



**20  
23  
APRIL  
ADMISSIONS  
PROSPECTUS**

**DOCTORAL  
RESEARCH  
PROGRAMMES**



# **The Underlying Philosophy**

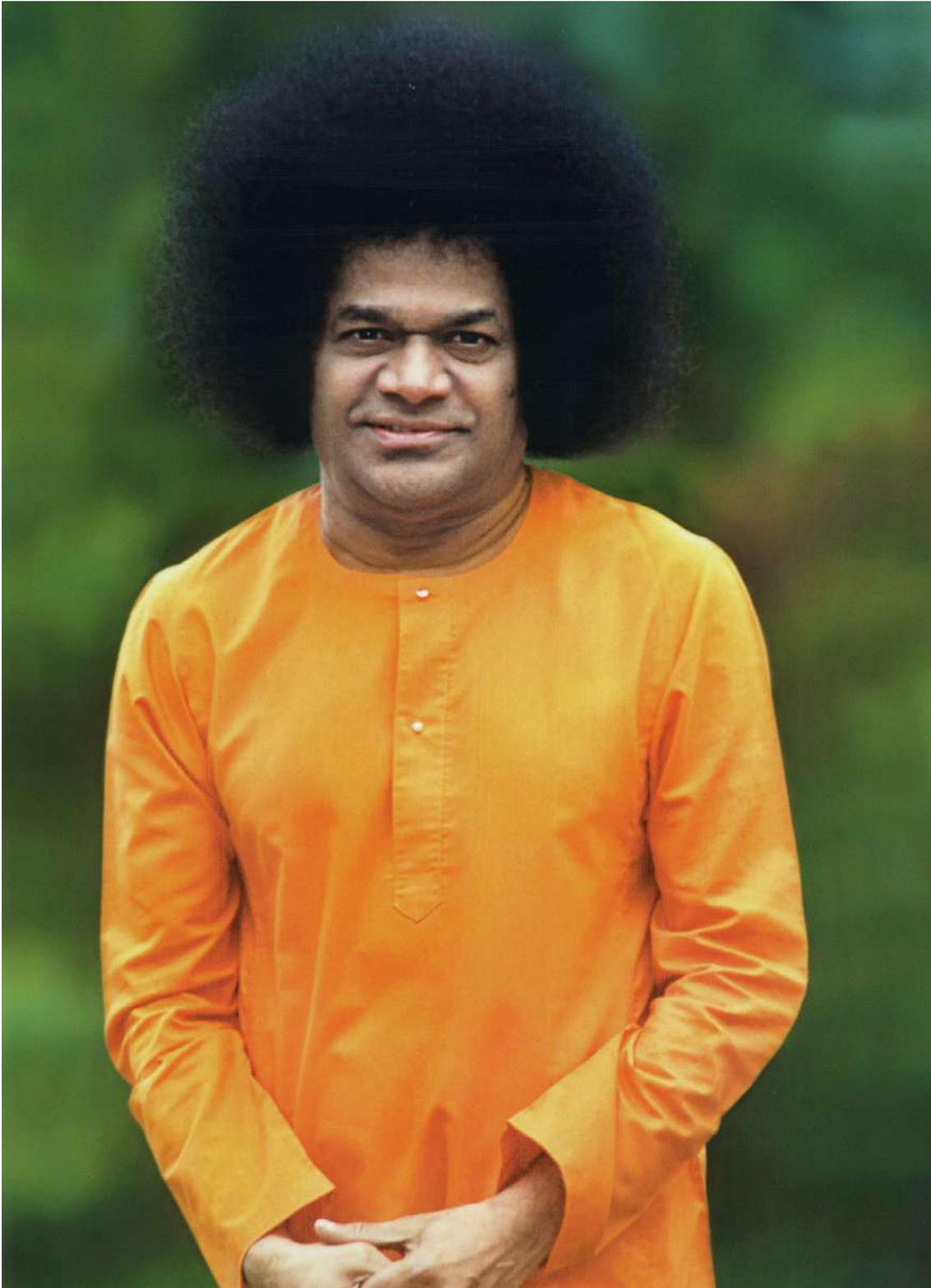
**The Sai educational institutions have been established not merely to enable students to earn a living but to make them acquire good traits, lead ideal lives, and give them ethical, moral and spiritual strength. I have established them with a view to inculcate love and teach good qualities to students. They will learn here humility, discipline and faith.**

**I have established these institutions to impart spiritual education as a main component and worldly education as a secondary one. Education should enable one to cultivate good qualities, character and devotion. The teaching of the University curricula is only the means employed for the end, namely, spiritual uplift, self-discovery and social service through love and detachment.**

**This will be a Gurukula - a place where teachers and taught will grow together in love and wisdom - and like the ancient system of education, it will develop in its students a broad outlook and promote virtues and morals, which serve to foster noble ideals in society.**

**This Institute will be a temple of learning where youth are shaped into self-reliant, contented and enterprising heroes of action and self-sacrifice, for the purpose of serving humanity.**

**SRI SATHYA SAI BABA  
Revered Founder Chancellor, SSSIHL**



**Education softens the heart. If the heart is hard,  
one cannot claim to be educated.**

**SRI SATHYA SAI BABA  
Revered Founder Chancellor, SSSIHL**

## From the Admissions Office

Welcome to Sri Sathya Sai Institute of Higher Learning (SSSIHL).

This prospectus is for students interested in applying for doctoral research study at SSSIHL.

The first part introduces Sri Sathya Sai Institute of Higher Learning and its unique philosophy of education, including current key statistics of the institution.

The second part will give a clear view on how to apply to the Ph.D. programmes of SSSIHL. This includes a step-by-step process, eligibility requirements, hostel guidelines and other application procedures in general.

The third part of the prospectus lists the department-wise information on available Areas of Research for April 2023 entry along with the available research infrastructure and admissions test syllabi.

Detailed information about the Institute can be found on our website, [sssihl.edu.in](http://sssihl.edu.in).  
Good Luck and Sai Ram!

**Admissions Office**  
**Office of the Registrar, SSSIHL**

# Admissions Prospectus April 2023

Doctoral Research Programmes

## Contents

### Introduction

<b>Sri Sathya Sai Values-based Integral Education</b>	<b>6</b>
<b>Why Research at SSSIHL?</b>	<b>8</b>
<b>SSSIHL Statistics 2021/22</b>	<b>9</b>
<b>SSSIHL Central Research Instruments Facility (CRIF) and SSSIHL Central Research Laboratory (CRL)</b>	<b>10</b>

### How to Apply

<b>Eligibility Criteria</b>	<b>12</b>
<b>Application Process</b>	<b>13</b>
<b>Information on Hostel Life</b>	<b>15</b>

### Departments: Areas of Research

<b>Biosciences</b>	<b>16</b>
<b>Chemistry</b>	<b>17</b>
<b>Humanities and Social Sciences</b>	<b>18</b>
<b>Languages and Literature</b>	<b>19</b>
<b>Management and Commerce</b>	<b>20</b>
<b>Mathematics and Computer Science</b>	<b>21</b>
<b>Physics</b>	<b>22</b>

### Departments: Test Syllabus

<b>Biosciences</b>	<b>23</b>
<b>Chemistry</b>	<b>24</b>
<b>Humanities and Social Sciences</b>	<b>25</b>
<b>Languages and Literature</b>	<b>25</b>
<b>Management and Commerce</b>	<b>26</b>
<b>Mathematics and Computer Science</b>	<b>26</b>
<b>Physics</b>	<b>28</b>

# Sri Sathya Sai Values-based Integral Education

Sri Sathya Sai Institute of Higher Learning (Deemed to be University), Prasanthi Nilayam, Andhra Pradesh, India, is a visible manifestation of Bhagawan Sri Sathya Sai Baba's vision of education for human transformation.

Sri Sathya Sai Values-based Integral Education was designed by Bhagawan Baba to ensure deep inner transformation of the student during their student journey at SSSIHL. This concept is very unique to our institution.

