



# **SURGE**

**Summer Undergraduate Research Grant for  
Excellence**

**Annual Report 2007**



---

Office of Dean, Resource Planning & Generation  
Indian Institute of Technology Kanpur  
Kanpur 208016  
December 2007

## Executive Summary

To develop the agenda of undergraduate research and promote a culture of research and interdisciplinary education amongst 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 California Institute of Technology (Caltech), a pioneer in undergraduate research.

The Summer Undergraduate Research Grant for Excellence (SURGE) programme of IIT Kanpur holds 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 class-room and real world, and leads to 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.*

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, the 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 the students start work in the summer so as to have an effective lead time. The Office of Dean, Resource Planning and Generation at IITK facilitates the coordination and infrastructure.

The programme is being received very well by students and mentors both. 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, favourable number of these young minds show 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".

Based on success of the programme, the number of students was substantially increased to 59 in the summer of 2007 as compared to 27 in summer of 2006. In addition to the ongoing exchange with Caltech, Ecole Centrale Paris too joined in the programme this year. This report summarises the work carried out by the 59 undergraduate students and the overall assessment of the programme.

## Acknowledgements

The support and participation of the following is gratefully acknowledged:

- Generous donors who made contributions to support the programme.
- Ms. Carolyn Ash (Quondam Director) and Ms. Rypisi Candace (Director), Student-Faculty Programmes, Caltech (USA), for providing guidance to the Institute in developing an undergraduate research programme at IIT Kanpur
- Professor Pierre Becker of Ecole Centrale Paris for his enthusiasm and participation in developing the relationship with Ecole Centrale Paris
- 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.
- Dr. Sharad Tripathi (BT/AE/1969) and Mr. Anoop Tandon (both based in Paris) for their support towards building relationship with Ecole Centrale Paris.
- Members of the Advisory Committee, Implementation Committee, and numerous other faculty members who helped in the programme.
- Professor S. Sundar Kumar Iyer and Dr. Vibha Tripathi for coordinating the SURGE Programme, and Ms. Anamika Dixit Vajpai for preparation of this report.
- The staff of the Office of Dean, Resource Planning and Generation for support and assistance.
- The faculty mentors at IIT Kanpur and the SURGE students for their enthusiastic participation.

# Table of Contents

	<i>page</i>
<i>Executive Summary</i>	i
<i>Acknowledgements</i>	ii
<i>Table of Contents</i>	iii
<i>List of Tables</i>	iv
<b>1. Introduction</b>	<b>1</b>
<b>2. Inception of SURGE Programme</b>	<b>1</b>
<b>3. The SURGE Programme</b>	<b>2</b>
<b>4. SURGE 2007 Programme</b>	<b>3</b>
<b>5. Feedback of Mentors and Students of 2007 SURGE Programme</b>	<b>4</b>
5.1 Mentor Feedback	4
5.2 Student Feedback	4
<b>Appendices</b>	
Appendix A: <b>Abstracts:</b> 2007 SURGE Research Projects Done at IIT Kanpur	<b>11-29</b>
Appendix B: <b>Abstracts:</b> 2007 SURGE Research Projects Done in Overseas Universities	<b>30-31</b>

## List of Tables

<b>Table</b>	<b>Title</b>	<b><i>page</i></b>
1	Participants in SURGE 2007 at IIT Kanpur	<b>5-7</b>
2	IIT Kanpur Students in SURGE 2007 at Overseas Universities	<b>8</b>
3	Quantitative Responses in Mentor Feedback to Summer 2007 SURGE Programme	<b>9</b>
4	Quantitative Responses in Student Feedback to Summer 2007 SURGE Programme	<b>10</b>

# 1. Introduction

Summer Undergraduate Research Grant for Excellence (SURGE) programme at IIT Kanpur presents opportunities for undergraduate students to do research under the mentorship of senior researchers at the frontiers of engineering and science. Undergraduate research fosters collegiality and welcomes students into the community of researchers and scholars. It promotes self-discovery, helps to bridge the gap between classroom and real world, and leads to social, professional and educational development of the student.

IIT Kanpur launched this 10-week programme entitled Summer Undergraduate Research Grant for Excellence (SURGE) in summer 2006. The programme aims to promote a culture of research amongst undergraduate students of not just IIT Kanpur but also at select other 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](http://www.surf.caltech.edu)). In its second year, SURGE was expanded to cover a much larger number of students, and has now included an exchange arrangement with Ecole Centrale Paris.

## 2. Inception of SURGE Programme

The concept of 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 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 fall 2005, the concept of SURGE was debated and finalized at IIT Kanpur. Applications were invited from students of IIT Kanpur desirous of participating in Caltech's 2006 SURF Programme. A rigorous procedure of selection was put in place. The applications from students of all 17 National Institutes of Technology in the country and 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, 11 students from different NITs across the country participated in the programme. 3 students from Caltech joined for 10-week summer research at IIT Kanpur and 3 IIT Kanpur students went to Caltech.

All the students benefited greatly from the experience and learned not only science but also interpersonal skills (please see 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 viewed 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 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 additional Rs.10,000 Award plus a commendation certificate will be given to those SURGE students who produce exceptional quality research during the 10 weeks.

All 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 to be sought from the aspiring students in their applications are given on the SURGE website ([www.iitk.ac.in/surge](http://www.iitk.ac.in/surge)). As the SURGE programme involves students from different categories of universities, the selection procedure differs slightly for all.

- 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 further short-listed students are 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 proposal 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 submit an application along with the research proposal. Short-listed students are called for 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 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 student's interest and interviews. The applications and areas of interest of the selected students are received at SURGE office, which then matches appropriate mentors and invites the international students to correspond 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 and feedback of student experiences.

Care is taken to ensure that SURGE focuses not only on "research" but also on 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, these 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 2007 Programme**

In the 2007 SURGE Programme, as many as 59 undergraduate students (18 from IIT Kanpur, 29 from National Institutes of Technology across India, 5 from Ecole Centrale Paris and 2 from Caltech), who completed II/III year of undergraduate programme of any branch of engineering and sciences, were chosen based on a very competitive search for their strong academic background and aptitude to do high quality research. These young researchers spent 10-weeks of their summer vacation at IIT Kanpur to do research at the frontiers of engineering and science under the mentorship of IIT Kanpur faculty members. Further, in the 2007 SURGE Programme, 3 IIT Kanpur students participated in a 10-week research at Caltech and 2 students did likewise at Ecole Centrale 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 its history in several visits planned and executed by the students themselves. The students also took a tour of Agra, a neighboring historical city that houses well renowned TajMahal. There were a variety of extra-curricular activities during evenings. In particular, all the faculty members and students got together every Wednesday evening for "happy hour". In

fact, the mentors joined them for non –academic programmes as well. This teacher-student interaction is rated as one of the high-points of the SURGE Programme.

Abstracts of the research undertaken by the students during 2007 SURGE Programme are given in Appendices A and B, 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 the student 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 thankful 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 enough for them to taste the flavor of research.
- (c) A number of students felt that mid-term report was done when they were still inadequately prepared. They suggested that mid-term report might be replaced by informal discussions.

**Table 1: Participants in SURGE 2007 at IIT Kanpur**

Sl. No.	Name of the Institute	Name	Project	Mentors
1.	From Caltech	Chaitanya Rastogi <i>B.Tech./BEM/APh/II Yr</i>	Instability of Thin Bilayers on Physically Patterned Surfaces	Ashutosh Sharma <i>Chemical Engineering</i>
2.		Chan Nathan W <i>B.Tech./ESE/Environmental Engineering/IV Yr</i>	The Effects of Thermophoresis and Electrostatic Charge Drifting	Tarun Gupta <i>Civil Engineering</i>
3.	From Ecole Centrale Paris	Yvonnick Banchieri <i>Masters Degree (ECP Engineer Diplome) /Applied Mathematics/V Yr</i>	Proper Orthogonal Decomposition	Sanjay Mittal <i>Aerospace Engineering</i>
4.		Thomas Chasseneiux <i>Masters Degree (ECP Engineer Diplome) /Applied Mathematics/V Yr</i>	Proper Orthogonal Decomposition	Sanjay Mittal <i>Aerospace Engineering</i>
5.		Damien Dreano <i>Masters Degree (Intg.)/Civil Engineering/II Yr</i>	Air Pollution Studies	Mukesh Sharma <i>Civil Engineering</i>
6.		Guillaume Cardon <i>Masters Degree/Process Engineering /III Yr</i>	Influence of Solution Filtration on Organic Solar Cell Efficiency	S. Sundar Kumar Iyer <i>Electrical Engineering</i>
7.		Alba Jimenez <i>Bachelors Degree/Industrial Engineering/V Yr</i>	Role of Fat in Wingless Gradient Formatio Im Wimg Imaginal Disc of Drosophila Melanogaster	Pradip Sinha <i>Biological Science &amp; Bio-Engineering</i>
8.	From Different NITs	Abhipsa Mahapatra <i>B.Tech./CHM/III Yr, NIT, Rourkela</i>	Synthesis and Characterization of Novel Coordination Polymers of Iron Porphyrin Incorporating Several Azo Ligands as Linkers	S. P. Rath <i>Chemistry</i>
9.		Preet Joseph Joy <i>B.Tech./CHE/III Yr, NIT, Surathkal</i>	Cumene Synthesis by Reactive Distillation	Nitin Kaistha <i>Chemical Engineering</i>
10.		P. Sai Ravindra <i>B.Tech./CHE/III Yr, NIT, Warangal</i>	Cumene Synthesis by Reactive Distillation	Nitin Kaistha <i>Chemical Engineering</i>
11.		Deepti Ballal <i>B.Tech./CHE/III Yr, NIT, Surathkal</i>	Hot Water Freezing Before Cold Water	V. Shankar <i>Chemical Engineering</i>
12.		Vinayak Rakshith R. <i>B.Tech./CHE/III Yr, NIT, Surathkal</i>	Mixing in Microchannels	Animangsu Ghatak <i>Chemical Engineering</i>
13.		Karan Chouksey <i>B.Tech./CE/III Yr, NIT, Durgapur</i>	Mathematical Modeling of One-Dimensional Sediment Flow	Pranab Mohapatra <i>Civil Engineering</i>
14.		Tankala Chandan <i>B.Tech./CE/II Yr, NIT, Kurukshetra</i>	Modeling of Seawater Intrusion in Coastal Aquifer	Bithin Dutta <i>Civil Engineering</i>
15.		Ramya Mohan <i>B.Tech./CE/III Yr, NIT, Thiruchirapalli</i>	Contaminant Transport Modeling of Groundwater Aquifers due to Hydrocarbons and Design of Optimal Monitoring Network	Bithin Dutta <i>Civil Engineering</i>
16.		Spriha Shankar <i>B.Tech./CE/III Yr, NIT, Durgapur</i>	Frequency Analysis in Pipes	Pranab Mohapatra <i>Civil Engineering</i>
17.		R. Ananda Padmanabhan <i>B.Tech./CE/III Yr, NIT, Thiruchirapalli</i>	Chromium (VI) Migration Through Ground Water and Remediation	Rajesh Srivastava and Purnendu Bose <i>Civil Engineering</i>

