

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY



Information Brochure

Ph.D.

2013-14

CONTENTS

- I. Important Guidelines for Ph.D. Application
- II. Important Dates for Autumn and Spring Semester

(A) GENERAL

- A.1) The Institute
- A.2) Research Facilities
- A.3) Student Amenities
- A.4) Ph.D. Programme
- A.5) General Eligibility Criterion for Admission
- A.6) Categories of Ph.D. Candidates
- A.7) Admission Procedure
- A.8) Payment of Fees and Deposits - **Appendix I - Fees and Deposits.**
- A.9) Financial Support
- A.10) Registration for the Ph.D. Degree
- A.11) Confirmation of Registration
- A.12) Submission of Thesis and Award of Degree

(B) INFORMATION ON DEPARTMENTS, INTERDISCIPLINARY GROUPS, CENTRES AND SCHOOLS

Departments

- B.1) Aerospace Engineering (AE)
- B.2) Biosciences and Bioengineering (BB)
- B.3) Chemical Engineering (CL)
- B.4) Chemistry (CH)
- B.5) Civil Engineering (CE)
- B.6) Computer Science and Engineering (CS)
- B.7) Earth Sciences (ES)
- B.8) Electrical Engineering (EE)
- B.9) Energy Science & Engineering (EN)
- B.10) Humanities and Social Sciences (HSS)
- B.11) Mathematics (MA)
- B.12) Mechanical Engineering (ME)
- B.13) Metallurgical Engineering and Materials Science (MM)
- B.14) Physics (PH)

Interdisciplinary Groups:

- B.15) Industrial Engineering & Operations Research (IO)
- B.16) Systems & Control Engineering (SC)
- B.17) Educational Technology (ET)
- B.18) Climate Studies (CM)

Centres

- B.19) Centre for Environmental Science and Engineering (CESE)
- B.20) Industrial Design Centre (IDC)
- B.21) Centre of Studies in Resources Engineering (CSRE)
- B.22) Centre for Research in Nanotechnology & Science (CRNTS)
- B.23) Centre for Technology Alternatives for Rural Areas (CTARA)

Schools

B.24) Shailesh J. Mehta School of Management (SJM SOM)

(C) APPENDICES

- C.1. Fees and Deposits.
- C.2. Sponsorship letter for full-time candidates
- C.3. Employer's Letter in case of candidates joining Ph.D. programme on Study leave
- C.4. Sponsorship certificate for External Registration
- C.5. No Objection Certificate for College Teacher

(D) Statement of Purpose for Ph.D. Application (SoP)

I. Important Guidelines for Ph.D. Application

1	Please read the instructions given in the brochure CAREFULLY before filling up the application form.
2	Online Application Form & Information Brochure is available on the Institute website http://www.iitb.ac.in/newacadhome/phd.jsp from 16th March, 2013 to 3rd April, 2013 . Candidates are required to submit their application ONLINE only . After filling the form, candidates are advised to take a printout and keep the same for the record.
3	<p>The application fee is ₹ 300/- for GN/OBC-NC and ₹.150/- for SC/ST. The fee is to be paid by Debit Card/ Credit Card/ SBI Internet Banking/ Online Payment System/ Demand Draft drawn in favour of ‘Registrar, IIT Bombay’ payable at SBI or Canara Bank, IIT Powai/Mumbai branch. You must write your Name, Department, Application number or GATE registration number and Email address on reverse side of the Demand Draft.</p> <p>If you are paying through Demand Draft, you MUST send the Demand Draft along with the completed copy of the application.</p> <p>If you have paid the application fee through Debit Card/ Credit Card/ SBI Internet Banking/ Online Payment System you do not have to submit the hard copy of the application.</p> <p>Applications without online payment details/Demand Draft will not be considered.</p> <p><u>APPLICATION FEE IS NON-REFUNDABLE.</u></p>
4	You can apply for THREE programmes in ONE application by paying the application fee ONCE . A candidate can submit multiple applications, if he/she wishes to apply to more than three programmes.
5	Along with your application, you have to submit a statement of purpose. If you are applying to Shailesh J. Mehta School of Management , you are required to submit a sample of your recently published writings on a relevant topic or an essay proposal(1500 words) on a topic of research interest in place of Statement of Purpose . The proposal should contain a) problem identification, b) brief review of literature, and c) methodology.
6	You should complete the application form in all respects. Incomplete application will not be considered.
7	<p>You MUST upload the following while submitting the Ph.D. Application.</p> <ul style="list-style-type: none"> • Scanned version of photograph • Scanned version of signature • Marksheet of the last semester/ Consolidated marksheet of the qualifying degree. • (Exam pending/result awaited candidates have to upload their latest/previous semester marksheet). • Caste Certificate (OBC-NC/SC/ST), if applicable. An affidavit for having applied in case the certificate is not yet received. • PD Certificate, if applicable • Statement of Purpose (SoP)
8	<p>OBC candidates may note that the limit of annual income is raised to ₹4.5 lakhs for determining the creamy layer among Other Backward Classes (OBC-NC) candidates.</p> <p>The OBC-NC certificate issued after 01.04.2012 (financial year for 2012-13) by the Competent Authority in the prescribed format must be uploaded/submitted in the ONLINE application form/at the time of admission.</p>
9	The copy of the completed application along with the demand draft (of the required amount) is to be sent in an envelope superscribing on the top ‘Application for Ph.D. Programme’, to the following address: Deputy Registrar (Academic), IIT Bombay, Powai, Mumbai–400 076 and must reach this office by 3rd April, 2013 .

10	You should check the Institute website http://www.iitb.ac.in/newacadhome/phd.jsp for results/important announcements.
11	You should check emails sent to the email address provided in your application for all important communications and announcements.
12	Candidates called for written test/interview should bring with them (i) Photo ID Card (ii) Hard copy of the application submitted online (iii)/Final year thesis / dissertation / report / publication / copy of certificates / Marksheets.
13	Candidates having degree from foreign universities are required to submit equivalence certificate from Association of Indian Universities (AIU), New Delhi for qualifying Exam and proof of having First class or 60% (55% for SC/ST) or equivalent in qualifying examination

Please read the guide-lines given in this Brochure of the respective programmes.

Candidates need to apply ONLINE only. Availability of application forms for Postgraduate Admission is entirely ONLINE. No Downloadable Forms will be available.

II) IMPORTANT DATES : (for Autumn Semester)

No	Particulars	Dates
01.	Advertisement (in all leading Newspapers and on website)	March 10,2013
Mode of Application form : Online		
02.	Availability of application forms	March 16 th ,2013
03.	Last date for submission of completed application forms*	April 3 rd ,2013
04.	Last date for Department(s) to send the list of candidates to be called for Written Test/Interview	April 12 th ,2013
05.	To display the list of candidates called for Entrance Test and/or Interview	April 15 th ,2013
06.	<u>Date of Entrance Test and/or Interview (for all categories)</u>	
	<u>Sciences Department :</u> Mathematics, Physics, Earth Sciences	May 7 th 2013 (Written Test) May 7 th & 8 th ,2013(Interview)
	Biosciences & Bioengineering	May 7 th ,8 th & 9 th ,2013 (No Written Test, only Interviews)
	Chemistry	May 7 th 2013 (Written Test) May 7 th , 8 th ,& 9 th ,2013(Interview)
	<u>All Engineering Departments:</u> Aerospace Engg, Civil Engg, Computer Sci. & Engg, Mech. Engg, Met.Engg. & Mat.Sci., Energy Sci. & Engg	May 8 th ,2013 (Written Test) May 8 th & 9 th ,2013(Interview)
	Chemical Engineering.	May 8 th & 9 th ,2013(Interview) 2 days interview (Candidates needed on both days. No written test)
	Electrical Engg,	May 13 th ,2013 (Written Test) May 13 th & 14 th ,2013(Interview)
	<u>All Interdisciplinary Groups :</u> IE&OR	May 13 th ,2013 (Written Test) May 13 th & 14 th ,2013(Interview)
	Systems & Control Engg.	May 3 rd ,2013 (Written Test and/or Interview)
	Educational Technology	May 13 th ,2013 (Written Test and/or Interview)
	Climate Studies	May 13 th ,2013 (Written Test and/or Interview)
	<u>Centres:</u> Industrial Design Centre,	May 8 th ,2013 (Written Test and/or Interview)
	CSRE, CRNTS, CTARA	May 9 th ,2013 (Written Test and/or Interview)
	Environmental Sc. & Engg.	May 13 th ,2013 (Written Test and/or Interview)
	<u>Schools:</u> Shailesh J. Mehta School of Management	May 13 th 2013 (Written Test) May 13 th & 14 th 2013(Interview)
	<u>Departments:</u> Humanities & Social Sciences	July 1 st , 2013 (Written Test) July 2 nd ,2013 (interview)

07.	Recommendations from Heads of Dept/School/ Centre/ID groups to reach Academic Office	May 17 th ,2013	
a).	Humanities & Social Sciences	July 5 th ,2013	
08.	Declaration of Result/Payment of fees	Result Announcement	Last date of payment of fees
	1 st offer	May 21 st ,2013	May 27 th ,2013
	2 nd offer(if required)	May 30 th ,2013	June 5 th ,2013
	Final Offer (if required)	June 7 th ,2013	June 13 th ,2013
09.	Humanities & Social Sciences	July 5 th ,2013	July 11 th ,2013
10	Registration and Orientation Programme	July 12 th ,2013 to July 17 th 2012	
11.	Instructions begins	July 18 th ,2013	

*Application forms received after the last date will be considered in the next semester(Spring Semester 2013-14).

