Indian Institute of Technology Dharwad

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Information Brochure

Ph.D. Admissions

(For Indian Nationals)

Autumn Semester 2023-24

Version 1.1

Contents

A. SCHEDULE OF Ph.D. ADMISSION

Sr. No.	Description	Relevant dates*
1.	Applications open	29th March 2023
2.	Last Date to apply online	30th April 2023
3.	Announcement of shortlist of eligible candidates	3rd May 2023
4.	Interview Schedule	8th May 2023 to 4th June 2023
5.	Declaration of provisional list of selected & waitlisted candidates	16th June 2023
6.	Admission process for recommended candidates	17th June 2023 to 25th June 2023
7.	Admission for waitlisted candidates	26th June 2023 onwards

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

All potential candidates are requested to keep visiting the institute website regularly for updated information about the admission process. **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 defence, 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 of8 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 and research performance.
4. As per MoE directives, the employees on the rolls (with or without pay) of anyorganization 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.
6. The reservation to various social categories is applicable as per the Govt. of India norms.

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 visionof 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 technologydegrees. 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 researchbased 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 toregister 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 (AppendixA) 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 calledfor 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 shouldbe 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. This information brochure and future updates regarding the admission process will bemade

available on the institute website under section Academics >> Admissions >> Ph.D.

5. 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.
6. The application fee is as follows: Please visit the link given below and choose "Application Fee (M.Tech/MS/PhD)", fill all the particulars and chose an amount based on your social category. **Please submit and note down the transaction reference number to be mentioned in the application form as well as for future reference.**

State Bank Collect (onlinesbi.sbi)

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

7. **The Application Form without valid online payment details will not be considered. Application FEE once paid is Non-Refundable.**
8. 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.
9. 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.
10. **Keeping checking the institute website and your emails regularly for any communication from the institute regarding the selection process. It is candidate's responsibility to be aware about the schedule of various events related to the admission process.**
11. The Shortlisted candidates' list will be uploaded on the institute website as per the schedule given above in Section A.
12. Candidates (if) called for written test / interview should bring with them Photo ID Card, PrintedCopy 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 relevantdocuments.
13. **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 availablefacilities
Hostel Room Allocation(on sharing basis)	You will be allotted a room in the hostel & the room key will behanded 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 forthese items.
Possession of motorized vehicle	NOT ALLOWED, however bicycles are permitted in thecampus.
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 tentative fee applicable for admission to PhD programme for Autumn 2023-24 is provided below for reference purpose. **The actual fee to be paid will be made available at the time of declaration of final results.**

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
8.	Convocation Fee	3000.00	3000.00
9.	Alumni Fee	1000.00	1000.00
Sub-Total (A)		**13,600.00**	**13,600.00**
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	5,000.00	5,000.00
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)		**20,800.00**	**18,300.00**
***11.**	**Mess Fee Advance**	**24,500.00**	**24,500.00**
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)		**61,900.00**	**59,400.00**

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
8.	Convocation Fee	3000.00	3000.00
9.	Alumni Fee	1000.00	1000.00
Sub-Total (A)		**13,600.00**	**13,600.00**
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	5,000.00	5,000.00
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)		**43,300.00**	**18,300.00**
***11.**	**Mess Fee Advance**	**24,500.00**	**24,500.00**
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)		**84,400.00**	**59,400.00**

Note:

- All the SC/ST/Divyangjan students are exempted from payment of Tuition fee.
- *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.
- ^IIT Dharwad reserves the right to revise the Tuition Fee-Statutory Fee (infuture).

F. DEPARTMENT OF BIOLOGICAL SCIENCES AND BIOENGINEERING

F.1 ELIGIBILITY FOR ADMISSION

F.1.1 Qualifying Degree

- **MTech/M.Sc.** or equivalent in Bioinformatics/ Chemistry/Biotechnology/Microbiology/life-sciences or other allied biology subjects.
- M.Sc. students must have qualified GATE for TA category.
- MTech. students are exempted from GATE qualification for TA category.
- Junior Research Fellowship (JRF) of CSIR/UGC/DST INSPIRE/DBT/MHRD/ICMR or any other relevant funding agencies is mandatory for FA category.