18.	Anshul Agarwal <i>B.Tech./CE/III Yr, Motilal Nehru NIT, Allahabad</i>	Strengthening of Masonry Walls using FRP (Fibre Reinforced Polymers): An Experimental Study	K. K. Bajpai <i>Civil Engineering</i>
19.	Puneet Nagrani <i>B.Tech./CE/III Yr, NIT, Warangal</i>	Repair and Strengthening of Cracked Reinforced Concrete Beams	K. K. Bajpai <i>Civil Engineering</i>
20.	Susmit Kumar Deb. <i>B.Tech./MME/III Yr, NIT, Rourkela</i>	Tribology of Pure Cold Rolled Titanium in Cryogenic Conditions	Bikramjit Basu <i>Material &amp; Metallurgical Engineering</i>
21.	Sidharth Rai <i>B.Tech./CSE/III Yr, Dr. B. R. Ambedkar NIT, Jalandhar</i>	Development of Parallelizing Compiler for C	Sanjeev K. Aggarwal <i>Computer Science &amp; Engineering</i>
22.	Saumye Rastogi <i>B.Tech./CSE/III Yr, NIT, Allahabad</i>	Intelligent Railway Information System	Dheeraj Sanghi <i>Computer Science &amp; Engineering</i>
23.	Susmita Dash <i>B.Tech./ME/III Yr, NIT, Rourkela</i>	Study of Possibility of Flow-Control by Small Periodic Perturbations on a Circular Cylinder	K. Murlidhar <i>Mechanical Engineering</i>
24.	R. Girish Kumar <i>B.Tech./ME/III Yr, NIT, Thiruchirapalli</i>	Modeling of Fluid Flow Past a Square Cylinder and Extension of the Model for Prediction of Heat Transfer in Electronic Equipments	S. Sarkar <i>Mechanical Engineering</i>
25.	Abhishek Haritwal <i>B.Tech./PE/III Yr, NIT, Thiruchirapalli</i>	A Novel Nanofinishing Process for Ultra High Speed Shafts	J. Ramkumar <i>Mechanical Engineering</i>
26.	Nilanjan Sen <i>B.Tech./ME/III Yr, NIT, Rourkela</i>	Numerical Simulation of Laminar Flow and Heat Transfer Downstream of a Backward Facing Step in a Channel	P. S. Ghoshdastidar <i>Mechanical Engineering</i>
27.	Bhaskar Mazumdar <i>B.Tech./ME/III Yr, Motilal Nehru NIT, Allahabad</i>	Performance, Emission and Combustion Characteristics of Biodiesel (Waste Cooking Oil Methyl Ester) Fuelled Indirect Injection Diesel Engine	Avinash Kumar Agarwal <i>Mechanical Engineering</i>
28.	Raghavendra Ranganathan <i>B.Tech./ME/III Yr, NIT, Warangal</i>	Rotational Abrasive Flow Machining	J. RamKumar <i>Mechanical Engineering</i>
29.	Avinash Chopde <i>B.Tech./ME/III Yr, Visvesvaraya NIT, Nagpur</i>	Hydrodynamic Characteristics of Single-Phase Flow Through Mini/Micro-Channels	Sameer Khandekar <i>Mechanical Engineering</i>
30.	Savirigana Venkata Rajesh Kumar <i>B.Tech./EE/III Yr, NIT, Durgapur</i>	Design of Fixed-Point DSP Based Universal Control Platform for Education and Research in Power Electronic System	P. S. Sensarma <i>Electrical Engineering</i>
31.	Binod Prasad Koirala <i>B.Tech./EE/III Yr, Malviya NIT, Jaipur</i>	Modeling of Solar Cell/Panel in MATLAB and Maximum Power Point Tracking	P. S. Sensarma <i>Electrical Engineering</i>
32.	Reena Panda <i>B.Tech./EE/III Yr, NIT, Rourkela</i>	Age and Gender Classification From Speech	S. Umesh <i>Electrical Engineering</i>
33.	Ajay S. <i>B.Tech./ECE/III Yr, NIT, Surathkal</i>	Adaptive Active Noise Control	L. Behera <i>Electrical Engineering</i>
34.	Pradeep Kumar Sahoo <i>B.Tech./EIE/III Yr, NIT, Rourkela</i>	GSM Based Communication and Its Applications	L. Behera <i>Electrical Engineering</i>
35.	Saurabh Chandra <i>B.Tech./ECE/III Yr, NIT, Allahabad</i>	Effect of Encapsulation on Stability and Performance of P3HT-PCBM Based Organic Solar Cell	S. Sundar Kumar Iyer <i>Electrical Engineering</i>
36.	Shalini Dubey <i>B.Tech./EEE/III Yr, NIT, Thiruchirapalli</i>	Comparative Study of The Effect of Solvents in The Making of P3HT: PCBM Blend Films for Organic Solar Cells	S. Sundar Kumar Iyer <i>Electrical Engineering</i>

37.	From IIT Kanpur	Rohan Nag <i>B.Tech./EE/II Yr</i>	Optimization of The Design of a Grating Assisted Lateral Directional Coupler Based on Impurity Induced Quantum Well Intermixing of InGaAs/GaAs	Utpal Das <i>Electrical Engineering</i>
38.		Kunal Singal <i>B.Tech./EE/II Yr</i>	Effect of Surface Treatment of ITO and Thickness of Heterojunction Layer on Efficiency of CuPC/C60 Based Organic Solar Cells	Satyendra Kumar <i>Physics</i> S. Sundar Kumar Iyer <i>Electrical Engineering</i>
39.		Abhishek Sharma <i>B.Tech./EE/II Yr</i>	Remote Pointer Control Through Visual Servoing	K. S. Venkatesh <i>Electrical Engineering</i>
40.		Abhinav Dubey <i>B.Tech./BSBE/II Yr</i>	Evolutionary Relationship Among Pro-Apoptotic and Anti-Apoptotic Bcl-2 Family of Proteins.	R. Sankararamakrishnan <i>Biological Science &amp; Biological Engineering</i>
41.		Vivek Bansal <i>B.Tech./BSBE/II Yr</i>	Identification of Aquaporins in Microbial Genomes	R. Sankararamakrishnan <i>Biological Science &amp; Biological Engineering</i>
42.		Kritika Bhargava <i>B.Tech./BSBE/II Yr</i>	Analysis of Fluid Flow in Stomach-A Numerical Approach	Anupam Pal <i>Biological Science &amp; Biological Engineering</i>
43.		Unnati Gupta <i>B.Tech./BSBE/II Yr</i>	Imaging the Early Cellular Properties of Tumor Mutant Cells in Drosophila Model Using Genetic Mosaic Techniques	Pradip Sinha <i>Biological Science &amp; Biological Engineering</i>
44.		Prateek Goel <i>M.Sc.(Intg.)/CHM/II Yr</i>	Protein Cavities According to Wavelets	Pinaki Gupta Bhaya <i>Chemistry</i>
45.		Anurag Gupta <i>B.Tech./MME/II Yr</i>	Synthesis of Iron- Cementite Nano-Composites by Hot Pressing Technique	Sandeep Sangal <i>Material and Metallurgical Engineering</i>
46.		Saurabh Agarwal <i>M.Sc.(Intg.)/PHY/II Yr</i>	Searching for The Signs of Large Scale Anisotropy Showing Redshift Dependence	Pankaj Jain <i>Physics</i>
47.		Manali Singh <i>M.Tech.(Dual)/CE/II Yr</i>	Measurement of Dynamic Properties of Compacted Soil Specimens in Proctor Mould.	Amit Prashant <i>Civil Engineering</i>
48.		Kapil Mathur <i>B.Tech./CE/II Yr</i>	Characterization of FRP Bars for Use in Civil Infrastructure	K. K. Bajpai and Sudhir Mishra <i>Civil Engineering</i>
49.		Prateek Bhargava <i>B.Tech./ME/II Yr</i>	Instability and Transition in Rayleigh-Benard Convection	Gautam Biswas <i>Mechanical Engineering</i>
50.		Ashank Mittal <i>B.Tech./ME/II Yr</i>	Study of Heat Transfer Characteristics in Quenching of Metal in Nanofluids	Sameer Khandekar and Y. M. Joshi <i>Mechanical Engineering</i>
51.		Katta Naga Praveen Kumar <i>B.Tech./CSE/II Yr</i>	Proposal for the augmentation of Globus Middleware Toolkit(GT4) to enable Business Process Outsourcing	R. K. Gosh <i>Computer Science and Engineering</i>
52.		Ankit Sinha <i>B.Tech./CHE/II Yr</i>	Thermophysical Properties of n-alkanes Confined in Nanoporous Materials	J. K. Singh and Anil Kumar <i>Chemical Engineering</i>
53.		Diviya Sinha <i>B.Tech./CHE/II Yr</i>	Stress-Time Superposition in a Model Soft Material (Toothpaste)	Y. M. Joshi <i>Chemical Engineering</i>
54.		Lava Agarwal <i>M.Tech.(Dual)/CHE/II Yr</i>	Designing a Plant-Wide Control Structure for Butane Isomerization Process	Nitin Kaistha and Siddhartha Panda <i>Chemical Engineering</i>

**Table 2: IIT Kanpur Students in SURGE 2007 at Overseas Universities**

Sl. No.	Name of the Institute	Name	Project	Mentors
1.	At Caltech	Sidhant Mishra <i>B.Tech./EE/III Yr</i>	Compressed Sensing for DNA Microarrays	Babak Hassibi <i>Associate Professor of Electrical Engineering</i>
2.		Nerella Tejaswi Venu Madhav <i>M.Sc. (Intg)/PHY/III Yr</i>	Waveplate Modeling Using the 4x4 Matrix Technique	Andrew Lange <i>Goldberger Professor of Physics</i>
3.		Piyush Srivastava <i>B.Tech./CSE/II Yr</i>	Average Case Complexity Theory	Chris Umans <i>Assistant Professor of Computer Science</i> Leonard Schulman <i>Professor of Computer Science</i>
4.	At Ecole Centrale Paris	Vikas Kumar Sharma <i>B.Tech./EE/III Yr</i>	Hardware Implementation of Fuzzy Logic Using VHDL	Laurent Cabaret <i>Professor &amp; Head, LISA: Electrical and Computer Engineering Laboratory</i> Celine Hudelot <i>Professor, LISA: Electrical and Computer Engineering Laboratory</i>
5.		Tapish Agarwal <i>B.Tech./AE/III Yr</i>	Post Treatment of PIV experiments	Sebastien Ducruix <i>Responsible for Research, Laboratoire EM2C</i> Severine Barbosa <i>Doctorate Student, Laboratoire EM2C</i>

**Table 3:** Quantitative Responses in Mentor Feedback to 2007-08 SURGE Programme

#	Question	Average score
<b>Student</b>		<b>2007</b>
3	Did the student measure up to your expectations? (1: Well below expectations; 5: Beyond expectations)	4.09
4	How much supervision did the student require? (1: A lot; 5: Not much)	3.42
5	Did the student work when you expected him/her to? (1: Never; 5: Always)	4.43
6	Did the student observe guidelines you set forth? (1: Never; 5: Always)	4.58
7	Did the student work well with your research group? (1: No; 5: Yes)	4.38
8	Did the student participate in department seminars or discussion groups? (1: No; 5: Yes)	3.37
9	How well suited was the student for the research in terms of: (1: Low; 3: Medium; 5: High)	
	(a) Enthusiasm for the work	4.54
	(b) Preparatory Coursework	3.40
	(c) Skills or abilities, etc.	4.00
	(d) Background knowledge	3.25
10	Would you recommend this student for the 2008 SURGE Program? (1: No; 5: Yes)	4.42
11	Would you like to work with this student again? (1: No; 5: Yes)	4.43
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)	4.45
13	Please give us your overall evaluation of the student. (1: Poor; 5: Excellent)	4.33
<b>Research</b>		
14	Did the research you expected from the SURGE research project get done in the 10 weeks? (1: No; 5: Yes)	3.81
15	Is the work worth publishing in a refereed Journal? (1: No; 5: Yes)	3.23
<b>Overall</b>		
16	Were you satisfied with the assistance and administrative support provided by the Office of the DRPG hosting the SURGE Program? (1: Poor; 5: Excellent)	4.32

**Table 4:** Quantitative Responses in Student Feedback to 2007-08 SURGE Programme

#	Question	
<b>Research</b>		<b>2007</b>
3	On an average, how many hours per week did you interact with your Mentor and/or Co-Mentor? (1: 25 hours or more; 5: 5 hours or less)	3.18
4	Did you get the required equipment & facilities needed to carry out your research? (1: No; 5: Yes)	4.39
5	Did you attend research group meetings or participate in discussions with your research group members? (1: No; 5: Yes)	3.79
6	Did you feel comfortable asking questions to your Mentors and Co-Mentors? (1: No; 5: Yes)	
	(a) Mentor	4.68
	(b) Co-Mentor	4.74
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	3.88
	(b) Skill in interpretation of results	3.82
	(c) Tolerance for obstacles faced in research process	4.26
	(d) Readiness for more demanding research	4.16
	(e) Understanding how knowledge is constructed	4.08
	(f) Understanding of the research process in your field	4.22
	(g) Ability to integrate theory and practice	4.00
	(h) Learning ethical conduct in your field	3.78
	(i) Learning laboratory techniques	3.60
	(j) Skill in how to give an effective oral presentation	3.86
	(k) Skill in science writing	3.75
	(l) Self-confidence	4.18
	(n) Others (please state):	4.67
8	How does your undergraduate research experience compare to the expectations you held before you began your project? (1: Well below expectations; 5: Well above expectations)	3.77
9	Evaluate the overall performance of your Mentor or Co-Mentor: (1: Poor; 5: Excellent)	
	(a) Mentor	4.54
	(b) Co-Mentor	4.27
<b>Overview</b>		
10	Please comment on the effectiveness of the following: (1: Low; 3: Medium; 5: High)	
	(a) Writing the research proposal or project plan before coming to IIT Kanpur	3.37
	(b) Oral presentations	3.88
	(c) Writing your final technical paper	3.94

## Appendix A

### Abstracts: 2007 SURGE Research Projects Done at IIT Kanpur

---

2007/CALTECH/IITK/1

#### **Instability of Thin Bilayers on Physically Patterned Surfaces**

*Chaitanya Rastogi, Undergraduate Student (BEM/APH), California Institute of Technology, Pasadena, CA, USA*

Mentor: *Ashutosh Sharma, Department of Chemical Engineering*

In this study, we show the effect of patterned solid substrates on the instability induced by van der Waals forces in thin ( $< 100$  nm) liquid bilayers. Long-wave nonlinear equations for the evolving interfaces are derived from the equations of motion of the liquid layers and under the appropriate boundary conditions. The bilayers are classified based on the macroscopic wettability behavior of the films. In general, dewetting of thin bilayers on homogeneous solid surfaces often leads to random equilibrium structures. Initially, we show here the effect of a physically heterogeneous patch on the dewetting pathway. Further, we identify the conditions for many interesting interfacial morphologies, for example, an array of microchannels, ordered encapsulated droplets etc., on the substrates with periodic sinusoidal patterns. In the process, we also show the potential of these bilayers in generating moulds or stamps because of its pattern transfer capability from one interface to the other. These moulds and stamps can be very useful in generating next generation nano-scale structures.

