# University of Mumbai



NAAC Accredited "A" Grade (2012) University University with Potential for Excellence

# Department of Physics (Autonomous)



Funded under UGC-SAP (SAP-I), DST-FIST (level-I) and DST-PURSE Schemes

# **Information Brochure**





- मुंबई विद्यापीठ हे माझे विद्यापीठ आहे आणि या विद्यापीठाचा मी एक सदस्य आहे याचा मला सार्थ अभिमान आहे.
- या विद्यापीठातील ज्ञानद आणि कार्यात्मक परंपरांविषयी मला आदर आणि प्रेम आहे.
- या विद्यापीठाच्या बहुभाषिक, बहुधर्मीय आणि वैविध्यपूर्ण स्वरुपाचा मला अभिमान आहे.
- मुंबई विद्यापीठाने रुजविलेल्या आणि जोपासलेल्या आधुनिक विचारप्रणालींचा वाहक होण्याची पात्रता माझ्या अंगी यावी, म्हणून मी संदैव प्रयत्न करेन.
- या विद्यापीठाचे कुलगुरू, प्र-कुलगुरू आणि कुलसचिव यांच्यासह सर्व गुरूजनांचा व वरिष्ठांचा मी मान ठेवीन. तसेच त्यांचा सुहृद्व होण्यासाठी मी प्रयत्न करेन.
- माझे सर्व सहकारी तसेच विद्यार्थी, पालक व इतरेजन यांच्याशी मी सौजन्याने व सहृदयपूर्वक वागेन.
- 💠 भारत देशातील या अतिशय प्रतिष्ठित विद्यापीठाशी मी सदैव निष्ठा राखेन.
- 👌 या विद्यापीठाचा लौकिक वाढविण्यासाठी मी कटिबद्ध आहे.
- मुंबई विद्यापीठाची शतकोत्तरी प्रतिष्ठा आणि या विद्यापीठाचा भविष्यकाळ उज्ज्वल करण्यासाठी मी सदैव प्रयत्नशील राहीन, यातच माझे सौख्य सामावलेले आहे.

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# Department of Physics (Autonomous)

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# Department of Physics (Autonomous)



Where the mind is without fear and the head is held high Where knowledge is free Where the world has not been broken up into fragments By narrow domestic walls Where words come out from the depth of truth Where tireless striving stretches its arms towards perfection Where the clear stream of reason has not lost its way Into the dreary desert sand of dead habit Where the mind is led forward by thee Into ever-widening thought and action Into that heaven of freedom, my Father, let my country awake -Rabindranath Tagore



Prof. Suhas Pednekar Honourable Vice-Chancellor University of Mumbai Mumbai

# From the Desk of the Head of the Department



The Department of Physics is a vibrant and invigorating department at the Kalina campus. It has provided an iconic leadership in academic research and training and shines as a "Jewel in the Crown" of the prestigious University of Mumbai. Established 47 years ago, the department has grown and emerged out as an epitome of academic excellence and knowledge devoted to education, training, research and industrial collaboration. It offeres various specialized courses (core and electives) in frontier areas of Physics. There has been a sizeable increase in the number of students of this Department entering into the industry as well as National Research Institutions. Many of them also opt to pursue higher studies and research career abroad. A large number of them succeed in securing gainful employment within the country. The list of achievements of this department is indeed voluminous, and ever since its inception, the department has provided a platform for some of India's most renowed Phyicists who could rise to international fame and glory. The Department of physics has always been a source of inspiration to the new generation of students encouraging them always to aim for the sky and gain from the experiences of their predecessors who are well placed at BARC, TIFR, PRL and other National Institutes. I exhort you to be in the forefront and make this part of your educational tenure memorable so that you can cherish it throughout your life.

> Imagine, Invent, Inspire ! Stay Blessed !

> > Dr. Vaishali Bambole Professor and Head

![](_page_11_Picture_0.jpeg)

Late Professor M. C. Joshi Founder Head of the Department of Physics (1971-1983)

## Our Vision

To be a Globally Recognised Centre of Excellence in Physics Education and Research

## Our Mission

- Continually ignite young minds to boldly and inquisitively explore un-trodden paths
- Establish a world-class academic programme, with dual emphasis on foundational and frontiers teaching and research
- Navigate learners towards the frontiers of Physics
- Instil the spirit of inquiry and innovation
- Create opportunity platforms for nucleation and incubation of entrepreneurs
- Build synergistic channels for productive knowledge transfer and utilisation through industry partners

## Our Approach

- Craft a pool of world class human resource in physics
- Establish the best in class infrastructure to facilitate the process of learning and research with the core strengths of the Department
- Nurture experimental, theoretical and computational physics with core strengths in Materials Science, Soft Condensed Matter, Nuclear Physics, High Energy Physics, Astronomy and Space Physics, Atomic Physics and Computational Physics.
- Network with national and global academic institutions through vibrant exchange programs and collaborations in teaching and research
- Involve physics-based industries in academic programmes to enrich the courses and create value-added linkages and career opportunities for faculty and students
- Ensure the creation of responsible personnel through engagement in socially relevant outreach programmes

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Disclaimer:

Every effort has been made to prepare an up-to-date and error-free document. If any typographical or other errors are found, they may be brought to the notice of the Head, Department of Physics. The errors will be corrected by publishing an addendum, if necessary.

## 1 Introduction

The University of Mumbai is one of the three oldest Universities of India. It is one of the largest universities in the country and has been recognized as a NAAC Accredited "A" Grade (2012) University and as a University with Potential for Excellence by the University Grants Commission in the year 2012.

The Department of Physics, which is one of the most active and vibrant departments on the Kalina Campus, was established in 1971 under the dynamic leadership of its Founder Head of the Department Late Prof. M.C. Joshi who is well known for his pioneering work in the area of ion implantation. Ion implantation based research has continued to be the major thrust area of the Department. However, the Department has established itself as a research center and teaching institution with expertise in all the major areas of Physics under the able guidance of various Heads of the Department.

The Department has been granted autonomy in the year 2013 and continues to be known as the main post graduate centre for Physics in the city of Mumbai by offering a variety of elective courses and project opportunities to the students and by establishing M. Sc. and research labs in several major sub-areas of Physics.

## Members of the Management Board

- 1. Prof. Tarun Kant (Chairman)
- 2. Prof. M. Barma
- 3. Prof. S. M. Chitre
- 4. Prof. R. P. Dahiya
- 5. Dr. P. Ganguli
- 6. Dr. P. Sekhar
- 7. Prof. Vaishali A. Bambole (Member Secretary)
- 8. Prof. A. Misra
- 9. Representative of Director, Higher Education

## Members of the Academic Board

- 1. Prof. Vaishali A. Bambole (Member Chairperson)
- 2. Dr. H. C. Pradhan
- 3. Prof. K. Rustagi
- 4. Prof. A. Misra
- 5. Dr. R. Srinivasan
- 6. Dr. S. K. Dubey
- 7. Dr. B. J. Nagare
- 8. Representative of Director, Higher Education

## Members of the Subject Board

- 1. Prof. Vaishali A. Bambole (Member Chairperson)
- 2. Prof. A. A. Rangwala
- 3. Prof. R. Nagarajan
- 4. Dr. M. N. Nyayate
- 5. Prof. A. Misra
- 6. Dr. R. Srinivasan

## Former Heads of the Department

1.	Late Prof. M. C. Joshi	1971-1983
2.	Prof. A. A. Rangwala	1983-1993
3.	Prof. Ram Pratap	1993-1994
4.	Late Prof. S. B. Patel	1994-2000
5.	Prof. V. H. Kulkarni	2000-2002
6.	Prof. A. M. Narsale	2002-2004
7.	Late Prof. T. R. Rao	2004-2005
8.	Prof. S. J. Gupta	2005-2007
9.	Prof. A. D. Yadav	2007-2010
10.	Prof. D. C. Kothari	2010-2013
11.	Prof. Anuradha Misra	2013-2016

# 2 Department Profile

## 2.1 Faculty Members

1.	Dr. Vaishali A. Bambole, Professor and Head of Department
	Ph.D. University of Mumbai (ICT, formerly known as UDCT)
	Research Area: Polymer Physics, Electronics, Bio-nano Physics
2.	Dr. Anuradha Misra, Professor
	Ph.D. I.I.T., Kanpur
	Research Area: Theoretical High Energy Physics
3.	Dr. Radha Srinivasan, Associate Professor
	Ph.D. University of Mumbai (TIFR)
	Research Area: Experimental Condensed Matter Physics, Material Science
4.	Dr S. K. Dubey, Assistant Professor
	Ph.D. University of Mumbai
	Research Area: Ion Implantation, Swift Heavy Ion
5.	Dr.Balasaheb J. Nagare, Assistant Professor
	Ph.D. University of Pune
	Research Area: Computational Physics, Electronic Structure Theory
6.	Dr. Sajeev S. Chacko, Assistant Professor
	Ph.D., University of Pune
	Research Area: Computational Physics, Electronic Structure Theory
7.	Dr. M. Hemalatha, UGC Assistant Professor
	Ph.D., Bhabha Atomic Research Centre, Mumbai
	Research Area: Experimental and Theoretical Nuclear Physics
8.	Dr. Milind V. Rundhe, Assistant Professor
	Ph.D. Institute of Physics, Bhubaneshwar
	Research Area: Experimental Condensed Matter Physics, Material Science
9.	Dr. Pradip Sarawade, Assistant Professor
	Ph.D., Hanyang University, South Korea
	Research Area: Material Science
10.	Dr. Nainesh Patel, UGC Assistant Professor
	Ph.D. University of Trento, Italy
	Research Area: Material Science, Energy Studies
11.	Dr. Sucheta Sengupta, DST Inspire Faculty
	Ph.D. IACS (University of Calcutta).
	Research Area: Materials Science, Energy Studies
12.	Dr. Ritwika Chakrabarti, UGC Assistant Professor
	Ph.D. UGC-DAE Consortium for Scientific Research, University of Calcutta
	Research Area: Nuclear Physics, Nuclear Structure, Gamma Ray Spectroscopy
13.	Dr. Anil N. Raghav, Assistant Professor
	Ph.D., University of Mumbai
	Research Area: Solar-terrestrial Physics, Space Physics, and Cosmic Rays Modulation
14.	Mr. Chetan Gurada, Assistant Professor
	M.Sc., M. Phil. University of Mumbai
	Research Area: Materials Science and Nano Science
15.	Mr. Nitinkumar M. Bijewar, Assistant Professor
	M.Sc., I.I.T., Bombay
	Research Area: Materials Science, Space Physics
16.	Mr. Siddharth Kasthurirangan, Assistant Professor
	M.Sc. University of Mumbai
	Research Area: Atomic Physics 5

