

Indian Institute of Technology Dharwad



॥ सा विद्या या विमुक्तये ॥

Information Brochure

(For Indian Nationals)

Ph.D. Admissions

Autumn Semester 2022-23

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A. SCHEDULE OF Ph.D. ADMISSION

Sr. No.	Description	Relevant dates*
1.	Applications open	15-March-2022
2.	Last Date to apply online	15-April-2022
3.	Announcement of shortlist of eligible candidates	26-April-2022
4.	Online Interview Schedule	28-April-2022 to 28-May-2022
5.	Declaration of provisional list of selected candidates	15-June-2022
	Declaration of final list of selected candidates	27-June-2022
6.	Admission for waitlisted candidates starts	06-July-2022
7.	Admission for waitlisted candidates ends	16-July-2022

***All deadlines are defined exactly to be at 5:00pm on the respective date.**

All potential candidates are requested to visit the institute website regularly for updated information about the schedule, especially in the context of ongoing Coronavirus (COVID-19) related developments. **Future updates regarding the admission process will be made available on the [institute website](#) under section Academics >> Admissions >> [Ph.D.](#)**

B. APPLICATION CATEGORIES & FINANCIAL SUPPORT

IIT Dharwad admits Ph.D. candidates as full time students with research scholarship or Teaching Assistantship (TA) or Project Assistantship (PA). Also, part-time externally sponsored research scholars or institute staff can be admitted. However, **each department may not have openings in all the following modes of support.** More details can be found in the departmentspecific section in this document.

B.1 Teaching Assistantship (TA)

Funded by the Ministry of Education (MoE), Government of India, the TAs are expected to assist in the academic/administrative work for smooth functioning of the Institute. Students under this category are entitled to the financial support as per the MoE norms.

1. For students with M.Tech./M.E./M.Sc.(Engg.)/M.Phil. or equivalent degree as the qualifying degree, the assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. At present, the monthly rate of assistantship is ₹31,000 for the first 2 years and enhanced rate of ₹35,000/- for the remaining 3 years and HRA as per rules.
2. The students awarded with Teaching Assistantship must assist in teaching, research and/or administrative work as assigned by the respective Academic Unit to the extent of 8 hours of work per week.
3. The continuation of the assistantship will be subject to the satisfactory performance of the duties assigned by the Departments as well as satisfactory academic performance.
4. As per MoE directives, the employees on the rolls (with or without pay) of any organization are not eligible for admission under this category. Candidates selected in this category have to resign from the current job and submit a relieving letter from their employer before joining the programme.
5. Students getting assistantships from the Institute may join projects sponsored by external agencies and obtain corresponding fellowships in lieu of TA ship.

B.2 Fellowship Awardee (FA)

B.2.1 Description – FA

The financial support under this category is provided by various Government / Semi Government schemes (for example, CSIR, UGC, DAE, DST, DBT, NBHM, etc.) and some other organizations.

A valid Junior Research fellowship (JRF) award letter from the Government / Semi Government agencies (e.g. CSIR / UGC / DAE / DST / DBT / NBHM / (confirmed) DST INSPIRE, etc.) are required for the execution of this fellowship.

The amount, duration of the fellowship, and HRA will be as specified by the awarding agency. The disbursement and continuation of the fellowship will be subject to as per the norms specified by the awarding agency or specified by IIT Dharwad, as deemed fit.

B.2.2 PMRF: A brief Note on Prime Minister's Research Fellowship

The Prime Minister's Research Fellows (PMRF) Scheme has been designed for improving the quality of research in various higher educational institutions in the country. With attractive fellowships, the scheme seeks to attract the best talent into research thereby realizing the vision of development through innovation. The scheme was announced in the Budget 2018-19. The institutes which can offer PMRF include all the IITs, all the IISERs, Indian Institute of Science, Bengaluru and some of the top Central Universities/NITs that offer science and/or technology degrees. The candidates will be selected through a rigorous selection process and their performance will be reviewed suitably through a national convention.

B.3 Project Assistantship (PA)

Funded from projects sponsored by industries and government funding agencies. Under this category, candidates will be paid fellowship as per the rules & regulations of the governing project.

B.4 Externally sponsored Ph.D. (EX)

The candidates employed in recognized R&D organizations and desirous of pursuing Ph.D. programme while in employment may apply for admission as external candidates. The option of external registration is for applicants who are working in well-equipped scientific institutions, laboratories, R&D establishments and industrial organizations engaged in research based activities. Persons working in colleges/universities are not eligible under this category. After fulfilling the coursework requirement at the Institute, these candidates will be allowed to register for Ph.D. with a Supervisor (internal) from the Institute and a Co-supervisor (external) from their parent organization where they will be doing the research work. The admissions are based on the following norms:

1. The competence of these candidates will be assessed along with the regular candidates.
2. Along with application, the candidate should submit a Sponsorship Certificate (Appendix A) from the organization in which he / she is employed giving an undertaking that the candidate would be released from the normal duties to fulfill the coursework requirement (and qualifier examination, if applicable). The certificate should also provide details of facilities relevant to the research programme and available to the candidate.
3. The candidate is required to be at the Institute as a full-time student for the coursework (and qualifier examination, if applicable) of his/her Ph.D. Programme. The coursework requirement is likely to be a period of 1-2 semesters. Depending on the student's background and the programme requirements, an additional semester may be needed to

- complete the coursework/qualifier examination.
4. To promote interaction between the internal supervisor and external co-supervisor, meetings between them should be arranged at least once in a year in the Institute or in the sponsoring organization.
 5. The Ph.D. registration of an external candidate would be reviewed at the end of each year from the date of registration in terms of his progress in courses / seminars / approved research programme by a Research Progress Committee (RPC) nominated by the concerned Department Postgraduate Committee (DPGC).
 6. At the time of joining the programme, the students will have to produce a “Relieving certificate” from his / her employer that he / she has been fully relieved from normal duties during the semester(s) to complete the course work and other academic work at IIT Dharwad.

B.5 Institute Staff for Ph.D.

Existing employee of IIT Dharwad can be admitted under the category Institute Staff subject to fulfillment of conditions mentioned in the PhD Rule Book.

Based on the information provided by the applicants a list of the eligible candidates called for the selection process will be declared on the Institute website on the date specified in the schedule. Only the eligible candidates are permitted to participate in the selection process.

C. GENERAL GUIDELINES for APPLYING ONLINE

1. Please read all the instructions given in the brochure carefully before filling up the application form.
2. Please note that the application is to be filled at one go. There is no save and proceed option. The application process flow is given below:
 - a. The institute application form should be filled first, the form contains general information such as your name, category, email id, contact details, address and most importantly preference for departments (especially for those candidates who want to apply for more than one department).
 - b. After the successful submission of the institute form, a Submission Id is generated and the same to be noted for all future references.
 - c. After filling the institute form, department specific application form should be filled.

Please note that it is mandatory to fill both institute and department specific application forms. Failure to submit both the forms leads to non-consideration of your application for the selection process.

Only the applicable single application fee should be paid per applicant irrespective of the number of the departments applicant is applying to.

3. Keep all the documents handy >> pay the application fee through SBI e collect facility >> Note down SBI e collect reference No>> Start online application form>> Fill all particulars including SBI e collect reference No>> Take a print/ save a pdf copy of preview of completed application form >> Final submission of application form >> Note down submission ID for future reference

4. The procedure to pay the application fee is made available on the website and application form.
5. This information brochure and future updates regarding the admission process will be made available on the institute website under section Academics >> Admissions >> Ph.D.
6. You are required to submit the application form online. There are no downloadable forms available. After filling the form, you are advised to take a print and keep the same for future reference.
7. The application fee is as follows:

Gen/Gen (EWS)/OBC/ all other candidates	₹ 200/-
Women/SC/ST/PwD category candidates	₹ 100/-

8. **The Application Form without valid online payment details will not be considered. Application FEE is Non-Refundable.**
9. Applicants may find it convenient to keep following information handy while filling the application form online (whichever relevant). This is especially important as the form cannot be saved and as such once started one needs to complete the entire form and submit:
 - Skype Id or Gmail Id for G-meet
 - Passport size photo whose size is less than 50 kb
 - Educational details from secondary school onwards
 - GATE qualification details
 - Statement of Purpose (pdf file)
 - List of fellowship/ awards
 - Publications
 - Sponsorship Letter and CV of co-supervisor if you are applying under 'EX' category.
 - JRF Award Letter if you are applying under 'FA' category, if applicable.
 - Any other achievements/information.
10. Amendments to the form will not be possible once the last date to apply online is over. However, amendments can be considered if the applicant resubmits the entire form without making repeat fee payment before the deadline.
11. Keeping checking the institute website and your emails regularly for any communication from the institute regarding the selection process.
12. The Shortlisted candidates' list will be uploaded on the institute website as per the schedule given above in Section A.
13. Candidates (if) called for written test / interview should bring with them Photo ID Card, Printed Copy of Online Application Form, Photocopies of Academic Transcripts, Degree Certificates & Experience Certificates, Caste Certificate (if applicable), PwD Certificate (if applicable), EWS Certificate (if applicable), Thesis/Dissertation/Report/Publications and all other relevant documents.
14. **Please note that the candidates (if selected) should be able to produce all relevant documents within a short period of notice. If the documents are not produced within the deadline, the admission is liable to be cancelled.**

D. INFORMATION PERTAINING TO HOSTELS

About IIT Dharwad	Kindly visit the website https://www.iitdh.ac.in/ for available facilities
Hostel Room Allocation(on sharing basis)	You will be allotted a room in the hostel & the room key will be handed over on your arrival at the Institute. Each room will accommodate roughly two/four students (depending on the prevailing conditions) and has an attached bath & toilet.
Are hostel rooms furnished	Each student will be provided a cot, chair & study table and wardrobe. Students can purchase mattress/bedding, bucket, etc. locally. Arrangements will be made for on-campus shopping for these items.
Possession of motorized vehicle	NOT ALLOWED, however bicycles are permitted in the campus.
Climatic conditions	The weather at Dharwad is pleasant throughout the year. Generally, it will be raining in the months of June to September and weather will be windy and cold during the months of October to January. It is suggested that you carry protective clothing accordingly.

E. FEES, DEPOSITS & HOSTEL RENT

The fee applicable for admission to Ph.D. programmes (as collected during the Spring Semester 2021-22) is provided below for reference purpose only:

E.1 Details of Applicable Fee for Admission:

E.1.1 TA Category

S. No.	Fee Amount (In Rs.)	For General/ General (EWS)/OBC (NCL)	For SC/ST/PwD
A. One-time payment at the time of Admission			
1.	Admission Fee	2,200.00	2,200.00
2.	Thesis Fee	2,500.00	2,500.00
3.	Medical Examination	400.00	400.00
4.	Provisional Certificate	500.00	500.00
5.	Student Welfare Fund	1,000.00	1,000.00
6.	Modernisation & Upgradation	2,500.00	2,500.00
7.	Identity Card	500.00	500.00
Sub-Total (A)		9,600.00	9,600.00
B. Semester Fee			
^1.	Tuition Fee – Statutory Fee	2,500.00	Nil
2.	Examination Fee	1,000.00	1,000.00
3.	Registration Fee	750.00	750.00
4.	Gymkhana Fee	1,750.00	1,750.00
5.	Student Benevolent Fund	500.00	500.00
6.	Medical Fee	1,500.00	1,500.00
*7.	Hostel Room Rent	2,000.00	2,000.00
*8.	Electricity & Water Charges	3,000.00	3,000.00
*9.	Hostel Establishment Charges	3,000.00	3,000.00
*10.	Mess Establishment Charges	1,550.00	1,550.00
Sub-Total (B)		17,550.00	15,050.00
*11.	Mess Fee Advance	26,000.00	26,000.00
C. Deposits (Refundable) to be paid at the time of Admission			
1.	Institute Security Deposit	1,000.00	1,000.00
2.	Library Security Deposit	1,000.00	1,000.00
3.	Mess Security Deposit	1,000.00	1,000.00
Sub-Total (C)		3,000.00	3,000.00
GRAND TOTAL FEE (A + B + C+ Mess Advance)		56,150.00	53,650.00