---

2007/CALTECH/IITK/2

#### **The Effects of Thermophoresis and Electrostatic Charge**

*Chan Nathan, Undergraduate Student (ESE/Environment Engineering), California Institute of Technology, Pasadena, CA, USA*

Mentor: *Tarun Gupta, Department of Civil Engineering*

Micron-scale aerosols are known to persist in ambient environments for extended periods of time. Their long duration of aerial suspension is a concern because they are able to penetrate deep into mammalian lungs. Thus, such aerosols pose a possible threat to human health and deserve serious scientific inquiry. The purpose of this study was to experimentally determine how aerosols are affected by thermal and electrical gradients. Understanding these effects is important because they are present in various analytical techniques and devices used to study aerosols. The theory of such effects is well explored, but no extensive experimental work has corroborated the theory. For this study, an Optical Particle Counter (OPC) was used to count and classify aerosols  $0.3\text{-}20\text{ }\mu\text{m}$  in diameter. Thermal and electrical gradients were independently induced upon a 2.5-meter conducting copper inlet tube, and the particle losses resulting from these gradients were recorded. Results of the study are pending, and experimental data will be compared With theoretical models. Future work should determine the effects of thermophoresis, electrostatic charge drifting, and diffusiophoresis on smaller aerosols using a Scanning Mobility Particle Sizer (SMPS).

---

2007/EC/IITK/3 & 4

#### **Proper Orthogonal Decomposition**

*Yvonnick Bunchier, Masters Student (Applied Mathematics) and Thomas Chasseneux, Masters Student (Applied Mathematics), Ecole Centrale Paris, France*

Mentor: *Sanjay Mittal, Department of Aerospace Engineering*

The Proper Orthogonal Decomposition method (P.O.D), first described by Lumley, allows the transformation of a system of partial differential equations into a system of ordinary differential equations. My work during SURGE 2007 presents a computer method to determinate eigen values and eigen vectors of each points of the system from the mesh of one hundred pictures at different times. That is to say the project results in the realisation of a program which calculate eigen values and eigen vectors of each points, using the Temporal Proper Orthogonal Decomposition. This eigen values could after be used to determinate the energy contains in each modes, to know how many modes are interesting to after simplify aerodynamic problems with same geometry. The geometry is here a two dimensional flow around a circular cylinder. This geometry has been under active investigation for more than one hundred years. Despite its simple geometry, the flow exhibits an important range of phenomena like Karman Vortex Street. The input data of the program are the mesh of a number of snapshots. In this mesh, there is the relation between each element and its points. And for each

points, we have access to the velocity and the pressure. As a result this program is not perfect since there is a problem with the loop to get modes and unfortunately we don't have the time to fix it and to separate subroutines which are gather in the subroutine tableau. But, the energy repartition is encouraging and seems to be agree to the theory. This program has the advantage to be able to be adapted for undefined number of snapshot and undefined Meshes which are the input data. Endly, we hope that it can be useful to simplify many studies about unsteady compressible flows.

---

2007/EC/IITK/5

#### **Air Pollution Studies**

*Damien Dreano, Masters Student (Intg.)(Civil Engineering), Ecole Centrale Paris, France*

Mentor: *Mukesh Sharma, Department of Civil Engineering*

Since fifty years, India has seen a drastic change in the composition of air. We know it is air pollution. Various policy makers, researchers and organizations are working to control the levels of air pollutants such as respirable suspended particulate matter (RSPM), sulphur dioxide (SO<sub>2</sub>) and nitrogen dioxide (NO<sub>2</sub>). Kanpur, which can be considered as one of the most polluted cities in India today, is also going through the implementation phase of the control policies. Ambient air quality data monitored during 2005 to 2007 (January to June), at a site in Kanpur, was analyzed to assess the impact of implementation of fuel change in vehicles to Compressed Natural Gas (CNG). This paper discusses the variation in air quality in Kanpur city before and after the use of CNG as fuel for many vehicles. The parameters considered for the present study are respirable suspended particulate matter (RSPM), total suspended particulate matter (TSPM), sulphur dioxide (SO<sub>2</sub>), nitrogen dioxide (NO<sub>2</sub>) and elemental and organic carbon (EC, OC). Between 2005 and 2006, an increase of all pollutant in the air can be observed. The increase of the number of vehicles can explain that evolution. Since 2006, the concentration of SO<sub>2</sub> has decreases but remains too low as compared to the standard proposed by CPCB. During the 3 years NO<sub>2</sub> levels stay quite similar, but a moderate decrease since 2007 can be observed. PM<sub>10</sub> and TSPM concentrations have decrease since 2006. The reduction is about 30 to 60 % for both pollutants. Comparing EC and OC in 2006 and 2007, a great decrease can be stress. The evolution of OC/EC ratio between the two last years is in agreement with the fact that OC concentration is higher in diesel than EC. Indeed, OC has higher decreasing rates than EC.

---

2007/EC/IITK/6

#### **Influence of Solution Filtration on Organic Solar Cell Efficiency**

*Guillaume Cardon, Masters Student (Process Engineering), Ecole Centrale Paris, France*

Mentor: *S. Sundar Kumar Iyer, Department of Electrical Engineering*

In this work, the effect of filtration of the solution of poly (3-hexylthiophene)-2,5-diyl (P3HT) and 1-(3-methoxycarbonyl) propyl-1-phenyl [6,6] C61 (PCBM) blend dissolved in chlorobenzene solvent on solar cell devices fabricated by spin coating was studied. The nano-morphology determined by atomic force microscopy of the films from unfiltered solution was found to be homogenous whereas that from filtered solution showed phase separations. The absorption spectra of the films formed by the two types of solutions were found to be similar. Devices from both filtered and unfiltered solutions were then fabricated and compared. The photovoltaic responses of filtered and unfiltered devices were comparable. The devices had open circuit voltages above 1.2 V and fill factors (FF) between 41 % and 61 %. The short circuit current densities were, however, very low - around 5  $\mu$ A cm<sup>-2</sup>. The effect of the degradation of the devices after five days of fabrication was also quantified. Degradation rate is above 98 % for all devices confirming the need for better encapsulation.

---

2007/EC/IITK/7

#### **Role of Fat in Wingless Gradient Formatio Im Wimg Imaginal Disc of Drosophila Melanogaster**

*Alba Jimenez, Undergraduate Student (Industrial Engineering), Ecole Centrale Paris, France*

Mentor: *Pradip Sinha, Department of Biological Science and Bioengineering*

The appendage of the adult *Drosophila melanogaster*, such as wings, legs and antennae, develop from imaginal disc, simple pouches of epithelium within the larvae which undergo a series of profound anatomical changes during metamorphosis from pupa to adult fly. We are interested in the expression pattern of a growth regulator Wingless (wg) in the wing imaginal disc. Wg protein functions as a morphogen during embryonic and larval development. It can be interesting to observe the mechanisms assuring Wg secretion in cells mutant for the fat gene, a tumor supressor. Our first aim is

to develop an in vitro culture model to study the dynamic expression pattern of Wg in the wing imaginal disc. The second objective is to study the Wg staining pattern in fat mutant clones and cells overexpressing fat. We observe that Wg secretion and diffusion through the wing disc is maintained after twelve hours in vitro culture. This result could be interesting for the study of the action of external agents during prolonged time. Concerning interaction between wg and fat, we observe that cells having a null mutation for fat have a different behaviour concerning Wg endocytosis whereas cells overexpressing fat don't behave differently from wild type cells.

---

2007/NIT/IITK/8

**Synthesis and Characterization of Novel Coordination Polymers of Iron Porphyrin  
Incorporating Several Azo Ligands as Linkers**

*Abhipsa Mahapatra, Chemistry, NIT, Rourkela*

Mentor: *S. P. Rath, Department of Chemistry*

A new class of porous materials, known as coordination polymers, which are constructed from transition metal ions and organic bridging ligands, have attracted a great deal of attention recently. Design and preparation of coordination polymers as well as investigation of their potential applications are of remarkable research area. The construction of coordination polymers with new network motifs is of current interest for the development of new functional materials and in fundamental studies of crystal engineering and supramolecular chemistry. There has been an increasing interest in metal-organic hybrid material containing paramagnetic metal ions exhibiting extended structures in the field of molecular magnetism and materials chemistry. Judicious choice of Iron-porphyrins as appropriate molecular building blocks provides the means to create a rich variety of new materials with interesting structural and magnetic properties. The use of suitably tailored ligands is crucial for controlling the structure and properties of the final assembled complexes. The organic molecules containing two or more coordinated nitrogen atoms such as 4,4'-Azopyridine, N,N'-Bis-pyridin-4-ylmethylene-hydrazine etc are used extensively in this purpose, and a number of extended structures with diverse topologies are expected. The azo-ligands have attracted attention due to their structural aesthetics, electrochemistry, optical properties and biological relevance and the complexes are expected to be potentially important in view of their promising physical and physicochemical properties and potential applications in display technology and molecular switch.

---

2007/NIT/IITK/9 & 10

**Cumene Synthesis by Reactive Distillation**

*Preet Joseph Joy, Chemical Engineering, NIT, Surathkal*

*& P. Sai Ravindra, Chemical Engineering, NIT, Warangal*

Mentor: *Nitin Kaistha, Department of Chemical Engineering*

The design and control of a Reactive Distillation based process to synthesize cumene is studied. The process consists of a reactive distillation column, followed by a simple distillation column. The reactive distillation column consists of a reactive section on top of a stripping section with propylene being fed at the bottom of the reactive section and benzene at the top of the column. The bottoms of the reactive distillation column are sent to the distillation column where cumene is separated from the heavies. The heavies mainly consisting of Di-isopropyl Benzene are recycled back to the reactive distillation column. Hence, the process uses the concept of "recycle to Extinction". A plant wide control structure is designed and run in Aspen Dynamics. The results show that the plant can handle changes in purity of feed as well as changes in production rate. Economic analysis is done for the process using reactive distillation and for the conventional process. It was found that the process using reactive distillation was much cheaper and consumed less energy per unit mass of cumene produced.

---

2007/NIT/IITK/11

**Hot Water Freezing Before Cold Water**

*Deepti Ballal, Chemical Engineering, NIT, Surathkal*

Mentor: *V. Shankar, Department of Chemical Engineering*

Co-Mentor: *Y. M. Joshi, Department of Chemical Engineering*

If two bodies of water identical in every respect except in their initial temperatures are exposed to identical sub-zero surroundings, the initially hot water freezes first, under certain conditions. This is called the "Mpemba Effect". It was introduced to the modern scientific society by a Tanzanian school boy Erasto Mpemba who observed it while making ice-cream. Though the effect has been reported by many scientists, the reasons given for explaining this paradoxical phenomenon are many and are

often contradictory. Here, experiments were done with various liquids. Mpemba effect was not conclusively observed with water although peculiar properties around 80°C were observed. An attempt made to look for this effect in other liquids lead to supercooling and thus they could not be investigated.

---

2007/NIT/IITK/12

### **Mixing in Microchannels**

*Vinayak Rakshit R., Chemical Engineering, NIT, Surathkal,*

Mentor: *Animangsu Ghatak, Department of Chemical Engineering*

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 crosslinked poly(dimethylsiloxane) (PDMS) and to optimize the channel geometry to increase the mixing efficiency so as to provide better control and diminished size of devices. In this work, twisted microchannels of different cross sections have been fabricated by embedded template assisted fabrication using twisted nylon threads as the template and their effectiveness in mixing of fluids have been studied. Mixing on a micro scale is difficult as, at practical pressure gradients the viscous forces predominate. The mixing in these twisted channels is enhanced by chaotic advection which takes place due to the asymmetry in the cross section. This enhanced mixing is due to a large increase in the surface area of contact between the fluids due to the chaotic nature of the flow thus leading to a great reduction in the length of the channels necessary for effective mixing. The mixing efficiencies for the same length of the channel with different cross sections have been found for a range of Reynolds numbers and the optimal geometry of cross section of the channel has been determined.