II a) IMPORTANT DATES : (for Spring Semester)

No	Particulars	Dates
01.	Advertisement (on IITB website)	September 2 nd ,2013
Mode of Application form : Online		
02.	Availability of application forms	September 2 nd ,2013
03.	Last date for submission of completed application forms *	October 31 st ,2013
04.	Last date for Department to send the list of candidates for Written Test/Interview	November 8 th ,2013
05.	To display the list of candidates called for <u>Entrance Test and/or Interview</u>	November 12 th ,2013
06.	Date of Entrance Test and/or Interview (for all categories)	
	All Departments (except Biosc. & Bioengg. & Chemistry)	December 4 th ,2013 (Written Test) December 4 th & 5 th ,2013(Interview)
	Biosciences & Bioengineering	December 4 th ,5 th & 6 th ,2013 (No Written Test, only Interviews)
	Chemical Engineering.	December 4 th & 5 th ,2013(Interview) 2 days interview (Candidates needed on both days. No written test)
	Chemistry	December 4 th ,2013 (Written Test) December 4 th ,5 th & 6 th ,2013(Interview)
	All Interdisciplinary Groups : Systems & Control Engg.	December 2 nd ,2013 (Written Test and/or Interview)
	IE&OR, Educational Technology, Climate Studies	December 7 th ,2013 (Written Test and/or Interview)

	Centres: CSRE, CRNTS, CTARA, Environmental Sc. & Engg., Industrial Design Centre,	December 7 th ,2013 (Written Test and/or Interview)
	Schools: Shailesh J. Mehta School of Management	December 7 th ,2013 (Written Test and/or Interview)
06.	Recommendations to reach Academic office	December 13 th ,2013
07.	Declaration of Result	December 18 th ,2013
08.	Payment of fees on or before	December 26 th ,2013
09.	Registration and Orientation Programme	January 1 st , 2014 to January 3 rd , 2014
10	Instructions begins	January 6 th , 2014

* Application forms received after the last date will be considered in the next semester (Autumn Semester 2014-15).

- Results will be declared on IITB website: <http://www.iitb.ac.in/newacadhome/phd.jsp> on the tentative date as mentioned above. Candidates are instructed to check the web site regularly for all updates.
- Candidates should check emails sent to the email address provided in your application for all important communications and announcements.
- All applicants appeared for interviews are requested to check the result on Institute website on the above date.
- If you are paying through Demand Draft, send the Demand Draft along with a printout of your online application. **You must write your Name, Department, Application number and Email address on reverse side of the Demand Draft.**

The copy of the completed application along with the demand draft (of the required amount) is to be sent in an envelope superscribing on the top 'Application for Ph.D. Programme', to the following address: Deputy Registrar (Academic), IIT Bombay, Powai, Mumbai-400 076 .

A) GENERAL

A.1) THE INSTITUTE

The Indian Institute of Technology Bombay (IIT Bombay) is one of the higher Institutes of Technology in the country set up with the objectives of making available facilities for higher education, research and training in various fields of Science and Technology. IIT Bombay was established in 1958.

The Institute is located at Powai in a campus extending over 220 hectares amidst picturesque surroundings with Vihar and Powai lakes on either side.

At present, Undergraduate, Postgraduate and Doctoral programmes are offered by Aerospace Engineering, Biosciences & Bioengineering, Chemical Engineering, Civil Engineering, Computer Science and Engineering, Earth Sciences, Energy Science & Engineering, Electrical Engineering, Mechanical Engineering and Metallurgical Engineering and Materials Science Departments and by certain Interdisciplinary groups.

The Industrial Design Centre of the Institute offers a 2-year M.Des. Programme in Industrial Design, Visual Communication, Animation, Interaction Design, Mobility and Vehicle Design and a Ph.D. Programme in Design. M.Sc. and Ph.D. programmes in Applied Geology and Applied Geophysics, Chemistry, Mathematics, Physics, M.Sc. Programme in Applied Statistics and Informatics are offered by the respective Departments. The Department of Physics also offers a 4-year B.Tech. Programme in Engineering Physics. The Institute has a Humanities and Social Sciences Department, which offers doctoral programmes and a 2-year M.Phil programme. The Centre of Studies in Resources Engineering (CSRE) offers a 2-year M.Tech. Programme in Geoinformatics & Natural Resources Engineering and doctoral programmes. The Departments of Physics, Energy Science and Engineering, Centre for Environmental Science and Engineering are also offering M.Sc. - Ph.D Dual degree programmes and their admissions are through JAM. The Institute offers M.Tech. in Technology and Development offered by CTARA and also offers a doctoral programme, Ph.D in Nano Technology - offered by CRNTS, M.Tech. in Petroleum Geoscience offered by the Department of Earth Sciences, M.Tech in Steel Technology offered by the Department of Metallurgical Engineering & Material Sciences. The Institute offers Cross- Departmental M.Tech programme in Materials, Manufacturing & Modelling(MMM) offered by Mechanical Engg., Met. Engg. & Mat. Sci. & Mathematics. The Institute has also started PG Dual Degree Programmes (M.Tech/M.Phil/Ph.D) in various disciplines

From 2011-12

1. M.Sc.- Ph.D-Dual Degree programme in Earth Sciences in Applied Geology & Applied Geophysics
2. M.Sc.- Ph.D-Dual Degree programme in Chemistry.
3. M.Sc. +M.Tech. Dual Degree programme in the Physics and Metallurgical Engg. & Materials Science.
4. M.Tech in Nuclear Engineering (ME4) as specialisation in Department of Mechanical Engg.

From 2011-12 (Spring Semester)

1. Interdisciplinary (IDP) Ph.D. programme in Climate Studies

Interdisciplinary Programmes in Industrial Engineering & Operations Research and Systems & Control Engineering offer Ph.D. & M.Tech. Programmes. The Industrial Engineering and Operations Research in Operations Research also offers M.Sc.+ Ph.D. -Dual Degree Programme in Operation Research.

The Shailesh J. Mehta, School of Management offers a 2-year Master of Management programme and also a doctoral programme. The School of Management also conducts a wide range of courses for the Undergraduate and Postgraduate Programmes.

The Department of Biosciences and Bioengineering offers M.Sc. in Biotechnology, Ph.D. and M.Tech. programmes in Biomedical Engineering and M.Sc.- Ph.D. Dual Degree Programme in Biotechnology.

The DIIT Programme (Post Graduate Diploma of IIT) is offered through Distance Education mode.

The Institute on an average admits 1131 candidates for the Undergraduate programmes and 1476 candidates for different Ph.D / Postgraduate programmes every year. Students from Bangladesh, Egypt, Ethiopia, Fiji, Iran, Iraq, Jordan, Mauritius, Malaysia, Nepal, Palestine, Sri Lanka, Vietnam and Yemen are also undergoing training in various programmes. In addition to these academic programmes, the

Continuing Education Programme (CEP Cell) organizes short, intensive courses in specialized topics both for practicing engineers as well as for teachers from engineering colleges; and also conduct seminar and conferences on current scientific and technological developments. Further, under Quality Improvement programme (QIP), teachers from various engineering colleges also join Institute for the postgraduate and doctoral programmes.

A.2) RESEARCH FACILITIES

All the departments of the Institute have well equipped research laboratories and workshop facilities. In addition, there are a number of central facilities, which include Computer Centre, Central Library, Workshop, Xerox and Photography Sections. The Central Library has a very large collection of books, back volumes of periodicals, standard specifications and other literature. The Library has now more than 3 lakhs books and volumes and subscribes to over 1500 current journals in Science, Engineering, Humanities and Social Sciences.

The Centre of Studies in Resources Engineering (CSRE) established by the Department of Education, Ministry of Human Resources Development, Govt. of India, offers M.Tech. Programme in Natural Resources Engineering. The CSRE is concerned with the area of Remote Sensing pertaining to natural resources exploration, exploitation and management.

The Centre for Research in Nano-Technology & Science (CRNTS), is well equipped for pursuing research in nanotechnology. Almost all sophisticated tools required for Nanotechnology research are housed here.

The Center for Environmental Science and Engineering (CESE) funded by the Department of Education, Govt. of India, is concerned with air and water quality management, Computer Added Design for wastewater engineering systems, low waste techniques, etc.

The Department of Science and Technology (DST), Defense Research & Development Organization (DRDO) and Ministry of Human Resources Development (MHRD) of Government of India, has sponsored the setting of a National Geotechnical Centrifuge Facility (NGCF) to facilitate research in frontier areas.

The Centre for Technology Alternatives for Rural Areas (CTARA) is concerned with development, transfer and impact-assessment of technology in the context of socio-economic development of a small region. To this end, the centre offers courses (coupled with field work) to impart necessary perspectives and quantitative skills.

The Industrial Design Centre established in 1969, has followed an integrated and interdisciplinary approach towards design education. The centre over the past years has experimented with different methods in design education to develop a flexible structure to suit the needs of students.

Schools in Cryogenics, Lasers and Laser Systems, Offshore Engineering and Management have special facilities in these areas of research work. New facilities under the Thrust Area Programmes in the fields like Microelectronics, Microprocessor Applications, Intelligent Systems, Robotics, CAD/ CAM, Remote Sensing, Telematics, etc. have been created.

Centre for Aerospace Systems Design & Engineering (CASDE) and Centre for Formal Design and Verification of Software (CFDVS) have been established recently.

The Institute has many research collaborations with leading universities in USA, Europe, Japan, and other East countries. As part of these collaborations, the post graduate students get opportunities to carry out joint research projects with faculty and students from these universities.

The Centre for Distance Engineering Education Programme (CDEEP) was started by the Indian Institute of Technology (IIT) Bombay with the express aim of providing high quality distance education in engineering and science to a large number of participants throughout the country and abroad. CDEEP would like to share the expertise of IIT Bombay faculty with students and working professionals everywhere. The courses offered through distance education are the very same ones that are taken by IIT Bombay students. To reach as many learners as possible, CDEEP is using different mediums and various technologies.

Approximately 7 to 10 M.Tech. projects will be taken up every year in collaboration with German Academic Exchange Service (DAAD) wherein students work on their projects in reputed German Universities like Aachen, Berlin, Darmstadt, Karlsruhe, Stuttgart and Dresden.