The Institute hosts students from across the country at its four campuses located in Andhra Pradesh and Karnataka, India and provides quality education totally free for all programmes of study.

#### For Women:

- Anantapur Campus at Anantapur, Andhra Pradesh

#### For Men:

- Prasanthi Nilayam Campus at Puttaparthi, Andhra Pradesh
- Brindavan Campus at Kadugudi, Bangalore, Karnataka
- Muddenahalli Campus at Muddenahalli, Karnataka

The programmes offered include undergraduate, postgraduate, professional and research. It has a merit-based open admissions policy for all, irrespective of income, religion or social status.

#### Programmes Offered Include:

- Undergraduate: B.A., B.A. (Hons.), B.Com. (Hons.), B.Sc. & B.Sc. (Hons.), B.B.A., B.P.A
- Postgraduate: M.A., M.Sc.
- Professional: B.Ed., M.B.A., M.Tech.
- Research: Ph.D.

## A Modern Gurukula

Sri Sathya Sai Institute of Higher Learning (SSSIHL) was founded to inculcate ethical and moral values in students along with Secular education. Since its inception, transformation of the students has been the guiding principle with the integration of ethics and values being the undercurrent of every subject taught at the institute. Combined with academic and research excellence, the Institute provides a holistic framework of intrapersonal and interpersonal development for its students. Its residential character trains the mind, body and spirit of the student in an environment similar to the ancient Indian 'gurukula' system of education, in the most modern context. Teachers and students live and grow together in an atmosphere of mutual trust and unity. This helps students develop a wholesome and balanced personality, one where academic competence is inter twined with value systems.

## Distinctive Features

#### Admissions

- Merit-based open admissions policy for all irrespective of income, religion or region
- Quality education provided free for all students

#### Residential Character

- Residential character where all doctoral research scholars, students, and select teaching faculty reside together in the hostel which enables translation of lessons learnt into practical skills through experiential learning
- Spiritual ambience in an environment of discipline and love
- Cultivation of the spirit of self-reliance, brotherhood and sacrifice through mentoring and personal example

#### Infrastructure

- Campuses are set in spacious and peaceful surroundings
- Well equipped, modern science laboratories and cutting edge, state-of-the-art Research Instruments Facility
- Automated Library using Integrated Library Management System (ILMS) and has digitisation facility and is accessed through the on-line Public Access Catalogue (OPAC) within the campus premises.
- Libraries across campuses with over 1.88 Lakh volumes
- Connected to the National Knowledge Network (NKN)
- Computer and Multimedia learning centres with ultra-high speed internet connectivity
- International Centre for Sports in the Prasanthi Nilayam Campus and sports facilities in the respective campuses.

#### Academics & Research

- Integrated 5-year programmes combining undergraduate and postgraduate studies for a systematic and graduated learning process
- Research Collaborations with premier Indian and Foreign institutions and Industry
- Interdisciplinary research for societal benefit
- Awareness Programmes and Moral Classes reinforcing human values

#### Integral Education

- Life lessons learnt through the message of the Revered Founder Chancellor, Bhagawan Sri Sathya Sai Baba
- Application of what is learned in daily life
- Integrating human values with secular knowledge
- Inculcating the spirit of self-reliance and service to society
- Synthesis of science and spirituality for societal benefit
- The concept of integral education that SSSIHL imparts is pursued by all teachers, staff and students.

## The Process

Sri Sathya Sai System of Integral Education system is a modern, rational and scientific education system rooted in Indian ethos. It takes the best of both ancient and contemporary learning techniques.

The image on the right forms the basis of the system of Values-based Integral Education at SSSIHL. The base depicts the concept of a modern Gurukula that sustains all relationships and activities at SSSIHL. It is responsible for creating and sustaining the congenial environment necessary for the teacher-student interaction to grow and develop.

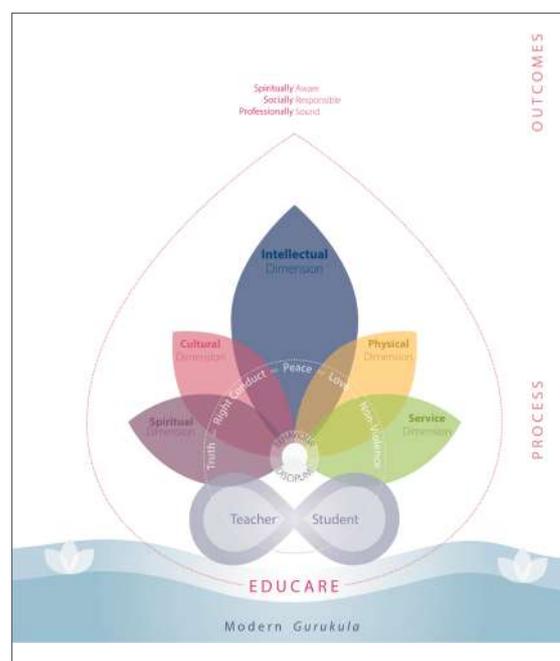
Adherence to discipline and appropriate behaviour are the two important aspects that encompass all interactions. The five human values of Truth, Right Conduct, Peace, Love and Non-violence form the undercurrent of all the dimensions of integral education.

These dimensions are: Intellectual, Physical, Cultural, Spiritual and Service. The key activities for each of these dimensions form the basis of how students spend their time at SSSIHL.

Bhagawan Baba purposefully designed the system of Integral Education so that students spend their time on academics (intellectual capacities) and also on the development of other qualities. This enables students to inculcate the virtues of team work, self-reliance, empathy, adaptability, discipline and cooperation.

### The Daily Routine

This is a crucial component of this process. Each student's day starts at 5:00 a.m., with a couple of hours spent in prayer, exercise and other vocational pursuits (such as practice sessions for music, band, traditional Indian music and the likes).



Classes commence around 9:00 a.m. After college hours at around 4:00 p.m., students move to the Sports Field/ Mandir/Prayer hall/ for participation in sports and games / congregational chanting (veda), devotional singing (bhajans) and other spiritual activities. These also include talks by eminent speakers on a variety of spiritual topics. Post which, students continue to concentrate on their studies.

### The Outcome

The outcomes of the system of Values-based Integral Education at SSSIHL are threefold. It prepares all graduates to be:

- Spiritually aware
- Socially responsible and
- Professionally sound

It helps develop a strong character and positive qualities in students and nurtures virtues like adaptability, tolerance and sacrifice; shaping them into noble and responsible citizens.

***I have established these institutions to impart spiritual education as a main component and worldly education as a secondary one. Education should enable one to cultivate good qualities, character and devotion. The teaching of the University curricula is only the means employed for the end, namely, spiritual uplift, self-discovery and social service through love and detachment.***

**Sri Sathya Sai Baba  
Revered Founder Chancellor, SSSIHL**

# Why Research at SSSIHL?

## Departments & Areas of Research

Sri Sathya Sai Institute of Higher Learning has 9 Departments offering\* opportunities for research to both men and women.

- Biosciences
- Chemistry
- Education
- Food and Nutritional Sciences
- Humanities and Social Sciences
- Languages and Literature
- Management and Commerce
- Mathematics and Computer Science
- Physics

*\*Refer to pages 16-22 for the details of the areas of research offered by each department.*

## Research Growth

The research output at SSSIHL has seen a significant rise over the years. The five science departments, viz. Mathematics & Computer Science, Physics, Chemistry, Biosciences and Food & Nutritional Sciences are increasingly pursuing research collaborations with premier external Institutions.

To name a few:

- Indian Institute of Technology, Madras
- Indian Institute of Technology, Kharagpur
- FDA-Center for Biologics Evaluation and Research, USA
- Raman Research Institute, Bangalore
- Tata Institute for Fundamental Research, Mumbai
- Japan Advanced Institute of Science and Technology, Japan
- George Mason University, USA

In addition, collaborative research projects with Sri Sathya Sai Institute of Higher Medical Sciences (SSSIHMS), Madras Diabetes Research Foundation, Chennai and Central Leprosy Teaching and Research Institute, Chennai are testimonial to the rise in the quality of research at the institute. A glimpse of our publications can be [viewed here](#).