---

2007/NIT/IITK/13

### **Mathematical Modeling of One Dimensional Sediment Flow**

*Karan Chouksey, Civil Engineering, NIT, Durgapur*

Mentor: *Pranab K. Mohapatra, Department of Civil Engineering*

The de Saint Venant Equation comprising of non-dimensional momentum equation and water continuity equation describing un-steady flow in open channel and the sediment continuity Equation are numerically solved to determine the aggradation in one dimensional prismatic channel bottom due to an imbalance between water flow and sediment discharge in case of mobile bed channels. For this purpose, Mac-Cormack Explicit Finite Difference Scheme is used. This scheme is second order accurate, handle shocks and discontinuities in the solution without any special treatment. The water flow equation used in this is validated by implementing it to the dam break simulations (flow in rigid bed channels). This scheme allows simultaneous solution of the water and sediment equation, thereby removing the needs of iterations. Numerical experiments are executed for a range of values available from the experimental data. Principal dependent variables, such as change in bed level from equilibrium levels and water surface profile are determined from the computer based numerical experiments. The computed results are compared with the earlier available numerical results. The agreement between the computed and earlier results is satisfactory.

---

2007/NIT/IITK/14

### **Modeling of Seawater Intrusion in Coastal Aquifer**

*Tankala Chandan, Civil Engineering, NIT, Triuchirapalli*

Mentor: *Bithin Datta, Department of Civil Engineering*

This study strives to simulate the physical processes in a real life Coastal aquifer i.e., the Waiwhetu Artesian Aquifer, at Lower Hutt, Wellington Bay, in New Zealand. This aquifer is being extensively used for groundwater withdrawal for the nearby urban areas. This groundwater supplements the surface water supply and constitutes approximately 40 percent of the total water supply in this region (Phreatos Limited, 2001). The groundwater flow and possible saltwater transport in this confined multilayered aquifer system is adjacent and below the Wellington Bay. The present withdrawal scenario from this aquifer, apparently not adversely affecting saltwater intrusion. However, the main objective of this study is to simulate the aquifer responses to various critical withdrawal and freshwater recharge scenario to examine if significant amount of saltwater intrusion may occur in future, with growth in demands and depletion of fresh water recharge. This study is aimed at using a numerical 3-D flow and transport simulation model to test the response of the aquifer to various critical stress scenarios. These simulation results for various hypothetical future withdrawal and recharge scenarios are utilized to predict the possible aquifer state and possibility if any of saltwater

intrusion in this aquifer system, which could endanger the fresh water supply from this aquifer. These simulation results are used to predict the response of the aquifer system to various stress scenarios.

---

2007/NIT/IITK/15

**Contaminant Transport Modeling of Groundwater Aquifers due to Hydrocarbons and Design of Optimal Monitoring Network**

*Ramya Mohan, Civil Engineering, NIT, Triuchirapalli*

Mentor: *Bithin Dutta, Department of Civil Engineering*

Remediation of contaminated aquifers poses a serious challenge. Often the contamination of the aquifer is detected long after the source of contamination had been active. Once the contamination is detected, the contamination plumes may have spread widely in the aquifer. An effective remedial measure therefore, becomes even more difficult to implement. The widespread release of petroleum hydrocarbons in the environment has led to subsurface contamination by toxic and water-soluble substance like benzene, toluene. These compounds are highly toxic, and mobile in subsurface systems. Their effect is felt after a long time after dumping and hence there is a need for simulating the movement of these pollutants in aquifers. Implementation of ground water monitoring networks in an optimal manner is essential to check the concentration level and to detect the contaminant plume migration in the aquifer. Designing monitoring network grid is thus the first and the basic step prior to remediation, once the ground water has been polluted. The most important benefit of the design is the cost effectiveness involved. Having wells throughout to monitor may be feasible but it is highly expensive. Moreover the dynamic approach which considers stepwise implementation of the network in tune with the contaminant plume movement proves to be even more economical because contaminant plume when migrating might have different concentration at different locations varying with time. The optimal design incorporates transient flow and transport conditions. Uncertainties in the modeling process are incorporated by random generation of pollutant plume realizations. The performance of the monitoring design model is evaluated for an illustrative study area.

---

2007/NIT/IITK/16

**Frequency Analysis in Pipes**

*Spriha Shankar, Civil Engineering, NIT, Durgapur*

Mentor: *Pranab K. Mohapatra, Department of Civil Engineering*

A methodology for the detection of blockage in single pipelines by frequency response method is presented here. A steady oscillatory flow produced by the periodic opening and closing of a valve located at the downstream end is analyzed in the frequency domain by using the transfer matrix method. Pressure frequency response at the valve end is developed. The Fourier transform of the Peak Pressure Frequency Response obtained by joining the peaks of the frequency response curve is used to predict the blockage size and location. The cases considered are (i) Single Blockage without Friction; (ii) Single Blockage with Friction; (iii) Double Blockage without Friction; and (iv) Double Blockage with Friction. If there is a single blockage in piping system, the location of it can be predicted by studying the location of trough and peaks in the Fourier transform. The mean peak pressure fluctuation which is represented by the Y-axis variation gives the size of the blockage. In case of double blockage also the blockage size and location of individual blockage can be predicted. The obtained Fourier transform for a case of double blockage is the superposition of the single blockage at that location. The entire study is limited for rigid, single piping system.

---

2007/NIT/IITK/17

**Chromium (VI) Migration Through Ground Water and Remediation**

*R. Anandapadmanabhan, Civil Engineering, NIT, Tiruchirapalli*

Mentor: *Rajesh Srivastava, Department of Civil Engineering*

Co-Mentor: *Purnendu Bose, Department of Civil Engineering*

Contaminant migration is on the rise due to excess waste generated due to rapid industrialization. The wastes when disposed, pose a serious threat to the ground water wherein heavy metals and other chemicals migrate through the soil and impair the aquifer making it unfit for use. Migration is a complex processes, and depending on the nature of the waste they can be of varying degrees of significance. Also it becomes a challenging task due to the uncertainties inherent in modeling a natural system like an aquifer. Mathematical modeling is one of the ways to study contaminant migration. A chromium contaminated site in Kanpur was taken for study and modeling was done using VISUAL

MODFLOW 4.1. Remediation consists of reduction of Cr(VI) to Cr(III). Certain bacterium have been shown to have the ability to reduce the hazardous Cr(VI) to the safe and more stable Cr(III). One such bacteria was used in the field under study. With the help of field data the rate at which the bacteria reduces Cr(VI) to Cr(III) was determined by modeling. Iron is also shown to reduce Cr(VI) to Cr(III) through redox reaction. A column experiment was conducted to find the efficiency of reduction of Cr(VI) at different flow rates and to study the possible use of Iron as a filter for domestic use or barrier in dumping sites. It was found that reduction was 100% at very low flow rates.

---

2007/NIT/IITK/18

### **Strengthening of Masonry Walls Using FRP (Fibre Reinforced Polymers): An Experimental Study**

*Anshul Agarwal, Civil Engineering, Motilal Nehru NIT, Allahabad*

Mentor: *K. K. Bajpai, Department of Civil Engineering*

Masonry infill walls are commonly used as filler walls (both interior and exterior walls) in reinforced concrete building frame. Depending on design considerations, these infill walls can resist lateral and gravity loads. In well designed RC frame buildings, masonry infill walls are the weakest elements due to weak strength and absence of poor anchorage to adjoining concrete members. They may crack, tear and collapse under the combined effects of out-of-plane and in-plane loads generated by seismic forces. Seismic strengthening of masonry walls is a very important as majority of Indian constructions are either masonry load-bearing or masonry-infill frame structures. The properties of FRP like high strength-to-weight and stiffness-to-weight ratios, corrosion resistance, light weight and potentially high durability, make it very attractive for use in civil infrastructure. FRP can be effectively used for strengthening of masonry walls due to ease of handling and application with minimal disruption to the structure's current function. Diagonal shear tests on masonry walls strengthened with FRP can provide insights in to the applicability of FRP systems for seismic strengthening of masonry structures. A servo-controlled 250 kN hydraulic actuator is employed to perform the diagonal shear test (ASTM E519-02). Various forms of FRP like glass fabric, strips, bars of various diameters have been used and compared for subscribing the most efficient form and pattern to be used in strengthening of masonry walls.

---

2007/NIT/IITK/19

### **Repair and Strengthening of Cracked Reinforced Concrete Beams**

*Puneet Nagrani, Civil Engineering, NIT, Warangal*

Mentor: *K. K. Bajpai, Department of Civil Engineering*

Crack is one of the most common defects observed in reinforced concrete slabs and beams. Major cracks in concrete structures may occur due to overloading, corrosion of reinforcement or differential settlement of support. To restore the structural capacity of the distressed elements, retrofitting or strengthening is needed. There are different techniques available for retrofitting and strengthening of reinforced concrete structural elements. This study investigates the structural performance of reinforced concrete beams, which are repaired using different techniques. Five different techniques are used for the purpose of repair in the cracked beams namely; cement grout, epoxy injection, ferrocement cover, use of glass fiber reinforced polymer (GFRP) composites and section enlargement. The GFRP composites are relatively new material for construction industry, particularly in India and very few field applications are reported on the use of GFRP composites in civil infrastructure. The lack of available design and testing standards is one of the important factors restricting the take-off of the formal use of GFRP in civil infrastructure in India. The use of GFRP composites in upgrading reinforced concrete (RC) structures was chosen as the basis, which is compared with other types of conventional repair works. The parameters for glass fibers were GFRP strips, GFRP rods, and overlays of GFRP (bidirectional fabric) using hand lay up technique. A series of three-point bending tests conducted on pre-cracked RC beams to evaluate the performance of deteriorated RC beams after application of repair work. The load-deflection curves from which increase in load capacity, ductility and energy absorption are compared for different strengthening techniques.

---

2007/NIT/IITK/20

### **Tribology of Pure Cold Rolled Titanium in Cryogenic Conditions**

*Sushmit Kumar Deb, Materials & Metallurgical Engineering, NIT, Rourkela*

Mentor: *Bikramjit Basu, Department of Materials & Metallurgical Engineering*

For application at very low sub zero temperatures as in case of space operations, titanium has always been preferred to other metals because of its high strength to weight ratio and for its excellent

corrosion resistance. During this project high sliding speed wear of titanium disk against steel ball counterbody was studied by using ball-on-disk tribometer in cryogenic environment i.e. LN2 environment without any lubrication. The normal load applied was from 5 to 15 N with operating angular speeds of 850 rpm. Different sliding velocities were obtained by changing the track radius from 7.5 to 15 mm. During this the velocities obtained were 0.66 to 1.33 m/sec. The experimental time period was kept at 5 minutes. The tests reveal that the coefficient of friction increased with increase in load but decreased with sliding speeds. The steady state of the plot between COF and time was obtained after a few seconds of the commencement of the experiment. The wear rate was found to be decreasing with increase in sliding speeds. The mechanism of wear was found to be mainly abrasion and microploughing and there was a non oxidative surface damage (i.e. there was no or little oxygen present in the worn surfaces and all titanium).

---

2007/NIT/IITK/21

#### **Development of Parallelizing Compiler for C**

*Sidharth Rai, Computer Science & Engineering, Dr. B. R. Ambedkar NIT, Jalandhar*

Mentor: *Sanjeev K. Aggarwal, Department of Computer Science & Engineering*

Multi core architectures have become common processors for the desktop workstations and servers, However most of the programmers still write sequential programs and therefore unable to exploit the full power of multi core processors. My project aims at developing a tool which convert sequential applications programs written in C into equivalent multi threaded versions. These Multi threaded application exploit the full power of the multi core processor. Open MP library have been used for having the multi-threaded version of the programs. The tool does data dependence analysis on the sequential C program and identify the code which can be executed in parallel. Data dependence analysis focuses on the loop and converts them into parallel if the dependence do not prevent re-ordering of the instructions. GCD and Banerjee test are done on dependent variables to identify data dependence within the for loops of programs. The tool applies transformations like loop normalization, Loop interchange to resolve dependencies present in for loops present in the source code. I have tested the tool on benchmarks programs like matrix multiplication and get average speedup of 1.669. The tool was developed on Linux platform and coded in C. Currently the tool cannot work for tertiary statements, switch case inside the for loop .I will be working on this project even after SURGE-2007 and will take care to these constraints present in the tool.

---

2007/NIT/IITK/22

#### **Intelligent Railway Information System**

*Saumye Rastogi, Computer Science & Engineering, Motilal Nehru NIT, Allahabad*

Mentor: *Dheeraj Sanghi, Department of Computer Science and Engineering*

An Indian railway is Asia's largest railway network system. Due to its vastness and complexity it is a tough problem to find out the route between any two stations. This project aims at developing an Intelligent Railway Information System (IRIS) for finding the direct as well as indirect routes between the given stations. Finding a suitable rail route is not a simple graph problem as it may appear at first instance. Due to the vast expanse and hence complex nature of the rail network it can not be handled in the same way as the airway route problem. In this project we developed an indigenous method to find the suitable routes between any two stations through the concept of 'important stations'. The important stations had been found for each station in the database making use of a suitable algorithm. The finished application is capable of giving the direct as well as indirect routes along with user friendly interface which gives option of stopover station, stopover time and duration and also handles the incorrect spellings entered by the user while operation of the application. This application proves to be very helpful in solving the traveling problems and has the future prospective to be developed as a complete traveling planner, which can be the answer to all the troubles of a traveler by including the airways also in the system functioning.

