based on next hop remaining battery and hop distance) to the existing framework. We have also implemented Source Pheromone Aversion (SPA) in our algorithm, which is akin to repulsion of data packets by source in addition to attraction. Further small changes are proposed in search mechanism, costing function and route reinforcement mechanism. NS-2has been used (Network Simulator 2 ver. 2.33), as the simulator for performance evaluation of the algorithm. The simulation work is ongoing.

2008/IITK/14

Molecular characterization of development of fovea in vertebrate retina

Vikas Trivedi, Biological Sciences and Bioengineering, IIT Kanpur
Mentor: *Jonaki Sen, Department of Biological Sciences and Bioengineering*

Vision is made possible when the retina of an organism receives photons from the surrounding visual field and converts it to neural signals to be conveyed to the brain. In animals that are diurnal (primates and birds of prey) and require ability to distinguish colors there is a specialized region in the central retina known as fovea which is the center of high acuity vision. It is packed at a high density with cones but is almost completely devoid of rods. The importance of fovea in visual function is clear from the fact that many retinal degenerative diseases including age-generated macular degeneration (AMD) appear to begin with loss of photoreceptors in the foveal region of the retina eventually leading to blindness. However not much is known about why foveal photoreceptors are particularly susceptible to degeneration. Chick (Gallus gallus) is an ideal model organism to study the development of the fovea because it has a distinct rod free zone (fovea) in the retina. Using RNA in situ hybridization of chick retina it was found that fibroblast growth factor (Fgf8) is expressed in the area of the rod free zone and thus may be involved in determination of fovea. Sequence comparison of Fgf8 loci from several vertebrate species (both with and without fovea) revealed four evolutionarily highly conserved non-coding sequences that were present in vertebrates with fovea. Further investigations revealed a number of transcription factor binding sites in these evolutionarily conserved regions. With the help of various molecular biology techniques coupled with bioinformatics we molecularly characterize the mechanism of foveal determination through identification of upstream regulators of Fgf8 that govern its specific expression pattern.

2008/NIT/IITK/15

Synthesis and Characterization of Water Soluble Carbon Nanotube from Industrial Waste

Ajay Singh, Chemistry, Dr. B. R. Ambedkar NIT, Jalandhar
Mentor: *Sabyasachi Sarkar, Department of Chemistry*

Since their discovery by Ijima in 1991, carbon nanotubes have been in the forefront of nanoscience and nanotechnology because of their unique electrical, mechanical and chemical properties. However due to the lack in the solubility of CNTs in water and in other organic solvents their use is limited in many potential applications especially in biochemical sciences and engineering. Moreover, because of their high surface energy CNTs have a tendency to aggregate making them very difficult to disperse. So the poor solubility of CNTs has hindered their use in many applications. To overcome the problem of poor solubility, functionalizations and solublization of CNTs have received much attention. The functionalisation can be done by many methods such as chemical oxidation, covalent and non-covalent functionalisation, polymer wrapping, DNA wrapping, and by using a pulsed steamer discharge method, and by microwave-assisted Functionalizations. For our survival the waste product disposal is a big issue.

Some of these materials are not biodegradable and often leads to waste disposal crisis and environmental pollution. The present work seeks the possibilities of whether some of these waste materials can be utilized for the synthesis of nonmaterials. In this work we used waste material from the rubber industry, as we all know the amount of tyre waste has been increasing year after year and the natural decomposition process of these tyres is very slow because they are not readily biodegradable. If tires are disposed of unsafely, they can cause environmental pollution. The project work starts with the aim to synthesize nanomaterial from this waste material (rubber industry). The process begins with the collection of soot from this waste material and treating it with different solvent to remove impurities and unwanted material, After all these treatment we get a fine quality of carbon nanotube. Oxidative treatment of these provided us water soluble carbon nanotubes. These have potential in use in wide range of application in biochemical sciences and engineering. The method we used here to synthesize water soluble CNT is very cost effective. In one hand we get the material (CNT) which is expensive like diamond and in other wise we get new way to dispose off waste materials..

2008/NIT/IITK/16

Strengthening of Unreinforced Masonry Walls For Out-of-Plane Loading Using FRP

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Unreinforced masonry walls are the most common construction practice all over the world. They are prone to failure when subjected to overstresses caused by wind load, structural weaknesses, earthquake and settlements. They are considered to be the most vulnerable part of a structure. The walls are subjected to mainly two types of loading during an earthquake: these are in-plane loading and out-of-plane loadings. The failure of the walls in in-plane loading is less as compared to that in out-of-plane loading. The research work on strengthening of masonry walls is rather limited under out-of-plane loading. The present study deals with strengthening of unreinforced masonry walls for out-of-plane loading using FRP (fiber reinforced polymers). FRP is very effective in strengthening as well as in retrofitting existing structures including masonry walls. Four point bending tests were carried on masonry wall specimens according to ASTM C78. Total 11 specimens (size 1.18m by 0.58m, thickness 0.11m) were tested including control specimens and specimens strengthened with different types of FRP. Displacement controlled load was applied by a servo hydraulic actuator. The specimens were strengthened by various forms of FRP such as GFRP bars, fabric, strips and roving and their combination to find out their effectiveness in bearing out-of-plane load. Based on the test results various parameters such as peak load, displacement, strains in FRP, amount of energy absorbed etc. were compared for different FRP strengthening schemes. Substantial increase in the peak load, displacement at peak load and energy absorbed has been observed as compared to control specimen in all the specimens. Out of different FRP strengthening schemes tested the use of hybrid composite (short fibers and unidirectional rovings) in the horizontal bed joints with two cross FRP rebars (rectangular cross section) has produced the optimum strengthening of masonry walls subjected to out-of-plane loading.

2008/NIT/IITK/17

COMPARISION OF THE VARIOUS PLANE EXTRACTION METHODS ON THE BASIS OF SIMULATED LiDAR DATA AND MAKING ASSESSMENT OF THEIR ACCURACY, EFFICIENCY AND SENSITIVITY

Arpan Kusari, Civil Engineering, NIT, Tiruchirapalli
Mentor: *Bharat Lohani, Department of Civil Engineering*

Airborne LiDAR is an upcoming method for accurate topographic data collection at very high speed. LiDAR data can be acquired fast thus showing potential for their use in disaster management efforts where buildings are important entities. For the data presented by LiDAR, the data has to be processed so as to have meaningful geo-information. An important part of the 3D-geoinformation is the identification

of buildings. Buildings in LiDAR data can be identified using the conceptual approaches of height difference, shape difference and the planar surface identification. The planar surface identification from LiDAR data and their subsequent intersection to generate a building wireframe is an important technique and is used widely. The accuracy of plane identification from LiDAR data governs the accuracy of final building extracted. Methods have been put together for identification of plane surfaces, the two main being Hough transform and Random Sample Consensus (RANSAC) paradigm. However, still ones there is no quantitative evaluation of these methods for their accuracy, speed and versatility. Their principles, their codes and flowchart diagrams have been included in the present work. Algorithms are coded in MATLAB for the plane identification methods and are tested for their correctness. An attempt has been made for the comparison of the two methods on the basis of their speed, accuracy and versatility. The evaluation of the methods is done by taking the data from LiDAR simulator 'Limulator' which aims at generating data as per given characteristics which is appropriate for testing. Though Hough transform and RANSAC have their own limitations, it is shown that RANSAC fares better than Hough transform.

