

Anuj Sethia

Indian Institute of Technology Bombay



Research Interests: Quantum Computing, Quantum Information Theory, Quantum Control

EDUCATION

Indian Institute of Technology Bombay

[Jul 2016 - Apr 2020]

B.Tech, Mechanical Engineering (GPA: 8.22/10)

Minor: Engineering Physics

Awards: Undergraduate Research Award

PUBLICATIONS

1. Visualization and Modelling of Pool Boiling Bubble Growth and Departure

Anuj Sethia, Amrita Birhman, Janani Srree Murallidharan

FMFP 2018 (*Published*)

2. Subcooled Pool Boiling on Ultra-thin strips of varying cross-sections

Amrita Birhman, Sanjid C S, John Pinto, **Anuj Sethia**, Janani Srree Murallidharan

JEES 2019 (*Published*)

RESEARCH PROJECTS & INTERNSHIPS

Security Analysis of DPS QKD

[Jun '20 - Sep '20]

Guide: [Dr. Anindita Banarjee](#) | QNu Labs, Bengaluru

Introduction: Differential Phase Shift (DPS) is an unidirectional Quantum Key Distribution scheme that encodes information in the phase of a weak coherent light. Key information is transferred through a train of pulses with specific phase modulation.

- Studied individual attacks such as Beam Splitting, Intercept Resend, Photon Number Splitting, Sequential attacks and their security analysis on DPS protocol
- Proved security of DPS against Phase attack thus dropping out the need for phase randomised source
- Performed assessment of Quantum State Separation eavesdropping on DPS via unambiguous state discrimination measurement and soft filtering

Optimal Quantum Control

[Jan '20 - May '20]

Guide: [Prof. Sai Vinjinampathy](#) | Physics Department, IIT Bombay

Introduction: Quantum computation represents unitary operations to transform the desired qubits into a target state. A robust protocol is needed to design a time-varying Hamiltonian to obtain the target evolution. Constructing this time-optimal protocol would be a straightforward error-reducing technique thus, of paramount importance.

- Studied Quantum Brachistochrone Equation for its applicability in Quantum Control problem and it's numerical solutions to obtain optimal unitary operation for the time-polynomial reachable states
- Studied Quantum Speed Limit and it's corollary time lower bound for arbitrary unitary transformation
- Studied precision bounds based on the fidelity, to derive correlations with recently proposed information theoretic bounds

Bubble Dynamics in Pool Boiling

[Nov '17 - Aug '19]

Guide: [Prof. Janani Srree Murallidharan](#) | Mechanical Engineering, IIT Bombay

Introduction: We studied boiling heat transfer for industrial systems like Pressurized Water Reactors (PWRs) in which safety crisis related events, such as the 'Critical Heat Flux' occurs frequently. The near-wall vapour dynamics which trigger CHF was studied for designing safe and efficient systems.

- Studied bubble growth and departure dynamics (including lift-off) in **two-phase flows**, and in boiling **heat transfer** phenomena for both **pool and flow boiling** conditions
- Assessed the prediction capabilities and underlying assumptions of existing bubble departure models
- Developed a more accurate mechanistic **bubble growth and departure** diameter model with increased capability for low sub-cooling conditions up to 60 K
- Studied the applicability of the bubble growth models for operating conditions pertaining to boiling crisis in **nuclear reactors** i.e., critical heat flux prediction in PWR's

Non-linear Dynamics of elastic materials

[May '19 - Jul '19]

Guide: [Prof. Qu Shaoxing](#) | School of Aeronautics and Astronautics, Zhejiang University

Introduction: Soft materials like gelatin and hydrogel are usually used to simulate the complex response of various human tissues under multiple loading conditions. These materials follow nonlinear dynamics, such as viscoelasticity, hyperelasticity, or hyper-viscoelasticity.

- Devised a Matlab model for detection of cavitation size in the gelatin filled cuvette to extract diameter
- Experimented gelatin and hydrogel under various impact conditions to investigate the effect of cavitation nuclei on cavitation in tissue similar soft material
- Studied the behavior of gelatin under drop hammer impact load and devised constitutive model based on **Neo-Hookean hyperelasticity** to analyse dependancy of various parameters
- Reviewed several **hyperelastic constitutive models** for brain tissues for predicting response of tissues under blast and blunt impact conditions

Sloshing in Liquid Nitrogen

[May '18 - Jul '18]

Guide: [Prof. Milind D. Atrey](#) | Mechanical Engineering, IIT Bombay

Introduction: Sloshing refers to the free surface movement of a fluid inside a container. Sloshing in cryogenics like LN_2 and LO_x produces boil-off, eventually leading to loss of cryogen. Sloshing is studied to design tank by adding baffles to reduce loss in transit.