---

2007/NIT/IITK/23

#### **Study of Possibility of Flow Control by Small Periodic Perturbations on a Circular Cylinder**

*Susmita Dash, Mechanical Engineering, NIT, Rourkela*

Mentor: *K. Muralidhar, Department of Mechanical Engineering*

Flow around bluff bodies produces alternatively shed vortices in intermediate Reynolds number region known as Karman Vortex Street. Bluff body wakes play a major role in industrial applications as well as in design of environmental settings including tall buildings and structures such as bridges,

chimneys, cooling tower and heat exchangers etc. The diversity of applications necessitates the study of the bluff body wake and effort towards modifying it for accomplishing flow control. The investigation focuses on the generation of the vortex structures in the near-wake region, arising from flow past a stationary circular cylinder for intermediate Reynolds number i.e.300-400. Dye injection method is used for flow visualization. Shear layer surrounding the recirculation bubble region behind a cylinder are discussed in terms of flow physics and vortex formation length of Karman vortices. It is found that the values of Strouhal number as well as the wake patterns are functions of the cross-section of the cylinder and Reynolds number. Wake behavior of stationary and oscillating cylinder are compared. Efforts are made to use a small amount of energy through very small perturbations on a circular cylinder to obtain significant changes in the wake structure, which is a very strong signature of any bluff body. Hence a method of flow control is devised.

---

2007/NIT/IITK/24

**Modeling of Fluid Flow Past a Square Cylinder and Extension of the Model for Prediction of Heat Transfer in Electronic Equipments**

*R. Girish Kumar, Mechanical Engineering, NIT, Tiruchirapalli*

Mentor: *S. Sarkar, Department of Mechanical Engineering*

Two dimensional fluid flow and heat transfer in a rectangular duct with heater sources have been studied numerically in the context of cooling of electronic equipments. A code has been developed to solve the simplified form of the Navier – Stokes equations. To validate the code, the code has been used to analyse the fluid flow past a square cylinder in a rectangular duct. The results obtained were found to be in accordance with published literature. The validated code has been extended, by inclusion of the energy equation, and has been used to study the heat transfer from a heater source and the fluid flow around it. Initially, the validated code has been used to analyse fluid flow in a horizontal channel consisting of repetitive geometric modules. Since the flow becomes identical over successive heaters, an isolated heater source is chosen for analysis and the results are re-imposed upon the successive heaters. Streamline, Vorticity and temperature plots have been generated for different Reynold's numbers and for different values of the space in between successive heaters. Next, the code has been used to analyse fluid flow in a vertical channel with a heater source. Effects of pure forced convection and that of mixed convection are studied. Streamline and temperature contours have been plotted and the results have been interpreted and concluded. The Nusselt number calculated indicates the extent of heat transfer.

---

2007/NIT/IITK/25

**A Novel Nanofinishing Process for Ultra High Speed Shafts**

*Abhishek Haritwal, Production Engineering, NIT, Tiruchirapalli*

Mentor: *J. Ramkumar, Department of Mechanical Engineering*

Ultra High Speed Gas Bearings used in cryogenic diffusers are supported by Inconel shafts rotating at very high speeds exceeding 1, 50,000 RPM. These shafts are subjected to considerable amount of wear and hence the fatigue strength and load bearing area of these shafts should be increased for better life. To improve the properties of these shafts, it is necessary to obtain nano-finishing on their surface. Nano-finishing of these shafts reduces the frictional force developed, which in turn reduces the noise generation, power losses, and running costs of the Ultra High Speed Gas Bearings. In the present research, the Magnetic Abrasive Finishing (MAF) process has been employed to get a fine surface finish. In this process, a magnetic field is applied across the machining gap (between magnet and workpiece) filled with unbounded magnetic abrasive powder UMAP i.e. a homogeneous mixture of abrasives and ferromagnetic iron particles. The ferromagnetic particles get aligned along the magnetic lines of force and form a flexible magnetic abrasive brush (FMAB). This FMAB, originate micro indentations into the workpiece surface. The brush is flexible in nature and it is able to access the surface where the conventional tools are hardly applicable in practical use. In the present study, a set-up was developed where in four shafts can be simultaneously finished to nano scale level. Initial trials have been successfully made and optimizing the process parameters is to be carried out for better performance and further enhancement of the process.

---

2007/NIT/IITK/26

**Numerical Simulation of Laminar Flow and Heat Transfer Downstream of a Backward Facing Step in a Channel**

*Nilanjan Sen, Mechanical Engineering, NIT, Rourkela*

Mentor: *P. S. Ghoshdastidar, Department of Mechanical Engineering*

In this work laminar and steady forced convection heat transfer in a separating and reattaching flow has been numerically studied by simulating the flow and heat transfer downstream of a backward facing step in a channel. A fully developed flow at a uniform temperature higher than that of the top, bottom and side walls enters the channel. All the walls are kept at the same temperature. SMAC algorithm has been used to obtain the flow field and pressure distribution. The finite-difference method has been applied to discretize the governing differential equations. The number of grid points taken is 200 x 40. The computation of flow field has been satisfactorily validated with Gartling[1]. A series of computations has been conducted in which two principal parameters governing heat transfer in this geometry (i.e. Reynolds number and Prandtl number) are systematically changed while keeping a fixed channel expansion ratio. The results show that (a) the distribution of local Nusselt number at the lower wall depends strongly on Re and Pr; (b) the peak of the local Nusselt number at the lower wall occurs just after the point of flow reattachment; (c) the temperature profiles at various X-locations in the channel reveal that the same are asymmetric in the recirculation zone while the symmetry is restored far from the inlet; (d) the shear stress distribution at the lower wall and the pressure contours in the channel show realistic trends.

---

2007/NIT/IITK/27

**Performance, Emission and Combustion Characteristics of a Biodiesel (Waste Cooking Oil Methyl Ester) Fuelled Diesel Engine**

*Bhaskar Mazumdar, Mechanical Engineering, Motilal Nehru NIT, Allahabad*

Mentor: *Avinash Kumar Agarwal, Department of Mechanical Engineering*

Biodiesel (fatty acid methyl ester) is a nontoxic and biodegradable alternative fuel that is obtained from renewable sources. A major hurdle in the commercialization of biodiesel from virgin oil, in comparison to Petroleum-based diesel fuel is its cost of manufacturing, primarily the raw material cost. Used cooking oil or waste cooking oil is one of the economical sources for biodiesel production. Waste cooking oil can help in commercialization, as it is cheaper than vegetable oil. However, the products formed during frying such as free fatty acid and some polymerized triglycerides, can affect the transesterification reaction and the biodiesel properties. In this study, waste cooking oil from restaurants was used to produce neat (pure) biodiesel through transesterification, and this converted biodiesel was then used to prepare biodiesel/diesel blends after that. The performance, combustion & emission characteristics of biodiesel in a commercial diesel engine were analyzed. It was observed that mass emissions did not deviate much from baseline mineral diesel data. NO<sub>x</sub> emissions increased with higher blends, while CO emissions decreased with higher blends of biodiesel. In addition, Brake Thermal Efficiency (BTE) of biodiesel blends was observed to be higher as compared to mineral diesel. For higher blends of biodiesel, Brake Specific Fuel Consumption (bsfc) slightly deviates from diesel. In addition, earlier heat release was observed for biodiesel blends.

---

2007/NIT/IITK/28

**Rotational Abrasive Flow Machining**

*Raghavendar Ranganathan, Mechanical Engineering, NIT, Warangal*

Mentor: *J. Ramkumar, Department of Mechanical Engineering*

More than 15% of the total cost in manufacturing is incurred on finishing operations. The growing need for automated high production with uniform surface finish demands reliable fine finishing processes. Literature survey carried out clearly indicates that conventional finishing processes can procure good finish on flat and simple contours only. Achieving precision/fine finishing of complex and intricate profiles, calls for new finishing approaches. One of the non-conventional processes used for fine finishing is the Abrasive Flow Machining (AFM), which offers both automation and flexibility in final machining operations. It involves the removal of material by a viscous, abrasive laden semi-solid grinding media flowing under pressure, through or across the work piece. The aim of this project has been to develop a Hybrid process called Rotational Abrasive Flow Machining (R-AFM), which is an improvement over the existing AFM setup. In this case, along with the to and fro motion of the abrasive laden media through the workpiece the workpiece is made to rotate via a motor-gear arrangement, so that a combined reciprocatory as well as a rotary motion could exist which is very similar to honing process. The experimental set up has been completed and initial trial experiments have been conducted which gave satisfactory results towards achieving a fine finish as well as improved form geometry of the work piece material. A theoretical approach explaining the mechanism of material removal has also been formulated.

---

2007/NIT/IITK/29

### **Hydrodynamic Characteristics of Single-phase Flow through Mini/Micro-Channels**

*Avinash Chopde, Mechanical Engineering, Visvesvaraya NIT, Nagpur*

Mentor: *Sameer Khandekar, Department of Mechanical Engineering*

Pressure drop during internal flow is one of the most important considerations in designing a fluid flow system. The Reynolds number for flows in mini/micro-channels is generally very low as the flow velocity in these small hydraulic diameter passages is quite small. The friction factor and pressure gradients are both quite high in such flows since the available surface area for a given flow volume is high. The fluid flow characteristics in mini/micro-channels are quite different from those predicted by using the relationships established for macro-channels. There is a wide discrepancy in the reported data as regards to the pressure drop characteristics. One of the main reasons for this, is uncertainty in measurement. As the length scales become smaller, metrological challenges are all the more important to harmonize the available data base. In this research project, the single-phase hydraulic characteristics of channels of hydraulic diameter 2.1 mm, 1.6 mm, 490  $\mu\text{m}$  and 390  $\mu\text{m}$  are experimentally studied in detail. The laminar to turbulent flow transition is also vividly discussed based on the obtained experimental data. Excellent indications of early transition to turbulent flow are obtained. Transition occurs at 1400, 1200, 450 and 350 Reynolds number, for 2.1 mm, 1.6 mm, 490  $\mu\text{m}$  and 390  $\mu\text{m}$  diameter channels respectively. The conventional transition limit being 2300 Reynolds number, the results prove the dependence of the transition limit on the hydraulic diameter of the channels in mini/micro-channel domain. Effect of internal roughness of the channels is also discussed. A theoretical account of uncertainty in measurement in the experimentation process is also given.

---

2007/NIT/IITK/30

### **Design of Fixed-Point DSP Based Universal Control Platform for Education and Research in Power Electronic Systems**

*Savirigana Venkata Rajesh Kumar, Electrical Engineering, NIT, Durgapur*

Mentor: *P. S. Sensarma, Department of Electrical Engineering*

There is rising interest in using digital controllers in power electronic applications. The development of signal processing algorithms for real-time purposes is still difficult and often requires specialized training in a particular Assembly language for the targeted DSP. Moreover, even if the skill is acquired, the process of project development is tedious and time consuming as the level of complexity increases. Hence, fast development tools and a platform for testing of new DSP real-time applications are necessary, as the need to shorten the design cycle for new applications becomes critical. The design of Universal control platform based on TMS320F2812 processor having 150 MIPS of operating speed and programming DSP as a standalone embedded system is presented. The proposed hardware basically consists of three units. These are Data Acquisition unit, DSP unit and Communication interface unit. Data acquisition unit consists of an 8 channel Analog to Digital Converter (ADC), 4 channel Digital to Analog Converter (DAC). It also consists of input-output buffers for ready interface to the external circuit. All the required computations are carried out in the DSP unit. In addition to the internal 18K RAM, the DSP unit also contains 64K x 16 bits high speed CMOS static RAM for additional memory requirement. The Communication interface unit consists of MAX232 logic level converter along with a D9 connector for compatibility with serial communication Port of Personal Computer (PC). Serial Communication Interface (SCI) capability of the F2812 is used for programming the Flash memory of the F2812 through SDFlash serial utility. Thus it is made possible to embed the application code into the Flash memory of F2812. The proposed design can be used in educational institutions to help conceptualization of embedded controllers specific to target usage.