## Needs-based Research

In line with the vision of the Revered Founder Chancellor, all research at SSSIHL ultimately leads to societal benefit. Thus, the topics for doctoral research across all departments

are chosen with great diligence. In the present day world, the need of the hour is to integrate expertise from different departments to transform it into translational research or directed basic research.

## Interdisciplinary Approach

Interdisciplinary research is indispensable for academic innovation. It brings together different minds, across various disciplines, and encourages emerging areas to converge and together make an impact on any programme.

In order to foster this ambiance for interdisciplinary research at the institute, an Interdisciplinary Science Colloquium has been initiated (several years ago) to provide an opportunity for Doctoral Research Scholars and the Teaching Faculty – involving the departments of Physics, Chemistry, Biosciences and Food & Nutritional Sciences—to share their research experiences with fellow researchers.

This has facilitated the promotion and consolidation of their knowledge base. Besides, it has also proved to be an effective optimal method of sharing available resources for research.

SSSIHL has taken giant strides in this direction of interdisciplinary research by collaborating with top notch institutions, both within the country and abroad.

For more information view our [Annual Report](#).

# SSSIHL Statistics 2021-22

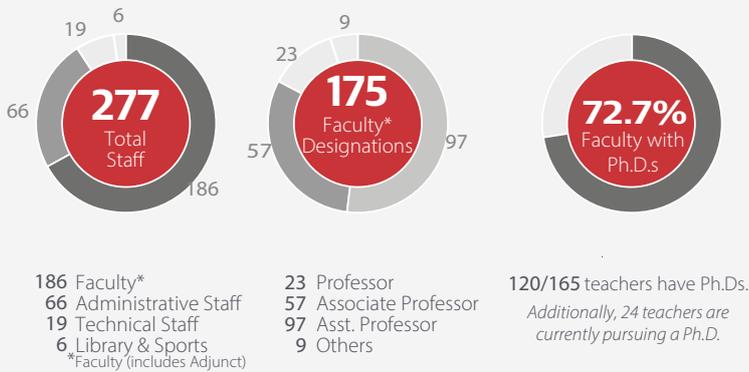
## Student Profile



## Expenditure on Equipment & Infrastructure



## Staff Profile



## National Exams (Combined)



GATE: 31% | UGC-CSIR-NET (JRF): 40% | UGC-CSIR-NET (LS): 14% | UGC-NET (JRF): 25% | UGC-NET (LS): 18% | IA: 68.5% | CTET: 40% | JEST: 17% | IIT JAM: 20% | AP SET: 100%

\*The above data pertains to the final year postgraduate students who attempted these exams and qualified.

## Admissions



## Research & Teaching Grants



## Central Research Instruments Facility (CRIF) and Central Research Laboratory (CRL)

**SSSIHL Central Research Instruments Facility (CRIF), based at the Prasanthi Nilayam Campus and SSSIHL Central Research Laboratory (CRL), based at the Anantapur Campus for Women, are one of the few such facilities in the country (and the first of its kind in a rural location) that house advanced characterization/analytical tools to carry out translational research in various areas of science and technology such as physical, biological, chemical, materials science, food & nutritional sciences and computational and interdisciplinary areas.**

The facilities, built with a funding of over 45 crore with the kind support of Sri Sathya Sai Central Trust, hosts a range of cutting-edge instruments and laboratories as listed on the opposite page. It has significantly strengthened the existing research facilities at SSSIHL by providing state-of-the-art infrastructural facilities under a single roof.

This has allowed faculty, post-doctoral fellows, doctoral students and postgraduate students at the institute to accelerate their research work in all the major research areas of the Faculty of Sciences - Health, Energy and Environment.

It will enable them to keep pace with the scientific developments taking place globally; and to publish their research findings in peer reviewed high impact journals; and through their concerted efforts to carry out research in cutting edge areas of Science and Technology and contribute to the needs of the society at large.

Full-time technical assistants with specific expertise to operate and maintain the instruments and laboratories.



SSSIHL CRIF facilitates the strengthening of interdisciplinary health related research collaborations between SSSIHL and Sri Sathya Sai Institute of Higher Medical Sciences (SSSIHMS). Some of these include: Regenerative Medicine & Tissue Engineering, Rapid Detection of Endemic Diseases, Diabetic Retinopathy, Development of Cost Effective Multi- Modal Microscopes, SPCE-based Point of Care Devices, etc.

### Core Facilities

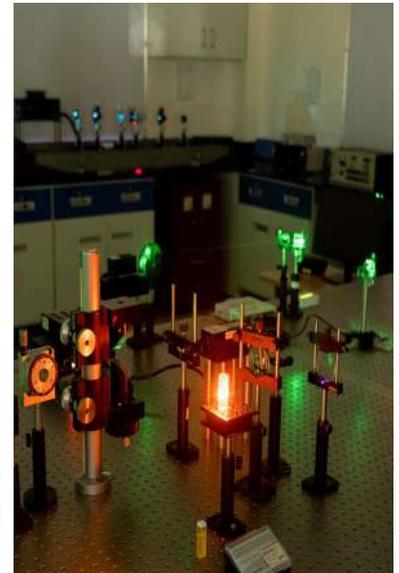
The following core facilities at CRIF and CRL are shared resources offering a range of services to the research community at SSSIHL:

- Femto Fab
- Electron Microscope Facility
- NMR and Mass Spectrometry Facility (LC-MS-QQQ and LC-MS-QTOF)
- Materials Characterization Facility
- Thermal and Optical Characterization Facilities
- Liquid Nitrogen Facility
- Central Utilities Facility
- Optical Imaging and Integration

### Laboratories

In addition, CRIF hosts the following labs:

- Wet Chemistry Laboratories
- Functional Materials Laboratory
- Materials Synthesis Laboratory
- Water Research & Electrochemistry
- Bio-Safety Labs: Level 1 and Level 2
- Computational Science and Plasmonics
- Non-linear Optics Laboratory



# Eligibility Criteria

## Areas of Research for April 2023 Entry:

Each department has listed in the pages below the specific areas in which research can be undertaken in April 2023. The Prospective candidates who would like to apply should ensure that they clear the eligibility criteria listed below.

- All Ph.D. applicants should not be more than 29 years of age as on 31 May 2023
- The applicant should be unmarried.
- It will be a residential programme. Selected candidates must reside in the hostel till they complete their Ph.D. programme without exception
- **Academic Qualifications:** Applicants must have completed a Master's degree correlating to the Ph.D. programme they are applying for (final year students must have appeared for their final exams by the time of the admissions tests) with minimum 60% marks (aggregate) or equivalent grade from SSSIHL or any other recognized university in the following disciplines:
  - **Mathematics:** Any one of the following degrees: M.Sc. Mathematics / M.Sc. Statistics / M.Sc. Operations Research/ M.Sc. Actuarial Sciences or PG equivalent in Actuarial Science as per UGC, M.Sc. Mathematics or Statistics or Data Science and Computer Science
  - **Computer Science:** Any one of the following degrees: M.Sc. in Computer Science / M.Sc. in Information Technology / M.Sc. in Data Science and Computing / Master of Computer Applications / M.Sc. in Mathematics (with sufficient background in CS and programming) / M.Sc. Statistics (with programming skill) / M.Tech. in Computer Science / M.Tech. in Computer Science and Engineering / M.Tech. in Information Technology / M.Tech. in any branch of Science and Engineering with sufficient background in Data Structures, Algorithms and Programming, M.Sc. Actuarial Science, M.Sc. Mathematics, M.Sc. Statistics, M.Sc. Data Science, M.Sc. data Science and Computing and/or PG equivalent in Actuarial Science as per UGC.
  - **Physics / Photonics / Nuclear Physics:** Any one of the following degrees: M.Sc. in Physics / M.Sc. in Photonics / M.Sc. in Nuclear Physics
    - › **Materials Science:** Any one of the following degrees: M.Sc. in Physics / M.Sc. in Chemistry / M.Sc. in Photonics / M.Sc. in Materials Science / M.Sc. in Nanoscience and Nanotechnology / M.Tech. in Materials or Ceramic Engineering
  - **Chemistry:** M.Sc. in any branch of Chemistry (Organic, Inorganic, Physical, Analytical and Biochemistry)
  - **Biosciences:** Master's degree in any branch of Biological Sciences
  - **Management & Commerce:** M.B.A (with any specialization), M.Com., M.M.S.
  - **Economics:** M.A. in Economics
  - **English Language & Literature:** Master's degree in English Language & Literature, ELT, Linguistics, Communicative English and Media Studies

# Application Process

## Meeting Eligibility Criteria

Candidates who meet the minimum eligibility criteria listed above can apply

## Candidates Eligible for a Direct Interview

Candidates who have qualified in the UGC CSIR (JRF) / UGC NET (JRF) / ICMR(JRF) / ICAR(JRF) National Examination need not take the admission test of the institute and they will be considered for the Interview based on their performance in the evaluation test in English and a technical viva.