2008/NIT/IITK/18

Permeability of Fly Ash Under Stress

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Mentor: *Amit Prashant, Department of Civil Engineering*

The influence of stress state on permeability of fly ash has been investigated using a combination of oedometer and permeability setup. Three types of fly ash specimens have been prepared using air pluviation method for obtaining loosest state, standard proctor test and modified proctor test OMC for densest state, and soaking method for studying weathering effect of fly ash. A series of 1-D consolidation tests followed by permeability tests have been performed on these specimens, and variation in permeability at different loading conditions during consolidation test has been studied for constant stresses of 27 kPa, 71 kPa, 143 kPa, 269 kPa, 528 kPa and 1046 kPa. Fly ash specimens were first consolidated under given constant stress and then permeability of the specimen was obtained. Permeability of Fly ash was evaluated at different stress levels for loading as well as unloading conditions. The correlations have also been developed between permeability and stress values for all three cases during loading and unloading conditions using a combined setup of Oedometer and falling head permeability testing devices.

2008/NIT/IITK/19

A Simple Robust Algorithm for Rigorous Design of Multicomponent Distillation Columns

Avanti Dahiwadkar, Chemical Engineering, NIT, Surathkal
Mentor: *Nitin Kaistha, Department of Chemical Engineering*

A robust tray-by tray algorithm for the rigorous design of simple multicomponent distillation columns is presented. The algorithm is applicable for ideal as well as mildly non-ideal systems. A major advantage is its ability to handle column design problems with any type of split i.e. direct splits, indirect splits and intermediate splits where both the light key and heavy key components are intermediate boilers. A spectrum of column designs for specified key component recoveries can be generated by varying the recoveries of either the lighter than light key component or heavier
than heavy key component. This provides a direct means for obtaining the "best" column design as the one with the minimum number of trays. The proposed approach is similar to the Lewis-Matheson method tray-by-tray calculations that proceed from the two ends of the column towards the feed tray. The discrepancy in the component flows at the feed tray is driven to zero using Newton-Raphson corrections on the iteration variables. The method is simple, rigorous and the same formalism applies to both rating and design problems. A range of problems with different number of components and various types of splits are studied to demonstrate the efficacy of the method.

2008/NIT/IITK/20

STUDIES TOWARDS THE SYNTHESIS OF CONSTRAINED CHIRAL AMINO ACIDS USING DIELS-ALDER REACTION

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Mentor: *Y. D. Vankar, Department of Chemistry*

The importance of peptides and their analogs in contemporary biology, has led several groups to work on unnatural chiral amino acids. Particularly, synthesis of constrained amino acids has gained momentum as they offer restricted conformations of the corresponding peptides. It is with this view, that the present project is aimed at making these molecules using Diels-Alder cycloaddition reaction.
The cycloaddition reaction constitutes one of the most potent techniques in synthetic chemistry that enables the chemist to achieve synthetic targets in an enantio-specific manner. The unique feature of the Diels -Alder reaction is that it generates upto four new stereogenic centers in one step; combined with a variety of useful reactants has made it a favourite methodology for constructing molecular diversity. Since carbohydrates contain many functional groups and stereogenic centers in one molecular unit, and serve as a cheap, replenishable source of chiral compounds, available in various cyclic and acyclic forms, chain lengths and oxidation or reduction states, they have been widely utilised in organic chemistry. Thus, carbohydrate derived diene has been prepared and its cycloaddition reactions with ethyl -nitro acrylate has been studied. Diels-Alder adduct can be easily transformed into constrained -amino acids in a few further steps. Such type of conformationally constrained cyclic - amino acids are synthetic precursors for a wide variety of useful compounds that include natural products, modified peptides and also exhibit interesting structural and useful biological properties.

2008/NIT/IITK/21

Effect of buoyancy on the flow structure and heat transfer characteristics in a periodic array of square pin-fins inside a channel at various Reynolds Number

Gaurav Mishra, Mechanical Engineering, NIT, Durgapur
Mentor: *A. K. Saha, Department of Mechanical Engineering*

A numerical study has been carried out to analyze the flow and heat transfer characteristics in a periodic array of cubic pin-fins placed in an in-line fashion inside the channel. The two dimensional Navier Strokes and energy equations are discretized using a central difference scheme. The code has been developed for solving the Navier Strokes and Energy Equation based on MAC formulation. The simulation is carried out at various Reynolds numbers for the two different values of Richardson number Ri=0 and -0.1 at a prandtl number of 0.7 corresponding to air. The present paper reports the two dimensional numerical study in the heat exchanger passage with rectangular cross-section pin fins. Both the steady and non steady flow regimes in the periodically developed region have been studied for an inline array of fins.

2008/NIT/IITK/22

Phone Based Train-Name Recognition System

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Mentor: *S. Umesh, Department of Civil Engineering*

To build a system that recognizes train names when spoken on a telephone and provides relevant information about it. The modeling is done on phone level so that extension of the system is easier. The system is interfaced with a telephone using asterisk an open source communication platform. This system is built on the concept of hidden markov models. Here, some data is first collected by building a telephone based recording system where required train names are recorded. These are then converted into their Mel Frequency Cepstral Coefficients (MFCC). Then these are used to build Hidden Markov Models at phone level. A dictionary is maintained and a proper word net is built. When the speech to be tested is received, first its MFCC is found and then the most likely word is found by using the viterbi algorithm.

Here, this system is an isolated word , speaker independent , easily extendable vocabulary, finite state context insensitive vocabulary telephone based system.

2008/NIT/IITK/23

Design and Analysis of Landing Skid and Avionics Box of Mini Autonomous Helicopter

G Parithi, Mechanical Engineering, NIT, Tiruchirapalli
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Small autonomous rotor craft represents both a technology challenge and a potential new vehicle class that may have substantial societal impact in the near future. Computational analysis has become an integral part in the field of prototyping in the present day and Finite Element Method (FEM) based analytical approach is used and is found to be applicable both together with and as an alternative to experimental tests. This study presents Static and Dynamic Analysis of Landing Skid and Avionics Box by a Finite Element Analysis (FEA) Model. Three different structural models of Landing Skid and one model of Avionics Box were developed and finite element method (FEM) was employed to investigate their mechanical characteristics under static and dynamic conditions. The CAD modeling was done with the help of the softwares 'ANSYS Workbench 10' and UNIGRAPHICS NX4 .The stress distribution, strain, and elastic deformation contours under static conditions were obtained. The fundamental modes of vibration dynamic conditions were also obtained. Analysis of the calculation results of different models was conducted. The first three natural frequencies predicted by the FEA model are consistent with those obtained by the tests .The landing skid and avionics box was fabricated to the required dimensions and tested under real time conditions. The materials used in the FEM calculation and for fabrication was Aluminium alloy. The established FEA model predicts the reliability and functionality of current design from a vibration viewpoint. The mechanisms of helicopter flight create a unique, high-vibration environment which can play havoc with the accurate operation of on-hoard sensors. Vibration isolation of electronic sensors from structural home oscillations is paramount to their reliable and accurate use. It can also help engineers and researchers improve the mechanical design and product reliability when used in harsh vibration environments.