---

2007/NIT/IITK/31

### **Modeling of solar Cell/ Panel in MATLAB and Maximum Power Point Tracking**

*Binod Prasad Koirala, Electrical Engineering, Malviya NIT, Jaipur*

Mentor: *P. S. Sensarma, Department of Electrical Engineering*

The work focuses on conceptualization and validation of Maximum Power Point Tracking (MPPT) of a solar cell/panel used for renewable energy generation. The solar cell/panel is modeled on MATLAB using its electrical equivalent circuit. As the Power vs. Voltage and Current vs. Voltage characteristics are non-linear for solar panel, MPPT algorithms are essential to maximize the photovoltaic panel output power, irrespective of the temperature, insolation conditions and the load electrical characteristics. The objective of the MPPT algorithm would be to track the MPP with minimal

perturbation and best possible accuracy, in the least possible time. The energy extraction system considered here consists of boost converter between solar panel and load with the output of solar panel connected directly to the input of boost converter. Boost converter has been used because it can always track the MPPT and is superior to other converter topologies. The PV array output power is used to directly control the dc/dc converter through the duty cycle, thus reducing the complexities of the system. At the heart of the MPPT approach presented is a structured optimizer, popularly known as the "hill-climbing" algorithm. Simulation results shows that at the normal condition the MPPT Converges well at MPP. The Proposed system increases the efficiency and decreases the cost of PV power system as it make possible to extract maximum power form the same panel all the time. Keywords: Photovoltaic (PV), Maximum Power Point Tracking (MPPT), Hill Climbing algorithm (HC), Boost Converter

---

2007/NIT/IITK/32

### **Age and Gender Recognition Using Speech**

*Reena Panda, Electrical Engineering, NIT, Rourkela*

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

Speech is the strongest tool for communication. Apart from the underlying message, it so contains speaker specific information like a speaker's age, gender, emotion, level of education, ethnicity etc. The main aim of this project is to make use of these speaker-specific information present in speech signal to build a text-independent recognizer that will classify speakers on the basis of their gender and age. Such systems have many potential applications like, sorting telephone calls by gender (e.g. for gender sensitive surveys), enhancing speech recognizer performance by providing gender or age information, improve performance of speaker recognition systems, for targeted advertisements, as a biometric tool for security and general applications and developing more flexible and user-friendly dialogue systems. We use statistical modeling techniques (Gaussian Mixture Models) for accomplishing the task in our project. The baseline system is built using Mel Frequency Cepstral Coefficients (MFCC), which are considered to be standard features in speaker recognition systems. We tried improving over the baseline system by including features like Delta and Delta-Delta Cepstral Energy (DCE and DDCE), Maximum Auto-correlation Values (MACV) and Vocal Tract Length(VTL). All the experiments are done on standard databases, which include Texas Instruments-MIT (TIMIT) and Texas Instruments-DIGITS(TIDIGITS). The results indicate that including certain features provide better results whereas some features did degrade the performance of the recognizer. Appending DCE, DDCE and MACV have provided better recognition performance over baseline, whereas VTL degraded. We have got recognition accuracies upto 98.8% for gender and 89.6% for age classification. Keywords: Age and gender classification, speech, Gaussian Mixture Models.

---

2007/NIT/IITK/33

### **Adaptive Active Noise Control**

*Ajay S, Electronics & Communications Engineering, NIT, Surathkal*

Mentor: *L. Behera, Department of Electrical Engineering*

Active Noise Control (ANC) is a technique of acoustic noise reduction using a secondary source of sound which produces "antinoise" that destructively interferes with the primary noise, thereby reducing it. ANC is useful at low frequency range ( $< 600\text{Hz}$ ) where passive noise control devices like mufflers and silencers become bulky and ineffective. In this project, narrowband single channel feedback ANC for headsets application is focused upon. This is suitable for reducing low frequency periodic noise like that from an engine or a pump. This architecture uses a single error microphone and a single canceling headphone speaker with a controller using an adaptive algorithm to generate antinoise. The secondary path effects due to the acoustic environment of the system are incorporated into the system. The secondary path modeling is done using Least Mean Squares (LMS) algorithm. The ANC is implemented using the feedback form of Filtered-X LMS (FXLMS) algorithm. The algorithm verification is done on MATLAB and the system is simulated on C platform. Real time implementation of the system is done using TMS320C6713 DSP Starter Kit (DSK). The simulation results using a two tone noise signal show a noise reduction of 16.19 dB. The real time practical setup using DSK shows a noise reduction of 8.57 dB under the same testing conditions. The inferior performance of the practical system is attributed to the acoustic environment of the system which is complex to model. Advanced adaptive algorithms like Kalman Filter is also implemented for ANC but the implementation fails to be real time due to DSK hardware limitations.

---

2007/NIT/IITK/34

### **GSM Based Communication and its Applications**

*Pradeep Kumar Sahoo, Electronics & Instrumentation Engineering, NIT, Rourkela*

Mentor: *L. Behera, Department of Electrical Engineering*

The Global System for Mobile communications (GSM) is the most popular standard for mobile phones in the world. GSM has been the backbone of the phenomenal success in mobile telecom over the last decade. Now, at the dawn of the era of true broadband services, GSM continues to evolve to meet new demands. In this project it is proposed to use the SMS feature of GSM for developing a GPS based Tracking system and a Control and Automation system. In the tracking system, specially designed circuits are attached with the object to be tracked. It would collect data regarding the location and transmit it to the control station. The component of the circuit, to be mounted on the object to be tracked includes a Global Positioning System (GPS) receiver. A microcontroller would collect data from the receiver and would send it to the control station through a GSM module via SMS. At the control station the object would be perfectly tracked on a map. In the Control and Automation system, the designed circuit is connected with the devices to be controlled. The component of the circuit at the device end includes a relay circuitry. The devices to be controlled are assigned particular device Ids by which they will be accessed. From the SMS obtained in the GSM, the microcontroller extracts the device Id and the operation to be carried out over the device. The microcontroller controls the operation of the relay circuit, which in turn controls the devices.

---

2007/NIT/IITK/35

### **Effect of Encapsulation on Stability and Performance of P3HT-PCBM based Organic Solar Cell**

*Saurabh Chandra, Electronics & Communication Engineering, Motilal Nehru NIT, Allahabad*

Mentor: *S. Sundar Kumar Iyer, Department of Electrical Engineering*

Organic solar cells have the potential to provide low cost and environment friendly alternative to the existing non-renewable sources of energy. In spite of the many advantages, organic solar cells have some limitations, such as poor efficiency, device stability and reliability. The device degradation is particularly acute when operated under light in the presence of oxygen and moisture. Encapsulation is a common technique to inhibit the degradation rate. The goal of this project is to study the effect of encapsulation on the stability and performance of P3HT (poly (3,hexylthiophene-2, 5-diyl)) - PCBM ([6, 6]-phenyl-C61-butyric acid methyl ester) based organic solar cell. Two different method of encapsulation using araldite epoxy and epotek epoxy OG 14217 are used. The results indicate that the degradation is comparable when using the two types of encapsulation. However, after one week, encapsulation with araldite epoxy shows marginally better performance in terms of the solar cell parameters.

---

2007/NIT/IITK/36

### **Comparative study of the effect of solvents in the making of P3HT: PCBM blend films for organic solar cells**

*Shalini Dubey, Electrical & Electronics Engineering, Tiruchirapalli*

Mentor: *S. Sundar Kumar Iyer, Department of Electrical Engineering*

Organic photovoltaic cells have the potential to be a low cost alternative to other renewable energy technologies. The goal of this project work is to test a solvent to build a layer of P3HT:PCBM blend used in polymer photovoltaic cells. Two solvents used for the study are Chlorobenzene (CB) and 1,2,4-trichlorobenzene (TCB). Their boiling points are 1310C and 2130C respectively which has a bearing in the thin film processing. In present work the thickness of P3HT:PCBM film is optimized using both the solvents so as to get a common thickness. Morphologies of the films are compared using AFM (Atomic Force Microscopy) images. Film deposited using TCB showed higher roughness and better fiber like formation of P3HT as compared to film deposited using CB. Absorption spectrum of both types of films is studied and both are found to be almost similar with negligible decrease in bandwidth in case of TCB based film.

2007/IITK/IITK/37

**Optimization of The Design of a Grating Assisted Lateral Directional Coupler Based on Impurity Induced Quantum Well Intermixing of InGaAs/GaAs**

*Rohan Nag, Electrical Engineering, IIT Kanpur*

Mentor: *Utpal Das, Department of Electrical Engineering*

A novel waveguide grating assisted coupler, suitable for a CWDM system, based on quantum well intermixing process in InGaAs/GaAs has been designed and a complete numerical simulation has been performed. The work actually hinges upon this device; or rather upon improving its response. The primary requirement of such a device is that it should couple power from one waveguide to another, with the maximum possible power-coupling ratio for a certain range of wavelengths, and should not couple in other ranges. The ideal response should be a flat-topped function, with minimum possible side lobes, however as in any other physical device, it shows considerable side lobe levels, when implemented with uniform grating width. The work focuses on reducing the side lobe levels, through the use of a tapered spacing function, which is generally used for such cases. The problem remains to find the optimum spacing function, which would give us your desired response. I have implemented techniques like the Gelfand-Marchenko-Levitan algorithm, which given a desired response, is supposed to be able to return the optimum spacing function to be used. However since, the method is based upon the approximate Coupled Mode Theory, the function it returned was not optimum enough for our device, which was simulated using the more accurate Transfer Matrix + Beam Propagation Method. However after studying the trends displayed by different functions, and making a few calculated guesses, I have been able to arrive at a function, which displays considerably lowered side lobe levels compared to all other options tried before though I think it may still be possible to further improve the response.

---

2007/IITK/IITK/38

**Effect of Surface Treatment of ITO on Efficiency of CuPc/C60 Based Organic Solar Cells**

*Kunal Singal, Electrical Engineering, IIT Kanpur*

Mentor: *Satyendra Kumar, Department of Physics*

Co-Mentor: *S. Sundar Kumar Iyer, Department of Electrical Engineering*

Indium Tin Oxide (ITO) is the transparent anode used in organic electronic devices. Its properties such as work function, surface roughness, resistivity and mobility are affected by surface treatments. These properties affect the working of the organic solar cell and its efficiency. Different surface treatments affect the cells in different ways and optimizing the treatment with respect to different parameters for best results. In this study, the effect of Ozonization with respect to time has been studied. To study the effect on organic solar cells, single layer simple Schottky Devices (ITO/ 400 nm CuPC/ 1000nm Al), with ITO surface treated for different times under ozone, were fabricated under similar conditions. The Current-Voltage graphs are obtained by characterizing the devices and a comparative study based on the obtained characteristics helps in optimizing the surface treatment with respect to time. Also, the devices were annealed and characterized again to study its effect. The obtained results show that ozonization initially improves the characteristics of the devices by improving the mobility, work function and reducing number of traps and roughness of the surface. But prolonged exposure to ozonization results in degradation of the devices and poor characteristics, which might be due to excessive oxidation on the surface. Also, annealing improved the characteristics of the devices but reduced the current that flows through them.

---

2007/IITK/IITK/39

**Remote Pointer Control Through Visual Servoing**

*Abhishek Sharma, Electrical Engineering, IIT Kanpur*

Mentor: *K. S. Venkatesh, Department of Electrical Engineering*

The project titled "REMOTE POINTER CONTROL THROUGH VISUAL SERVOING" aims at making a laser spot follow the mouse cursor with the help of Visual Servoing. Visual Servoing is a rapidly maturing approach to the control of robot manipulators that essentially involves a feedback based on visual perception of robot and workpiece location. It is a multi-disciplinary research area spanning computer vision robotics, kinematics, dynamics, control and real-time systems. The methodology involves setting up an efficient closed loop system to track the mouse-cursor as well as the laser spot coordinates and to control the stepper motors (based on the visual feedback given by a fixed camera) so as to achieve the task in minimum time (in order of milliseconds). The implementation of

the project is successful to the extent that the laser spot comes close to the mouse cursor limited by an error arising due to the inherent discrete motion of the stepper motors. The use of DC motors with feedback could have been a better solution but was financially infeasible. The concept can be implemented in auto-pilot control and the research can be extended to the problem of dimensioning a 3-D space.

---

2007/IITK/IITK/40

**Evolutionary Relationship Among Pro-Apoptotic and Anti-Apoptotic Bcl-2 Family of Proteins**

*Abhinav Dubey, Biological Sciences & Bioengineering, IIT Kanpur*

Mentor: *R. Sankararamakrishnan, Department of Biological Sciences & Bioengineering*

Proteins are the products of evolution. Variations in protein sequences are continuously generated via several molecular mechanisms. Proteins get modified due to mutations and those with advantages are selectively retained. If the modified protein allows survival of progeny, the mutation is accepted in the population, and it can become the most frequent variant if it confers a selective advantage to the individual. This development implies that only functional, or at least non deleterious, variations of protein sequences are retained. Once we identify evolutionary relationship between two proteins from different species and highlight conserved amino acids, these amino acids are likely candidates for involvement in functional or structural behavior. This observation immediately suggests a strategy for detecting these residues. Our protein of interest over here is Bcl-2 family of proteins. The members of this family are critical regulators of pathways involved in Apoptosis or programmed cell death. They have been implicated in cancers and several neurological disorders. They all have similar folds despite the overall divergence in their sequences. We have attempted the reason behind the similar folds by investigating evolutionary relationship at the primary sequence level.