- Studied (2-D) liquid sloshing phenomena in a moving tank subjected to various accelerations and **discovered its dependencies** on parameters like density, viscosity, amount of liquid
- Compared numerical methods and simulation software which are optimum to study **two-phase flow** and **free surface phenomenon** for closed and ambient environment
- Developed a numerical model based on VOF method on **ANSYS Fluent** to capture free surfacing and validated it with the experimental work already existing in the literature
- Investigated the applicability of sloshing in areas like spacecraft's fuel tanks, tanks subjected to oceanic motion, oceanographic and other engineering situations of free fluid surface

SCHOLASTIC ACHIEVEMENTS

- Secured **All India Rank 707** in JEE-Advanced among 200,000 engineering applicants ['16]
- Recipient of the prestigious **KVPY Fellowship** for basic sciences by **IISc Bangalore** ['16]
- Acquired rank of **86 (Gold Medal)** in **International Mathematics Olympiad** by SOF ['15]
- Secured rank of **251 (Gold Medal)** in **National Science Olympiad** by SOF ['15]
- Among the **top 9%** of participants in **UNSW Global Mathematics Assessment** ['16]
- Secured a percentile of **99.68%** in JEE Mains among **1.5 million** engineering aspirants ['16]

RELEVANT COURSES & TECHNICAL SKILLS

Mechanical Engineering	Physics	Maths & Others
Cryogenics Engineering Fluid Mechanics Thermodynamics Heat Transfer Solid Mechanics Manufacturing Processes Machine Design Microprocessor & Controls	Quantum Optics Quantum Mechanics (I & II) Thermal and Statistical Physics Classical Mechanics Electricity and Magnetism Quantum Physics Quantum Info. & Computing Condensed Matter Physics	Numerical Analysis Differential Equations Linear Algebra Data Interpretation & Analysis Computer Programming Optimization Models Operations Analysis Calculus

Programming: Qiskit, C/C++, Python, MATLAB, Mathematica, OpenCV, \LaTeX
Softwares: ANSYS, FLUENT, ABAQUS, AutoCAD, SolidWorks, Photoshop, Premiere Pro

OTHER KEY PROJECTS

Dilution refrigerator

[Spring '19]

Guide: [Prof. Milind D. Atrey](#), ME420 Course Project, IIT Bombay

- Reproduced perfect continuous counter flow heat exchanger models existing in the literature to study the performance of dilution refrigerator and its various dependencies
- Analyzed the effect of **Kapitza resistance** between solid-liquid, mixing temperature and effective surface area of the heat exchanger on the cooling power and studied the heat leaks
- Developed models and compared them with experimental data available in the literature for varying circulation rates and surface area

Laser Cladding

[Autumn '18]

Guide: [Prof. Ramesh Singh](#), ME338 Course Project, IIT Bombay

- Performed laser cladding experiments using CPM9V at multiple power and feed rates on mild steel
- Studied the Heat Affected Zone (HAZ) of laser cladded surface and analysed the depth and height of the melt by varying the input parameters like laser intensity, cross-section

SeDriCa: Self Driving Car

[Oct '17 - Mar '18]

[Unmesh Mashruwal](#) Innovation Cell, IIT Bombay

- Developing the first **autonomous driving car** suitable for Indian roads and conditions to compete in the 3-Stage **Mahindra Rise Driverless Car Challenge** for a prize of **\$1 Million**
- Programmed and tested modules for instantaneous speed bumper and zebra-crossing detection through **image processing** using OpenCV libraries
- Attempted to enhance speed bumper detection using **Machine Learning** based on Indian roads with a combination of a synthetic and natural dataset of over **5000+** images

RESPONSIBILITIES

Teaching Assistant | IIT Bombay

[Jul '19 - Nov '19]

- **Conducted weekly tutorials** and help sessions for course PH107: Quantum Physics & Applications
- Assisted the faculty in teaching and evaluating the performance of 60 undergraduate students
- Covered topics such as Quantum nature of light, Uncertainty Principle, Schrodinger Equation, Eigen-value Problem, Tunneling, & Quantum Statistics

Institute Student Mentor | SMP, IIT Bombay

[Apr '19 - Present]

- Part of a 105-member team, mentoring a total of 1000+ first-year undergraduate students
- Selected based on **strong overall performance**, inter-personal skills & peer-reviews
- **Mentoring 12** freshmen in academic and personal matters for a smooth transition to institute life

- Served as a bridge between the department and **500+ undergraduate** students
- Pioneered in conducting various Department activities like orientations, open day, excursion trips, **industrial visits**, merchandises for more than 800 students

EXTRACURRICULAR

- Intermediate level knowledge of **Chinese (Mandarin)**
- Completed **80+ hours of teaching** to secondary students for Education Outreach, NSS
- Helped in organizing CURED: a **diabetes awareness campaign** attempting Guinness World Record for the maximum number of glucose level check-ups covering 170+ camps in 10 states
- Conducted sciences experiments for underprivileged secondary students and also **YouTube** video demonstrations for Open Learning Initiative, NSS IIT Bombay
- **Won 1st prize** in the Biotech General Championship for preparing microscopic slides
- Part of the winning team of PAF-Performing Arts Festival bagging **13 out of 14 awards**
- **Wrote articles** for Summer Bucket list published in Freshmen Newsletter by Insight
- Interviewed 25+ professionals, 100+ participants for an event documentary which received over 20,000+ views for Inter IIT Cultural Meet - 2016