Mere fulfilling the eligibility criterion does not guarantee shortlisting or final selection.

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 (MTech. /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 2023-24 semester of IIT Dharwad are also eligible to apply. However, if offered, 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 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 an offline interview process. All the eligible candidates will be called for onsite interview/s at BSBE Department IIT Dharwad. For the syllabus, please refer to the section below.

F.3 SYLLABUS

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

Bioinformatics: Statistics, Descriptive statistics, Correlation and regression, basic machine learning, Hypothesis Testing, Probability theory,

Biophysics: 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 Focus area of research

1.Cancer biology
2.Metabolomics using Raman spectroscopy.

F.5.1 Teaching Assistantship (TA)

In this call, applications are invited under TA category only for research area number 2.

F.5.2 Fellowship Awardee (FA)

In this call, applications are invited under FA category for research areas number 1 and 2.

G. DEPARTMENT OF CHEMICAL ENGINEERING

G.1. ELIGIBILITY FOR ADMISSION

G.1.1 Qualifying Degree

M.Tech./M.E./M.Sc.(Engg.) or equivalent degree in Chemical Engineering or any related stream.

G.1.2 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) OR Candidate must have at least one SCI indexed journal publication as a first/second author.

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 must qualify in GATE at least once (Candidate need not to have a valid GATE score) OR Candidate must have at least one SCI indexed journal publication as a first/second author.

G.1.3 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 2023-24 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 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.

G.2. Modality of selection process

Our PhD selection process is highly competitive and involves two rounds of interviews. Only eligible applicants will be permitted to participate in the selection process, which is designed to evaluate the applicant's research potential, academic background, and motivation for pursuing a PhD in Chemical Engineering. The first round of the interview process will be conducted in online mode and will consist of a detailed discussion on the applicant's research interests and academic background. This round is aimed at evaluating the applicant's research potential and identifying candidates who have a strong foundation in the field of chemical engineering based on fundamental questions from GATE syllabus. The second round of the interview process will be conducted in-person at IIT Dharwad and will provide shortlisted candidates with the opportunity to interact with our faculty members, tour of IIT Dharwad, and gain an in-depth understanding of our research programs. This round is designed to assess the applicant's research skills, scientific reasoning, and suitability for our PhD program.

G.3. Focus area of research

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

The broad areas of research will be in the following fields: Our PhD program is aimed at developing the next generation of innovators and leaders in the field of chemical engineering. We encourage all eligible applicants to apply for our program and look forward to welcoming the most promising candidates to our department.

1. Multiphase flows: Computational Fluid Dynamics (CFD), Gasification, Microfluidics, Slurry transport, Modeling and simulation, and Droplet/bubble dynamics
2. Molecular modeling and simulation of macromolecules to accelerate healthcare innovation.
3. Development of novel electrolyte materials for use in clean and renewable energy technologies
4. Understanding of transport barriers in next generation nano-bio materials

G.4. First round interview Instructions:

If you have been shortlisted for the first round of the interview process, you will be invited to participate in an online interview. The online interview will be conducted via Google Meet, and you will receive detailed instructions and a link to access the interview prior to the scheduled date. Here are some important guidelines to follow during the online interview:

1. Technical requirements: Make sure you have a reliable internet connection and a functioning webcam and microphone on your computer or device. You should also test your equipment and internet connection in advance to ensure that they are working properly.
2. Log in to the video conferencing software at least 10 minutes prior to the scheduled interview time.
3. During the interview, speak clearly, maintain good eye contact, and be professional in your demeanor. Remember to listen carefully to the interviewer's questions and respond thoughtfully.
4. Find a quiet and distraction-free space for the interview to avoid windy noisy. Turn off any notifications on your phone or computer to minimize disruptions.
5. Ensure that equipment is charged to avoid power issues.
6. 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.