E.1.2 PA/EX/FA Category

S. No.	Fee Amount (In Rs.)	For General/ General (EWS)/OBC (NCL)	For SC/ST/PwD
A. One-time payment at the time of Admission			
1.	Admission Fee	2,200.00	2,200.00
2.	Thesis Fee	2,500.00	2,500.00
3.	Medical Examination	400.00	400.00
4.	Provisional Certificate	500.00	500.00
5.	Student Welfare Fund	1,000.00	1,000.00
6.	Modernisation & Upgradation	2,500.00	2,500.00
7.	Identity Card	500.00	500.00
Sub-Total (A)		9,600.00	9,600.00
B. Semester Fee			
^1.	Tuition Fee – Statutory Fee	25,000.00	Nil
2.	Examination Fee	1,000.00	1,000.00
3.	Registration Fee	750.00	750.00
4.	Gymkhana Fee	1,750.00	1,750.00
5.	Student Benevolent Fund	500.00	500.00
6.	Medical Fee	1,500.00	1,500.00
*7.	Hostel Room Rent	2,000.00	2,000.00
*8.	Electricity & Water Charges	3,000.00	3,000.00
*9.	Hostel Establishment Charges	3,000.00	3,000.00
*10.	Mess Establishment Charges	1,550.00	1,550.00
Sub-Total (B)		40,050.00	15,050.00
*11.	Mess Fee Advance	26,000.00	26,000.00
C. Deposits (Refundable) to be paid at the time of Admission			
1.	Institute Security Deposit	1,000.00	1,000.00
2.	Library Security Deposit	1,000.00	1,000.00
3.	Mess Security Deposit	1,000.00	1,000.00
Sub-Total (C)		3,000.00	3,000.00
GRAND TOTAL FEE (A + B + C+ Mess Advance)		78,650.00	53,650.00

Note:

- a. All the SC/ST/Divyangjan students are exempted from payment of Tuition fee.
- b. *Students not staying in the campus or not provided married accommodation are not required to pay fee at sl. no. 7, 8, 9, 10 & 11.
- c. ^IIT Dharwad reserves the right to revise the Tuition Fee-Statutory Fee (in future).

E.2 Procedure for Tuition Fee Payment:

Students will pay fees through SBI Collect by visiting the below mentioned link:
<https://www.onlinesbi.sbi/sbicollect/icollecthome.htm?corpID=3407756>

Follow the steps mentioned in procedure for paying fees using SBI Collect (Guidance document is attached with email).

In case of fees being paid through - (a) loan from a Bank, and (b) a sponsoring agency (private/government), the concerned student should request the bank / sponsoring agency to transfer the fees amount through our SBI collect OPG (online payment gateway). In this way, fee receipt will be generated automatically and delay will be avoided.

Students paying fees through online fee payment must ensure that their transaction is completed in all respect.

Students who fail to register himself/herself for Autumn Semester 2022-23 on the stipulated date, his/her studentship/registration is liable for cancellation.

The detailed and applicable fee structure for Autumn 2022-23 semester will be made available to the selected candidates at the time of announcement of results for this round of admission.

F DEPARTMENT OF BIOLOGICAL SCIENCES AND BIOENGINEERING

F.1 ELIGIBILITY FOR ADMISSION

F.1.1 Qualifying Degree

M.Tech/MSc. or equivalent in Bioinformatics/

Chemistry/Biotechnology/Microbiology/Computer Science or other allied biology subjects.

- **Junior Research Fellowship** (JRF) of CSIR/UGC/DST INSPIRE/DBT/MHRD/ICMR or any other relevant funding agencies.

F.1.2 Minimum score in the qualifying degree

For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree (M.Tech./MSc.):

- 1) a minimum of 60% marks (without round off) in aggregate, OR,
- 2) a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).

For SC/ST category candidates and differently abled candidates (PwD), a relaxation of 5% (or CPI/CGPA of 0.5 on the scale of 0-10) in the qualifying degree is applicable.

F.1.3 Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving above mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022-23 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in the section above considering updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in section A should be used to determine eligibility for application and same to be reported in the online application.

F.2 MODALITY OF THE SELECTION PROCESS

The selection process will comprise of two stages of online interviews. All the eligible candidates will be called for Round 1 interview. From this round, the top 10 candidates will be selected for the second round of interview. Final selection will be made based on performance in Round 2 interview. The Round 1 interview (~10-15 min in duration) will test the basic understanding of the biology concepts and will be conducted for all in the eligibility shortlist. For the syllabus, please refer to the Ph.D. brochure. The Round 2 interview (~30 min in duration) will be specific to the candidate's preferred research area.

F.3 SYLLABUS

For the online interviews, the following syllabus will be followed. Candidates can expect questions based on aptitude and reasoning as well.

Bioinformatics and Biophysics: Basics of programming, Statistics, Descriptive statistics, Correlation and regression, basic machine learning, Hypothesis Testing, Probability theory, Raman spectroscopy, Absorption spectroscopy, Fluorescence spectroscopy, and NMR.

Biochemistry, Microbiology, Molecular & Cell Biology, Genomics: Biomolecules, Metabolism, Membrane transport, Structure and regulation of prokaryotes and eukaryotes genes, Transcription, Translation, Post-transcriptional and Translational modifications, Molecular interaction, Molecular markers, Genetic and physical mapping, Gene interaction; Population genetics, Genetic engineering; Cloning and expression vectors, rDNA technology, Gene cloning approaches, Whole-genome sequencing & annotation, High throughput gene expression, and Function elucidation technologies, PCR, Blotting Techniques, Gene transfer technologies, Protein-protein interactions, Mass spectrophotometry, Signal transduction pathways, and their elucidation, Primary and secondary metabolic pathways, Systems biology frameworks for metabolic engineering, Nano biotechnology, Genomics, and proteomics.

F.4 RESEARCH TOPICS

Project title 1: Identifying novel Genes involve in cancer development.

Project title 2: Role of Mitochondrial genes in cancer development.

Project title 3: Understanding of surfacosome in cancer development.

Project title 4: Label free metabolomics for bioprocess monitoring.

F.5 Focus area of research

Cancer biology and Raman Spectroscopy

F.5.1 Position 1

Code – AU22-23_PhD_BSBE_T1

Broad domain of research – Cancer Biology

Eligible social category to apply – SC, ST, EWS and PwD

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – **TA Duration of funding** - 5 years **Details** (if any) -

Topic – Identifying novel Genes involve in cancer development.

Most, if not all, cancers are caused by two types of genes: proto-oncogenes and tumor-suppressor genes. We will use bioinformatics, biostatistics, and molecular biology methods in this project to identify novel cancer-associated genes and their functions.

F.5.1 Position 2

Code - AU22-23_PhD_BSBE_T2

Broad domain of research – Cancer Biology

Eligible social category to apply – Not applicable

Fee – refer section [FEES, DEPOSITS & HOSTEL RENT](#)

Type of funding support – **FA Duration of funding** - 5 years **Details** (if any) -

Topic – Role of Mitochondrial genes in cancer development.

Mitochondria plays a critical role in cell physiology. The project aims to understand the role of mitochondrial genes in cancer development.

F.5.1 Position 3

Code - AU22-23_PhD_BSBE_T2

Broad domain of research – Cancer Biology

Eligible social category to apply – Not applicable

Fee – refer section [FEES, DEPOSITS & HOSTEL RENT](#)

Type of funding support – **FA Duration of funding** - 5 years **Details** (if any) -

Topic – Understanding of surfacosome in cancer development.

Cell membrane proteins play a critical role in cell physiology. The project aims to understand the role of surface proteins in cancer development.

F.5.1 Position 4

Code - AU22-23_PhD_BSBE_T3

Broad domain of research – Biophysics

Eligible social category to apply – Not applicable

Fee – refer section [FEES, DEPOSITS & HOSTEL RENT](#)

Type of funding support – **FA Duration of funding** - 5 years **Details** (if any) -

Topic – Label free metabolomics for bioprocess monitoring

Large scale production of proteins and biopharmaceuticals within bioreactor systems requires continuous monitoring of product formation and microbial growth. Three different types of monitoring methods are inline, online, and at line. These are often real time but involve destructive approaches. Main objective of this work will be to assess the potential of different optical sensing methods for their prospective application in monitoring production of different biochemical.

G. DEPARTMENT OF CHEMISTRY

G.1 Eligibility for Admission

G.1.1 Qualifying Degree

M.Sc. or equivalent degree in any area of Chemistry/Biochemistry/Biotechnology/Microbiology/Pharmacy and/or any other related areas.

The candidates must also fulfill **any one** the following additional requirements:

- **Valid GATE Score** or M.Phil or M.Tech./M.E. or equivalent degree in chemistry (for **TA category**)-applicable to SC, ST, EWS or PWD candidates only for this round
- **Junior Research Fellowship (JRF)** of CSIR/UGC/DST INSPIRE/DBT/MHRD/ICMR or any other relevant funding agencies (**for FA category**)-open to all social categories

G.1.2 Minimum score in the qualifying degree

1. For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree is First Class, as specified by the candidate's Institution/University. If the Institution/University does not specify the division/class, then one of the following will be considered as the eligibility criteria:
 - a minimum of 60% marks (without round off) in aggregate. (OR)
 - a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).
2. **For SC/ST/PwD category candidates, a relaxation of 5% in the qualifying degree is applicable.**

G.1.3 Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving above mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022-23 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in section above considering updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in above section should be used to determine eligibility for application and same to be reported in the online application.

G.2 Modality of the Selection Process

Only the eligible applicants are permitted to participate in the selection process.

- The selection process consists of **one round** of online interview.

G.3 Syllabus

- Fundamental principles of chemistry
Recommended textbooks: J. Clayden, L. G. Wade, J. D. Lee and P. Atkins
- Spectroscopy: NMR spectroscopy and mass spectrometry
Recommended textbooks: C. N. Banwell, D. L. Pavia, Silverstein and H. Gunther
- Organic name reactions: Reactions and their mechanisms
Recommended textbooks: W. Carruthers and J. Clayden
- Basic biochemistry: Biomolecules (proteins, carbohydrates, nucleic acids and fatty acids) and their chemistry, biomimetic chemistry, metabolic pathways, biosynthesis of biomolecules, enzymes mechanisms, metalloenzymes, central dogma of life, medicinal chemistry
Recommended textbooks: Voet and Voet, Lehninger, Hermann Dugas

G.4 Focus area of research

The broad areas of research will include organic chemistry, biochemistry, and chemical biology. Students will have exposure to different interdisciplinary areas of chemistry and protein biochemistry. The Department of Chemistry admits Ph.D. candidates under the Teaching Assistantship (TA) and Fellowship Assistantship (FA) category for this round of admissions in the following focused areas given below. Applicants have to choose at least one of these topics and mention those in application form with appropriate order of preference under the relevant question.

G.4.1 Position 1

Code - AU22-23_PhD_CY_OCB1

Broad domain of research – Organic chemistry and chemical biology

Eligible social category to apply – SC, ST, EWS and PWD

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (as per the institute guidelines)

Duration of funding - 5 years

Details: Brief outline of the topic is given below:

1. Organic chemistry of the enzyme catalysed reactions in antibiotic compounds:

Enzymes are nature's organic chemists that carry out remarkable chemical reactions, particularly in the synthesis of antibiotics and other important drug compounds. To study the enzyme reaction mechanisms, one requires sound knowledge of chemistry and biochemistry. One particular area of interest is the ribosomally synthesized and post-translationally modified (RiPP) peptide natural products which show unique antibiotic properties. In today's world, the emergence of antibiotic resistance in bacteria is proving to be a serious and increasing threat to human health. Therefore, discovery of new structural motifs with novel antibacterial targets exhibiting activity against multi-drug resistant pathogens is of utmost importance. RiPP natural

products, produced by bacteria, are an emerging class of peptide derived compounds with diverse structural features exhibiting wide array of bioactivities ranging from antibacterial to anticancer properties. RiPP precursor peptides are direct ribosomal gene products that undergo various post-translational modifications (PTMs) by enzymes to synthesize the mature, structurally complex antibiotics. We would like to study the chemistry of the enzyme mechanisms (such as C-H activation, C-C bond formation, molecular rearrangement, amide bond activation etc.) involved in synthesizing these natural products. One class of enzymes involved is called radical S-Adenosylmethionine (rSAM) enzymes that contain [4Fe-4S] clusters and carry out fascinating transformations using organic radical mediated chemistry. Recently, they were shown to catalyze reactions via an organometallic (Fe-C) intermediate as well. We would employ interdisciplinary techniques from chemistry (synthetic organic chemistry, physical organic chemistry, spectroscopic techniques, inorganic chemistry and anaerobic techniques), biochemistry/chemical biology, protein chemistry, and molecular biology/microbiology during these studies and suitable collaborations (such as for protein crystallography, complex synthesis, EPR techniques, proteomics, and synthetic biology etc.) will be initiated to gain insights into the molecular details of these mechanisms. In addition, analog generation for medicinal chemistry, enzyme inhibitors development and structure-function elucidation of new compounds will also be undertaken in the future. Students will get exposure to synthesis, biochemistry, molecular biology, and various spectroscopic techniques.

