Department of Chemical Engineering, IIT Bombay.
Preference for TA, TAP and FA Ph.D Topics for Spring, 2019
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Timestamp	Name and email of faculty	Title:	Objectives:	Nature of the project (Experimental/Modeling/Theoretical/):	Type of the project (TAP, TAP or FA, FA only)	Background required:
1	---	TA	(Guide and topic will be decided later based on the availability of the topics and positions with the faculty)			
2	---	Ansys Fellow	Guide and topic will be decided later, student will work in the area of CFD or Pharma [Each Ansys fellowship tenure is for 5 years and consists of a fellowship amount of Rs. 5 Lakhs per student/year and one-time research grant of Rs. 10 Lakhs per student]			
3	Guruswamy Kumaraswamy; guruswamy@iitb.ac.in	Additive manufacturing by extrusion and ice templating of slurries	Currently, extrusion methods such as fused filament extrusion are used for additive manufacturing of polymers. This method is widely adopted due to its robustness and cost effectiveness. For metals and some ceramics, laser sintering is primarily used. The aim of this project is to employ ice templating to develop extrusion based techniques for additive manufacturing of ceramics and metals.	Experimental	TAP	Strong fundamentals of transport phenomena, understanding of materials science, some exposure to additive manufacturing
4	Pramod Wangikar (wangikar@iitb.ac.in)	Non-stationary 13C-Metabolic flux analysis of cyanobacteria.	13C-MFA helps quantify intracellular reaction rates by recursively fitting experimentally observed patterns of 13C isotope labeling of metabolites. There are two broad categories of 13C-MFA: (i) Stationary 13C-MFA that requires metabolic and isotopic steady state and (ii) Non stationary 13C-MFA that makes the use of systems that are in metabolic steady state but in a state of transition in terms of isotope labeling. Although experimentally and computationally more challenging, the non-stationary 13C-MFA is emerging as a preferred tool to probe cellular metabolism. The method provides a better resolution of the reaction rates with the ability to map a much bigger part of the network. In our group, we have developed a novel pipeline for the collection of labelling data for over 100 metabolites and fragments using LC/MS/MS. While E coli and yeast are the conventional model organisms with several applications in biotechnology, a number of non-model organisms have emerged with novel applications. The proposed work therefore involves improvement of this pipeline and 13C-MFA of non-model organisms such as cyanobacteria. The work will provide insights into (i) the overall energy efficiency of the metabolic network, (ii) flexibility at branch points in the network, and (iii) carbon overflow mechanism. The work becomes a precursor for classical metabolic engineering. The student will get an opportunity to perform both the computational and experimental aspects of the work. The experience with non-model organisms will be a key to biotechnological applications Project type: Majorly experimental involving 13C labelling, LC/MS/MS data acquisition, data analysis, and use of modelling software.	Includes both, experiments and modeling	TAP or FA	M Sc or B Tech in biotechnology, life sciences or chemical engineering.

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5	Pramod Wangikar (wangikar@iitb.ac.in)	Synthetic biology and metabolic engineering of cyanobacteria.	Cyanobacteria or blue-green algae are a group of prokaryotes well known for their ability to carry out oxygenic photosynthesis. These photoautotrophs show greater photosynthetic efficiency, simpler genetic structures and faster growth compared to terrestrial plants and green algae. Moreover, cyanobacteria can be engineered genetically and can grow on non-arable land, waste-water and seawater. These properties make cyanobacteria an interesting host for biotechnological applications. In several proof-of-concept studies, cyanobacteria have been engineered to produce biofuels, plastics and commodity chemicals. However, a significant improvement in rate, yield and titer would be needed to make these processes commercially viable. In this project we propose to engineer a locally isolated strain of cyanobacteria, Synechococcus elongatus PCC11801 for the production of various platform chemicals. The work involves the following: (i) design and characterization of native and synthetic promoters, terminators and ribosomal binding sites and other DNA elements in cyanobacteria, (ii) development of synthetic biology tools for genome editing and transient gene expression in cyanobacteria, and (iii) engineering of the pathway of interest. Project type: Majorly experimental involving synthetic biology of cyanobacteria.	Experimental	TAP or FA	M Sc or B Tech in biotechnology, life sciences or biochemistry.