Candidates submitting their GATE / JEST scores will be assessed by the respective Department of the Institute and those found eligible need not take the admission test of the institute and they will be considered for the Interview based on their performance in the evaluation test in English and a subject viva.

## Candidates Who Must Appear for the Admission Test

All other candidates who have not qualified in one or more of the above National Examinations but meet the minimum eligibility criteria listed in the previous page, will be required to take the Admission Test if shortlisted, along with a test in English and a subject viva to be considered for the interview to the Ph.D. programme.

## How to Apply?

- Click on the relevant link provided for Men and Women separately on the [Apply Online](#) page to access the Application forms
- Create an account by registering yourself (Applicant) using a valid email ID
- Use the credentials received in your email inbox to login into your account
- Click the 'New Application' button
- Choose Ph.D. from 'Application Type' field
- Choose the Admission year as '2023-2024'
- Choose the default Program type given in the dropdown
- Choose the Term as 'Semester-1'
- Click on 'Start Applying'
- Review the important information and eligibility criteria given on the first page
- Make a payment of Rs. 200/- towards the application fee using the SBI Collect link provided in the form (Under Primary Information)
- Choose the department you wish to apply to - and add the 3 preferred areas of research
- Fill in the rest of the form and make sure to attach the necessary documents
- After submission, view/print your application using the link provided on your login page
- All your information is transmitted through a secure server and is kept fully confidential. Your application information and accompanying credentials are reviewed by authorised representatives of the Institute.

**NOTE:** Ph.D. entrance test and interviews will be conducted online. Clear guidelines or any changes in procedure will be provided to candidates shortlisted for the exam/ interviews.

## Important Instructions

- The candidates must carefully fill and submit the online application form on or before the specified date.
- After the last date, all applications will be screened and qualifying candidates selected for the admission test/viva/interviews will be intimated by email
- All communication with candidates will be by email only.
- Kindly check our website for periodic updates.
- In case of any application related queries, email us at [admissions@sssihl.edu.in](mailto:admissions@sssihl.edu.in) with your application number mentioned on the subject line or you may also reach us on +91 9441911391/ +91 8331034774/+91 8555 287239 between 9am and 4.30pm, Monday to Saturday (Except holidays).
- All your information is transmitted through a secure server and is kept fully confidential
- Your application information and accompanying credentials are reviewed by the SSSIHL admissions team and/or by other authorised members of the Institute
- Please note that false or misrepresented information on the application will result in rejection of the application for admission or even result in the cancellation of the candidate's registration of the Ph.D. program.

## Application Availability and Submission Deadline:

All applications must be submitted by 24 May 2023 on or before 5pm IST

**List of Mandatory Documents to be scanned, self-attested and submitted along with your duly filled in Application form**

1. Government approved Photo ID card - Aadhar card
2. Recent Photograph of Candidate (formal photo taken in past few days) - in JPG/JPEG/PNG formats only
3. Application Fee -Payment Receipt Copy
4. Educational Certificates/Mark Sheets of your X, XII, Bachelor's, Master degree and MPhil (if applicable) duly attested by candidate
5. Self-attested copies of the caste certificates in case of SC/ST
6. Relevant copies of certificates of UGC/JRF, CSIR/NET, GATE/GEST etc., (if applicable)

### Await Confirmation on Eligibility for Written Test

- Once the Admissions Office processes your application those eligible will receive an Admissions Entrance Test card (Hall ticket) by email.
- The Hall Ticket (printed copy) should be produced and shown on Camera to the Examination Proctor on the day of the entrance exam to verify and confirm your identity.

- Applications not meeting the eligibility criteria will be rejected and the candidates will be informed by email.
- The final list of candidates qualifying for the admissions test will be published on our website post scrutiny.

### Test / Interview Dates\*

**Admission Test: 29 May 2023**

**Interviews: 05 June 2023**

*\* All dates are tentative only and are subject to change. Please stay tuned to [sssihl.edu.in](http://sssihl.edu.in) for regular updates.*

### Final Selection & Admissions Confirmation

- The final list of selected candidates for the SSSIHL Ph.D. programme will be published on SSSIHL's website [sssihl.edu.in](http://sssihl.edu.in), stay tuned.
- The Selected candidates will be informed of the Ph.D. programme commencement date
- Provisional admission to the Doctoral Research Programme stands confirmed subject to candidates satisfying the eligibility criteria and submission of original marks statement of all the examinations, degree certificate and other certificates as required by SSSIHL, within one month from the date of Admission, failing which, his/her admission will be cancelled.
- Provisionally selected candidates will be examined for medical fitness by SSSIHL's Medical officer

### Remuneration

- Candidates successfully admitted to Doctoral Research Programme, and who have not qualified to receive a stipend/ scholarship/fellowship from any of the granting agencies will receive a monthly research stipend from Sri Sathya Sai Institute of Higher Learning.

### Question Paper Pattern

Subject Test (75 Marks)

Part A: Multiple Choice Questions (30x1 = 30 marks)

(Please NOTE that an incorrect response will attract negative marking).

Part B: Answer any 9 (out of the following) in about 150 words each (9x5 = 45 marks)

### Evaluative Test in English (50 Marks)

Questions to test the knowledge of usage of articles, tenses, overall Grammar and Comprehension and writing skills in English.

### Model Test Papers

To help you better prepare for your Admissions Test, you can view model test papers on [our website](#).

### CONTACT US

**For further assistance email us at [admissions@sssihl.edu.in](mailto:admissions@sssihl.edu.in)  
Or call us on +91 9441 911 391/  
+91 8331034774/+91 8555 287239  
Lines are open between 9am and 4.30pm, Monday to Saturday  
(Except holidays).**

## Information on Hostel Life

Given the compulsory residential nature of the system of Sri Sathya Sai Values-based Integral Education imparted at SSSIHL, a student's stay at the hostel becomes an important component of the holistic, character building education imparted during their stay here.

The hostel provides a conducive environment for the practice of inputs on values and spirituality received at the campus through community living and encourages experiential learning and blossoming of the human personality. The undercurrent of life at the hostel is discipline, self-regulation and well-mannered behaviour, epitomising the adage 'simple living and high thinking.'

The daily hostel routine includes prayer and meditation, games and sports, participation in social service and attending bhajans.

Doctoral Research Scholars—being the senior most students need to be role models worthy of emulation by other students. They therefore need to be impeccable in their behaviour as well as personal grooming and attire at all times. They are also expected to contribute to the functioning of the Hostel by either taking care of one or two students' rooms (as Room Teachers) or taking charge of a specific Self-Reliance department at the hostel.