The location of IIT Bombay in close proximity to several leading R & D Centers and major industrial establishments offers excellent opportunities to interact with them and plan some of research programmes in collaboration with them. The Industrial Research and Consultancy Centre (IRCC) coordinates collaborative projects with industry and other research organizations such as BARC, TIFR and CSIR. The Institute is actively collaborating with several organizations of other countries on a bilateral basis.

The Computer Centre of IIT Bombay provides high end computing facilities to the Institute. It has several high performance computing machines, which include a 4 CPU Digital machine, HP's K-class machine, SGI Octane and several SUN servers. Students are provided email access through a cluster of 10 J class HP computers. The Computer Centre is a level 3 Centre for the national computing facilities under the ICOSER project of the Department of Science and Technology's TIFAC.

The entire academic area of the Institute as well as its hostels are connected to the Institute's backbone by a 10 Mbps optical fiber link connected to an ATM switch through several fast ethernet switches. The Institute backbone is linked to a 2 Mbps Internet link through a radio modem. In addition, there are two lower capacity Internet links, each of 64 kbps. Each student hostel has a computer room with several PCs, which can directly access any server in the Institute through the Internet link.

A.3) STUDENTS AMENITIES

The Institute is fully residential and has 14 hostels for students. Each hostel is an independent entity with its own mess facilities, recreation areas, etc. However students may be permitted to have their own arrangements for accommodation outside campus.

Extra curricular activities are provided by the Students' Gymkhana. These activities include sports, cultural programmes, social service and the NCC. Various clubs of the Gymkhana encourage individual talents of students in hobbies such as painting, modeling, music, photography, aeromodelling and fabrication of electronic devices. A swimming pool is an additional facility. A well-planned student Activities Centre is functioning.

A.4) Ph.D. PROGRAMME

As a result of the sound research base and extensive infrastructural facilities available, the Institute offers Ph.D. programme in a wide range of areas in Engineering, Science & Humanities and Social Sciences. The broad objectives of the Ph.D. programme is not only to keep pace with the expanding frontiers of knowledge but also to provide research training relevant to the present social and economic objectives of the country.

The academic programme leading to the Ph.D. degree is broad-based and involves a minimum course credit requirement and research thesis. The Institute also encourages research in interdisciplinary areas through a system of joint supervision and interdepartmental group activities. The presence of a strong research oriented faculty provides excellent opportunities for such programme. The Institute undertakes sponsored research and development projects from industrial and other organizations in public as well as private sector.

Facilities for research work leading to the Ph.D. degree are available in the departments of Aerospace, Chemical, Civil, Computer Science and Engineering, Energy Science & Engineering, Electrical, Mechanical and Metallurgical Engineering and Material Sciences, Chemistry, Earth Sciences, Mathematics and Physics as well as in the department of Humanities and Social Sciences, Shailesh J. Mehta School of Management (SJMSOM), Department of Bioscience & Bioengineering (BB), Centre for Environmental Science and Engineering (CESE), Industrial Design Centre (IDC) and Centre of Studies in Resources Engineering (CSRE), Centre for Research in Nanotechnology and Science (CRNTS) & Centre for Technology Alternatives in Rural Areas (CTARA). Interdisciplinary Groups in Industrial Engineering & Operations Research as well as Systems & Control Engineering and Educational Technology.

A.5) GENERAL ELIGIBILITY CRITERION FOR Ph.D. ADMISSION

One of the following in appropriate subject areas:

- 1) First class or 60% marks (55% marks for SC/ST) in Master's Degree in Engineering / Technology or equivalent
- 2) For Humanities and Social Sciences Department and Industrial Design Centre: 55% marks or equivalent (50% for SC/ST) in Bachelor's Degree in Engineering/Technology OR Master's Degree in Arts/ Social Sciences or equivalent.
- 3) A First class or 60% marks (55% marks for SC/ST)* Master's degree in Science or a first class or 60% marks (55% marks for SC/ST)* in Bachelor's degree in Engineering/Technology. Candidates meeting this requirement **MUST also fulfill one of the** following additional requirements:
 - Valid Gate Score
 - CSIR /UGC / NBHM / DBT / DST Inspire Award or Fellowship.
 - Minimum of 2 years of professional work experience (for Sponsored(SW)/Self-Financed(SF)/Institute Staff (IS) category.
 - Minimum 6 months project work experience in IIT Bombay (for Project Staff (PS) category)

Requirements for Teaching Assistantship (TAship)/ Research Assistantship (RAship):

Candidates with Master's Degree in Engineering / Technology are eligible for TAship/RAship. Candidates without Master's Degree in Engineering/ Technology require either a valid GATE score or CSIR/ UGC/ NBHM/ DBT/ DST Inspire fellowship to be considered for TA/ RAship.

This is general eligibility criterion, however, applicant must satisfy the eligibility criterion specified by the respective Departments/Centres/ Schools/ ID Groups as per the Ph.D Information Brochure 2012-13.

Admission for IIT B.Tech. degree holders

Candidate having an IIT B.Tech. Degree and having a CGPA/CPI score of 8.00 and above are exempted from requirement of GATE qualification. They will be admitted to Ph.D.. Programme under TA/RA positions through written test / interview.

Requirement of First Class/60% for PG admission at IIT Bombay

For general category students and/or for students where no concession in academic performance is called for, the First Class/60% in the qualifying degree examination as the eligibility requires meeting **ANY ONE of the following criteria**:

- (1) a minimum of 60 percent marks in the final academic year of the programme
- (2) a minimum of 60 percent marks in aggregate or as specified by the university (any one of them)
- (3) a first class as specified by the university
- (4) a minimum CPI of 6.0 on the scale of 10; with corresponding proportional requirements when the scales are other than on 10,(for example, 4.8 on a scale of 8)

For students from the SC/ST category, the corresponding criteria are:

- (1) a minimum of 55 percent marks in the final academic year of the programme
- (2) a minimum of 55 percent marks in aggregate or as specified by the university (any one of them)
- (3) a first class as specified by the university
- (4) a minimum CPI of 5.5 on the scale of 10; with corresponding proportional requirements when the scales are other than on 10,(for example, 4.4 on a scale of 8)

A.6) CATEGORIES OF Ph.D. CANDIDATES

The minimum 2 yrs. Duration is from the date of registration (3 yrs. for External candidates) and the maximum duration is 6 yrs. The Assistantship/Fellowships will be payable for duration fixed by the MHRD (or the granting agency) or date of submission of thesis, whichever is earlier.

The Institute admits Ph.D. candidates under the following categories:

A.6.1 FULL-TIME RESEARCH SCHOLAR

- i. Institute Research Scholars with Teaching Assistant-TA
- ii. Govt. / Semi Govt. Fellowship Awardees (FA - QIP, CSIR, UGC, DAE, DST, DBT, NBHM, etc.)
- iii. Sponsored candidates(SW)
- iv. Self-financed (Indian/Foreign)/Study Leave (SF)
- v. With Indian Council for Cultural Relations Award (ICCR) (Foreign Students)

A.6.1.1 *Institute Research Scholar: Teaching Assistantship –TA*

Students under this category are entitled for Institute Teaching Assistantship. as per MHRD norms (*Please refer Item No. A.9 for financial support*)

Teaching Assistantship Through Project (TAP)

(Employees on the rolls (with or without pay) of any organization are not eligible for admission under this category).

Only few academic units have TAP seats. Candidates must refer to admission schedule for details.

Candidate to this category will be admitted subject to:

- i. Those students having B.E. / B.Tech. / B.Arch / M.Phil. / B.Sc.(Engg)/ M.Sc. / M.A. / M.Com. Or equivalent MUST have a valid GATE or National Level test-UGC / CSIR / NBHM/DBT etc. (JRFship) will be considered for assistantship for period of 5 years.
- ii. Those student having M.Tech. / M.E. / M.Arch / M.Sc.(Engg) or equivalent/ M.B.B.S /MD/ MS and Management students with M.B.A. qualification with Engineering / Technical background will be considered for assistantship for period of 4 years.
- iii. Management students with M.B.A. qualification with Science /Commerce background will be considered for assistantship for period of 5 years.
- iv. Performance in Written Test / Interview

The students joining the programme under this category will be considered for Assistantships based on the following norms:

- The TAP holders are required to work in a sponsored R&D project being carried out at the institute.
- They will also do their Ph.D. dissertation work under same faculty group in same area as the sponsored project.

Fellowships are also available from agencies such as Aeronautics Research & Development Board (ARDB), Dept. of Science and Technology (DST), Forbes Marshall, Pune, Textile Machinery Manufacturers' Association (TMMA), Atomic Energy Regulatory Board (AERB), International Energy Initiative, Department of Atomic Energy (DAE).

A.6.1.2 *Govt. / Semi Govt. Fellowship Awardees (FA - CSIR, UGC, DAE, DST, DBT, NBHM, etc.):*

These candidates are financially supported under various Govt. / Semi Govt. schemes.

The admission procedure and other requirements are same as applicable to Institute Research Scholars.

A.6.1.3 *Sponsored candidates (SW)*

These candidates are sponsored by recognized R&D organizations for doing research work in the Institute on a full time basis. Candidates are expected to be released for full time research work at the Institute for a minimum period of three years. **They will not receive any financial support**

from the Institute. Sponsorship letter (**Appendix II**) should be brought at the time of written test and/or interview.

A.6.1.4 Self Financed (Indian / Foreign) / Study Leave (SF)

a) **Indian:** This category refers to persons with experience and with good track record to join the doctoral programme. They are admitted along with the regular research students through the usual admission procedure but **they would not get any financial support from the Institute.**

This is a non-residential student category and the students are not entitled for hostel accommodation on campus. If admitted, these students have to complete their programme within prescribed time without any financial support from the Institute.

b) **Foreign:** These students are admitted through Embassy of the respective Govt. after getting approval from the Ministry of External Affairs and no objection certificate from Ministry of Human Resources Development, Department of Education, Govt. of India.

c) **Study Leave:** This category refers to candidates who are released from Governmental or educational institutions on study leave for a period not less than three years for doing research work at the Institute. Employer's letter (**Appendix III**) should be produced at the time of joining, if selected.