2. Synthetic, mechanistic, and biotechnological studies on promysalin biosynthesis

Promysalin is a novel antibiotic, isolated from *Pseudomonas putida* which exhibits potent antibacterial activity particularly against Gram-negative *P. aeruginosa*, a notorious opportunistic human pathogen. The biological target of promysalin is succinate dehydrogenase, an enzyme involved both in the TCA cycle and in cellular respiration. Recently, it was shown to be active against several drug resistant Gram-positive pathogens as well with a mode of action involving cell membrane damage. This amphipathic molecule, composed of salicylic acid and 2,8-dihydroxymyristamide bridged by a unique 2-pyrroline-5-carboxyl moiety, is proposed to be synthesized by a hybrid NRPS-PKS pathway. This project is aimed at organic synthesis, biochemical and mechanistic characterization of intriguing biosynthetic enzymes that activate and assemble salicylic acid, proline, and myristic acid fragments to synthesize this broad-spectrum antibiotic. This will provide a strong foundation for performing combinatorial biosynthesis to generate antibiotic analogs and engineering of the fatty acid hydroxylases for potential biotechnological applications. Students will get exposure to synthesis, biochemistry, molecular biology, and various spectroscopic techniques (NMR/MS/UV-Vis) in this project.

G.4.2 Position 2

Code - AU22-23_PhD_CY_OCB2

Broad domain of research – Organic chemistry and chemical biology

Eligible social category to apply – Not Applicable (All categories are eligible)

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – FA (as per the funding agency guidelines)

Duration of funding - 5 years

Details: Brief outline of the topic is given below:

2. Tryptophan derived bioactive compounds: Chemistry of the biosynthetic pathways

Tryptophan, the most chemically complex and the least abundant of the 20 common proteinogenic amino acids, is a biosynthetic precursor to many complex microbial natural products (such as antibiotic pyrrolnitrin), which are promising scaffolds for drug discovery and development. The chemical features of tryptophan, including its ability to undergo chemistry at almost every atom makes it a unique biological precursor for the generation of chemical complexity. Recently it was discovered that tryptophan leads to the formation of a few novel anticancer compounds of highly functionalized alkaloid family which were shown to induce DNA single and double strand breaks and metal dependent DNA complex formation. Moreover, they also cause several chromosomal aberrations, and blocks the synthesis of DNA and RNA by inhibiting topoisomerase II. Our goal would be to study the chemistry of the biosynthetic machineries (synthesis by enzymes in a biological set up) of such natural products *in-vitro*, understand the fundamental principles of the complex organic/inorganic chemical reactions (they also involve metalloenzymes) and characterize the molecular details of these proteins using various techniques from chemistry (synthetic chemistry, bioorganic/bioinorganic and biophysical chemistry) and biology (protein biochemistry, bioinformatics, molecular and cell biology). This investigation will also enable us to create variants of such compounds as potential anticancer agents by using chemo-enzymatic methods. Students will get exposure to synthesis, biochemistry, molecular biology, and various spectroscopic techniques (NMR/MS/HPLC/UV-Vis) in this project.

H. DEPARTMENT OF CIVIL ENGINEERING

H.1 Qualifying Degree

M.Tech. or equivalent degree in Civil Engineering with the specialization of Geotechnical Engineering, Transportation Engineering, Structural Engineering, Water Resource Engineering and Environmental Engineering (or any other equivalent PG specialization in Civil Engineering)

H.1.1. Minimum score required in the qualifying degree and GATE Qualification

For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree (M.Tech./M.E.):

1. a minimum of 60% marks (without round off) in aggregate, OR,
2. a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).
3. Candidate must qualify in GATE at least once (Candidate need not to have a valid GATE score)

For SC/ST category candidates and differently abled candidates (PwD), a relaxation of 5% (or CPI/CGPA of 0.5 on the scale of 0-10) in the qualifying degree is applicable. However, candidate qualify in GATE at least once (Candidate need not to have a valid GATE score)

H.1.2. Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving the above-mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join an academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in the section above considering updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in section A should be used to determine eligibility for application and same to be reported in the online application.

H.2. Modality of selection process

Only the eligible applicants are permitted to participate in the selection process. The selection process would involve two rounds; Round-1: An online interview to test the fundamentals of all the broad areas in Civil Engineering. The shortlisted candidates will be called for interview by the respective panel based on the research area preference mentioned in the admission form. The candidates are encouraged to check the Institute Website from time to time. Selection committee decisions are final in all matters including any disciplinary matters/malpractice.

H.3. Focus area of research

Geotechnical Engineering: Unsaturated soils, Energy Geotechnics, Geotechnical Earthquake Engineering, Slopes and Landslides, Ground Improvement Techniques, Geosynthetics, Retaining Walls and Deep Excavations, Pavement Geotechnics, Buried Pipelines.

Pavement Engineering: Pavement Materials, Hot Mix Asphalt, Warm Mix Asphalt, Asphalt Binder Rheology, Pavement Evaluation, Pavement Management System.

H.4. Interview Syllabus

Engineering Mathematics:

Linear Algebra: Matrix algebra; Systems of linear equations; Eigen values and Eigen vectors.

Calculus: Functions of single variable; Limit, continuity, and differentiability; Mean value theorems, local maxima and minima; Taylor series; Evaluation of definite and indefinite integrals, application of definite integral to obtain area and volume; Partial derivatives; Total derivative; Gradient, Divergence and Curl, Vector identities; Directional derivatives; Line, Surface and Volume integrals.

Ordinary Differential Equation (ODE): First order (linear and non-linear) equations; higher order linear equations with constant coefficients; Euler-Cauchy equations; initial and boundary value problems.

Partial Differential Equation (PDE): Fourier series; separation of variables; solutions of one-dimensional diffusion equation; first and second order one-dimensional wave equation and two-dimensional Laplace equation.

Probability and Statistics: Sampling theorems; Conditional probability; Descriptive statistics – Mean, median, mode and standard deviation; Random Variables – Discrete and Continuous, Poisson and Normal Distribution; Linear regression.

Numerical Methods: Error analysis. Numerical solutions of linear and non-linear algebraic equations; Newton's and Lagrange polynomials; numerical differentiation; Integration by trapezoidal and Simpson's rule; Single and multi-step methods for first order differential equations

Structural Engineering:

Engineering Mechanics: System of forces, free-body diagrams, equilibrium equations; Internal forces in structures; Frictions and its applications; Centre of mass; Free Vibrations of undamped SDOF system.

Solid Mechanics: Bending moment and shear force in statically determinate beams; Simple stress and strain relationships; Simple bending theory, flexural and shear stresses, shear centre; Uniform torsion, Transformation of stress; buckling of column, combined and direct bending stresses.

Structural Analysis: Statically determinate and indeterminate structures by force/ energy methods; Method of superposition; Analysis of trusses, arches, beams, cables and frames; Displacement methods: Slope deflection and moment distribution methods; Influence lines; Stiffness and flexibility methods of structural analysis.

Construction Materials and Management: Construction Materials: Structural Steel – Composition, material properties and behaviour; Concrete - Constituents, mix design, short-term and long-term properties. Construction Management: Types of construction projects; Project planning and network analysis - PERT and CPM; Cost estimation.

Concrete Structures: Working stress and Limit state design concepts; Design of beams, slabs, columns; Bond and development length; Prestressed concrete beams.

Geotechnical Engineering:

Soil Mechanics: Three-phase system and phase relationships, index properties; Unified and Indian standard soil classification system; Permeability - one dimensional flow, Seepage through soils –two - dimensional flow, flow nets, uplift pressure, piping, capillarity, seepage force; Principle of effective stress and quicksand condition; Compaction of soils; One- dimensional consolidation, time rate of consolidation; Shear Strength, Mohr's circle, effective and total shear strength parameters, Stress-Strain characteristics of clays and sand; Stress paths.

Foundation Engineering: Sub-surface investigations - Drilling bore holes, sampling, plate load test, standard penetration and cone penetration tests; Earth pressure theories - Rankine and Coulomb; Stability of slopes – Finite and infinite slopes, Bishop’s method; Stress distribution in soils – Boussinesq’s theory; Pressure bulbs, Shallow foundations – Terzaghi’s and Meyerhoff’s bearing capacity theories, effect of water table; Combined footing and raft foundation; Contact pressure; Settlement analysis in sands and clays; Deep foundations – dynamic and static formulae, Axial load capacity of piles in sands and clays, pile load test, pile under lateral loading, pile group efficiency, negative skin friction.

Water Resources Engineering:

Fluid Mechanics: Properties of fluids, fluid statics; Continuity, momentum and energy equations and their applications; Potential flow, Laminar and turbulent flow; Flow in pipes, pipe networks; Concept of boundary layer and its growth; Concept of lift and drag.

Hydraulics: Forces on immersed bodies; Flow measurement in channels and pipes; Dimensional analysis and hydraulic similitude; Channel Hydraulics - Energy-depth relationships, specific energy, critical flow, hydraulic jump, uniform flow, gradually varied flow and water surface profiles.

Hydrology: Hydrologic cycle, precipitation, evaporation, evapo-transpiration, watershed, infiltration, unit hydrographs, hydrograph analysis, reservoir capacity, flood estimation and routing, surface run-off models, ground water hydrology - steady state well hydraulics and aquifers; Application of Darcy’s Law.

Irrigation: Types of irrigation systems and methods; Crop water requirements - Duty, delta, evapo-transpiration; Gravity Dams and Spillways; Lined and unlined canals, Design of weirs on permeable foundation; cross drainage structures

Transportation Engineering:

Transportation Infrastructure: Geometric design of highways - cross-sectional elements, sight distances, horizontal and vertical alignments.

Geometric design of railway Track – Speed and Cant.

Concept of airport runway length, calculations and corrections; taxiway and exit taxiway design.

Highway Pavements: Highway materials - desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes

Traffic Engineering: Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster’s method; Types of intersections; Highway capacity.

Environmental Engineering:

Water and Waste Water Quality and Treatment: Basics of water quality standards – Physical, chemical and biological parameters; Water quality index; Unit processes and operations; Water requirement; Water distribution system; Drinking water treatment. Sewerage system design, quantity of domestic wastewater, primary and secondary treatment. Effluent discharge standards; Sludge disposal; Reuse of treated sewage for different applications. Air Pollution: Types of pollutants, their sources and impacts, air pollution control, air quality standards, Air quality Index and limits. Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal)

In this call, applications are invited under TA category only.

Number of openings: 2

Position Code: AU22-23_Civil_PhD_TA

I. DEPARTMENT OF COMPUTER SCIENCE AND ENGG.

I.1. Qualifying Degree

M.Tech. or equivalent degree in Computer Science and Engineering or any related stream.

I.1.1 Minimum score in the qualifying degree

For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree (M.Tech./M.E.):

1. a minimum of 60% marks (without round off) in aggregate, OR,
2. a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).

For SC/ST category candidates and differently abled candidates (PwD), a relaxation of 5% (or CPI/CGPA of 0.5 on the scale of 0-10) in the qualifying degree is applicable.

I.1.2 Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving the above-mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join an academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in the section above considering updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in section A should be used to determine eligibility for application and same to be reported in the online application.

I.2. Modality of selection process

Only the eligible applicants are permitted to participate in the selection process. The selection process would involve two rounds; round-1: An online interview to test the aptitude, programming skills and knowledge of discrete structures, data structures and algorithms of the candidate; round-2: The shortlisted candidates from round-1 will be called for interview by the respective panel based on the research area preference mentioned in the admission form. The candidates are encouraged to check the Institute Website from time to time. Selection committee decisions are final in all matters including any disciplinary matters/malpractice.

I.3. Focus area of research

The research topics are broadly classified as given below. The applicant may be asked to indicate the choice of the research topics in the order of preference.