# Adjunct Faculty / Honorary Professor / Scientist / Emeritus Fellow (last 5 years)

- 1. Prof. S. J. Gupta
- 2. Prof. D. C. Kothari
- 3. Prof. V. H. Kulkarni
- 4. Prof. R. K. Manchanda (NASI Fellow)
- 5. Prof. Lakshmi Natarajan
- 6. Late Prof. S. B. Patel
- 7. Prof. A. A. Rangwala
- 8. Prof. A. D. Yadav

## Post-doctoral fellows / Scientists

1. Dr. Mamta Agarwal

## Technical and Research Staff

- 1. Dr. S. R. Iyer Technical Assistant
- 2. Dr. T. K. Achal Technical Assistant
- 3. Dr. V. Jadhav Research Assistant

## Administrative, Library, Laboratory and Workshop Staff

## Administrative Staff

1.	Mr. Harjuram Jaggaram	Senior Clerk
2.	Mr. S. R. Salunke	Junior Clerk
4.	Ms. Usha Tupe	Junior Clerk
7.	Mr. R. H. Ghadi	Peon
8.	Mr. D. R. Khapare	Hamal
9.	Mr. Kiran Londhe	Peon
10.	Mr. Ravindra Kudtadkar	Peon
11.	Mr. Vishal Khadtar	Peon

## Library Staff

1. Ms. Megha Ghogare Junior Professor and Assistant Librarian

## Laboratory Staff

1.	Mr. V. D. Ghag	Lab. Assistant
2.	Mr. V. V. Jadhav	Lab. Assistant
3.	Mr. M. A. Pawar	Lab. Attendant
4.	Mr. S. K. Chavan	Lab. Attendant
5.	Mr. Y. C. Raut	Lab. Attendant
6.	Mr. M. S. Rane	Lab. Attendant

## Workshop Staff

1. Mr. Nitin Baing Helper

#### 2.2 Research Profile

Faculty members of the department are engaged in active research in frontline areas of Nano technology and Material Science, Condensed Matter Physics, High Energy Physics, Polymer Physics, Ion beam technology, Nuclear Physics, Liquid Crystals, Astronomy and Space physics. Specific research interests of faculty members are as follows:

- 1. Prof. Vaishali Bambole: Conducting polymers, electron beam technology: Application to improve the shelf life of ready to eat foods, radiation dosimeters, ion implantation: application to polymers, thin films devices: PECVD, molecular biology, biosensors, electronic noise, bio-nano physics.
- 2. Prof. Anuradha Misra: Light front field theory, spin physics, resummation in quantum chromodynamics.
- 3. Dr. Radha Srinivasan: Nanomaterials for biomedical applications, magnetic materials, magneto-optics, low temperature physics.
- 4. Dr. S. K. Dubey: Ion implantation, nano-structuring by swift heavy ions, dilute magnetic semiconductor reactions.
- 5. Dr. B. J. Nagare: Computational physics of large molecules, clusters and solids.
- 6. Dr. Sajeev S. Chacko: Computational studies of nanomaterials, electronic structure theory, bio-nano system, molecular interactions.
- 7. Dr. M. Hemalatha: Nuclear Reactions of stable and weakly bound nuclei, Nuclear Structure, Laser Spectroscopy of nuclei away from stability.
- 8. Dr. Milind V. Rundhe: Cluster growth and dynamics on a semiconductor surface, interaction of highly charged ions with metals, insulators and semiconductors.
- 9. Dr. Pradip Sarawade: Development of nano-porous materials, metal organic framework (MOF), metal nanoparticles for environmental protection.
- 10. Dr. Sucheta Sengupta: Research Area: Materials Science, Energy Studies.
- 11. Dr. Nainesh Patel: Development of Nano-materials for energy (hydrogen) production and environmental (water) purification.
- 12. Dr. Ritwika Chakrabarti: Nuclear physics, nuclear structure, gamma ray spectroscopy, exotic nuclear phenomena away from stability.
- 13. Dr. Anil N. Raghav: The dynamic evolution of large-scale magnetic structure in interplanetary space, their interactions, the energy exchange processes involved therein, their geo-effectiveness and their effect on cosmic ray modulation. (Coronal mass ejections (CMEs), Co-rotating interacting regions (CIRs), solar wind, magnetic clouds, shock-sheath regions, geomagnetic storms, Forbush Decrease, ground level enhancement (GLE), magneto-hydrodynamic (Alfvén) waves, planar magnetic structures, magnetic reconnection etc.)
- 14. Mr. Chetan V. Gurada: Materials Science and nano science.
- 15. Mr. Nitinkumar M. Bijewar: Materials science, space physics, cosmic rays, space weather.
- 16. Mr. Siddharth Kashturirangan: Physics of highly charged ions, X-ray spectroscopy.

#### 2.3 Major Research Facilities

- 1. Accelerator Mass Spectrometer (AMS)
- 2. BET surface area analyser
- 3. Scanning Tunning Microscope (STM)
- 4. Vibrating Sample Magnetometer (VSM)
- 5. Physical Quantities Measurement System (PQMS)
- 6. Polarization Measurement System (PMS)
- 7. LASER Lithography Technique
- 8. Alpha Spectrometer and Scintillation Detector
- 9. 30 keV Ion Implanter
- 10. X-Ray Diffraction with Small angle and glazing angle measurement unit
- 11. Differential Scanning Calorimeter (DSC)
- 12. UV-VIS-NIR Spectrometer
- 13. Fabry-Perot Scattering Set-up
- 14. Mossbauer Spectroscopy set-up with variable temperature
- 15. Computational Facility Servers, Workstations, PCs
- 16. LX -200, GPS Meade 12' Telescope with ccd
- 17. Energy Dispersive X-ray Fluorescence Spectroscopy
- 18. Keithley electrometer/ high resistance meter
- 19. DC and RF Sputtering systems
- 20. Ellipsometer
- 21. Thin film vacuum coating system with accessories RTHf
- 22. Data Thermal Analysis
- 23. Multiwavlength Refractometer
- 24. Experimental Kit from Indian Academy of Sciences.
- 25. Fluorescence Spectrometer
- 26. FTIR Spectrometer
- 27. Multi frequency Ultrasonic Interferometer (RT to 200 C)
- 28. Table Top Ion Accelerator

<b>2.4</b>	Major	Research	Funding
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Funding Agency	Year	Amount (Rs. lakhs)
DST-FIST Programme-I	2001-2006	41.5
UGC-SAP-DRS Level I	2003-2009	33.2
DST-Device Grade Nano-materials	2003-2006	62.3
DST-FIST Programme-II	2007-2012	99.0
UGC-SAP-DRS Level II	2009-2014	44.0
UPE Green Technology	2009-2014	_
DST-PURSE Scheme	2014-2019	_
UGC-SAP - DSA Level I	2015-2020	185.0
DST-FIST Programme-II	2016-2021	_
RUSA	Submitted	77.0

## 2.5 Research Collaborations

## NATIONAL:

- Indian Institute of Science (IISc), Bangalore
- Tata Institute of Fundamental Research (TIFR), Mumbai
- Indian Institute of Technology (IITB), Mumbai
- Institute of Mathematical Sciences (IMSc), Chennai
- UGC-DAE-CSR at Indore, Mumbai and Kolkata Centers
- Bhabha Atomic Research Centre (BARC), Mumbai
- Inter-University Accelerator Center (IUAC), New Delhi
- Sophisticated Analytical Instrumental Facility (SAIF)- IIT, Bombay
- Indian Institute of Geomagnetism (IIG), New Mumbai
- Materials Science Research Laboratory, Dept. of Physics, J.C.D.A.V College, Dasuya
- Institute of Chemical Technology (ICT), Mumbai
- Savitribai Phule Pune University, Pune

#### INTERNATIONAL:

• NIKHEF Theory Group, Netherlands

- Institut Curie, Centre de Recherche, CRNS UMR 168, Paris Cedex 05, France
- University of Trento, Italy
- Russian Academy of Sciences , Russia
- University of Seoul, South Korea
- King Abdullah University of Science and Technology, Saudi Arabia (KAUST)
- Hanyang University, Seoul , South Korea
- Heliophysics Science Division, NASA/Goddard Space Flight Center, Greenbelt, MD, USA
- University of Science and Technology of China, Hefei, Anhui, People's Republic of China
- University of Zagreb, Croatia
- GSI Helmholtz Centre for Heavy Ion Research, Germany
- Institut de Physique Nucléaire, Orsay, France

## 3 Academic Programmes: Courses

The Department of Physics, University of Mumbai is the University Department for postgraduate teaching and offers the following programmes:

- 1. Master's degree programme in Physics (M. Sc. by Papers)
- 2. Master's degree programme in Physics (M. Sc. by Research)
- 3. Master of Philosophy in Physics (M. Phil.)
- 4. Doctor of Philosophy in Physics (Ph.D.)

