IIT KANPUR

Indian Institute of Technology, Kanpur

ANNUAL REPORT 2016

SUMMER UNDERGRADUATE RESEARCH AND GRADUATE EXCELLENCE

Message from Dean, Research & Development

Dear SURGE Friends,

Congratulations to all the 2016 SURGE fellows and their mentors on another successful summer!

The success of the program has been possible due to hard work of SURGE fellows, enthusiastic and dedicated faculty mentors, excellent support provided by staff members, and financial support by our illustrious alumni .

A record number of approximate 1600 applications were received from different colleges and 92 excellent students from different institutions and from IITK were welcomed to the IITK campus for SURGE.

I would like to congratulate all the members of SURGE family who made this summer so successful. Thanks to the SURGE Core Committee, for their invaluable leadership. Thanks to the all mentors who took time out of their busy summers to direct the boundless energy of SURGEians down the most illuminating path.

Finally, thanks to all of the friends and alumni whose donations help make SURGE financially possible. I applaud all of your tremendous generosity and look forward to your continued support.

Helping support the next generation of innovators is truly an investment in the future!

Thank you!

Amalendu Chandra
Dean of Research & Development

SURGE Program-An Overview

IIT Kanpur launched a 8-week SURGE (Summer Undergraduate Research and Graduate Excellence) program in the summer of 2006. Under this program, a small number of selected undergraduate students from top engineering colleges from all over India are given an opportunity to explore research and to experience the academic atmosphere of IIT Kanpur. Students in second and third year of their academic program are selected from a large pool of applicants. The students get selected on the basis of their academic record, their research proposal & their technical achievements.

Under the SURGE program, students undertake short duration, but focused on research project and push their intellectual abilities beyond those driven by the classroom. The SURGE participants are required to give a mid-term presentation after four weeks, to a review committee consisting of a group of academic staff members. The review committee gives feedback and suggests possible improvements in the work. At the end of the program all the SURGE students make a poster presentation of the work carried out at IITK. The poster presentation is open to the public. It is also evaluated by faculty members.

This year, the scope of the SURGE Programme was extended to include candidates which were to be funded through projects of faculty members and also those who would not be receiving any funding at all. This desired expansion of the SURGE program was aimed at creating more impact of undergraduate internship through the established platform of SURGE.

As per current institute norms, SURGE can recently accept 60 students from Institute Funding, 120 students from Project Funding, 100 students under Self Funded category and few students under Industry IITK tie-up. A maximum of 04 students from NEPAL + BHUTAN may be allowed to participate in the SURGE program. This year (in 2016), one SAARC student (from Nepal) was selected under SURGE program.

SURGE overseas program welcomes overseas institutes as well. At present, IITK has a exchange program with Melbourne School of engineering, Australia.

Few selected students are given stipend, all students are given a commendation certificate and those who produce exceptional quality research are given an award in addition to the certificate.

Table of Contents

	Page
Message from DORD	i
SURGE Program- An overview	ii
Funding SURGE	1
Participants of SURGE 2016 from IITK	2
Participants of SURGE 2016 at IITK from other Universities	4
Participants of SURGE 2016 from IITK to Overseas University	7
Photographs of Inauguration	8
Abstracts: SURGE 2016 Research Projects Done at IIT Kanpur	9
Abstracts: SURGE 2016 Research Projects Done in Overseas Universities	51
Surge Popular Lectures	52
Surge Awards	57
Acknowledgement	58
Surge 2016 Committee	59

Funding SURGE

The Dean of Resources and Alumni Office raises funds to support SURGE students from a variety of sources including gifts from individuals, foundations, and corporations. SURGE depends upon the generosity of its many friends for annual gifts or for contributions to the SURGE endowment to build a robust financial base. We thank the donors who have supported SURGE 2016 and beyond! Endowments help to ensure the future of the SURGE program and provide students with unparalleled research opportunities.

Special Thanks to: Batch 1977 and 1980, Shri N R Narayana Murthy

Institute Funded

This year 35 students received full support (stipend of Rs 12,500 for the eight week summer program**)** while 7 students received partial support and one student from Nepal received full support from the funds raised from external sources.

Project Funded

This year 9 student's received stipend from institute projects (The suggested stipend for 8 weeks duration is between Rs. 8000 to Rs. 12500).

Self Funded

This year 50 students were selected in SURGE Program under the self funded category.

Opportunities still available for new endowments

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

Participants of SURGE 2016 from IITK

S.N	Name of the Participant	Project Title	Mentor
1	Abhineet Singh Rajput	3D Sewing Machine	Prof. Ishan Sharma Mechanical Engineering
2	Aditya Srivastava	Robust Change Point Detection in Cognitive Radio Networks	Prof. Ketan Rajawat Electrical Engineering
3	Akshay Bhola	Turbomachine Blading & Rotor Analysis- Stress Patterns under flow path excitation	Prof. Nalinaksh S. Vyas. Mechanical Engineering
4	Alok Kumar	Fracture in soft brittle gel	Prof. Animangsu Ghatak Chemical Engineering
5	Amit Kumar Smarty	To study flow past an obstacle for different forms of surfaces	Prof. Arun K Saha Mechanical Engineering
6	Aneek Maiti	Braid Group	Prof. Abhijit Pal Mathematics & Statistics
7	Arindam Raj	Mechanical Properties of Double Walled Carbon Nanocones	Prof. Shakti Gupta Mechanical Engineering
8	Ashabari Majumdar	Synthesis and Characterization of Binary and Tertiary Compounds formed by Copper, Zinc, Tin and Sulfur	Prof. Sarang Ingole Materials Science & Engineering
9	Ayush Agrawal	Vulnerability of Indian widows	Prof. Debayan Pakrashi Humanities & Social Sciences
10	Ayush Gupta	Bio-inspired Antibacterial Adhesive	Prof. Animangsu Ghatak Chemical Engineering
11	Bhutada Sarang Shrirang	Fabrication Of A Bio-Mimetic Scaffold For Acl Tissue Engineering	Prof. D.S.Katti Biological Sciences & Bioengineering
12	Deepali Gupta	Fluid Transport Through Paper Based Microfluidic Devices	Prof. Panda Chemical Engineering
13	Dobaria Nisarg Jagdishbhai	Purification of recombinant Mycobacterial Toxin-antitoxin from M. smegmatis	Prof. S Matheshwaran Biological Sciences & Bioengineering
14	Ishan Agnihotri	To develop a function for computing common volume between two meshed cad models	Prof. Bhaskar Dasgupta Mechanical Engineering
15	Ishan Pandey	Turbomachine Blading & Rotor Analysis- Structural dynamic modeling of a turbine bladed disc	Prof. Nalinaksh S. Vyas. Mechanical Engineering
16	Kartikey Bhargav	Portfolio VaR Optimization for Asymmetrically Distributed Asset Returns	Prof. Praveen Kulshreshtha Humanities & Social Sciences
17	Kartikeya Srivastava	Solid to Mesh Generation using 3D scanner	Prof. Shikha Prasad Mechanical Engineering
18	Karttikeya Mangalam	Binary Image Recombination after Bitwise operations of Cellular Automaton	Prof. KS Venkatesh Electrical Engineering
19	Kisalaya Mishra	Elliptic Vortex Rings	Prof. Debopam Das Aerospace Engineering
20	Kumari Shilpa	Development of theoretical model for filtering drinking water through activated carbon block	Prof. Nishith Verma Chemical Engineering
21	Lakshya Gangwar	Development and Performance testing of a Flexible Heat Pipe for spacecraft applications	Prof. Sameer Khandekar Mechanical Engineering
22	Lavanya Taneja	Studying Photon Entanglement in the Orbital Angular Momentum Basis	Prof. Anand Kumar Jha Physics
23	Mohammad Ashraf	Aerodynamics of Cricket Ball using Finite Element Method	Prof. Sanjay Mittal Aerospace Engineering
24	Nisha Mehta	Electronic structure and hydration dynamics of portlandite material using Density Function Theoretical (DFT) Calculations	Prof. D.L.V.K. Prasad Chemistry

S.N	Name of the Participant	Project Title	Mentor
25	Prashant Singhla	Rheology of Clay Emulsions	Prof. Yogesh Joshi Chemical Engineering
26	Rishabh Agnihotri	Hyperbolic geometry and subgroup of surface group are almost geometric	Prof. Abhijit Pal Mathematics & Statistics
27	Ritwik Bera	A Differential Game-Theoretic Solution to Collision Avoidance	Prof. Mangal Kothari Aerospace Engineering
28	Sahil Jindal	Application of Ray Tracing Techniques in Analysis of Micro-Heat Transfer Using Laser Induced Fluorescence	Prof. Samir Khandekar Mechanical Engineering
29	Sana Khanum	Internally heat integrated propylene-propane splitter	Prof. Nitin Kaistha Chemical Engineering
30	Sharun Kuhar	Simulating flow past suspended aerofoil using discrete and continuous immersed boundary method	Prof. Arun K Saha Mechanical Engineering
31	Shashwat Ranjan Chaurasia	Turbomachine Blading & Rotor Analysis -Crack Initiation and Propagation Analysis and Life estimation	Prof. Nalinaksh S. Vyas. Mechanical Engineering
32	Shaurya Aarav	Experimental demonstration of a source with finite, translationally-invariant spatial coherence	Prof. Anand Kumar Jha Physics
33	Shivi Dixit	Study of Relaxation modulus at different pre and post gel states.	Prof. Yogesh Joshi Chemical Engineering
34	Sourav Kumar Sinha	Preliminary Design and Controller Development of a Small-sized Quad-Tiltrotor	Prof. Abhishek Aerospace Engineering
35	Utkarsh Shukla	Modelling of an evaporative cooler unit for post-harvest	Prof. Sandeep Sangal Materials Science & Engineering
36	Vishal Rana	Queuing Analysis for Cognitive Radio Networks	Prof. Aditya Jagannatham Electrical Engineering

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

Participants of SURGE 2016 at IITK from Other Universities

S.N	Name of the Participant	Institute Name	Project Title	Mentor
1	Aarush Sood	Chandigarh Col Of Engg & Technology	BANDSAW	Prof. Ishan Sharma Mechanical Engineering
2	Abhiram Shukla	NIT Raipur Chhatisgarh	Different techniques used for Measurement of Hydration of high performance cement based material and Material Characterization Techniques for Cement based materials	Prof. K V Harish Civil Engineering
3	Abhishek Kumar	IIT, Bhubaneswar	Performance Prediction and Conceptual Design of a Quadtiltrotor.	Prof. Abhishek Aerospace Engineering
4	Akash Dayal	Manipal University Jaipur	Safety Analysis of Nuclear Power Plant	Prof. Prabhat Munshi Mechanical Engineering
5	Alok Kumar	IIT, Patna	Wetting of textured surfaces (Laser Texturing)	Prof. J. Ramkumar Mechanical Engineering
6	Amal Jerald Joseph M	NIT, Trichy	Preparation and characterization of mechanical properties of Carbon Nanotube-Bioglass scaffolds for biological applications.	Prof. Niraj Sinha Mechanical Engineering
7	Anant Kumar Jain	BITS, Pilani	Pushing the limits of Piedfort Diads towards small molecule encapsulation	Prof. Raja Angamuthu Chemistry
8	Anchal Bhalotia	BITS Hyderabad	Brihaspati -4 , Peer -to - Peer protocol.	Prof. Y. N. Singh Electrical Engineering
9	Anubhav Gokhale	Motilal Nehru NIT	Flow Through Aerospike Nozzles	Prof. Rakesh K Mathpal Aerospace Engineering
10	Anushri Surbhi	Central University Of Jharkhand	Ytterbia co-doped Scandia stabilized Zirconia electrolyte for Solid oxide fuel cells.	Prof. Kantesh Balani Materials Science & Engineering
11	Apoorv Garg	Asian Inst Of Tech, Bangkok	Effect of Uncertainty in Coefficient of Friction on Performance of Base Isolated Structures	Prof. Samit Ray Chaudhary Civil Engineering
12	Arpit Tripathi	Motilal Nehru Nit Allahabad	Mirror finish on steel workpiece using advanced magnetic field assisted nanofinishing techniques	Prof. J. Ramkumar Mechanical Engineering
13	Avijit Saha	IIT Kharagpur	Development of solver for stability analysis of linearized Euler equations governing unsteady motions in combustion chambers	Prof. Sathesh Mariappan Aerospace Engineering
14	Ch.chandrasekhar	RGUKT NUZVID	Different Test methods on High Performance Concrete	Prof. K V Harish Civil Engineering
15	Digbijoy Mukherjee	Jadavpur University	Unsteadiness of Sudden Expansion Flow	Prof. Ashoke De Aerospace Engineering
16	Divyanshu Shahi	NIT, PATNA	Phase Change Materials(PCM) in Latent Heat Thermal Energy Storage Systems	Prof. Arvind Kumar Mechanical Engineering

S.N	Name of the Participant	Institute Name	Project Title	Mentor
17	Gagandeep Jasjeet Kalshi	College Of Engineering, Pune	EBSD study of thermomechanical processing of duplex steel	Prof. Shashank Shekhar Materials Science & Engineering
18	Gaurav Kunal Jaiswal	IIT, Kharagpur	Experimental and Computational investigation of jet from an under-expanded serpentine nozzle	Prof. Abhijit Kushari Aerospace Engineering
19	Gourav Mundhra	NIT Durgapur	Effect of Pre-strain On Tensile Behavior of Age Hardenable Aluminium Alloys	Prof. N P Gurao Materials Science & Engineering
20	Harleen	Panjab University	Metal ion mediation in C3 symmetric peptides	Prof. Sandeep Verma Chemistry
21	Jadhav Omkar Vikram	IIT, BHU	Frequency analysis to determine return period of floods	Prof. Shivam Tripathi Civil Engineering
22	Joglekar Shreyas Sanjay	Govt College Of Engg,Pune	Modelling of Homogenisation Kinetics with multicomponent Diffusion coefficients	Prof. Kaustubh Kulkarni Materials Science & Engineering
23	Kushaal Nair	NIT Calicut, Kozhikode	Cooling Flows in Hyper Gravity Environments	Prof. Vaibhav Arghode Aerospace Engineering
24	Laxmi Jha	NIT,Durgapur	peer to peer software development(combined version of tapestry and chord)	Prof. Y. N. Singh Electrical Engineering
25	Madhurima Chandra	University Of Hyderabad	Anaysis of Unorganized Sector using NSS Data	Prof. Tanika Chakraborty Humanities & Social Sciences
26	Mandar Bhanudas Kamalaskar	IIT Kharagpur	Missile Guidance with Impact Angle Constraints	Prof. Mangal Kothari Aerospace Engineering
27	Mohini Gupta	NIT Rourkela	Fabrication of LECs (Light Emitting Electrochemical Cells).	Prof. Deepak Gupta Materials Science & Engineering
28	Narendra Paidi	RGUKT NUZVID	A simple hoverer using flapping airfoil	Prof. Sachin Shinde Mechanical Engineering
29	Nimish Khandelwal	Motilal Nehru NIT, Allahabad	Numerical Modelling and Simulation of Solar Pond with Wall Shading effect.	Prof. Jishnu Bhattacharya Mechanical Engineering
30	Paritosh Gaiwak	S.G.S.I.T.S Indore	Indoor Localization using Cellular Technique	Prof. Ketan Rajawat Electrical Engineering
31	Puranjay Rohan Gulati	Delhi Technological University	Coherence Characterisation of Optical Sources	Prof. R. Vijaya Physics
32	R Santhosh Kumar	IIT, Madras	Visual Question Answering	Prof. Gaurav Sharma and Vinay Namboodiri Computer Science & Engineering
33	Raghavendran. R	SASTRA University	Acoustic instabilities in Solid Rocket Motors.	Prof. Sathesh Mariappan Aerospace Engineering
34	Rahul Kumar	IIT Kharagpur	Mesh Partitioning	Prof. Sanjay Mittal Aerospace Engineering
35	Rahul Mohideen K	Shiv Nadar University	Spatial Information using a light field array	Prof. KS Venkatesh Electrical Engineering
36	Rashika Mittal	MIT, Manipal, Karnataka	Quantum Dot immobilized TiO2 nanofibers for waste water treatment applications using photocatalysis.	Prof. Raju Gupta Chemical Engineering

S.N	Name of the Participant	Institute Name	Project Title	Mentor
37	Rinki Kumari	Indian School Of Mines,Dhanbad	Combined Electronic Structure / Molecular Dynamics Approach for Ultrafast Infrared and Raman spectroscopy for aqueous NaF solution	Prof. Amalendu Chandra Chemistry
38	Ronit Kumar	PDPM IIITDM Jabalpur	Phase Change Material based waste heat recovery system	Prof. Arvind Kumar Mechanical Engineering
39	Saheli Mitra	IIT, Kharagpur	Hannay angle in dissipative systems	Prof. Sagar Chakraborty Physics
40	Salil Manoj Pai	BITS Pilani Goa Campus	Primary Atomization of n-Dodecane	Prof. Santanu De Mechanical Engineering
41	Satyam Khanna	University Of Petroleum & Energy	Techno-Economical feasibility analysis of solar charging for E-rickshaws.	Prof. Anoop Singh Industrial & Management Engineering
42	Shiny Choudhury	CET Bhubaneswar	Numerical analysis of 1-D premixed and non-premixed flames in high temperature and low oxygen concentration oxidizer; using CANTERA	Prof. Vaibhav Arghode Aerospace Engineering
43	Shreya Jain	Motilal Nehru NIT	Flow modelling in vertically heterogeneous unsaturated soils	Prof. Richa Ohja Civil Engineering
44	Shweta	Rajasthan Techical University Kota	1-Dimensional stability analysis of Blasius flow using spectral method	Prof. Alkesh Chandra Mandal Aerospace Engineering
45	Somesh Pandey	IIT, Roorkee	Traffic Modelling using Microscopic Simulation	Prof. Anurag Tripathi Chemical Engineering
46	Sourabh Khandelwal	IIT BHU ,Varanasi	Electrohydrodynamic Atomisation	Prof. Pradipta Panigrahi Mechanical Engineering
47	Sourav Jena	BIT Mesra, Patna	Retrofitment of CNC machines for hybrid layered manufacturing.	Prof. J. Ramkumar Mechanical Engineering
48	Sumit Vashishtha	Z.H.C.E.T, AMU	Large Eddy Simulation for Rayleigh-Benard Convection.	Prof. Mahendra K. Verma Physics
49	Suryadeep Nath	IIEST	Effect of wing stiffness on Aerodynamics of flapping winged creatures	Prof. Debopam Das Aerospace Engineering
50	Suyash Sudhir Nilawar	VNIT Nagpur	Design and development of experimental facility for an active control of coaxial jet flow field and its study.	Prof. Pradipta Panigrahi Mechanical Engineering
51	Swapnil Shandilya	PDPM IIIT DM	Design and Manufacture of a novel Hovering Device	Prof. Sachin Shinde Mechanical Engineering
52	Taaresh Sanjeev Taneja	BITS Pilani K K Birla, Goa Campus	Development of Rapid Models of Air Flow through Louvers	Prof. Vaibhav Arghode Aerospace Engineering
53	Tanmoy Paul	IIT, BHU	Robust Path Planning Algorithms	Prof. Mangal Kothari Aerospace Engineering
54	Vinayak Mahbubani	IIT Kharagpur	Public opinion analysis of climate change and energy in the United States of America.	Prof. Deep Mukherjee Humanities & Social Sciences
55	Vishal Rathor	IIT Kharagpur	Linear Stability Analysis	Prof. Sanjay Mittal Aerospace Engineering
56	Vishal Vyas	Rajasthan Technical University	1-D stability analysis of Falkner and Skan flow by spectral method	Prof. Alkesh Chandra Mandal Aerospace Engineering

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

Participants of SURGE 2016 from IITK to Overseas University				
S.N	**Name of the Participant**	**Name of the Institute**	**Project Title**	**Mentor**
1	Arunothia Marappan	Melbourne School of Engineering, University of Melbourne	Propagation Complete Encodings for SAT Solvers	Associate Professor Harald Sondergaard


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Abstracts: SURGE 2016 Research projects done at IIT Kanpur

3D Sewing Machine
Abhineet Singh Rajput, Mentor: Prof. Ishan Sharma

The objective of this project is to design and fabricate a sewing machine that mechanizes the production of handicraft goods made from sikki grass. The idea behind sewing is to tie two forms of sikki grass using helical loops. These loops are formed by the needle that rotates about one bundle hence forming a rope and at the same time involving few grasses from previous bundle that gives rise to a two dimensional structure. This base is then connected along its end using the same helical patterns hence forming a 3d model.

The machine consists of a motor that powers the system. This system consists of needle that punches hole and provides the feed. While punching hole it doubles the loop that are made single again by a spring loaded wheel that rotates in phase with needle and is powered by the same motor. A gear train involving 3 gears powers this wheel. While the needle is powered by sun and planet system. The present design of machine is a improved version of previous designs that uses 60 cm feed and has reduced frictional force. This reduction in frictional force increases the punching force that makes sewing easier.