A.6.1.5 Indian Council for Cultural Relations Award (ICCR) (Foreign Nationals) (FN)

These students are sponsored by their Governments and awarded scholarship by them. They should apply for admission through Indian Embassy in their country.

A.6.2 PART-TIME RESEARCH SCHOLAR

- i. Institute Faculty / Staff (IS) (for faculty/staff of IIT Bombay)
- ii. Project Staff (PS) (for Project staff of IIT Bombay)
- iii. Institute Research Assistants (RA)
- iv. External candidates (Sponsored) (EX)
- v. Candidates working in Colleges / Educational Institutes (CT)

A.6.2.1 Institute Faculty / Staff (IS)

A staff of the Institute (IIT Bombay) having completed at least TWO years of service and having at least TWO years of period remaining at the time of application.

A.6.2.2 Project Staff (PS)

(only for project staff members of IIT Bombay)

This category refers to candidates who are working on various Projects undertaken by the Institute and admitted to the Ph.D. programme, if the duration of the Project at the time of admission is around 3 years.

A.6.2.3 Institute Research Assistantship (RA)

Only few academic units have RA seats. Candidates must refer to admission schedule for details.

Depending upon the requirements, each Department/Centre /School may induct **one** Research Assistant every year.

Students under this category are entitled for Institute Research Assistantship. as per rule (**Please refer Item No. A.9 for financial support**)

Project Research Assistantship (PA)

Only few academic units have PA seats. Candidates must refer to admission schedule for details.

Candidate to this category will be admitted subject to:

- i. Those students having B.E. / B.Tech. / B.Arch / M.Phil. / B.Sc.(Engg)/ M.Sc. / M.A. / M.Com. Or equivalent **MUST** have a valid GATE or National Level test-UGC / CSIR / NBHM / DBT etc. (JRFship).

- ii. Those student having M.Tech. / M.E. / M.Arch / M.Sc.(Engg) or equivalent/ M.B.B.S / MD / MS and Management students with M.B.A. qualification with Engineering /Technical background.
- iii. Management students with M.B.A. qualification with Science /Commerce background. Performance in Written Test / Interview.

The students joining the programme under this category will be considered for Assistantships supported under Sponsored Research Project being carried out at the Institute based on the following norms:

- Research Assistants have to work in Sponsored R&D project. They will do their thesis / dissertation in same project area.
- They are required to work for about 20 hours a week on the Sponsored Research Project.

A.6.2.4 External Candidates (Sponsored) (EX)

After fulfilling one semester (M.Tech. / M.E. / equivalent) or two semesters (B.E. / B.Tech. / M.Sc. or equivalent) of residential requirement at the Institute, these candidates will be allowed to register for Ph.D. with a supervisor from the Institute (Internal) and a supervisor from their parent organization (External) where they will be doing the research work. A sponsorship certificate from the organization (**Appendix IV**) must be attached, to the application form.

A.6.2.5 College Teacher Category (CT)

(only for candidates working in Colleges/Educational Institutes)

- i. These candidates carry out Research work during week-ends, holidays and vacations, at IIT Bombay.
- ii. After fulfilling one (M.Tech. / M.E. /equivalent) or two semesters (B.E. / B.Tech. / M.Sc. or equivalent) of residential requirement at the Institute, these candidates will be allowed to register for Ph.D. with a supervisor from the Institute (Internal) and a supervisor from their parent organization (External) which is optional based on recommendations of the supervisor and respective DPGC / IDPC / PGC. Sponsoring certificate from the organization (**Appendix-V**) must be attached to the application form.
- iii. **Candidates admitted under this category will be treated on par with Self-finance category as far as payment of fees and deposits are concerned.**
- iv. Place of work will be IIT Bombay even though candidate may be carrying out part of work at their College/Institute. These candidates are required to be available to the Supervisor (Internal) during week-ends, holidays and vacations.

A.7) ADMISSION PROCEDURE

Admission is offered on the basis of an interview held usually a month before the commencement of the semester for which admission is sought. The interview may be supplemented by a written test, if necessary.

A.7.1 Travelling Allowance for appearing in written test/interviews

Regular candidates called for the written Test/Interview under Teaching Assistantship (TA) category will only be paid to and for single second class railway fare by the shortest route from their place of residence to the Institute. They have to produce evidence (Original/Photocopy of Railway Ticket) in support of their claim only for one discipline.

No other categories of candidates are eligible for Traveling Allowance.

A.7.2 Admission of External candidate (Sponsored) (EX)

The candidates desirous of pursuing Ph.D. programme while in employment should apply for admission as external candidates. These applications should be made at the same time prescribed in the advertisement for regular candidates. **The minimum qualifications and other eligibility criterion for admission are the same as for regular full time students.** It should be noted that the Ph.D. programme of this Institute will be the same for both, for a regular (TA) student as well as for an external candidate. However, the following additional conditions are to be noted/fulfilled by the external candidates :-

- A.7.2.1 The Institute will decide the competence of these candidates along with the regular candidates.
- A.7.2.2 The following certificates must be submitted by the candidate at the time of test/interview
- a) Sponsorship certificate from the organization in which he / she is employed, identifying the supervisors (internal and external) and giving an undertaking that the candidate would be released from his / her normal duties to fulfill the residential requirements. The prescribed format for the certificate is given in **Appendix-IV**.
 - b) Details of facilities relevant to the research programme available in the organization, duly certified by the sponsoring authority.
 - c) A certificate stating that these facilities will be made available to the candidate by the organization.
- A.7.2.3 The candidate is required to be in residence at the Institute during the first semester (second semester, if required) of his Ph.D. Programme.
- A.7.2.4 To promote interaction and association of the Institute Faculty and the external organization concerned, meeting between the two supervisors (internal and external) should be arranged at least once in a year in the Institute or in the sponsoring organization to ensure a continuous dialogue and participation in the joint supervision programme. These meetings could also be arranged during the stay of the candidate as mentioned in 7.2.3 above.
- A.7.2.5 The Ph.D. registration of an external candidate would be reviewed at the end of each year from the date of registration in terms of his progress in courses / seminars / approved research programme by a Research Progress Committee (RPC) nominated by the concerned Department postgraduate Committee (DPGC)/Interdisciplinary Programme Committee (IDPC) / Postgraduate Committee (PGC) for School and Centre.
- A.7.2.6 The facilities of external registration are for those who are working in well-equipped scientific institutions, laboratories, R&D establishments and industrial organizations engaged in research based activities.
- A.7.2.7 Persons working in colleges / universities are eligible for registration as external candidates, provided he / she fulfills the requirements stated under 7.2.1 to 7.2.3 above and produces a letter from the university (**as in Appendix IV**) stating that the university has no objection for IIT Bombay awarding the Ph.D. Degree.
- A.7.2.8 For fulfilling the residential requirements during the first semester, a candidate will have to produce a certificate from his / her employer that he / she has been fully relieved from normal duties during the semester(s) to complete the residential requirement at IIT Bombay.
This certificate is to be produced at the time of joining the programme.

A.7.3 Admission for IIT B.Tech. degree holders

Candidate having an IIT B.Tech. Degree and having a CGPA/CPI score of 8.00 and above are exempted from requirement of GATE qualification. They are admitted to Ph.D.. Programme through normal procedure for selection of candidates for TA/RA positions through written test and/or interview.

A.8) PAYMENT OF FEES AND DEPOSITS

Various fees and deposits for the programme are given in **Table A.I**

Table A.1

Fees, Deposits & Hostel Rent for Ph.D students

Sr. No	Particulars	Revised fee payable (RS)			
		GN/OBC		SC/ST/PD	Institute Staff
		Group I (Concessional Fee)#	Group II (Non Concessional Fee)@		
A) One time payment at the time of Admission					
	a.1. Admission fee	1400	1400	1400	1400
	2. Grade Card	00	00	00	00
	3. Medical Examination	200	200	200	00
	b.1. Provisional Certificate	200	200	200	200
	2. Student Welfare Fund	1000	1000	1000	1000
	3. Modernisation	1500	1500	1500	1500
	4. Identity Card	400	400	400	00
	5. Courses of Study bulletin	00	00	00	00
	6. Institute Day Celebration	00	00	00	00
	7. Valedictory Function Fee	00	00	00	00
	8. Thesis fee	1500	1500	1500	1500
	Total (A)	6200	6200	6200	5600
B) Per Semester Fees					
	a.1. Tuition Fee - Statutory fees	5000	25000	00	00
	2. Examination Fee	500	500	500	500
	3. Registration Fee	500	500	500	500
	4. Gymkhana Fee	750	750	750	00
	* 5. Hostel Seat Rent	500	500	500	00
	* 6. Elect. & Water Charges	2500	2500	2500	00
	b.1. Medical Fee	1000	1000	1000	00
	2. Student Benevolent Fund	1000	1000	1000	1000
	* 3. Hostel Establ. Charges	2000	2000	2000	00
	4. Medical Fund	00	00	00	00
	* 5. Contribution to Hostel Subsidy	6000	6000	6000	00
	6. Internet Fee	00	00	00	00
	* 7. Hostel Maint. Fees	00	00	00	00
	Total (B)	19750	39750	14750	2000
C)	Annual Med. Insu. Premium (once in a year)	126	126	126	00
D) Deposits (Refundable) to be paid at the time of Admission					
	1. Institute Security Deposit	1000	1000	1000	00
	2. Library Security Deposit	1000	1000	1000	00
	*3. Mess Security Deposit	1000	1000	1000	00
	Total(D)	3000	3000	3000	00
	Total Fees (A+B+C+D) -for GN/OBC categories - for SC/ST categories	29076	49076	24076	7600

* Students not staying in Hostel are exempted from the payment of Hostel fees.