6	venks@iitb.ac.in, KV Venkatesh	Modeling immune and metabolic network in keratinocytes	The project deals with developing model for skin cell response to immune signaling. The model will be linked to data from experiments to provide dynamic insights into the modeling and immune states.	Theoretical/Computational	TAP	Chemical engineering, desire to apply mathematical models to biological systems
7	Rajdip Bandyopadhyaya (rajdip@che.iitb.ac.in)	Catalytic degradation technology for treatment of wastewater	Through earlier work in our laboratory, we have developed porous material based catalytic nanoparticles, which have been shown to degrade dye and possibly other contaminants, present in wastewater, at an enhanced rate. We have also developed a model combining transport and reaction rates to capture diffusion, adsorption and reaction undergone by this contaminant inside the catalytic-nanoparticle, within the porous material. In the proposed research project, we now want to conduct both experiments and develope the model further to optimize the catalytic degradation process and scale-up to make the technology functional and use it for wastewater treatment.	Includes both, experiments and modeling	TAP or FA	Background in one of the areas/disciplines from among Chemistry, Materials Sc. & Engg., Chemical Engg. Environmental Sc. & Engg. is desirable.
8	jb@iitb.ac.in [Jayesh Bellare, A K Suresh, Ulhas Kharul (NCL co-guide)]	Membrane technologies for water	To develop new technologies for wastewater treatment with membranes and allied methods	Experimental	TAP	
9	Jayesh Bellare jb@iitb.ac.in and Kishor Paknikar (Chemistry Dept IITB co-guide)	Microbial aspects of water processing technologies	To overcome microbial issues in wastewater treatment with nanotechnology methods	Experimental	TAP	Bio experience with chemical engineering or allied
10	Jayesh Bellare jb@iitb.ac.in	Membrane technology for healthcare	To develop hollow fiber technology for biological and healthcare treatments where water plays a key role	Includes both, experiments and modeling	TAP or FA	Chemical Engineering or allied fields with cell culture experience
11	Abhijit Majumder. abhijitm@iitb.ac.in	To create organ-on-chip devices for biomedical applications and drug screening	The project aims to develop various microfluidics based organ-on-chip models. Such devices are useful to mimic tissue environment such as fluid flow, 3D architecture, and stiffness. The device created will be used for various biomedical applications such as drug discovery and drug screening. In the project, the student will be co-supervised by Prof. Debjani Paul, BSBE.	Experimental	TAP or FA	NA

Only those candidates who have external fellowsip/s like CSIR/DBT JRF, DST INSPIRE etc can opt for the following [12-30] topis

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12	Santosh Noronha noronha@iitb.ac.in	Development of novel fungal expression platforms	The work involves development and characterization of targeted genome editing tools for 2 industrially important fungal species, and expression of biotherapeutics using these systems.	Experimental	Only FA	Candidates with M.Sc., or M.Tech Biochemistry, Life Sciences, Biotechnology or equivalent. Project-related experience with biochemistry, microbiology and molecular biology techniques would be an advantage.
13	Santosh Noronha noronha@iitb.ac.in	Catalytic microreactors	The objective is to design and implement catalytic microreactors. Work elements will involve standardization of a catalytic system, characterization of kinetic and transport aspects, process optimization, detection in real time.	Includes both, experiments and modeling	Only FA	Exposure to process reaction engineering and catalysis would be an advantage.
14	Pramod Wangikar (wangikar@iitb.ac.in)	Human metabolomics for precision medicine.	Metabolomics, the study of all cellular metabolites, promises to be the new cornerstone in disease diagnosis and precision medicine. Several recent reports demonstrate that metabolite profiles are excellent indicators of the health status of individuals. In addition, metabolomics monitoring is likely to be included in the clinical trials on a routine basis. Most of these reports are with Caucasian patients with almost no data available for the Indian population. Furthermore, the field of metabolomics is not nearly as developed as proteomics or transcriptomics. Identification and quantification of a large number of metabolites is a challenge. Our objective is to identify intracellular metabolites as biomarkers for the diagnosis and prognosis of the disease in the Indian population. In the present project, we will perform metabolomics experiments on diabetic and pre-diabetic patients and healthy controls. The aim is to identify biomarkers that will accurately predict the pre-diabetic condition. In addition, samples and data will be obtained from the UK Biobank and the Swedish twin registry. The data will be collected with the high-resolution LC/MS/MS available in our lab. The work will involve extensive data analysis and multivariate statistical analysis. Project type: Involves experimental work, design of experiments and LC/MS data analysis.	Includes both, experiments and modeling	Only FA	M Sc or B Tech in chemical engineering, biotechnology, life sciences or biochemistry.