H. DEPARTMENT OF CHEMISTRY

H.1. Eligibility for Admission

H.1.1. Qualifying Degree

M.Sc. or equivalent degree in any area of Chemistry 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**)
- **Junior Research Fellowship** (JRF) of CSIR/UGC/DST INSPIRE/DBT/MHRD/ICMR or any other relevant funding agencies (**for FA category**)

H.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).

For SC/ST/PwD category candidates, a relaxation of 5% in the qualifying degree is applicable.

H.2. Modality of the Selection Process

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

The selection process comprises two rounds of interviews.

(1) Online interview

(2) Offline interview for those who are shortlisted in the online interview

H.3. Syllabus

- Organic Chemistry
  Recommended textbooks: J. Clayden, N. Greeves, S. Warren
- Inorganic Chemistry
  Recommended textbooks: J. E. Huheey, E. A. Keiter, R. L. Keiter
- Physical Chemistry
  Recommended textbooks: Atkins' Physical Chemistry
- Spectroscopy
  Recommended textbooks: C. N. Banwell and D. L. Pavia

H.4. Focus area of research

The broad areas of research will include organic chemistry, biochemistry, and chemical biology, organometallic chemistry, materials chemistry and computational chemistry. Students will have

exposure to different interdisciplinary areas of chemistry, protein biochemistry and material science. 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 research areas.

1. **Functional π-conjugated compounds:** The π-conjugated compounds (oligomers, one-dimensional and two-dimensional polymers) are of great importance in semiconducting applications because electron delocalization along the π-conjugated backbone gives rise to interesting electronic and optical properties. Thus, the π-conjugated compounds have been well explored for various applications in molecular electronics such as organic field effect transistors (OFETs), Organic light emitting diodes (OLEDs), solar cells, fluorescent/resistive sensing and photocatalysis. Thus, our group is interested in developing new π-conjugated organic compounds using novel synthetic routes and exploring their applications in organic materials with a particular interest in fluorescent sensing and photocatalytic applications for organic transformations and hydrogen evolution.
2. **Bio-organic Chemistry and Chemical Biology:**

   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. Our area of research involves studying the organic chemistry of enzymes involved in the synthesis of biologically active compounds (anticancer, antibacterial, antifungal etc.). Some natural products that we focus in the lab are ribosomally synthesized and post-translationally modified (RiPP) peptide natural products, non-ribosomal natural products and nucleoside based compounds. All these have impressive antibacterial properties to combat antibiotic resistance, a global health threat nowadays. We study the chemistry of the enzyme mechanisms (such as C-H activation, C-C bond formation, molecular rearrangement, amide bond activation, peptide bond formation etc.) involved in synthesizing these natural products. We employ interdisciplinary techniques from chemistry (synthetic organic chemistry, physical organic chemistry, spectroscopic techniques, inorganic chemistry, and anaerobic techniques), biochemistry/chemical biology, protein chemistry, molecular biology, and microbiology during these studies. Suitable collaborations (such as for protein crystallography, complex organic synthesis, EPR techniques, proteomics, and synthetic biology etc.) will be initiated to gain insights into the molecular details of these enzymatic 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 for drug design. Students will get exposure to synthesis, biochemistry, molecular biology, and various spectroscopic techniques.

3. **Surface Organometallic Chemistry***:* Organometallic complexes are widely known for their reactivity in coupling reactions, dehydrogenations, C-H or C-X (X= N, O, Cl, Br, F) activations, transfer hydrogenations, metathesis, polymerization, Michael addition etc. Most of the industrial processes comprise heterogeneous catalysts. The surface organometallic chemistry unifies the benefits of homogeneous and heterogeneous catalysis. The most common approach is immobilization of molecular complexes on support. The advantages offered by immobilization are ease of separation and recyclability can be privilege for a chemical reaction. These integrated systems will be made in a way that can be applied to reactions which are difficult to achieve otherwise e.g., conversion of renewable raw materials CO_2, CO, H_2, N_2 into value added chemicals and biomass valorization among others through thermal or photochemical activations.