1. **Data Science and Artificial Intelligence (DSAI):** Machine Learning (ML), Deep Learning (DL), Reinforcement Learning (RL), Stochastic Control and Optimisation, Bayesian Optimization, Text Mining, Speech and Audio Processing, Handwriting and

Document Processing, ML for Cyber Physical Systems, Mining large data streams, ML for Cyber Security, Big Data Analytics, Distributed data processing.

2. **Computer/Communication Networks (CN):** 5G/IoT Networks, AI Driven Networking, Network Virtualization, Network/Cyber Security, Blockchains, Software Defined Networks, Network Function Virtualization, Data Center Networking.
3. **Embedded systems and Computer Architecture (ESCA):** Application of neural networks on Edge devices, Reliability and Security of Autonomous vehicles, Modeling and characterization of heterogeneous processors, Efficient Computer Architectures, Runtime Verification of Hardware.
4. **Theoretical Computer Science (TCS):** Algorithms, Concurrency, Formal Verification, and Graph Theory.
5. **High Performance Computing and Programming Languages (HPCPL):** Parallel Computing, Compilers and Translation Systems, Programming models and runtime systems.

I.4. Teaching Assistantship (TA)

In this call, applications are invited under TA category only for research areas (1)-(3). The applicant may be asked to indicate the choice of the research topics in the order of preference.

Position Code: Au22_CSE_PhD_TA

I.5. Externally Sponsored (EX)

In this call, applications are invited under EX category for all research areas (1) -(5).

I.6 Project Assistantship (PA)

Details of the PA positions are given below.

I.6.1. Position 1

Code: Au22_PhD_CSE_DSAI1 / Au22_PhD_EE_CSML1

Project Title: Speech Technologies in Indian Languages - Speaker Recognition

Description: This project involves development of artificial intelligence and deep learning based systems for speaker recognition.

Broad domain of research: Speech Processing, Natural Language Processing, machine learning and deep learning.

Requirement: The candidate should have exposure to the basics of probability, signal processing and good programming skills in python.

Type of funding support – PA (Rs. 35000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding – 3 years

Number of openings: 1

I.6.2. Position 2

Code – Au22_PhD_CSE_DSAI2 / Au22_PhD_EE_CSML2

Project Title: Standalone Domain Specific Speech to Speech Translator for Hindi, English and Tamil Languages

Description: This project involves development of artificial intelligence and deep learning based systems for speaker recognition.

Broad domain of research: Speech Processing, Natural Language Processing, machine learning and deep learning.

Requirement: The candidate should have exposure to the basics of probability, signal

processing and good programming skills in python.

Type of funding support – PA (Rs. 35000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding – 3 years

Number of openings: 1

I.7. Syllabus

- **Discrete Mathematics:** Propositional and first order logic. Sets, relations, functions, partial orders and lattices. Groups. Graphs: connectivity, matching, coloring. Combinatorics: counting, recurrence relations, generating functions, Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and Eigenvectors, LU decomposition. Calculus: Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration. Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.
- **Computer Organization and Architecture:** Machine instructions and addressing modes. ALU, data-path and control unit. Instruction pipelining. Memory hierarchy: cache, main memory and secondary storage; I/O interface (interrupt and DMA mode).
- **Programming and Data Structures:** Programming in C. Recursion. Arrays, stacks, queues, linked lists, trees, binary search trees, binary heaps, graphs.
- **Algorithms:** Searching, sorting, hashing. Asymptotic worst case time and space complexity. Algorithm design techniques: greedy, dynamic programming and divide-and-conquer. Graph search, minimum spanning trees, shortest paths.
- **Theory of Computation:** Regular expressions and finite automata. Context-free grammars and push-down automata. Regular and context-free languages, pumping lemma. Turing machines and undecidability.
- **Compiler Design:** Lexical analysis, parsing, syntax-directed translation. Runtime environments. Intermediate code generation.
- **Operating System:** Processes, threads, inter-process communication, concurrency and synchronization. Deadlock. CPU scheduling. Memory management and virtual memory. File systems.
- **Computer Networks:** Concept of layering. LAN technologies (Ethernet). Flow and error control techniques, switching. IPv4/IPv6, routers and routing algorithms (distance vector, link state). TCP/UDP and sockets, congestion control. Application layer protocols (DNS, SMTP, POP, FTP, HTTP). Basics of Wi-Fi. Network security: authentication, basics of public key and private key cryptography, digital signatures and certificates, firewalls.

J. DEPARTMENT OF ELECTRICAL ENGINEERING

J.1. Eligibility Criterion

J.1.1. Qualifying Degree

M.Tech., MS, ME or equivalent degree in Electrical Engineering, Electronics and Communication Engineering, Electrical and Electronics Engineering, Instrumentation Engineering, Computer Science and Engineering, or any related stream.

OR

MSc in Mathematics and Statistics with valid GATE or NET scores, or any related stream.

J.1.2. Minimum score in the qualifying degree

For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree (M.Tech./M.E/MSc):

- 1) a minimum of 60% marks (without round off) in aggregate, OR,
- 2) a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).

For SC/ST category candidates and differently abled candidates (PwD), a relaxation of 5% (or CPI/CGPA of 0.5 on the scale of 0-10) in the qualifying degree is applicable.

J.1.3. Eligibility of applicants who are in the final phase of getting the qualifying degree

Students who are in the final phase of receiving the above-mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join an academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining at IIT Dharwad. They need to meet the criteria specified in section above considering an updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission should be used to determine eligibility for application and same to be reported in the online application.

J.1.4. Application Categories and Financial Support

The Department of Electrical Engineering offers admission to PhD program under TA, PA, FA, and EX categories. The details of each application category are given in Section APPLICATION CATEGORIES & FINANCIAL SUPPORT of this document.

Note: In TA category, the vacancies available in different social categories are mentioned along with the research areas in Section Department. **The PA, EX, and FA category vacancies are unreserved.**

J.2. Guidelines for Shortlisted Candidates

J.2.1. Modality of Selection Process

All the eligible candidates are invited for the first round of interviews via video conferencing. After the first-round interviews, another shortlist will be announced for the second round of interviews. The shortlisted candidates will be asked to attend the second round of interview via video conferencing. Syllabus for the interview is given Section I.4 of this document.

The interview slot (date and starting time) specific to each candidate will be communicated online at https://www.iitdh.ac.in/academics_phd.php.

Selection committee decision is final in all matters including any disciplinary matters/malpractice.

J.3. Research Areas

J.3.1. For TA, FA, and EX categories

The research areas are broadly classified in five streams as described below. **The applicant MUST indicate the choice of the research topics in an order of preference.**

1. **Microelectronics and VLSI:** Including but not limited to, Analog / Mixed signal / RF Integrated Circuits and Systems, Power management and Energy harvesting circuits

Eligible social category to apply for TA position: - GEN, OBC, SC, ST and PwD

2. **Communication Technologies:** Including but not limited to, physical and medium access control (MAC) layer technologies in Next Generation Wireless Systems (5G and beyond), Internet of Things (IoT), novel multiple access methods like non-orthogonal multiple access (NOMA), massive multi-input multi-output (MIMO) systems, millimeter wave (mmWave) communications, energy harvesting based communications and low-latency communications, Machine Learning (ML) and Blockchain (BC) oriented resource allocation in 6G, Quantum Communication etc.

Eligible social category to apply for TA position: - GEN, OBC, SC, ST and PwD

3. **Control and Robotics:** Including but not limited to Control of Robots through Speech Signals, Autonomous Vehicles, Control for Differential Games, Control of Structures etc.

Eligible social category to apply for TA position: - SC, ST and PwD

4. **Electronic Devices:** Including but not limited to Gas sensors, Nano-electronics, GaN-based High-electron mobility transistors (HEMTs), Silicon Carbide (SiC) Power Diodes.

Eligible social category to apply for TA position: - GEN, OBC, SC, ST and PwD

5. **Power & Energy Systems:** Power system stability and control; cyber security in smart grid, synchrophasor applications to power systems protection, monitoring and control; microgrid; game theory based incentives for ancillary services, Impact of renewables, battery energy storage and Electric Vehicles on Grid; Smart Grid; Power Electronics and converters for Electric Vehicle; Power Electronics and converters for Renewable Energy; Medium voltage hybrid DC circuit breakers; Grid connected multilevel inverters; high voltage power electronics and control; Electrical drives for Electrical Vehicles.

Eligible social category to apply for TA position: - GEN, OBC, SC, ST and PwD

J.3.2. For PA category (Project Funded Positions)

No reservation is applicable for PA category.

J.3.2.1. Position 1

Code-Au22_PhD_EE_CSML1/Au22_PhD_CSE_DSAI1

Project Title: Speech Technologies in Indian Languages - Speaker Recognition

Description: This project involves development of artificial intelligence and deep learning based systems for speaker recognition.

Broad domain of research: Speech Processing, Natural Language Processing, machine learning and deep learning.

Requirement: The candidate should have exposure to the basics of probability, signal processing and good programming skills in python.

Type of funding support – PA (Rs. 35000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 3 years

Number of openings: 1.

J.3.2.1. Position 2

Code-Au22_PhD_EE_CSML2/Au22_PhD_CSE_DSAI2

Project Title: Standalone Domain Specific Speech to Speech Translator for Hindi, English and Tamil Languages

Description: This project involves development of artificial intelligence and deep learning based systems for speaker recognition.

Broad domain of research: Speech Processing, Natural Language Processing, machine learning and deep learning.

Requirement: The candidate should have exposure to the basics of probability, signal processing and good programming skills in python.

Type of funding support – PA (Rs. 35000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 3 years

Number of openings: 1.

J.3.2.1. Position 3

Code - CRG/2021/003827

Broad domain of research – Power Systems, Cyber Security Smart Grid & Machine Learning

Fee – refer Section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – PA (Rs. 31000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 3 years

Desired Knowledge - Good exposure to power systems analysis, power systems stability and power system protection (UG level).

Topic -Cyber Security in Smart Grid. The main purpose of this project is to model different types of false data injection attacks that can possibly destabilize the grid or make the power system insecure, and to develop algorithms to detect the cyber-attacks.

J.3.2.1. Position 4

Code - CRG/2020/004611

Broad domain of research – VLSI Circuits, Network Theory, and Analog Electronics.

Fee – refer Section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – PA (Rs. 31000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 2 years

Details (if any) - Good exposure to VLSI Circuits, Network theory and Analog Electronics with good background in circuit simulation tools.

Topic - Powering the Ultra-Low-Power Wireless System/IoT Node by Scavenging Multi-Band Radio Frequency (RF) Energy. The scope of this project is to develop an on-chip energy processing unit for powering an ultra-low-power wireless sensor/IoT node by scavenging multi-band RF energy.

J.3.2.1. Position 5

Code - EEQ/2020/000047

Broad domain of research – Wireless Communication and Network Designing.

Fee – refer Section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – PA (Rs. 31000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 2 years

Details (if any) - Exposure to the basics digital communication systems and wireless communication networks.

Topic: The project is focused on developing Deep learning-oriented, Block chain-enabled resource allocation strategies for next-generation (6G) wireless networks. The candidates will explore the area of basics digital communication systems and advanced wireless communication networks.

J.3.2.1. Position 6

Code - Au22_PhD_EE_SEN

Broad domain of research – Gas sensors.

Fee – refer Section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – PA (Rs. 31000/-; for first 2 years, Rs. 35000/-; for 3rd and 4th year, additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 4 years

Details (if any) – Funding is from Technology Innovation Hub. This project is on developing resistive sensors for vapors which indicate stresses in crops. This will require synthesis of sensing materials characterizing them, exhaustively testing the material for the vapors. The work will also include assembling interfacing electronics for the prototype development.

Requirement: Candidate should be keen to do experimental work as it requires experience in Cleanroom

J.3.2.1. Position 7

Code - Au22_PhD_EE_DECI

Project Title: Developing Efficient Communication Infrastructure - Connecting Ground Sensors and Satellites/Drones to Cloud and Cloud to Actuators

Brief Project Description:

In farms-of-the-future, which we expect to be smart and technology-driven, data based decision making is critical. This makes the task of data collection, analysis, and generation of actionable insights and their communication to actuators extremely important. In this project, our goal is to develop a framework and infrastructure for data collection and actuator signaling. The main motivation for this is that it is not feasible to directly adopt existing wireless networks, such as the 4G/5G cellular network, for arriving at a low-cost solution as an enormous number of nodes need to be planted in farms, which are usually energy-constrained. Hence, this work aims to obtain a wireless network powered from energy harvesters such as solar cells/micro windmills to achieve timely collection of data and their storage in a cloud platform, and connecting cloud to actuators.