---

2007/IITK/IITK/41

**Identification of Aquaporins in Microbial Genomes**

*Vivek Bansal, Biological Sciences & Bioengineering, IIT Kanpur*

Mentor: *R. Sankararamakrishnan, Department of Biological Sciences & Bioengineering*

Water is the major component of all cells and tissues of all organisms. Initially it was believed that water is transported through biological membranes by simple diffusion only. But several phenomenon like the high permeability of RBCs and renal tubes, regulatory phenomenon observed for water transport could not be explained by membrane diffusion process only. Thus it was proposed that there exist some channel proteins in the membrane for transporting water. The discovery of 28-kDa integral membrane protein in RBCs and renal tubules ended this controversy. This water transporting membrane channel protein is named as 'Aquaporin', which can transport three billion water molecules per second. Several aquaporins have been identified till date and extensive studies have been carried out from various organisms. But no systematic study of Aquaporins in microbes has been carried out to our knowledge. Complete genome sequencing of 827 microbes has been done and sequences are available in public database repositories like NCBI. A search using bioinformatics tools is made in genome sequences of all these microbes to identify the probable genes coding for Aquaporins. We have identified the protein sequence from microbial genomes and these were further compared with already known sequences of plant and animal's aquaporins. One of the important properties of aquaporin is that it consists of two conserved NPA residues but we identified few sequences, which do not show this property. We also tried to categorize them according to their net positive charge and we further compared them with that of plant aquaporin's families. This study helps us a lot in better understanding of microbial aquaporins but further study and analysis is required for their characterization.

---

2007/IITK/IITK/42

**Analysis of Fluid Flow in Stomach-A Numerical Approach**

*Kritika Bhargava, Biological Sciences & Bioengineering, IIT Kanpur*

Mentor: *Anupam Pal, Department of Biological Sciences & Bioengineering*

Stomach is a multi functional muscular organ of the digestive tract where significant parts of digestion e.g. mixing, grinding and controlled release take place so that nutrients from chyme can be absorbed in small intestines at an optimum rate. The stomach has a highly complex three dimensional geometry with moving boundaries and the fluid within stomach is present in multiple phases. In addition detailed study of gastric flow is impossible in vivo. Thus we choose to simulate the flow using computer models. Presently two-dimensional models of stomach have been developed to simulate flow. We used

the Lattice Boltzmann method (LBM) to analyze the flow, which provides an easy way of implementing boundary conditions and usage of parallel algorithms. We have simulated flow in a two dimensional cavity with a moving lid and for two-dimensional stomach model. The stomach model analyzed flow associated with a peristaltic wave at a particular time instant and observed that influence of peristaltic wave is localized in the regions close to it. Mixing takes place in regions close to the peristaltic wave and not in the fundus. Scope for future work includes simulating flow for a more realistic two dimensional as well as three-dimensional geometry.

---

2007/IITK/IITK/43

**Imaging The Early Cellular Properties of Tumor Mutant Cells in Drosophila Model Using Genetic Mosaic Techniques**

*Unnati Gupta, Biological Sciences & Bioengineering, IIT Kanpur*

Mentor: *Pradip Sinha, Department of Biological Sciences & Bioengineering*

The high pathway and functional conservation of tumor suppressors between Drosophila and mammals suggest that carcinogenesis studies in flies can contribute to understanding of human cancer. Lot of research has been done on developed tumorous cells. But much less attention has been given to recently mutated cells which have potential to develop into tumorous cells and knowledge of whose cellular properties can lead to early diagnosis of cancer. Genetic mosaic techniques generate somatic clones by inducing genetic changes in a subset of cells, and are used to find out early stage differences between tumorous and normal cells. Endocytosis plays an important role in degradation of signaling, hence analysing endocytic properties of both type of cells can reveal early stage distinction between them. In my project work, I first standardized clone generation in *lgl Minute* genotype which has growth advantage. To study endocytosis FM dye was used which flouresces in hydrophobic environment. Initially experiments were done to standardize incubation time, optimum concentration, chase timing etc. Using lambda scan in confocal microscope excitation /emission bands for FM dye were determined. Successful live cell imaging was done using XYZt scanning. Experiments on fat mutant cells revealed that endocytosis was much more pronounced in tumor cells as compared to normal cells. This fascinating result lead to the hypothesis that endocytosis may be perturbed in tumor mutants.

---

2007/IITK/IITK/44

**Protein Cavities According to Wavelets**

*Prateek Goel, Chemistry, IIT Kanpur*

Mentor: *Pinaki Gupta-Bhaya, Department of Chemistry*

Proteins are the action molecules of life. An increasing number of protein structures are being determined for which no biochemical characterization is available. The analysis of protein structure is becoming an unexpected challenge. The shape analysis of protein cavities is done because cavities are the secondary structural elements, which have received less attention as compared to alpha helix and beta pleated sheets. Techniques have been developed to model the shape of protein cavity surfaces and the features have been analyzed with the technique of multiresolution wavelet analysis. Comparison has been done between corresponding cavities to extract the evolutionary relationships in protein structure, although entirely qualitatively.

---

2007/IITK/IITK/45

**Synthesis of Iron- Cementite Nano-Composites by Hot Pressing Technique**

*Anurag Gupta, Materials & Metallurgical Engineering, IIT Kanpur*

Mentor: *Sandeep Sangal, Department of Materials & Metallurgical Engineering*

Iron-Carbon system is one of the most important systems, scientifically as well as industrially. It finds use in areas of steel manufacturing, laminated structure production, tool coatings to name a few. In this study, nano-scale Cementite ( $\text{Fe}_3\text{C}$ ) powder was prepared through a dual-drive planetary mill, fabricated indigenously at IIT-Kanpur. The nano-scale Cementite ( $\text{Fe}_3\text{C}$ ) was mixed in varying proportions of 10 vol% and 20 vol% with pure Iron (Fe) to prepare a nano-composite by employing Hot Pressing technique. Samples were prepared by restricting two degrees of freedom, pressure and temperature, of the hot press to one, i.e. temperature. Pressure was held constant and the composite mixture was soaked at specified temperature for 30 minutes, followed by air cooling of the samples. Thereafter, the samples were characterized by Optical Microscopy and X-Ray diffraction. The effect of temperature variation on microstructure and hardness of the composite was studied. Based on this analysis, optimum conditions were determined for synthesis of the composite.

2007/IITK/IITK/46

**Searching for The Signs of Large Scale Anisotropy Showing Redshift Dependence**

*Saurabh Agarwal, Physics, IIT Kanpur*

Mentor: *Pankaj Jain, Department of Physics*

The first part of the project attempts to obtain the orientation axis of certain radio galaxies for which the celestial coordinates (B1950) are known. It has been attempted using astronomical data processing software like AIPS. The second part of the project attempts to find out the signs of some large scale anisotropy which not only depend on the declination and right ascension of radio galaxies but is also red shift dependent, so that alignment effect in the optical polarization from radio galaxies could be delimited by angular as well as radial coordinates. The likelihood has been used for testing the anisotropy assuming the null distribution is von-mises. A correlation has been proposed ansatz between the position of the sources and the polarization angle. The log likelihood of the modified function involves unknown parameters, which has to be then maximized. In order to achieve the same, a code has been written down, but so far the value of the parameter could not be found, perhaps a lot of calculated guess work is needed to achieve the same. Once this is done one can tell whether the red shift dependence is significant or not.

---

2007/IITK/IITK/47

**Measurement of Dynamic Properties of Compacted Soil Specimens in Proctor Mould**

*Manali Singh, Civil Engineering, IIT Kanpur*

Mentor: *Amit Prashant, Department of Civil Engineering*

The dynamic properties of compacted soils are required before designing an embankment for railway track or highway against static and seismic forces. Standard proctor test on the soil from borrow area are integral part of geotechnical investigations before proceeding with design as the compacted soil in a proctor mould represents approximately the same state of material and stress as it exists in the field after construction and the dynamic properties of soil are known to be a function of material state. The conventional methods are cumbersome, expensive and require expert hands. Alternatively, Bender-Element-System provides an easy, cost-effective and non-invasive way of determining wave velocities. The wave velocity is also measured often using bender elements in the tri-axial apparatus; however, the applied stress-state on the sample in this method is significantly different from field conditions and the specimen is subjected to considerable disturbance during sampling procedure. Here, the wave velocity is determined in the proctor mould itself by trying various alternative configurations mainly emphasizing on minimizing the boundary effects. Comparison of shear wave velocity with different time periods and different travel length has been made, which are essential for standardization of the procedure.

---

2007/IITK/IITK/48

**Characterization of FRP Bars for Use in Civil Infrastructure**

*Kapil Mathur, Civil Engineering, IIT Kanpur*

Mentor: *K. K. Bajpai, Department of Civil Engineering*

Co-Mentor: *Sudhir Misra, Department of Civil Engineering*

Fiber reinforced plastic (FRP) composite bars are available as alternatives to steel bars in reinforced concrete construction. Compared with steel, FRP bars offer the advantages of noncorrosive and nonmagnetic nature, high tensile strength and lightweight. However, FRPs are very new to the Indian construction scenario and unlike many countries, design codes on FRPs do not exist in India. Keeping above in mind, in the present study tensile characteristics of some commercially available FRP bars (with unidirectional glass fibres as reinforcement) were investigated and two efficient gripping mechanisms were proposed. Further, pull-out tests were conducted to investigate the bond behaviour of FRP bars and the effects of key parameters were observed. The bond-slip data obtained were compared with some existing bond-slip models, to examine their adequacy of reproducing experimental results. Finally, the basic development length of these bars was estimated and the findings were correlated with the provisions of American Concrete Institute Design Code (ACI 440).

---

2007/IITK/IITK/49

### **Instability and Transition in Rayleigh-Bénard Convection**

*Prateek Bhargava, Mechanical Engineering, IIT Kanpur*

Mentor: *Gautam Biswas, Department of Mechanical Engineering*

Thermal convection is an extremely important mechanism involving mass and energy transport in nature and technology. The classical Rayleigh-Bénard problem of the horizontal fluid layers heated from below offers a first approach to highly complex convective flow processes. This problem is characterized by the thermally unstable stratification in the gravitational field. The Rayleigh-Bénard convection in three-dimensional enclosures of intermediate aspect ratios (10 X 1 X 10) has been simulated by solving the unsteady Navier-Stokes and energy equations. The effect of thermal bounciness is brought about by the inclusion of a body force term. Boussinesq approximation was involved. The equations have been solved in primitive variables by using a modified version of Marker And Cell (MAC) algorithm in a uniform staggered grid. Up to a certain Rayleigh number, it is found that the flow can be described by two dimensional rolls. Beyond a certain Rayleigh number (greater than 6000) oscillatory instability creeps in and flow becomes unsteady periodic. Here the flow can be viewed as a dynamical system and Rayleigh number works as a forcing function. With further increase in Rayleigh number, the flow oscillates with multiple frequencies. It is conjectured that the flow bifurcates following a period doubling route. Finally, around a Rayleigh number of 30,000 the flow becomes chaotic. The exact route to chaos that describes the transition from one quasi-stable situation to another was tried to be deciphered as a part of the project.

---

2007/IITK/IITK/50

### **Study of Heat Transfer Characteristics in Quenching of Metal in Nanofluids**

*Ashank Mittal, Mechanical Engineering IIT Kanpur*

Mentor: *Sameer Khandekar, Department of Mechanical Engineering*

Nanofluids are suspensions of particles with sizes between 1 nm to 100 nm in a common base fluid like water, ethanol, toluene etc. These nanoparticles can be alumina, laponite, CuO or carbon nanotubes etc. Previous researches [1] have suggested that thermal conductivity of fluids with nanoparticles is enhanced by a significant amount. Since nineteenth century, concept of adding solid particles to base fluids to improve properties was prevalent. But due to sizes in milli or micro ranges, these fluids had the rheological and stability problems and settled down rapidly undergoing agglomeration and clogging. This motivated for development of nanofluids. The conductivity of nanoparticles are much higher than that of base fluids. Previous research has suggested trends like large increase in thermal conductivity, enhancement/reduction of heat transfer coefficients and increase in pool boiling and flow boiling on use of nanofluids. When a body heated to high temperature is quenched in a fluid, then it dissipates heat first by vapor bubble formation and later by creation of convection cycles. In both these stages, heat transfer coefficients are different. The aim of this work was to find the relative changes in these coefficients for water and nanofluids. A copper cylinder was heated to a high temperature of 400°C, flowed by rapid quenching in the subject fluid at room temperature. Temperature vs time plot was obtained using thermocouples attached with data acquisition system. A comparative analysis was conducted for experimental data obtained for different fluids. It was concluded that on use of alumina nanofluid, heat transfer coefficient increases in boiling regime but decreases in convection regime. While in case of laponite nanofluid, no significant changes are observed. Keywords: quenching, nanofluid, heat transfer coefficient, pool boiling

---

2007/IITK/IITK/51

### **Proposal for The Augmentation of The Globus Middleware Toolkit (GT4) to Enable Business Process Outsourcing**

*K. N. Praveen Kumar, Computer Science & Engineering, IIT Kanpur*

Mentor: *R. K. Ghosh, Department of Computer Science & Engineering*

Our idea is to develop a model for large collaborative business processes over the Internet. Trust and security are major concerns that are likely to hinder large business processes to be successfully conducted in a global scale. Also discovering the right partner for collaboration is an issue when an enterprise enters an increasingly competitive market. Fortunately, the concept of Grid promises to be a fully secure, high class collaborating platform among organizations irrespective of their physical locations across the globe. Though grids are mostly used for large scale scientific collaborations, they are becoming increasingly popular for commercial collaborations as well. An indepth study of the

Globus Middleware Toolkit (GT4) gives significant insight into building and deploying grid services and applications which solve the above problems. It's Monitoring and Discovery Service (MDS) solves the problem of discovering the competitive service providers. It's Grid Security Infrastructure (GSI) tackles the problem of securing Business transaction details through its robust authentication, authorisation and encryption mechanisms. The only problem that remains to be dealt with is the "trust" related to business deals. To represent trust management adequately in the context of BPO, we propose a rating system in the form of a centralised trust management model. In the proposed rating system, for each business entity in the system, we maintain a "Rating Reputation", "Normalisation factor", and a "Trust value". When a business transaction is initiated between two parties, they exchange signed "trust tokens" which have "a once use property". These tokens are used for mutual rating of the partners after the transaction is completed. The rating score can be viewed as the rater's perception of trust about the rated party on a fixed scale. So, our current task was to make necessary augmentations to the GT4 to implement this model.