Robust Change Point Detection in Cognitive Radio Networks
Aditya Srivastava, Mentor: Prof. Ketan Rajawat

Cognitive Radios use the radio spectrum owned by other users. They perform radio environment analysis, identify the spectral holes and then operate in those holes. In cognitive radio terminology Primary user refers to a user who is allocated the rights to use the spectrum. Secondary user refers to the users who try to use the frequency bands allocated to the primary user when the Primary User is not using it.

Cognitive radio networking allows the unlicensed secondary users to opportunistically access the licensed spectrum as long as the performance of the licensed primary users does not degrade. This dynamic spectrum access strategy is enabled by cognitive radio coupled with spectrum sensing technologies. Due to the imperfection of wire-less transmissions, collaborative spectrum sensing (CSS) has been proposed to significantly improve the probability of detecting the transmissions of primary users. Nevertheless, current CSS techniques are sensitive to malicious secondary users,

leading to a high false alarm rate and low detection accuracy on the presence of the primary users.

Turbomachine Blading & Rotor Analysis- Stress Patterns under flow path excitation

Akshay Bhola , Mentor: Prof. Nalinaksh S. Vyas

Turbomachines have versatile applications and it is important to analyze the rotors design to predict their life and to improve it. Emerging blade technologies are finding it increasingly essential to correlate blade vibrations to blade fatigue in order to assess the residual life of existing blading and for development of newer designs. A major step toward fatigue analysis of turbine blade is the determination of stress field on blade. In this study, efforts have been made to estimate the effects of stresses induce at steady state and transient state of turbine rotor using Finite Element Method. A 3D CAD modal of rotor and blade is created. Blade has tapered, twisted, asymmetric cross section and is mounted at stagger angle with radial direction of turbine. The material of the rotor is 28CrMoNi steel and properties of the material are updated to the modal. The modal is analysed for steady and transient motion of blade. Both free and forced vibration analysis is conducted using modal and harmonic analysis. The stresses induced due to vibration in static and transient state is evaluated. Modelling of the turbine is conducted in Solidworks-16 and for analysing the structure by Finite Element Method; ANSYS-15 platform is used.

Fracture in soft brittle gel

Alok Kumar, Mentor: Prof. Animangsu Ghatak

The objective of our work is to study the shear fracture in polyacrylamide hydrogel block. The hydrogel blocks were connected to each other through a particular geometric shape. The effect of the geometric shape and the shear modulus of the hydrogel on the fracture energy of the gel block was studied. It was found out that the initiation of fracture, its progress and the fracture energy depended on both geometric shape and the shear modulus of the hydrogel block. In the shear fracture process, before the fracture starts fingering like phenomenon takes place. The fingering phenomena start near the periphery of shape, propagates radially inward, and merges at the end of fracture. The fracture starts only after a certain force Fmax is applied. For the same contact area between the two blocks, the different geometric shapes showed different fracture energy and maximum force attained in the process of fracture. The pentagon has the highest while triangle has the lowest fracture strength among triangle, rectangle, pentagon, hexagon and circle. To investigate the effect of aspect ratio on fracture energy we had conducted the shear fracture on gel sample connected with elliptical and rectangular opening of different aspect ratios varying from 0.32 to

3.125. In case of rectangular opening, the fracture strength decrease asymptotically with aspect ratio.

To study flow past an obstacle for different forms of surfaces
Amit Kumar Smarty, Mentor: Prof. Arun K Saha

The objective of this work is to study the flow past different forms of surfaces. We have studied two dimensional flows past four different bluff bodies – square, triangular, diamond - basically a combination of triangular cases. We have also studied the drag and lift forces that act on an obstacle of triangular cylinder, by calculating the drag coefficient for upstream and downstream cases as well as for diamond case. The Direct Numerical Simulation (DNS) of two dimensional incompressible flows past these bluff bodies were carried out at various Reynolds number in both the steady and unsteady cases. The Navier Stokes equations are solved using higher order spatial and temporal discretization. Numerical simulations were carried out using the MAC method. In the case of triangular cylinder, both the cases of the triangle – the vertex facing the flow and base facing the flow were studied. In all of the cases, the recirculation lengths and strouhal number were determined for various Reynolds number. In each case, the range in which the critical Reynolds number lies was also determined.

Braid Group
Aneek Maiti, Mentor: Prof. Abhijit Pal

In this project I have discussed about "Braid Group" and 'Word Problem' for Braid Group. Every group has its own word problem, which is given two elements (words) of a group can we say if they are equal. I have find out a solution for this problem in Braid Group. I have taken both words in a particular canonical form and then compared them. Then I have discussed about an efficient way to find the solution, which includes an isomorphism from the positive semigroup of Braids to Symmetric Group. Then we define a lattice structure and find the particular canonical form.

Mechanical Properties of Double Walled Carbon Nanocones
Arindam Raj, Mentor: Prof. Shakti Gupta

Here, we present a molecular mechanics (MM) based study to show sharp changes in the variation of potential energy and wall morphology in double walled carbon nanocones (DWCNCs), when the constituent cones are pulled away from each other.

In the MM simulations, bonded and non-bonded inter-actions among carbon atoms are prescribed

using MM3 potential. The process of pulling out is simulated by constraining the base atoms of an inner cone and incrementally moving the tip atoms of the outer cone in the coaxial direction. In the relaxed state DWCNCs, the wall to wall normal distance between the cones is found to be 3.4 Å, consistent with that obtained in two-layered graphene sheets. For each incremental step of separation, the minimum energy configuration of the entire system is obtained and the associated potential energy recorded. The instability leads to loss of concentricity of the cross-sections of cones in the sense that the wall of the outer cone deforms, making a single-sided cam-lobe type structure. We simulate a nanoscopic CNC as a macroscopic frame-like structure, primary bonds modeled as beams and the van der Waals force as springs between two interacting. The stiffness matrix method for linearly elastic space frame problems has been used and the required parameters for the structural analysis were obtained from the MM3 force field energy formulations.
Subsequently, pulling apart of constituent shells of DWCNCs was simulated similarly to the scheme followed in MM simulation as described above, and the pattern of the strain induced was studied to explain the effect described above.

Synthesis and Characterization of Binary and Tertiary Compounds formed by Copper, Zinc, Tin and Sulfur
Ashabari Majumdar, Mentor: Prof. Sarang Ingole

CZTS solar cells are the emergent solar cells. These have properties such as less toxic, renewable and elements required are abundant in nature. To understand the functioning of the cells it is important to study the properties of the compounds formed with these elements –copper, zinc, tin and sulfur. So we tried to study all the possible binary and tertiary compounds formed by the above mentioned elements by synthesizing them and analyzing their characteristics through scanning electron Microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX), X-ray diffraction (XRD) and with Raman spectroscopy. .This was done to investigate the chemical properties of the compound formed in CZTS cells and to compare it with the characteristics of binary and tertiary compounds. Cu2SnS3 showed same XRD peaks as CZTS solar cells which is promising to some extent.Tin Sulphide has high vapour pressure, so it evaporates easily and the nature of thin film becomes flaky. It was noticed as the partial pressure was increased the film became more and more flaky.

Vulnerability of Indian widows
Ayush Agrawal, Mentor: Prof. Debayan Pakrashi

This project is an effort to get the insights of their health conditions and to locate various socio-

economic factors that can affect their well-being. Emphasis is given on their Anthropometry conditions to find their physical well-being.

To achieve our purpose, we have used India Human Development Survey (IHDS) dataset ,which is a multi-topic survey of 41,554 households in 1503 villages and 971 urban areas. The first round of this survey was done in 2004-05 and the second round was completed in 2011-12.

In this project, one of our prime aim is be to compare the difference in health status of married women and widows in Indian household. To get the complete insight , we have used the literacy level of Indian women and their employment status to deduce the impact of these variables on their health status.

Bio-inspired Antibacterial Adhesive
Ayush Gupta, Mentor: Prof. Animangsu Ghatak

Dry adhesive pads of several creatures including spiders, insects (beetles and flies) and geckoes are capable of attaching to variety of surfaces. Compared to artificial visco-elastic glues, the bio-inspired ones have the advantage that they remain usable even after repeated applications. There have been several attempts to mimic these properties by manufacturing hierarchically structured adhesives, with some success. The important challenge, however, is scaling up of hierarchical structures over a large surface area in an economically viable process.

Self-assembled patterning via template synthesis is promising field for the generation of hierarchical structures (micro to nano) which resolves scaling issues without the use of expensive lithographic techniques. Inspired by natural dry adhesive systems, here we describe a process which essentially involves moulding a crosslinkable material on a rough template. When a crosslinkable elastomeric material is cured against such rough templates, it results in surface patterns of different length scales from few microns to tens of nano-meters.

Fabrication Of A Bio-Mimetic Scaffold For Acl Tissue Engineering
Bhutada Sarang Shrirang, Mentor: Prof. D.S.Katti

Anterior cruciate ligament (ACL) is one of the major ligament in the knee joint which joins femur to the tibia and provide knee stability. ACL injury is one of the most common musculoskeletal. Due to the intra-articular environment of ACL, ACL injury does not heal on its own. The treatment options include primary surgical procedures and ACL reconstruction procedures. But these treatments have high failure rates and certain other disadvantages.

Hence researchers are trying to develop an alternative approach to treat ACL injuries using tissue engineering. Tissue engineering aims to regenerate the damaged tissue by using cells, scaffold,

biological factors either alone or in combination.

The objective of this work is to develop a scaffold which mimics the architecture of native ACL. The native ACL has two zones. The inner zone has longitudinally aligned cells and ECM which is surrounded by a layer called epiligament having circumferentially aligned cells and ECM. We attempted to mimic this architecture. Silk was isolated from *B. mori* cocoons. The longitudinally aligned porous scaffolds were fabricated using freeze-drying. Different combinations and concentrations of polymers were used for optimization of pore size. It was found that the pore size was improved using acetic acid and decreasing the polymer concentration increased the pore size. The outer layer of the scaffold is a circumferentially aligned silk fibre sheet which was fabricated using electrospinning. Electrospinning parameters were optimized to get aligned silk + PEO fibres. But the alignment was lost after β-sheet induction. Further optimization need to be done to achieve desired fibre alignment fabricate final scaffold.

Fluid Transport through Paper Based Microfluidic Devices
Deepali Gupta, Mentor: Prof. Panda

'Paper based Microfluidics' is a new alternative technology for fabricating simple, low cost, portable and disposable analytical devices for many application areas including clinical diagnosis, food quality control and environmental monitoring. The unique properties of paper which allow passive liquid transport and compatibility with chemicals are the main advantages of using paper as a sensing platform. It is cheap, accurate, can be used by anyone and can reach places where sophisticated instruments cannot. All these features make it an attractive field of research and development.

The objective of the project was to study about fluid transport through paper with a vision of development of a paper based microfluidic sensor. First, characterization of flow of different fluids through different types of papers was done. We experimented with the length and width of paper to minimize wastage of analyte. The flow rate proved very difficult to measure accurately since the rate decayed very rapidly as liquid moved farther along the membrane. An easier parameter to measure was the capillary flow time, the time required for liquid to move along and fill completely a strip of defined length. We designed experiments to determine thermodynamic parameters namely- *porosity* of paper, and *permeability* related to fluid flow.

We also designed methods to control fluid flow rate. We used sugar solutions of different concentrations to make delays through paper channels. An attempt was made to design an affordable '*multiplexed lateral flow biosensor*' which aims for detection of more than one biomarker in an assay.

Purification of recombinant Mycobacterial Toxin-antitoxin from M. smegmatis
Dobaria Nisarg Jagdishbhai, Mentor: Prof. S Matheshwaran

Studies regarding DNA damage and repair have been carried out for a long time to explore the cell's complex phenomenon to rescue its genomic integrity in DNA damaging conditions. 'Save Our Soul' or SOS response is one of the major regulation systems consisting of DNA repair genes e.g ruvC, lexA, recA etc.; which are upregulated during different DNA damaging conditions. Our major research interest is to explore these uncharacterized genes present under M. tuberculosis SOS regulon, which might play important role in DNA repair and helps in attaining the persistent state. It has been noticed that only one putative VapBC Toxin-Antitoxin module is present under this regulon. The aim of the current study is to elucidate the significance of this TA system under the regulation of SOS in the light of DNA repair.

To develop a function for computing common volume between two meshed cad models
Ishan Agnihotri, Mentor: Prof. Bhaskar Dasgupta

The objective of this project is to develop a function to compute the volumetric infringement between three dimensional bodies while assembling them, in a specified geometry of the system. The computation will provide the degree of volumetric infringement of the body and the assembly (which could itself be another isolated body). There are infinite ways by which we can take a body (a component) from a given place to another (say a location in the assembly). When there is zero infringement between the two entities while doing this action, we say the process to be feasible. An algorithmic approach to this idea can help in designing programs for computer applications and machines that can autonomously find the optimal way to perform assembly or at least give its layout, on giving inputs of certain geometrical parameters.

Turbomachine Blading & Rotor Analysis-Structural dynamic modeling of a turbine bladed disc
Ishan Pandey, Mentor: Prof. Nalinaksh S. Vyas.

The objective of this project is to design various components of a steam turbine and to carry out analysis of the turbine blade. The turbine disc, roots and turbine blades are to be designed. The mean and alternating stresses acting on the turbine blade are to be calculated. Fluid flow analysis and steady state analysis of the steam turbine blade in computational environment are carried out in the present work. For reliable and economic designs of the turbine blade, it is necessary to estimate the modal characteristics of the turbine blade accurately. Among the dynamic characteristics of the

turbine blade, determining the natural frequencies and associated mode shapes are of fundamental importance in the study of resonant responses. For this a modal analysis of the turbine blade is performed. Finally the initiation and propagation life of the turbine blade is to be determined using fatigue analysis.

Portfolio VaR Optimization for Asymmetrically Distributed Asset Returns
Kartikey Bhargav, Mentor: Prof. Praveen Kulshreshtha

The Value-at-Risk (VaR) is an important and widely used measure of the extent to which a given portfolio is subject to risk inherent in financial markets. Yet efficient optimization of VaR remains a very difficult problem. Conditional VaR (CVaR) takes into consideration asymmetries in the distributions of returns and is coherent, which makes it desirable from a financial theory perspective. The problem of choice between VaR and CVaR has been very popular in financial literature. We try to explain strong and weak features of these risk measures by presenting results of a numerical experiment with a representative selection of 5 major stocks and bond indices (BSE Sensex, BSE MidCap, GOVT IND BOND 5YR, Shanghai Composite & MSCI EEM) from the perspective of Indian & Asian financial market. The portfolio optimizations are performed for data between FY14 to FY16. These periods were chosen to capture both positive and negative financial market episodes, with FY14 representing a period of generally good results, while FY16 was relatively down (2015 Chinese Stock Market Crash). It is shown that the resulting efficient frontiers & weights assigned to portfolio assets are quite different. We believe that the CVaR approach can be very useful for better portfolio allocations than the mean-variance during market downturns when asset return distributions are often fat-tailed or skewed.

Solid to Mesh Generation using 3D scanner
Kartikeya Srivastava, Mentor: Prof. Shikha Prasad

This project principally deals with handling and translation of 3D point data. Its goal is to generate good quality tetrahedral meshes suitable for numerical methods and scientific computing. It collaborates a wide range of pre-defined methods and algorithms under one roof to achieve the desired results. This project also aims to automate the various processes involved by writing scripts for the same. Users will get a brief overview of the kind of tetrahedralizations and meshing problems handled by the script. They will also learn a bit about 3D scanning and the method to create tetrahedral meshes using suitable input files.

Binary Image Recombination after Bitwise operations of Cellular Automaton
Karttikeya Mangalam, Mentor: Prof. KS Venkatesh

A weighed summation method to recombine binary images for better performance of Cellular Automaton (CA) based Image Processing algorithms is developed. Generally, Cellular Automaton operates on cells having a small number of states because of exponential dependence of search space on number of possible states. So,any application of CA on gray scale images involves transforming the image to many new images with fewer states such as binary images using methods like thresholding and then their recombination to produce the originally transformed gray scale image. We have developed a regression based weight evaluation algorithm to yield a better gray-scale image from binaries. The algorithm is extended to include images with more states(Ternary) with a corresponding increase in the computational requirements. The algorithm is implemented in MATLAB R2016b in the speci c case of denoising Salt and Pepper Noise to test against standard benchmark algorithms such as Median Filter for various images, noise levels and segmentation factors.

Elliptic Vortex Rings
Kisalaya Mishra, Mentor: Prof. Debopam Das

The objective of the project is to observe the dynamics of vortices generated from orifices with elliptic cross sections. Evolution of various parameters like vortex ring diameter, core radius, velocity and axis switching with distance and time is to be studied. Further the impact of aspect ratio and hydraulic diameter of the elliptic orifice on the vortex generated is also studied. Flow visualisation done using a laser, high speed camera and smoke is used for observation and further analysis. The work describes axis switching, which is observed quite distinctly. The dynamics is governed by self induction, the effect of one portion of vortex rings on another. This causes vortex rings with higher curvature to convect ahead of the rest, which in turn increases the curvature of lagging portions. These portions overtake and decrease the curvature of initial high curvature sections, hence result in axis switching. Further the instabilities induced in the ring as it travels has been observed and reported.

Development of theoretical model for filtering drinking water through activated carbon block
Kumari Shilpa, Mentor: Prof. Nishith Verma

Carbon filtering is an effective approach to purifying water for drinking purposes. Activated carbon uses chemical adsorption to remove contaminants and impurities from wastewater. To predict the

filter efficiency of the carbon blocks, a model is to be developed. We developed a model using FORTRAN subroutine and code that could solve the mass balance equations based on the model postulates. Linear adsorption isotherm model was assumed and theoretical results were fitted to the experimental data. The model is applied to study the effects of various parameters such as column height, thickness, porosity, diffusivity, adsorption and desorption coefficient, on effluent concentrations for volume of water passed through filter blocks. In other words, breakthrough curves were plotted to study variations of efficiency (Ca/Cin) and bed saturation time (measured in terms of volume of water passed) with respect to changes of various input parameters. The breakthrough curves, which are of sigmoidal type, fitted well with the experimental data within acceptable error.

Development and Performance testing of a Flexible Heat Pipe for spacecraft applications

Lakshya Gangwar, Mentor: Prof. Samir Khandekar

Heat pipe technology has been successfully applied in the last forty years for the thermal management of a variety of applications like heat exchangers, economizers, space applications, and electronics cooling. This research describes the development, testing, and characterization of bellow used in fabrication of a flexible heat pipe. The heat pipe is being designed for thermal management of satellites and for other space applications wherein passive heat transfer is required to be coupled with vibration isolation requirements. The evaporator section, to which the heat load is attached, is to be vibration-isolated from the radiator or the condenser section. The inherent flexibility of the developed heat pipe prevents the heat pipe, the heat load, and the heat sink, from getting damaged under mounting and launch related stresses. The flexibility is provided in the adiabatic section of the heat pipe container using a flexible bellow. This research includes theoretical modelling of bellow and analysing stiffness of bellow. Experiment is done for axial and angular stiffness and results are compared with theoretical models including EJMA. Finite element analysis (FEA) of the bellow is performed in Autodesk INVENTOR 2015 and is benchmarked against the experiments. It is found that axial, angular (pure bending-moment type) and lateral stiffness are well predicted by Reissner as well as EJMA equations. FEM simulations also confirm it.

Studying Photon Entanglement in the Orbital Angular Momentum Basis

Lavanya Taneja, Mentor: Prof. Anand Kumar Jha

The Orbital Angular Momentum (OAM) basis is significant in quantum computation,because it is a discrete and infinite basis, which can be used to construct higher dimensional qudits. To work with

such abasis, it is important to be well versed with the physical aspects of the same. The work for the summers involved familiarization with the Spatial Light Modulator and its applications in beam shaping, mainly inproducing high quality OAM mode beams. We then move donto experimentation in the single photon domain. The single photon interference experiments gave a better understanding of the quantum super position of wave functions and the nature of photons.

Aerodynamics of Cricket Ball using Finite Element Method
Mohammad Ashraf, Mentor: Prof. Sanjay Mittal

Flow past a cricket ball is investigated in this study using three dimensional calculations. A stabilised finite element method is used to solve the incompressible Navier Stokes equations employing Galerkin formulation. The geometry of the cricket ball is created using Autodesk Inventor. Ansys Fluent is used to generate a mesh around the geometry. The elements of the mesh generated by Fluent were converted to 8-noded elements using Tecplot360 binary file reader. Two meshes were created, a fine and a coarse mesh with 22 million and 10 million elements respectively. Computations are being done on the meshes from Reynolds number 100 to 1000 for steady and unsteady flows. The computations were performed on a distributed memory parallel computer. The results when compared with the data from the available literature was found to match. The trips on the sphere did not cause any significant change in flow pattern when compared with that of smooth sphere at low Reynolds number (upto 400).