The following pages contain a brief description of the course structure and syllabi of these programmes.

## 3.1 M. Sc. in Physics

M.Sc. Program is a two year Master's degree program with a Credit based grading system on a scale of 10.

## 3.1.1 M.Sc. (by papers) Course Structure and Distribution of Credits

M. Sc. in Physics Program consists of total 16 theory courses, total 6 practical laboratory courses and 2 project courses spread over four semesters. Eleven theory core courses and four practical laboratory courses are common and compulsory to all the students. One theory core course is an option between Experimental Physics and Numerical Techniques & Programming as per the preference of the students. Remaining four theory courses can be chosen from the list of elective courses offered by the department. Two laboratory courses can be chosen from the elective laboratory courses offered by the department every year. The list is updated every year. Each theory course is of 4 credits, each practical laboratory course is of 4 credits and each of the two projects is of 4 credits. A project can be on theoretical physics, experimental physics, applied physics, developmental physics, computational physics or based on industrial product development. A student earns 24 credits per semester and total 96 credits in four semesters. The intake capacity for the course has been increase to 68 students per year.

#### Paper-1 Paper-2 Paper-3 Paper-4 Mathematical Classical Solid State Quantum Semester-I Mechanics Mechanics-I Physics Methods Semiconductors Quantum Semester-II Nuclear Physics Electronics and Electronic Mechanics-II Devices Experimental Physics / Semester-III Elective-1 Electrodynamics Elective-2 Numerical Techniques Atomic and Statistical Molecular Semester-IV Elective-3 Elective-4 Mechanics Physics

#### Theory courses

The elective courses can be chosen from a wide range starting from Nuclear and Particle Physics, Solid State Physics, Solid State Device Physics, Electronics and Communications, Electronics Microprocessor, Microcomputers, Embedded systems, Astronomy, Space Physics, Materials Science, Laser Physics, Plasma Physics and Quantum Field Theory up to other advanced specialized topics. In a given year, only some of the electives will be offered by the department. Every year different electives may be offered depending on the availability of experts.

#### Laboratory courses

Semester-I	Lab Course-1: General Physics I	Lab Course-2: Electronics I	
Semester-II	Lab Course-3: General Physics II	Lab Course-4: Electronics II	
Semester III	Drojact 1	Advanced Physics Lab I /	
Semester-III	r toject-1	Advanced Electronics Lab I	
Semester IV	Droject 2	Advanced Physics Lab II /	
Semester-IV	F10Ject-2	Advanced Electronics Lab II	

#### Semester I

M.Sc. in Physics Program for Semester-I consists of four theory courses and two laboratory courses. The details are as follows:

Theory courses (4): 16 hours per week including lectures and tutorials

Course Code	Subject	Hours (L+T)	Credits
PSPHC01	Mathematical Methods	60	04
PSPHC02	Classical Mechanics	60	04
PSPHC03	Quantum Mechanics I	60	04
PSPHC08	Solid State Physics	60	04
	Total	240	16

Laboratory courses (2): 16 hours per week including practicals and tutorials

Course Code	Subject	Hours (P)	Credits
PSPHP01	General Physics Lab I	120	04
PSPHP03	Electronics and Programming Lab I	120	04
	Total	<b>240</b>	8

#### Semester II

M.Sc. in Physics Program for Semester-II consists of four theory courses and two laboratory courses. The details are as follows:

Theory courses (4): 16 hours per week including lectures and tutorials

Course Code	Subject	Hours (L+T)	Credits
PSPHC04	Electronics	60	04
PSPHC06	Nuclear Physics	60	04
PSPHC07	Quantum Mechanics II	60	04
PSPHC11	Semiconductor and Electronic Devices	60	04
	Total	<b>240</b>	16

Laboratory courses (2): 16 hours per week including practicals and tutorials

Course Code	Subject	Hours (P)	Credits
PSPHP02	General Physics Lab II	120	04
PSPHP04	Electronics and Programming Lab II	120	04
	Total	240	8

#### Semester III

M.Sc. in Physics Program for Semester-III consists of four theory courses, one laboratory course and one project. The details are as follows:

Course Code	Subject	Hours (L+T)	Credits
PSPHC05	Electrodynamics	60	04
PSPHC12	Experimental $Physics^{\dagger}$	60	04
PSPHC13	Numerical Techniques <sup>†</sup>	60	04
*	Elective Course	60	04
*	Elective Course	60	04
	Total	240	16

Theory courses (4): 16 hours per week including lectures and tutorials  $^{*,\dagger}$ 

**Project (1):** 8 hours per week

Course Code	Subject	Hours (P)	Credits
PSPHP05	Project I	120	04

Laboratory course (1): 8 hours per week<sup>‡</sup> (Any one from the following courses:)

Course Code	Subject	Hours (P)	Credits
PSPHP07	Advanced Physics Lab I	120	04
PSPHP09	Applied Electronics Lab I <sup>‡</sup>	120	04
PSPHP11	Electronic Communication Lab-I <sup>‡</sup>	120	04

#### Semester IV

M.Sc. in Physics Program for Semester-IV consists of four theory courses, one laboratory course and one project. The details are as follows:

Theory courses (4): 16 hours per week including lectures and tutorials \*

Course Code	Subject	Hours (L+T)	Credits
PSPHC09	Statistical Mechanics	60	04
PSPHC10	Atomic and Molecular Physics	60	04
*	Elective Course	60	04
*	Elective Course	60	04
	Total	240	16

**Project** (1): 8 hours per week

Course Code	Subject	Hours (P)	Credits
PSPHP06	Project II	120	04

Laboratory course (1): 8 hours per week<sup>‡</sup> (Any one from the following courses:)

Course Code	Subject	Hours (P)	Credits
PSPHP08	Advanced Physics Lab II	120	04
PSPHP10	Applied Electronics Lab II <sup>‡</sup>	120	04
PSPHP12	Electronic Communication Lab II <sup>‡</sup>	120	04

<sup>\*</sup>To be chosen from the list of electives announced in Sem II. This list is updated every year.

<sup>&</sup>lt;sup>†</sup>The student has a to select any 1 core course between Experimental Physics and Numerical Techniques. <sup>‡</sup>Applied Electronics and Electronic Communication Labs I and II shall be offered only to those students who choose all four elective courses from electronics specialisation.

## List of electives

Electives shall be offered from the following list, which is updated every year:

Subjects	Lectures (Hrs)	Credits
Biomedical Physics and Instrumentation	60	04
VLSI Design and Embedded Systems	60	04
VHDL, C++ and Python Programming	60	04
Embedded C, ARM and Interfacing	60	04
Digital Communication Systems and Python	60	04
Programming		
Computer Networking	60	04
Signal Modulation and Transmission Techniques	60	04
Microwave Electronics, Radar and Optical Fiber	60	04
Communication		
Nuclear Structure	60	04
Nuclear Reactions	60	04
Electronic Structure of Solids	60	04
Surfaces and Thin Films	60	04
Semiconductor Physics	60	04
Thin Film Physics and Techniques	60	04
Fundamentals of Materials Science	60	04
Nanoscience and Nanotechnology	60	04
Plasma Physics	60	04
Galactic and Extragalactic Astronomy	60	04
Liquid Crystals	60	04
Polymer Physics	60	04
Group Theory	60	04
Experimental Techniques in Nuclear Physics	60	04
Particle Physics	60	04
Crystalline and Non-crystalline solids	60	04
Properties of Solids	60	04
Physics of Semiconductor Devices	60	04
Semiconductor Technology	60	04
Materials and their applications	60	04
Energy Studies	60	04
Astronomy and Astrophysics	60	04
Laser Physics	60	04
Quantum Field Theory	60	04
Applied Thermodynamics	60	04
Accelerator and Beam Physics	60	04
Quantum Computation	60	04
Dynamical Systems	60	04
Computational Methods in Physics	60	04

#### Project Courses PSPHP05 and PSPHP06

The project courses are PSPHP05 and PSPHP06 in semester 3 and 4 respectively.

In the project courses, the student can perform an experimental/theoretical/computational project under supervision of one or more faculty members. In the first part of the project, the student is expected to learn the basics of the topic chosen, learn how to do literature survey and learn and set up the basic experimental /theoretical / computational techniques needed for the project. In the second part, the student addresses the objectives of the project. The second part can also be a reading/learning project if the topic chosen is sufficiently advanced.

The Department encourages projects both in experimental and theoretical areas of Physics, in collaboration with other institutes like UM-DAE CBS, TIFR, BARC, ICT, IIT, SAMEER, IIG or any other institute or industry. In the first two years of its implementation (2013-14 and 2014-15), there were some projects carried out in collaboration with TIFR, BARC and IIG. There were conference presentations and publications in peer reviewed journals that emerged from a few of these projects.