Group I : Concessional Fee (Tuition fee @ ₹ 5000/- i.e. Tuition fee waiver of ₹ 20,000/-)

- (1) Teaching Assistantship(TA),
- (2) Research Assistantship(RA),
- (3) TAP,
- (4) PA,
- (5) Govt./Semi-Govt. Fellowships awardees(QIP/ UGC/ CSIR/ DAE/ DST/ DBT/ NBHM/ ICSSR/ MNES/ICAR/MERC/ ARCI/ CPHEEO/ ICMR/HBNI/ICPR/AERB/DAE/AICTE/ENDOWMENT etc.)

@Group II : Non Concessional fee (Tuition fee @ ₹ 25,000/- i.e. No waiver in Tuition fee)

All other categories i.e. SW, EX(First / Second Semester), SF, CT, PS, DRDO Sponsored, IITB-Monash, SFA etc.

- External students who have completed the course work and joined the parent organisation are required to pay ₹ 5126/- as continuation fee (₹ 2176/- for SC/ST/PD)
- Students who have permitted temporarily withdrawal from the programme are required to pay ₹2000/- as continuation fee per semester.
- Research Scholars who are staying in quarters such as Tansa, Tulsi, QIP etc. are required to pay license fee, F.R., etc., as applicable to this quarters as per Estate Office rules.

A.9) FINANCIAL SUPPORT

Students joining Ph.D. programme will be considered for Teaching / Research Assistantship based on the following norms:

A.9.1 Institute Teaching Assistantship(TA)

(Employees on the rolls (with or without pay) of any organization are not eligible for admission under this category).

- A.9.1.1** Those students having B.E. / B.Tech. / B.Arch / M.Phil. / B.Sc.(Engg)/ M.Sc. / M.A. /M.Com. or equivalent and who have either a valid GATE or National Level test–UGC / CSIR / NBHM / DBT etc. (JRFship) will be considered for monthly assistantship of ₹16,000/-for first 2 years and on enhanced rate of ₹ 18,000/- for remaining 3 years.
- A.9.1.2** Those student having M.Tech. / M.E. / M.Arch / M.Sc.(Engg) or equivalent/ M.B.B.S /MD / MS and Management students with M.B.A. qualification with Engineering /Technical background will be considered for monthly assistantships of ₹ 18,000/- for first 2 years and on enhanced rate of Rs. 20,000/- for remaining two years.
- A.9.1.3** Management students with M.B.A. qualification with Science /Commerce background will be considered for monthly assistantships of ₹ 16,000/- for first 2 years and on enhanced rate of ₹18,000/- for remaining three years.
- A.9.1.4** The assistantship is payable for maximum period of 5 years for candidates with B.E./ B.Tech./ M.Sc. as qualifying degree & maximum period of 4 years for candidates with M.E./ M.Tech. as qualifying degree or date of submission of thesis, whichever is earlier.
- A.9.1.5** To get Teaching Assistantship, the students concerned must assist in teaching or research, as assigned by the Institute, **to the extent of 8 hours of work per week.**

A.9.2 Institute Research Assistantship(RA)

(Employees on the rolls (with or without pay) of any organization are not eligible for admission under this category).

- A.9.2.1** Those students having B.E. / B.Tech. / B.Arch / M.Phil. / B.Sc.(Engg)/ M.Sc. / M.A. /M.Com. or equivalent and who have either a valid GATE or National Level test–UGC / CSIR / NBHM / DBT etc. (JRF ship) will be considered for monthly assistantship of ₹ 18,000/-for first 2 years and on enhanced rate of ₹ 20,000/- for remaining 3 years.

A.9.2.2 Those student having M.Tech. / M.E. / M.Arch / M.Sc.(Engg) or equivalent/ M.B.B.S /MD / MS and Management students with M.B.A. qualification with Engineering /Technical background will be considered for monthly assistantships of ₹ 20,000/- for first 2 years and on enhanced rate of ₹ 22,000/- for remaining 3 years.

A.9.2.3 The assistantship is payable for maximum period of 5 years (irrespective of qualifying degree) or date of submission of thesis, whichever is earlier.

A.9.2.4 These Research Assistants have to look after the laboratories and also assist in teaching or research or other work assigned by the Head of the Department / Centre / School or Convener IDPC. **They are required to work for about 16-20 hours a week.**

The continuation of the assistantship(TA/RA) will be subject to satisfactory performance of the duties assigned by the Department / Centre / School as well as satisfactory academic performance.

As per MHRD directives, the employees of any organizations undergoing Ph.D. /Post-Graduate Programmes by availing study leave with or without pay are not eligible for Teaching Assistantship(TA)/ Research Assistantship(RA) category. Such candidates, if found suitable, will have to complete their programme as Self Finance / Sponsored full time or part time, as the case may be.

Students getting assistantships (Teaching Assistantship(TA)/Research Assistantship(RA) category) from the Institute can join projects sponsored by external agencies like Aeronautics Research & Development Board (ARDB), Department of Science & Technology (DST), Council for Scientific & Industrial Research (CSIR) etc. and obtain corresponding fellowships in lieu of Teaching Assistantship(TA)/Research Assistantship(RA) category.

A.9.3 Other fellowships

A.9.3.1 Few fellowships(@ ₹ 14,000/- per month are also available in the Department of Metallurgical Engineering & Materials Science, sponsored by the International Advanced Research Centre for Powder Metallurgy & New Materials.

A.9.3.2 Ph.D. Programme offered jointly by IIT Bombay and Monash University, Australia

Applicants to Ph. D. IIT Bombay will also have an opportunity to opt for aco-badged Ph.D. Programme offered jointly by IIT Bombay and Monash University, Australia. Exceptional students will be enrolled at both the Institutions and they will have at least two supervisors, one in each Institute. The student admitted in IIT Bombay will be governed by the rules and regulations of the Senate of the Institute. The scholarship will be paid by the Monash University. The joint Ph.D. programme will initially apply to the Engineering and Science disciplines.

Candidates selected for the joint Ph.D. programme will be required to spend a minimum of 3 months for research work in Australia, after they have completed the required course work at IIT Bombay and the first Annual Progress Seminar Report formalities of the programme.

Scholarship support will be available for the IIT Bombay-Monash Ph.D. scholars for a maximum of 4 years in the programme. English language proficiency is an additional requirement of this programme.

Eligibility criterion is same as fixed for Teaching Assistantship category.

A.9.3.3 Crompton Greaves Limited (CGL) Fellowship to undergo Ph.D programme at IITB

Few fellowships sponsored by Ms. Crompton Greaves Ltd., Mumbai will be available for Ph.D. Research Scholars in the specific areas of Electrical Engineering, Industrial Design Mechanical Engineering & Metallurgical Engineering & Materials Science of the Institute. This scheme is called the 'CG Research Fellowship' and the student offered this fellowship will be called : 'CG Research Fellow'.

Eligibility criterion is same as fixed for Teaching Assistantship category.

A.10) REGISTRATION FOR THE Ph.D. DEGREE

After a candidate has been admitted to the Institute, he/she has to make an application on a prescribed form for registration for the Ph.D. degree. This application will be considered by the Departmental Postgraduate Committee (DPGC)/Interdisciplinary Programme Committee (IDPC) / Postgraduate Committee for Centre and School (PGC) which will make appropriate recommendations to the Senate regarding (a) the course work prescribed for the candidate and (b) the date of registration.

The period of validity of Ph.D. registration for all candidates is FIVE/SIX years from the date of confirmation of registration. (Registration is confirmed as per rules, after successfully completion of course credit requirements).

A.11) CONFIRMATION OF REGISTRATION

Some academic units (departments/Interdisciplinary programmes/centres/schools) prescribe qualifying examinations/qualifying procedures for the Ph.D. Programme. These must be completed successfully prior to confirmation of registration.

All Ph.D. Admissions are provisional until the “Confirmation of registration” is done. This confirmation takes place after six months to a year of admission and only if academic performance criterion set by the department are met. Failure to meet satisfactory performance criterion may lead to termination of studentship (For more information please refer “ Rules & Regulations for Ph.D. Programme” at our Institute website <http://www.iitb.ac.in/academichome/rules.jsp>).

A.12) SUBMISSION OF THESIS AND AWARD OF DEGREE

Subject to fulfilling the course credit requirements and other conditions as may be laid down from time to time, the candidate may submit the Ph.D. thesis after two years from the date of registration (3 years for external candidates).

The thesis is examined by two/three referees from outside the Institute. The Senate examines the reports of the referees and on acceptance of the thesis, appoints a Board of Examiners to conduct a viva-voce examination at which a candidate is required to defend the thesis.

On the basis of the report of the Board of Examiners, the Senate decides the students eligibility for award of the degree of Doctor of Philosophy.

(B) INFORMATION ON DEPARTMENTS AND INTERDISCIPLINARY AREAS, CENTRES AND SCHOOLS

In addition to the eligibility requirements given in 5a), following are the eligibility requirements for admission for each Department / School / Centre/ Interdisciplinary group

DEPARTMENTS

B.1 AEROSPACE ENGINEERING : AE

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST)* in :

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. B.Tech. (or B.E.)/M.Tech.(or M.E.) in Aerospace OR Mechanical Engineering OR
- ii. B.Tech.(or B.E.)/M.Tech.(or M.E.) in other branches of engineering may be considered if academic background of the candidate is consistent with the research areas available in the department.

Merely satisfying the general eligibility criterion as well as criterion set for each category is no guarantee for being called for test/interview. The Department may put additional academic performance based shortlisting criterion in this regards.

The department prefers Masters students for its Ph.D. programme. However, candidates with a BE/B.Tech., a valid GATE score in the relevant disciplines and very good academic performance record may be considered for shortlisting.

Candidates are advised to visit the department web page: <http://www.aero.iitb.ac.in> for available research topics and the corresponding background expected of the candidates. The research areas and the backgrounds given in the web page must match with those of the prospective applicants for final selection.