**IMPORTANT:** Given the unique Gurukula system of Values-based Integral Education at the Institute—where students need to be residing full-time at the hostel during the entire period of their Ph.D. programme—only unmarried (bachelor/maiden) students will be admitted. **Engaged or married students need not apply.**

**Any breach of this policy during the course of study will result in the admissions confirmation being revoked.**

**Additionally, since its inception in 1981, Sri Sathya Sai Institute of Higher Learning has gender-specific campuses.** Accordingly, admissions (to all programmes) are campus-specific.



# Biosciences

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

- **Substrate Specificity of Enzymes:** Identification of important amino acids in PDE isoforms which are crucial in imparting substrate specificity to PDE proteins.
- **Obesity and Diabetics:** (i) Studies on biochemical pathways to understand obesity associated metabolic abnormalities (ii) Identification of specific miRNA from adipocyte profile analysis and understanding the effects of selected miRNA on adipocyte dysfunction and metabolic disorders.
- **Neurodegenerative Disorder - Alzheimer's Disease (AD):** Investigate the genes that are essential for amyloid formation by RNAi and perform transcriptomic and metabolomic analysis to understand the onset of AD.
- **Nutraceutical Potential of Mushrooms:** Investigation of nutraceutical compounds, metabolomic analysis, anti-amyloid and anti-cancer properties of mushrooms.

### For Men

- **Disease Biology:** (i) Multi-Omic analysis of clinically well characterized Huntington's Disease (HD) patients (ii) Integrated study of clinical data, multimodal MRIs and metabolomics of Parkinson's Disease (PD) patients to understand deregulation of pathways in amyloid formation.
- **Microbial Biotechnology:** Anti-diabetic, Anti-cancer and Anti-bacterial studies and Metabolite profiling of endophytic fungi isolated from Medicinal plants.
- **Wastewater Analysis Treatment and Energy Recovery:** Developing cost-effective strategies for sustainable treatment and reuse of wastewater.

### Infrastructure

In addition to the common facilities at the Central Research Instruments Facility (CRIF), the department hosts the following facilities/ laboratories for research:

- Mycology and Plant pathology
- Plant tissue culture
- Animal cell culture
- Wastewater analysis
- Structural biology
- Antimicrobial resistance lab
- Bioinformatics

Research equipment housed in the department include:

- PCR Thermal cycler
- Real time PCR
- UV-VIS Spectrophotometers
- Ultracentrifuge
- UV-Vis
- Fluorescence and Fourier Transform Infra-Red (FTIR) spectrophotometers
- Multimode microplate reader
- Chemi-doc documentation system
- Fast Protein Liquid Chromatography (FPLC)
- Nanodrop
- Qubit
- Nikon fluorescence microscope
- Hypoxia incubator
- CO<sub>2</sub> incubators
- Luminometer
- FACS analyzer
- Biosafety cabinets (Class II-A2)
- Lyophilizer
- Ultra-deep freezers (-150°C and -80°C)
- Incubators
- Humidity chambers
- Orbital shakers
- Ice flaker

# Chemistry

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

#### Nanoscience

- Development of nanostructured materials/composites based on polymers and inorganic nanostructures for environmental, sensing, biomedical and energy-based applications
- Design and development of nanomaterials as targeting and delivery moieties in theranostic and biomedical applications
- Tuning the optical properties of fluorescent nanomaterials for several strategic applications like anti-counterfeiting and multi-color imaging
- Fabrication of well-ordered assembly of zero-dimensional quantum dots for food safety applications

#### Materials Science

- Design and development of functional materials for strategic and societal applications
- Design and fabrication of various types of sensors- fluorescent sensors, electrochemical sensors and biosensors
- Design and synthesis of novel, highly efficient polymer-based sorbents for organic dye removal, defluoridation, and heavy metal sorption

#### Organic and Bio-organic Chemistry

- **Natural products:** Exploration of natural products and their derivatives as potential bio-active compounds
- Design, synthesis and evaluation of flavones with potential antimicrobial activity

#### Computational Chemistry:

- Extensive study on the role of biopolymers in adsorption desalination
- Study of novel biopolymers as hydrogen storage materials
- Design and study of novel bioactive molecules for potent antimicrobial activity

### For Men

#### Nanoscience

- Designing novel polymeric nanocomposites using DFT calculations
- Design of nanocomposites as electrocatalysts for energy and sensing applications
- Novel nanomaterials and nano thin films for plasmonic applications

#### Materials Science:

- DFT studies on mixed organic and inorganic double perovskite materials for applications in solar cells
- Design, synthesis, characterization and processing of bio-active bio-materials for orthopedic applications and dental implants
- Thin films of Metal-Organic Frameworks (MOFs) for biosensing applications and clinical diagnostic applications
- Rational design of TADF molecules for OLED applications - A computational and spectroscopic approach
- Design of electrode materials via theoretical and experimental analysis for battery type energy storage

- applications
- Design of functionalized carbon composites for fuel cell applications
- Design of materials for carbon dioxide capture and its electrocatalytic reduction

#### Physical Chemistry

- Theoretical calculation of flash point of complex volatile organic mixtures to be used in the perfume industry and software development
- Experimental and computational study of interactions of small molecules with biomolecules / nanostructures

#### Environmental Chemistry

- Nano sponges for environmental application
- Aerosol chemistry: Chemical characterization of aerosols and their impact on the cloud condensation nuclei and radiative forcing.
- Microplastics screening and detection from various Environmental Matrices
- Design and application of Perovskite materials for catalysis and environmental applications

#### Organic and Medicinal Chemistry

- **Natural Products:** Semi-synthesis of medicinally active compounds
- **Synthetic Organic Chemistry:** Synthesis of organic compounds with potential pharmacological activity and Non-linear Optical (NLO) properties
- Microwave Assisted Organic Synthesis (MAOS)
- Computational drug design
- UHPLC-MS based identification of Triterpenes in various biological matrices for therapeutic and nutraceutical applications
- Drug re-purposing - using a drug for an alternate target
- Synthesis of pro-drugs to improve bioavailability, selectivity of the drug interaction with cells or processes

#### Infrastructure

- Gas Chromatography- Mass Spectrometer (GC-MS)
- Gas Chromatography with ECD detector (GC-ECD for pesticide residue analysis)
- High-Pressure Liquid Chromatography system (with DAD and RI Detectors)
- Microwave Reactor
- UV-Vis Spectrophotometers
- FT-IR Spectrometer with ATR
- Fluorescence Spectrophotometer
- Atomic Absorption Spectrometer
- Ion Chromatography System
- Differential Scanning Calorimeter (DSC)
- Electrochemical Workstation (potentiostat/galvanostat)
- Flash Chromatography System

Wet labs are equipped with minor equipment required for carrying out research work.

# Humanities and Social Sciences

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

#### Economics

- Women Empowerment
- Self-help Groups

### For Men

#### Economics

##### Macroeconomic Modelling of the Indian Economy:

- Macroeconomy
- International Economics & Finance
- Monetary Theory & Policy

##### Financial Economics:

- Financial Sector & Economic Growth
- Public Finance & Fiscal Policy



# Languages and Literature

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

#### English Language & Literature

##### Literary Studies

- Poetry as a Literary Genre
- Literary Theory and Criticism
- Indian Aesthetics and Mythology
- Eco-critical Studies
- Modern/ Postmodern Literature
- Popular Culture Studies
- Life Writing
- Literary and Cultural Theories
- Early Modern English Literature

##### Language Studies

- Applied Linguistics
- Stylistics

### For Men

- Popular Culture Studies
- Morality/ Philosophy and Literature
- Linguistics
- Teaching of English as a Second Language

The Department of English Language and Literature at SSSIHL is committed to achieving excellence in research, and employs eclectic methods to both analyse and synthesise. With its creative, supportive and collaborative research ambience, the scholars in the department are encouraged to generate fresh ideas which are debated and ratified.

Research in both language and literature offer new modules and fresh perspectives that contribute notably to the fund of knowledge. The department uses the literary text as a pretext to unravel the deeper mysteries and meanings of the human condition and predicament; and relates 'art experiences' to 'life experiences'. It also helps draw from the exercise, valuable moral lessons that would help the scholars to become morally empowered individuals.