Electronic structure and hydration dynamics of portlandite material using Density Function Theoretical (DFT) Calculations
Nisha Mehta, Mentor: Prof. D.L.V.K. Prasad

Although the hydration phase of Portlandite, $Ca(OH)_2$ is primarily responsible for the functionality of the ubiquitous cement material, its hydration phase and the process of hydration are still remained to be understood. In the studies presented here we shed some light on the theoretical atomic and electronic structure of calcium hydroxide in its native and hitherto unknown hydrated phases. While the calcium hydroxide is known as a linear molecule in gas phase, its condensed solid crystalline and amorphous phases are extended layer-like structures. Therefore, at first, the structural lineage between molecular – cluster-like – bulk solid was established in our calculations by performing density functional theoretical calculations (DFT). The calculated structural parameters of monomer and crystalline $Ca(OH)_2$ are in excellent agreement with experimental values. It is interesting to note that $[Ca(OH)_2]_n$ clusters (n=2,3..6) with $n \geq 4$ resemble structural patterns of crystalline Portlandite. The hydrated $Ca(OH)_2$ structures were optimized at molecular

level by selecting the energetically best native molecular $Ca(OH)_2$. As a result, we were able to locate the preferred favourable binding sites for hydration in $Ca(OH)_2$-clusters.

Rheology of Clay Emulsions
Prashant Singhla, Mentor: Prof. Yogesh Joshi

This work aims to study rheological behaviour of clay emulsions. In this study clay system was used to stabilise paint emulsions. Solid-stabilized, or Pickering, mini emulsion polymerizations using Laponite clay disc as stabilizer are investigated. Clay used is a modified synthetic magnesium aluminium silicate laponite S482. As a precautionary measure to prevent slight sedimentation of paint Optigel WX was used. Different types of oil+water based paints were used to study their behaviour with the clay. In this work, we prepared 8.2wt% laponite S482 solution to carry different experiments. Various rheological parameters like storage modulus, loss modulus and shear stress were observed at various temp and different parameters. These experiments showed that emulsion system can be stabilised by the laponite S482. This study further showed that there is no aging and change of relaxation modulus within the experimental time.

Hyperbolic geometry and subgroup of surface group are almost geometric
Rishabh Agnihotri, Mentor: Prof. Abhijit Pal

The objective of my work is to understand basic hy-perbolic geometry and di erence between the hyperbolic geometry as there is big di erence in Euclidean geom-etry and Hyperbolic geometry like as parallel postulate not hold in hyperbolic geometry and sum of angle of a tri-angle less than .By using hyperbolic geometry we also nd that genus-2 surface have a metric w.r.t. genus-2 surface have curvature at each point -1.

By using the property of hyperbolic space and group gen-erated by re ection in hyperbolic space we do our main result that surface group of genus-g surface is LERF,for genus 0,1 it is easy to understand that surface group is LERF,for higher genus-g surface we get our result by using simple fact about group of isometry generated by re ection of sides of pentagon and its fundamental re-gion.

A Differential Game-Theoretic Solution to Collision Avoidance
Ritwik Bera, Mentor: Prof. Mangal Kothari

Pursuit-Evasion games have been studied due to their wide civilian and military applica-tions. The project aims to establish a frame-work for aerial collision avoidance by utilizing Differential Game Theory to construct sets of backward reachable states that will demarcate the entire state space into

escape and capture zones, and also specify the optimal strategies for an evader that wishes to avoid collision.

In this paper, a pursuit-evasion game involving two non-holonomic agents is solved using the theory of differential games. It is assumed that the two players move on the Euclidean plane with fixed but different speeds and have a minimum turn radius constraint. They steer at each instant by choosing their turn radius value and direction of turn. By formulating the game as a game of kind, we characterize the regions of initial conditions that lead to capture as well as the regions that lead to evasion, when both players play optimally. The game is then formulated as a game of degree to obtain time-optimal paths of the pursuer and the evader inside the capture region. Subsequently, cases are considered with different speed ratios and different manoeuvrability constraints between the players separately. Solutions are provided for the game based various simulation parameters that aid in understanding the characteristics of the game under a wide range of constraints. Also, different parameters such as time to collision and safe evasion distance are considered for evaluation optimal decision-making strategies for the players.

Application of Ray Tracing Techniques in Analysis of Micro-Heat Transfer Using Laser Induced Fluorescence

Sahil Jindal, Mentor: Prof. Samir Khandekar

The objective of this work is to design a set of algorithms which compute the illumination of a given micro-fluid system by tracing the path of light rays though it so as to predict the effect of refraction, scattering and other such optical phenomena on the subsequent induced fluorescence in the system. Using this prediction, we can normalize the photographed images of the fluorescing system to obtain images which reflect the intensity distribution resulting solely from thermal effects and not from optical effects.The properties of the system such as spatially varying temperature, refractive index, fluid velocity, fluid composition etc. are taken as input in the form of arrays along with the information about the fluorescence inducing laser light source such as location of the source, geometry of the source (point, surface, etc.) and the type of emission distribution (collimated, evenly divergent, Gauss-normal distribution etc). Using this information and the laws of optics, the algorithms trace the pat of rays and evaluate the amount of light received by each voxel/pixel of the system. Thus, an array of incident light distribution is obtained. The intensity of light emitted during fluorescence is a function of temperature and it also varies linearly with the incident light intensity. The images obtained experimentally include the undesirable effect of unequal light distribution which can be eradicated by normalizing the value of each image pixel with respect to the corresponding output array element values.

Internally heat integrated propylene-propane splitter
Sana Khanum, Mentor: Prof. Nitin Kaistha

Distillation is one of the most popular methods of separation in chemical and petrochemical industries. However, this process is also energy intensive in the process industries. In order to reduce energy consumption of distillation columns, one of the efficient ways is the externally heat-integrated (heat pump assisted) distillation column. This study introduces an industrially viable, externally heat integrated vapor recompression system of the propylene-propane splitter. The model proposed is tested on the rigorous dynamic simulation software (Aspen HYSYS) that reproduces the system as a virtual plant, enabling design and verification of process control schemes, safety studies, relief valve sizing and failure analysis. The propylene distillation system is simulated with the proposed control and optimization strategies and the results show that, from the economic performance and robustness viewpoint, this model is significantly better than the conventional way of separation.

Simulating flow past suspended aerofoil using discrete and continuous immersed boundary method
Sharun Kuhar, Mentor: Prof. Arun K Saha

The aim of the study is to implement, on a finite difference based solver, the Immersed Boundary Method (IBM).To begin with, a modified Marker And Cell (MAC) method based Navier-Stokes (NS) solver is developed. 2D flow past a square cylinder is simulated on a uniform Cartesian grid for a few Reynold's numbers on this solver. Later, the IBM is incorporated into this solver to make it capable of simulating 2D flow past a general shaped body with just the coordinates of its boundary points being specified. This employs the Ghost-Cell technique, a discrete forcing IBM, to implement boundary conditions around the curvilinear shape on the non-body-conforming Cartesian grid. Flow past a few general shaped bodies (like--naca 0012 aerofoil, forward facing triangle, etc.) is successfully s simulated using this solver.

Turbomachine Blading & Rotor Analysis -Crack Initiation and Propagation Analysis and Life estimation
Shashwat Ranjan Chaurasia, Mentor: Prof. Nalinaksh S. Vyas.

Emerging blade technologies are finding it increasingly essential to correlate blade vibrations to blade fatigue in order to assess the residual life of existing blading and for development of newer designs. Fatigue analysis and consequent life prediction of turbomachine blading requires the stress load history of the blade. A blade designed for safe operation at particular constant rotor speeds

may, however, incur damaging stresses during start-up and shut-down operations. During such operations the blade experiences momentary resonant stresses while passing through the criticals, which may lie in the speed range through which the rotor is accelerated. Fatigue due to these transient influences may accumulate to lead to failure. In this project a fatigue damage assessment procedure is described. The fatigue failure surface is generated on the S-N-mean stress axes and Miner's Rule is employed to estimate the accumulation of fatigue. A life prediction algorithm is developed that is based on combinational method, which combines the local strain approach to predict the initiation life and fracture mechanics approach to predict the propagation life. Dynamic and static stresses incurred by the blade forms the input of the life estimation algorithm. Neuber's rule is applied to the dynamic stresses to obtain the elasto-plastic strains and then the material hysteresis curve is used to iteratively solve for the plastic stress.

Experimental demonstration of a source with finite, translationally-invariant spatial coherence
Shaurya Aarav, Mentor: Prof. Anand Kumar Jha

We have suggested the existence of light sources which are spatially stationary and whose coherence function, and in turn coherence length, remains invariant of spatial propagation. Also, the coherence lengths of these sources are finite. We built such a source and demonstrated the properties of interest with experimental data. Further, we showed how to construct user modulated coherence functions, which have the aforementioned properties, using a general setup. The experimental verification for two simple coherence functions are provided: Coherence function resembling the intensity pattern due to diffraction from a single slit and the intensity pattern due to interference from two spatially separated slits. The visibility, as a function of slit separation, of the central fringe from a Young's double slit interference is used to denote the spatial coherence functions.

Study of Relaxation modulus at different pre and post gel states.
Shivi Dixit, Mentor: Prof. Yogesh Joshi

The objective of this work was to study the relaxation modulus at pre and post gel states of Laponite XLG dispersion and also different parameters related to gel state. Laponite is a synthetic clay material and widely used as a rheology modifier. LAPONITE XLG is used to modify the rheological properties of many household products. It is possible to formulate gelled products for spray, Cosmetic products, Paints etc. In this Project, we conducted several cyclic sweep frequency experiments on different Laponite XLG wt% in a linear viscoelastic region. From these experiments different parameters like tan d, G',G" were found and tan d vs t curve were plotted to find out if it

satisfies winter-chambon criterion .The Gel point was then calculated from the plot . The observed results showed that gel point decreases with increase in wt% ,It was also observed that the gel point was slightly effected by the weather conditions. Logarithmic dependency of storage and loss moduli on frequency was also studied.

Preliminary Design and Controller Development of a Small-sized Quad-Tiltrotor
Sourav Kumar Sinha, Mentor: Prof. Abhishek

The objective of this project is to study the modelling and control of a quad-rotor Unmanned Aerial Vehicle (UAV). Quad-rotor has two pairs of counter rotating rotor each on every end of the plus or cross configuration which controls the quadrotor. In this work the plus configuration of the Quadrotor has been taken into consideration. Quad-rotor has symmetrical body about center of gravity and the origin of the body-frame reference coincides with the CG.In this work the Newton's and Euler's laws has been used to define the dynamic equations of the system. Momentum theory is used to estimate the propeller thrust and torque. In this project, a linear proportional-integral-derivative (PID) controller based feedback control system is developed. MATLAB is used as a platform for the development of PID attitude, position and altitude controllers and the simulation of the quadrotor. The quad-rotor model is simulated using PID controller to achieve attitude stabilization from any current orientation to the hovering positon within one second. The PID controller also helps maintain the stability of the quad-rotor during rigorous translation motion. Further the trajectory tracking control of a quad-rotor has also been tested in this simulation. The result of the simulation shows that quad-rotor UAV is able to track the given arbitrary trajectories. Finally, through the simulated result for attitude, position stabilization and trajectory tracking the validation of the proposed model and control system approach is verified.

Modelling of an evaporative cooler unit for post-harvest
Utkarsh Shukla, Mentor: Prof. Sandeep Sangal

An evaporative cooler uses the principal of evaporative cooling to maintain a cool interior temperature for food preservation. The device is made of clay walls, which is kept continually moist. The inner temperature of the storage can reach near to wetbulb temperature which is decided by ambient temperature and relative humidity of the surrounding. This project would focus on thermal modelling of such evaporative cooler i.e. preparing approximate results of temperature and rate of evaporation through designing and solving equation based on heat and mass transfers happening in the system to generate cooling effect.

Queuing Analysis for Cognitive Radio Networks
Vishal Rana, Mentor: Prof. Aditya Jagannatham

We present an analysis for queuing performance measures of multiple antenna cognitive radio system using downlink beam forming. The paradigm of multi-user MIMO zero-forcing beam forming is used to null the interference at the primary user. This cannot be achieved by the existing single antenna systems. A closed form expression is derived for the probability density function of successful packet transmission time followed by results for the average waiting and transmission times in an M/G/1 secondary user queuing system. Further, this framework and the results are also extended to a scenario with partial channel state information (CSI) at the secondary transmitter. Analysis with Automatic Repeat Request (ARQ) has also been incorporated. Numerical simulation results are presented to validate the theoretical performance analysis.

BANDSAW
Aarush Sood, Mentor: Prof. Ishan Sharma

The objective of this project is to design and manufacture a band saw that would be cheaper, more efficient and economical for small industry workers who make small toys, decorative pieces, etc. using wood across the world. These workers have fine artistic skills to manufacture beautiful pieces from wood and other material but lack in terms of capital and investment, so the main objective of this project is to make band saw that is also small to cut small pieces without compromising its mechanical efficiency. According to my study, band saws available in the market are very expensive and huge to be used by the small-scale workers. The most important factor when we use any machine is its safety and present band saws which are available in market lack safety. Presently, the work piece is fed to the blade of the band saw using hands which could be dangerous as moving blade can cause injury to one's hand. Therefore, the mechanism is to be developed to hold the work piece which could guide a work piece to obtain the desired shape from it. The main feature of the band saw is that it is widely used to cut irregular shapes in industry. Band saws which are available in the market have a thick blade which causes problems when small curves have to be cut on the work piece.

Different techniques used for Measurement of Hydration of high performance cement based material and Material Characterization Techniques for Cement based materials
Abhiram Shukla, Mentor: Prof. K V Harish

The main aim of the present investigation is to gain insight on the effects of rice husk ash and silica

fume addition on the hydration process and microstructural development of cement paste. In the last decade, the use of supplementary cementing materials has become an integral part of high strength and high performance concrete mix design. These can be natural materials, by-products or industrial wastes, or the ones requiring less energy and time to produce. Some of the commonly used supplementary cementing materials are fly ash, Silica Fume (SF), Ground Granulated Blast Furnace Slag (GGBFS) and Rice Husk Ash (RHA) etc. RHA is a influence in improving the mechanical and durability properties of mortar and concrete The limited available resource and the high cost of silica fume (SF) in producing ultra-high performance concrete give the motivation for searching for the substitution by other materials with similar functions, especially in developing countries.

Performance Prediction and Conceptual Design of a Quadtiltrotor
Abhishek Kumar, Mentor: Prof. Abhishek

Conventional rotary wing aerial vehicles generally have VTOL (vertical take-off/landing) and hovering capability but lacks in cruising speed (forward speed) also make loud noises and generate higher vibrations. On the other hand the fixed wing vehicles have high cruising speed and is better in other aspects as compared to rotary wings but they generally does not have hovering capability.
So, the basic objective of this work was to design a conceptual model and to do the performance analysis of a quadrotor convertiplane UAV which integrates both (VTOL) and (high cruising speed). Quadrotor convertiplane UAV can be visualized as an aerial vehicle with four fixed wing and four rotors are to be mounted along with some part of wings which can be tilted from horizontal plane of rotation to vertical plane of rotation and vice – versa. This configuration gives rise to hovering capability while rotors are in horizontal plane of motion and also can achieve high cruise speeds by tilting the rotors in vertical plane of motion as the fixed wings support the weight. The blade model consists of rigid blades and only flap degree of motion is allowed.Rotor loads are calculated using numerical integration.

Safety Analysis of Nuclear Power Plant
Akash Dayal, Mentor: Prof. Prabhat Munshi

These days fulfilling power need is a challenge for the whole humankind and Engineering world. Nuclear energy is one of the best possible approach to satisfy the human need as it is cleaner and abundant. The major challenge in nuclear power sector is the safety of the plants. So I selected the project on the safety analysis of these power plants taking into account the most recent and well know accident that occurred in the city FUKUHIMA. The work focusses on the study the methodology of safety analysis of FUKUSHIMA type nuclear accidents using USNRC licensed

thermal hydraulic safety code RELAP5/SCDAPSIM/MOD3.5. This code, designed to predict behavior of PWR/BWR systems during normal and accident conditions, is currently under development at Innovative Systems Software (ISS) as part of the international SCDAP Development and Training program (SDTP). It uses RELAP5/SCDAP models developed by US Nuclear Regulatory Commission (USNRC). Further to study the FUKUSHIMA type accident, I studied Laguna Verde Nuclear power plant as it is like a cousin plant of FUKUSHIMA. Laguna Verde BWR Model has been widely used to access FUKUSHIMA accident progression because it is BWR-5 whose reactor coolant system is very similar to FUKUSHIMA Units 2 and 3 (BWR-4). The differences are only in the containment design. Initially, in the process I started with learning of RELAP5/SCDAPSIM/MOD3.5 in which I took some sample problems with various distinct specifications which is discussed further. Finally, I tried try to provide an overview of the AP1000 power plant which India is going to import in the coming future.

Wetting of textured surfaces (Laser Texturing)
Alok Kumar, Mentor: Prof. J. Ramkumar

Titanium alloy Ti6Al4V is extensively used in biomedical fields due to its excellent biocompatibility. This project aims to analyse the wetting behaviour of textured Ti6Al4V surfaces prepared by epilog laser machine. Wetting phenomenon of both homogenous as well as heterogeneous surfaces was studied from available literature. Literature survey regarding the dynamics of capillary action was also done and analogy between capillary action and our experiment was drawn. The roughness parameters r and Φ_s were taken into account. An expression for height attained by the liquid as a function of time was found out. The wetting experiments were performed by three different liquids methanol, water and hydraulic oil on a set of prepared textures. The dynamics of the liquid film was found to obey a diffusive-type law.

Preparation and characterization of mechanical properties of Carbon Nanotube-Bioglass scaffolds for biological applications.
Amal Jerald Joseph M, Mentor: Prof. Niraj Sinha

Bio active glasses have been used for various applications such as tissue scaffolds, bone grafts and dental implants, but its lean mechanical strength limits its applications in load-bearing positions. Mechanical properties of these glasses can be improved by reinforcement to fabricate composite materials. Carbon nanotubes (CNTs), with their high aspect ratio and excellent mechanical properties, have the potential to strengthen and toughen bioactive glass material without offsetting its bioactivity. In this work, multiwall carbon nanotube (MWCNT)-Borate based bioactive glass

composite scaffolds were prepared by polymer foam replication technique. In this work, 1393-B1 glass was synthesized by the sol-gel processing method. The powders were then ball milled to obtain micron size particles. Further, the powders were ball milled with varying percentage of MWCNT (0%, 0.2%, 0.6%, and 1% (by wt.)). The obtained material was characterized using X-ray powder diffraction (XRD), analysed for glass transition temperature variation, Bio-activity and Fourier transform infrared spectroscopy (FTIR). The mechanical properties of the scaffolds, such as compression strength and elastic modulus, were measured. The optimal composition of CNT was determined to be 0.2 wt. % based on compressive test results. FTIR results confirm that there is no characteristic bond formation between CNT and bioactive glass powders. From the bioactivity tests, it was observed that the ability for hydroxyapatite to form on the surface of the scaffolds increases with composition of CNT.

Pushing the limits of Piedfort Diads towards small molecule encapsulation
Anant Kumar Jain, Mentor: Prof. Raja Angamuthu

The triazine-based compounds were synthesised in good yields to study the lone pair – π interactions between the triazine ring centroid of these molecules and the halogentaed solvents. All the four compounds prepared were well characterised using ^{1}H and ^{13}C NMR spectroscopy, Mass Spectrometry and Single Crystal X-Ray Diffraction (SCXRD). All these compounds are expected to show intresting properties in the solid state.

Brihaspati -4 , Peer -to - Peer protocol
Anchal Bhalotia, Mentor: Prof. Y. N. Singh

The objective of this work is to design a new hybrid algorithm and implement the master server for the ongoing project – brihaspati-4: learning management system. This new hybrid algorithm is for the peer-to-peer communication between the nodes. This is a hybrid of both the two famous algorithm chord and tapestry. This has been designed to overcome their flaws.The next work done was to design the flow for the communication between the master-server and the Secure Certificate Signing Server (SCSS) and also to write the pseudo-code for the same.

This process involves the implementation of Self-signed certificate generation using open SSL commands. This work also includes the pseudo –code using the security library of the java language for the HTTP communication protocol.

Flow Through Aerospike Nozzles
Anubhav Gokhale, Mentor: Prof. Rakesh K Mathpal

Spacecraft propulsion is governed by its rocket engine. A rocket engine provides the thrust by combustion & expulsion of propellant gases at hypersonic velocities from rocket engine nozzle. Rockets most commonly use a Convergent-Divergent configuration based Bell nozzle design (termed CD Nozzle). Despite its extensive commercial use, traditional Bell Nozzle exhibits "altitude dependent fuel efficiency constraints" as it provides thrust efficiency only for the specific altitude for which it was designed.