2008/NIT/IITK/24

Identification of Source in Groundwater Pollution by Using Artificial Neural Network

Hemant Kumar, Civil Engineering, NIT, Warangal
Mentor: *Ashu Jain, Department of Civil Engineering*
Co-Mentor: *Rajesh Srivastava, Department of Civil Engineering*

This project presents the results of a study aimed at estimating pollution source location and pollution source strength (pollutant concentration) from observed breakthrough curve by using ANN. ANNs have emerged as an attractive field of research like inverse modeling of pollution location and concentration. In this project the problem has been studied based on double output layer type of ANN to find – 1) the concentration of pollution source and 2)its distance from observation's wells. Since it is much more complex problems, to come over this type of problem the feed-forward multi layer perceptron type ANN is employed. The ANNs are trained using the back-propagation training algorithm on stimulated data. The results show that the ANNs can be very efficient tools for locating pollution sources and that it is possible to obtain good ANN model performance even with very simplified architectures involving a few input variables to the ANN.

2008/NIT/IITK/25

PREPARATION OF GIS DATABASE FOR ARCHEOLOGICAL STUDIES

Indu Priyadarshani, Civil Engineering, NIT, Patna
Mentor: *Onkar Dikshit, Department of Civil Engineering*

This project is aimed at developing a Cultural Resource Management System (CRM) for Archeological Monuments of India. The goals of Cultural resource management system are preservation, identification,

and maintenance of cultural sites and removal of culturally valuable materials from areas where they would otherwise be destroyed. The whole work is divided into two parts a) Development of geospatial database: This will be used as a spatial database to view the result of some query on the raster or vector map which has been geo-referenced in UTM 44, WGS-84 co-ordinate system. For example, if a query is made to show the entire Monument found in a particular circle office such as Lucknow or if a user makes a Query about the monuments which are used as offices or museums, then the raster map of India will open and the required location will be highlighted or marked. b) Development of database management system (DBMS) for monuments, heritage and antiquities found at particular site (Non spatial database): Database Management Systems (DBMS's) are computer programs that automate the collection, storage, manipulation and retrieval of structural bodies of information. This will be used to carry out editing of the records. Editing will include addition of new records, updating existing records and deletion of existing records. There is a large numbers of monuments in India and there is no proper documentation of these monuments and built heritage. Hence the database has been created in such a way that the queries related to these monuments are answered quickly. A query shell has been created to facilitate queries regarding the monuments. The query shell is divided into two parts: • First part is similar to a SQL server in which the user can type SQL statement in order to make some query. This has been provided to perform complex queries. • Second part is an interface in which the user can enter the requirements for a particular field of query and hence obtain the result directly. For primary queries, this is very friendly as the SQL statement is created internally.

2008/NIT/IITK/26

Synthesis and Characterization of Carbon Nanotube Formed from Leather Industrial Waste

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Mentor: *Sabyasachi Sarkar, Department of Chemistry*

Nanotechnology is the era to converge toward the future prosperity. A new form of Carbon is Carbon nanotube & fullerene. Both have very vast and versatile applications. Carbon nanotube has got much more importance due to many of its properties e.g. small size (in nm), high strength (much stronger then steel) etc. But the hydrophobic nature of carbon nanotube limits its uses in many potential applications like in biomedical engineering and biomedical sciences. So it must be solubilized in organic solvents and especially in water. And once it gets water solubilizes we can easily use it in biomedical applications such as Drug delivery. Here we have tried to synthesize the Carbon nanotube made from PUFF which can be made in the following steps. First, the collection of the starting material (soot) by a primitive type of chemical vapour deposition method, by burning puff with the help of Benzene. Second, purification of the soot by different solvent in soxhlet followed by oxidation with concentrated HNO3 etc. After oxidation it will become water soluble and can be separated into wsCNT and non soluble part with the help of different pore size cellulose acetate membranes; it can be further characterized by SEM (Fig: (A, B), and a higher magnification image Fig (C) having the scale bar 400nm) Fig: (D) AFM image, Fig: (E) showing the Raman spectra (D-band and G-band at 1350 cm-1 and 1650 cm-1 respectively, fig: (F) EDAX analysis.

2008/NIT/IITK/27

Identification of Groundwater Pollution using Artificial Neural Network

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Co-Mentor: *Rajesh Srivastava, Department of Civil Engineering*

Groundwater is one of the major sources of water in India. Harmful chemicals produced due to rapid industrialization, increased use of pesticides, and undetected leakage from pipes, waste storage containers and underground tanks (e.g., gasoline) are the main causes of groundwater contamination. It takes a significant amount of time and expenditure to restore the contaminated aquifer to a usable state. Therefore it is necessary to identify the source of pollution so that suitable punitive measures could be imposed on polluting industry or agency to recover some of the cost. Previously, to find the source of groundwater

pollution in aquifers, conceptual methods were used using observation wells data. There are various methods available for Identification of the pollution source. One of these is the inverse problem approach. In this approach, an optimization technique is used to solve the inverse formulation. Many earlier researchers have used classical optimization techniques for solving the inverse formulation. Classical optimization techniques are highly sensitive to initial solution supplied and they may converge at local optimal solutions. A few researchers have used non-classical optimization techniques such as Genetic Algorithm, Simulation Annealing, etc., to overcome the problems associated with the classical optimization approach. However, applicability of these algorithms is limited to small-scale studies only. Recently, artificial neural network has emerged as an attractive alternative to solve complex problems efficiently. The Neural Network is a massively parallel - distributed processor made up of simple processing units, which has a natural propensity for storing experimental knowledge and making it available to us. Typically, the only data available is the breakthrough curve at a few observation wells. So the main objective of the study is the determination of source concentration, duration and location, just by knowing the breakthrough curve taken at a point over a certain interval of time. For the source identification of groundwater aquifer, a feed forward 3 layer ANN model is used which is trained by using Back Propagation training algorithm. The data for the ANN model is generated by using an analytical solution of a one dimensional steady flow and transient contaminant transport in an homogeneous aquifer. The performance of the ANN model is evaluated using five standard statistical measures: Normalized Root Mean Square Error (NRMSE), Nash-Sutcliffe Efficiency (E), Coefficient of correlation(R), Average Absolute Relative Error (AARE) and Threshold Statistics (TS). The results show that ANN can be a very efficient tool for locating pollution sources, and it is possible to obtain a good ANN model performance even with extremely simplified architecture and with lesser number of input variables.