4. **Computational Chemistry:** We employ density functional theory (DFT) based computational techniques to study various problems in chemistry and material science. Our current research interests are designing electrocatalysts for nitrogen reduction reactions to ammonia. In this project, we will be employing high-throughput based calculations in conjunction with molecular dynamics simulations for rational catalysts design. We are also interested in studying the covalent organic frameworks based organic electrodes for alkali ion batteries using computational methods.

I. DEPARTMENT OF CIVIL ENGINEERING

I.1 Qualifying Degree

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

I.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 (MTech. /M.E.):

- 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).
- Candidate must qualify in GATE at least once (Candidate need not to have a valid GATE score) OR Candidate must have at least one SCI indexed journal publication as a first/second author.

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 must qualify in GATE at least once (Candidate need not to have a valid GATE score) OR Candidate must have at least one SCI indexed journal publication as a first/second author.

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 2023 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 consideringupdated 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 Ashould 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 shortlisted candidates will be called for interview by the respective panel based on the research area preference mentioned in the admission form. The selectionprocess would involve two rounds (online mode).
Round 1: Candidates must make a presentation of their own research work for 10 minutes duration. Instructions: (a) The First slide must contain candidates' brief biodata. (b) The last slide must contain a prospective Ph.D. research problem statement.
Round 2: Round 1 selected candidates will be called for a technical interview. The technical interview will be based on the Civil Engineering GATE equivalent syllabus.
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

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, Concrete Pavement, Sustainable Road Material.

Environmental Engineering: Water, industrial, and wastewater treatment, solid waste management, composting, life cycle assessment (LCA), Environmental impact assessment (EIA), Affordable electrochemical reactors development, electrochemical, and advanced oxidation techniques, nonthermal plasma techniques.

I.4. Teaching Assistantship (TA)

The positions mentioned below are available for Gen, OBC-NCL, SC, ST and PwD categories.

I.4.1. Position 1

Code – AU23_Civil_PhD_TA1
Broad domain of research – Geotechnical Engineering

I.4.2. Position 2

Code – AU23_Civil_PhD_TA2
Broad domain of research – Pavement Engineering

I.4.3. Position 3

Code – AU23_Civil_PhD_TA3
Broad domain of research – Environmental Engineering

I.4.4. Position 4

Code – AU23_Civil_PhD_TA4
Broad domain of research – Geotechnical Engineering

I.5. Project Assistantship (PA)

I.5.1. Position 1

Code – AU23_Civil_PhD_PA1
Broad domain of research – Geotechnical Engineering
Eligible social category to apply for PA position: - Open to all categories
Type of funding support – PA (*presently Stipend Rs. 31000/-; additional HRA applicable for stay outside campus; it may vary as per the policy applicable from time to time)
Topic: Use of Industrial By-Products in Railway Geo-technics.

I.6. Externally Sponsored (EX)

In this call, applications are invited under EX category for all research areas mentioned above. The candidates will be shortlisted as per the rules mentioned in B.4 section and I.1 Section.

J. DEPARTMENT OF COMPUTER SCIENCE AND ENGG.

J.1. Qualifying Degree

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

J.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.):

- 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).

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.1.2 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 2023-24 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.

J.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 (online) by the respective panel based on the research area preference mentioned in the admission form. The candidates are encouraged to check the Institute website https://www.iitdh.ac.in/academics_phd.php from time to time. Selection committee decisions are final in all matters including any disciplinary matters/malpractice.

J.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, Natural Language 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 robustness of Advanced driver assistance systems (ADAS), Modeling and characterization of heterogeneous processors, Runtime Verification of Hardware and Efficient Computer Architectures
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.

J.4. Teaching Assistantship (TA)

In this call, applications are invited under TA category only for research areas (1)-(4). The applicant may be asked to indicate the choice of the research topics in the order of preference.