Some of the projects carried out by students in academic years 2014-18 are listed below:

Project title	Guide	
Path Integral Formulation of QM and QFT	Anuradha Misra	
Supersymmetry	Anuradha Misra	
Magnetostriction measurement of RFe <sub>2</sub> alloys	Dr. Radha Srinivasan	
Magneto resistance of Bismuth: Bulk and thin Film	Dr. Radha Srinivasan	
Study of non-linear effects in ferrofluids and other colloids	Dr. Radha Srinivasan	
Synthesis and characterization of some magnetic ceramic compounds of pseudo-brookite series	Dr. Radha Srinivasan	
Tera Hertz Radiation Emission from Ion Implanted GaAs	Dr. Milind Rundhe	
Paul's Ion Trap for mesoscopic particles	Dr. Milind Rundhe	
Study of Multilayer Thin Film Coating Based on CrN and AlN	nd Mr. Chetan Gurada	
Dual band GSM mobile Jammer	Mr. Chetan Gurada	
Android based WiFi video conferencing	Mr. Chetan Gurada	
Photo rover Robot & ECG Filtering	ng Dr. S K Dubey	
Hydrogen generation from chemical hydrides using Co-Mo-B. nanocatalyst for fuel-cellDr. Nainesh Pa		

Project title	Guide	
Hydrogen production by sodium borohydride using Co-Cr-B	Dr. Nainesh Patel	
nanocatalyst		
Study of hydrogen evolution reaction in water splitting using	Dr. Nainesh Patel	
Co-in-B nanocatalyst		
Simple model for dynamic concentration of pollutants over	Mr. Nitin Bijowar	
Mumbai region	Mr. Nitin Bijewar	
Catalytic Activities of Nanoparticles	Dr. Sajeev Chacko	
Electronic structure calculations of 2-d quantum spin Hall	Dr. Sajooy Chacko	
materials	DI. Sajeev Chacko	
Thermodynamics of Nanoparticles	Dr. Sajeev Chacko	
Interaction of Bio-nano system	Dr. Sajeev Chacko	
Function Finishing of textile by UV Protection	Prof. Vaishali A. Bambole	
Conducting Polymer using Plasma Polymerization	Prof. Vaishali A. Bambole	
Functional Finishing of textile antibacterial	Prof. Vaishali A. Bambole	
Dyeing of textile (Cotton Fabric) using natural dye	Prof. Vaishali A. Bambole	
Functional Finishing of textile hydrophilic & hydrophobic	Prof. Vaishali A. Bambole	
Forbush Decrease: A Case Study	Dr. Anil Raghav	
Design and simulation of an x-ray spectrometer for atomic	Mr. Siddharth	
physics experiments	Kasthurirangan	
Synthesis of silica aerogels at an ambient pressure and its	Dr. Dr. dir Commenda	
application	Dr. I facily Safawade	
Study of numerical models for trace gas transport	Mr. Nitin Bijewar	
Development of Electro Spray Ion Source with Paul Trap	Dr. Milind Rundhe	

#### 3.1.2 Scheme of Examination and Passing

- 1. This course will have 40% weightage for Continuous Assessment (CA) and 60% weightage for End Semester Assessment (ESA) for each theory course and 60% weightage for Continuous Assessment (CA) and 40% weightage for End Semester Assessment (ESA) for each laboratory course. All examinations will be conducted by the Department as per the existing norms approved by the examination committee. Mode of continuous assessment will be decided by the teacher concerned for theory courses and by the laboratory committee for lab courses.
- 2. Continuous Assessment (CA) and End Semester Assessment (ESA) shall have separate heads of passing.
- 3. To pass, a student has to obtain minimum pf 40% marks or above separately in the CA and ESA (written/practical examination).
- 4. The end-semester examination for Theory and Laboratory courses shall be conducted at the end of each Semester and the evaluation of Project work i.e. Dissertation will be held at the end of each Semester.
- 5. The candidates shall appear for examination of 4 theory courses and 2 practical courses each at the end of each semester. End Semester Assessment will consist of a written examination of at least  $2\frac{1}{2}$ -hour duration for each Theory Course and a practical examination of 4 hours duration for each Laboratory Course.
- 6. The candidate shall prepare and submit for practical examination a certified Journal based on the practical course with minimum number of experiments as specified in the syllabus for each group.
- 7. There will be a continuous evaluation of the performance in the laboratory courses throughout the semester and the Continuous Assessment (CA) marks in the laboratory course will be based on this.
- 8. The student shall carry out the project work for the project course PSPHP05 and PSPHP06 under supervision of a guide from the department or at another institute under joint supervision of a guide from the Department and a co-guide from the concerned institute after taking permission from the Department. The student shall submit project reports in the prescribed format at the end of semester III and semester IV, which will be evaluated by internal and external examiners, one of these being the guide. Project evaluation will be based on continuous assessment by the guide, the project report, an open presentation and viva voce conducted by the examiners.

#### 3.1.3 Standard of Passing for University Examinations

As per ordinances and regulations prescribed by the University for semester based credit and grading system, and examination rules framed by the Examination committee and Subject Board of the Department of Physics.

#### 3.1.4 Standard point scale for grading

1. The following range of marks shall be used to assign grades to the students:

Percentage of marks	Grade
$80 \le x \le 100$	0
$70 \le x < 80$	A+
$60 \le x < 70$	А
$55 \le x < 60$	B+
$50 \le x < 55$	В
$45 \le x < 50$	С
$40 \le x < 45$	D
x < 40	F

2. The following grade scale will be used for assigning grade points to the students:

Grade	Grade points
0	10.0
A+	9.0
А	8.0
B+	7.0
В	6.0
С	5.0
D	4.0
F	0.0

3. The CGPA of all semesters shall be converted into a Final grade point using the following table:

CGPA	Final Grade
9.50-10.00	О
9.00-9.49	A+
8.00-8.99	А
7.00-7.99	B+
6.00-6.99	В
5.00-5.99	С
4.00-4.99	D
below 4.00	F

#### 3.1.5 Grade Point Average (GPA) calculation

- 1. GPA is calculated at the end of each semester after grades have been processed and after any grades have been updated or changed. Individual assignments / quizzes / surprise tests / unit tests / tutorials / practicals / project / seminars etc. as prescribed by University are all based on the same criteria as given above. The teacher will convert his/her marking into the Quality-Points and Letter-Grade.
- 2. Performance of a student in a semester is indicated by a number called Semester Grade Point Average (SGPA). It is the weighted average of the grade points obtained in all the subjects registered by the students during the semester.

$$SGPA = \frac{\sum_{i=1}^{n} C_i p_i}{\sum_{i=1}^{n} C_i}$$

 $C_i$  = the number of credits assigned to the  $i^{th}$  course of a semester  $p_i$  = the grade point earned in the  $i^{th}$  course i = 1, 2, ..., n represents the number of courses for which the student is registered.

The Final grade will be decided on the basis of Cumulative Grade Point Average (CGPA) which is weighted average of the grade points obtained in all the semesters registered by the learner

$$CGPA = \frac{\sum_{j=1}^{N} C_j p_j}{\sum_{j=1}^{N} C_j}$$

 $C_j$  = the number of credits assigned to the  $j^{th}$  course up to and including the semester for which CGPA is being calculated

 $p_i$  = the grade point earned in the  $j^{th}$  course

j = 1, 2, ..., n represents the number of courses for which the student is registered up to and including the semester for which CGPA is being calculated

#### Note:

A letter Grade lower than D in a subject shall not be taken into consideration for the calculation of CGPA.

The CGPA is rounded up to the two decimal places.

#### 3.2 M. Sc. (by Research) Degree Course in Physics

A candidate for being eligible for admission to the M. Sc. (by Research) in Physics must have passed the Bachelor of Science (B. Sc.) degree examination with Physics as the major subject with minimum higher 2nd Class (CGPA equivalent to grade B+), or an examination of another University recognized as equivalent thereto. M. Sc. course by research is of minimum two year duration *i.e.* only after completing this period a candidate can submit his / her M.Sc. thesis for evaluation. The student enrolling for M. Sc. by research in the subject of Physics is required to pass separately 8 theory courses from those prescribed for the regular M. Sc. Physics course in a minimum period of three semesters, before he/she can submit his/her thesis for the award of the Master's degree (by Research) in Physics. The total number of credits is 96 distributed over 4 semesters, same as the regular M. Sc. Programme, with at least 32 credits of relevant theory courses. The structure of the programme is as given below. The final CGPA will be based on the credits accrued in the theory courses and the research work carried out under the guide and the evaluation of the dissertation by a team of examiners, as prescribed by the Academic Board of the Autonomous Department.

The Department generally admits students, depending on the number of vacancies available; which is presently of the order of 25. The notification regarding admission to this programme will be notified on the website, soon after the admission process of the regular course is completed.

1 <sup>st</sup> SEMESTER		2 <sup>nd</sup> SEMESTER		3 <sup>rd</sup> SEMESTER		4 <sup>th</sup> SEMESTER	
COURSE	CREDIT	COURSE	CREDIT	COURSE	CREDIT	COURSE	CREDIT
Mathematical Methods	4	Statistical Mechanics	4	Electrodynamics	4	Research Work	8
Classical Mechanics	4	Elective - 1	4	Elective - 2	4	Dissertation	8
Quantum Mechanics	4	Research Work	16	Research Work	16	Research Work	16
Research Methodology	4						
Research Work (towards dissertation)	8						
TOTAL	24		24		24		24

M. Sc. (by Research) Theory Courses and Dissertation

## 3.3 M. Phil. Degree Course in Physics

The M.Phil Degree programme in Physics is a  $1\frac{1}{2}$  years full time course consisting of course work of one year duration and Dissertation work of six month duration. The course work will consist of two core courses of 6 credits each in I Semester, one Survey of Practical/Theoretical course or dissertation with 6 credit in I semester and two elective papers with 6 credits each and dissertation with 6 credits in II semester. The third semester will have only dissertation with 18 credits. The intake capacity for this course is 25 students per year. Brief Description of M. Phil. Syllabus and Distribution of Topics is shown below.