2008/NIT/IITK/28

Design of pavement with non-uniform thickness

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Generally a pavement surface is designed with an asphalt layer and a granular layer with uniform thickness throughout the cross section, but since the lateral distribution of traffic on a cross section of road never remains same throughout the section, there always exists possibility of designing a pavement section such that the thickness varies according to the lateral distribution of traffic on the cross section. With the advent of modern computer controlled slip form pavers,the construction of non uniform thickness of pavement layers is no longer a difficult task. In the present project, design of asphalt pavement is considered. Mechanistic –empirical (M-E) pavement design approach has been used in this study. The lateral distribution of the traffic is found out and used as the input along with other standard design input parameters. Pavement analysis (Finite element analysis) is performed using the software ABAQUAS (6.7.1version). The design geometry is determined for uniform as well as non uniform layer thickness. Designs are also done for various alternative geometries. In the end a study is done on the relative economy of such various alternative geometries. With the design that has been proposed we will be able to reduce the cost of construction by 6-7 %.

2008/NIT/IITK/29

Measurement of Inhalable Ambient Particles present in Microenvironments within IIT-K

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Aerosol Science can be broadly classified into two aspects, the good and the bad. The good aspect relates to the formation of commercial products like titania, silica, carbon black, indium, aluminium etc., in powdered form through aerosol mediated routes. The bad aspect relates to aerosols produced as by-products of anthropogenic activity. Such aerosols are emitted either into the indoor environment through activities like smoking and the burning of incense and mosquito coils, or in the outdoor environment

through vehicular traffic, biomass burning, power plants, etc. While epidemiological studies have consistently demonstrated the adverse effects of particulate matter exposure on human health, the mechanism of effect is currently unclear. The first aim of this study was to measure inhalable ambient particles by a portable sampler called Optical Particulate Counter (OPC) in the microenvironments, i.e. hostel (room, mess, canteen etc), temple, basketball court, bank, computer centre etc. OPC uses the light scattering technology for each particle. Particles are counted as counts/litre or mass as µg/m3. The second aim of this study was to compare the personal exposure to particles and bio aerosols with the exposure measured by portable samplers in these microenvironments. Firstly the instrument was set up in different microenvironments. Sampling was done for 1hour each day. These counts can be displayed and are also stored in the data storage card and may be transferred via the RS 232 for further analysis. The health effects of airborne particulates are determined by several factors: Mass concentration, Particle size. This report contains the effect of these fine particles with reference to their mass and particle size. The effect of these particles is analyzed and compared with standard values. Finally, time life non carcinogenic risks and relative risk for a normal person spending time in these microenvironments are analyzed.

2008/NIT/IITK/30

Flow Past an Erodible Island In a Natural Stream

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River flow carries a variety of sediment load. Along the flow path, bends alternately develop and the river flows against recently reworked, older, more indurated sediments or highly resistant materials. Non-erodibility of the sediment deposited on the river bed gives rise to formation of rivers in the islands in the river. These islands may grow in size or get completely washed out depending on the flow regime in the river. As the size of the formed islands increases, it becomes habitat for different aquatic lives and even for human beings, bringing into existence a unique civilization and culture. The flow around these erodible islands in the natural stream may be turbulent during high flow or may be laminar during the period of low flow. The mere existence of the form island in a river is mainly dependent on the protection provided against erosion to the island by the understanding of not only the erosion in front of the island but also of the wake information behind the island and of the flow along the sides of the islands. For adopting any measures for the protection of the island, the flow and erosion pattern around the island in a natural stream under different hydro-meteorological conditions have to be investigated. Therefore, during the research work, flow field around an erodible island in an open channel with a mobile bed has been mapped under different flow conditions by measuring the velocity and erosion characteristics around the island. The output of this work will have direct application in devising protection measures for the world's largest riverine island, Majuli in River Brahmaputra. Majuli today is only about 422 sq. km., while it used to be about 1200 sq. km. In the beginning of the 20^{th} century. It is constantly threatened by the erosion by the mighty and unstable river.

2008/NIT/IITK/31

A Simple Robust Algorithm for Rigorous Design of Multicomponent Distillation Columns

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A robust tray-by tray algorithm for the rigorous design of simple multicomponent distillation columns is presented. The algorithm is applicable for ideal as well as mildly non-ideal systems. A major advantage is its ability to handle column design problems with any type of split i.e. direct splits, indirect splits and intermediate splits where both the light key and heavy key components are intermediate boilers. A spectrum of column designs for specified key component recoveries can be generated by varying the recoveries of either the lighter than light key component or heavier than heavy key component. This provides a direct means for obtaining the "best" column design as the one with the minimum number of trays. The proposed approach is similar to the Lewis-Matheson method tray-by-tray calculations that proceed from the two ends of the column towards the feed tray. The discrepancy in the component flows

at the feed tray is driven to zero using Newton-Raphson corrections on the iteration variables. The method is simple, rigorous and the same formalism applies to both rating and design problems. A range of problems with different number of components and various types of splits are studied to demonstrate the efficacy of the method.

2008/NIT/IITK/32

Development of an efficient and a low cost methodology for analyzing Polycyclic Aromatic Hydrocarbons

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PAH are of marked environmental concern in air pollution studies as several of them are either known carcinogens or are suspected carcinogens and mutagens. Nevertheless, very little attention has been focused to monitor and control these compounds in ambient air. Currently these PAH‘s are collected using sampler (LVS/HVS), followed by adsorption on filters like quartz, Teflon PUF etc. Then these compounds are extracted using a soxhlet extraction or extraction under reflux or by ultra sonication process depending on the nature and type of PAH(3-4 rings or 5-7 rings) to be extracted. Samples are analyzed using simple HPLC or HPLC with programmable fluorescence detection (needs less clean up or maintenance) and GC/ MS with their standards in accordance with those specified by ISO or EPA. Though this methodology gives a fairly accurate result, it is highly time consuming and costly, and hence proper and frequent monitoring of these PAH in ambient air has not yet been possible. So it is proposed to develop a low cost methodology for estimating these deadly carcinogenic PAH compounds based on a simple concept of LOI, which is frequently used in air quality analysis. Loss-on-ignition (LOI) has been successfully used for estimating organic matter in Suspended Particulate Matter (SPM) particularly, PM10, dust and street dust (Xie et al., 2000; Boon et al., 1998). LOI may prove to be an economic chemical analysis tool for developing countries like India for analysing organics/PAH in particulate matters. In this project we will make an attempt to standardize LOI method for determining PAH/organic compounds associated with the particulate matters in the ambient air.

2008/NIT/IITK/33

Study Towards The Synthesis of Sugar Carbasugar Hybrid as a New class of Glycosidase inhibitors

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Since Glycosidase inhibitors play an important role in fundamental biological processes it has been the area of interest especially in relation to the treatment of various diseases such as diabetes, hepatitis, Gaucher’s disease, influenza infection, cancer, and AIDS. Various azasugar, carbasugar and thiosugar have been extensively studied over the past decades and been found to act as glycosidase inhibitors. Based on design, glycosidase inhibitors such as miglitol and acarbose are used for diabetes type II, N-butyl-1-deoxynojirimycin for Gaucher’s disease, and zanamivir and oseltamivir (Tamiflu) for influenza. However the search for new highly active and selective glycosidase inhibitors is still in need. The hybrid molecules (made up of different molecular species) are the new class of glycosidase inhibitors. Several examples of hybrid molecules have been reported in literature1-4 .In this project we have synthesized a new bicyclic hybrid of sugar-carbasugar molecule (figure 1), using Diels-Alder reaction as the key step starting from D-glycals. Subsequently we have functionalized the cycloadduct to get the different hybrids.