15	Rajdip Bandyopadhyaya (rajdip@che.iitb.ac.in)	Design and operation of a gravity-driven packed-bed filter for high throughput water disinfection by nanoparticles	We have developed a silver (Ag) and copper (Cu) nanoparticle impregnated activated carbon granular system, which can rapidly kill E. coli and other microorganisms present in water. Therefore, we have scaled up this water decontamination process from shake-flask experiments to continuous, column-scale filters, in order to achieve a high throughput of clean, drinking water from our column-filters. The aim of the present project is to further improve the performance, by optimizing the column to work under gravity-flow mode, so that it can be operated without any power source and at any point-of-use. This will require experiments to improve the water-nanoparticle-bacteria contact mechanism, in order to achieve better nanoparticle mediated cell-killing, simultaneously modeling the packed-bed flow and reaction profile, the way it takes place in the filter-column. This will expose the student to a combination of chemical, biochemical and materials engineering concepts, which is at the crossroads of both basic science and engineering design expertise. The final product will be a self-supported water-filter to produce safe, drinking water at a high flow-rate, taking advantage of the very high reactivity of nanoparticles developed by us.	Includes both, experiments and modeling	Only FA	Background in any of the areas/discipline among Life Sciences, Biological Sciences & Engg., Chemical Engg., Materials Sc. & Engg., Environmental Sc. & Engg.
16	Jhumpa Adhikari & adhikari@iitb.ac.in	Phase equilibria of gas hydrates using Monte Carlo simulations	Molecular insights into gas hydrate phase behaviour, Prediction of equilibrium conditions, Study of impact of guest -guest interactions, Role of promoters such as tetrahydrofuran	Theoretical/Computational	Only FA	

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17	Sameer Jadhav (srjadhav@iitb.ac.in)	Biochemical systems modeling of sperm motility	Sperm motility is a result of conversion of chemical energy to mechanical energy. The biochemical signalling mechanisms leading to synchronized motion of the sperm flagella are not well understood. The work involves identifying the molecular pathways involved in sperm motility and to develop a dynamic model to predict the various types of experimentally observed sperm motion. Co-Supervisor:Prof. Ganesh Viswanathan	Theoretical/Computational	Only FA	Biotechnology/biomedical/chemical engineering
18	Ganesh Viswanathan (ganeshav@iitb.ac.in)	Single-cell data guided modeling of phenotype switching	Tumor necrosis factor alpha, a pleiotropic cytokine capable of exhibiting pro-survival, apoptosis, or necrotic phenotypes, is implicated in several cancers and rheumatoid arthritis. Understanding the underlying mechanism that governs a cell's decision to the phenotypic response can help obtain insights on how signal flow can be modulated to achieve a desired phenotype. The goal of this project is to develop a mechanistic model of underlying biochemical network that predicts single-cell phosphor-protein dynamics and phenotypic response due to TNF□ exposure measured in-house. The model will be used to decipher possible interventional strategies that will ensure reliable phenotype switching. This project will be a combination of moment-closure approaches and computations. Candidate will work closely with experimentalists. Candidate must have some MATLAB programming experience. Interest in learning basic biology and performing inter-disciplinary research is preferable.	Theoretical/Computational	Only FA	B.Tech/M.Tech Chemical/Mechanical/Biotech or M.Sc Biotech/Physics
19	Supreet Saini (saini@che.iitb.ac.in)	How do new species form?	Ever since Darwin's publication of Origin of Species, there has been an intense interest and debate about how new species come into being. However, despite 150 years of thought and research, we have little understanding of how new species come into being from existing ones. In this project, we use theory to understand speciation, where one species splits into two. Understanding this process has implications in health and ecological stability.	Theoretical/Computational	Only FA	Biotechnology, Engineering, Sciences.
20	Supreet Saini (saini@che.iitb.ac.in)	Experimental demonstration of speciation in yeast.	What do organisms need to exist as species, incapable of mating with each other & exchanging genes? In other words, why can they not exist as varieties, each capable of mating with the other. Is there a biological necessity for organisms to exist as discrete units called species? In this project, we explore the above questions using the yeast, S. cerevisiae, as the model system.	Experimental	Only FA	Biology, Biotechnology, Engineering, Sciences
21	Ateeque Malani	Computational Study of Enhance Oil Recovery	In the secondary and tertiary phase of oil recovery the crude oil in direct contact with mineral surface needs to be displaced using external medium mostly water. The mechanism of replacement is governed by the structural and energetic behaviour of interfacial water versus hydrocarbon oil at the mineral surface. This project is aimed at understanding the interfacial behaviour of crude oil-water at mineral interface. The obtained understanding will be used to enhance the oil recovery.	Theoretical/Computational	Only FA	