Therefore an altitude compensating nozzle, such as an Aerospike nozzle, has been widely studied in researched on in past decade as an effective alternative to CD Nozzle. During this short duration summer project, a CD Nozzle & Aerospike Nozzle computer models were designed & a comparative analysis of gaseous flow for given set of boundary conditions viz. mass flow etc. were studied and inferenced. It was also endeavored to simulate the relation between Spike Truncation and Thrust reduction to determine the highest possible efficiency (thrust to weight) nozzle.

Ytterbia co-doped Scandia stabilized Zirconia electrolyte for Solid oxide fuel cells.
Anushri Surbhi, Mentor: Prof. Kantesh Balani

In this work the effect of 1 mol% ytterbia co-doping on the phase formation and ionic conductivity of (7-8) mol% scandia stabilized zirconia is studied and the values where compared with (8-9) mol% scandia stabilized zirconia. The powders were synthesized using conventional solid state reaction method. The polycrystalline pellets of the compositions were synthesized using conventional pressure-less sintering. The air sintered samples of ytterbia codoped Scandia stabilized zirconia sample showed the density in the range of 87-89 %. From the XRD data, it is observed that pure ScSZ pellets contain both cubic and rhombohedral phase.

However on substituting scandia with ytterbia, the rhombohedral phase is found to be suppressed. The ionic conductivity of the samples was measured using ac impedance spectroscopy in the temperature range of 750- 325 ˚C. The comparative study of both the samples ytterbia codoped Scandia stabilized zirconia and Scandia stabilized zirconia is done.

Effect of Uncertainty in Coefficient of Friction on Performance of Base Isolated Structures
Apoorv Garg, Mentor: Prof. Samit Ray Chaudhary

The frequent occurrence of earthquakes leaves a trail of destruction of property and more importantly lives. There is an immediate need for structural solutions to tackle these problems. One

of the solutions for such problems is the isolation of base of structures from the seismic ground vibrations. In this report the effect of uncertainty in coefficient of friction has been studied through experiments on Single degree of freedom structure. The structure was placed on a shake table to evaluate the effect of damping through sliding of structure on the base. Actual earthquake ground motions were processed and provided to the shake table for the experiment. Essentially two main cases were examined, structure fixed on the base and structure isolated from the base. On comparison of the results in both the cases it was found that isolated structure showed lesser structural acceleration, i.e., 3.1g, compared to that of the fixed case, i.e., 8g for one of the ground motion. Similar studies of different earthquake motions for both the cases also demonstrated the same result that an isolated base is structurally sounder than a fixed base. Hence this technique can be applied in real buildings to reduce the damage of life and property.

Mirror finish on steel workpiece using advanced magnetic field assisted nanofinishing techniques

Arpit Tripathi, Mentor: Prof. J. Ramkumar

Study of new and cost effective finishing processes has always been an area of keen interest to overcome the difficulties of existing finishing process. Magnetic Abrasive Finishing (MAF) is a process in which a mixture of non-ferromagnetic abrasives and ferromagnetic iron particles is used to do finishing operation with the aid of magnetic force. The iron particles in the mixture are magnetically energized using a magnetic field. The iron particles form a lightly rigid matrix in which the abrasives are trapped. This is called Flexible Magnetic Abrasive Brush (FMAB), which when given relative motion against a metal surface, polishes that surface. The major studies concerning MAF have been done regarding the behaviour of the process under the effect of various parameters like working gap, mesh number of abrasive, speed of relative motion on cylindrical and flat work-pieces taking one type of material, non-ferromagnetic or ferromagnetic only. But limited comparative study by taking stainless steel with ferromagnetic behaviour has been done to analyze the surface roughness that is generated during the process. Surface finish has a vital influence on functional properties such as wear resistance and power loss due to friction on most of the engineering components. Magnetic abrasive finishing (MAF) is one of the advanced finishing process in which a surface is finished by removing the material in the form of microchips by abrasive particles in the presence of magnetic field in the finishing zone. This project has aim of getting mirror finish on flat stainless steel workpiece by MAF & studying the effect of the process parameters (volume percentage of abrasives and mesh number of abrasive particle) on the surface

roughness during MAF of ferromagnetic flat S.S. work-piece. The effect of selected process parameters was studied on the response characteristic of MAF process.

Development of solver for stability analysis of linearized Euler equations governing unsteady motions in combustion chambers
Avijit Saha, Mentor: Prof. Sathesh Mariappan

Thermo-acoustic oscillations (combustion instability) occur when increase in the acoustic energy due to unsteady heat release rate of the flame exceeds the losses (viscous loss, end loss etc.) of the acoustic energy from the system. The problem of thermo-acoustic instability is a concern in many devices for various reasons, because each of the device may have a unique mechanism causing unsteady heat release rate and may have unique boundary conditions. Therefore to predict and quantify thermo-acoustic instabilities it is necessary to describe the interaction between the propagation of acoustic perturbations, flame behavior and acoustic losses correctly. Apart from the generation of acoustic waves, unsteady flame is a source of entropy fluctuations. However the influence of entropy fluctuations in the occurrence of combustion-acoustic oscillations still remains an unexplored area. The objective of this project is to numerically investigate the role of entropy waves in the onset and occurrence of combustion instability. A combustor of a gas turbine engine is used as example. Five academic configurations have been investigated. Results are obtained by solving the eigenvalue problem arising from the Linearized Euler Equations written in the frequency domain. Mode shape and phase for each of the academic configuration are plotted. The oscillations in amplitudes for various Mach number are highlighted.

Diffeerent Test methods on High Performance Concrete
Ch.chandrasekhar, Mentor: Prof. K V Harish

A research program is conducted to evaluate the Different properties of High Performance Concrete, target compressive strength and Bond Strength. As an outcome of the experiments and researches, cement based concrete which meets special performance with respect to workability, strength and durability known as ***"High Performance Concrete (HPC)"*** was developed. In this paper we discussed about different test methods like ***Pull off test, Rebar Pull out or Bond test and Compression test on rectangular and I- beams***. For the compression test we tested different composition of beams like fibered and non-fibered in different curing conditions. For testing of Rebar Pull Out test because of unavailability of equipment we made a new equipment by applying load manually using hydraulic jack. This research is based on the measurement of early age characteristics of the High Performance Concrete (HPC), the study of the influence of water binder

ratio and the influence of strength, the bond between different materials. To evaluate the tensile strength and bond strength between high performance concrete and other normal concrete we use Pull off test method. And to find out the bond between concrete to steel, we use Pull out test. For the comparison of compressive strength between Rectangular beams and I sections we did compression test. The compressive strength of High Strength Cementitious Composites (HSCC) slightly lower for I –beams than for rectangular beams, indicating Keywords— High Performance Concrete, Helical Reinforcement, Epoxy adhesive material, Compressive Strength, Tensile Strength, Load-Displacement Relationships, Linear variable differential transformer (LVDT).

Unsteadiness of Sudden Expansion Flow
Digbijoy Mukherjee, Mentor: Prof. Ashoke De

The laminar flow in two-dimensional channel may produce either symmetric or non symmetric steady solutions, depending on the value of the Reynolds number as compared with some critical value. The results revealed that the flow remains symmetric up to a certain Reynolds number depending upon the expansion ratio while asymmetries appear at higher Reynolds numbers. The geometric expansion ratio in the current study was 3:1.The bifurcation phenomenon has been investigated for sudden expansion flow. A passive control is built by introducing a two dimensional plate in the flow with the aim of stabilizing the unstable symmetric flow configuration in the channel. The computations indicated that the critical Reynolds number of the symmetry- breaking bifurcation increases as the length of the plate increases.

Phase Change Materials (PCM) in Latent Heat Thermal Energy Storage Systems
Divyanshu Shahi, Mentor: Prof. Arvind Kumar

The objective of this work is to study the property-enhancement of phase change materials using nano-particles. Phase change materials based latent heat thermal energy storage systems are gaining significance in present scenario due to the depleting fossil fuels and impending energy crisis. But the low thermal performance of PCM is imposing a problem in their efficient use in various areas. Hence the enhancement of PCM properties by various methods has to be explored to obtain optimum performance results. This work describes the property-enhancement of Wax (paraffin) using copper nano-particles. The results have been obtained for a rectangular geometry, where the variation of liquid fraction of PCM and centerline temperature of considered domain have been analyzed with varying concentration of nano-particles. The governing equations of continuity and momentum have been solved to obtain the results. Various thermo-physical properties of wax and copper have been considered while performing the analysis. The results suggest that the thermal

performance of PCM enhances with the increasing percentage of nano-particles.

EBSD study of thermomechanical processing of duplex steel
Gagandeep Jasjeet Kalshi, Mentor: Prof. Shashank Shekhar

12X21H5T Russian grade duplex steel is used to make pressure vessels, piping systems, condensers, reactors in various industries due to their corrosion resistance and excellent mechanical properties, due to the combination of γ and δ phases. Though they account for only 2% of total steel consumption in world, their dual phase characteristics have proved superior over both austenitic and ferritic grades. This work is a part of ongoing research by my guide to understand various aspects of the steel. Hardness maximas(94HRB at 450^{o}C and 99 HRB at 700^{o}C from 91HRB in as-cast material) and impact energy minimas(50J at 450^{o}C and 37J at 700^{o}C from 127J in as-cast material) were observed for increasing ageing temperatures and we wish to understand the changes occurring in the steel due to increasing cold rolling and subsequent ageing. EBSD is used as the characterization technique as it gives orientation map and phases content in selected area, identifies grains and sub-grains, and phase geometry. It also enables us to get useful information concerning nucleation sites and orientation, which shall be useful to understand new phase development. Optical micrographs are taken to predict phases. Solution annealing temperature of 1000^{o}C for 3hr avoids precipitation of σ in γ during ageing.

Experimental and Computational investigation of jet from an under-expanded serpentine nozzle
Gaurav Kunal Jaiswal, Mentor: Prof. Abhijit Kushari

Infrared radiation signatures of gas turbine engine exhaust are suppressed markedly when equipped with a serpentine nozzle compared to an axisymmetric nozzle. The experimental and computational work has been carried out to assess the efficiency of curved elliptic nozzle over the straight circular in promoting the mixing of high subsonic and under expanded jet for various nozzle pressure ratios (NPRs). The internal as well as external flow analysis is done both experimentally as well as computationally to obtain both qualitative and quantitative aspects of the flow through the nozzle. The aim of our research is to find more detailed characteristics of the serpentine nozzle with elliptical exit. The experimental quantitative study of internal flow includes the pitot pressure measurements along and across the centerline of the flow at NPRs 1.4, 1.6, 1.9, and 2.2. The experimental quantitative analysis of external flow includes the calibration of five-hole pitot probe at circular nozzle at NPRs 1.7, 2.0 and 2.3. Then, further using these calibration data, the external characteristics velocity profile, mass entrainment, centerline pressure decay, total pressure

distribution and Mach number are observed at NPRs 1.6 over serpentine nozzle. For qualitative analysis shadowgraph flow visualization was used. Then numerical simulation of the experimental model (circular as well as serpentine) are carried out using CFD software ICEM and FLUENT at NPRs 1.6, 2.2, 2.5, and 3.0. The turbulence model SST K-□□is adopted for computational analysis. Detailed flow characteristics are observed both for internal and external flow. Compression and expansion zones are also observed in computational results and NPR 2.2 density contour is matching with shadowgraph images. The computational and experimental results clearly shows that the curved nozzle is the better mixing promoter compared to the circular nozzle. Also the flow characteristics of serpentine nozzle internal flow are different from circular one due to the curved nature of former.

Effect of Pre-strain On Tensile Behavior of Age Hardenable Aluminium Alloys
Gourav Mundhra, Mentor: Prof. N P Gurao

Effects of change in the magnitude and direction of pre-strain on tensile behavior of commercially pure aluminum has been studied using X-ray diffraction line profile analysis (XRDLPA) and electron back scatter diffraction (EBSD). Commercially pure aluminum plate of 20 mm thickness was rolled to 94% rolling reduction and subjected to annealing at 873 K for 2 hours to obtain a fully recrystallized microstructure. The recrystallized sheet of aluminum was tested in tension till failure and some samples obtained with pre-strain of 1%, 5% and 8% in tension along rolling direction were further tested along 15° to the original tensile axis till failure.

The results of tensile tests on samples punched at 15° to the direction of uniaxial prestrain, show that as the magnitude of pre-strain increases the material strain-hardens and the yield strength of the material increases with a concomitant decrease in the percentage elongation to failure. The reorganization of dislocation distribution after a change in strain path results in transient reduction in work-hardening rate in the plastic region due to partial dissolution of the original dislocation substructure. The relative magnitude of work hardening rate depends on the deformation sequence. The change in hardening rate of aluminum after a change in strain path is dominated by moderate changes in magnitude of prestrain and strain path which also cause reduction in the limits of stable elongation. Effect of prestrain on back stress was also studied and the results obtained signify that firstly the back stress increases as the prestrain increases, and at a certain critical uniaxial prestrain the back stress reaches a saturation value and after that it becomes independent of prestrain as multi slip becomes operative thereafter. The evolution of substructure obtained from XRDLPA and EBSD corroborated the decrease in dislocation density and qualitative evolution of back stress.

Metal ion mediation in C3 symmetric peptides
Harleen, Mentor: Prof. Sandeep Verma

Metal peptide frameworks are compounds consisting of metal ions or clusters coordinated to peptide ligands forming 1, 2, or 3 dimensional structures. They attract significant attention due to their wide range of applications in drug delivery, gas storage, gas separation, tissue repairing, catalysis, gas purification. In this project, we have synthesized a C_3 symmetric benzene tri-carboxyl-L-tyrosine conjugate, $Bta(YOH)_3$ for metal peptide framework with copper ions.

Frequency analysis to determine return period of floods
Jadhav Omkar Vikram, Mentor: Prof. Shivam Tripathi

The effects of natural and man-made interventions on flood events have been studied by analysing the trends. This has been done by analysing the trends in annual maximum discharge time series of various Indian. Also by determining the trends in quantiles of 2 and 5 year return periods. To determine the trend, non-parametric Mann-Kendall Test and linear regression have been applied. A total of 66 stations having record length more than 35 years have been analysed.

Results show that a large number of stations show trends in 2 and 5 year return periods' quantiles whereas very few stations which show a trend in annual maximum series. Majority of the stations show negative trend. Interestingly, the stations which show trend in 2 year return period also show trend in 5 year return periods' quantiles.

Modelling of Homogenisation Kinetics with multicomponent Diffusion coefficients
Joglekar Shreyas Sanjay, Mentor: Prof. Kaustubh Kulkarni

A mathematical model of interdiffusion for ternary system was developed. Fe-Ni-Cr system is selected for experimental validation of the developed model. Three compositions were selected from the data of interdiffusion coefficients from research done by M.A.Dayananda and G.J.Duh in Defect and Diffusion forum. The alloys were characterized using X-ray Diffraction, Energy Dispersive X-ray Spectroscopy and microstructural analysis. Model was simulated for the inhomogeneity in individual alloys. Multi-layered structure of combination of two alloys with Composition Fe-Ni-Cr (68.1-28.55-9.35 atomic %) and Fe-Ni-Cr (31.3-46.1-21.6 atomic %) was simulated for homogenization at 1100ºC and effect of cross diffusion coefficients on concentration profiles were analyzed. Simulations conclude that a change up to 0.3% in concentration profile of chromium is detected between 100 and 200 hour of homogenization treatment. The effect of cross diffusion was concluded to be dependent upon the concentration gradient of diffusing species and

thickness of the inhomogeneity. Concentration profile obtained from the homogenized multilayered structures using EPMA will be compiled and compared with the simulated profile in order to experimentally validate the established mathematical model.

Cooling Flows in Hyper Gravity Environments
Kushaal Nair, Mentor: Prof. Vaibhav Arghode

Hyper gravity acceleration is defined as the condition where the acceleration of a body exceeds the acceleration due to gravity on the surface of Earth. The high speed rotation of the blades in gas turbines and propulsion of modern aircraft and rockets achieve such accelerations and hence requires efficient cooling systems in those conditions. Previous experiments have studied the effects of hyper gravity by fixing them onto sounding rockets, or performing parabolic flight profiles aboard aircraft, or by using a large centrifuge.

The project aims to simulate the hyper-gravity conditions exerted by means of a centrifuge and study the properties of liquid cooling systems and fluid flow using computational fluid dynamics (CFD) software.

Peer to peer software development (combined version of tapestry and chord)
Laxmi Jha, Mentor: Prof. Y. N. Singh

The main focus of this project was to analyse a combined version of chord and tapestry so that the routing for the distributed systems can be made more easier ,to compare different distributed hash table variants. And to develop the code for master server using HTTPS so that the certificate signing process can be authenticated and to know how a peer to peer system an example of which is Brihaspati4 (B4) developed. The role played by master server, Self signed certificate server (SCSS) and peer client in the complete process of certificate authentication and also the use of SSL and Certificate Toolkit in this method.

The work discusses the basic ideas and concepts required to implement a master server and the protocols that can be used to establish a secure connection over the internet across the client and server.

Anaysis of Unorganized Sector using NSS Data
Madhurima Chandra, Mentor: Prof. Tanika Chakraborty

This project seeks to explore numerous characteristics of the unorganized manufacturing sector in India. This has been done using data from National Sample Survey Organization. The 62nd Round

Schedule 2.2 data has been studied and analyzed in depth. The processes involved were data extraction, integration and analysis. The raw data was extracted and converted into a format suited for analysis. Numerous variables relating to enterprises of this sector are studied, such as their current condition, their growth (or stagnancy), their status as a recognized enterprise, source and destination agency, operating expenses, value added, problems they face etc.

Missile Guidance with Impact Angle Constraints
Mandar Bhanudas Kamalaskar, Mentor: Prof. Mangal Kothari

The objective of this work is to design a new guidance law so as to hit the target at a desired impact angle. A nonlinear guidance law is proposed to satisfy terminal impact-angle constraints against a stationary target in every possible planar surface-to-surface engagement scenario. The proposed guidance scheme is developed based on the geometry of a circular arc trajectory. This trajectory is defined by the radius of the circular arc, characterized by target's relative position and the required terminal impact angle. This radius is updated as missile moves towards the target. Based on missile heading error, the radius of the ideal trajectory and an estimation of time for interception, an acceleration command is generated to guide the missile towards the target along the nominal circular trajectory at the desired impact angle.

Fabrication of LECs (Light Emitting Electrochemical Cells)
Mohini Gupta, Mentor: Prof. Deepak Gupta

Light-emitting electrochemical cells (LECs) convert electric current to light within an active material comprising an electroluminescent organic semiconductor and an electrolyte. It is well established that it is the presence of this electrolyte that enabled the recent development of low-cost fabrication methods of functional LECs as well as the realization of unique device architectures. They operate with low voltages, which allows for high power efficiencies, and air-stable electrodes, which simplifies the encapsulation requirements. At the same time, it should be acknowledged that the current lower performance of LECs in comparison to the state-of-the-art organic light-emitting diode(OLEDs), at least in part, is intimately linked to the utilization of non-ideal electrolytes. In this report I consider electrochemical cells fabrication using a blend of two polymers to produce the luminescent, ionically and electronically conductive polymer layer. The polymer layer consists of a blend of the luminescent, electronically conducting polymer poly[2-methoxy, 5-(2'-ethyl-hexyloxy)-1,4-phenylene vinylene] (MEH-PPV) and the ionically conducting polymer poly(ethylene oxide) (PEO). The blend is doped with the ionic salt lithium perchlorate. The intermixing of the two polymers in the blend and their thin-film formation when spun-cast on ITO

coated substrate is studied in detail.

A simple hoverer using flapping airfoil
Narendra Paidi, Mentor: Prof. Sachin Shinde

Main motive of work is to demonstrate the ability of flexible wings to generate thrust. A prototype capable of hovering still in air using flapping of flexible wings was planned. Whole project involved the design and manufacturing of the prototype. Similar attempts have been made previously but with purely pitching flexible aero-foil in still fluid is first one. Several mechanisms were studied to actuate the wings in such a way that they produce only a one directional jet. The wings had to be in out of phase oscillations to avoid lateral forces. Achieving high frequency oscillations while maintaining lightest possible weight was a big challenge. Proper mounting of flexible portion of the wing on rigid aero-foil was another problem source for high frequency oscillations.

