

Indian Institute of Technology Dharwad



॥ सा विद्या या विमुक्तये ॥

Information Brochure

(For Indian Nationals)

Ph.D. Admission
Visvesvaraya PhD Fellowship

Spring Semester 2022-23

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A. SCHEDULE OF Ph.D. ADMISSION (under Visvesvaraya PhD Fellowship)

| Sr. No. | Description | Relevant dates* |
|---------|---|---|
| 1. | Applications open | 10 th November-2022 |
| 2. | Last Date to apply online | 30 th November-2022 |
| 3. | Announcement of shortlist of eligible candidates | 2 nd December 2022 |
| 4. | Online Interview Schedule | 3 rd December -2022 to 8 th December 2022 |
| 5. | Declaration of provisional list of selected & waitlisted candidates | 09-December 2022 |
| 6. | Admission process for recommended candidates | 12-December 2022 to 15-December 2022 |
| 7. | Admission for waitlisted candidates | 17-December 2022 to 27-December 2022 |

***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 >> [Doctoral – Visvesvaraya Fellowship](#).**

B. FINANCIAL SUPPORT DETAILS

Please refer to the annexure (section 4). This position will be considered as Fellowship Award. (FA category)

Visvesvaraya PhD Fellowship Scheme Overview

Under this scheme following areas are approved this year by the administrators of the scheme:

ESDM IT/ITES Indicative Research areas proposed for additional PhD candidates [ESDM/IT/ITES/ALL]:

Artificial Intelligence, 5G Communication, Augmented Reality, Big Data, Bioinformatics, Blockchain, Cloud Computing, Cryptography, Cyber Security, Data mining, Data Warehousing, Distributed Computing, e-Governance, Human-computer interactions, Image Processing/ DSP, Internet of Things/ Wireless Sensor Network, Machine Learning, Natural Language Processing, Neuron networks, Pattern Recognition, Quantum Computing/ Communication, RF/ Wireless Communications, Robotics, Semantic web, VLSI Design, Compiler Design, Virtual reality

Other Indicative Research Areas:

Data Mining, Distributed Computing, Internet of Things/ Wireless Sensor Network, Machine Learning, Pattern Recognition VLSI design, Compiler Design, Electronics systems design/embedded systems, Depth imaging and 3D modeling.

Applicants are ensured that their profile meets suitability for the above-mentioned area of research. Selection committee may disqualify applicant for any further rounds of assessment based on CV and prior academic credentials included in the applications if the profile is not found suitable for the above-mentioned area.

C. GENERAL GUIDELINES for APPLYING ONLINE

Applicants need to separately apply for Visvesvaraya scheme even if they have applied for the normal PhD positions for Spring 2022-23.

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. Please read the brochure thoroughly and make a payment of application fee as applicable to you. Please use the link below and choose “Application Fee (M.Tech/MS/PhD) and make a payment
 - b. The link is [State Bank Collect \(onlinesbi.sbi\)](#)
- 3.

| |
|---|
| Please note that the incomplete application form or forms without valid fee payment are liable to be rejected. |
|---|

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

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

8. **The Application Form without valid online payment details will not be considered. Application FEE once paid is Non-Refundable.**
9. Applicants may find it convenient to keep following information handy while filling the application form online (whichever relevant). This is especially important as the form cannot be saved and as such once started one needs to complete the entire form and submit:
 - Skype Id or Gmail Id for G-meet
 - Passport size photo whose size is less than 50 kb
 - Educational details from secondary school onwards
 - GATE qualification details
 - Statement of Purpose (pdf file)
 - List of fellowship/ awards
 - Publications

- Sponsorship Letter and CV of co-supervisor if you are applying under ‘EX’ category (if applicable).
 - JRF Award Letter if you are applying under ‘FA’ category, if applicable.
 - Any other achievements/information.
10. Amendments to the form will not be possible once the last date to apply online is over. However, amendments can be considered if the applicant resubmits the entire form without making repeat fee payment before the deadline. The latest application will be considered by default for scrutiny.
 11. Keep checking the institute website and your emails regularly for any communication from the institute regarding the selection process.
 12. The Shortlisted candidates’ list will be uploaded on the institute website as per the schedule given above in Section A.
 13. Candidates (if) called for written test / interview should bring with them Photo ID Card, Printed Copy of Online Application Form, Photocopies of Academic Transcripts, Degree Certificates & Experience Certificates, Caste Certificate (if applicable), PwD Certificate (if applicable), EWS Certificate (if applicable), Thesis/Dissertation/Report/Publications and all other relevant documents.
 - 14. Please note that the candidates (if selected) should be able to produce all relevant documents within a short period of notice. If the documents are not produced within the deadline, the admission is liable to be cancelled.**

D. INFORMATION PERTAINING TO HOSTELS

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

E. FEES, DEPOSITS & HOSTEL RENT

The fee applicable for admission to Ph.D. programmes (as collected during the Autumn Semester 2022-23) is provided below for reference purpose only: The actual fee applicable for Spring 2022-23 will be made available to the candidates at the time of declaration of results.