	Paper	Max. marks	Min. marks	Contact hrs	Credits
1	Research Methodology	100	50	60	6
2	Experimental Methods / Theoretical Physics	100	50	60	6
3	Survey of Practical / Theoretical Course <b>OR</b> M. Phil Dissertation by Research – Part I	100	50	60	6
	TOTAL	300	150	180	18

## M. Phil. Part I, Semester - I

#### M. Phil. Part I, Semester – II

Note: Any two modules

from the available modules offered (the number of modules offered can vary from year to year)

	Paper	Max. marks	Min. marks	Contact hrs	Credits
1	Semiconductor Physics	100	50	60	6
2	Modern Electronics	100	50	60	6
3	Nanotechnology	100	50	60	6
4	Accelerator Physics	100	50	60	6
5	Nuclear Physics	100	50	60	6
6	Laser and Plasma Physics	100	50	60	6
7	Materials Science	100	50	60	6
8	Condensed Matter Physics	100	50	60	6
Q	Advanced Quantum Mechanics	100	50	60	6
3	and Quantum Field Theory	100	50	00	0
10	M. Phil Dissertation by	100	50	60	6
10	Research - Part II	100	50	00	0
	TOTAL	300	150	180	18

#### M. Phil. Part II, Semester - III

	Paper	Max. marks	Min. marks	Contact hrs	Credits
1	M. Phil Dissertation by Research - Part III	300	150	180	18

S. No.	Semester	Theory	Research/Survey	Total
1	Ι	12	6	18
2	II	12	6	18
3	III	-	18	18
Total		24	30	54

## Semester-wise Summary of Credits:

#### 3.4 Ph.D. Degree course in Physics

A candidate for being eligible for admission to the Ph.D. Degree in Physics must have passed the Master of Science (M.Sc.) / M. Phil degree examination with Physics. Generally, applications are invited twice in an academic year. The candidates should have a B+ grade in M.Sc. and should have cleared University PET/ NET/ SET examination.

Short listed candidates are called for an interview clearing which they are admitted to the Ph.D. program.

Each learner after having been admitted to the Ph.D. degree programme, shall be required to undertake course work for a minimum period of one semester. The course work shall be treated as pre-Ph.D. preparation.

The Ph.D. course work shall be offered with credit system. The entire course work will have total 18 credits. The learner will have to earn 18 credits before synopsis submission.

The candidates with an M. Phil degree shall be exempted from course work. After selection, the candidate pursues research in frontline areas of Physics. The research programme in the department is being carried out in the following areas:

#### A. Experimental Physics

Ion implantation, Ion Beam Mixing	Nano structuring by Swift Heavy Ions
Elastic Recoil Detection Analysis	Recrystallization
Semiconductor Devices	SIMOX /SIMNI, Thin Films
Photovoltaics	Magnetism
Dilute Magnetic Semiconductors	Nanomaterials and Nanotechnology
Bio-nano materials	Surface Physics
Liquid Crystals	Crystal Growth
Nuclear Reactions and Nuclear Structure	Polymer Physics
Energy Studies and Environment	Catalysts and Photocatalysts

## **B.** Theoretical Physics

Condensed Matter Physics Modeling and Simulation of Materials Dusty Plasma Quantum Chromodynamics High Energy Physics Ion Atom Collisions Quantum Field Theory

## 4 Facilities in the University Department

## 4.1 M. Sc. Laboratories

M. Sc. laboratories of the Department of Physics, University of Mumbai are well equipped to carry out experiments in Electronics, Solid State Electronics, Solid State Physics, Nuclear Physics, Laser and Plasma Physics, Liquid Crystals, Astronomy and Space Physics, Electronic Communications and Microprocessors & Microcomputers.

In Microprocessor lab, students are encouraged to study the 8051 Microcontroller -Programming & Assembly and hand coding on the 8085 microprocessor kits. They are also exposed to numerical methods by programming and by writing algorithms on PCs. In Electronic telecommunication lab, students are exposed to the Fiber Optic, Microwave, PC to PC communication experiments. As a part of their curriculum, they do projects which involve designing, fabrication and testing of new circuits. In Solid State Electronics lab, students are encouraged to fabricate simple devices such as Schottky barrier diodes, MOS etc. and characterize them. High temperature furnace required for oxidation of Si and doping of impurities, vacuum thin film units, Electron beam gun, D.C. Sputtering are available for device fabrication. Structural characterization is carried out in Solid State Physics lab. X-ray diffractometer and Fourier transform infra-red spectrometer are the major facilities available to students. In Materials science lab, synthesis and characterization of materials is emphasized. In Nuclear Physics laboratory students perform experiments using alpha and gamma-ray spectroscopy. Na(Tl) Scintillation and gas filled detectors are some of the radiation detectors. In Liquid Crystal Lab, students study R.I. and dispersive power of material using Abbeys Refractometer. The Department has recently procured the 12' Telescope (Meade Autostar II) and some night-sky observations have been carried out.

The Department has been associated with IUCAA, Pune for experiments on Observational Astronomy where the students spend 4-5 days in mid February on IUCAA campus performing the experiments under the guidance of IUCAA faculty members.

![](_page_44_Picture_5.jpeg)

## 4.1.1 Facilities

Electronics Workstation

![](_page_45_Picture_0.jpeg)

Michaelson Interferrometer

X-Ray Apparatus

![](_page_45_Picture_3.jpeg)

Ellipsometer

![](_page_45_Picture_5.jpeg)

Solar Cell

## 4.2 Research Laboratories

Major experimental research facility is in the field of ion beam modification of materials. The Department has a high-current ion implanter, which is one of the few implanters of its kind. It can provide mass analyzed ion beams of energy 30 keV of any species ranging from hydrogen to uranium. Major application of such a beam is to produce novel phases having exotic properties in the near surface region of any material. The Department has several sophisticated instruments e.g. X-Ray Diffractometer, Ultraviolet-Vis-NIR spectrometer, Metallurgical Microscope, Fourier Transform Infrared Spectrometer Differential Scanning Calorimeter, with image analyzer, Mossbauer spectrometer, XRF spectrometer, Low Energy Electron Diffraction, High Vacuum Plasma Discharge system, Czochralski crystal growth system, Thermal Evaporation, d.c sputtering systems, Electron gun evaporation, Four point probe resistivity set-up, Polarization microscope, I-V and C-V setup to name the major facilities. Thin films, plasma physics, condensed matter physics, surface physics, solid-state device physics are some of the areas in which active experimental research is being carried out in the Department. In the liquid crystal research Lab, students can learn the use of spectroscopic techniques to study the opto-electronical properties and physico-chemical reactions. These studies will be useful in the future for exploring various possibilities of using CLC and mixtures with Nano-powder, elastomers, micro-fluids, quantum dots for diverse applications like Smart windows, detection of blockages in blood flow, detection of bubbles in coating of metal sheets, etc.

The department faculty members have active collaborations with faculty members of the National Centre for Nanoscience and Nanotechnology, which is also situated in the Vidyanagari campus. The highly sophisticated experimental facilities at the Nano-Centre are expected to be operational soon, and shall be accessible to all members of the Department of Physics.

The Department also has a Theoretical Physics group actively engaged in research in frontline areas in nonlinear phenomena including nonlinear optics, laser physics, space plasma physics and particle physics.

The Department is also a major user of UGC sponsored National Facility - Pelletron Heavy Ion Accelerator at the Inter-University Accelerator Center (formerly the Nuclear Science Centre), New Delhi. Research programmes are actively pursued in the fields of Nuclear Reactions and Structure.

#### 4.2.1 Laboratories

#### Accelerator Mass Spectrometer Facility

The 1 MV Accelerator Mass Spectrometer (AMS) facility funded by DAE-BRNS will satisfy a vital experimental need in the field of archaelogy, to quantitatively explore an understand our past with unprecedented detail. It is a dream facility for Indian Archaeology community for precisely dating historic artefacts. The AMS can date any historical object as old as 60,000 years, with a precision of 50 years. The quantity required for dating is minute, as small as 0.5 mg of graphitized sample. This is the third such machine for carbon dating in India. AMS relies on high sensitivity measurements of isotopes of different elements.

![](_page_46_Picture_7.jpeg)

Accelerator Mass Spectrometer (AMS)

#### Molecular Electronics Laboratory

The laboratory is equipped with different instruments like four and two probe conductivity set up conceptualized and indigenously fabricated to measure conductivity of ultra-thin films. The gas sensor set up is a novel instrument for gas sensing The design of sensor head is unique and novel and accommodates upto 20 sensors. The sensor head set-up is integrated with a data acquisition system and is sensitive to ppm level of gas as well as selective to a particular gas. Plasma enhanced chemical vapour deposition system is low cost system with a unique facility of generating pulsating Plasma. Due to which ultra-thin (tailor made to thickness and size) of conducting polymers can be synthesis which can be used as electrodes for super capacitor. Electrospinning set-up for fabricating nanofibres is designed to synthesize 'Nanofibres' of conducting polymers for making Polymer Nanocomposites. Excellent nanofibres can be synthesized which form the seed of "Tissue Engineering".