J.5. Externally Sponsored (EX)

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

J.6 Project Assistantship (PA)

Code: AU2023_CSE_01
Title: Multimicrophone processing for sound source localization and tracking in robot applications
Description: This project involves development of signal processing, artificial intelligence and deep learning-based algorithms for sound source localization and tracking
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

Code: AU2023_CSE_02
Title: Development of Standalone Speech to Speech Translator for Indian Languages
Description: This project involves development of artificial intelligence and deep learning-based systems (speech recognition, machine translation, text to speech and speech to speech translation) for selected Indian languages.
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.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.

K. DEPARTMENT OF ELECTRICAL ENGINEERING

K.1. Eligibility Criterion

K.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.

K.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.

K.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 2023-24 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.

K.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: **The PA, EX, and FA category vacancies are open to all social categories.**

K.2. Guidelines for Shortlisted Candidates

K.2.1. Selection Process

All the eligible candidates are invited for the first round of interviews via video conferencing. After the first-round interviews, a shortlist will be announced for the second round of interviews. The shortlisted candidates will be asked to attend the second round of interview. **Note that the second round of interviews will be offline and the candidates must report to the institute for the same**. Institute will provide accommodation for the second round with nominal charges. Syllabus for the interview is given in Section K.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.

K.3. Research Areas

K.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 etc.

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

3. **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.

4. **Signal Processing and Machine Learning :** Machine learning for signal processing, Deep Learning for signal processing, speech and natural language processing, biomedical signal and image processing and optical character recognition, handwriting recognition and document processing, bioinformatics.

5. **Power & Energy Systems:** (a) Power systems: Power Systems 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;
   (b) Power Electronics and Drives: Converters for grid-interfacing, modular and multi-level inverters, power converters for Electric Vehicles (Chargers, Drivetrains, Power Supplies); DC Circuit Breakers for medium-voltage applications (renewables, aircraft, shipboard, etc.), Design of Wide-bandgap device based converters (GaN and SiC based topologies); Modeling and Controls for Advanced Power Electronics (soft-switched and resonant converters, distributed control, etc)

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

K.3.2 For PA category applications are called in following broad domains

1. Microelectronics and VLSI
2. Power and energy systems
3. Communications
4. Signal processing and Machine learning

K.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: 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 3: 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.

L. DEPARTMENT OF HUMANITIES AND SOCIAL SCIENCES

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

L.1 Eligibility for Admission

L.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 **(Philosophy)**

1. M.A. in Philosophy
2. UGC-NET/GATE Qualified or M.Phil. in Philosophy
   UGC-NET/JRF Qualified Candidates are encouraged to apply
3. Candidates who do not have UGC-NET or M.Phil. are also eligible to apply, provided they have minimum of 2 years of professional experience (acquired after obtaining the qualifying degree (M.A. Philosophy)).

L.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.

L.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 2023-24 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.

L.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.

L.3 Focus Area of Research

Economics: International Finance, Open Economy Macroeconomics, Monetary Economics, Applied Econometrics, and International Trade.
Broad Domain of Research – International Finance, Open Economy Macroeconomics, Monetary Economics, Applied Econometrics, and International Trade.
Eligible Social Category to Apply for TA Positions – GEN/OBC(NCL)/SC/ST/PwD only.
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

Philosophy: Analytic Philosophy

Broad Domain of Research –
Ethics: AI and Ethics, Ethics of Technology
Metaphysics: Modality, Philosophical Logic, Ontology
Eligible Social Category to Apply for TA Positions –Gen/SC/ST/PwD.
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

L.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:

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

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

History of Philosophy

- Rationalism of Descartes, Spinoza and Leibniz
  Empiricism of Locke, Hume and Berkeley.

Analytic philosophy

Exposure to the works of the following early analytic philosophers is required.