E.1 Details of Applicable Fee for Admission: PA/EX/FA Category

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

Note:

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

F. DEPARTMENT OF COMPUTER SCIENCE AND ENGG.

F.1. Qualifying Degree

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

F.1.1 Minimum score in the qualifying degree

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

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

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

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

F.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.

F.3. List of Project Topics

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.

Building Programmable Monitors to Verify Systems at Runtime

Faults during the operation of mission-critical systems can prove to be catastrophic. A popular example is the avionics system of an aircraft. Such systems are becoming increasingly complex, with more functionalities being added and quality-of-service constraints becoming more stringent. There are three classes of faults. Firstly, complex systems are difficult to formally verify statically due to their enormous complexity. Hence, there is a chance that design bugs may slip through undetected to the commissioned system. Secondly, such systems typically contain hardware and/ or

software components that are procured from an external vendor. This opens the door to potentially security attacks. Thirdly, electronics are subject to manufacturing defects and aging-related issues. One approach to detecting the occurrence of these three classes of faults is to have a trusted monitor verify the working of the system at runtime. The properties are specified unambiguously using formal languages, and tools are used to generate monitors that are then commissioned along with the system. The state-of-the-art includes software monitors, purpose-built hardware monitors, and monitors that run on an FPGA. We seek to approach runtime monitoring in a different way by having the monitor in the form of a processor that can be programmed. Such a capability will enable rapid incorporation of runtime verification in modern systems.

The group is looking for capable and enthusiastic scholars who have an aptitude for Systems (Computer Architecture, Operating Systems, Compilers) and Theory (Logic, Automata Theory, Algorithms).

Parametrizing the Compilation of Programs from Linear Algebra

Domain-specific languages are programming languages that trade off performance for faster development cycle. Importantly, the programming language is targeted towards a specific domain. Well-known success stories include MATLAB for creating numerical software and SQL for interacting with databases. Halide is a lesser-known success story in the domain of image processing. Halide exposes to programmers the scheduling requirements and separates them from the functional requirements of a program. The functional requirements are necessary for correctness of the program, while the scheduling requirements are necessary to achieve performance on modern hardware. E.g., to do a single floating-point multiplication: i) the two numbers must be loaded into registers before any computation can begin, ii) before adding the mantissa, the exponents must be aligned, and so on. Here, the ordering of operations must be followed. This is a functional requirement. When special registers are available, say, a register that can store 8 floating point numbers, 8 floating point multiplications can be done in the same amount of time as done with non-special register. So, if the programmer has the knowledge of the availability of such special registers, he/she can indicate it in the program to make the computation faster. This is an example of a scheduling optimization. Exocompilation takes a cue from Halide and exposes the features of modern hardware and other scheduling options to programmers (this is also referred to as externalizing the program compilation process or also referred to as parametrizing), while targeting the efficient implementation of matrix-multiplication program. This proposal aims to parametrize the compilation of programs from Linear Algebra to make them run efficiently on a variety of hardware including NUMA servers (shared-memory systems with few hundred cores), accelerators such as GPUs, and clusters (distributed-memory systems with millions of cores).

It is well-known that creating high performing Linear Algebra library implementations is a costly effort, often requiring embedding assembly-language code, and hand-tuning to match the capabilities of underlying hardware. A typical compiler that compiles the program for a specific hardware architecture leaves a lot of room for hand optimizing the program on modern hardware. This hand optimization is critical and necessary for some programs in domains ranging from Machine Learning to Scientific Computing to Computer Graphics. E.g., a program such as matrix-multiplication forms the core (kernel) of enclosing application software. As the core is run often and a significant number of times, it is crucial to optimize the core. We propose to identify such kernels in trendy domains and accelerate the development of programs through a variety of techniques such as automatic code generation, program synthesis, and runtime development, which all culminate in the development of a new domain specific language targeting efficient implementation of kernels from Linear Algebra.