2008/NIT/IITK/34

ANALYSIS OF MULTIPLE DAM BREAK FLOW

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This study illustrates the multiple dam break flow analysis. When more than one dam is built on the same river and their catchments lie close to each other, the dam break flow resulting from the failure of the dam

lying upstream may lead to the failure of the downstream dam. The case in point for this study is Mullaperiayar dam and Idukki dam on river Periyar. Three different scenarios are investigated. Scenario one illustrates the breaking of Mullaperiyar dam due to overtopping. Scenario two illustrates the breaching of Idukki dam lying 50km downstream of the Mullaperiyar dam. Scenario three illustrates the consecutive breaking of both the dams. All the three cases are analyzed using NWS DAMBRK software. The governing equations used are the conservative form of the Saint Venant equations which are solved by Preissmanns implicit weighted four point scheme. An inflow of about 1500 cumecs can result in the complete failure of the Mullaperiyar dam which has a design spillway capacity of 850 cumecs much of which has been clogged already due to leaching of materials from the dam surface. Such a dam failure can produce a sudden outflow with the outflow peak reaching almost 10944 at 50 km from the downstream of the Mullaperiyar dam, where the Idukki dam is situated. But even a much lesser inflow of 3200 cumecs itself can cause a breach in Idukki dam. A failure of Idukki dam would lead to the submergence of three districts of Kerala and thousands of acres of forest land.

2008/NIT/IITK/35

Eco-friendly toilets with "zero discharge"

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Globally, the need for water recycling is increasing due to rising water demands and finite water resources. So new eco-friendly toilets with "zero discharge" which can indirectly contribute to the reuse of water has been developed. The aim of the study is to evaluate the efficiency of the separator which is an important part of this toilet. The separation of water from the feaces is investigated. This flushed water can then be reused for another flushing in toilets as a means to tackle water shortage problems. This toilet with "zero discharge" provides an economical solution for us. This toilet does not have any moving part. The solid –liquid separation is based on the whirlpool effect, gravity and centrifugal force. The trial and the performance testing shows that this new eco-friendly toilet with "zero discharge" is a new structure which can save 90% water, ensure sanitary security, ease of using and is a simple process environmental equipment. These toilets have the following features: • Use of separator saves 90% water • No moving parts and external energy requirement • Compact novel device for recycling flushed water • Improved toilet seat • Water seal with negligible amount of fresh water usage. A new rectangular separator is proposed which would be more economical than the circular separator. The existing separator is modified to make it more efficient. It would be a good alternative for environmental sanitation, which strives for the recycling of water, instead of polluting adjoining waters.

2008/NIT/IITK/36

Construction of combined dispersion curve in spectral analysis of surface waves (SASW) technique

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Soil behavior under cyclic loading or dynamic conditions is of interest for a wide range of problems, from foundations to site response during an earthquake. The stiffness and dissipative characteristics of geomaterials at shallow depth play an important role in site amplification of the motion during earthquakes. That also leads to soil site characterization. In this respect, the attention will be restricted to seismic methods based on wave propagation, from which soil parameters at very low strains are obtained. SASW is one of the non-invasive tests of seismic methods. Experimental dispersion curves have been constructed as the phase velocity of Rayleigh wave is a function of frequency. As there are large degrees of uncertainties like far field, near field effects, poor data quality etc, dispersion curves for different receiver spacing have been constructed. The objective of this work is to collect the whole ensemble of data using a series of geophone configurations and to assemble them to create only one final dispersion curve covering a wide range of frequency. Usually for any subset of frequency (or wavelength) the average value of phase velocity needs to be calculated. As there is a lot of overlapping information in a given frequency range, there is a problem in calculating the mean of phase velocity by statistical

distribution. Therefore, weighting factor is applied to data of each geophone spacing and then weighted average is calculated. A probability distribution is chosen to distribute the data in such a way that it increases to a peak value and then decreases. This is because as source and geophone distance increases some of the frequencies die out gradually. Data is normalized and weighting factors obtained are applied to data of each geophone spacing and the weighted mean of phase velocity and wavelength are calculated .Finally, the dispersion curve for this combined data is constructed.

2008/NIT/IITK/37

Optimising the thickness of P3HT-PCBM blend active layer in Organic Solar Cells

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Organic solar cells have the potential to provide a low cost and environment friendly alternative to the existing non-renewable sources of energy. In addition the organic solar cell has the advantage of large area production and compatibility with flexible substrates with the use of printing technologies and roll-to-roll processing. The goal of this project is to optimise the thickness of P3HT (poly (3.hexylthiopene-2, 5-diyl)) - PCBM ([6, 6]-phenyl-C61-buytric acid methyl ester) blend active layer in bulk heterojunction organic solar cells. Calculations based on optical absorption show that the thickness of at least 400 nm is needed for the active layer. However the experimental results suggest that the maximum efficiency is obtained for an active layer thickness between 90 and 140 nm. This discrepancy is explained by the increased resistance for electrons and holes generated by photovoltaic process with increase in active layer thickness. The recombination of photo generated excess electrons and holes is also higher in thicker films. These factors offset the increased absorption efficiency for thickness above 140 nm.

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2008/NIT/IITK/38

Membraneless Microfluidic Fuel Cell

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The objective of this work is to design and fabricate microfluidic devices based on fabrication of 2-D and 3-D microchannel patterns in a flexible platform of cross-linked poly(dimethyl siloxane) (PDMS) and to optimize channel geometry so as to provide better control and diminished size of the device. The method used for the fabrication of these microfluidic devices is not as complicated as some of the other methods and can be easily implemented on a large scale. In this work, Y, T- channels of different cross sections have been fabricated by embedded template assisted fabrication using transparency sheets as the template.The work describes a small fuel cell fabricated using a design that omits the membrane normally used to separate anodic and cathodic compartments. This design exploits the laminar flow that occurs in liquids flowing at low Reynolds number (Re) to eliminate convective mixing of fuels. Two separate streams – one oxidizing and one reducing, flow parallel to one another through the channel. The fuel cell operates with formic acid as fuel and oxygen bubbled in sulfuric acid as oxidant. Because of laminar flow, the diffusive mixing between these two streams is confined within a small interfacial region. This characteristic eliminates the need of a membrane (PEM) to separate the two streams. Preliminary studies show that it produces about 0.1 Volts at a Reynolds number of ~0.5.