Broad domain of research: Wireless communication, Embedded systems for Communications

Candidate Requirement: M. Tech./M.E. degree in Electrical Engineering or Computer Science and Engineering or equivalent area.

Type of funding support – PA - 1 (Rs. 31000.00 per month + 16% HRA)

Duration of funding - 4 years

Number of openings: 2

J.3.2.1. Position 8

Code -Au22_PhD_EE_TiH_Farm Produce/Au22_PhD_MMAE_TiH_FarmProduce

Project Title: Grading of farm produce quality using computer vision and machine learning

Brief Project Description: The project will focus on applied research to translate computer vision and machine learning techniques for classification of the farm produce. Major focus will be on the assessment of various techniques to capture the scene appropriately and algorithms to efficiently and effectively provide automated inferences using low cost hardware. This project is funded by IIT Dharwad SPOKE for the BITS BioCyTiH Foundation.

Broad domain of research: Computer Vision, AI in Agriculture, 3D modeling

Candidate Requirement: This research would need interdisciplinary skill sets - specifically computational geometry, image processing, and computer vision. Candidates should be interested in algorithmic thinking and coding skills across various platforms. This project will also involve instrumentation work and field visits for conducting surveys and field testing to ensure that the project remains relevant for the various stakeholders. Prior relevant experience in industry or productization will be valuable.

Type of funding support – PA (Rs. 36000/-; additional HRA applicable if staying outside the campus; it may vary as per the policy applicable from time to time)

Duration of funding - 36 months' maximum

Number of openings: 1

J.4. Interview Syllabus

All applicants should choose one stream for the interview while submitting the online application form.

Common for all the streams

- 1. General aptitude, reasoning and comprehension**
- 2. Engineering Mathematics:** Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors, Concepts from integration and differentiation, Fourier Transform and Laplace Transform.

Stream 1: Communication and Signal Processing

- 1. Basic Electrical Networks:** KCL, KVL, Node and Mesh analysis, Network theorems etc.
- 2. Signals and Systems:**
 - a. Continuous-time signals:** Fourier series and Fourier transform representations, sampling theorem and applications;
 - b. Discrete-time signals:** discrete-time Fourier transform (DTFT), DFT, FFT, z-transform and sampling theorem
 - c. LTI systems:** definition and properties, causality, stability, impulse response, convolution, poles and zeros and frequency response.
 - d. Random processes:** basics of probability, random variables, CDF, PDF, random processes, mathematical expectation, conditional probability and conditional expectation.
- 3. Communication:**
 - a. Random processes:** Basics of probability, random variables, CDF, PDF, random processes, mathematical expectation, conditional probability and conditional expectation.
 - b. Digital communications:** Digital modulation schemes, MAP and ML decoding, notions of bandwidth, SNR and BER for digital modulation, fundamentals of error correction codes (e.g.: Linear Block Codes like Hamming code).

Stream 2: Control and Robotics

- 1. Basic Electrical Networks:** KCL, KVL, Node and Mesh analysis, Network theorems etc.
- 2. Mathematical modeling and representation of systems, Basic control system components, Feedback principle, Transfer function, Block diagram representation, Transient and steady -state analysis of LTI systems, Frequency response, Stability analysis, Routh-Hurwitz, Bode plots, and root-loci, P, PI and PID controllers. State-space representation, State-transition matrix, and solution of state equation of LTI systems, Controllability and Observability, Design of state-feedback controllers, principle of optimality, dynamic programming, Pontryagin's Maximum Principle.**

Stream 3: Electronic Devices and Mixed signal ASIC Design

- 1. Basic Electrical Networks:** KCL, KVL, Node and Mesh analysis, Network theorems etc.

2. **Electronic Devices:** Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; Generation and recombination of carriers; Poisson and continuity equations; P-N junction, Zener diode, BJT, MOS capacitor, MOSFET, LED, photo diode and solar cell; Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography and twin-tub CMOS process.
3. **Analog Circuits:** Basics of Analog circuits.
4. **Digital Systems:** Number systems; Combinatorial circuits; Sequential circuits.

Stream 4: Power and Energy Systems

1. **Electric Circuits:** KCL, KVL, Node and Mesh analysis, Transient response of dc and ac networks, Sinusoidal steady-state analysis, Resonance, Ideal current and voltage sources, Thevenin's theorem, Norton's theorem, Superposition theorem, Maximum power transfer theorem, Three phase circuits, Power and power factor in ac circuits.
2. **Power Electronics:** characteristics of MOSFET, IGBT and diode, DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters.
3. **Power Systems:** Per-unit quantities, Newton-Raphson load flow methods, Voltage and Frequency control, Power factor correction, Symmetrical components and fault analysis, Power System Stability, Power System Protection.
4. **Electrical Machines:** Single phase transformer: equivalent circuit, phasor diagram, open circuit and short circuit tests, regulation and efficiency; Three phase transformers: connections, parallel operation; Three phase induction motors: principle of operation, types, performance, torque-speed characteristics, no-load and blocked rotor tests, equivalent circuit, starting and speed control; Synchronous machines: cylindrical and salient pole machines, performance, regulation, starting of synchronous motor, characteristics, P&Q Control.

K. DEPARTMENT OF HUMANITIES AND SOCIALSCIENCES

Online Applications are invited for admission into the Ph.D. Programme (**in Economics and English**) in the Department of Humanities & Social Sciences (HSS). The minimum eligibility criteria are as follows:

K.1 Eligibility for Admission

K.1.1 Qualifying Degree (Economics)

1. Master's Degree in Economics / Engineering / Science/ Commerce / Business Administration
2. UGC-NET/GATE Qualified or M.Phil. in Economics

UGC-NET/JRF Qualified Candidates are encouraged to apply

Qualifying Degree (English)

1. M.A. in English
2. UGC-NET Qualified or M.Phil. in English
UGC-NET/JRF Qualified Candidates are encouraged to apply

K.1.2 Minimum score in the qualifying degree

Category	Minimum Eligibility
General	55% aggregate overall in Master's Degree, (without round off), or CPI 5.5 on the scale of 10
OBC	55% aggregate overall in Master's Degree, (without round off), or CPI 5.5 on the scale of 10
SC	50% aggregate overall in Master's Degree, (without round off), or CPI 5 on the scale of 10
ST	50% aggregate overall in Master's Degree, (without round off), or CPI 5 on the scale of 10
PwD	50% aggregate overall in Master's Degree, (without round off), or CPI 5 on the scale of 10

Please Note: Corresponding proportional requirements are applicable when the scales are other than on 0-10 (for example, 4.8 on a scale of 0-8 for General Category Candidates). For SC/ST/PwD category candidates, a relaxation of 5% in the qualifying degree is applicable.

K.1.3 Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving above mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in section above considering updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in above section should be used to determine eligibility for application and same to be reported in the online application.

K.2 Modality of the Selection Process

Only the short-listed applicants are permitted to participate in the selection process.

The applicant needs to submit a Research Proposal (Word Limit: 1500-2000).

The selection process consists of either online screening tests and/or interviews.

Candidates will be offered a PhD position based on their performances in the selection process.

K.3 Focus Area of Research

Economics: International Finance, Open Economy Macroeconomics, Monetary Economics, Applied Econometrics, and International Trade.

K.3.1 Position 1

Code – Au22_PhD_HSS_ECO_TA/FA

Broad Domain of Research – International Finance, Open Economy Macroeconomics, Monetary Economics, Applied Econometrics, and International Trade.

Eligible Social Category to Apply for TA Positions – Not Applicable (All Categories are Eligible) i.e., GEN/OBC(NC)/SC/ST/PwD/EWS.

Eligible Social Category to Apply for Fellowship Awardees – All categories

Fee – refer section FEES, DEPOSITS & HOSTEL RENT

Type of Funding Support – FA/TA (Please find the funding related details in Section B)

Duration of Funding - Please find the funding related details in Section B

English: Digital Humanities, South Asian Literature, Gender and Feminist Theories, Literature and the Environment

K.3.2 Position 2

Code – Au22_PhD_HSS_ENG_TA/FA

Broad Domain of Research – Literary Theory and Criticism, Important Movements, Schools, Ideas in Critical Thought and Literature, Analysis/Appreciation of ‘texts’.

Eligible Social Category to Apply for TA Positions – SC/ST/PwD/EWS.

Eligible Social Category to Apply for Fellowship Awardees – All categories

Fee – refer section FEES, DEPOSITS & HOSTEL RENT

Type of Funding Support – FA/TA (Please find the funding related details in Section B)

Duration of Funding - Please find the funding related details in Section B

K.4 Syllabus

Economics: Consumer Behaviour, Production and Costs, Market Environments –Perfect Competition, Monopoly, Monopolistic Competition, Oligopoly.

National Income Accounting Methods, Classical Model, Keynesian Model, IS-LM Model, Fiscal and Monetary Policies, Solow Growth Model, Inflation, Index Numbers, Indian Money Market and RBI’s Monetary Policy.

Vectors and matrices, matrix operations, determinants. Functions, limits, continuity, differentiation of functions of one or more variables. Unconstrained optimization, definite and indefinite integrals, integration by parts and integration by substitution. Constrained and Unconstrained Optimization: First and Second order conditions.

Elementary probability theory, conditional probability, Bayes’ theorem, probability distributions –Binomial, Poisson, Uniform and Normal, measures of central tendency,

skewness, kurtosis, dispersion, correlation and regression, Assumptions of the CLRM and properties of the estimators, OLS, Violations of CLRM assumptions.

The Standard Theory of International Trade, Offer Curves and the Terms of Trade, The Heckscher - Ohlin Theory, Economies of Scale, Imperfect Competition and International Trade, Trade Restrictions: Tariffs and Nontariff Trade Barriers, Economic Integration, The Balance of Payments, Foreign Markets and Exchange Rate Determination, The International Monetary System and Macroeconomic Policy Coordination, Economic Crises.

Suggested Readings:

1. Intermediate Microeconomics by Hal R. Varian
2. Microeconomic Analysis by Hal R. Varian
3. Macroeconomics by Rudiger Dornbusch & Stanley Fischer
4. Principles of Macroeconomics by N. Gregory Mankiw
5. Fundamental Methods of Mathematical Economics by Alpha C. Chiang
6. John E. Freund's Mathematical Statistics with Applications
7. Introductory Econometrics: A Modern Approach by Jeffrey Wooldridge
8. Basic Econometrics by Damodar N. Gujarati
9. International Economics by Dominick Salvatore

English: Literary Theory and Criticism, Important Movements, Schools, Ideas in Critical Thought and Literature, Analysis/Appreciation of 'texts'.

Shortlisting process will also involve a defence of the research proposal shared by the candidate.

L. DEPARTMENT OF MATHEMATICS

L.1. Eligibility Criteria

L.1.a Qualifying degree

M.Sc. Mathematical Science, M.Phil in Mathematical Science (or equivalent degree).

L.1.b. Minimum score required in the qualifying degree

Category	Educational qualification
General/ General (EWS)	The eligibility criteria in the qualifying degree is First Class, as specified by the candidate's Institution/University. If the Institution/University does not specify the division/class, then one of the following will be considered as the eligibility criteria: (1) A minimum of 60% marks (with out round off) in aggregate or (2) a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).
OBC (NC)	Same as general
SC/ST/PWD	A relaxation of 5% in the qualifying degree is applicable

L.1.c. The candidates who do not have M. Phil. degree must also fulfill ONE of the following additional requirements:

- Valid GATE score.
- Junior Research Fellowship in Mathematical Sciences from CSIR, UGC, DST (INSPIRE fellowship), NBHM and other externally funded candidates are encouraged to apply and they are exempted from possessing a valid GATE score.

L.1.d. Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving above mentioned qualifying degree and who are likely to

graduate before commencement of Autumn 2022-23 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join an academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in the section above considering an updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in section A should be used to determine eligibility for application and same to be reported in the online application.

L.1.e. Application categories and Financial Support

The Department of Mathematics admits Ph.D. candidates under the full time research scholarship - Teaching Assistantship (TA) and Fellowship Award (FA).