- Halide: <https://halide-lang.org>
- Automatic code generation: <https://doi.org/10.1145/3295500.3356205>
- Y. Ikarashi, G. L. Bernstein, A. Reinking, H. Genc, and J. Ragan-Kelley, “Exocompilation for productive programming of hardware accelerators,” in Proceedings of the 43rd ACM SIGPLAN International Conference on Programming Language Design and Implementation, 2022, pp. 703–718.

Carbon aware Cloud Computing

The aim of this work is to reduce the carbon footprint of applications running on the cloud computing infrastructure. Cloud providers offer different services to accomplish the same task. But not all the services have the same power consumption-performance-cost tradeoffs. In this work, we aim to profile and characterize the different services offered by the cloud provider and compute performance, power and cost related metrics. The bigger goal of this work is to build a recommender framework that can guide the end users of the optimal choice of services given the carbon emission as well QoS tradeoffs. We will look into policies for dynamic allocation, scaling and tuning of applications on cloud platforms with the goal of minimizing the carbon emission.

F.4. 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.

G. DEPARTMENT OF ELECTRICAL ENGINEERING

G.1. Eligibility Criterion

G.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.

G.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.

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

G.2. Guidelines for Shortlisted Candidates

G.2.1. Modality of Selection Process

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

The interview slot (date and starting time) specific to each candidate will be communicated online at Visvesvaraya PhD Fellowship webpage on the institute portal.

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

G.3. Research Areas

Research topic: (Project 1) Development of Spoken Language Technologies for Under-Resourced Languages

The trends in artificial intelligence powered by deep learning over the last decade has remarkably improved the performance of spoken language technologies in major languages of the world. Deep learning approaches generally need more speech data to achieve very good performance. The recent approaches that can exploit models developed for major languages by adaptation to under-resourced languages is an attractive proposition. Using the same we can fast track the research and development of spoken language technologies for Indian languages, especially tribal languages which are mostly under-resourced languages. The scope of this work is to study the existing works for developing spoken language technologies for under-resourced languages. Based on the study gaps need to be identified for the current work. Novel explorations then need to be developed using machine learning and deep learning approaches.

Research topic: (Project 2) Instrumentation circuits and systems design for CMOS-MEMS inertial sensors

Micro-Electro-Mechanical-Systems (MEMS) have found many applications due to the excellent mechanical properties of Silicon. These electro-mechanical systems have used transduction schemes like capacitive, piezoresistive or piezoelectric transduction, which are more or less well understood. Recently, there have been developments towards transistor based MEMS sensors, wherein the gate of a FET is suspended over the channel and is free to move. This type of sensor has many advantages over the conventional 'passive' transduction schemes like easy interface with read-out circuits, easy CMOS-MEMS integration and are promising candidates for better noise performance. The scope of this work will include the design of such a suspended gate MEMS transistor device, techniques for simulating systems with this type of devices and interface circuits for the same. Interface circuits involve low noise amplifiers to high voltage charge pump circuits which are required for driving actuators required for closed loop operation.

Research topic: (Project 3) Federated (Distributed) Learning: Algorithms and Implementation

An unprecedented increase in the data generation at various connected edge devices has made machine learning in a *distributed/federated* manner inevitable. Moreover, stringent conditions on data privacy requires zero exchange of data with other devices or central servers, which makes federated learning a good choice. Due to heterogeneity in data, designing algorithms to learn models in a federated/distributed manner is very challenging. This project deals with designing algorithms for learning **shallow and deep learning** models depending on the application, and subsequently providing mathematical guarantees for the same. Further, the algorithms need to be implemented on edge devices to show real world performance. The last part will be done with the help of interns/project assistants under the supervision of the PhD student and myself.

Research topic: (Project 4) Non-Terrestrial Networks for 5G and beyond

A novel network architecture being considered in 5G and beyond is the Non-Terrestrial Network (NTN) architecture, where aerial platforms serve as Base Stations (BSs). One such NTN architecture being considered by the Third Generation Partnership Project (3GPP) employs Unmanned Air Vehicles (UAVs) as aerial platforms. A UAV-based NTN requires the modeling of Air to Ground (A2G), Air to Air (A2A) and Ground to Air (G2A) links. Moreover, when it is used to serve the IoT devices located on the ground, it presents a distinct advantage over conventional communication links, since the A2G and G2A links will have strong Line of Sight (LOS) paths with a high probability. The other NTN

architecture being considered uses low Earth orbiting (LEO) satellites as BSs. The main challenges in this regard is to encounter the delay and the Doppler shift caused by signal transmission and reception from the satellite. To this end, the project will be exploring the design and development of novel communication mechanisms for both UAV-based and LEO-based NTN's focussing on serving IoT users efficiently. The project will also involve hands-on implementation of some of these algorithms on a software defined radio and evaluating them for real-time performance.