22	Ateeque Malani	Materials for water purification and desalination	Although earth is covered with 70% of water only 2% of it is available as fresh drinkable water. Access to this fresh water is scarce in many parts of the country. The groundwater contamination due to industrial pollution and geological minerals leads to many health issues especially in childrens and women. Conversion of sea-water to fresh water is an expensive and energy-intensive process. The aim of this project is to find organic and inorganic porous materials for water purification.	Theoretical/Computational	Only FA	

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23	Sarika Mehra, sarika@che.iitb.ac.in	Bioprocess development for production of biosimilars	Chinese hamster ovary cells are the workhorses for the production of recombinant therapeutics such as monoclonal antibodies. The Biosimilars market is fast expanding in India. This project will develop process strategies include chemically defined media and fed-batch/perfusion platforms to obtain high yields and product quality of model biosimilars.	Experimental	Only FA	B.Tech/M.Tech Chemical Engineering/Biotechnology
24	Sarika Mehra, sarika@che.iitb.ac.in	Role and Regulation of efflux pumps from soil bacteria	Soli bacteria such as Streptomyces harbor many novel efflux pumps that eventually find their way into pathogenic bacteria. In this project we will understand the role of these bacteria in the host species and their regulatory mechanisms.	Experimental	Only FA	M.Sc Biochemistry/Molecular Biology/Biotechnology. B.Tech/M.Tech Biotechnology
25	Hemant Nanavati hnanavati@che.iitb.ac.in	Ab Initio Protein Structure Prediction	Ab Initio protein structure prediction methods (prediction of the 3-D molecular structure using the knowledge of only the amino acid sequence) have exhibited considerable promise in the recent past with several methods, being successful in community-wide experiments (CASP). We have formulated the protein-folding problem as a combinatorial optimization problem where, a variant of Monte Carlo Minimization Algorithm has been employed to achieve the minimum energy configuration. The search for the optimum has been simplified by incorporating the various geometrical constraints of the secondary structural elements using a distance restraint potential function. Additionally, the sample space has been reduced by considering the probability distribution of backbone torsions observed in nature. Simulations carried out on a sequences varying from 29 to 85 amino acids belonging to all classes, have exhibited positive results, and indicate that large proteins can be simulated by this approach in the future in the project offered at the doctoral level	Theoretical/Computational	Only FA	Masters in Chemistry, Physics, Chemical Engineering, Bioengineering
26	Hemant Nanavati hnanavati@che.iitb.ac.in	Synth., Value--Addn and Processing of Biodegradable Poly(L--lactic acid) Nanocomposites, with “Green” Nanofillers (TA/FA)	Based on the Patent Applications submitted by our group for high Mol Wt. PLLA Nanocomposites with Clay Nanoparticles, we will be embarking on the challenge of incorporating ecofriendly, Cellulosic Nanoparticles as Nanofillers. We have submitted a proposal to the DST for funding this project.	Includes both, experiments and modeling	Only FA	BTech/MTech in Chemical Engineering, or allied field
27	Hemant Nanavati, hnanavati@che.iitb.ac.in	Multiscale Investigations on Polymeric NEMS (Nano-Electro-Mechanical-Systems)	Modeling and Experiments (Nanoindentation, etc.) on Polymeric Materials to develop an understanding of relevant aspects for NEMS Applications.	Includes both, experiments and modeling	Only FA	BTech/MTech in Chemical/Materials/Mechanical, MSc Physics/Chemistry
28	Hemant Nanavati, hnanavati@che.iitb.ac.in	Multiscale Ananlysis of Elasticity of Spider Silk and Related Biopolymers	In this project, the aim is to understand quantitatively the molecular elasticity of biopolymers with potential engineering applications. The first example is Spider Dragline Silk, which may be several times stronger than steel (after normalizing the density). The work involves experimental, computational and theoretical analyses of the molecular structure of the biopolymer system.	Includes both, experiments and modeling	Only FA	BTech/MTech Chemical and Similar Field, MSc Physics/Chemistry
29	Hemant Nanavati, hnanavati@che.iitb.ac.in	Multiscale Analyses of Filled Elastomers - Applications as Solid Propellant	Filled elastomers or filled rubbers have found extensive uses - particularly as Solid Propellant. The fillers provide advantageous properties over unfilled systems - including providing an oxygen sourse for combustion in Rocket Motors, as well as various other aplications. One important property that bears investigation is the stress-strain relationship of the elastomers and its relationship to the primary molecular architecture. Experimental data and theoretical developments have been presented earlier. The current investigation aims toward a systematic study of the objective relationship between molecular structure and stress-elongation relationship. The approach involves experiments, modeling as well as theory development, which will be validated using literature data as well from experiments performed during the research. Potential Collaboration with TIFR.	Includes both, experiments and modeling	Only FA	BTech/MTech in Chemical or allied fields, MSc in Physics/Chemistry

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30	Hemant Nanavati, hnanavati@che.iitb.ac.in	Accurate Molecular Models for Real Polymers	We develop compact, closed form, but accurate molecular models as well as elasticity relationships for real polymers, incorporating structural aspects. The applications include synthetic as well as high performance Bio-sourced polymers.	Theoretical/Computational	Only FA	BTech/MTech in Chemical or allied field, MSc Physics/Chemistry