---

2007/IITK/IITK/52

#### **Thermophysical Properties of n-alkanes Confined in Nanoporous Materials**

*Ankit Sinha, Chemical Engineering, IIT Kanpur*

Mentor: *J. K. Singh, Department of Chemical Engineering*

Co- Mentor: *Anil Kumar, Department of Chemical Engineering*

The normal alkanes are among the most fundamental series of molecules, being important in technological and scientific (organic, polymeric, and biological) fields. The grand canonical transition matrix monte carlo method and molecular dynamics have been adapted to study the properties of n-alkanes confined in cylindrical and slit pores. Monte carlo simulations have focused on mica pores while molecular dynamics simulations are done with graphite walls and single walled carbon nanotubes. Critical temperature, critical density, saturation pressure, z-density profiles and radial distribution function are considered for several alkanes. Effects of increase in number of carbon atoms in chain, temperature, material of walls, geometry and change in slit widths are considered. It is observed that the fluid phase diagram is substantially modified under confinement in porous materials. The critical temperature is lower than that in the bulk. Interestingly, all the properties show similar trends for both mica and carbon based walls, except critical density, which increases for mica based walls as opposed to carbon based walls. Molecular dynamics simulations are done using DL\_POLY, a molecular dynamics package. Characteristic z-density profiles and radial distribution function plots are obtained for ethane, propane and butane in graphite slit pores. Velocity Autocorrelation function is also calculated which will later be used to get diffusivity coefficients.

---

2007/IITK/IITK/53

#### **Stress-Time Superposition in a Model Soft Material (Toothpaste)**

*Diviya Sinha, Chemical Engineering, IIT Kanpur*

Mentor: *Y. M. Joshi, Department of Chemical Engineering*

Soft materials available commercially such as emulsions, foams, toothpastes and hair gels are structurally disordered and are not in thermodynamic equilibrium. The non-equilibrium state appears to be unstable and the gradual approach to equilibrium affects many properties of the material. These properties change with time, and the material is said to undergo "physical aging". The aging behavior in toothpaste (model of soft material) is investigated experimentally at different temperatures and deformation fields by a stress controlled rheometer. Aging has practical implications for the long-term behavior (creep or stress-relaxation) of soft materials as the material gradually stiffens with increasing time. An attempt to predict the long-term creep from tests of short duration taking into account the aging effects, by stress-time superposition, has been made.

---

2007/IITK/IITK/54

#### **Designing Plant-Wide Control Structure for Butane Isomerization Process**

*Lava Agarwal, Chemical Engineering, IIT Kanpur*

Mentor: *Nitin Kaistha, Department of Chemical Engineering*

Co- Mentor: *Siddhartha Panda, Department of Chemical Engineering*

Increasing competition in a global economy has rendered it essential for technical processes to be made more efficacious and economic. However, integration efforts involving introduction of material and energy recycles within the process lead to a dramatic increase in complexity of its dynamic behavior. In particular, traditional control strategies are designed for isolated production. Plant wide

control structure design in a chemical plant deals with structural decisions of a control system. This involves the choice of the attributes to control, how to pair variables, choice of plant equipment etc. This task calls for the synthesis of effective decentralized control structures. The current study focuses on designing the Control Structure for a chemical plant. As a test case, we consider an isomerization process that converts normal butane into isobutane. Initially, an optimum process flow sheet is designed for this process. Specifications of the DIB column, Purge column and the Adiabatic PFR are experimented with. The steady state case is then analyzed in detail. Various Plant Wide regulatory control structures are experimented with, the best working model is then chosen, and the dynamic performance of the plant is analyzed. The Reactor Inlet temperature was found to be a good production Handle. Simulations are done on HYSYS 3.2, comprehensive and powerful software used for simulation of chemical plants and oil refineries.

---

## Appendix B

### Abstracts: 2007 SURGE Research Projects Done in Foreign Universities

---

2007/IITK/CALTECH/1

#### **Compressed Sensing for DNA Microarrays**

*Sidhant Mishra, Undergraduate student (Electrical Engineering), IIT Kanpur*

*Mentor: Babak Hassibi, Associate Professor, Department of Electrical Engineering, California Institute of Technology, USA*

DNA microarrays are devices for sensing the presence and concentration of several genes simultaneously. Microarrays have spots that are capable of sensing a particular set of genes. To save on cost compressed sensing is done which can be formulated as an undetermined system of linear equations  $y=Ax$ , where  $x$  is the signal vector and  $y$  is the observed vector respectively.  $A$  is an  $m$  by  $n$  matrix called the sensing matrix, with  $m < n$ . This system in general cannot be solved unless the vector  $x$  is sparse and has less than  $k$  non-zero elements. The most popular method for recovery is L1 minimization. The measurement matrices in microarrays have a special structure which is not exploited by L1 minimization. We suggest an algorithm having a preprocessing step preceding L1 minimization that exploits the structure of the matrix. This algorithm performs much better than L1 minimization in terms of speed and the allowable number of non-zero elements in the signal vector  $x$ . It performs best with LDPC matrices. Further research on this issue includes extending the preprocessing algorithm to handle noise in measurements and construction of measurement matrices similar to LDPC matrices with  $m/n$  ratio suitable for practical applications.

---

2007/IITK/CALTECH/2

#### **Waveplate Modeling Using the 4x4 Matrix Technique**

*Nerella Tejaswi Venu Madhav, Undergraduate student (Physics), IIT Kanpur*

*Mentor: Andrew Lange, Goldberger Professor, Department of Physics, California Institute of Technology, USA*

Experiments designed to measure the polarization of the cosmic microwave background (CMB) answer crucial questions about the beginnings of the Universe. They aim to detect the gravity-wave background (GWB), which would confirm the inflationary model. Slabs of birefringent materials, called waveplates, are necessary optical components for such experiments. Difficulties arise in the study of the waveplate performance when the incident radiation is off axis and coherent. This is because the multiple reflections multiply the number of rays geometrically. The rays then add in a coherent manner. The performance of the waveplate was studied using a different approach, which used a 4x4 matrix to represent the transformation of the radiation as it passed through the system. This makes it easier to study the combined effect of the antireflection coatings also. The performance of the waveplate was studied off axis to around 10° and over two harmonics – at 150 and 225 GHz. The effects of dielectric loss, axis tilt and finite coherence length were also studied. The performances of Crystal Quartz and Sapphire were compared at 225 GHz. The algorithm used enables a complete study of the effect of any parameter on waveplate performance.

---

2007/IITK/CALTECH/3

#### **Average Case Complexity Theory**

*Piyush Srivastava, Undergraduate student (Computer Science and Engineering), IIT Kanpur*

*Mentor: Chris Umans, Assistant Professor, Department of Computer Science, California Institute of Technology, USA*

*Co-Mentor: Leonard Schulman, Professor, Department of Computer Science, California Institute of Technology, USA*

Informally, Average case Complexity theory considers the average complexity with respect to a probability distribution over the set of inputs, instead of the complexity on the worst case input, as a criterion for the hardness of a problem. With regard to this theory, we explore the notion of a natural distribution. In particular, we consider different bounds on the min-entropy of such distributions over input strings of a fixed length, and generalize the incompleteness theorem (under deterministic

reductions) for distributional problems using techniques based on the work by Gurevich[1991] . We also present some weak restrictions on randomized reductions under which problems with a uniform distribution are average case complete. These restrictions have generalizations to the case when the distribution is not uniform but still has an upper bound on its min entropy, over strings of a given length. We also describe our attempts to study the effect of unnatural encodings on average case completeness.

---

2007/IITK/EC/4

**Hardware Implementation of Fuzzy Logic Using VHDL**

*Vikas Kumar Sharma, Undergraduate student (Electrical Engineering), IIT Kanpur*

*Mentor: Laurent Cabaret, Professor & Head, LISA: Electrical and Computer Engineering Laboratory, Ecole*

*Centrale Paris, France*

*Co-Mentor: Celine Hudelot, Professor, LISA: Electrical and Computer Engineering Laboratory, Ecole Centrale*

*Paris, France*

A Fuzzy Logic approach is proposed to design the controller for a robot which has to come out of a maze by finding the suitable path on its own, if it is left anywhere inside the maze. The project involves designing a controller using Fuzzy Logic, an Artificial Intelligence tool to control the robot's speed and direction of motion and its hardware implementation on FPGA using VHDL. The most commonly used controller is proportional-plus-derivative-plus-integral (PID) controller, which requires a mathematical model of the system. Fuzzy Logic controller provides an alternative to PID controller since it is a better tool for control of systems that are difficult in modeling. The control action in Fuzzy Logic controllers can be expressed with simple "if-then" rules. The vision sensors sense the distance of the robot from any obstacle ahead and controller tells the robot to slow/fast its speed or/and to change the direction accordingly. First, the appropriate Fuzzy Logic functions were chosen for the robot's speed and their appropriate 'Rules' were formulated. Then, the speed controller was successfully simulated on VHDL. Finally, it is appropriately connected with the other parts of the controller (vision sensors, PWM and rotation sensor etc) and implemented on actual robot through FPGA.

---

2007/IITK/EC/5

**Post Treatment of PIV Experiments**

*Tapish Agarwal, Undergraduate student (Aerospace Engineering), IIT Kanpur*

*Mentor: Sebastien Ducruix, Responsible for Research, Laboratoire EM2C, CNRS et Ecole Centrale Paris, France*

*Co-Mentor: Severine Barbosa, Doctorate Student, Laboratoire EM2C, CNRS et Ecole Centrale Paris, France*

The work at the Laboratoire EM2C, Ecole Centrale Paris; comprised of the posttreatment of the images obtained by the PIV experiments. This included analysis of the data using Flow Manager for the correlation of the images and finding the velocity field of the flow. MATLAB was also used to verify and rectify the results obtained by Flow Manager. Tomography of the images was performed to locate some interesting sequence of images where moving vortices were visible to the naked eyes. Various schemes for the detection of vortices in the flow field were compared using some synthetic velocity fields so as to determine the better methods to find the convection speed and the frequency of the vortices in the actual flow field. Lambda2 method was selected as the best representation of characteristics of the actual flow field. The work also involved the development of a model of the actual injector and the combustion unit with CATIA so as to simulate the flow through the injector in FLUENT.

## **2007 SURGE Programme**

### ***Advisory Committee***

Sanjay G. Dhande (Director)

Sudhir K. Jain (Dean, Resource Planning & Generation)

R. K. Thareja (Dean, Academic Affairs)

Prawal Sinha (Dean, Student Affairs)

### ***Implementation Committee***

@ IIT Kanpur

Ajit Chaturvedi (Electrical Engineering)

C. V. R. Murty (Civil Engineering)

Manindra Agrawal (Computer Science & Engineering)

S. Sundar Kumar Iyer (Electrical Engineering)

Sanjay Mittal (Aerospace Engineering)

Sudhir K. Jain (Dean, Resource Planning & Generation)

Vibha Tripathi (Samtel Center for Display Technologies)

@ Caltech

Carolyn Ash (Student-Faculty Programmes)

Candace Rypisi (Director, Student-Faculty Programmes)

Siddharth Dasgupta (MSc5/CHM/1980) (Associate Director)

@Ecole Centrale Paris

Pierre Becker (Professor)

Sebastien Ducruix (Professor)

### **RPG Office Staff in SURGE Team**

Mohammad Shakeel

Bhaskar Bapat

Sandhya Agnihotri

Neha Gupta

Anamika Dixit Vajpai

A. C. Saini

S. S. Tiwari

---

## **For more details, please contact**

Dean, Resource Planning & Generation  
Indian Institute of Technology Kanpur  
Kanpur 208016

Phone: (91-512) 259 7635  
Fax: (91-512) 259 0353  
E-Mail: [drpg@iitk.ac.in](mailto:drpg@iitk.ac.in)