- Bertrand Russell: **Logical Atomism and** Theory of Descriptions
  Ludwig Wittgenstein: Language and Reality, Theory of Meaning
  W V O Quine
  Ontology and Metaontology

Branches of Philosophy

a. Ethics: Trolley Problem and Normative Ethics, Utilitarianism, Immanuel Kant's Deontology and Virtue Ethics
b. Epistemology: Traditional analysis of knowledge (Justified True Belief Account (JTB)), Edmund Gettier's Counterexamples to JTB account and The problem of Skepticism.
c. Metaphysics: Causality, Freewill, Modality and Universals & Particulars
d. Logic: Basics of First Order Sentential/Propositional Logic

M. DEPARTMENT OF MATHEMATICS

M.1 Eligibility Criteria

M.1.A Qualifying degree

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

M.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 (recognized by GOI). 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 (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).
OBC (NCL)	Same as general
SC/ST/PWD	A relaxation of 5% in the qualifying degree is applicable

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

1. Valid GATE score.
2. 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.

M.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 2023-24 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 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.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).

M.2 Guidelines for shortlisted applicants

M.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.

M.3 Research Topics

Numerical Analysis & Scientific Computation

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

Algebra

Fundamental theorem of arithmetic, divisibility in 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 numerical analysis is expected to have some knowledge in some of the following topics:

1. Numerical methods (Interpolation, Quadrature formula, Numerical solution of ODEs)
2. Basic ideas of Ordinary Differential Equations and Partial Differential Equations
3. Knowledge in Numerical Linear Algebra is desirable but not mandatory

M.5 Focus area of research

Numerical Analysis and Scientific Computation is the research area floated in the Department of MATHEMATICS for the PhD program this semester.

N. DEPARTMENT OF MECHANICAL, MATERIALS AND AEROSPACE ENGINEERING

N.1 Eligibility for Admission

N.1.1. Qualifying Degree

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

N.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 requirementswhen 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.

N.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 2023-24 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.

N.1.4 Institute Staff

The institute staffs can apply for the PhD if they fulfil the eligibility criteria. It is mandatory to follow the institute's guidelines while applying.

N.2. Guidelines for The Shortlisted Applicants

Based on the information provided by the applicants a short-list of candidates called for the selection process 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. The following are the important guidelines of the institute to be followed by the shortlisted applicants on the day(s) of selection process

1. Shortlisted applicants should report to the institute on 22nd of May, 2023 at 8.00 am. Interviews might extend to next day, candidates should plan their travel accordingly.
2. Based on the availability, limited accommodation may be provided to the candidates during the selection process or interview. First come first serve policy will be followed in this regard.
3. Applicants should bring the following:
    a. Photo ID card (any one of these: PAN/AADHAAR/Driving License/Voter ID/Passport/Govt. issued ID/Educational Institute ID)
    b. Printed copy of the application

c. Thesis/dissertation/report of M.Tech./M.E./M.Sc.(Engg.) or equivalent degree
d. Copy of certificates and mark-sheets
e. Two recent passport size photographs
f. Non Programmable Scientific calculator

N.2.1 Examination policy

1. Mobile phones are not allowed in the examination hall or in the interview room
2. Department's decision is the final decision regarding any matter pertaining to this selection process.
3. Institute doesn't take any responsibility of your luggage/items that you leave before entering the examination hall.
4. A candidate will not be allowed to take exam if he/she arrives late at the venue 20 or more minutes after the exam has started.

N.3. Modality of selection process

The selection process consists of two written tests and an interview. The written tests comprise of two stages - First Round and the Second Round, respectively. The interview is the Third Round. Candidates shortlisted based on the selection criteria are eligible to attend the First Round. Questions will be objective and will be based on the syllabus given in Section N.5 and stream-specific syllabus given in Section N.6. Only candidates selected in the First Round will be allowed to write the Second Round. No change in stream will be allowed. The Second Round comprises of a subjective/objective test appropriate to their chosen stream in the PhD application form. It will be based on the syllabus given in Section N.5 and stream-specific syllabus given in Section N.6.