Numerical Modelling and Simulation of Solar Pond with Wall Shading effect.
Nimish Khandelwal, Mentor: Prof. Jishnu Bhattacharya

A salt gradient solar pond is a simple and economical solar energy storage system. It consists of three distinct regions: the upper convective zone (UCZ), the non-convective zone (NCZ) and the lower convective zone (LCZ). The UCZ is the topmost layer of the solar pond. It is relatively thin and consists mostly of fresh water. The NCZ is the region just below the UCZ which has linear density gradient and acts as an insulating layer for LCZ. The LCZ is the bottommost layer of the solar pond with highest percentage salinity but without any concentration gradient. For sufficiently high salinity gradient of the NCZ, convection motion will be suppressed in this region, and the energy absorbed in the bottom of the pond will be stored in the LCZ.

Indoor Localization using Cellular Technique
Paritosh Gaiwak, Mentor: Prof. Ketan Rajawat

Indoor localization is a hot field for research. Global Positioning system (GPS) is used in open spaces for locating the user but it cannot be used in closed spaces. For the sake of indoor localization, various bayesian filters such as kalman filter and particle filter are used. In this project, particle filter is used to first localize the position of the user and to plot the trajectory of the user by using the measurement and motion model. The measurement model gives the probability of finding a reading given a position:p(z(k)/x(k)) and the motion model gives the

location at time instant t given the location at time instant t-1:p(x(k)/x(k-1)). Motion and measurement model can vary as per the requirement of the project i.e. there is no one particular model fit for all the projects.

Coherence Characterisation of Optical Sources
Puranjay Rohan Gulati, Mentor: Prof. R. Vijaya

Coherence properties of optical radiation can vary significantly for different sources, which need to be determined before using the source in any coherence-sensitive application. The present work is geared towards building a set-up which characterizes the temporal coherence of a source. A simple Michelson interferometer is often used for this purpose. But it does not suffice for complex broadband coherent sources which require the direct characterization of phase relationship between the different spectral components.

Hence the design requires the characterization of an electro-optic phase modulator, which when used in a Mach-Zehnder interferometer, provides data on the inter-spectral phase values of any given source. The phase modulator has been characterized in this work.

Visual Question Answering
R Santhosh Kumar, Mentor: Prof. Gaurav Sharma and Vinay Namboodiri

Visual Question Answering is the task of providing an answer to a question based on the given image. Several methods have been proposed in literature to address this problem. We propose a method of aligning the image and text representations for improved performance in Visual Question Answering. Our hypothesis is that aligning the image representation with the text representation can help the network model the multimodal dependencies more effectively. Supervised and unsupervised methods are used to align the image and text representations. We align the two representations and use the aligned image representation to train a VQA model. Fusion models (early and late) are learnt to combine the different representations learnt. We show that the representations learnt are complementary. Quantitative results showing improvement of fusion models over the baseline model are provided.

Acoustic instabilities in Solid Rocket Motors
Raghavendran. R, Mentor: Prof. SatheshMariappan

Combustion instability is a serious complication in development of Solid Rocket Motor. The probability of Vostok 1 exploding was 50%. The coupling between the various flow variables such as pressure, velocity, heat release rate and entropy makes them formidable task to model. The

objective of this work is to model and simulate quasi 1-D flow in a solid rocket motor. The governing equations are derived for the system and the equations are decomposed into steady state and perturbations. The perturbed equations are linearized and non-dimensionalized. Initially steady state equations are solved to obtain the flow values at all the points. This work accounts for both entropy fluctuations and mass flux due to the burning of the propellants. Since the burning rate of propellant is too small the perimeter of the motor is assumed to be constant for small periods of time without loss of much accuracy in modeling.

Mesh Partitioning
Rahul Kumar, Mentor: Prof. Sanjay Mittal

An existing FEM (Finite Element Method) based CFD(Computational Fluid Dynamics) solver code is modified for using the partitioned mesh for flow computation. Ansys is used for mesh generation. Firstly, METIS is used for partitioning the mesh and thus used in the solver code. Time log information is tabulated. In many cases the runs were repeated to ascertain the timings. An aforewritten program is modified to obtain the partitioned mesh files from the result obtained from METIS and ParMETIS. A parallel code is written in order to use the ParMETIS library for partitioning the mesh. Mesh is then partitioned using ParMETIS. Partitioned mesh is then used in the solver code and the re- sults are verified. Communication time obtained from METIS, ParMETIS and non-partitioned mesh is compared. Although, a significant difference in communication time is observed between the non-partitioned and partitioned meshes but there is very little difference observed between the partitioned meshes with METIS and ParMETIS. From the study it is also observed that the Partitioning with ParMETIS is more effective for meshes with large number of nodes. The effect of mesh partitioning on the scalability is also studied. A significant reduction in communication time is observed with partitioning that leads to an overall improvement of speedup. Percentage time difference between non-partitioned and partitioned meshes is studied with different number of processor.

Spatial Information using a light field array
Rahul Mohideen K, Mentor: Prof. KS Venkatesh

The objective is to be able to extract spatial information and depth slices of a scene from a set of epipolar plane images. If we have set of epipolar plane images, the image points occur in the epipolar line of the first image. If they are missing, that indicates the presence of occlusions in the scene. We are trying to recreate the missing information from the set of images. We can also slice the scene according to depth. To be able to that, we have to understand the basics of epipolar

geometry. This is done by starting with projective transformations, moving on to stereo reconstruction.

Quantum Dot immobilized TiO2 nanofibers for waste water treatment applications using photocatalysis.
Rashika Mittal, Mentor: Prof. Raju Gupta

There is a problem of increasing waste water and the need of its treatment. This is a cause of concern for the environment as well as humans. This project aims at creating a novel photocatalyst that can treat waste water by degrading toxic organic compounds into water and carbon dioxide and produce clean water. The photo catalyst used is titanium dioxide (titania) which is layered with CdS quantum dots (QDs) using linker molecules. The purpose of using linker molecules is that they enable a firm and uniform deposition of quantum dots on the titanium dioxide solid nanofibers. If the QDs are immobilized on the nanofibers directly, there is a chance of their getting peeled off. This modification made enhances and fastens the process of the degradation of toxic organic compounds into simpler molecules. A well-known model water pollutant dye, Methylene Blue (MB), is used to test the photocatalytic degradation. The resultant CdS QDs sensitized TiO_2 nanofibers exhibit excellent photocatalytic activity as shown with the degradation of MB dye in aqueous medium.

Combined Electronic Structure / Molecular Dynamics Approach for Ultrafast Infrared and Raman spectroscopy for aqueous NaF solution
Rinki Kumari, Mentor: Prof. Amalendu Chandra

We have investigated the spectral properties of isotopically diluted OD/OH stretching local mode vibration in aqueous NaF solution through combined electronic structure and molecular dynamics simulation (ES/MD) technique. In order to calculate the line shape function of infrared and Raman spectra empirical mapping between electric field and other quantum mechanical properties is established from electronic structure calculation of extracted random clusters. Then in our simulated system we have used those mapping to get spectra and frequency fluctuation time correlation function.

Phase Change Material based waste heat recovery system
Ronit Kumar, Mentor: Prof. Arvind Kumar

One of the technologies which help to reduce energy consumption is the thermal energy storage for heating or cooling applications through latent heat or waste heat storage in phase change materials

(PCMs). Such materials would be suitable for use in buildings, cold storage, refrigerated trucks etc. because they can store a large amount of heat and phase change occurs at a constant temperature, thereby increasing thermal comfort. There are need of advanced systems that take advantage of renewable, ambient and waste energy to approach ultra-low energy buildings. Such buildings will need to consider Thermal Energy Storage (TES) techniques customized for smaller loads.

The aim of this study was to investigate how and where PCMs are used in the cooling systems, how are these systems related to buildings, if they provide lower energy consumption, how the indoor temperatures change due to PCMs and if the indoor air conditions improve. This work includes simulations performed to get the basic understanding of physics involved behind Phase Change Materials. A 2D numerical study was performed in COMSOL Multiphysics 5.0 to simulate melting of a PCM including both conduction and convection heat transfer. The heat transfer in fluids and laminar flow physics interfaces were used. To model natural convection, the proper volume force was applied to the PCM. One more model was simulated which includes flow of high temperature air over a flat slab filled with PCM placed in a pipe or duct. Various results like enthalpy and temperature distributions indicate heat energy storage capacity of PCMs while melting that can be used for cooling purpose.

Hannay angle in dissipative systems
Saheli Mitra, Mentor: Prof. Sagar Chakraborty

In recent times geometrical phase shifts are of great interest in various fields of physics. In 1985 Berry showed that in a quantum mechanical system there can exist a non-trivial geometrical phase of the wave function after a closed adiabatic excursion of the Hamiltonian in parameter space. It is termed as ‘geometrical’ since it depends only on the closed path of external parameters. Even this phase can be measured in terms of interference experiments! This fundamental result encouraged to look for such geometrical shifts in classical systems. Hannay showed in classical conservative systems also such phenomenon is observed as shifts in angle variables when the Hamiltonian is represented in action angle variables. Our project concerns about such geometrical shifts in dissipative systems, where energy is not conserved. In 1991 Kepler and Kagan first showed such geometrical shift can arise in limit cycle evolutions. In 2008, Sinitsyn and Ohkubo showed that this shift can be identified with the Hannay angle of the system.

Primary Atomization of n-Dodecane
Salil Manoj Pai, Mentor: Prof. Santanu De

Primary atomization of n-dodecane injected into quiescent Nitrogen atmosphere under ambient

pressure of 6MPa and temperature 303k has been studied. Non evaporative analysis has been performed primarily to focus on primary jet breakup, formation of blobs and ligaments. Numerical simulation is performed using VOF-LES method. Primary atomization region being optically dense, no proper experimental data is available regarding the formation of blobs and ligaments, and their topology. Due to numerical advancements, high resolution simulations are possible in order to gain insights of the process.

In this study, because of time constraints simplified injector geometry was constructed, but having the correct dimensions of the nozzle region with outlet diameter of 90 μm and k factor of 1.8. Inlet conditions were provided so as to get a Reynolds number (Re) and Weber number (We) in the atomization mode at the nozzle outlet. Simulation was carried out using OpenFOAM CFD code.

Techno-Economical feasibility analysis of solar charging for E-rickshaws.
Satyam Khanna, Mentor: Prof. Anoop Singh

Electric mobility as a means of public transportation is slowly emerging on the urban landscape in the country. A number of E-rickshaws can now be noticed carrying passengers between fix points IIT-Kanpur campus. The range of these rickshaws and hence the number of trips depends completely on the capacity in charging status of the on-board batteries. Solar PV panels mounted on top of these rickshaws can help in the range of the vehicle and hence the income derived from the same.

This study undertakes a techno-economic evaluation for the same. Based on Geo-spacial analysis of the common routes taken by the e-rickshaws and the MATLAB-Simulated performance of a proposed layout of roof mounted solar PV panels, we calculate the average daily extended range of these vehicles. We find that at 350 W mono-crystalline PV module can provide an average daily additional range of about 13 km. based on simulated path for which solar irradiance was estimated under with and without shadow conditions. This is found to be economically attractive, while at the same time reducing electricity consumption from the grid.

Numerical analysis of 1-D premixed and non-premixed flames in high temperature and low oxygen concentration oxidizer; using CANTERA
Shiny Choudhury, Mentor: Prof. VaibhavArghode

Premixed flame is a self-sustaining propagation of a local combustion zone at subsonic velocities. For a flame burning in a mixture of known composition and pressure two characteristic properties are defined, the flame temperature and flame velocity. A flame approaching unburnt air-fuel mixture is accompanied by a paradigm shift in species concentration, temperature profile and heat

generation patterns all within a mere region of few millimetres. In this project we aim to numerically solve combustion equations to plot variations in flame velocity and flame thickness at high temperature and low oxygen concentration cases.

Flow modelling in vertically heterogeneous unsaturated soils
Shreya Jain, Mentor: Prof. Richa Ohja

A mathematical model of interdiffusion for ternary system was developed. Fe-Ni-Cr system is selected for experimental validation of the developed model. Three compositions were selected from the data of interdiffusion coefficients from research done by M.A.Dayananda and G.J.Duh in Defect and Diffusion forum. The alloys were characterized using X-ray Diffraction, Energy Dispersive X-ray Spectroscopy and microstructural analysis. Model was simulated for the inhomogeneity in individual alloys. Multi-layered structure of combination of two alloys with Composition Fe-Ni-Cr (68.1-28.55-9.35 atomic %) and Fe-Ni-Cr (31.3-46.1-21.6 atomic %) was simulated for homogenization at 1100ºC and effect of cross diffusion coefficients on concentration profiles were analyzed. Simulations conclude that a change up to 0.3% in concentration profile of chromium is detected between 100 and 200 hour of homogenization treatment. The effect of cross diffusion was concluded to be dependent upon the concentration gradient of diffusing species and thickness of the in homogeneity. Concentration profile obtained from the homogenized multilayered structures using EPMA will be compiled and compared with the simulated profile in order to experimentally validate the established mathematical model.

'1-Dimensional stability analysis of Blasius flow using spectral method'.
Shweta, Mentor: Prof. Alkesh Chandra Mandal

Disturbances introduced in wall-bounded flows can grow and lead to transition from laminar to turbulent flow. In order to reduce losses, a fundamental understanding of the flow stability is important. In our work, the stability of wall-bounded flows is investigated by means of linear stability equations. Wall-bounded flows are investigated, viz. plane poiseuille flow and the Blasius boundary layer flow (zero pressure gradient). Stability theory deals with the mathematical analysis of the evolution of disturbances superposed on a laminar base flow. We start with finding 1-Dimensional stability of the Blasius boundary layer flow and end with verification of the results of stability for the same flow. Spectral collocation method is used for obtaining information regarding the transition phenomenon. The numerical code based on spectral collocation technique is used to find the stability of flows. By this code we can find neutral stability curve for incompressible flow just by putting velocity profile and boundary conditions.

Traffic Modelling using Microscopic Simulation
Somesh Pandey, Mentor: Prof. Anurag Tripathi

This project aims to develop a traffic model using microscopic simulations. The model will try to replicate the heterogeneous traffic conditions under which Indian traffic operates. The novelty in this project is its emphasis on 'time to collision' approach, which is unprecedented in traffic modelling. A large portion of the time was spent on extracting and analysing data relevant to the vehicles' dimensions, mass, and scaling of the parameters. The language used for running the simulation was C++, while GNUplot was used for visualising and preparing animations for the required code. Separating Axis theorem and Velocity Verlet Algorithm were used to model interaction between vehicles.

We tried to prepare a simplistic model in which several vehicles would interact and avoid collisions as the preliminary step. Once the force equations and the desired nature of interaction is successfully achieved between two vehicles, to extend it to a set of vehicles would be a walk in the park. Our emphasis in the Surge program duration was to fool-proof set of interactions between two vehicles. For this, around 25 cases were considered, including head on, head on with an offset, vehicles meeting at an angle etc. The force according to which the vehicles would interact with other vehicles in based on 'time to collision' – in how much time the vehicles would collide if they move without any force. Much of the work of developing a model is done as the nature of forces is pretty much analysed and tested. However, developing a full-fledged model for traffic simulation that exactly replicates the data from any Indian traffic scenario will take some time as of now.

Electrohydrodynamic Atomisation
Sourabh Khandelwal, Mentor: Prof. Pradipta Panigrahi

The first aim of this project is to design a charged injected nozzle with needle shaped pointed electrode for the purpose of injection of charge into the low conductivity fluids such as fuel, to be used for engines. The second aim of the project is to study the spray current and its behaviour at different input voltage, flow rate and electrode gap (i.e. by varying the gap between two electrodes) under steady Direct Current electric field. The diameter of the droplet is also calculated theoretically to analyse the change in diameter with current.

The process of electro hydrodynamic atomization is basically the atomization of fluid under the influence of electric forces. It has a wide range of applications in both industrial processes and analytical instrumentation. Research carried out over the last decade has greatly increased the capabilities of EHD processing, providing the capability to coat, print, spin, thread, bubble or encapsulate a wide variety of materials. Out of many uses the process has got its use in GDI

engines is discussed and nozzle has been designed keeping in mind the low conductivity of fuel so as to increases the efficiency of the engine at low load conditions by producing fine droplets at low pressure using EHDA technique.

Retrofitment of CNC machines for hybrid layered manufacturing.
Sourav Jena, Mentor: Prof. J. Ramkumar

The objective of this project is to study the modelling and control of a quad-rotor Unmanned Aerial Vehicle (UAV). Quad-rotor has two pairs of counter rotating rotor each on every end of the plus or cross configuration which controls the quad rotor. In this work the plus configuration of the Quadrotor has been taken into consideration. Quad-rotor has symmetrical body about centre of gravity and the origin of the body-frame reference coincides with the CG.

In this work the Newton's and Euler's laws has been used to define the dynamic equations of the system. Momentum theory is used to estimate the propeller thrust and torque. In this project, a linear proportional-integral-derivative (PID) controller based feedback control system is developed. MATLAB is used as a platform for the development of PID attitude, position and altitude controllers and the simulation of the quadrotor. The quad-rotor model is simulated using PID controller to achieve attitude stabilization from any current orientation to the hovering position within one second. The PID controller also helps maintain the stability of the quad-rotor during rigorous translation motion. Further the trajectory tracking control of a quad-rotor has also been tested in this simulation. The result of the simulation shows that quad-rotor UAV is able to track the given arbitrary trajectories. Finally, through the simulated result for attitude, position stabilization and trajectory tracking the validation of the proposed model and control system approach is verified.

Large Eddy Simulation for Rayleigh-Benard Convection.
Sumit Vashishtha, Mentor: Prof. Mahendra K. Verma

In the present work we have carried out Large Eddy Simulations (LES) of fluid Turbulence using Renormalisation parameters. The simulations were carried out using an in-house parallel pseudo spectral code Tarang for a cubical enclosure with periodic boundary conditions. Direct Numerical Simulation (DNS) for 512^3 and 128^3 grids were also performed and LES was performed for a grid size of 256^3 and 64^3 . Initial conditions were obtained from the interpolation of steady state data of 512^3 runs for the given grids. Turbulence was allowed to decay (no forcing at any wave number) and observations were made for the time evolution of Kinetic Energy and fixed time instants plots of Kinetic Energy spectrum and Kinetic energy flux . LES of 64^3 is compared

with DNS of 128^3 whereas LES of 256^3 is compared with 512^3 DNS. It is observed that the time evolution of Kinetic Energy almost overlap for both the comparisons. Also the LES is able to capture the inertial range of wave numbers (and hence Kolmogorov's 5/3 scaling law) equally well vis-a-vis DNS results .

Effect of wing stiffness on Aerodynamics of flapping winged creatures
Suryadeep Nath, Mentor: Prof. Debopam Das

The aim of the project is to do a parametric study of aerodynamic forces with different wing stiffness and study wing deformation characteristics. When a wing flaps, then a span-wise deformation of the wing occurs due to pressure difference across wing surface, pulling back the leading edge. Consequently, there occurs a span-wise twist of the wing surface. So, when the leading edge spar is constrained by a spring, the span-wise deformation is altered and as a result span-wise twist angle also alters. This alteration in twist angle will affect the lift, drag and thrust that the wing will generate while flapping. In our project we designed a flapping wing robot with a nose screw on which a slider was slipped. A thread with springs at either end, was passed through the slider and the springs were hooked to each wing spar. Equal tension was produced in each wing as the springs were connected in series by a single inextensible thread.

Design and development of experimental facility for an active control of coaxial jet flow field and its study.
Suyash Sudhir Nilawar, Mentor: Prof. Pradipta Panigrahi

Active control of coaxial jet gaseous fluids using dielectric barrier discharge (DBD) plasma actuator is one of the method for the enhancement and control of mixing in the near field region (x/D <1) of jets. Mixing in the initial zone is important thereafter molecular diffusion occurs at higher rates. DBD plasma actuators are the sensors used to actuate the flow in the near field region. Coaxial jet nozzle design is the most important aspect of this work so that flow separation should not occur at any location along the nozzle contour and at the same time the nozzle profile must be such that Gortler vortices should not form. For designing the nozzle Thwaites method for axisymmetric geometries was used. Selection of the inner and outer/annular jet fluid combinations was also important by taking into account the cost, availability and pollution factors, at the same time the fluid combination need to have higher value of density ratio in order to distinguish the fluids in coaxial jet stream. Velocity field measurement at the nozzle exit has been performed to get the boundary layer thickness at the nozzle exit. Interpretation of various graphs obtain is also very important.

Design and Manufacture of a novel Hovering Device
Swapnil Shandilya, Mentor: Prof. Sachin Shinde

Main motive of work is to demonstrate the ability of flexible wings to generate thrust. A prototype capable of hovering still in air using flapping of flexible wings was planned. Whole project involved the design and manufacturing of the prototype. Similar attempts have been made previously but with purely pitching flexible aero-foil in still fluid is first one. Several mechanisms were studied to actuate the wings in such a way that they produce only a one directional jet. The wings had to be in out of phase oscillations to avoid lateral forces. Achieving high frequency oscillations while maintaining lightest possible weight was a big challenge. Proper mounting of flexible portion of the wing on rigid aero-foil was another problem source for high frequency oscillations. Mechanism components were made out of light weight, hard acrylic material to ensure their endurance capability of 50-60 Hz oscillations. To avoid diversion of efforts in making a drivetrain, it was adopted from a toy helicopter.