Research topic: (Project 5) Development of novel deep learning methods for prognosis and treatment prediction in patients with cancer

Computer-assisted analysis for improved picture interpretation has been a long standing problem in medical imaging. Recent breakthroughs in machine learning, particularly deep learning, have made significant strides in identifying, classifying, and quantifying patterns in medical pictures. At the heart of the breakthroughs is the use of hierarchical feature representations learned exclusively from data rather than handmade features largely generated based on domain-specific expertise. This project will use existing methods of image processing to analyze the medical image data for diagnosis and prognosis prediction of cancer patients. We will also work on optimizing the existing image analysis methods along with novel deep learning methods to provide improved prognosis and treatment prediction.

1. Research topic: (Project 6) Deep Learning Enabled Methodological Strategies for 6G Semantic Communication

The sixth generation (6G) communication networks aim to envision unprecedented objectives, such as ultra-high data rates and higher network capacity, ameliorated spectrum efficiency, enhanced energy efficiency, embellished Quality of Service and Experience (QoSE) and system throughput, ultra-high user connectivity density and reliability, and ultra-low latency. On the contrary, Claude Shannon's information theory constrained the maximum data rate accomplished by a communication channel. As a result, the semantic aspects of information were extraneous, and prior generations of communications aimed to maximize the data rates per Shannon's theory. In contrast, the proliferation of internet users, Internet of Things (IoT) devices, and exponential growth in demand for high data rates compel 6G for revolutionary theories and technological innovations supporting the data rates beyond Shannon's fundamental limit. A semantic communication system that considers the semantic aspects of the information appears as a potential solution to overcome Shannon's fundamental limit. The semantic communication technology will employ the Knowledge Graph (KG) oriented Deep Neural Network (DNN) system to encode and decode the information semantics plummeting semantic ambiguity and semantic error rate. Deep Learning (DL) integrated 6G semantic communication will increase the data rates and throughput, reduce bandwidth occupancy, improve spectrum and energy efficiency, enhance reliability and latency, reduce redundancy and enhance intent clarification. Furthermore, 6G targets ambitious applications, such as holographic and haptic communications, Augmented Reality (AR)/Virtual Reality (VR), connected intelligence, intelligent sensing, and control, where DL integrated semantic communication will play a vital role. Thus, the current project proposal contemplates developing a DL-enabled 6G semantic communication system model and methodological strategies to accomplish the aforementioned objectives.

2. Research topic: (Project 7) Deep Learning Oriented Blockchain Method based Resource Allocation in 6G Wireless Networks

The fifth-generation (5G) stands on the terminus of commercialization and deployment during 2021-22. However, complete integration of Machine Learning (ML), decentralization, security, and privacy endure immediate impediments of 5G. On the contrary, the sixth-generation (6G) aims to strengthen the complete integration of ML, decentralization, extreme security, and privacy enabled network

infrastructure. Moreover, 6G's preliminary requirements constitute to support ultra-high data rates and network capacity, improved spectrum and energy efficiency, enhanced Quality of Service and Experience (QoSE) and system throughput, ultra-high user and connectivity density, ultra-low latency, high-mobility, and reliability. On the contrary, the necessity of large data volumes and super massive connectivity imposes the challenges of effective resource management, security, and privacy in 6G wireless networks. Consequently, intelligent, automated, decentralized, and secured Resource Allocation (RA) remain the immediate necessities in 6G wireless networks. Therefore, in the current project, we propose Deep Learning (DL) Oriented (O) Blockchain Technology (BT) based methodological strategies for RA in 6G wireless networks. BT endures highly immutable and recognized for decentralized and secure resource sharing network environments. BT can significantly improve the training phase of the DL model in a decentralized and secure manner. Moreover, it enhances the intelligence and decision-making accuracy of the ML model. On the other hand, the DL method accurately examines the RA pattern observing the complex data and will significantly reduce the computation complexity associated with the BT implementation and intensify intelligence in the 6G wireless networks. Therefore, the proposed project on joint DLOBT methodological strategies for RA will accomplish the preliminary requirements of 6G, as mentioned earlier.