![](_page_47_Picture_2.jpeg)

Physical Quantity Measurement System (PQMS)

![](_page_48_Picture_0.jpeg)

Scanning Tunneling Microscope (STM)

![](_page_48_Picture_2.jpeg)

Electrospinning system

#### **Bio-Nano Physics Laboratory**

The laboratory is fully equipped for doing bio nano research. It is a well equipped center for food technology research also. The instruments procured in the laboratory is of high quality and standard. The laminar airflow allow the researcher for doing microbial analysis with out any external contamination. The deep freezer and incubator provides sufficient environment to keep the analysis intact. Lab is equipped for doing various characterizations. Protein estimation cane be done with the Kjeldal apparatus. Like that muffle furnace, hot air oven and bacterial counter provides the suitable instruments for characterization. A high quality autoclave machine is there. The centrifuge and stomacher instruments provides the add on facility for testing. The ambience and facility inside the laboratory is par with international facility.

![](_page_49_Picture_2.jpeg)

Bio-Nano Laboratory

#### **Advanced Nuclear Physics Laboratory**

The Nuclear Physics Laboratory was initially set up by Prof. M.C. Joshi who was the Founder Head of Department of Physics. It is now being upgraded and a new Advanced Nuclear Physics (ANP) Laboratory is being set up with innovative and open-ended experiments.

A few detectors for measuring gamma rays and alpha particles along with some signal processing electronics are available in the laboratory. New detectors and instrumentation to perform high resolution spectroscopy are being planned. The experiments will be interfaced to computers to enable data collection and subsequent analysis. The ANP Laboratory Course would include experiments with variety of detectors and instrumentation.

![](_page_50_Picture_3.jpeg)

Advanced Nuclear Physics Laboratory

#### Liquid Crystal and Chemical Synthesis Laboratory

Our research aims to synthesize shape and size controlled metal and metal oxide nanocatalyst which will be used to produce hydrogen and oxygen gas by splitting water under the appropriate electrochemical conditions. Our main goal to synthesize nanomaterials with various morphology using a facile solvothermal synthesis process. Prepared nanomaterials with specific size and shape for energy and environmental related applications, such as CO2 capture from air in order to reduce the increasing pollution, water purification, Hydrogen and Oxygen production from water by water splitting process.

Our research group also focuses on synthesis of extremely porous nanoprous silica and carbon (Silica & carbon aerogel) with specific pore size, pole volume and surface area and their application for environmental related problems.

![](_page_51_Picture_0.jpeg)

Polarising Microscope

#### Surface Physics Laboratory

The Surface Physics Laboratory derives its name from the low-energy electron diffraction (LEED) setup which is the central experimental setup in the lab. The LEED has been used extensively in the past for surface structure determination studies, and several Ph. D. scholars of the Department have utilised this facility. With the induction of active researchers in the field of Atomic Physics in 2014, a plan has been evolved to modify the existing setup for atomic and molecular physics experiments, while retaining the original functionality. Other facilities in this laboratory include a set of 4 computers, used with dual purpose -(a) analysis of experimental data generated collaboratively with TIFR (Prof. Lokesh Tribedi: Accelerator-Based Atomic Physics group), (b) theoretical calculations of atomic structure and spectra using state-of-the-art atomic structure codes such as GRASP2K, RATIP and FAC, for comparison with laboratory and astrophysical data.

![](_page_51_Picture_4.jpeg)

Low-energy electron diffraction LEED Setup

#### Astro, Space, Atmospheric Physics Laboratory

In Astro, Space, Atmospheric Physics laboratory (ASAP Lab), we investigate the dynamic evolution of large-scale magnetic structure in interplanetary space, their interactions, the energy exchange processes involved therein, their geo-effectiveness, and their effect on cosmic ray modulation. These studies are executed using various spacecraft (*e.g.* ACE, WIND, Helios 1 and 2, IMP 8, GOES etc. ) and ground base (an *e.g.* Worldwide network of Neutron monitors and muon monitors) archival data. The work is executed using 5 computers available in the ASAP Lab. Besides this, the ASAP Lab also has 12" Mead telescope (Manual) and its accessories. Moreover, the ASAP group has been earmarked adequate funding through UGC-SAP (Rs. 55 lacs). The work of ASAP Lab is recognized by the international scientific community. There have been 8 international publications in the last two years alone, including a large number entirely from the work of M.Sc. Students.

#### Material Science and Ion Implater Laboratory

Well organized chemical synthesis laboratory has been set-up in this laboratory which contains magnetic stirrers, sonicators, centrifuge machines, double distilled water plant, muffle furnaces, fume-hood, milling, spin-coater and dip-coater. All these equipment are used to synthesize catalyst, photocatalyst, magnetic, optical etc. materials for different applications. The major research works that are conducted are as follows:

- 1. Nano-catalyst synthesis based on transition metals for production of H2 as a clean energy using water splitting and hydrolysis of chemical hydrides.
- 2. Development of photocatalyst nanomaterials for photocatalytic water splitting and for degradation of organic water pollutants using solar energy.
- 3. Magnetic materials such as various spinel ferrites are fabricated in this laboratory for application towards spintronic.
- 4. Interaction of biomolecules, like protein & DNA, with inorganic nanoparticles is also studied in this lab.

RF-sputtering, DC-sputtering and thermal vapor deposition are also established in this laboratory for fabricating solid-state thin films of metal and metal oxide on various substrates. This laboratory also accommodate 30 KeV Ion Implanter facility but it is currently under repair and maintenance and no active research is been persuade. This Lab is used by all faculties and students working in the field of Material Science and Nanomaterial synthesis.

In this laboratory X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF) facilities have also been installed. These are common facilities used by all students and faculties of the department working in the field of Material Science. XRD is used to investigate the structural properties of the material in form of powders as well as thin films. XRF provides the elemental composition of the materials.

![](_page_53_Picture_0.jpeg)

Ion Implater Laboratory

![](_page_53_Picture_2.jpeg)

Semiconductor and Thin Film Laboratory

## 4.2.2 Facilities

![](_page_54_Picture_1.jpeg)

X-Ray Diffraction System (XRD)

![](_page_54_Picture_3.jpeg)

Photo Reactor

![](_page_54_Picture_5.jpeg)

Magnetoresistance and Hall Effect System

![](_page_55_Picture_0.jpeg)

## Stirrer

## 4.3 Computing and Internet Facilities

The Department of Physics has established excellent Computing and Internet facilities for faculty as well as for students. A separate computer laboratory for students has been set up under the DST-FIST programme. This laboratory has also been recently upgraded. Computers are extensively used in the M.Sc. labs, where the students are taught about computer hardware as well as programming. At the research level, students become familiar with the sophisticated software packages and learn how to adopt them for the research problems of interest.

![](_page_55_Picture_4.jpeg)

## Internet Laboratory

## 4.4 Departmental Library

The department has a library in Tilak Bhavan III Floor. The library is being equipped with all the reference books and other reference material needed for ready reference of department students.

![](_page_56_Picture_3.jpeg)

Departmental Library

## 5 Admissions

The procedure for enrolment of candidates to the M.Sc. Physics course (by papers) is as follows:

- 1. The Department shall admit students only for University Department of Physics (UDP) (Autonomous). The selection of candidates would be strictly on merit basis within each category.
- 2. The application form for admission to the course and information brochure can be had from the office of the Department of Physics, University of Mumbai, Vidyanagari Campus, Santacruz (East), Mumbai - 400 098. The brochures carry serial numbers, which have to be mentioned in the Application Form and the Computer Data Entry Form. Any form not so numbered will not be accepted by the Department. While filling up the application form for admission, every student should go through the brochure carefully and fill up the application form for admission according to the instructions mentioned therein.
- 3. The Computer Data Entry Form has to be filled online only. The link to the form is https://goo.gl/forms/xXNpep0MtnegZJwl2. Once the form is filled online and submitted, a PDF copy of the same will be generated and sent to the candidate's valid e-mail ID. A printout of this PDF duly signed, and with the brochure number entered in the appropriate column has to be submitted along with the Application Form.
- 4. All marks (paper-wise as well as total) must be entered without considering any grace marks/additional marks awarded in the total or in any individual paper.
- 5. The application forms duly filled-in and signed and accompanied by the originals as well as certified copies of statement of marks, caste certificate and caste validity certificate should be submitted to the staff-in-charge of the admissions during the period specified for the purpose on the notice board in the Department. In case of DT-A (V.J), NT-B, NT-C, NT-D, OBC and SBC reserved category candidates the non- creamy layer certificates of the current financial year is also required. Incomplete applications without mark sheet, caste certificate issued by competent authority will be rejected.
- 6. For the students from University of Mumbai, only the marks obtained by the candidate in Physics (no Applied Component) in the third year B.Sc. V<sup>th</sup> and VI<sup>th</sup> semesters examinations of the University will be considered for deciding merit for admission to the M.Sc. course in Physics. Thus the merit list will be prepared based on the third year B.Sc. marks in Physics only. There will be a reduction of 3% of the marks for those candidates who have passed the examination at the second attempt.
- 7. No individual intimation will be sent to candidates selected for admission including those who are from other Universities. The list of students selected for admission to the course will be put up on the notice board of the Department. Generally three such admission lists based on merit are displayed one after the other in a short interval of time.
- 8. 3% seats are reserved for students coming from other Universities.
  - (a) For applicants from Universities other than University of Mumbai there will be a reduction of 10% of marks while preparing merit list.