Shortlisted candidates will be called for written test and interview or interview.

I. Aerodynamics

Experimental Aerodynamics, Experimental Hypersonic Aerothermodynamics, Shock Waves and their applications, Computational Hypersonic Aerothermodynamics, Computational Fluid Dynamics, Computational Electromagnetics, Vortex and Particle methods, Vortex flows, Aero- acoustics, Aircraft Design, Air Transportation, Turbulence modeling and applications, Computational studies of scramjet intakes, Supersonic mixing, Computation of high enthalpy flows, Turbulence and transport in magnetized plasmas, Plasma assisted flow control.

II. Dynamics and Control of aerospace vehicles

Flight mechanics, guidance, navigation, tracking and control of launch vehicles, spacecraft, missiles, aircraft, mini aerial vehicles (MAV), Formation control of satellites, integrated navigation systems, airborne and space-borne sensors and precision tracking systems, space-based aircraft navigation; attitude dynamics and control, reentry dynamics and GN&C, Hardware-In-Loop- Simulation, Co-operative missions for MAVs.

III. Propulsion

Aircraft and Spacecraft Propulsion, Experimental and numerical studies on detonations, Combustion instabilities, Development of new techniques for emission reduction from combustion systems, Heat Transfer, Infra-red Signatures of Aerospace Vehicles, Micro-channel Cooling of Gas Turbine Blades, CFD of propulsive systems, Aerodynamic design and performance analysis of axial flow turbomachines, Flow control of turbomachines and internal duct flows, Computational hypersonic aerothermodynamics, Turbulence modeling and applications, Computational studies of scramjet engines, Supersonic mixing and combustion, Computation of high enthalpy flows, Turbulence and transport in magnetized plasmas, Plasma assisted combustion and flow control.

IV. Aerospace Structures

Structural Health Monitoring, Wave Propagation, Aeroelasticity, Aeroservoelasticity, Structural Dynamics & Stability, Multidisciplinary Optimization, Mechanics of Materials (Metals, Metallic Alloys and Composites), Fracture and Fatigue in materials.

B.2 BIOSCIENCES AND BIOENGINEERING:

BB

PREAMBLE

The Department of Biosciences and Bioengineering comprises of BT (Biotechnology) and BM (Biomedical Engineering) as core academic groups. Eligibility criterion and research areas are mentioned below. Students should mention in item No.10(b) of Application Form in the order of priority the groups (BT, BME) they wish to join. Based on the respective eligibility criterion and academic performance, applications will be screened independently by these two groups for conducting interview, according to the priority mentioned by the candidate in the application form.

B.2.1. BIOTECHNOLOGY

Minimum Eligibility for Admission

First Class or 60% marks (55% marks for SC/ ST) in*:

*as specified in the General Eligibility Criterion for admission in this brochure.

- i) M.Sc. or equivalent degree in subjects related to Life Sciences / Physics / Chemistry OR B.Tech Biotechnology with
 - a) a valid GATE score (eligible for Institute TAsip/RAship) OR
 - b) a valid CSIR/UGC/DBT JRF (eligible for FA category) OR
 - c) a valid ICMR JRF (not linked to ICMR project) (eligible for FA category) OR
 - d) Two years of relevant post M.Sc. Research experience (eligible only for project positions) OR
 - e) UGC/CSIR (Lectureship) eligible only for project position
- ii) First Class or 60% marks(55% marks for SC/ST) in M.Tech or equivalent degree in Biotechnology.

RESEARCH AREAS

Enzyme kinetics and enzyme secretion, microbial metabolism and regulation, aromatic hydrocarbon metabolism and genetic engineering, enzyme inhibitor design, peptide synthesis; protein structure, function and engineering; yeast molecular biology, transcriptional regulation of gene expression; microtubule dynamics and cancer chemotherapy; immunology, signal transduction, Glycobiology; molecular and membrane biochemistry: proteomics and systems biology, bacterial cell division, protein aggregation and statistical dynamics, cytoskeletal dynamics, chromosome segregation during mitosis and meiosis in yeast.

B.2.2 BIOMEDICAL ENGINEERING

Minimum Eligibility for Admission

First Class or 60% marks (55% marks for SC / ST) in* :

*as specified in the General Eligibility Criterion for admission in this brochure.

1. M.Tech / M.E. or B.Tech/B.E. in Biomedical, Chemical, Computer Science, Electrical, Electronics, Telecommunications, Instrumentation and Mechanical Engineering and Engineering Physics.
2. M.Sc. or equivalent in Biochemistry, Biophysics, Biotechnology, ceramics, Chemistry, Electronics, Ergonomics, Material Science, Mathematics, Molecular Biology, Physics and Physiology.
3. MBBS/BDS/BPTh/ BOPh/BVSc(4 yr. Degree) or equivalent in appropriate branches, with AIIMS (PG Entrance Test)/MCI entrance examination for MD/MS (for Medical graduates).
4. MBBS with MD/MS, BVSC. With MVSc., BDS with MDS, BPTh with MPTh, BOPh with MOPh.
5. For project positions only : MBBS/BDS/BPTh/BOPh/BVSc.(4 yr. Degree) or equivalent in appropriate branches, with two years of relevant work/research experience(outside IIT Bombay) or six months (within IIT Bombay) in lieu of AIIMS PG Entrance Test/MCI entrance examination for MD/MS.
6. M.Pharm
7. B.Pharm with entrance examination, MPAT

Applicants desiring Institute financial support should have cleared GATE (for Engineering and Science graduates) or AIIMS/MCI/JIPMER/PGI- Chandigarh/ AFMC-Pune post graduate entrance examinations (for medical graduates).

Alternatively (applicable to project positions only) for Engineering, Science and Medical/paramedical graduates, two years of relevant work/ research experience (outside IIT Bombay) or six months (within IIT Bombay) can be considered equivalent to GATE/All-India PG qualifying entrance exams mentioned above. Eligibility/rank/experience certificates are required for all such entrance examination OR work or research experience acquired.

For FA category, a valid CSIR/UGC/DBT JRF or a valid ICMR JRF (not linked to ICMR project).

RESEARCH AREAS

Currently fundamental and applied research is being conducted in the broad areas of : Bioinstrumentation for diagnostics and therapeutics, Biomaterials, prostheses and medical devices, Physiological system modeling and analysis. Bioinstrumentation for early detection of carcinoma and tropical diseases, Biomedical transducers and sensors including biosensors and bioMEMS devices, Biostatics and mathematical modeling, Cardiac electrophysiology and muscle mechanics, Development and validation of novel biomaterials and implantable devices, Hemorheology and microcirculation, Neurophysiology, prosthetic devices including aids for the handicapped, Signal processing, Telemedicine and knowledge based systems.

B.3 CHEMICAL ENGINEERING :

CL

ELIGIBILITY FOR ADMISSION

First Class or 60% marks(55% marks for SC / ST) in *:

*as specified in the General Eligibility Criterion for admission in this brochure.

- i) B.Tech. / M.Tech. or equivalent degree in Chemical Engineering OR
- ii) B.Tech. / M.Tech. or equivalent degree in other branches of Engineering may be considered in areas consistent with the research areas of the department OR
- iii) M.Sc. in disciplines consistent with the research areas of the department.

Candidates with Bachelors degree in Engineering or Masters degree in science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

RESEARCH AREAS

- **Process Systems Engineering:**
Process Simulation, Optimization, Process Integration and Scheduling, Energy Conservation and Optimal Resource Management, Artificial Intelligence and Mathematical Modelling, Multi-scale Modelling, Systems Identification and Process Safety Analysis, Nonlinear control, fault diagnosis.
- **Biotechnology & Bio-Systems Engineering**
Metabolic & Genetic Engineering, Bio-separations, Bioinformatics, Systems Biology, Drug Discovery, Enzymology, Bioprocess Development, Vermiculture for Waste Management, Dehydration of Food Systems, Controlled Atmosphere Storage, and Process Development of Food Systems.
- **Materials Engineering**
Polymer materials, Polymer Reaction Engineering, Polymer Processing, Polymer Physics, Polyurethane, Rubber, Polymer Rheology, Ceramics, Polymers, Biomaterials, Drug Delivery, Food Engineering, Microscopy, Nano-composites, Statistical Thermodynamics, and Supercritical Fluids.
- **Catalysis & Reaction Engineering**
Catalysis, Multiphase Reactions, Bio-reaction Engineering and Reactor Modelling, Process intensification & reactive distillation.
- **Transport, Colloids & Interface Science**
Fluidization, Granular flows, Powder Mixing, Membrane Separations, Rheology of Complex Fluids, Colloids, Sol-gels, Emulsions & Foams, Paints and Coatings, Microstructural Engineering, Aerosols,

Electro-hydrodynamics, Fluid Mechanics & Stability, Computational Fluid Dynamics, Heat & Mass transfer, Porous media, and Surfactants.

- **Energy and Environment**

Climate change, Coal Gasification, Energy Integration, Green Engineering, Renewable Resources, Waste Management, Pollution Control, Air Pollution Prediction & Control and Vermicultur.

B.4 CHEMISTRY :

CH

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in* :

***as specified in the General Eligibility Criterion for admission in this brochure.**

M.Sc. or equivalent degree in Chemistry / Physics / Biochemistry and Biotechnology including Bioinformatics.

Candidates with Masters degree in science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

Candidates are advised to visit the department webpage: <http://chem.iitb.ac.in> for more details on Ph.D. Admissions and research topics.