2008/NIT/IITK/39

Study of Hydrodynamics of Oscillating Slug Flow in Capillary Tubes

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Miniaturization is the current trend and this craze has particularly gripped the electronics and allied industry. Although this ‘increase power-decrease size’ scenario has been prevalent for many decades, in recent years, thermal management has become the major feasibility bottleneck for microelectronics. Two

phase passive devices (like conventional heat pipes, thermosyphons etc) are proven present day solutions. Owing to favorable operational characteristics coupled with high heat flux handling capability and relatively cheaper costs, pulsating heat pipes (PHPs) are presently being researched for potential applications in various areas. The diameter of the PHP ranges from 0.1 mm to 5 mm so that liquid plugs can be formed by surface tension. Due to vapor expansion in the evaporating section and contraction in the condensing section, an oscillating motion of the slugs and bubbles in the tube occurs. Slug flow is one of the basic gas-liquid flow patterns in pipes, occurring in almost all applications involving two-phase flows in pipes. The velocity of the two-phase flow inside the PHP is not known a priori [Vasiliev L.L., 2005; Khandekar S. et al., 2006]. This prevents the prediction of the two-phase pressure drop and overall heat transfer coefficient of the system. Therefore, design rules cannot be formulated unless a clear understanding of the velocity scales encountered in the device is well documented.The present research aims to model unsteady slug flow which is known to be dependent on the flow in the wake of the Taylor bubble rising ahead. However, to get a better understanding of the mechanism of coalescence, the approach involves characterizing the hydrodynamics associated with a single slug in the tube. The setup consists of a cam-follower system which provides mechanically driven pulsations to the slug in the capillary, simulating the flow in PHPs with the absence of heat flux. High speed data acquisition is done in the time domain by varying the frequency. Velocity profiles in the wake of the slug and the effect of contact angle hysterisis on slug dynamics is studied. A simultaneous flow visualization is carried out in the μ-PIV setup for better velocity characterization.

2008/NIT/IITK/40

Fluid Flow along a Horizontal Wavy surface

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A study of two-dimensional mixed convective heat transfer along a horizontal wavy surface in a fully developed situation is presented. The time-dependent, Navier-strokes and continuity equations are solved for different flow regimes for a range of Reynolds numbers. Sinusoidal configuration is considered for a range of geometric configurations. The sinusoidal wavy surface considered is maintained at a constant wall heat flux. The Finite Volume Method on a collocated grid is used for the computation of the flow. The flow regime, the flow characteristics for the configurations considered is presented. Three different geometries have been studied. These three configurations vary in their height ratios. The effects of Reynolds number (Re) and the height ratio (H min/H max) on fully developed velocity profiles, streamlines and transverse velocity contours have been studied. In the study of the streamlines, it was observed that the flow remains unsteady at small value of Re. The recirculation flow covers a smaller portion of the domain at relatively lower Re values, and it completely covers the concave areas at higher values of Re. An increase in the height ratio leads to a decrease in the recirculation length. For greater height ratios, turbulence was obtained at a larger Reynolds number. The transverse velocity was also found to vary with Reynolds number. As the Reynolds number increases for a particular height ratio, the transverse velocity near the walls decreases and the maximum transverse velocity increases. The values of the friction factor for the cases considered have been calculated. The Strouhal number has also been evaluated.

2008/NIT/IITK/41

ONLINE MONITORING OF SURFACE ROUGHNESS DURING GRINDING USING ACOUSTIC EMISSION

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Process automation is very crucial because it helps in batch production, reduces the gap between design and production time, reduces production cost and also ensures superior product quality. The success of manufacturing process automation hinges primarily on the effectiveness of the process monitoring and control systems. Process monitoring is the measurement and estimation of a process using various

sensing techniques. There are several process monitoring techniques available such as using force, temperature and acoustic emission. But acoustic emission is regarded as one of the most effective process monitoring techniques because it provides good fault detection and is relatively noise free. One of the most important attributes of a machined work piece is surface texture. Several parameters are used to characterize surface texture such as defects and flaws, directionality, surface roughness, waviness etc. Surface roughness is the most widely used parameter to describe surface texture due to its direct influence on friction, fatigue, electrical and thermal contact resistance and appearance. Grinding is a process used to improve surface finish, abrade hard materials, and tighten the tolerance on flat and cylindrical surfaces by removing a small amount of material. This project aims to study the application of acoustic emission as an on-line surface roughness-monitoring tool and to understand the relation between surface roughness and acoustic emission in grinding.

2008/NIT/IITK/42

DC Motor Speed Control Methods, Including A feedback Control System, For DC Motor Drives using MATLAB

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In this report, simulation models for the d.c. motor speed control methods have been presented. In addition, a proportion-integral controller has been proposed for control of a d.c. drive system. The mode of communication is obtained through a frequency modulation technique. The proposed scheme has been designed for a typical industrial environment. The anticipated signal-to-noise ratio (SNR) is high. Therefore, a drive is required to track noisy reference signals, which demand alternative forms of control methods immune to noise as well as to plant parameter variations. Generally, the state-of-the-art techniques for the design of a controller make the response of a controller independent of the system parameter variations. The main objective of the controller is to minimise the error between actual and desired output parameters. To meet these specifications, a PI controller is employed. Gain parameters of the controller are tuned to their optimum values with the help of computer simulations. A personal computer is used for supervisory control and data acquisition (SCADA). Especially designed FM transmitter and receiver circuits are employed to obtain a reference speed signal for the drive system from a remote point of the laboratory. The results obtained by the controller have been compared, under the loading conditions, by giving step variations in the reference speed. The results establish the validity and accurate performance of the proposed controller.

2008/NIT/IITK/43

Micro fabrication of a pH Meter

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The aim of the project is to fabricate a 2D pH meter on a chip, which overcomes many of the limitations that arise from other pH meters. The work basically deals with the design of the components to be used in the pH meter, in particular, it concentrated on the membrane used to separate the two wells on the chip. It focused on the flow of ions through membranes in general so as to develop an understanding of the expected functions of the glass membrane used. Also, an analysis of the flow of ions through the micro-channels made in the membrane, based on the pore size and on the sizes of the hydrated ions that pass through was carried out. The differences in the diffusion coefficients of the ions within the pore and in the bulk solution and the rejection ratios of the ions have been mathematically simulated and obtained.

2008/CALTECH/IITK/44

A Probabilistic Approach to the Random Matching Problem

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In 2008, Johan Wastlund, in, examined a problem involving a complete graph with n=2k vertices. In this complete graph of 2k vertices, the edges are each assigned independent and identically exponentially distributed costs with rate 1. He provided a particular set of bounds on the minimal total cost C of a k-matching in the graph, where a k-matching in a graph is a set of k edges such that any two edges in the graph have no common vertices. In particular, he showed that E(C) was bounded by π^2/12 and π^2/12 + log n/n, thus proving that as n approaches infinity, E(C) approaches π^2/12. In this paper, we analyze the limiting behavior (as n tends to infinity) of the expected value of the minimum cost of a k-matching in a complete graph with n=2k vertices using a probabilistic approach, rather than the graph theoretical approach that Wastlund uses. In particular, we will make use of the probability density function of the cost and then explicitly use the definition of the expected value to arrive at an expression for E(C). Then, using a series of inequalities, we will arrive at a lower bound for E(C). It may thus be possible to derive tighter bounds for E(C) using this purely probabilistic approach.