Development of Rapid Models of Air Flow through Louvers
Taaresh Sanjeev Taneja, Mentor: Prof. Vaibhav Arghode

Louvers or vents are primarily used in air-conditioners, fans and air-coolers for directional circulation of air in the confinement they are used to cool. A detailed Computational Fluid Dynamics analysis can be done by replicating the exact geometry of these louvers and setting the appropriate boundary conditions to simulate airflow in the confinement as directed by the louvers. However, this involves huge computational costs and time. The central aim of this project is to develop a rapid air flow model based on correlations in order to simulate the exact flow conditions without geometrically resolving all the features. This saves a lot of computational time and costs. In order to achieve this, a momentum flow rate source term (or equivalently a body force term) of suitable magnitude and direction can be introduced. Specification of a body force term obviates the need for resolving the louver geometry.

A theoretical first-hand approach using control volume analysis and Reynolds Transport Theorem can be used as a starting point to obtain a mathematical expression for this source term. Further changes are to be done iteratively in the rapid model case for matching the various downstream flow characteristics such as flow turning angle, mass weighted average velocity as a function of downstream distance, static pressure contours, etc. This study focuses on identifying the different variables affecting the downstream flow characteristics and obtaining a correlation, assuming steady state analysis.

Robust Path Planning Algorithms
Tanmoy Paul, Mentor: Prof. Mangal Kothari

The project based on rapidly exploring Random Trees (RRT) a path planning algorithm. The work started with development of a simple RRT algorithm proceeded by its simulation. To handle the uncertainties involved within the system and the environment, the original RRT was modified to accommodate a stochastic model which allows the user to define a probability of failure for the search of target location in a configuration space. Modification was accomplished using the method of Chance Constraint (CC) to incorporate the uncertainties and make the path planner more robust in realistic environment. The work describes the obstacle avoidance condition used in development of both the algorithms. A nonlinear system is described along with the control command to execute the system along the desired path obtained from the CC-RRT algorithm. After successful simulation, validation of the developed algorithms was carried out by implementation on a working model. The project introduced to a compact multi-functional robot based on Arduino named Ringo which is used for implementation of the original RRT algorithm. The attempt to implement the algorithm either by integrating MATLAB commands using Simulink or by creating user defined libraries and functions for Arduino to implement RRT, however, was not successful due to couple of drawbacks in Ringo. The work tries to explain the limitations of Ringo in implementing extensive and advanced algorithms or programs.

Public opinion analysis of climate change and energy in the United States of America.
Vinayak Mahbubani, Mentor: Prof. Deep Mukherjee

Climate change is one of the most preeminent environmental risks confronting the world today and has several adverse effects such as changes in rainfall resulting in more floods, droughts, or intense rain as well as more frequent and severe heat waves. Since climate change is not a personal matter, any effort to reduce climate change comes under the realm of regulation and policymaking. In a democracy, an important ingredient to policy formulation is public opinion. In 2011, the United States was the second largest emitter of CO2, accounting for 16% of the global emissions just after China. The United States of America, despite its high emissions, did not sign the Kyoto Protocol in 1998. The 2015 United Nations Climate Change Conference negotiated the Paris Agreement, a global agreement in reduction of climate change. The United States has not yet signed the agreement. The current study aims to identify the impact of socio-economic and demographic factors on an individual's opinion towards emission limits for power plants to mitigate climate change in the United States in the light of the current political scenario.

Linear Stability Analysis
Vishal Rathor, Mentor: Prof. Sanjay Mittal

Neglecting non-linear terms in reduced naiver stokes equation after adding small perturbation in base flow , Assuming small perturbation as function and applying Finite Element Method one can get generalized Eigen value problem in form (AX=λBX), where A and B are large non symmetric matrices We need to find out λ (eigenvalue) and eigenmodes to check the stability of flow. For the system to be stable it is necessary that the eigenvalues corresponding to all the modes must have negative real parts. We solve this equation by using SuperLU and ARPACK software along with our in house built sequential and parallel programming codes.

Our in house parallel code is not able to solve the equation after a certain limit of Matrix size and Getting Memory problem and hence not giving eigen value also our sequential code is not correct to get eigen values Solving eigen value problems for three dimensional flows require a large number of equation and our sequential code is not able to solve. Thus a parallelized eigen value solver is required for large matrices A and B. Storage of matrices is done in compressed column storage in order to reduce the memory size.

1-D stability analysis of Falkner and Skan flow by spectral method'
Vishal Vyas, Mentor: Prof. Alkesh Chandra Mandal

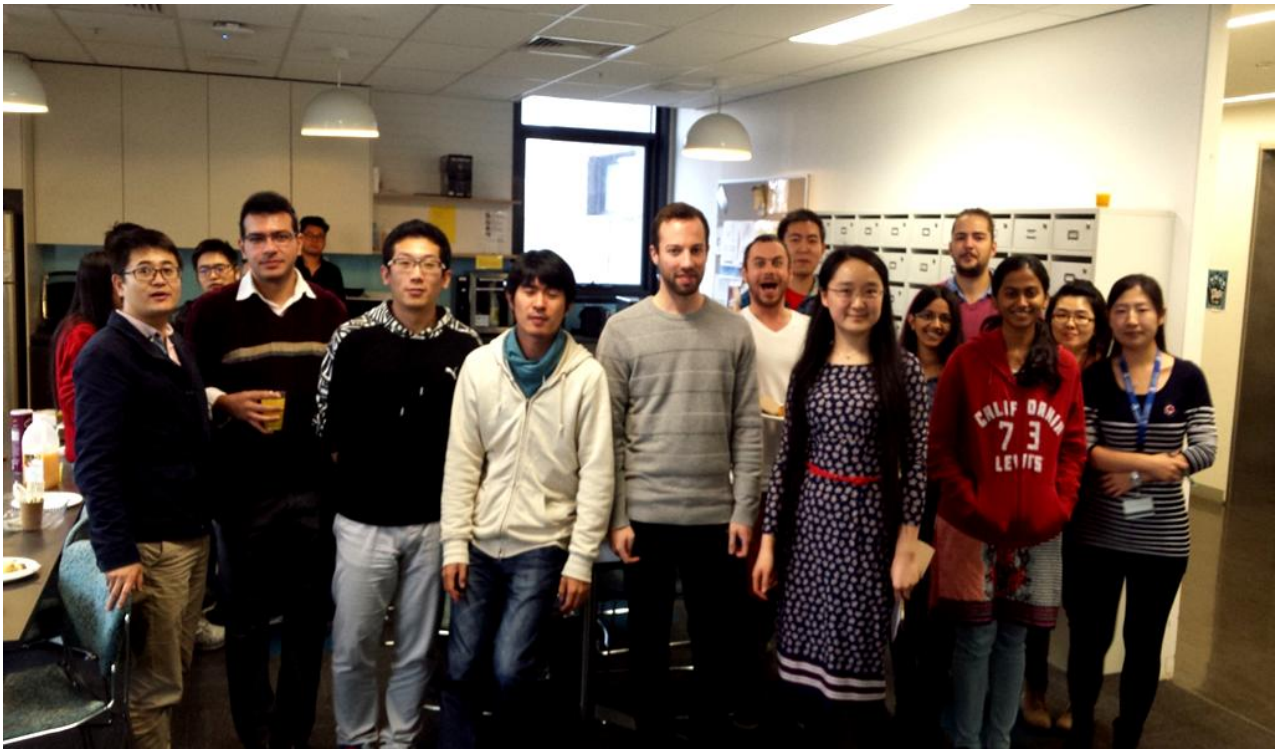
Objective of this project is to perform 1-Dimensional stability analysis of the Falkner and Skan boundary layer. For the Falkner and Skan boundary layer, the temporal stability analysis is carried out over initial stream wise location. The Linear stability theory (LST) deals with the spatial and temporal evolution (growth/decay) of small amplitude perturbation superimposed upon a steady or unsteady laminar base flow. The method involved a new version of the tool for the derivation of the 1-Dimensional stability equations, a tool for their automatic implementation in MATLAB via the spectral collocation method to apply boundary conditions and execute the analysis corresponding to a prescribed mean flow. The problem is linearized by the companion matrix technique for semi-infinite domain using a mapping transformation. The method can be easily adapted to problems with different boundary conditions requiring different transformations. Mean velocity for the prescribed flow is calculated at Gauss-Lobatto points and by using Linearized Navier-Stokes Equations (LNSE). Now the problem has become a simple Eigen value problem from which we can check stability of the given flow.

Abstracts: SURGE 2016 Research projects done in Overseas University

Propagation Complete Encodings for SAT Solvers
Arunothia Marappan, Mentor: Associate Professor Harald Sondergaard

Boolean Satisfiability Problem (SAT) is fundamental to the class of NP complete problems. Even though the problem of P versus NP remains one of the most difficult conundrums till date, it is firmly believed that NP complete problems cannot be solved in polynomial time. Enhancing a given SAT input encoding to become a propagation complete encoding (PCE) by adding additional clauses of pruning information for unit propagation makes the task of SAT solvers much simpler. Especially all those encodings for which the corresponding PCE remains polynomial in length of the original encoding, the SAT Solver can solve it in polynomial time. Hence, it is wise to convert all standard encodings to a corresponding equi-satisfiable PCE as this will save the SAT solver from delving along any unyielding path during its execution.

In this work, we came up with an algorithm to compute PCE of any given input encoding. Our algorithm is inspired by the idea of minimal unsatisfiable cores/sets (MUSes) and is practically faster, more intuitive and simpler to implement than the previously presented ones.



SURGE 2016 Popular Lectures

Dr. Abhishek

Prof. Abhishek is currently the Professor in the Department of Aerospace Engineering at Indian Institute of Technology, Kanpur. His area of interest is Rotary Wing Aeromechanics, Hover Capable Micro Air Vehicles, Multi-body Dynamics, Inverse Flight Dynamics Simulation for Helicopters, Helicopter Design, Wind Turbines.

Title: "The Frontiers of Unmanned Aerial Systems Research"

Abstract: Various types of Unmanned Aerial Vehicles (UAVs) would be briefly introduced and the principles of flight of the UAVs would be elucidated. The civilian and military applications of Unmanned Aerial Systems would be discussed in detail. This would be followed by discussion of various elements of UAV research and the associated challenges. The multi-disciplinary nature of UAV research would be established.

Ms. Suratna Das

Ms. Suratna Das is currently the DST Inspire Fellows in the Department of Physics at Indian Institute of Technology, Kanpur. Her specialization is Cosmology/Astroparticle Physics.

Title: Discovery of Gravitational Waves: Another feather in Einstein's cap

Abstract: Einstein gave his theory of General Relativity in the year 1915, which completely changed our perception of (Newtonian) gravity. This theory was tested within four years of its prediction, in 1919, when Arthur Eddington measured the deflection of light by Sun during a total solar eclipse, which made Einstein's General Theory of Relativity very popular. This theory has survived all the tests ever since and the recent direct detection of gravitational waves is just another jewel in the crown of Einstein's General Theory of Relativity. But, unlike other tests of General Theory of Relativity, direct detection of gravitational waves has opened up a new window of astronomy, a new eye through which we can look at the cosmos around us. I will discuss in this talk what we mean by gravitational waves, how we detect them and what we learn about our universe by detecting them.

Dr. Y. N. Singh

Dr. Y. N. Singh is currently a Professor in the Department of Electrical engineering at Indian Institute of Technology, Kanpur. His research interest is Peer to peer networking, Overlaid multicasting, Technology development for E-learning and E-education, Delay Tolerant Networks, Optical networks - protection and restoration, Optical Packet switching architectures, Packet and circuit switching, Telecomm Network Management, Network security, Embedded systems.

Title: Brihaspati initiative

Abstract: IIT Kanpur has been involved in the development of open source free learning management system (LMS) named Brihaspati and live lecture delivery system Brihaspati-sync, since 2004. The project was funded by DIT and its objective is to develop software system as loosely coupled software modules with single authentication to provide for online functionalities useful for academic institutes.

Mr. Navpreet Singh

The fourth lecture of the SURGE program is delivered by Mr. Navpreet Singh. Mr. Navpreet Singh is Chief Engineer at IIT Kanpur and manages the Campus Network and Internet Services of IITK. Area of Interest is Network Design, Implementation, Management, Security and Performance Analysis, Web Programming.

Title: Network Architectures

Abstract: Network Architecture is the complete framework of an organization's computer network providing a full picture of the established network with detailed view of all the resources accessible. The current talk will focus on IITK Campus Network. This network now has more than 20000 nodes providing connectivity to more than 8000 users in Academic Departments, Student Hostels and Residences. The talk will cover issues like hardware components used for communication,

cabling and device types, network layout and topologies. It will also include topic such as DNS, Proxy, Web server, email etc.

Dr. Sameer Khandekar

The fifth lecture of the SURGE program is delivered by Dr. Sameer Khandekar. He is currently a Professor in the Department of Mechanical Engineering at Indian Institute of Technology, Kanpur. His research interest is Phase-change heat transfer, Heat pipes, Pulsating heat pipes, Electronics thermal management and Energy systems.

Title: Ifs and Buts of Entrepreneurship as a Career Option?

Abstract: Why is it that everyone is talking about entrepreneurship today in our country? Is this a viable option for young graduate engineers to start their career? What is needed and what is expected from you to jump into this economic space? The talk will outline the importance of entrepreneurship, especially in the emerging economies and the developing eco-system which is now available in our country for nurturing innovation and entrepreneurship.

Dr. T. Ravichandran

Dr. T. Ravichandran is currently a Professor in the Department of Humanities and Social Sciences at Indian Institute of Technology, Kanpur. His current research interests are Posthumanism, The Anthropocene, Climate Fiction, Cyberpunk, Postmodern Science Fiction, Postcolonial Literature, Indian Writing in English, Cultural Studies, Film Studies, Cybercriticism, Ecocriticism, Global/Intercultural Communication

Title: Report Writing and Presentation.

SURGE 2016 Awards

"Dr. Elizabeth and Dr. Verkey Cherian Award" for Best Project and an "**Outstanding Poster Award" for Best Poster** who produce exceptional quality research during the SURGE program. Award of Rs. 5000 plus a commendation certificate will be given to SURGE students for best project and an Award of Rs. 5,000 plus a commendation certificate for Outstanding Poster will be given to SURGE students. This year SURGE Evaluation committee has been shortlisted the following SURGE participants for SURGE 2016 Awards.

S. N	Name of the Participant	Project title	Mentor Name	Award Name
1.	Nisha Mehta	Electronic structure and hydration dynamics of portlandite material using Density Function Theoretical (DFT) Calculations	Prof. D. L. V. K. Prasad Chemistry	Best Project
2.	Ayush Agrawal	Vulnerability of Indian widows	Prof. Debayan Pakrashi Humanities & Social Sciences	Best Poster
3.	Shivi dixit	Study of Relaxation modulus at different pre and post gel states.	Prof. Yogesh Joshi Chemical Engineering	Best Poster

Acknowledgement

The support and participation of the following is gratefully acknowledged:

1. The faculty mentors at IIT Kanpur and the students for their enthusiastic participation.

2. The generous donors who made contributions to support the program.

3. Members of the Executive Committee, Advisory Committee, Departmental Representatives, Lecture hall staff and numerous other faculty members who helped in the program.

4. Prof Abbas Rajabifard, Associate Dean, International and Beth Hunter, Global Mobility Coordinator at University of Melbourne for developing cooperation.

5. Department faculty coordinator and the Project Evaluation Committee.

6. Mr. Abhishek Singh and Ms. Shobhi Srivastava of SURGE office for coordinating the SURGE program.

SURGE 2016 Committee

The surge program is run with the help of the following sub committees:

1. Advisory Committee

2. Executive committee

3. Departmental representatives

4. Project Evaluation Committee

Advisory Committee: The responsibilities of the Advisory committee are to guide and review the program from the time to time and provide necessary support to the Coordinator for the smooth running of the SURGE program.

Members of Advisory Committee are as follows:

- Prof. Amalendu Chandra (DORD),
- Prof. Neeraj Mishra (DOAA),
- Prof. A. Kushari (ADIR),
- Prof. Sudhir Kamle (Faculty in-charge SURGE),
- Dr. R. K. Sachan (Special Invitee, Sr. DR, DORD),
- Students' Gymknaha Representative
- Prof. B. V. Phani (DORA)

Executive Committee: This committee creating a Framework such that the SURGE Internship program is in line with the DOAA regulations. The accommodation requirement and administrative requirements (such as access to health centre, computer facility, Library facilities, ID Card etc.) can be managed. Members of this committee are as follows:

- Prof. Sudhir Kamle (Faculty-in-charge SURGE, Chairman)
- Prof. Kantesh Balani (ADHA)
- Prof. Abhijit Kushari (ADIR)
- Prof. A. Ghatak (ADIC)
- Prof. Jayant K. Singh (ADUG)

- Students Gymkhana representative
- Dr. R. K. Sachan (Sr. DR, DORD)

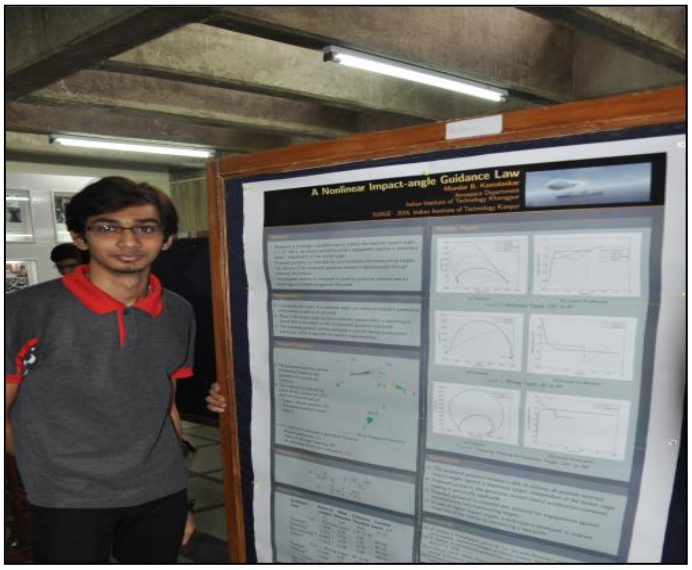
Departmental representatives: A list of candidates according to department wise is sent to individual departments. The departments choose the probable students & the supervisors & send the list back to surge office for final selection.