While the literary researches bring in fresh perspectives, the language researches give value-addition to the existing practices. Weekly departmental colloquia, very regular interactions between scholars and supervisors, and insistence on quality research enhances the academic climate which promotes worthwhile research.

# Management and Commerce

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

- Human Resources Management
- Entrepreneurship and Technology

### For Men

- Rural Marketing and Digital Marketing
- Corporate Social Responsibility (CSR)



# Mathematics and Computer Science

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

#### MATHEMATICS

- Graph Theory: Theory of domination in chessboard graphs, topological indices of chemical compounds.
- Fluid Dynamics

### For Men

#### MATHEMATICS

- Fractal Interpolation Functions and Applications
- TB Disease Modeling
- Infectious Disease Modeling through PDE approach
- Non-Linear Diffusion Equations on Sheaves
- Arithmetic Properties of the Gaussian-Ramanujan Sums
- Functional Differential Equations-theory and Applications
- Computational Algebra for Cryptography

#### COMPUTER SCIENCE

- Data Mining & AI for better Health care
- Data Mining for Effective Analysis and Implementation of Social Security Schemes
- Natural Language Processing: Sentiment Analysis, Text Summarization
- Deep Reinforcement Learning
- Image Processing - Fractional Calculus Based Image Processing, Medical Image Processing, Drone-based Video Analysis for Surveillance

- Data-Centric AI
- A Framework to Integrate Artificial Intelligence and Machine Learning for Next Generation Hybrid Educational System
- A Decentralized Database Based on Blockchain for Large Scale Applications
- Privacy Preserving Data Analytics

#### ACTUARIAL SCIENCE

- Interpretable Machine Learning
- Modelling for Fraud detection in Health Insurance

#### Infrastructure

- The Department of Mathematics & Computer Science (DMACS) is equipped with a good library for books, monographs and access to journals in various domains of interest in Mathematics and Computer Science.
- Computing facility in DMACS supports the kind of research work in the area of Computer Vision, ML & DL, Security, HPC etc.
- Computing facility includes a three-node cluster, Four High end computing Nodes with Nvidia K40, TitanX and Intel MIC.
- The lab is also equipped for embedded processing with ARM processors and Jetson TK100. A Hadoop cluster is in place for developing applications in Hadoop and SPARK platform.
- The lab for Cybersecurity is equipped with server and necessary hardware to set up Honeypots for detecting and recognizing malware. Besides this the DMACS has access to a number of supercomputing facilities in USA.

# Physics

## AREAS OF DOCTORAL RESEARCH AVAILABLE FOR APRIL 2023 ENTRY

**Note:** Applicants should enter a maximum of three preferred areas of research on the application form (in the order of preference) from the areas listed below.

### For Women

#### Materials Science:

- Nanomaterials-based water purification
- Nanomaterials for sensing and quantification of contaminants in air and water
- Fabrication of thin films for solar cell applications
- Fabrication of nanocomposites for photoelectrochemical water splitting applications

### For Men

#### Photonics:

- Design and development of ultrafast fiber lasers for applications in spectroscopy and imaging
- Developing novel photonic materials for applications towards optoelectronics and biological imaging

#### Biomedical Spectroscopy:

- Applied spectroscopy with chemometrics for biomedical and analytical applications

#### Materials Science:

- Design of novel materials for energy storage and varistor applications
- Study and fabrication of novel lead-free gamma radiation shielding materials

#### Nuclear Physics:

- Theoretical and experimental study of pure E2 transitions

#### Computational Biophysics:

- Computational studies on interaction of dendrimers with fullerenes and drug molecules

### Infrastructure

With the support of funded projects from various funding agencies like UGC, MHRD, DST, DAE-BRNS, DRDO and along with the support from our parent organization, Sri Sathya Sai Central Trust, the Department of Physics houses state-of-the-art facilities, including:

- Femtosecond Laser facility, Nd:YAG Laser with Harmonics generators, Sources and Detectors
- Fusion splicer, High Bandwidth Digital Oscilloscope, Optical Energy/Power meters, Solar Simulator, Vector Network Analyzer, UV-Visible spectrophotometer
- Planetary Ball Mill, Harman system for Thermoelectric Figure of Merit measurement, Modular Raman Spectrometer
- Spin coating unit for Thin Films Fabrication, Solvo/ Hydrothermal Reactor, High Temperature Furnaces and Ovens
- Radiation survey meters, Scintillation detectors, Semiconductor detectors HPGe and Si(Li), NIM - Nuclear Instrumentation Modules, Turbo-molecular pump

The above facilities are in addition to the Central facilities available at SSSIHL Central Research Instruments Facility (CRIF) listed on pages 10 and 11 above.

# Admissions Test Syllabus

## Biosciences

**Molecular Cell Biology:** Organization of prokaryotic and eukaryotic cells, Cell wall and membrane, Major cell organelles, Membrane transport, Cell junctions, Cell adhesion and Extracellular matrix, Cellular communication and signaling pathways, Cell cycle and Cell division, Cell death.

**Molecular Biology and Genetic Engineering:** Genome organization in prokaryotes and eukaryotes, DNA replication, Transcription, Protein synthesis, Regulation of gene expression in prokaryotes and eukaryotes, DNA repair and damage, Molecular cloning strategies, Molecular diagnostics, Transgenic plants and animals, Gene therapy.

**Biological Chemistry:** Structure, function and metabolism of carbohydrates, proteins, lipids and nucleic acids, Enzyme kinetics and regulation of enzyme activity, Electron transport chain and oxidative phosphorylation.

**Immunology:** Cells and organs of immune system, Antigens, Structure and function of immunoglobulins, Major Histocompatibility Complexes, Humoral immune response, Cell mediated immunity, Hypersensitive reactions, Autoimmunity.

**Developmental Biology:** Gametogenesis, Fertilization, Cleavage - Blastulation, Gastrulation and Neurulation, Proximate tissue interactions, Genetics of axis specification in *Drosophila*, Stem cells and their applications.

**Microbiology:** Bacterial structure and function, Bacterial growth and metabolism, Microbial Recombination, Conjugation, Transformation, Transduction and Transposition, Structure of viruses, Viral replication strategies.

**Biotechnology:** Applications of fungi in biotechnology, Plant tissue culture and micropropagation, Production of secondary metabolites from microbes and plants, Biomineralization, Biotechnological approaches for pollution control, Intellectual Property Rights and patenting of biological materials.

**Biostatistics:** Measures of central tendency, Measures of dispersion, Statistical hypothesis testing, Analysis of variance, Chi-square analysis, Correlation and Regression analysis

**Analytical techniques:** Principle and applications of microscopes (light microscope, phase contrast microscope, fluorescent microscope) pH meter, biosafety cabinets, centrifugation techniques, electrophoretic techniques, blotting techniques



## Chemistry

### Analytical Chemistry

**Instrumental:** UV-visible spectrophotometry, NMR and ESR spectroscopy, mass spectrometry. Chromatography including GC and HPLC.

**Spectroscopy:** Applications of UV-visible, IR, NMR and Mass spectrometry in the structural determination of organic molecules.

### Physical Chemistry

**Quantum chemistry:** Postulates of quantum mechanics, application of Schrodinger's equation to the particle in a one-dimensional box, rigid rotator, harmonic oscillator; Group theory: symmetry elements and operations, classification of molecules into different point groups; Statistical thermodynamics, thermodynamic functions in terms of the partition functions; Electrochemistry: Debye-Huckel Onsager equation (derivation), Butler-Volmer equation (derivation);

**Chemical Kinetics:** CTST, unimolecular gas phase reactions, complex reactions; Fast reaction kinetics: relaxation method and flash photolysis; Langmuir and BET adsorption isotherms; Electrical double layer and zeta potential.