3. Research topic: (Project 8) Deep Learning (DL) Enabled Reconfigurable Intelligent Surfaces (RIS) Oriented Green Methodological Strategies for 6G Electric Vehicular Networks (EVNs)

Although the fifth-generation (5G) of communication is nearing commercialization, the complete integration of Artificial Intelligence (AI) remains unaddressed. On the other hand, the sixth generation (6G) of communication aspires for complete AI integration and ubiquitous connectivity. Furthermore, 6G aims to effectuate unprecedented objectives, such as ultra-high data rates and ameliorated network capacity, spectrum and energy efficiency (EE), Quality of Services (QoS) and Experience (QoSE), system throughput, connectivity density, and ultra-low latency, increased mobility, and reliability. 6G, on the other hand, will endeavor the transmission at Terahertz (THz) frequencies (0.1 – 10 THz), incurring enormous path losses, atmospheric absorption, rain attenuation, scattering, penetration losses, human blockage, and higher interference, ensuing in a lower Signal to Noise and Interference Ratio (SINR). Consequently, extraordinarily directed beamforming antennas and a proliferating number of base stations are enforced to extend network coverage at the expense of excessive energy consumption. To compensate for high path losses and improve the SINR with smaller energy consumption, Reconfigurable Intelligent Surfaces (RISs) have been envisioned in 6G. The progressive phase-shifting elements on RIS can radiate the beam in a specified direction. Furthermore, RISs are amenable to being programmable, employing Deep Learning (DL), further optimizing the operation. Also, the RIS will easily be mountable on buildings and street lights at a low cost. One of the scenarios considered in 6G is the Electric Vehicular Networks (EVNs) endure unique requirements, such as ultralow energy consumption and latency, ultra-high mobility and reliability, adaptive beamforming with seamless connectivity, elevated data rates, and enhanced QoSE and road safety. Subsequently, the current project solicits devising a DL-integrated RIS-assisted 6G-EVNs system model, optimization framework, and methodological strategies to accomplish the aforementioned objectives. In addition, the present project proposes Wireless Information and Energy Transfer (WIET) functionality for Energy Harvesting (EH) to aggrandize the EE in 6G-EVNs. The perfected DL-RIS-WIET-6G-EVNs methodological strategies will intelligently optimize the system performance in terms of data rates offered and reliability, convalesce EE and road safety, and conjecture charging stations. The WIET and EH framework will predominantly recuperate the battery life, EE, and elongate the ambit of 6G-EVNs. Additionally, DL-RIS optimization algorithms considering the local traffic acquire optimal speed management to augment battery life and lower the accidental probability, thereby ameliorating road safety. Finally, the current project inscribes the interdisciplinary problem amid the telecommunication and automobile industries, furnishing a solution for the next generation 6G-EVNs to attain the aforementioned objectives.

Research Topic: (Project 9) Cyber Security in Smart Grid

The Smart Grid, generally referred to as the next-generation power system, is considered as a revolutionary and evolutionary regime of existing power grids. More importantly, with the integration of advanced computing and communication technologies, the Smart Grid is expected to greatly enhance efficiency and reliability of future power systems with renewable energy resources, as well as distributed intelligence and demand response. The Smart Grid allows operators to be pro-active in the detection of generation, transmission, and distribution problems, to isolate the problem areas, and to prevent cascading power outages. In the current transition period, when elements of the Smart Grid and legacy system components co-exist in the electric grid, Cyber Security concerns are particularly relevant for the power and energy sector which has been identified as being among the top industrial security targets. Therefore, there is a lot of research effort to enhance smart grid security in industry, government, and academia. The security approaches are important to improve solutions against cyber-attacks in smart grid applications. Among the different types of cyber attacks, we are currently focusing on false data injection attacks that replace actual power system measurements with false data which can initiate unnecessary control actions e.g. tripping line and generator, changing generation and loads, etc. The aim is to develop algorithms to detect such false data injection attacks in smart grid.

Note: Candidates should have knowledge in power systems and allied subjects. Knowledge in computer science related subjects is not expected.