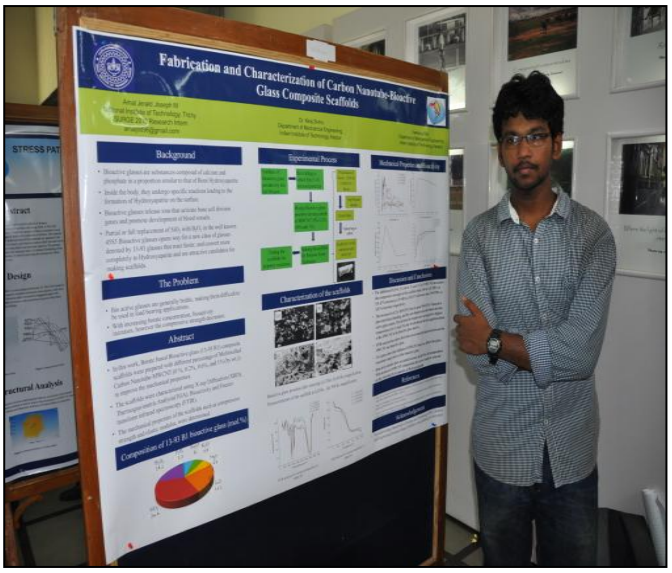
Members of this committee are as follows:

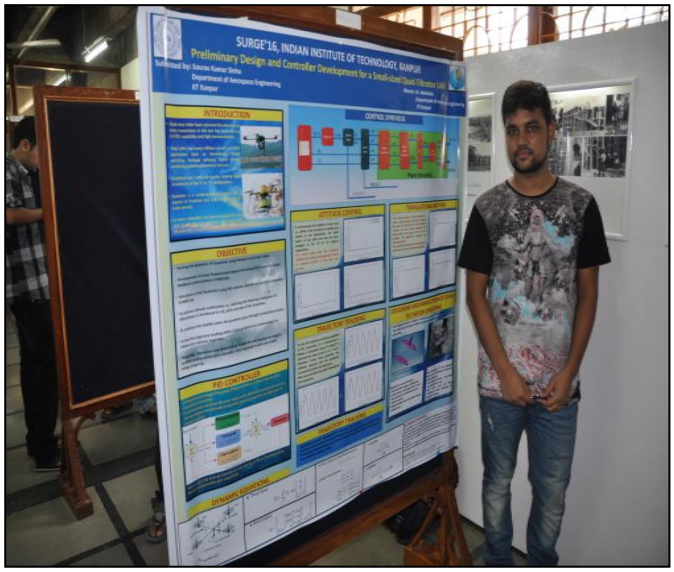
- Dr. Abhishek (Aerospace Engineering)
- Dr. M. Saravanan (Biological Sciences and Bioengineering)
- Dr. Naveen Tiwari (Chemical Engineering)
- Dr. Anand Singh (Chemistry)
- Dr. Sarvesh Chandra (Civil Engineering)
- Dr. Vinay P. Namboodiri (Computer Science & Engineering)
- Dr. Ketan Rajawat (Electrical Engineering)
- Dr. Deep Mukherjee (Humanities & Social Sciences)
- Dr. Deepu Philip (Industrial & Management Engineering)
- Dr. Rajdeep Mukherjee (Materials Science & Engineering)
- Dr. Anirban Guha (Mechanical Engineering)
- Dr. Anjan Kumar Gupta (Physics)

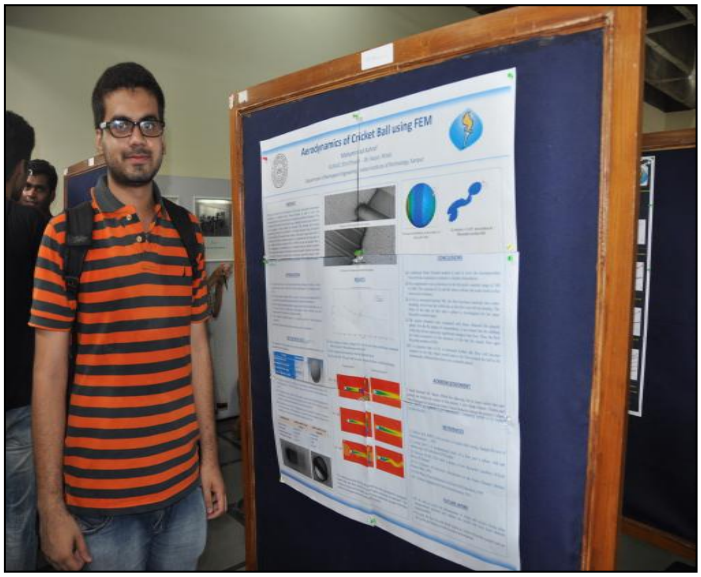
Project Evaluation Committee

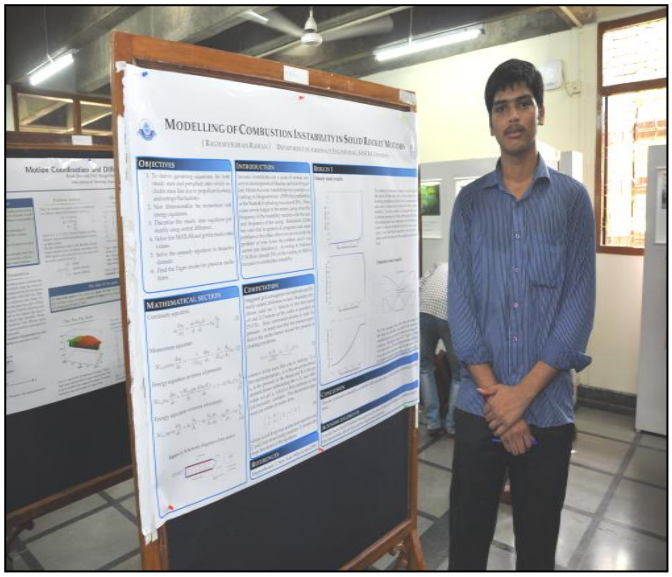
- Dr. Sudhir Kamle (Aerospace Engineering)
- Dr. Rakesh K Mathpal (Aerospace Engineering)
- Dr. Mangal Kothari (Aerospace Engineering)
- Dr. Abhishek (Aerospace Engineering)
- Dr. Kantesh Balani (Material Science & Engineering)

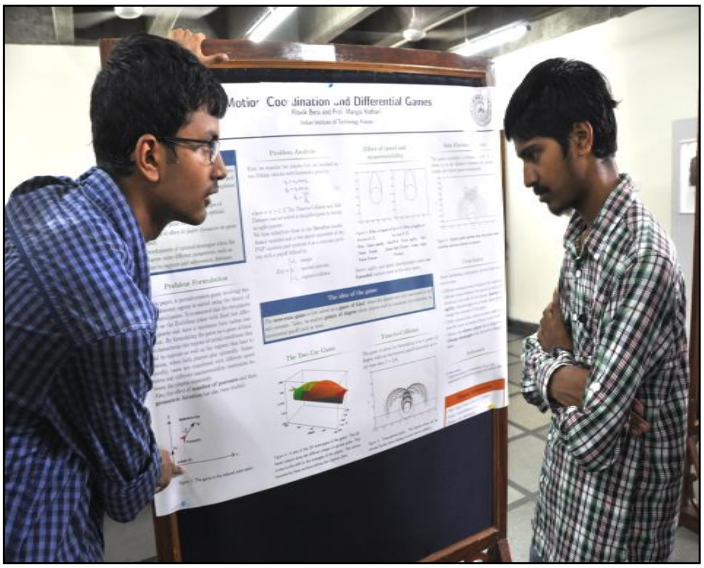

A Nonlinear Impact-angle Guidance Law

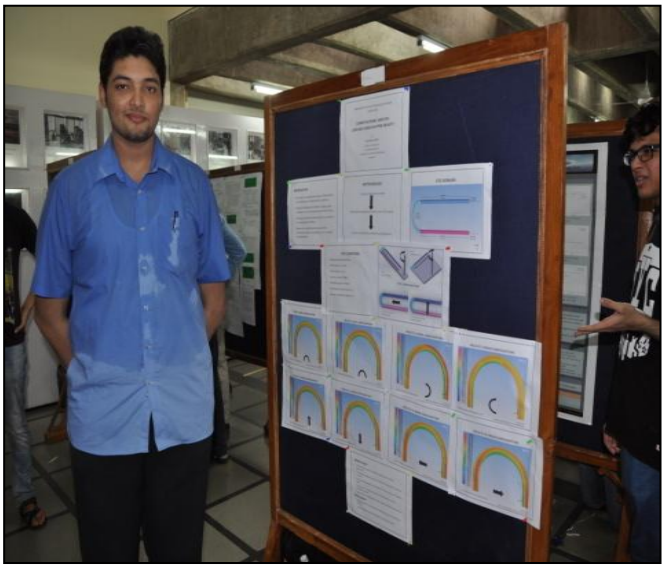

Fabrication and Characterization of Carbon Nanotube-Bioactive Glass Composite Scaffolds
Background
The Problem
Abstract

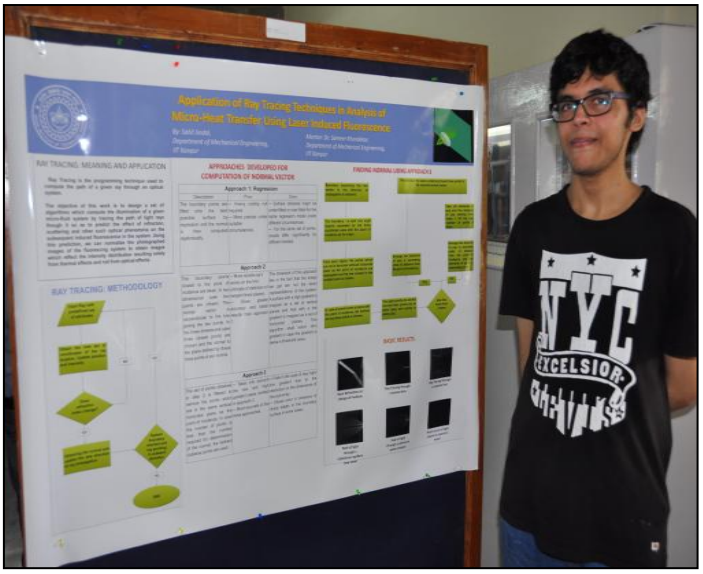

SURGE'16, INDIAN INSTITUTE OF TECHNOLOGY, KANPUR
Preliminary Design and Controller Development for a Small-sized Quad-Tiltrotor UAV
INTRODUCTION
OBJECTIVE
PID CONTROLLER
DYNAMIC EQUATIONS

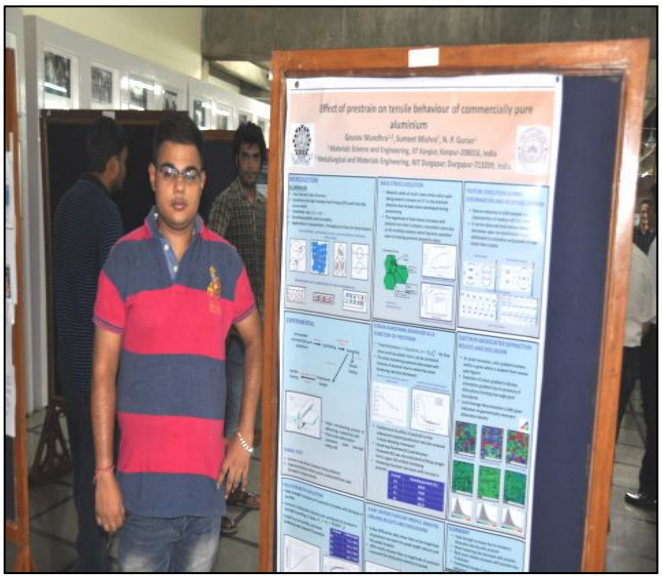

Aerodynamics of Cricket Ball using FEM

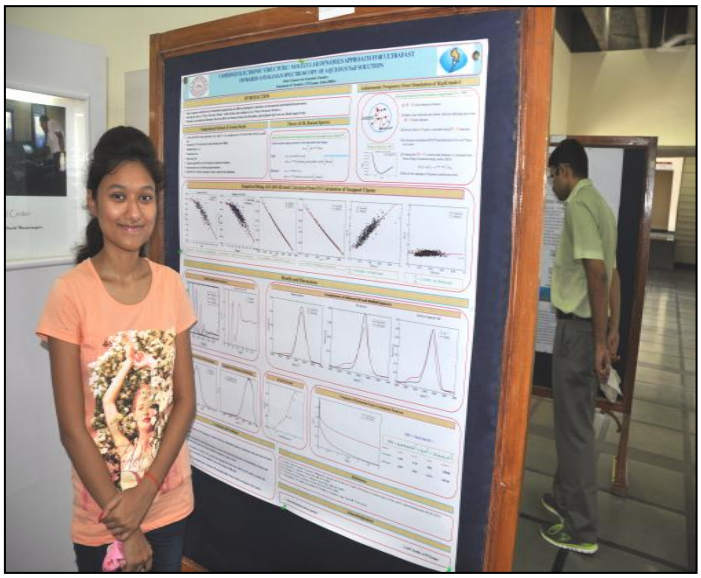

Modelling of Combustion Instability in Solid Rocket Motors
Objectives
Introduction
Mathematical Section
Conclusion

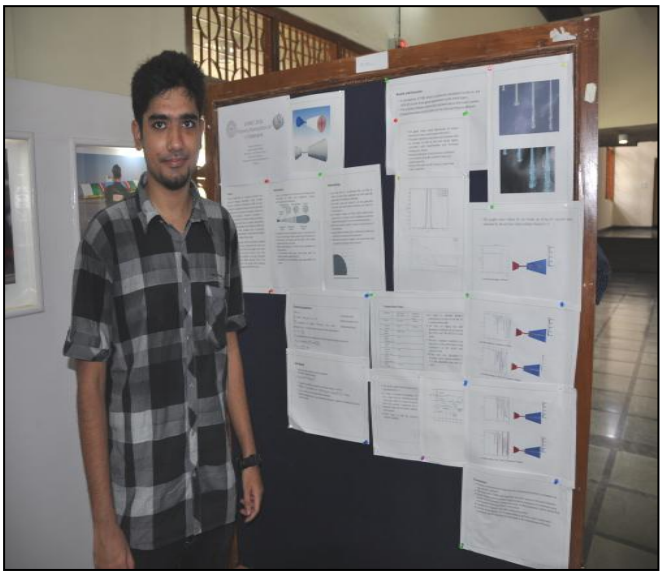

Motion Coordination and Differential Games

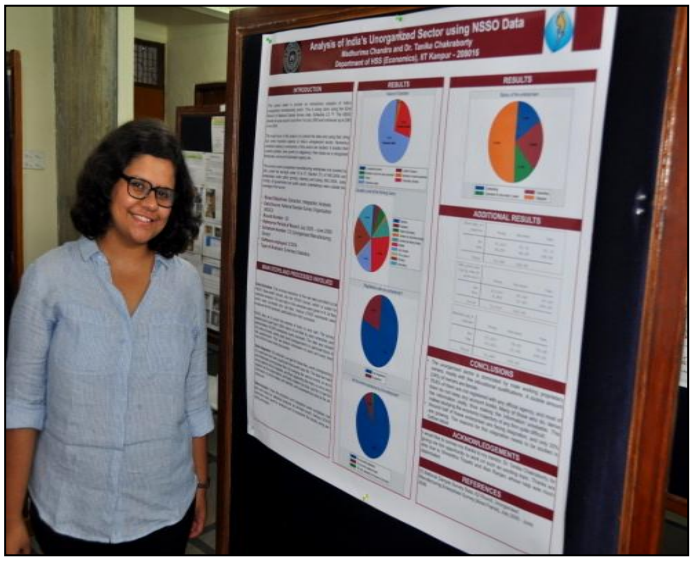


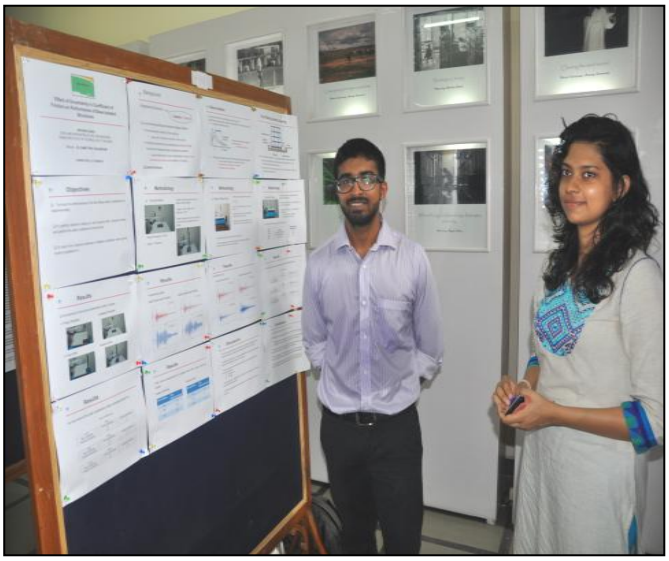

Application of Ray Tracing Techniques in Analysis of Micro-Heat Transfer Using Laser Induced Fluorescence
RAY TRACING: MEANING AND APPLICATION
RAY TRACING: METHODOLOGY
APPROACHES DEVELOPED FOR COMPUTATION OF NORMAL VECTOR
FINDING NORMAL USING APPROACH 3
BASIC RESULTS
NYC
EXCELSIOR

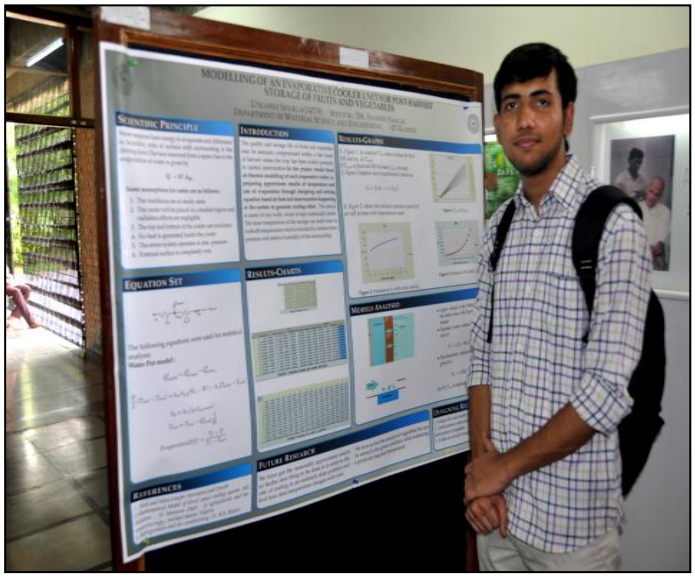

Effect of prestrain on tensile behaviour of commercially pure aluminium

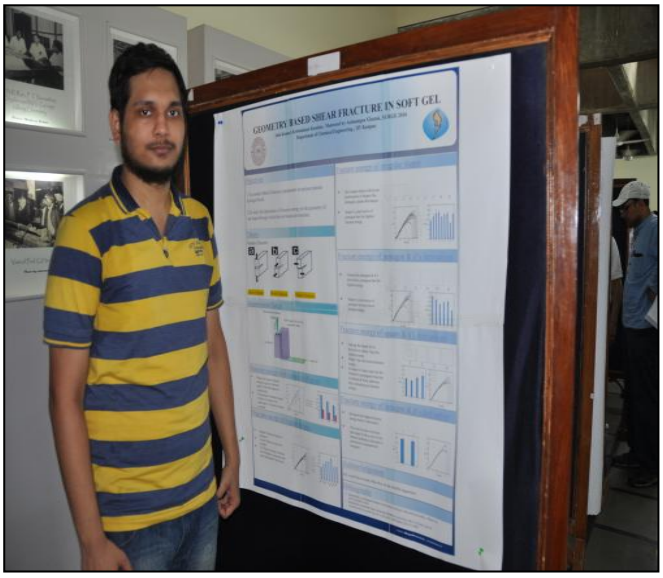


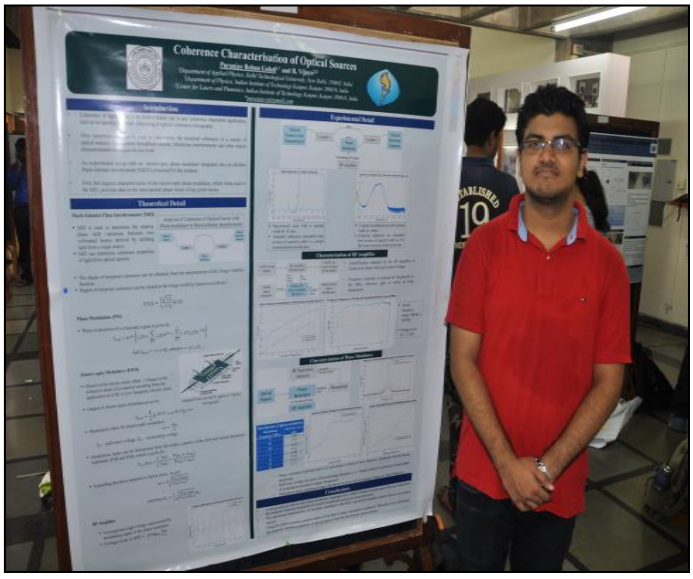


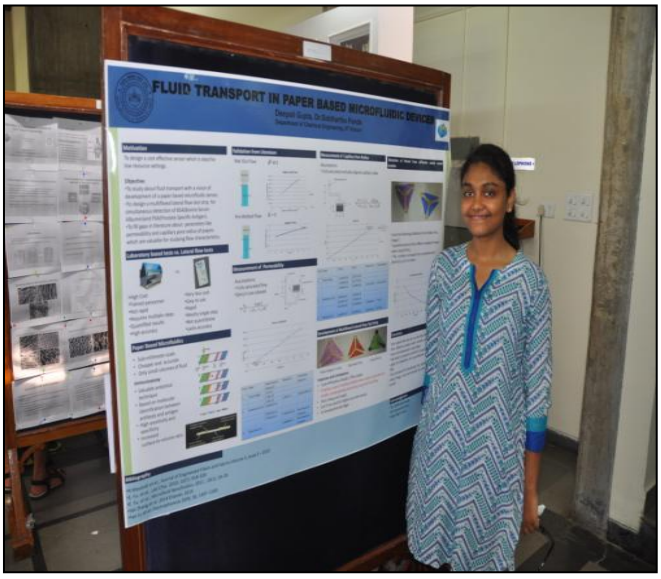

Analysis of India's Unorganized Sector using NSSO Data
Bidhurima Chandra and Dr. Tamiia Chakraborty
Department of HSS (Economics), IIT Kanpur - 208016
INTRODUCTION
RESULTS
RESULTS
ADDITIONAL RESULTS
CONCLUSIONS
ACKNOWLEDGEMENTS
REFERENCES