### Inorganic Chemistry

**Chemical Periodicity:** Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory); Concepts of acids and bases: Hard-Soft acid base concept, Non-aqueous solvents; Main group elements and their compounds: Allotropy, synthesis, structure and bonding, industrial importance of the compounds; Transition elements and coordination compounds: structure, bonding theories, spectral and magnetic properties, reaction mechanisms; Organometallic compounds: synthesis, bonding and structure, and reactivity; Organometallics in homogeneous catalysis.

**Solid State:** Crystal systems and lattices, Miller planes, crystal packing, crystal defects, Bragg's law, ionic crystals, band theory of metals and semiconductors.

### Organic Chemistry

**Stereochemistry:** Chirality of organic molecules with chiral centers and determination of their absolute configurations.

Geometrical isomerism.

**Reaction Mechanisms:** Basic mechanistic concepts - Nucleophilic and electrophilic substitution reactions (both aromatic and aliphatic). Addition reactions to carbon-carbon and carbon-heteroatom (N, O) multiple bonds. Elimination reactions. Reactive intermediates - carbocations, carbanions, carbenes, arynes and free radicals. Molecular rearrangements involving electron deficient atoms.

**Organic Synthesis:** Synthesis, reactions, mechanisms and selectivity involving the following classes of compounds - alkanes, alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids, esters, nitriles, halides, nitro compounds, amines and amides. Uses of Mg, and Li based reagents in organic synthesis. Michael addition reaction. Pericyclic Reactions: Electrocyclic, cycloaddition and sigmatropic reactions.

**Heterocyclic Compounds:** Structure, preparation, properties and reactions of furan, pyrrole, thiophene and pyridine, indole, quinoline and isoquinoline.

**Note:** Questions will cover areas in different branches like M.Sc. (Inorganic Chemistry), M.Sc. (Physical Chemistry), M.Sc. (Organic Chemistry) and M.Sc. (Analytical Chemistry)



## Humanities and Social Sciences

### Economics

**Microeconomics:** Consumer theory and Behaviour, Theory of Production and Cost, Market Structures, perfect and imperfect markets, Elements of Welfare Economics, General equilibrium.

**Macroeconomics:** Measurement of National Income, Classical theory of Employment, Income, Expenditure Model -Money and Goods market, Consumption and Investment, Business cycles, Macroeconomic Dynamics, Policy Implications.

**Quantitative Methods:** Sets and Functions, Differential Calculus of one variable and several variables, Economic applications of derivatives, Optimization, with and without constraints, Difference and differential equations of first order, Matrices, Operations on matrices, inverse of a matrix-probability, expectation and variance, Probability distributions, Binomial, Poisson, Normal.

**Development Economics:** Economic Growth and Economic Development, Theories of Economic Growth and Development Neoclassical and endogenous growth models, Inclusive Growth, Human Development, Rural Development.

**Public Economics and Fiscal Policy:** Public Finance, Principles of Taxation and Resource Allocation, Public Expenditure -Fiscal Functions and Theory of Public goods Fiscal Policy and the Budget, Federal Finance in India, Cost, Benefit Analysis

**Indian Economy:** Structure of the Indian Economy, Agriculture, Industrial and Tertiary Sectors, Role of government, Services and Trade, New Economic Policy, Contemporary Issues, Future Scenario.

**Econometrics:** Elements of statistical Inference, Theory of Estimation (OLS and MLE), Testing of Hypothesis (t, Chi square and F tests) - Multiple regression models, Multicollinearity, Heteroscedasticity, Autocorrelation, Dummy variables.

**Financial Economics:** Introduction to Financial system, Financial Markets and Institutions, Finance and Economic Development, Financial Reforms in India, Investment Environment, Risk Management.

**International Economics and Finance:** International trade theory, Economic integration, Balance of Payments, Exchange rates and Foreign exchange markets, International monetary system.

## Languages and Literature

### English Language & Literature

Based on the topics covered in the latest [syllabus](#) for M.A. in English Language & Literature at SSSIHL.



## Management and Commerce

**Entrepreneurship:** Traits of innovative Entrepreneur, Entrepreneurial Decision, Process, Opportunity identification, Types of entrepreneurship, Creativity and Innovation, Source of capital for entrepreneurship, Types of startup, Definition of Micro, Small and Medium Enterprises, Institutional Support and Legality. Formulating a business plan elements, Business plan pitch, Business Incubators.

**Marketing Management:** Core marketing concepts, Consumer Buying Behaviour, Market Segmentation, Digital Marketing, Product Life Cycle Strategies, Innovation and New Product development, Marketing Services, Pricing, Marketing Channels, Marketing Communication process.

**Financial Management:** The goal of financial management, Decisions in financial management, Time value of money and Valuation of securities, Investment decisions- Capital Budgeting, Calculating average return and risk, Efficient market hypothesis and its forms, Capital structure and cost of capital, Short term financing decisions.

**Statistics for Business Management:** Descriptive statistics, Probability and Decision Theory, Probability Distributions, Inferential statistics, Analysis of Variance, Non-Parametric Methods, Simple Correlation and Regression.

**Human Resource Management:** Changing nature of Human Resource Management, Human Resource Planning, Job Analysis and Job Design, Selection and Recruitment, Training and Development, Performance Appraisal, Compensation Management, Quality of Work Life.

**Management Accounting:** Analysis of financial statements, Cash flow statement, Cost Volume Profit analysis and decision making, Budgets and Budgetary control, Standard costing.

**Services Operations Management:** Operations strategy and Competitiveness, Service Quality, Demand forecasting, Managing Capacity and Demand, Managing Waiting Lines, Inventory Management, Supply chain management.

**Management Science:** Linear Programming Problems - Formulation of Linear Programming Problems, Graphical solutions, Simplex Algorithm, Industrial Applications of LPP, Transportation and Assignment models, Network Analysis using PERT and CPM.

## Mathematics and Computer Science

### Candidates Seeking a Ph.D. in Mathematics

**Linear Algebra:** Finite dimensional vector spaces, Linear transformations and their matrix representations, rank, systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalization, Hermitian, Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, self-adjoint operators.

**Complex Analysis:** Analytic functions, conformal mappings, bilinear transformations, complex integration, Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Zeros and singularities, Taylor and Laurent's series, Residue theorem.

**Real Analysis:** Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima; Riemann integration, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, compactness, completeness, Weierstrass approximation theorem; Lebesgue measure, measurable functions; Lebesgue integral.

**Ordinary Differential Equations:** First order ordinary differential equations, existence and uniqueness theorems for initial value problems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients; method of Laplace transforms for solving ordinary differential equations, series solutions (power series, Frobenius method); Legendre and Bessel functions and their orthogonal properties.

**Algebra:** Groups, subgroups, normal subgroups, quotient groups and homomorphism theorems, automorphisms; cyclic groups and permutation groups; Rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, Principle ideal domains, Euclidean domains, polynomial rings and irreducibility criteria.

**Functional Analysis:** Normed linear spaces, Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems, principle of uniform boundedness; Inner-product spaces, Hilbert spaces, orthonormal bases, Riesz representation theorem, bounded linear operators.

**Numerical Analysis:** Numerical solution of algebraic and transcendental equations; fixed point iteration; interpolation; error of polynomial interpolation; numerical differentiation; numerical integration; numerical solution of systems of linear equations: direct methods; iterative methods; numerical solution of ordinary differential equations and initial value problems.

**Partial Differential Equations:** Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems; solutions of Laplace, wave in two dimensional Cartesian coordinates, Separation of variables method for solving wave and diffusion equations in one space variable; Fourier transform method based solutions for the above equations.

**Topology:** Basic concepts of topology, bases, subbases, subspace topology, order topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma.

**Graph Theory:** Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Isomorphism; Depth first search and breadth first search.

### Candidates Seeking a Ph.D. in Computer Science

**Set Theory & Algebra:** Sets; Relations; Functions; Partial Orders, Groups, Boolean Algebra.

**Linear Algebra:** Algebra of matrices, determinants, systems of linear equations, Linear Transforms, Eigen values and Eigen vectors.

**Probability:** Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions.

**Graph Theory:** Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Isomorphism; Depth first search and breadth first search.