Research Topic: (Project 10) Electronic Sensory System for Rapid Detection of Cancer Biomarkers

The mortality rates associated with cancers are very high. This predominantly happens because of late diagnosis of the terminal disease. It is known and has been clinically proven that if the cancer is detected at the early stage, the survival rates improve significantly. Expensive diagnostics which are lab based and many-a-times invasive are the main causes of delayed diagnosis. Hence, the only way to facilitate early detection of cancer is by developing methods that are inexpensive, preferably simple so that the citizens can operate it themselves and can diagnose the disease using easily accessible live samples like saliva, urine, sputum, serum, breath etc. One of the ways to do so is by developing sensors for the secretive biomarkers (the biomarkers that get introduced into easily accessible body fluids). Several sensors have been explored and some of them are available for many such secretive sensors but those sensors are mostly based on optical methods. All the optical sensors require skilled expertise to operate sophisticated instruments and are mostly lab-intensive and hence, cannot serve the aforementioned purpose. This research plans to have an end-to-end development of electronic sensors for the secretive biomarkers which will make the detection system portable and easy-to-operate. The research will require nanomaterial synthesis, sensor fabrication and DC characterizations, and design, assembly and testing of interfacing electronics.

Research topic: (Project 11) Goal-Oriented Communication using Deep Learning

The existing communication networks are mainly optimized for exchanging information with respect to bit or block level similarity between sources and destinations. However, usually, in practice, communication is carried out for accomplishing certain goals that may require more than bit/block-similarity-optimized networks. For instance, in a fire monitoring system, one is interested in sensing a region of concern and communicating the information to a monitor so as to detect any unusual event and take actions if required. In this case, optimizing communication systems for bit or block level similarity may not lead to a good system performance as far as the end goal is concerned. Rather, extracting the semantics (i.e., finding out whether or not there is an unusual event) and prioritizing the communication accordingly (communicating information about an unusual event with a higher priority) so as to accomplish a goal (acting to bring the situation under control) seems to be better. In this research work, we would like to find out the right metrics for goal-oriented communications, optimize the

communication networks with respect to them and build prototypes of goal-optimized communication networks. In the research work, due to difficulty in obtaining simple analytical models for semantic content of information, one is required to adopt deep learning. The topic of this research is timely and important because it has been widely considered that 6G networks will be goal-optimized.

Research Topic: (Project 12) Powering the Wireless System/IoT Node by Scavenging Multi-Band Radio Frequency (RF) Energy

There is a great interest in powering ultra-low-power wireless systems/Internet of Things (IoT) nodes by scavenging ambient energy. Based on the applications and area of deployment, appropriate energy sources are utilized for powering the wireless-sensor node. RF energy scavenging is one of the viable alternative techniques to power a wireless-sensor node where solar, thermal, and vibrational energy sources are absent. Ambient RF energy includes FM radio signals (88-108 MHz), television broadcasting signal (585-698 MHz), GSM signals (2G: 900 & 800 MHz, 3G: 2.1 GHz, 4G: 2.3 GHz), and WiFi signals (2.4 GHz) could be used for powering the sensor nodes. However, the received power from a single band RF source is approximately in the range of 0.01-0.1 $\mu\text{W}/\text{cm}^2$ which is insufficient for powering the wireless-sensor/IoT node. Therefore, one has to scavenge energy from multiple RF bands/sources for powering the wireless sensor node. The output power from RF sources are not in a form so that one can power directly to the sensor node. Moreover, the extracted energy may not be sufficient to power the sensor node all the time. Therefore, an interface circuit is required in between the antenna and load to maintain regulation, ensure maximum power transfer, and condition output power to some usable form.

Research Description: (Project 13) Secure embedded controllers for interactive grid-connected applications

Cybersecurity of power hardware is becoming increasingly critical with the emergence of smart and connected devices such as Grid-connected inverters, EVs and their chargers, microgrid controllers, energy storage / energy management controllers, and smart appliances. Cyber-attacks on power hardware have had far-reaching and widespread impacts. For such cyber-physical systems, security must be ensured at all levels in the design - hardware, firmware, software and interfaces. In addition, controllers for such power electronics are becoming more and more complex, requiring some level of autonomous and hierarchical control. This project aims to develop a controller architecture based on (open-source) softcore processors such as the RISC-V Shakti complemented by VHLD logic implementation, real-time and pseudo-realtime firmware and security-aware control structure.

The project requires a strong grasp of all EE fundamentals, experience with embedded systems programming (C/C++ required, Verilog/VHDL desirable) and some exposure to fundamentals of Power Electronics/Electrical Machines.

G.4. Interview Syllabus

All applicants should choose one of the topics given below for the interview while submitting the online application form.

Common to all

Engineering Mathematics: Matrix Algebra, Systems of linear equations, Eigenvalues, Eigenvectors, Concepts from integration and differentiation, Fourier Transform and Laplace Transform.