- (b) A candidate belonging to University other than the University of Mumbai should have Physics as one of the major subjects at the third year of the B.Sc degree course. For the purpose of calculating the percentage for admission of such a candidate only the marks obtained in the subject of Physics in all the three years of B.Sc. will be taken into account.
- (c) Such candidates are required to produce the original mark sheets of all the three years along with their applications form duly filled in and signed and accompanied by certified copies of mark sheets of all the three years indicating clearly the marks obtained, along with the maximum marks in the subject of Physics each year. An application without this information will be considered incomplete and rejected.
- (d) Applicants from other Universities are required to submit a provisional certificate of eligibility while enrolling for the course. This provisional eligibility certificate can be obtained from the Registrar, Eligibility Section of University of Mumbai, Vidyanagari, Mumbai- 400 098 after submitting the application and necessary remittance.
- 9. The reservation for physically handicapped (PH) candidates is 03%. The reservation for Defence / CG, SG Transfer / Widow / Sports is 03%. The candidate should mention his/her category in the Application.
- 10. The quotas for reservation in admission in the course prescribed for different categories are:

arc.			
1	Scheduled Caste and Scheduled Caste-converts to Buddhism	(SC)	13%
2	Scheduled Tribes	(ST)	07%
3	Vimukta Jaati	$(VJ/DT-A)^{**}$	03%
4	Nomadic Tribes (NT)	(NT-B)**	2.5%
5	Nomadic Tribes (NT)	(NT-C)**	3.5%
6	Nomadic Tribes (NT)	(NT-D)**	02%
7	Other Backward Classes	OBC**	17%
8	Special Backward Classes	SBC**	02%

\*\* Non-creamy layer certificate of current financial year is compulsory.

#### N.B: The reserved quota is applicable only for Mumbai University Graduates and for graduates from other Universities within Maharashtra.

- 11. **IMPORTANT:** The applicants should keep the following certificates ready as soon as possible and submit along with the application:
  - (a) B. Sc. Original Mark-sheet and one attested copy.
  - (b) Caste Certificate Original and one attested copy (for reserved category students).
  - (c) Non-creamy Layer Certificate Original and one attested copy (for reserved category students).
  - (d) Gap Certificate (Affidavit. If a student had a gap in studies after B Sc course)
- 12. A candidate selected for admission to the M.Sc. Part I Physics course will have to pay the fees for registration as a post-graduate student, as notified in the list of selected candidates put up on the notice board of the Department. The fee will have to be paid on or before the last date mentioned in the list, failing which the candidate will forfeit his/her claim to the seat allotted in the list.

- 13. A candidate who fails to avail of the admission offered to him/her before the last date as mentioned in the first list of selected candidates will not be considered for a seat in the second or subsequent list.
- 14. The vacancies that may arise on account of the selected candidates not availing themselves of the admission before the last date or those who might withdraw their admission will be notified through subsequent announcements in the Department and students would be chosen from the merit-based waiting list.

If many seats remain unfilled after the first round, a second round of admissions will be announced and held shortly thereafter, wherein vacant seats in a specific merit list will be filled on basis of merit from the respective lists. If few seats remain unfilled, the vacant seats will be filled during spot admissions in a final round.

15. The candidates so selected for admission will have to pay the registration fee on or before the date indicated to them while admission is granted, failing which they will forfeit claim of admission to the course and the same will be offered to the next deserving candidate on the merit-based waiting list.

## 6 Fees

Details of the Yearly Fees for the M.Sc. course (all subjects, aided) as per the Circular no. UG/386/ of 2009, dated 6th October, 2009 of University of Mumbai are given below. Form and prospectus fees will be collected at the time of the purchase of prospectus. In addition, Railway concession fee, Cultural activity fee and library smart card fee will be collected at the time of admission for students taking admission in University Department of Physics, as prescribed by the University. Any additional applicable fees may be charged by University Department of Physics on recommendation of the Examination Committee/Management Board.

Fee	Amount (Rupees)
Tuition	1,000/-
Other fees/Extracurricular activities	250/-
Registration fee for M Sc Part I only	850/-
Registration form fee	25/-
Laboratory fee	6000/-
Laboratory deposit	400/-
Library	1080/-
Gymkhana	200/-
Admission processing fee	200/-
Vice chancellors fund	20/-
Magazine	100/-
Identity card	70/-
Group insurance	40/-
Student welfare	50/-
University sports and cultural activity	30/-
Development fee	500/-
Utility	250/-
Computer/internet	500/-
e suvidha	50/-
e charges	20/-
Disaster relief fund	10/-
Cultural Activity	6/-
Total	11,751/-

**Note:** The Fees may be upwardly revised by the University/Department and the revised Fees applicable at the time of admission will be charged.

Document verification (wherever applicable)	400/-
Form and Prospectus fee	100/-
University Exam fee	600/-
Mark sheet	50/-
Project fee(wherever applicable)	2000/-
Convocation fee only for M Sc part II	250/-
Refundable deposits:	
Caution money	150/-
Library deposit	250/-

NB: Foreign students will have to pay five times of prescribed fees.

## 7 Attendance Rules

The attention of students seeking admission to M. Sc. degree course is particularly invited to the following rules relating to the postgraduate studies.

- 1. For granting the permission to take final examination, in each subject minimum attendance of 75% both in theory lectures and practicals/tutorials is compulsory.
- 2. The students will be required to attend in each semester not less 75% of the total number of theory lectures delivered and also not less than 75% of the lectures delivered in each paper.
- 3. In addition to attendance at lectures and practicals, they will be required to carry out regularly the work assigned to them in the form of home assignments, problems, tutorials, etc. They shall be required to maintain a record in a properly bound journal. The work carried out by them shall be reviewed by respective teachers both during the semester and at the end of the semester.
- 4. The work that will be carried to them in the form of experiments, tutorials etc. shall be in addition to the practical work that they are required to do for the examination.

## 8 Opportunities after M. Sc. (Physics)

## Major exams conducted for Physics students in India

- For admission in PhD programme of Mumbai University PET Exam (conducted in February and July)
- For PhD entrance: General exams for admission to various national institutes
  - 1. CSIR/UGC NET
  - 2. GATE
  - 3. JEST (for PhD in 16 institutions around India)
- Entrance Exams for the specific Institutes
  - 1. Tata Institute of Fundamental Research (TIFR) graduate studies exam
  - 2. Indian Institute of Astrophysics (IIA) entrance exam
  - 3. Inter University Centre for Astronomy and Astrophysics (IUCAA) entrance exam
  - 4. Satyendra Nath Bose National Centre for Basic Sciences (SNBNCBS) exam
  - 5. Bhabha Atomic Research Centre (BARC) JRF exam
  - 6. Indira Gandhi Centre for Atomic Research (IGCAR) JRF exam
  - 7. Physical Research Laboratory (PRL) JRF exam
  - 8. Indian Institute of Geomagnetism (IIG) exam
  - 9. Aryabhatta Research Institute of Observational Sciences (ARIES) exam
  - 10. Harishchandra Research Institute (HRI) exam
  - 11. Saha Institutre of Nuclear Physics (SINP) exam
  - 12. Centre for Liquid Crystal Research (CLCR) exam
  - 13. Indian Neutrino Observatory (INO) exam
  - 14. IUCAA National Centre for Radio Astronomy (IUCAA-NCRA) Admission Test (INAT)
  - 15. Centre for Nanosciences & Nanotechnology, University of Mumbai

#### For further studies abroad

- 1. GRE (Graduate Record Exam)
- 2. TOEFL (Test of English as a foreign language)
- 3. IELTS (International English language testing system)

## Job opportunities

- 1. Bhabha Atomic Research Centre (BARC) Training School Exam
- 2. Defence Research and Development Organization (DRDO) SET (Scientist Entry Test)
- 3. Institute of Plasma Research (IPR) training programme

- 4. Indian Space Research Organization (ISRO)
- 5. Air traffic controller
- 6. Combined Defence Services Examination (CDSE) (Age limit 25)
- 7. Oil and Natural Gas Company (ONGC)
- 8. Medical Physicist at Tata Memorial Hospital (TMH)

## Training programmes

#### Summer training programmes

- 1. Science Academies' Summer Student Program
- 2. Indian Institute of Astronomy (IIA)
- 3. Indian Institute of Science (IISc)
- 4. Physical Research Laboratory (PRL)
- 5. Institute of Plasma Research (IPR)
- 6. Indian Institute of Technology (IITs)
- 7. Indian Administrative Service (IAS)
- 8. Harishchandra Research Institute (HRI)
- 9. Raja Ramanna Centre for Advanced Technology (RRCAT)
- 10. Raman Research Institute (RRI)
- 11. Tata Institute of Fundamental Research (TIFR)
- 12. Inter University Centre for Astronomy and Astrophysics (IUCAA)
- 13. Institue of Mathematical Science (IMSc)
- 14. Aryabhatta Research Institute of Observational Sciences (ARIES)
- 15. Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR)
- 16. The Centre for Nanosciences and Nanotechnology (CNNUM)
- 17. Indira Gandhi Centre for Atomic Research (IGCAR)
- 18. Saha Institutre of Nuclear Physics (SINP)

#### Winter training programmes

- 1. (PRT-PLANEX)
- 2. Indian Institute of Science (IISc)