L.2. Guidelines for shortlisted applicants

L.2.a Modality of the selection process

Only the short-listed applicants are permitted to participate in the selection process. The selection process will have two rounds (round 1 and round 2) of tests in the form of interviews or written exams.

Round 1 is compulsory for everyone.

Candidates qualifying in round 1, will be invited for round 2.

Dos:

- Ensure that you have participated in a mock call session before the actual round for the applicant to ensure the audio-video set up is ready. You may skip this session. However, in case of any issue during the actual online interview time slot, IIT Dharwad will not consider a plea for any extra time or chance to again appear for the interview.
- Accessing any technical resource (notes, book, internet, including peers or mentors) is not allowed during interview unless explicitly mentioned by the committee
- Have paper and pen or pencil calculators handy for any rough work.
- Keeping a glass of water ready may be a good idea.
- In case your area has scheduled power outages please alert us ahead of time in case your interview time slot coincides with that.
- Ensure that equipment is charged to avoid power issues.
- It is recommended to have at least 2 GB of internet data available in your plan. Also, try to locate yourself in a place with good internet speed (at least 1.5 Mbps) for a good quality video interaction

- In case you have requested any application modification requests post submission of the application, quickly (within 20-30 secs) remind the interview panel about the change.
- Ensure that the place from where you are attending the interview is conducive for effective interaction online. Best Practices while in online meetings:
- Sign in to the online client 10-15 minutes ahead of scheduled meeting time and stay signed in
- Turn your camera on and have your camera at eye level
- Stay muted unless you're talking to reduce background noise
- Make sure you sit in a well-lit and quiet place
- Be mindful of what's going on behind you. Think about having a solid wall/nice curtain behind you or turning on the virtual background (if available).
- Put your microphone on the mute when examiner(s) speak.

Don'ts:

- Avoid windy noisy surroundings during interview
- Do not record interviews in any form. Any such act will be considered as violation of the pledge you signed online and may invite punitive action from IIT Dharwad.
- Do not ask about the schedule of the results. It is better to use interview time for other better inquiries as the results will be declared online as soon as possible.
- Do not leave your place in front of the camera for the entire duration of the interview. Take necessary care to avoid interruptions in the interview process e.g. rest-room breaks.

L.3. Research Topics

Functional Analysis

L.4. Syllabus

Topics for round 1 Analysis

Elementary set theory, finite, countable and uncountable sets, Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem. Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

Linear Algebra

Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations. Algebra of matrices, rank and determinant of matrices, linear equations. Eigenvalues and eigenvectors, Cayley Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Inner product spaces, orthonormal basis. Quadratic forms, reduction and classification

of quadratic forms.

Complex Analysis

Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem,

P

Maximum modulus principle, Schwarz lemma, Open mapping theorem. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformation.

Discrete Mathematics

Counting, the pigeon-hole principle, principle of inclusion exclusion, derangements, recurrence relations, Ramsey theory, trees, matching, connectivity, planar graphs, coloring and chromatic number, cliques, independent sets, regular graphs, bipartite graphs.

Algebra

Fundamental theorem of arithmetic, divisibility in \mathbb{Z} , congruences, Chinese Remainder Theorem, Euler's phi-function.

Groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems.

Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domain, principal ideal domain, Euclidean domain, Chinese Remainder Theorem.

Topics for Round 2:

Apart from the topics mentioned above, candidates selected for the second round of interview can be asked questions from some advanced topics related to their area of interest. For example, a candidate interested to pursue research in functional analysis is expected to have some knowledge in some of the following topics:

Lebesgue measure on real line, Radon Nikodym theorem, atomic measure, singular continuous measure, probability measure on real line and its distribution function.

Stone-Weierstrass theorem, L^p spaces, Banach spaces, Bounded linear functionals and dual spaces, Hahn-Banach theorem. Bounded linear operators, open-mapping theorem, closed graph theorem, uniform boundedness principle. Hilbert spaces, Riesz representation theorem. Bounded operators on a Hilbert space. The spectral theorem for compact, self-adjoint, normal (including unbounded) operators.

Similarly, a candidate interested in Algebra should be able to answer questions from some of the following topics in the second round:

Fields, Finite extensions of fields, Algebraic extensions, algebraically closed field, Splitting fields, elementary Galois Theory

L.5. Focus area of research

Following topics are floated in the Department of MATHEMATICS for the PhD program this semester. Applicants have to choose at least one of these topics and fill in the application form.

L.5.1 Position 1

Code – 2022A_PhD_Math_01

Broad domain of research – Functional Analysis

Eligible social category to apply – for Fellowship Awardees - All categories; For Teaching Assistant - Gen, OBC, SC, ST

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – FA/TA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Details- Candidates should be highly motivated to perform theoretical research in topics related to the spectral theory of random operators, more specifically random Schrodinger operators. Prior knowledge of functional analysis, measure theory and probability theory is desirable.

Topic- Random Schrodinger Operators.

M. DEPARTMENT OF MECHANICAL MATERIALS AND AEROSPACE ENGINEERING

M.1 Eligibility for Admission

M.1.1. Qualifying Degree

M.Tech./M.E./M.Sc.(Engg.) or equivalent degree in Mechanical Engineering or Materials and Metallurgical Engineering or Aerospace Engineering or equivalent stream

M.1.2. Minimum score in the qualifying degree

For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree (M.Tech./M.E.):

1. a minimum of 60% marks (without round off) in aggregate, OR,
2. a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).

For SC/ST category candidates and differently abled candidates (PwD), a relaxation of 5% (or CPI/CGPA of 0.5 on the scale of 0-10) in the qualifying degree is applicable.

M.1.3. Eligibility of applicants in the final phase of getting the qualifying degree

Students who are in the final phase of receiving above mentioned qualifying degree and who are likely to graduate before commencement of Autumn 2022-23 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join an academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section A above. They need to meet the criteria specified in the section above considering an updated score in the qualifying degree. In the meanwhile, the aggregate academic performance announced by the respective university till the last date for submission mentioned in section A should be used to determine eligibility for application and same to be reported in the online application.

M.2. Modality of selection process

Only the eligible and confirmed applicants are permitted to participate in the selection process. The selection process consists of online interviews. There are two rounds in the selection process. Based on the performance of the first round of interview the candidates will be shortlisted for second round.

First round: An online interview based on prior experience/MTech Project will be conducted to assess the basic understanding related to project and overall Mechanical Engineering. The duration of this will be 20-30 min. You will be given a time-slot window (about 1–3 hours) during which we may connect with you anytime. The interaction must be taken on a desktop or laptop PC with a webcam, a speaker and a microphone. The candidates are not allowed to refer to their books and any online material during the test. The candidates are not permitted to communicate with any person during the test. The candidates may be remotely proctored via the webcam and screen-sharing options.

Second round Interview: Each applicant short-listed in first round will undergo an interview, with technical questions, for a duration of approximately 45 minutes. Access to books and online material is not permitted in this round, unless allowed by the interview panel.

You will be given a time-slot window (about 1–3 hours) during which we may connect with you anytime. Your specific time-slot will be communicated to you.

The interactions in the above rounds may be recorded by IIT Dharwad. Any suspicious activity indicating cheating during the first or second rounds of selection will be grounds for disqualification of candidature.

M.3. Dos and Don'ts

Dos:

- Please participate in a mock call session before the actual interview to ensure the audio-video set up is ready. Example, a pre-lunch slot mock call starts at 9:00 am.
- Please plan to have at least 2GB of data with you before the meeting. Also, try to locate yourself in a place with good internet speed (at least 1.5Mbps) for a good quality video interaction. Laptops/tablets are preferred for video conferencing.
- Have paper and pen or pencil calculators handy for any rough work.
- Keeping a glass of water ready may be a good idea.
- Ensure that equipment is charged to avoid power issues.
- Ensure that the place from where you are attending the interview is conducive for effective interaction online.
- Best Practices while in online meetings:
 - Sign in to the online client (Google Meet App/Desktop) 10-15 minutes ahead of scheduled meeting time and stay signed in
 - Turn your camera on and have your camera at the eye level
 - Stay muted unless you're talking to reduce background noise
 - Make sure you sit in a well-lit and quiet place
 - Be mindful of what's going on behind you. Think about having a solid wall/nice curtain behind you or turning on the virtual background (if available).

Don'ts:

- Avoid windy noisy surroundings during interview
- Do not record interviews in any form. Any such act will be considered as violation of the pledge you signed online and may invite punitive action from IIT Dharwad.
- Do not ask about the schedule of the results. It is better to use interview time for other better inquiries as the results will be declared online as soon as possible.

- Do not leave your place in front of the camera for the entire duration of the interview.
- Prepare yourself to avoid any kind of break during interview, including restroom-break
- Do not have anyone else around you. Any interaction with someone else other than the interview panel during the interview will be considered as a suspicious activity.

Note - For any matter related to the selection process, the decision of the selection committee would be considered as the final decision.

M.4. Focus area of research

Following topics are floated in the Department of Mechanical Engineering for the PhD program this semester. Applicants have to choose at least one of these topics and fill in the application form.

M.4.1. Position 1

Code – Au22_PhD_MMAE_M1

Broad domain of research – Material Science and Solid Mechanics

Eligible social category to apply – **Open to all**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Basics knowledge of materials science and mechanics of materials, experience with any programming language are desirable. Prior knowledge of (any one or more) material modeling, metal plasticity, experimental mechanics, and data analysis will be an added advantage.

Topic: Physics based experimentally informed micromechanical modeling of Ni and Co-based superalloys for high temperature applications.

Brief Description: In the broader perspective, this project aims at the development of Ni-based superalloys with better heat resistance, higher fuel efficiency, and low carbon emission to meet the extraordinary demands of aerospace industries. Under the scope of this project, we plan to simulate the temperature and strain rate dependent uniaxial, fatigue, and creep behavior of the Ni and Co-based superalloys. Modeling and simulation aspect of the project will include utilization of crystal plasticity and discrete dislocation dynamics approaches including some inputs obtained from atomistic simulations. Experimental part of the project will include heat treatment, mechanical testings, and material characterization of the single crystal and polycrystalline superalloys processed using casting, forging, and additive manufacturing. Selected Ph.D Student will have a head start with the conceptualization and macroscopic model developed and published by the research group (Crystal plasticity model for single crystal Ni-based superalloys : capturing orientation and temperature dependence of flow stress, International Journal of plasticity (2021), 137, 102896).

M.4.2. Position 2

Code – Au22_PhD_MMAE_M2

Broad domain of research – Material Science and Solid Mechanics

Eligible social category to apply – **Open to all**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Basics knowledge of materials science and mechanics of materials, experience with

any programming language are desirable. Prior knowledge of (any one or more) material modeling, metal plasticity, experimental mechanics, and data analysis will be an added advantage.

Topic: Crystal plasticity modeling of discrete evolution of mechanical twinning in HCP metals and alloys based on experimental observations.

Brief Description: The ultimate goal of this project is to improve the room temperature formability of the hexagonal (HCP) technological and structural alloys without sacrificing the strength. This is possible by understanding the formation of frequently observed mechanical twinning (both in two and three dimensions), their interaction with dislocation slip, and the consequences of the highly localized deformation caused by them. In this regard, modeling of discrete/binary evolution of mechanical twins within the full-field crystal plasticity framework of DAMASK (open source simulation kit) is far more advantageous as compared to conventional descriptions that are spatially homogenized and show only limited predictive capability. Experimental support including mechanical testing, and two and three dimensional characterization data of mechanical twins obtained from internal or external sources will complement the model development efforts. Selected student will take the advantage of already established experimental and numerical framework developed by the group.

M.4.3. Position 3

Code – Au22_PhD_MMAE_M3

Broad domain of research – Material Science and Solid Mechanics

Eligible social category to apply – **Open to all**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Basics knowledge of materials science and mechanics of materials, experience with any programming language are desirable. Prior knowledge of (any one or more) material modeling, metal plasticity, experimental mechanics, and data analysis will be an added advantage.

Topic: Development of multi-phase advanced high strength steels (AHSS) for automotive application.

Brief Description:

This project aims to develop a lightweight and crash-worthy multi-phase structural steel using microstructure-property relationship. Experimental activities involve specific heat treatments for adjusting the volume of different phases and grain size, cold rolling or annealing to alter the dislocation density, different mechanical testing and material characterization. Crystal plasticity constitutive model development specific to different phases such as ferrite, austenite and martensite will be complemented by the experimental inputs. For now, the plan is to work on Dual Phase (DP) steels, Martensitic steels, Transformation-Induced Plasticity (TRIP) Steels, and Twinning-Induced Plasticity (TWIP) steels. Past research experience of the group with crystal plasticity modeling of different phases in steels and characterization will be instrumental for the success of this project.