Topic 1: Communication and Signal Processing

1. Signals and Systems:

1. Continuous-time signals: Fourier series and Fourier transform representations, sampling theorem and applications;
2. Discrete-time signals: discrete-time
3. 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.

3. Communication:

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).

4. Random processes:

Basics of probability, random variables, CDF, PDF, random processes, mathematical expectation, conditional probability and conditional expectation.

Topic 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.

Topic 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.

Or, 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.

3. 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.

Topic 4: Machine learning

1. **Basic probability:** Basics of probability, random variables, CDF, PDF, random processes, mathematical expectation, conditional probability and conditional expectation, variance and moments, transformation of random variables.

Basic level ML: Bayes classifier, feedforward neural network, Gradient descent, SGD, logistic regression, linear regression, dimensionality reduction techniques.

H. DEPARTMENT OF MECHANICAL MATERIALS AND AEROSPACE ENGINEERING

H.1 Eligibility for Admission

H.1.1. Qualifying Degree

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

H.1.2. Minimum score in the qualifying degree

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

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

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

H.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 Spring 2022-23 semester of IIT Dharwad are also eligible to apply. However, if offered, the admission to those candidates would be provisional. To join an academic program at IIT Dharwad, such candidates need to furnish necessary documents regarding completion of the degree on the date of joining mentioned in the Section 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.

H.2. Modality of selection process

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

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

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

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

H.3. Dos and Don'ts

Dos:

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

Don'ts:

- Avoid windy noisy surroundings during interview
- Do not record interviews in any form. Any such act will be considered as violation of the pledge you signed online and may invite punitive action from IIT Dharwad.
- Do not ask about the schedule of the results. It is better to use interview time for other better inquiries as the results will be declared online as soon as possible.
- Do not leave your place in front of the camera for the entire duration of the interview.
- Prepare yourself to avoid any kind of break during interview, including restroom-break
- Do not have anyone else around you. Any interaction with someone else other than the interview panel during the interview will be considered as a suspicious activity.

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

H.4. Focus area of research

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

1. Multimodal scene interpretation for robotics, VR interaction, and inspection and material characterization

Traditionally RGB camera can create 2D projection of colour spectrum in the surrounding 3D space. Depth Vision is a recent technique, which can augment the RGB image by capturing the depth information of the scene. This along with some other additional triangulation techniques can impart robustness to the depth capture of the scene. This raw data can be further processed with other techniques to interpret the surrounding in a more meaningful way for applications such as path navigations in robotics, communications and user interface in the AR/VR applications, mechanical analysis of large deformation problems, inspection and quality control and so on. This proposed work would look into the accuracy vs efficiency trade-offs of various algorithms used in the preprocessing and post-processing of the captured information. The research is aimed at robust and cost-effective deployment of multimodal systems for scene interpretation, engineering analysis for IT and IT enabled services.

H.5. Syllabus – Specific to the selected stream

Engineering Mathematics

- Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors, Matrix decompositions – LU, QR, Spectral, Polar, Choleskey, Singular Value Decomposition.
- Calculus: Functions of single variable, limit, continuity and differentiability, mean value theorems evaluation of definite and improper integrals; double and triple integrals partial derivatives, total derivative, maxima and minima, Taylor series, 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.
- Probability and Statistics: Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.
- Numerical Methods: Numerical solutions of linear and non-linear algebraic equations; forward, backward and central difference methods, numerical interpolation, integration by trapezoidal and Simpson's rules;
- Geometry: Euclidean Geometry, Splines, Voronoi Diagrams and Delaunay Triangulation.

Analytical reasoning

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

Programming

Data structures and Algorithms, Object Oriented Programming, Foundations of coding using C/C++/Python, Graphs, Basic understanding of Image representation and morphological operations in image processing.

Mechanical Design

- Engineering Graphics: Orthographic projections of lines, planes and solids, true length and true angle, sections of solids and intersections of solids, solid modeling.
- Computer Aided Design (CAD), Machine Drawing Conventions
- Engineering Mechanics: Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.
- Theory of Machines: Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains;

ANNEXTURE 1

Guidelines-Visvesvaraya PhD Scheme for Electronics & IT – Phase II

1. Background

Ministry of Electronics and Information and Technology (MeitY) has approved implementation of Phase-II of Visvesvaraya PhD Scheme for Electronics & IT with the objective of enhancing the number of PhDs in the Electronic System Design and Manufacturing (ESDM) and IT/IT Enabled Services (ITES).