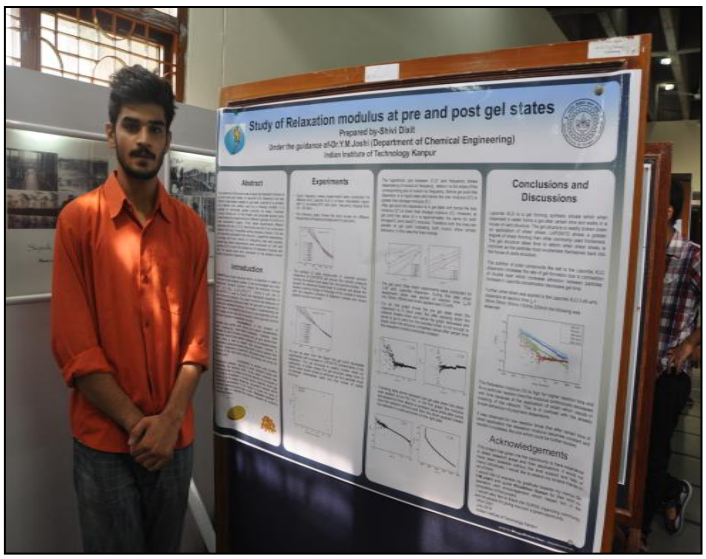


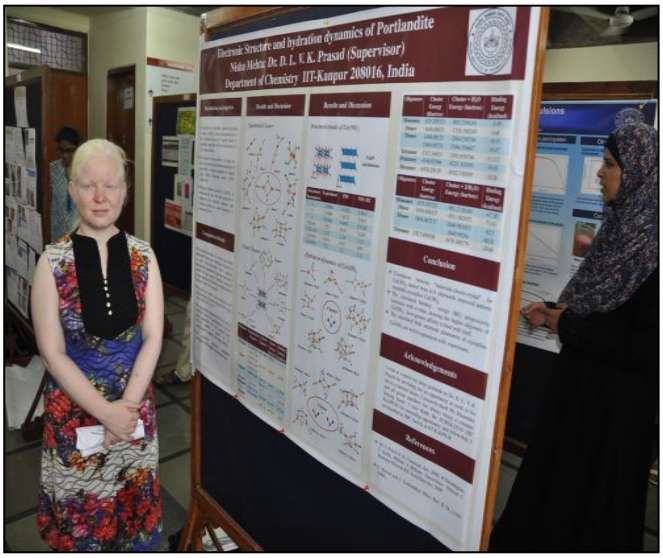

MODELLING OF AN EVAPORATIVE COOLER UNIT FOR POST-HARVEST STORAGE OF FRUITS AND VEGETABLES
SCIENTIFIC PRINCIPLE
INTRODUCTION
RESULTS-GRAPHS
EQUATION SET
RESULTS-CHARTS
MODELS ANALYSED
FUTURE RESEARCH
REFERENCES


GEOMETRY BASED SHEAR FRACTURE IN SOFT GEL

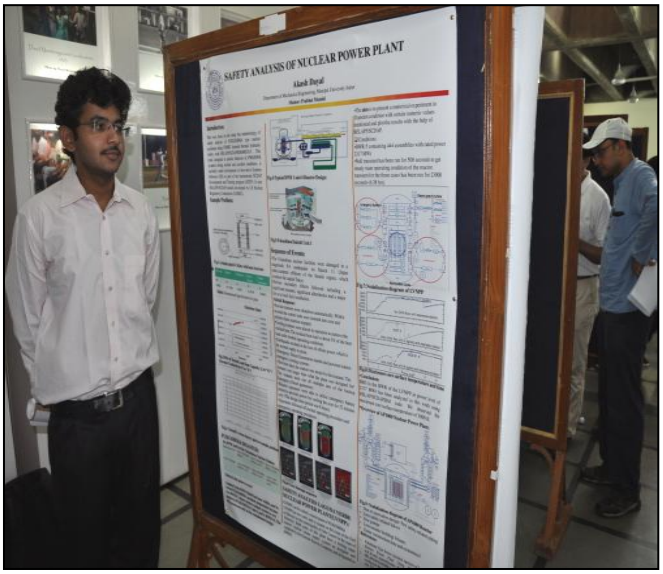

Coherence Characterisation of Optical Sources
Introduction
Theoretical Detail
Experimental Detail

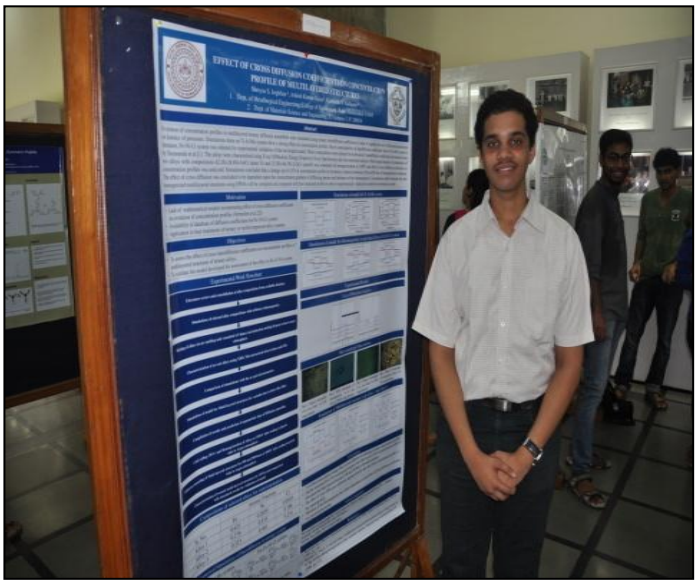

FLUID TRANSPORT IN PAPER BASED MICROFLUIDIC DEVICES

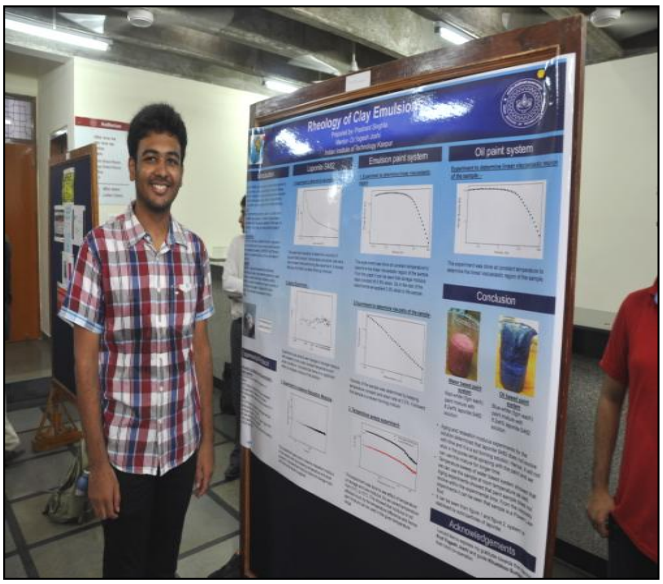

Study of Relaxation modulus at pre and post gel states
Prepared by-Shivi Dixit
Under the guidance of-Dr.Y.M.Joshi (Department of Chemical Engineering)
Indian Institute of Technology Kanpur
Abstract
Introduction
Experiments
Conclusions and Discussions
Acknowledgements

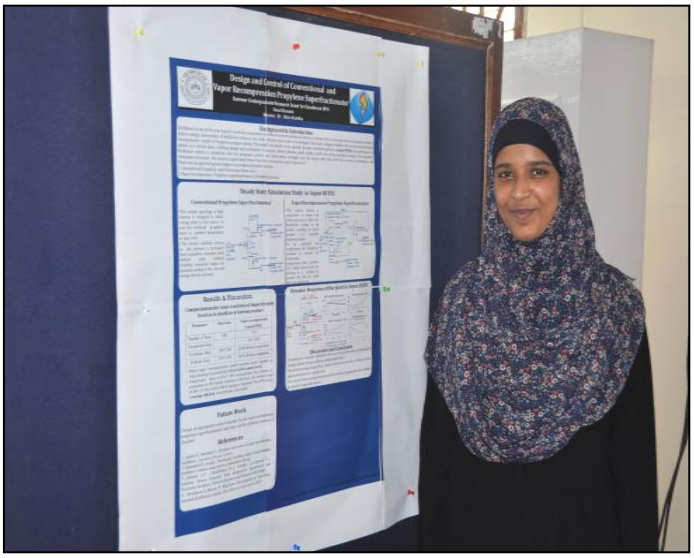

Electronic Structure and hydration dynamics of Portlandite
Department of Chemistry IIT-Kanpur 208016, India
Conclusion
Acknowledgements
References

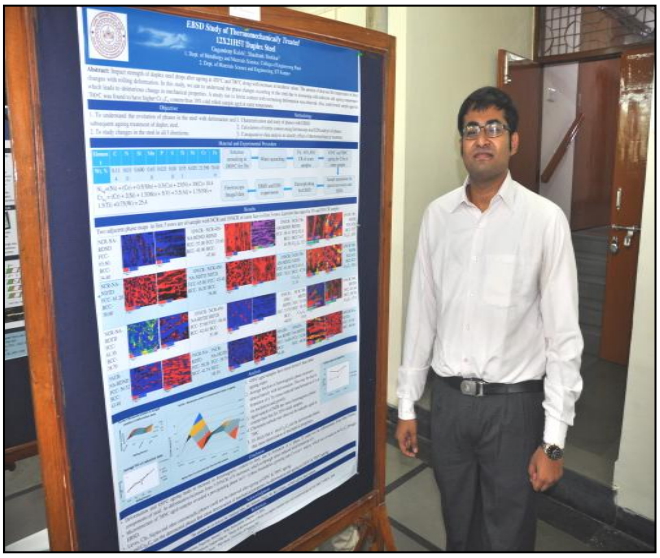

SURGE'16
Vulnerability of Indian widows
Department of Humanities and Social Sciences
Indian Institute of Technology Kanpur
Abstract
Results
Methodology

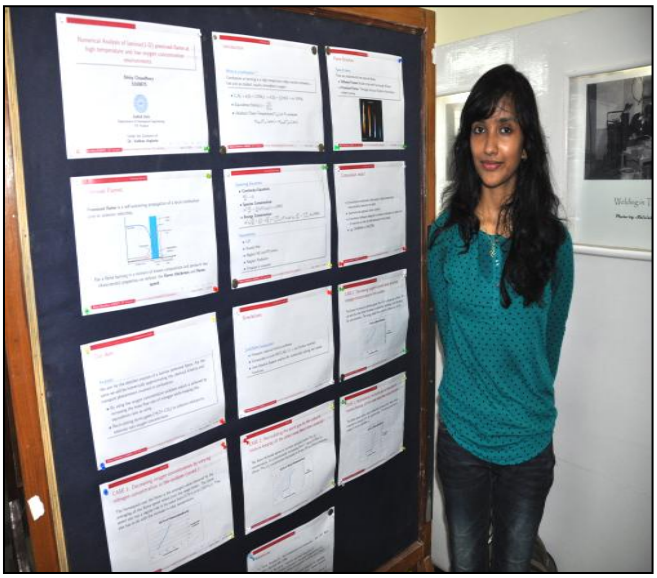

SAFETY ANALYSIS OF NUCLEAR POWER PLANT

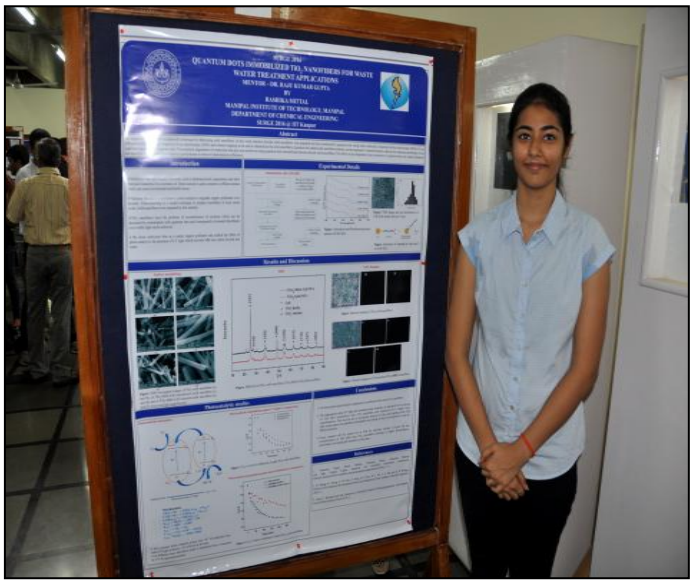


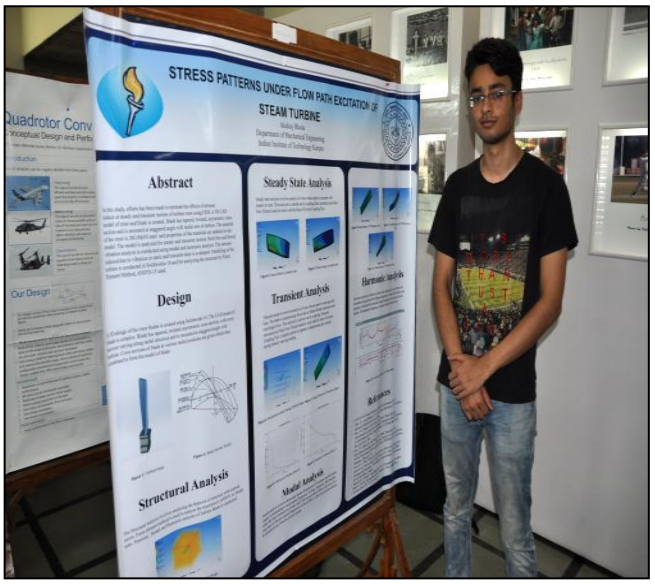

Rheology of Clay Emulsion
Oil paint system
Conclusion
Acknowledgements

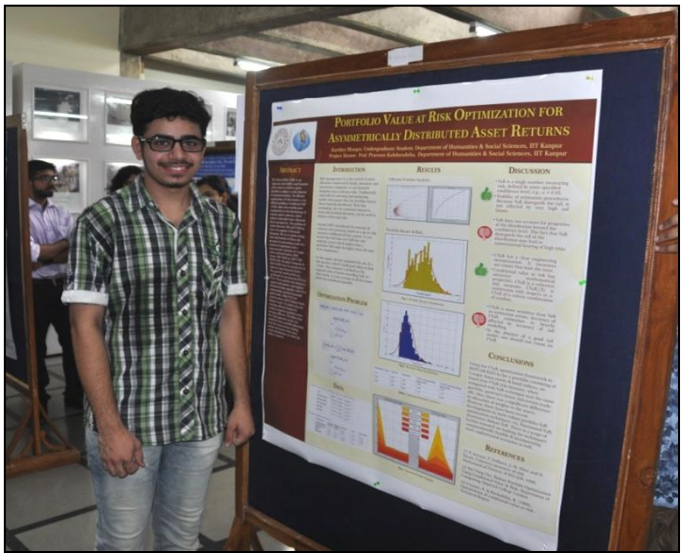




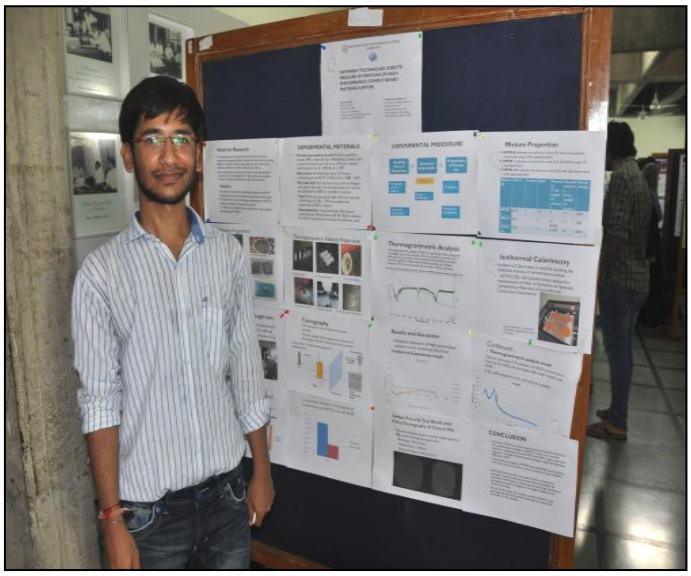


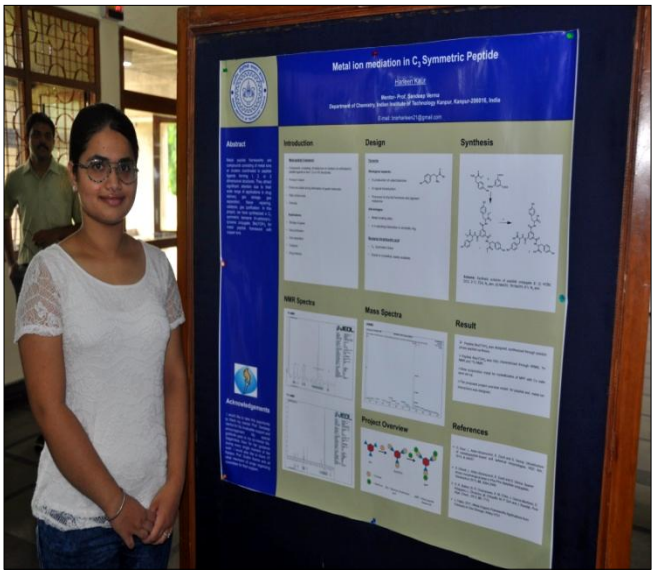

QUANTUM DOTS IMMOBILIZED TIO2 NANOFIBERS FOR WASTE WATER TREATMENT APPLICATIONS

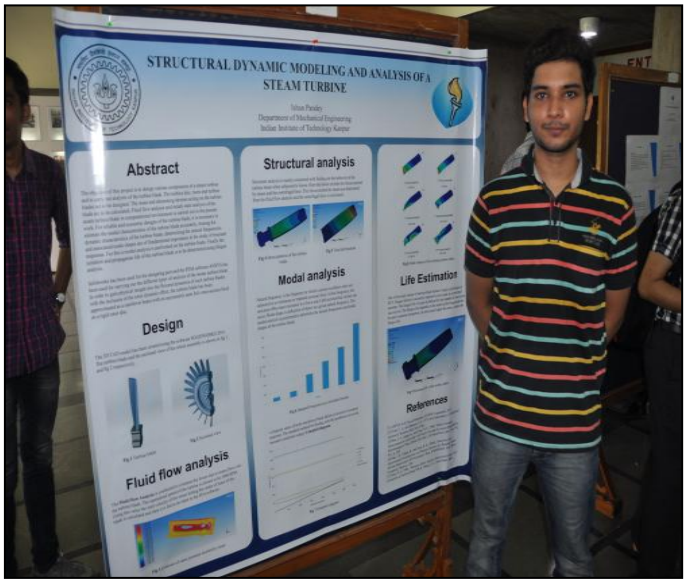

STRESS PATTERNS UNDER FLOW PATH EXCITATION OF STEAM TURBINE
Abstract
Steady State Analysis
Design
Transient Analysis
Structural Analysis

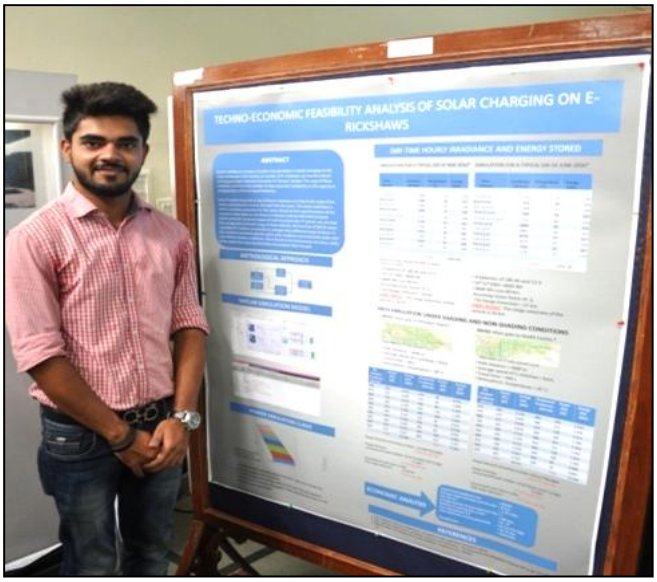

PORTFOLIO VALUE AT RISK OPTIMIZATION FOR ASYMMETRICALLY DISTRIBUTED ASSET RETURNS


Hannay angle in dissipative systems
Limit cycles in non linear systems




Metal ion mediation in C2 Symmetric Peptide


STRUCTURAL DYNAMIC MODELING AND ANALYSIS OF A STEAM TURBINE
Abstract
Structural analysis
Modal analysis
Life Estimation
Design
Fluid flow analysis
References


TECHNO-ECONOMIC FEASIBILITY ANALYSIS OF SOLAR CHARGING ON E-RICKSHAWS

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