**Computer Organization and Architecture:** Machine instructions and addressing modes, ALU and data-path, CPU control design, Memory interface, I/O interface (Interrupt and DMA mode), Instruction pipelining, Instruction level parallelism - hardware and software techniques (e.g., dynamic scheduling, superscalar, static and dynamic branch prediction,

VLIW, loop unrolling), Cache and main memory, multi-level caches, Cache consistency, snoopy protocols, Secondary storage.

**Programming and Data Structures:** Functions, Recursion, Parameter passing; Abstract data types, Arrays, Stacks, Queues, Linked Lists, Trees, Binary search trees, Heaps, O-O Programming Concepts: Class, object, instantiation. Inheritance, polymorphism and overloading.

**Algorithms:** Greedy algorithms, dynamic programming, divide-and-conquer, network flow, Notions of space and time complexity, Asymptotic analysis: Big Oh, Little oh, Theta, Worst case and average case analysis, Polynomial time algorithms, NP-algorithms, NP-hardness and NP-completeness.

**Relational Database Design and SQL:** E-R diagrams and their transformation to relational design, normalization-1NF, 2NF, 3NF, BCNF and 4NF. Limitations of 4NF and BCNF. Good working knowledge in SQL.

**Computer Networks:** Network fundamentals: LAN, MAN, WAN, Wireless Networks. Reference Models: The OSI model, TCP/IP model. Data Communication: Channel capacity. Internet working: Switch/Hub, Bridge, Router, Gateways, Tunnelling, Fragmentation, Routing algorithms, Sliding window protocols, Three-way handshake, Congestion control.

**System Software and Compilers:** Assemblers-2-pass and single-pass. Macros and macroprocessors. Loading, linking, relocation, program relocatability. Phases of compilation process. Lexical analysis. Context free grammars. Parsing and parse trees. Representation of parse (derivation) trees as rightmost and leftmost derivations. Bottom up parsers-shift-reduce, operator precedence, and LR.

**Operating Systems (with Case Study of Unix):** Main functions of operating systems. Multi Programming, multiprocessing, and multitasking. Memory Management: Virtual memory, paging, fragmentation. Concurrent Processing: Mutual exclusion.

**Critical regions, lock and unlock. Scheduling:** CPU scheduling, I/O scheduling, Resource scheduling. Deadlock and scheduling algorithms. Banker's algorithm for deadlock handling.

### Candidates Seeking a Ph.D. in Actuarial Science

**Numerical Analysis:** Numerical solution of algebraic and transcendental equations; fixed point iteration; interpolation; numerical differentiation; numerical integration; numerical solution of systems of linear equations: direct methods; iterative methods; numerical solution of ordinary differential equations and initial value problems.

**Partial Differential Equations:** Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification;

**Set Theory & Linear Algebra:** Sets; Relations; Functions; Partial Orders, Groups, Boolean Algebra, Algebra of matrices, determinants, systems of linear equations, Linear Transforms, Eigen values and Eigen vectors.

**Probability and Statistics:** Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; Exploratory Data Analysis, Statistical Inference; confidence intervals; Hypothesis testing; Regression Theory and applications; ANOVA

**Applied Statistics:** Bayesian statistics; Loss Models; Poisson Process; Time Series; Stochastic Processes; Survival Models, Fundamentals Machine Learning

## Physics

### For Candidates with a Masters (M.Sc.) degree in Physics, Photonics and Nuclear Physics

**Mathematical Methods of Physics:** Vector algebra and vector calculus; Linear algebra, matrices, eigenvalues and eigenvectors; ordinary differential equations of first & second order; Fourier transforms; Elements of complex analysis.

**Electromagnetism:** Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems. Magnetostatics: Biot-Savart law, Ampere's theorem. Electromagnetic induction. Maxwell's equations in free space and linear isotropic media; Electromagnetic waves in free space.

**Optics and Photonics:** Geometrical optics, wave optics: Interference, diffraction, polarization, optical anisotropy, light microscopy, spatial and temporal coherence.

**Quantum Mechanics:** Wave-particle duality. Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.). Commutator and Heisenberg uncertainty principle; orbital angular momentum, angular momentum algebra, spin, addition of angular momenta; Hydrogen atom

**Thermodynamic and Statistical Physics:** Laws of thermodynamics and their consequences. Thermodynamic potentials, Maxwell relations, chemical potential, phase space, micro- and macro-states. Micro- canonical, canonical and grand-canonical ensembles and partition functions

**Electronics:** Pn Junction diodes, transistors, Operational amplifiers and their applications. Digital Electronics: Logic Gates, Flip flops and applications.

**Atomic & Molecular Physics:** LS & JJ coupling schemes. Zeeman effect, Born-Oppenheimer approximation. Electronic, rotational, vibrational and Raman spectra of diatomic molecules, selection rules. Lasers: Spontaneous and stimulated emission, population inversion; Laser characteristics; Classification of lasers- two-level, three-level and four-level laser systems, Laser systems - He-Ne laser, CO<sub>2</sub> lasers, Dye lasers, Solid state lasers - Ruby laser, Nd-YAG laser, Nd-glass laser.

**Solid State Physics:** Bravais lattices. Reciprocal lattice. X-ray diffraction and the structure factor, bonding of solids. Elastic

properties, phonons, lattice specific heat. Free electron theory and electronic specific heat. Drude model of electrical and thermal conductivity. Hall effect and thermoelectric power; band theory of solids: metals, insulators and semiconductors; magnetism- dia, para, ferro and ferri-magnetism; dielectric and ferroelectric properties.

**Nuclear Physics:** Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, Evidence of shell structure, single-particle shell model, elementary ideas of alpha, beta and gamma decays and their selection rules.

**For Candidates with an M.Sc. in Physics, Chemistry, Materials Science, Nanoscience & Nanotechnology, or an M.Tech. in Materials Science & Engineering, Materials & Metallurgical Engineering, Nanotechnology, Materials or Ceramic Engineering**

**Crystal Structure & Defects:**

Crystal symmetry, indices of planes, close packing in solids, types of crystal structures, coordination, radius ratios concepts, Miller Indices, Defects in Solids: Point defects, dislocations (edge and screw) Burgers vector - grain boundaries.

**Materials Fabrication:**

Synthesis of Materials: Fabrication of Nanomaterials - Top-down & Bottom-up approaches; Soft chemistry routes: solvothermal/hydrothermal method, sol-gel method; methods of preparing single crystals; physical and chemical vapor deposition.

**Characterization & Spectroscopic Techniques:**

X-ray diffraction technique, indexing of diffraction patterns, Electron Microscopy - fundamentals of SEM and TEM; Scanning Probe Microscopy: STM & AFM; Spectroscopic tools - UV-Visible Spectroscopy, Vibrational spectroscopy: IR and Raman Spectroscopy.

**Physical properties of materials :**

Mechanical properties: Elements of elastic and plastic behavior of materials, stress-strain relations

Thermal properties: specific heat, thermal conductivity,

Magnetic properties: dia, para, ferro and ferri-magnetism,

Electrical and insulating properties: Electrical conductivity,

Dielectric behavior - piezo and ferro-electric materials,

elements of band theory, semiconductors, Hall effect,

Optical properties: refractive index, absorption coefficient,

frequency-dependent dielectric constant

**Quantum Mechanics:** Wave-particle duality, Schrödinger equation (time-dependent and time-independent). Eigenvalue problems (particle in a box, harmonic oscillator, etc.).

**Mathematical Methods:** Differentiation, integration, differential equations, vectors, matrices and determinants, eigenvalues and eigenvectors, complex numbers.

**Thermodynamics:** Thermodynamic potentials, Maxwell relations, chemical potential, phase rule, phase diagrams, solid solutions, lever rule; iron-carbon phase diagram, solidification, phase transformation, recrystallization, diffusion, mechanisms of diffusion.



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**Who is a Ph.D.?**

**A Ph.D. is one who helps others through their research and develops the country. This is the true objective of doing a Ph.D.**

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