M.4.4. Position 4

Code – Au22_PhD_MMAE_M4

Broad domain of research –Manufacturing

Eligible social category to apply – **SC, ST, PWD, GEN (EWS)**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - The candidate is expected to have good knowledge of additive manufacturing, plasticity, CAD/CAM and numerical analysis. Knowledge of crystal structure and microstructure of materials will be an added advantage. The project involves experimental, analytical and numerical simulation works.

Topic: Design and Development of Hybrid Metal Additive and Formative Manufacturing process

Brief Description:

Additive manufacturing is the process of adding materials layer by layer to create 3D objects starting from its CAD model. In formative manufacturing processes part geometry is obtained by plastically deforming the material. Both manufacturing processes have their own advantages and limitations. This project involves integrating metal additive and formative manufacturing processes, a novel methodology to add and deform the material alternatively. The project involves design and development of the novel process, mechanical and material characterization of the parts produced, simulation of the process etc.

M.4.5. Position 5

Code – Au22_PhD_MMAE_T1

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **OBC (NC), SC, ST**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Good mathematical/analytical skill is desirable. Prior knowledge of computational fluid dynamics and programming skill in C & Bash will be an added advantage.

Topic: Drop impact dynamics of yield stress fluids

Brief Description:

Drop impact process has importance in several industrial applications such as spray coating and painting, ink-jet printing, surface cleaning, cooling, and atomization in internal combustion engines. Rigorous investigation on yield-stress fluid drop impacts has been lacking although such flow conditions and impact configurations are common in industrial processes. Indeed, no comprehensive literature exists that seeks to model, or at least heuristically predict, the outcomes of drop impact of yield-stress fluids on dry and wet surfaces. With the increasing use of 3D printing and additive manufacturing technology, the drop impact and deposition process has become crucial in the fabrication processes. Understanding the role of each fluid property in a decoupled way is very important for the optimization of the flow in industrial applications. Although such decoupling is relatively difficult in experiments, numerical and theoretical studies facilitate such decoupling. In this research, we will perform the direct numerical simulation (DNS) on the impact of viscoplastic drops on dry and wet surfaces using the Basilisk solver (<http://www.basilisk.fr>). One of the main objectives of this research will be to disentangle the effect of yield stress on the drop impact dynamics. The prime focus will be on the drop impact dynamics on wet surfaces; a part of the research will also be allocated to the drop impact on dry surfaces to understand the effect of surface wettability.

M.4.6. Position 6

Code – Au22_PhD_MMAE_T2

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **OBC (NC), SC, ST**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Good mathematical/analytical skill is desirable. Prior knowledge of computational fluid dynamics and programming skill in C & Bash will be an added advantage.

Topic: Fluid dynamics of disease transmission

Brief Description:

The micro-drops can float in the air for a long time and can carry pathogens with them to a long distance. For example, saliva microdroplets generated by coughing and sneezing were one of the main carriers of coronavirus (COVID-19) from the infected host to the susceptible one. The aerosols formed during the impact of raindrops on contaminated plant leaves can carry the pathogens to thousands of kilometers and is the reason for foliar outbreaks after rainfall. It is extremely important to understand and control the outbreaks from a health as well as economic point of view. However, we continue to struggle to control the outbreaks because of a limited understanding of the flow physics. In this research, we plan to study this complex disease transmission process. Both experimental and numerical simulation tools will be deployed to understand the disease transmission process.

M.4.7. Position 7

Code – Au22_PhD_MMAE_T3

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **GEN, GEN (EWS)**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Topic: Emissions and combustion-acoustic oscillations in non-premixed jet flames

Brief Description:

The research is relevant for the development of low-emissions industrial furnaces. Both experimental and numerical approaches will be implemented in order to assess the dependence of emissions and combustion-generated acoustic oscillations in jet flames.

M.4.8. Position 8

Code – Au22_PhD_MMAE_T4

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **GEN, GEN (EWS)**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Topic: Combustion dynamics of turbulent flames having fuel fraction variations

Brief Description:

The fundamental and application-based investigation of combustion dynamics, thermoacoustic instabilities and flame stabilisation problems that are of interest to the aerospace propulsion. This work will involve both experiments and modelling to develop and test combustion systems operating at different fuel fractions.

M.4.9. Position 9

Code - Au22_PhD_MMAE_T5

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **OBC (NC), SC, ST**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Sound knowledge of fluid mechanics, engineering mathematics and an aptitude for conducting experiments and scientific programming.

Topic: Performance improvement of turbomachines using flow control

Brief Description:

Turbomachines such as centrifugal compressors are ubiquitous in several industries. Their performance improvement will lead to significant savings in terms of power consumed and operation hours. Use of flow control in existing systems allows for a wider range of operation, including operation under poor inflow conditions. The study aims to investigate the effect of inflow conditions on the aerodynamic performance of a turbomachine and the effect of flow control using experimental techniques supplanted by numerical studies.

M.4.10. Position 10

Code - Au22_PhD_MMAE_T6

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **GEN, GEN (EWS)**

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/-; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Good mathematical/analytical skill is desirable. Prior knowledge of computational fluid dynamics, compressible flow & gas dynamics, programming skill in C & Matlab will be an added advantage.

Topic: Simulation of Compressible Flows with mixing of species

Brief Description:

The work is related to numerical simulation of compressible fluid flows. For this purpose, extensions to the present in-house developed algorithms in two and three dimensions is envisaged. This research topic is relevant to problems of aerospace engineering, chemical reacting flows at high speeds, physics of solar wind. The goal is to simulate compressible flows, e.g. shear layers, with mixing of species, temperature field and to generate typical scaling laws. The effect of various non-dimensional numbers, e.g. Reynolds number, Mach number, Schmidt number would be assessed.

M.4.11. Position 11

Code - Au22_PhD_MMAE_T7

Broad domain of research – Thermal and Fluids

Eligible social category to apply – **GEN, GEN (EWS)**

Fee – **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Good mathematical/analytical and experimental skill is desirable. Prior knowledge of computational fluid dynamics and programming skill in C & Bash will be an added

advantage.

Topic: Experimental and numerical investigations of fluid-solid interactions

Brief Description

The work is related to the recent work from the group [Experimental insights on the water entry of hydrophobic sphere, Physics of Fluids 33, 102109 (2021); <https://doi.org/10.1063/5.0063040>]. For recording of the physical phenomena, a high-speed camera is to be used. The simulations are expected to be carried out using an immersed moving boundary method coupled with a discrete element - lattice Boltzmann method. The accuracy of the method is to be established using various experimental test cases and data from the literature, e.g. single-particle sedimentation, drafting-kissing-tumbling and multi-particle sedimentation.

M.4.12. Position 12

Code - Au22_PhD_MMAE_D1

Broad domain of research – Design and 3D modeling

Eligible social category to apply – **OBC (NC), SC, ST**

Fee – **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (*presently Stipend Rs. 31000/- ; additional HRA applicable if staying outside campus; it may vary as per the policy applicable from time to time)

Duration of funding - 5 years

Details - Good mathematical and programming skills is desirable. Prior knowledge of Data structures and algorithms will be an added advantage.

Topic: Biomechanical Analysis and Biomedical device design

Brief Description

Techniques leveraging the artificial intelligence (AI) methods especially in using computer vision to create high fidelity 3D geometrical models of the complex anatomical shapes and design of biomedical devices will be explored. This work may use the sophisticated non-linear computational mechanics simulations to optimize design and performance of biomedical devices as well the interesting and intriguing mysteries of tissue growth and homeostasis. The research work will broadly have the core theme of developing physics-informed AI techniques to model the life sciences. The research work is expected to be based on Non-linear solid mechanics foundations and simultaneously it will blend the algorithmic aspects typically relevant in the computational geometry and computer graphics, especially to ensure geometrical accuracy in the models.

M.4.13. Position 13

Code - Au22_PhD_MMAE_TiH_FarmProduce / Au22_PhD_EE_TiH_FarmProduce

Broad domain of research – Computer Vision, AI in Agriculture, 3D modeling

Eligible social category to apply – **Open to all**

Fee – **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – PA (Rs. 36000/- ; additional HRA applicable if staying outside the campus; it may vary as per the policy applicable from time to time)

Duration of funding - 36 months maximum

Details - This research would need interdisciplinary skill sets - specifically computational geometry, image processing, and computer vision. Candidates should be interested in algorithmic thinking and coding skills across various platforms. This project will also involve instrumentation work and field visits for conducting surveys and field testing to ensure that the project remains relevant for the various stakeholders. Prior relevant experience in industry or productization will be valuable.

Project Title: Grading of farm produce quality using computer vision and machine learning

The project will focus on applied research to translate computer vision and machine learning techniques for classification of the farm produce. Major focus will be on the assessment of various techniques to capture the scene appropriately and algorithms to efficiently and effectively provide automated inferences using low cost hardware. This project is funded by IIT Dharwad SPOKE for the BITS BioCyTiH Foundation.

M.5. Syllabus – Common for all streams

M.5.1. Engineering Mathematics

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.

Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.

Differential equations: First Order Equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.

Complex variables: Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

M.5.2. Analytical reasoning

Verbal reasoning: reading comprehension, drawing inferences based on multiple facts stated in short paragraphs.

Non-verbal reasoning: inductive, logical, abstract, diagrammatic and spatial reasoning.

M.6. Syllabus – Specific to the selected stream

M.6.1. Design Stream

Engineering Graphics: Orthographic projections of lines, planes and solids, true length and true angle, sections of solids and intersections of solids, solid modeling.

Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.

Mechanics of Materials: Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing

of reciprocating and rotating masses; gyroscope. Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.

Control Systems: Automatic Control, Use of Feedback, Automatic Assembly and Robots, Mechatronic Systems, Control System Design.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

M.6.2. Fluid-Thermal Stream

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes and bends, flow in convergent-divergent channels, vorticity and stream-functions, elementary Computational Fluid Dynamics, finite-difference approximation to the first and second order partial derivatives.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors radiation network analysis.

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

Applications Power Engineering: Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.

M.6.3. Manufacturing and Materials Stream

Engineering Materials: Structure and properties of engineering materials, Crystal Imperfections, phase diagrams, heat treatment, stress-strain diagrams for engineering materials. Dislocation theory, Strengthening mechanisms, fracture mechanics, fractography, ductile to brittle transition. Fatigue, Mechanisms of high temperature deformation and failure, X-ray Diffraction,

Metal Forming: Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes, Plastic deformation by slip and twinning.

Sheet Metal working: Die and punch clearances, blanking, piercing, punching, bending, cup drawing, coining, embossing, incremental forming.

Metal Casting: Different types of castings, solidification and cooling, Pattern materials, allowances, types of pattern, cores, element of gating systems, types of gates, riser design considerations, casting defects.

Polymers and Composites: Thermoplastics, thermosets, elastomers and composites, gradient material and related processes.

Computer Integrated Manufacturing: Basic concepts of CAD/CAM and their integration tools, tool path generation, additive manufacturing.

N. DEPARTMENT OF PHYSICS

N.1. Eligibility for Admission

N.1.1. Qualifying Degree

- M. Sc. or equivalent degree in Physics/Applied Physics/Photonics.
- B. Tech. / B. E. or equivalent degree in Engineering Physics/Electrical Engineering/ Electronics and Communications Engineering/Optics/Optoelectronics.
- M. Tech. / MS in Remote Sensing/Geoinformatics/Optics/Optoelectronics/Photonics/ Engineering Physics/Electrical Engineering.
- M. Phil in Physics.
- The candidates who do not have M. Tech. / M. Phil. degree must also fulfill ONE of the following additional requirements:
- Valid GATE Score in Physics.
- Valid Junior Research Fellowship (JRF) of CSIR/UGC/DST INSPIRE or any other funding agencies in Physical Sciences.

N.1.2. Minimum score in the qualifying degree

1. For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree is First Class, as specified by the candidate's Institution/University. If the Institution/University does not specify the division/class, then one of the following will be considered as the eligibility criteria:
 - a minimum of 60% marks (without round off) in aggregate. (OR)
 - a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).
2. For SC/ST/PwD category candidates, a relaxation of 5% in the qualifying degree is applicable.