In the Phase-I of the Scheme, a total of 1017 full Time, 330 Part Time PhD candidates and 158 Young Faculty Research Faculty (YFRFs) were supported under the scheme. It has been decided to continue the scheme for Phase-II to help increasing the number of PhDs in the country to enable India to compete globally in the coming decades, to develop an ecosystem of research development and IP creation in these knowledge intensive sectors.

2. Salient Features of Phase-II

- 2.1. The scheme aims at generating a total of 1000 Full-time PhD Candidates (@200 Candidates per year) and 150 Part-time PhDs (@30 candidates per year) in emerging research areas of ESDM and IT/ITES sectors over a period of 5 years.
- 2.2. The scheme will also identify and support 50 Young Faculty Research Fellowships (@10 Awards/year) to recognize and encourage young faculty involved in research and technology Development in the areas of ESDM and IT/ITES.
- 2.3. The scheme would support 225 Post-Doctoral Fellowships for candidates @ 25 seats per year for a period of support of one year to encourage specialized research in emerging research areas under ESDM and ITES sectors. The support has been provisioned for a total of 9 years.
- 2.4 The scheme will have a provision for one time support to 250 Full time PhD fellows for 6 months to facilitate visits to labs abroad, to broaden their research perspective and be in-sync with the state of art research being carried out throughout the globe.

3. Institutions Eligible for Support

3.1. All Indian Institute of Technology (IITs), National Institute of Technology (NITs), Indian Institute of Science (IISc), all Indian Institute of Science Education and Research (IISERs), Central Universities, Deemed Universities under Central Government, Colleges, and Institutions of national importance will be eligible for support under the scheme.

3.2 A University created under Provincial Act, State Act, State Universities, Private Universities, Private Deemed Universities, “Colleges that are allowed to offer PhD”, and other academic, R&D institutions with the following eligibility criteria:

3.2.1 The Institute should have existing post graduate stream in Electronics/IT and have Produced PhDs in these areas for the last 3 years. The PhD student (s) under this scheme to be admitted as per UGC admission norms and

3.2.2 The Institute should be recognized by AICTE & NBA (National Board of Accreditation) accredited with respect to Electronics/IT Programmes or The institute should be accredited by NAAC (National Assessment and Accreditation Council of UGC).

3.3 The minimum requirement for eligibility under the scheme will be as per the norms specified by UGC. This will comply to “UGC’s Minimum Standards & Procedures for award of M.Phil/ Ph.D. Degree, Regulation,2009” (ref. The Gazette of India July 11,2009 Part III Sec 4) as amended time to time.

4. Full-time PhD candidates (1000 candidates @200candidates/year):

4.1 Financial Support for Full-time PhD candidates:

4.1.1 Fellowship: Rs. 38,750 per month in 1st & 2nd year and @Rs. 43,750 per month in 3rd,4th and 5th years of PhD. (support till PhD completion or 5 years whichever is earlier).

4.1.2 Reimbursement of Rent (RoR): This component is linked with the fellowship of PhD Candidate and will be as per Govt. of India HRA norms, as notified by Ministry of Finance, for support duration of PhD candidate under the scheme.

4.1.3 Institutional Overheads: An amount of Rs. 25,000/Year/Full-time PhD candidate for Support duration of PhD candidate to be given to the institution.

4.1.4 Research Contingency Grant Support: An amount of Rs. 1,20,000/Year/Full-time PhD Candidate for support duration of PhD candidate. To avail it, the institute supported under the scheme would need to submit the procurement Proposal of the laboratory, equipment (excluding civil construction/expansion of the building) Signed by supervisor, nodal & competent authority of the institute. The proposal should clearly specify the Utility & role of the proposed equipment in research of the PhD candidate (s) whose eligibility is linked to the proposal. The format of the proposal & additional guidelines, if any would be made available subsequently.

4.1.5 Support for attending International Conference: Support upto Rs.1.5 Lakhs/Full-time PhD Candidate. This would cover the travel and other expenses of PhD candidate for attending International Conferences, where his/her research paper has been accepted for the presentation by him/her. A list of renowned International Conferences related to the areas of ESDM and IT/ITES would Be provided for this support under the scheme.

4.1.6 Visit to Labs abroad: One time support for selected 250 Full-time PhD candidates upto Rs.10.5 Lakhs/candidate for a 6month visit to labs abroad.