RESEARCH AREAS

- i. Biophysical Chemistry
- ii. Coordination Chemistry
- iii. Bio-inorganic Chemistry
- iv. Organometallic Chemistry
- v. Bio-organic Chemistry
- vi. Chemistry of Natural Products
- vii. Synthetic Organic Chemistry
- viii. Photochemistry and Spectroscopy
- ix. Polymer Chemistry
- x. Thermodynamics
- xi. Electrochemistry
- xii. Solid state Chemistry and Physics
- xiii. Catalysis
- xiv. Theoretical Chemistry

B.5 CIVIL ENGINEERING:

CE

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in* :

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. B.Tech. / M.Tech. or equivalent degree in Civil Engineering OR
- ii. B.Tech. / M.Tech. degree in any branch of Engineering OR
- iii. M.Sc. degree in any branch of Science may be considered for research areas consistent with the academic background and special interests.

Candidates with Bachelors degree in Engineering or Masters degree in Science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

RESEARCH AREAS

(i) Transportation Systems Engineering

Transport planning theory; Traffic flow theory and capacity analysis; Traffic control and management: DSS for urban transport operations; Land use and transport Planning models; Economics evaluation;

analysis and Environmental Impact assessment of transportation projects; Urban and regional transport network modelling; GIS / ES / FUZZY / GA / ANN theory and applications to transport planning; Mass transport planning and design; Behavioral travel modeling.

(ii) Geotechnical Engineering

Constitutive modelling of soil, Soil-structure interaction; Foundation for offshore structures, Earth dam problems; Rock Mechanics and tunneling; Soil dynamics; Soil stabilization; Expansive soils; Ground improvement; Reinforced soil structures and geosynthetics; Geotechnical centrifuge study; Optimization techniques and environmental geotechniques; Landslides.

(iii) Water Resources Engineering

Real fluid flow problems; Turbulent flows; Flow stability, Computational hydrodynamics; Diffusion of Jets; Marine Outfalls; Stratified flows; Steady state and transient flow characteristics in open channels; Fluid transients in closed conduits; Ground-water movement and recharge; Inverse modeling of large aquifer systems, Sea water intrusion in coastal Aquifer, Diffused and sharp interface models; Transport of pollutant in aquifers and aquifer remediation; Contaminant transport in surface waters; Problems of arid and humid zones; Optimization techniques in water resources engineering; Hydraulic structures; Inter-basin transfer; Urban water management; Urban water supply; Storm water and waste water treatment and disposal; Sedimentation in culverts / bridges; Flow around bridge piers; Water quality modeling; Fluid flow in large diameter pipelines; Analysis of random hydrological data.

Computational fluid dynamics; Hydro informatics; GIS and remote sensing applications in water resources; Finite elements and boundary element methods in environmental engineering and water resources.

(iv) Structural Engineering

Finite element techniques; Concrete technology; Composite materials and mechanics, Reinforced and prestressed concrete, Steel structures, Strength, stability and dynamics of thin membranes, plates and shells, Structural optimization; Structural response to impact and shock loading; Pressure vessels; Reliability analysis, Probabilistic design methods; Curved grid, Cable networks; Plastic analysis techniques, Structural dynamics; Earthquake engineering; Earthquake disaster management; Computational mechanics; Wind effects on structures; Inverse problems and artificial intelligence applications; Offshore structures; Shell foundation; Structural health monitoring.

(v) Geodesy and Remote Sensing

Development of methods and algorithms for digital analysis of Remotely Sensed Data (RSD); Digital Analysis of Thermal (IR) and Microwave RSD; Fuzzy and ANN approaches for RSD analysis; Digital Terrain Modelling (DTM); Remote Sensing, GIS and DTM in Hydrological Modelling; Decision Support Systems in Watershed Development; Cropland Suitability, Crop identification, acreage and yield estimation. Geodesy and space geodetic techniques; Global positioning system; Application of geodesy and GPS to earthquake studies; Geodesy for geodynamics; Space very long baseline interferometry.

B.6 COMPUTER SCIENCE AND ENGINEERING: CS

ELIGIBILITY FOR ADMISSION

1. First class or equivalent Master's Degree in Engineering / Technology (55% marks for SC/ST)* OR
2. A First class Master's degree in Science (55% marks for SC/ST)* or a first class in Bachelor's degree in Engineering/Technology (55% marks for SC/ST)*. Candidates meeting this requirement must also fulfill one of the following additional requirements:
 - Valid GATE score
 - CSIR / UGC / NBHM / DBT award
 - minimum of 2 years of professional work experience

*as specified in the General Eligibility Criterion for admission in this brochure.

REQUIREMENTS FOR TA/RAship

Candidates with Master's Degree in Engineering/Technology are eligible for TA/RAship. Candidates without Master's Degree in Engineering/Technology require either a valid GATE score or CSIR/UGC/NBHM/DBT award to be considered for TAship/RAship. MCA degree will be considered as equivalent to Master's degree in Science.

WRITTEN TEST

Eligible candidates will be further shortlisted and the shortlisted candidates will be called for written test and interview. The syllabus for written test can be found by following the website of the department at www.cse.iitb.ac.in.

WAIVER FOR WRITTEN TEST

“Eligible candidates meeting one of the criteria mentioned below may apply for a waiver of the written test”. All selected candidates shall undergo an interview regardless of waiver.

1. B.Tech. from the IITs who have graduated with a degree in Computer Science and Engineering/ Information Technology within the last five years and with a CPI/CGPA of 8/10 and above.
2. Masters from the IITs/IISc who have graduated with a degree in Computer Science and Engineering/ Information Technology within the last five years and with a CPI/CGPA of 9/10 (7.2/8) and above.
3. Bachelors/Masters who have passed the GATE exam in the discipline of Computer Science within the last five years and with a GATE score of 875/1000 and above.

Candidates seeking a waiver should email pgadm@cse.iitb.ac.in expressing their interest in the waiver before the last date for submission of completed application forms. Further, their application material must contain documents providing proof of the criteria mentioned above.

Candidates for whom the waiver has been approved will be notified by email. The information will also be put up on <http://www.cse.iitb.ac.in> -> Admissions -> PhD before the interview.

QUALIFIER

Candidates who are admitted to the Ph.D. programme will be required to pass a “Qualifying Exam” to continue to stay in the programme. Depending on the candidate’s academic background, this will be given six months to one year after their joining. Details regarding this examination can be found at <http://www.cse.iitb.ac.in/phdqualifier>.

INDUSTRY SPONSORED FELLOWSHIPS

Industry sponsored fellowships covering tuition fees, generous contingencies, and providing monthly stipends of approximately ₹ 25,000/- per month are available to meritorious Ph.D. students.

RESEARCH AREAS

Refer to the department web page for more information about various research areas. Candidates are also encouraged to visit individual faculty member’s home page to learn about his/her research interest.

(i) Algorithms

Algorithms and complexity; Combinatorics and graph theory; Geometric Algorithms.

(ii) Artificial Intelligence

Image Processing, Pattern Recognition and Computer Vision; Intelligent systems and their applications— tutoring systems, Natural language understanding; Machine learning and neural networks; Machine translation, Semantics Extraction; Document understanding; Cross lingual information Retrieval; Intelligent interfaces.

(iii) Computer Graphics, Computer Vision and Image Understanding

Computeraided graphics design; Multimedia; High Performance computing; Visualization; Rendering; Animation; Image and video retrieval; motion capture; point based methods.

(iv) Computer Security

Performance and security of cryptographic algorithms, Design/verification of security protocols for wired and wireless communication, malware and botnet obfuscation and detection, Web application security, Trust management in P2P networks.

(v) Computer Networks

Performance modeling, analysis and design of wired and wireless networks, Implementation and verification of network security protocols. Deployment, data management, communication and energy-efficiency issues in Sensor Networks, Design of content distribution networks for data dissemination, Architectures and protocols for metro optical networks, Network algorithms, Utility and Pricing models,

Quality of service protocols, Mobile Computing, Voice Routing, Voice over IP, RFID networks, Enterprise networks, Access and Broadband networks.

(vi) Database and Information Systems

Object oriented, temporal and parallel databases; Query optimization and transaction management; Real time databases systems, indexing multidimensional data; Widearea distributed database systems; Data dissemination systems; data warehousing and database and application security.

(vii) Data Mining

Data integration models and algorithms, Graphical models, Information extraction and retrieval, Forecasting and smart e-business, Sensor and Bioinformatics data mining, Text and Web data mining. Integrated mining with relational DBMS, Temporal mining, Integrating mining with OLAP .

(viii) Distributed Systems

Performance Evaluation, fault tolerance and scalability issues in distributed systems; Distributed object-based systems, Programming models and runtimes for generic agents, Parallel Computing, High performance cluster computing, Distributed operating systems, Selfconfiguration using abstract performance and capacity models of distributed component based applications, Topology based problem detection and root cause isolation in enterprise environments.

(ix) Formal Methods

Formal specification, design and verification of hardware and software systems including distributed systems; Logic, automata theory and their applications in reasoning about systems; Automated theorem proving; Model checking; Reachability analysis of large and infinite state spaces: exact and approximate techniques.

(x) Formal Languages and Bioinspired Computing

DNA, Membrane and Quantum Computing, Combinatorics on words.

(xi) Programming languages and Compilers

Theory of code optimization; Optimizing and parallelizing compilers; Analysis and implementation of functional and logic programming languages; Theory of programming languages.

(xii) RealTime and Embedded Systems

Functional Programming Applications, Reconfigurable computing, Automobile Telematics, Embedded control units, Design and development of robots and sensor platforms.

(xiii) Software Engineering

Object oriented software development; Component architectures. Reengineering of software; systems analysis and design; MIS systems; Project management; Quality assurance.

B.7 EARTH SCIENCES:

ES

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in *:

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. M.Sc. / M.Tech. / M.Sc.(Tech.) / M.Phil. (2-year) degree in Geology, Geophysics, Geochemistry or equivalent. OR
- ii. M.Sc. / M.Tech. / M.Sc. (Tech.) / M.Phil. (2-year) degree in Physics, Chemistry, Mathematics, Life Sciences, Marine Sciences, Atmospheric Sciences or equivalent and having Geology / Physics / Geochemistry at the B.Sc. stage as principal subjects.