# 9 Placements of past alumni

## Research

S. No.	Name	Degree	Year	Position	Organisation
1	Suraj Gupta	PhD	2016	PDF	IIT Bombay
2	Kamalnayan Chauhan	M.Sc	2016	Dip RP	BARC, Mumbai
3	Samata Gokhale	M.Sc	2016	$_{ m JRF}$	TIFR, Mumbai
4	Sumukh Purohit	M.Sc	2016	PhD	JNCASR, Bengaluru
5	Adiba Shaikh	M.Sc	2016	$_{ m JRF}$	TIFR, Mumbai
6	Gauri Datar	M.Sc	2016	PhD	IIG, Mumbai
7	Zubair Shaikh	M.Sc	2016	PhD	IIG, Mumbai
8	Avanti Gogate	M.Sc	2015	PhD	Univ. of Groningen, The Netherlands
9	Pooja Billimoga	M.Sc	2015	PhD	Univ. of Groningen, The Netherlands
10	Siddhesh Padwal	M.Sc	2015	$_{ m JRF}$	UDP, Mumbai
11	Niharika Rout	M.Sc	2015	PhD	IIT Madras
					University of
12	Tamasi Kar	M.Sc	2015	PhD	Heidelberg,
					Germany
13	Abhijit Bhogale	PhD	2015	PDF	UDP, Mumbai
14	Abhishek Iyer	M.Sc	2014	PhD	LNGS, Italy
15	Ajay Lotekar	M.Sc	2014	$_{ m JRF}$	IIG, Mumbai
16	Deepak Nayak	M.Sc	2014	$\mathbf{SA}$	NPCL
17	Hari Iyer	M.Sc	2014	Proj. Intern	IPR, Gandhinagar
18	Nakul Karle	M.Sc	2014	PhD	Univ. of Texas, USA
19	Pradeepkumar Yadav	M.Sc	2014	PhD	BITS, Pilani
20	Sonal Patel	M.Sc	2014	$_{ m JRF}$	TIFR, Mumbai
21	Anil Bohra	M.Sc	2013	PhD	BARC, Mumbai
22	Shazia Shaikh	M.Sc	2013	$_{ m JRF}$	BARC, Mumbai
23	Katheriene Rawlins	M.Sc	2012	$_{ m JRF}$	UMDAE-CBS
24	Manisha Yadav	M.Sc	2012	PhD	UDP, Mumbai
25	Namrata Maladkar	M.Sc	2012	$_{ m JRF}$	UMDAE-CBS
26	Pradnya Parab	M.Sc	2012	$_{ m JRF}$	UMDAE-CBS
27	Shyam Ramchandra	M.Sc	2012	$_{ m JRF}$	TIFR, Mumbai
28	Adityanarayan Pandey	M.Sc	2011	$\operatorname{SRF}$	RRCAT, Indore
29	Ashutosh Dubey	M.Sc	2011	PhD	IIT Bhubaneshwar
30	Buddhisagar Kharat	M.Sc	2011	Scientist	SAMEER, IIT Bombay
31	Kuldeep Pandey	M.Sc	2011	PhD	PRL, Ahmedabad
32	Purushottm Dubey	M.Sc	2011	$_{ m JRF}$	BARC, Mumbai
33	Ruchi Chudasama	M.Sc	2011	$\operatorname{SRF}$	BARC, Mumbai
34	Vijay Iyer	M.Sc	2011	PhD	NISER
35	Vivek Parker	M.Sc	2002	K. S. Krishnan Fellow	BARC
36	Remkrushn Rane	M.Sc	2002	Scientist	IPR Gandhinagar

## Teaching

S. No.	Name	Degree	Year	Position	Organisation
1	Dhanashree Haldavnekar	M.Sc	2016	Lecturer	VES College
2	Kajal Tiwari	M.Sc	2015	Lecturer	VESIT College
3	Kamlesh Kadam	M.Sc	2015	Lecturer	Xaviers junior college
4	Monika Kadav	M.Sc	2015	Lecturer	SDD College, Wada
5	Anıl Raghav	PhD	2015	Asst. Professor	UDP, Mumbai
6	Kamlesh Kadam	M.Sc	2015	Teacher	St. Xaviers College, Mumbai
7	Aditya Pal	M.Sc	2014	Asst. Professor	CKT College, Panvel
8	Amir Khan	M.Sc	2014	Teacher	
9	Anil Yadav	M.Sc	2014	Asst. Professor	
10	Samantha Wesley	M.Sc	2014	Asst. Professor	IMJ College, Vashi
11	Shruthi Thayyil	M.Sc	2014	Asst. Professor	KLE Society's Education College, Kalamboli
12	Elsa Jacoob	M.Sc	2013	Teacher	
13	Love Trivedi	M.Sc	2013	Asst. Professor	R.D National College
14	Manuel D'Souza	M.Sc	2013	Teacher	Podar International School, Santacruz
15	Shaili Badhani	M.Sc	2013	Teacher	IBDP and CIE, International School
16	Sneha Salap	M.Sc	2013	Lecturer	
17	Ashish Koli	M.Sc	2012	Asst. Professor	B.N Bandodkar College, Thane
18	Mujahid Hussain	M.Sc	2012	Asst. Professor	CHM College, Ulhasnagar
19	Gouri Pawaskar	M.Sc	2011	Asst. Professor	Bhavan's College
20	Harshali Valvi	M.Sc	2011	Lecturer	Acharya College, Mumbai
21	Heena Falahi	M.Sc	2011	Lecturer	
22	Jamvant Vishwakarma	M.Sc	2011	Lecturer	
23	Naim Shaikh	M.Sc	2011	Lecturer	
24	Siddhesh Sawant	M.Sc	2010	Lecturer	UDP, Mumbai
25	Jignesh Mehta	M.Sc	2009	Asst. Professor	Khalsa College, Matunga
26	Aswin Mohan	M.Sc.	2009	Asst. Professor	University of Tennessee, USA
27	Maulik Patel	PhD	2009	Asst. Professor	ICT, Mumbai
28	Raju Tandel	M.Sc	2009	Asst. Professor	Dandekar College, Palghar
29	Radheykrishna Dubey	PhD	2008	Asst. Professor	St. Xaviers College, Mumbai
30	Siddharth Kasthurirangan	M.Sc	2007	Asst. Professor	UDP, Mumbai
31	Sunil Kumar Wanchoo	PhD	2004	Asst. Professor	Mata Vaishno Devi University
32	Chetan Gurada	M.Sc.	2002	Asst. Professor	Department of Physics, University of Mumbai

## Industry

S. No.	Name	Degree	Year	Position	Organisation
1	Rajendra Dakua	M.Sc	2014	Material Manager	ONGC
2	Smitha Poojary	M.Sc	2014	Geographic Technician	Nokia
3	Divakar Chunarkar	PhD	2014		Industry
4	Nirmal Thorat	M.Sc	2013	Application Engineer	SMT Vasai
5	Kunal Kolambe	M.Sc	2012	Project Engineer	Oil and gas sector
6	Rajesh Mundotia	M.Sc	2012	Appln. Engineer	Surface Modification Technologies, Vasai.
7	Priyanka Kumbhar	M.Sc	2011	Subject Expert	Network 18
8	Sagar Parab	M.Sc	2011	Service Executive	Toshvin Analytical, Mumbai
9	Vishal S Pawade	M.Sc	2007	Assistant Director	Government Forensic Laboratory, Kalina
10	Chetan Samant	PhD	1997	Regional Head	West NASSCOM

## 10 Miscellaneous Information

## 10.1 Location

The Department of Physics is housed mainly in Lokmanya Bal Gangadhar Tilak Bhavan and partly in Sant Dnyaneshwar Bhavan located at the beautiful Vidyanagari Campus of the University of Mumbai. The Vidyanagari Campus is off the C.S.T. Road, now known as Vidyanagari Marg, near Kalina.

## 10.2 How to reach

Kalina Campus is accessible both from Central Railway (Kurla station) and Western Railway (Santacruz station). BEST buses 318, 313, 312, 37, 181, 213, 374, 306 and 449 pass via Vidyanagari Campus connecting different parts of the city of Mumbai.

## 10.3 Scholarships

The Department offers 'Merit Scholarships' and one 'Shri Nitin Rasiklal Parikh Memorial Scholarship'. These are awarded strictly on the basis of merit. There is also the 'Late Principal R. D. Godbole award' for a student standing first among those offering Nuclear Physics option. In addition, for financially needy students, department offers three 'Free Studentships' to be awarded on the basis of need-cum-merit. 'Earn-and-learn scheme' for M. Sc. students under Vice-Chancellor's scheme and Research Fellowships for Ph.D. students are offered by the Department. There are other scholarships which are available in the Department of Physics for meritorious and deserving students. These assistantships are available to only those students who are enrolled in the Department.

## 10.4 Central Library

The Jawaharlal Nehru Library at the Vidyanagari Campus is well equipped with Physics books, journals and periodicals. The students enrolled in the Department can avail of both the reading as well as lending facilities offered by the library.

## 10.5 Departmental Library

In addition, the Department has also refurbished its own Library and can lend books to students, as well as allow them to use the reading room facility. The Department library complements the main library with an excellent collection of classic Physics treatises and the latest books and monographs on emerging fields.

## 10.6 Hostel Accommodation

There are Girl's and Boy's hostels within the Campus. There are eight seats in Boys' hostel and eight seats in Girls' hostel reserved for the students of the Department of Physics. One seat is available at Jagannath Sankar Seth Hall / Hostel for boys' at Churchgate "B" Road, Mumbai-400 020.