2008/ECP/IITK/45
Searching with semantics
Pierre Amstutz, Ecole Centrale Paris, France
Mentor: *T. V. Prabhakar, Department of Computer Science and Engineering*

Semantic web is a new trend in web technologies that focus on data. It aims at allowing a better exchange of data by modelising the relations that exist between the concepts, classes and properties involved. Such a description constitutes an ontology. Much of the problem lies in modelising the data and being able to query it. This project was split into two parts. We first built a website to gather knowledge about algorithms, using a classic client-server-database architecture and the Model- View-Controller pattern. This website allows users to add, edit or search an algorithm in the database. The search function remained very basic, simply relying on SQL search capacity. Then, we tried to enhance the search by implementing a semantic search. In order to do so, we had to build an ontology representing the knowledge concerning algorithms and use a java framework (jena) to manipulate this representation through server side applications.

2008/ECP/IITK/46
Studying the influence of drying time and chlorobenzene's vaporization temperature on the performances of a P3HT: PCBM based Solar Cell
Quentin de Chabot, Ecole Centrale Paris, France
Mentor: *S. S. K. Iyer, Department of Electrical Engineering*

As other renewable energies, solar cells too have advantages and disadvantages. Organic solar cells can potentially provide a low cost renewable energy thanks to the materials involved in their fabrication process. Furthermore, the organic solar cells' flexible fabrication process allows us to believe that improvements on the efficiency of these devices are to come. The organic solar cell studied is a P3HT (poly (3.hexylthiopene-2, 5-diyl)) -PCBM ([6, 6]- phenyl-C61-buytric acid methyl ester) based blend solar cell. The solvent used for the active layer coating is chlorobenzene. The thickness of the active layer is 140nm. The goal of this project was to understand the influence of time and temperature applied for the active layer drying, on the solar cell performances. For each experiment we made one substrate for an AFM to observe the effects of vaporization time and temperature on the active layer's morphology. We also made devices to see the impact on efficiency. The Drying time dependence study showed that an optimized value for chlorobenzene was around 60 min. Drying temperature dependence showed increased performances for high temperatures.

2008/IITK/CALTECH/1
Renormalization Group Approach to solving 1D Random SU(2)5 Anyon chains
Paraj Titum, Physics, Indian Institute of Technology Kanpur, India
Mentor: *Gil Refael, California Institute of Technology*

Renormalization group as a technique for solving random 1-D interacting Hamiltonians have been used for quite some time now, most notably for random spin chains. Random singlet phases have been predicted for the random spin-1/2 chains using the Ma-Dasgupta renormalization procedure. Anyons, particles with non-trivial braiding rules and many more exotic properties, can have similar phases. Interactions between anyons can be described using fusion rules. As it turns out, the Hamiltonian has a lot of similarities to the interacting spin Hamiltonian. We have chosen a model of anyons given by the Chern-Simons theory. The simplest non-abelian model is the SU(2)3 anyon chain, also known as the Fibonacci chain. On doing a renormalization to a Fibonacci chain, random singlet phases and infinite randomness fixed points have been observed. We sought to generalize the method to a higher level anyon chain namely the SU(2)5 chain. In this project we defined the various RG rules that originate from the more complicated Hamiltonian.

2008/IITK/CALTECH/2
Asteroid detection in the DR1 region of the Palomar Quest Sky Survey
Saurabh Chatterjee, Computer Science and Engineering, Indian Institute of Technology Kanpur, India
Mentor: *George Djorgovski*
Co-Mentor: *Ashish Mahabal, California Institute of Technology*

Asteroid detection is important because it enables detection of 'killer asteroids' that have a chance of hitting Earth, and for potential targets in space exploration and mining. Astronomically, it also helps to distinguish transients (ie. changing objects) from asteroids. The Palomar Quest is a large digital synoptic sky survey done at the Palomar observatory, started in 2003. The first data to be released from this sky survey is called the DR1 (data release 1) area. This project attempts to use the Palomar Quest data to detect asteroids in the DR1 region and compute their orbits. The detection is based on the fact that asteroids move with respect to the celestial frame (like planets) whereas stars and other deep sky objects do not. Asteroids move with in an approximately linear motion (for short observations) and are thus detected as tracks, which are then matched to asteroids already known. The tracks are filtered to check if they really correspond to orbital motion, and if they do then their orbital elements are computed.

2008/IITK/CALTECH/3
Studying Entropic Vectors
Subhonmesh Bose, Electrical Engineering, Indian Institute of Technology Kanpur, India
Mentor: *Babak Hassibi, California Institute of Technology*

In Network Information Theory the problem of solving for the network capacity analogous to peer-to-peer channel capacity is still an open problem. Through optimization reduces to characterizing the space of entropy vectors Γ_n^*. A characterization of this space through finite groups is already known. We have generalized the characterization to infinite and particularly measurable groups for the case of continuous groups. Using measure theoretic concepts we prove that the ratio of measures of groups to measures of subgroups of measurable groups with the respective measures being defined suitably yields continuous entropy vectors. Using simulations on the space of unitary matrices we arrive at a particular example of a group and suitable subgroups to violate the Ingleton bound for a continuous entropic vector, which is by far the tightest inner bound known to the space of entropic vectors. We also prove that the space of continuous entropic vectors Λ_n^* is a convex cone and formally derive

2008/IITK/ECP/4

A mutual information and entropy based approach to feature selection and Image clustering

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Mentor: *Nikos Paragios, Ecole Centrale, Pari,s France*

In this paper, we present a fully unsupervised approach to image clustering and segmentation. We consider an image or a patch to be represented by a set of features. Each of these features has a certain distribution across the sample space of all images/patches. We consider statistical as well as non-statistical distance metrics like Kullback-Leibler, Jenson-Renyi to compare the distribution of diferent features. This gives a measure of the mutual information content between diferent features. The distance so obtained is used to cluster features with the cluster centers being the features which most distinguish the sample space. This is measured using the Shannon entropy. Once a representative reduced feature set has been constructed a suitable distance metric is used to arrive at a measure of similarity between diferent images/patches and consequently to cluster the images/patches using a Primal Dual algorithm. The approach is being tested on image features extracted using the K-SVD algorithm to do an image clustering and segmentation and some results for the same are presented.

2008/IITK/ECP/5

Soil-Structure Interaction Analysis in time Domain

Kapil Mathur, Civil Engineering, Indian Institute of Technology Kanpur, India
Mentor: *Didier Clouteau, Ecole Centrale Paris, France*

Foundation impedance functions provide a simple means to account for soil–structure interaction (SSI) when studying the seismic response of structures. Impedance functions represent the dynamic stiffness of the soil media surrounding the foundation. The fact that impedance functions are frequency dependent makes it difficult to incorporate SSI in a standard time-domain analysis. When the structure is linear the equations for the structure-soil system are most conveniently solved in the frequency domain, where the frequency dependency of the impedance coefficients can be readily considered. It is well known, however, that buildings are typically designed in such a way that significant inelastic behaviour can be anticipated in the event of severe ground motion. Thus, there is a need to incorporate this non-linear behaviour, which can be done in the time-domain analysis. Methods that combine frequency and time domain techniques offer an attractive alternative for solving SSI problems where the structure exhibits non-linear behaviour. One such computational technique, known as the hybrid-frequency-time-domain approach, has been investigated in this study. Besides the basic mathematical formulation, examples of applications to simple structural systems have been discussed as well. Issues related to stability of the responses have been also addressed.