Candidates selected in Second Round will be eligible for the Third Round comprising technical interview. If necessary, an applicant may have to appear before the interview panel more than once. The details of the tests/interview are given in the following sections.

N.3.1 Details of the first Round

- This consists of a 90-minute computer based objective test for all the eligible applicants.
- Syllabi common for all streams are given in Section N.5 and stream-specific syllabi are given in Section N.6.
- A user name and a password will be provided to you to login and start the exam.
- No changes will generally be allowed in the choice of field of specialization (stream) once specified in the application form.
- There will be a negative marking for the wrong answers.
- Submit/freeze your answers and logout after completion of your examination.
- After the examination, the applicants are expected to wait till the short-listing for the second round of selection will be announced.
- Second round of selection follows immediately after the announcement of the result.
- It is the responsibility of the applicant to note the results of the First and Second round. The results would be displayed at the location/notice board; announced during the test.
- Results will not be informed to the applicants personally, and no complaints in that regard would be entertained.

N.3.2 Details of the Second Round

- The examination contains 90 minutes of subjective/objective paper.
- Syllabi common for all streams are given in Section N.5 and stream-specific syllabi are given in Section N.6.

- All answers should be written in clear hand writing.
- Assumptions made should be written down clearly.
- The results will be announced for the third round of selection process on notice board.

N.3.3 Details of the Third Round of selection

1) A personal interview is conducted for each applicant who is successful in the second round.
2) The applicant is advised to read basics regarding the area of specialization and the topic that he/she has chosen in the application form.

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

N.4. Focus area of research

Department of MMAE, IIT Dharwad is looking for PhD students in the following broad research areas. Applicant should be interested in at least one of the following research areas.

Thermal and Fluids Stream: Atomization and sprays, Computational fluid dynamics, Fire dynamics, Multiphase flows, Turbomachinery aerodynamics, Combustion and Thermoacoustics, Dynamics of thin films

Design Stream: Fracture mechanics, Finite Element Analysis, Biomechanics, Multibody kinematics and dynamics, Tribology, Computer vision and augmented reality, Reduced order modeling

Manufacturing and Materials Stream: Metal forming, Additive manufacturing, Computational Materials Design, Physical and Mechanical Metallurgy, Digital Twins, Structural Materials for Aerospace and Automobile

N.5. Syllabus – Common for all streams

N.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, Poissonand 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.

N.5.2. Analytical reasoning

Verbal reasoning: reading comprehension, drawing inferences based on multiple facts statedin short paragraphs.
Non-verbal reasoning: inductive, logical, abstract, diagrammatic and spatial reasoning.

N.6. Syllabus – Specific to the selected stream

N.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 (linearand 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 withuniversal 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; balancingof reciprocating and rotating masses; gyroscope. Vibrations: Free and forced vibration of singledegree 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 andthe 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.

N.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, elementaryturbulent 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 parametersystem, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forcedconvective 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 workand 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, Steam and gas turbines, axial flow compressors.

N.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.

O. DEPARTMENT OF PHYSICS

O.1. Eligibility for Admission

Qualifying Degree

- M. Sc. or equivalent degree in Physics/Applied Physics/Photonics/Solid State Physics/or other topics in Physics.
- M.Tech. / MS in 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) or equivalent fellowship of CSIR/UGC/DST INSPIRE or any other funding agencies in Physical Sciences.

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 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).

For SC/ST/PwD category candidates, a relaxation of 5% in the qualifying degree is applicable.

O.2. Modality of Selection Process

O.2.1. Application Categories

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

O.2.2. Guidelines for shortlisted candidates

For all the 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.

O.2.3. Interview

Only the eligible applicants are permitted to participate in the selection process. The department will conduct two rounds of interviews for the shortlisted candidates. The first round of interview (R1) will be conducted in **online mode** and is compulsory for all shortlisted candidates. If the

department finds any candidate(s) suitable, then they may conduct a second round of interview (R2) for the candidate(s) found suitable in the first round of interview. The second round of interview will be in hybrid mode, i.e., the candidate can either choose to attend it in the online mode **OR** they can appear in-person for the R2 which will be conducted in IIT Dharwad. The duration of the interview (R2) in both online as well as offline mode will be nearly the same. 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.