N.2. Selection Process

N.2.1. Application Categories

The Department of Physics admits Ph.D. candidates under the full time research scholarship - Teaching Assistantship (TA) and Fellowship Award (FA).

N.2.2. Guidelines for shortlisted candidates

For both TA and FA categories, based on the information provided by the applicants, a short-list of candidates for the selection process will be prepared. The list will be declared on the Institute website on the date specified in the schedule. Only the short-listed candidates are permitted to participate in the selection process.

N.2.3. Interview

Only the eligible applicants are permitted to participate in the selection process. The department will conduct two rounds of online interviews for shortlisted candidates. The first round of online interview is compulsory for all shortlisted candidates. If the department finds any candidate(s) suitable, then they may conduct a second round of interview for the

candidate(s) found suitable in the first round of interview. The date and time for the interview will be notified to the shortlisted candidate(s) by email. Applicants are advised to check the website regularly from time to time.

N.2.4. Syllabus

1. **Quantum Mechanics-** Wave-particle duality, Uncertainty Principle, Schrodinger's equation, Simple Problems in One Dimension, Harmonic Oscillators, Hydrogen Atom, Ladder Operators. Angular Momentum Operators, Addition of Angular Momentum, Time-independent perturbation theory and applications, Variational method, Time-dependent perturbation theory and Fermi's golden rule, Identical particles, Pauli exclusion principle, spin-statistics connection.
2. **Mathematical Physics-** Linear Vector space, Scalar product, Metric spaces, Linear operator, Matrix algebra, Eigenvalues and Eigenvector, Complex analysis - Complex numbers, Analytic function, Taylor and Laurent series, Special functions (Hermite, Bessel, Laguerre and Legendre functions). Fourier series, Fourier and Laplace transforms.
3. **Classical Mechanics-** Phase space dynamics, stability analysis, Central force motions, Rigid body dynamics, moment of inertia tensor, Non-inertial frames and pseudoforces, Variational principle, Generalized coordinates, Lagrangian and Hamiltonian formalism and equations of motion. Conservation laws and cyclic coordinates, Periodic motion: small oscillations, normal modes. Special theory of relativity Lorentz transformations, relativistic kinematics and mass-energy equivalence.
4. **Electromagnetic Theory-** Electrostatics- Gauss's law and its applications, Scalar potential, Electrostatic potential energy, Multipole expansion, Conducting matter, Dielectric Matter. Boundary Value Problems, Solution of Laplace's equation: Potential theory, Uniqueness, Separation of Variables in different coordinate systems, Solution of Poisson's equation using Green's function, Method of Images. Magnetostatics, Steady currents, Biot-Savart law, Ampere law, Magnetic vector potential, Magnetic multipoles, Electrodynamics Dynamic and Quasi-static fields General EM Fields Waves in vacuum and dispersive media, Special Theory of Relativity- Galilean relativity, Einstein's relativity, Lorentz transformation Four-vectors, Relativistic Kinematics Electromagnetic quantities and Covariant Electrodynamics.
5. **Thermodynamics and Statistical Physics-** Zeroth law, First law, Second law, Carnot cycle, Clausius theorem, reversible work and heat transfer. Thermodynamic potentials, Maxwell relations, chemical potential, phase equilibria. Phase-space, micro- and macro- states. Micro-canonical, canonical and grand-canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Classical and quantum statistics. Blackbody radiation and Planck's distribution law.
6. **Electronics-** Semiconductor basics, diodes, transistors, transistor models, biasing, amplifiers (CE, CC, Swamped), Darlington pairs, difference amplifiers, operational amplifiers, feedback, instrumentation amplifier, filters, JFETs and MOSFETs, Digital electronics: Logic gates, Boolean algebra, Karnaugh maps, flip flops, shift registers, adders, counters, ADC and DAC.
7. **Condensed Matter Physics-** Crystal structures, reciprocal lattice, X-ray and electron diffraction. Lattice vibrations, Einstein and Debye models, phonons. Drude and Sommerfeld models. Bloch theorem, Empty lattice and nearly free electron model, tight-binding model, Density of states and Fermi surfaces. Semi classical model of electron dynamics. Concept of

Effective mass.

8. **Nuclear Physics-** Basic properties of nuclei and interactions, Nuclear binding energy, Nuclear moments, Nuclear models- independent particle model, shell model, Deuteron problem, Central and tensor forces, Radioactive decay-theory of alpha decay, Fermi theory of beta decay, gamma decay, Nuclear reactions- direct and compound reactions, Elementary particles- classification, symmetries and conserved quantum numbers, quark model.
9. **Atomic and Molecular Physics-** One-electron atom: Schrodinger equation, energy levels, interaction with electromagnetic fields, transition rates, density of states, dipole approximation, Zeeman and Stark effects; Multi-electron atoms: Helium atom, central field approximation, Thomas-Fermi model of the atom, Hartree-Fock method, L-S and J-J coupling, interaction with external fields; Molecular structure: Born-Oppenheimer approximation, Electronic structure of molecules, Hydrogen molecule ion, Approximate molecular orbital (MO) theory, homo and hetero-nuclear diatomic molecules, electronic term symbols, valence bond (VB) theory of diatomic molecules, comparison of VB and MO theories; Molecular spectra: Rotational, Vibrational and Electronic spectra.
10. **Optics-** Matrix formulation for lens, mirrors and combinations, image formation, brief introduction to primary monochromatic aberrations and chromatic aberrations, Fresnel and Fraunhofer diffraction, Two and Multiple beam interference, Michelson and Fabry-Perot interferometer, line width and coherence, multilayer thin films as antireflection coatings, Linear and elliptically polarized light, polarisers and retarders; birefringence, anisotropic media, principles of magneto-optics, electro-optics and acousto-optics.

N.3. Focus area of research

Ph. D. positions in the following four research areas are available in the Department of Physics during the Autumn 2022 semester. Applicants have to choose at least one of these topics and mention those in application form with appropriate order of preference under the relevant question.

Position 1

Code – 2022A_PhD_Phys_01

Broad domain of research – Quantum Information Theory

Eligible social category to apply –FA - All categories

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – FA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Position 2

Code – 2022A_PhD_Phys_02

Broad domain of research – Quantum Information Theory

Eligible social category to apply –TA –

SC/ST/PWD/EWS categories

Fee – refer section **FEES, DEPOSITS & HOSTEL RENT**

Type of funding support – TA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Details for Position 01 and Position 02- Candidates applying for these positions should be highly motivated to perform theoretical research in topics related to foundations of quantum

mechanics, quantum optics, many body physics, relativity and at their interfaces. There is a scope to work in topics related to quantum computation and quantum communications. Familiarity in the field of quantum information and quantum computation is desired. The candidate having adequate knowledge to execute higher level computational programs using any one of the standard programming languages may also be desired.

This position involves theoretical studies related to quantum information and its interface with relativistic quantum theory. Also, there is a scope to execute quantum computation and quantum communication related works.

Topic-Quantum information theory; its interface with quantum optics, relativity, and many body physics; Quantum Communication; Quantum Computation.

Position 3

Code – 2022A_PhD_Phys_03

Broad domain of research – Lasers, Nonlinear Optics & Photonics

Eligible social category to apply – for FA - All categories; For TA - Gen, OBC, SC, and EWS

Fee – refer section [FEES, DEPOSITS & HOSTEL RENT](#)

Type of funding support – FA/TA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Position 4

Code – 2022A_PhD_Phys_04

Broad domain of research – Lasers, Nonlinear Optics & Photonics

Eligible social category to apply – for FA - All categories; For TA - Gen, OBC, SC, and EWS

Fee – refer section [FEES, DEPOSITS & HOSTEL RENT](#)

Type of funding support – FA/TA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Details for position 03 and 04- The research work would primarily involve experimental work in the field of lasers and nonlinear optics, with the focus on experimental design/development/characterization of nonlinear frequency conversion/optical parametric oscillators/optical devices/optical materials, together with theoretical modelling and simulations. Collaborative work may require national travels. The candidate should be highly motivated to work in the described area. Some experimental working experience together with computer simulation skills, MATLAB programming, graphing and analysis (Origin) abilities are desirable.

Topic- Lasers, Nonlinear Optics & Photonics

- Experimental design/development/characterization of coherent light sources/optical devices based on nonlinear crystals in unprecedented wavelength regimes.
- Photo-physical response and investigation of various nonlinear materials.
- Frequency Combs- Fundamental studies in optical parametric oscillators for the generation of optical frequency combs for medical applications.

Position 5

Code – 2022A_PhD_Phys_05

Broad domain of research – Experimental Condensed Matter Physics

Eligible social category to apply – for FA - All categories; for TA - Gen, OBC, SC, and EWS

Fee – refer section [FEES, DEPOSITS & HOSTEL RENT](#)

Type of funding support – FA/TA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Details- Candidates should be motivated to work in the area of experimental Condensed Matter Physics. They should have adequate knowledge in the topics- Superconductivity and Magnetism. The research work will involve study of some interesting properties related to the superconductors and permanent magnets. Candidates should also be interested in the synthesis of single crystals and polycrystals of the superconductors/permanent magnets. The experimental work will involve structural, magnetic and transport characterization of these materials.

Topic- Experimental Condensed Matter Physics

- Superconductivity- Study of vortex dynamics, vortex phase transitions and phase diagrams in the single crystals of a variety of superconductors.
- Magnetism- Magnetic anisotropy, torque magnetometry studies in some rare- earth transition metal based permanent magnets. Study of magnetic anisotropy in rare-earth free magnets.
- Single crystal growth- Crystal growth of superconducting materials, rare-earth transition metal based permanent magnets and rare-earth free magnets.

Position 6

Code – 2022A_PhD_Phys_06

Broad domain of research – Spectroscopy and Remote Sensing

Eligible social category to apply – for FA - All categories; for TA - Gen, OBC, SC, and EWS

Fee – FEES, DEPOSITS & HOSTEL RENT

Type of funding support – FA/TA (Please find the funding related details in Section B)

Duration of funding - Please find the funding related details in Section B

Details- Candidates should be highly motivated to work in the area of experimental and applied Physics particularly in the domain of Spectroscopy with applications in Remote Sensing. Knowledge in Atomic and Molecular Physics and Spectroscopy will be necessary. Some exposure to Remote Sensing is desirable. The research work will involve investigations of various terrestrial parameters employing Spectroscopic and Remote Sensing techniques. The work will require satellite data processing and analysis along with simulations; hence, some knowledge of executing computational programs is desirable. The candidate is also expected to get involved in field data collection and analysis.

Topic- Spectroscopy and Remote Sensing

Study of various terrestrial parameters using:

- Remote Sensing: Study of optical (hyperspectral and multispectral) and microwave (Synthetic Aperture Radar) remote sensing data.
- Spectroscopy: Application of absorption and reflection spectroscopic techniques

O. Appendix A: Sponsorship Certificate for Ph.D. External Registration (EX)

(To be typed on letterhead of the Sponsoring Organization)

Name of the applicant:

Name of the sponsoring organization:

Address:

Present Designation of the applicant:

Present status of the applicant: (Permanent/Semi-permanent/Temporary)

Division where research work is proposed to be done:

Name of supervisor from the sponsoring organization:

(Bio-data of supervisor to be enclosed giving details of designation, qualification, research experience etc.)

Details of facilities relevant to the research problem which will be made available to the candidate by the organization.

Statement of proposed Co-supervisor (external)

If Shri / Kum. / Smt. _____

is registered for the doctorate degree, I, _____

, agree to act as his/ her research Co-supervisor along with the research Supervisor from IIT Dharwad.

Date:

Signature of proposed Co-supervisor (external)

=====*****=====

Statement of sponsoring authority

If Shri. /Kum. / Smt. _____

is admitted to the Ph.D. programme, we shall allow him/ her to undergo the programme of studies at IIT Dharwad.

Further, we shall fully relieve him/her from normal duties to complete the course work requirement (and qualifier examination, if applicable) at IIT Dharwad.

During the period of Doctoral programme, the candidate will be permitted to carry out his / her research work at our laboratories / organization and will be given the required facilities.

We also give our consent to Shri. /Kum. / Smt./Dr. _____

of our organization to be the Co-supervisor (external) of the Ph.D. thesis, along with a faculty member of IIT Dharwad as the Supervisor.

Date:

Signature and Seal of the Sponsoring Authority

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