2008/IITK/EP/6

Bounds on the leakage of the input's distribution in information-hiding protocols

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Mentor: *Catuscia Palamides, Ecole Polytechnique, France*

In information-hiding, an adversary that tries to infer the secret information has a higher probability of success if it knows the distribution on the secrets. We show that if the system leaks probabilistically some information about the secrets, namely there is a probabilistic correlation between the secrets and some observables, then the adversary can approximate such distribution by repeating the observations. More precisely, it can approximate the distribution on the observables by computing their frequencies, and then derive the distribution on the secrets by using the the correlation in the inverse direction. We illustrate this method, and then we study the bounds on the approximation error as- sociated with it, for various natural notions of error. As a case study, we apply our results to Crowds, a protocol for anonymous communication.

2008/IITK/EP/7

Perturbative Renormalization of the phi-fourth interaction in 2 and 3 dimensions and that of polynomial field interaction in 2 dimensions

Ananda Roy, Physics, Indian Institute of Technology Kanpur, India
Mentor: *Christoph Kopper, Centre of Theoretical Physics (CPHT), Ecole Polytechnique, France*

Initially, the Renormalization Group technique was introduced by Wilson to prove perturbative renormalizability of diferent models(eg: spin models of Statistical Mechanics) in two dimensions. It was Polchinski who first extended it to the realm of perturbative renormalization techniques and gave a proof of renormalizability of the Á4 4 interaction. Ever since then, the method has found tremendous applications in the a variety of fields like Supersymmetry, QED, spontaneously broken Yang-Mills theory, etc. In this project, perturbative renormalizability of the quantum field theory based on Wilson's diferential renormalization group equation to perturbative theory is carried out for the phi-fourth interaction in 2 and 3 dimensions and also for the polynomial field interaction in 2 dimensions. The best possible bounds are obtained for the respective cases, and also the dependence on external momenta in the bounds have been worked out.

2008/IITK/EP/8

Construction of a Kelvin Probe and using it to observe the changes in TCO workfunctions under different treatments and conditions

Rohan Nag, Electrical Engineering, Indian Institute of Technology Kanpur, India
Mentor: *Pere Roca i Cabarrocas, Ecole Polytechnique, France*

On reading the title of the project, one may feel inclined to ask "Yeah, so you are measuring the workfunction changes in TCOs (Transparent Conducting Oxides) , but so what?". Well the primary intention behind doing so is in a few words, to verify a method by which we can improve the efficiency of a solar cell (of which a TCO layer is an irreplaceable part). The TCO is as important as it is because it offers a rare combination of physical properties : good optical as well as electrical conductivity both of which are of prime importance in the making of an efficient solar cell. So, by observing the changes in TCO workfunctions as a result of different treatments, we aim to create the best possible work-function profile that optimizes both the mentioned afore properties. As is obvious, since most of this work is firmly connected to the field of solar cells, we would not be going out of our way if we cover something of that field in this introduction. Solar energy is essential for the survival of our species, it is the only source of energy exterior to the earth, and if someday this supply of energy ceases so shall humanity along with it. On the contrary, other sources of energy such as fossil and nuclear energy have limited reserves and are not replenished over time, as such their amounts decrease regularly. Their reserves are most probably still considerable, but the actual amount is difficult to estimate. Even if the exhaustion of petroleum deposits in the near future is dubious, nuclear and fossil sources of energy have on the other hand some very blatant disadvantages. The by-products associated with the production of these forms of energy have a severely negative impact on the earth' ecosystem, to be more specific carbon di-oxide from fossil energy and radioactive products from nuclear energy (which even today we do not know how to reprocess). Moreover the price of these energies as a result of the ever increasing demand also never ceases increasing. These inconveniences posed by the most prevalent forms of energy, have resulted in the president of the United States declaring in the February of 2006, that his country will reduce its imports of petroleum by 75% by the year 2025. This declaration also stated that as a result they will also concentrate on other forms of energy previously considered to be too expensive or not to be worth the effort, such as photovoltaic (solar), and try to develop the basic technology for the production of these forms of energy. Indeed if petroleum is expensive it is only because of the growing demand; however, the new forms of energy such as solar, are expensive because the production technology in those fields is not developed enough to be able to cope with the demand. For example, in the production of Solar energy we need high quality material for the electronics , however the methods of purification are not yet properly developed, which as a result cuts down the efficiency of solar cells. Electricity nowadays is an irreplaceable form of energy for our societies. It represents about 40% of the total energy consumption in the world, that is to

say around 15.45*10^(12) kWh in 2003. Coal is the main mode of production accounting for about 39% of the total production with hydroelectric, nuclear and gas each accounting for about 17%. In France (where this project was undertaken) the partition of energy production most certainly does not reflect the trends in total world production, with nuclear being the main mode of production, accounting for about 79% of the total production, hydroelectric and fossil account for about 10.2% and 11.2% respectively. Wind and solar energy each represent about 0.2% of the total production. The current environmental situation, the comfort of energy independence, the increasing importance of electrical energy, and the dead end in the reprocessing of radioactive by products , are some of the many decisive factors why we should concentrate on the production of cleaner forms of energy, which will also lead to diversification and better consumption control of electrical energy. Thus, we are now interested in the production of energy by solar cells, and more particularly in the type of cells containing an heterojunction of amorphous silicon/ crystalline silicon. This is a new type of cell fabricated by Sanyo, which made its appearance in the year 2002, with a record output on a large surface : 21.5% on 100 cm^(2) in the laboratory and 18.6 % in production. There will be a brief description on the operation of such a cell in the thesis report as well as on the methods of characterization which we have used, especially the Kelvin Probe. The assembly, operation and the measurements of the Kelvin Probe in particular will be described in detail.

Achievements

The SURGE Programme has proved to be a highly interesting and stimulating event for all participants. It has given a platform to students for their innovative ideas and has also given space for the implementation of the same. It has thus given them a direction towards a possible career in research. By the time this report went to press, we got three emails from students reporting their work based on SURGE 2008, which were presented at international and national conferences. The details sent to us are given below.

A Research Paper entitled “Effectiveness of FRP Composites for Flexural trengthening Uninforced Masonry Walls” by K. K. Bajpai (Mentor) and Amarendra, student from MNNIT Allahabad was accepted for proceedings of the 8th International Seminar on Structural Masonry (ISSM-08), held at Istanbul in November 2008.

The Abstract of a Project titled “Synthesis and Characterization of Carbon Nanotube formed from Leather Industrial Waste” by Sabyasachi Sarkar (Mentor) and Jagdeep Singh, student from NIT Jalandhar was accepted for the international conference at IIT Madras.

A Research Paper entitled “Synthesis and Characterization of Water Soluble Carbon Nanotube (CNTs) from Industrial Waste” by Sabyasachi Sarkar (Mentor) and Ajay Singh, student from NIT Jalandhar was selected for oral and poster presentation in two international conference.

1) AsiaNANO 2008 in Singapore. (Oral presentation)
2) FM 2008 in IIT Madras. (Poster presentation)

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The entire DRPG team played a vital role in the implementation of this task.

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