O.3. 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. Block 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 and Particle 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.

O.4. Focus area of research

Ph. D. positions in the following five research areas are available in the Department of Physics during the Autumn 2023-24 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.

Broad domain of research – Quantum Information Theory
Eligible social category to apply

- FA-All categories
- TA – Gen-EWS, OBC-NCL, 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 for the area "Quantum Information Theory" - Candidates applying for these positions should be highly motivated to perform theoretical research in the topics related to foundations of quantum mechanics, quantum optics, many body physics, relativity and at their interfaces. There is also scope to work in the topics related to quantum computation and quantum communication. Familiarity in foundations of quantum mechanics and quantum information is desired. The candidate having adequate knowledge to execute higher level computational programs using one of the standard programming languages is also desired.
Topic - Quantum information theory; its interface with quantum optics, relativity, and many body physics; Quantum Communication; Quantum Computation.

Broad domain of research – Lasers, Nonlinear Optics & Photonics
Eligible social category to apply – for FA - All categories; For TA - 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

Details for the area "Lasers, Nonlinear Optics & Photonics"- The research work 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 scientific and industrial applications.

Broad domain of research – **Experimental Condensed Matter Physics**
Eligible social category to apply –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
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.

Broad domain of research – **Experimental Atomic and Molecular Physics**
Eligible social category to apply – for PA - All categories;
Fee – refer section FEES, DEPOSITS & HOSTEL RENT
Type of funding support – PA (Please find the funding related details is Section B)
Duration of funding - Approximately 2 years 7 months from the date of PhD admission.
Details- The research work is related to studies of molecular dynamics in ultrafast timescales. The research work to be carried out is experimental in nature. A good background in Atomic, Molecular and Optical Physics and a strong aptitude for experimental work is necessary. The candidate will be involved in design and development of experimental facilities, performing experiments using femtosecond second lasers and advanced setups such as COLTRIMS and VMI as well as theoretical modeling and simulations. Collaborative work will require national travels. The candidate should be highly motivated to work in the described area. Experience in working with lasers, high vacuum generation, time of flight mass spectroscopy etc. together with computer simulation skills, MATLAB programming are desirable.

Topic- Experimental Atomic and Molecular Physics

- Suppression or enhancement of ionization/fragmentation of molecules due to different excitation regimes by varying the femtosecond laser parameters.
- De-excitation mechanisms of vibrationally excited molecules in ultrafast regime by

femtosecond pump-probe experiments.

- Strong field ionization and dissociation of molecules by intense femtosecond laser pulses.

Broad domain of research – Material Science
Eligible social category to apply – for TA/FA - All categories
Fee – FEES, DEPOSITS & HOSTEL RENT
Type of funding support – FA/TA (Please find the funding related details is Section B)
Duration of funding - Please find the funding related details in Section B
Details- The work would basically involve development of third generation solar cells- namely perovskite solar cells. We are looking for highly motivated PhD students with a strong interest in experimental research work to develop next generation high-efficiency halide perovskite solar cells using solution processed methods. The work will also include device modeling, therefore prior knowledge of a programming language and strong background in mathematics will be advantageous. The student will be embedded in a collaborative research work involving groups spreading pan India.
Topic-

- Thin-Film fundamentals and processing
- Perovskite Photovoltaics- Modelling, Materials, Devices and Integration

P. 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 fromIIT Dharwad.

Date: Signature of proposed Co-supervisor (external)

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Statement of sponsoring authority

If Shri. /Kum. / Smt. _____

is admitted to the Ph.D. programme, we shall allow him/ her to undergo the programmeof 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 requiredfacilities.

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 afaculty member of IIT Dharwad as the Supervisor.

Date: Signature and Seal of the Sponsoring Authority

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