Candidates with Bachelors degree in engineering or masters degree in science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

Candidates with First class or 60% marks (55% for SC/ST) in Postgraduate degree in Science/ Engineering and employed in a field / research area related to Earth Sciences may be considered for Ph.D. programme as external candidates, on a case-to-case basis depending on the research interest of the Department.

RESEARCH AREAS

- Active Tectonics and Tectonics
- Electromagnetism

- Engineering Geology
- Geochemistry
- Geothermics
- Geostatistics
- Geomagnetism
- GPS and Geodesy
- Gravity and Magnetic
- Hydrogeology
- Isotope Geology
- Igneous Petrology
- Mineralogy
- Micropalaeontology
- Metamorphic Petrology
- Ore Petrology and Ore deposit modeling
- Organic Geochemistry
- Petroleum Geology
- Remote Sensing and GIS
- Sedimentology
- Structural Geology
- Stratigraphy
- Seismology
- Volcanology
- Numerical modelling in Geophysics

B.8 ELECTRICAL ENGINEERING :

EE

ELIGIBILITY FOR ADMISSION

I. For general category students and/or for students where no concession in academic performance is called for, eligibility requires meeting ANY ONE of the following criteria as regards performance in the qualifying degree:

- (1) a minimum of 60 percent marks in the final academic year of the programme
- (2) a minimum of 60 percent marks in aggregate or as specified by the university (any one of them)
- (3) a first class as specified by the university
- (4) a minimum CPI of 6.0 on the scale of 10; with corresponding proportional requirements when the scales are other than on 10 – for example, on a scale of 8, the minimum will be 4.8

For students from the SC/ST category the corresponding criteria are:

- (1) a minimum of 55 percent marks in the final academic year of the programme
- (2) a minimum of 55 percent marks in aggregate or as specified by the university (any one of them)
- (3) a first class as specified by the university
- (4) a minimum CPI of 5.5 on the scale of 10; with corresponding proportional requirements when the scales are other than on 10 – for example, on a scale of 8, the minimum will be 4.4

II. The qualifying degrees are as follows:

B.E./B. Tech/M.E./M.Tech	Master of Science (M.Sc.)
Biomedical Engg., Computer Science, Computer Science and Engg., Computer Engg., Electrical Engg., Electronics Engg., Telecommunications Engg., Instrumentation Engg., Engineering Physics, Materials Science and Engg.	Mathematics, Physics, Electronic Sciences

III. The admission of a student as a PhD candidate shall be confirmed only after he/she has successfully completed the prescribed coursework and the comprehensive qualifier examination. A student who is unsuccessful in the comprehensive qualifier even after the prescribed number of attempts shall have to discontinue the PhD programme.

IV. A valid GATE score is necessary for Institute Teaching/Research Assistantship if a candidate has only a Bachelors degree in Engineering or a Master of Science degree.

AREAS OF SPECIALIZATION

- | | |
|--|-----|
| 1. Communication Engineering | EE1 |
| 2. Control and Computing | EE2 |
| 3. Power Electronics and Power Systems | EE3 |
| 4. Microelectronics | EE4 |
| 5. Electronic Systems | EE5 |

Current Research Areas

Communication Engineering (EE 1)

- Communication Systems
- Communication Networks and Internet
- Computational Electromagnetics
- Image Processing and Computer Vision
- Microwaves, RF and Antennas
- Multimedia Systems
- Optical Communication and Photonics
- Signal Processing
- Speech Processing
- Wireless and Mobile Communication
- Information Theory and Coding
- Magnetic Resonance Imaging

Control and Computing (EE 2)

- Linear Systems Theory
- Optimal Control and Optimization
- Modeling and Identification of Dynamical Systems
- Control of Distributed Parameter Systems
- Nonlinear Systems
- Modern Filter and Network Theory
- Behavioral Systems Theory
- Computational Methods in Electrical Engineering
- Software and System Reliability
- Cryptography and Security
- GPU-based Computing

Power Electronics and Power Systems (EE 3)

- FACTS, HVDC and Power Quality
- Distributed Generation
- Power System Restructuring
- Wide Area Measurements and System Protection
- EMI / EMC
- Coupled Field Computations
- Electrical Machines: Modeling, Analysis, Design and Control
- Special Machines
- Power Electronic Converters, Electric Drives
- Power Electronics for Non-conventional Energy Sources
- Reliability in Power Systems and Power Electronic Systems
- Smart Grids for Energy Harvesting

Microelectronics (EE 4)

- Devices and IC Technology
- Reliability of Electronic Devices and Circuits
- Device Simulation and Modeling
- VLSI and System Hardware Design
- CAD Tools
- MEMS Design and Technology (including Bio-MEMS)
- Flash Memory Devices
- Organic Semiconductor Devices
- CMOS Devices
- Spintronic Devices
- Photovoltaic Devices
- Material Growth and Characterization

Electronic Systems (EE 5)

- Electronic Instrumentation
- Signal Processing Applications
- Speech and Audio Processing
- Biomedical Electronics
- Embedded System Design

B.9 ENERGY SCIENCE AND ENGINEERING :

EN

Energy is a critical input required for development. Fossil fuel reserves in the country are limited and there is a need to develop viable cost effective alternatives. Renewable and Nuclear Energy can provide possible long term solutions for the energy problems. There are problems in the large scale development and deployment of these alternatives that need to be addressed. In the short run India has to aggressively pursue energy efficiency and Demand Side Management to Improve the efficiency of supply and utilization devices and systems. The development of new energy technologies provides a technological challenges as well as significant business opportunity. In order to help meet these challenges, the Department of Energy Science and Engineering (DESE) has been established with a mission to develop sustainable energy systems and solutions for the future. There is a requirement for high quality trained manpower in the energy sector. This also provides scope for engineering innovators/entrepreneurs. The DESE programme has two laboratories (Solar Energy and Energy Systems Laboratory) and a computational facility. In addition to this, DESE students are actively involved in the research and development activities of the Thermal Hydraulics facility, Gasification Laboratory, Heat Pump Laboratory (Mechanical Engineering), Power Electronics and Power Systems Laboratory (Electrical Engineering). DESE faculty have been organizing several Continuing Education Programme on a continuous basis on Renewable Energy, Energy Management, Process Integration, Solar Passive Architecture and have initiated a series of programmes for the Nuclear Power Corporation. DESE has established linkages with industries like Thermax, Forbes Marshall, BSES, Mahindra & Mahindra, BHEL and organization like Atomic Energy Regulatory Board, Ministry of New and Renewable Energy, International Energy Initiative and The Energy and Resource Institute which have sponsored M.Tech/Ph.D Projects. This has ensured the relevance of the DESE research output.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in *:

***as specified in the General Eligibility Criterion for admission in this brochure.**

a) B.Tech./M.Tech. Degree in any of the following branches of Engineering:
Aeronautical/ Aerospace, Chemical, Civil, Electrical, Energy, Mechanical, Metallurgical or equivalent disciplines relevant to energy and interest in energy research.

b) M.Sc. in Chemistry/Physics/Mathematics or any equivalent subject relevant to energy with a good academic record and interest in energy research.

Candidates with Bachelors degree in engineering or masters degree in science must have a valid GATE score to become eligible for the Teaching/Research Assistantship provided by the Institute or they should have award of CSIR/UGC/Research Fellowship.

AREAS OF RESEARCH

- **Energy Efficiency / Improvements in conventional Energy Systems.**

Heat pumps, Energy integration, Process integration for resource optimization, Pinch Analysis Development of techniques for optimization of Utility systems, Demand Side Management/Load Management in the Power Sector, Variable Speed Drives, Power Generation and Systems Planning, Energy Management and Auditing, Efficient Motor Drive Systems, Electronics Ballasts, Static VAR compensators, Illumination control, Power Electronics in Energy Efficient Systems, Electric Vehicles, Boilers and Fluidised Bed Combustion, Exhaust Heat Recovery, Cogeneration, Building Energy Management, Efficient Air Conditioning Systems, Hydrogen Generation and Storage, Fuel Cells.

- **Renewables**

Coal Gasification, Biomass Gasifier Design, Development and Testing, Liquid fuels from Biomass through the thermochemical and algal route, Microbial, Hydrogen, CNG Kit development, Industrial Solar Thermal concentrators, Stirling Engine Systems, Testing of Solar Collectors and systems, Passive Solar Architecture, Development of Carbon PV cell, Decentralized Power Systems Grid Integration Issues, Hybrid Systems for Rural Electrification, Wind Energy, Low Cost Solar Drier, Fuel Cells, Thin film solar cells, Carbon nano tubes for hydrogen storage, Solar photovoltaic concentrator, Development of Engines for SVO, Biodiesel, Dual fuelling etc., Biodiesel manufacturing process, Complex Fluid Dynamics, Flow of Granular Materials, Multiphase flows, Computational Fluid Dynamics, Molecular Dynamic Simulation of Particulate Flows.

- **Nuclear**

Nuclear Safety, Nuclear Waste management, Thermal Hydraulics Research, Computer Simulation Models for Analysis of Transients in Pressurized Heavy Water Reactor, Advanced Numerical Methods for neutron diffusion and fluid flow, Two-phase flow modeling, Nuclear thermal hydraulics and safety, Analytical solution of multilayer heat conduction problems .

- **Fellowships**

Several fellowships are normally available to DESE students ₹ 15,000 per month. In addition to Institute assistantship.

B.10 HUMANITIES AND SOCIAL SCIENCES :

HS

ELIGIBILITY FOR ADMISSION

I. For general category students and/or for students where no concession in academic performance is called for, eligibility requires meeting ANY ONE of the following criteria as regards performance in the qualifying degree:

- (1) a minimum of 55 percent marks (50% marks for SC/ST) in the final academic year of the programme
- (2) a minimum of 55 percent marks (50% marks for SC/ST) in aggregate or as specified by the university (any one of them)
- (3) a first class as specified by the university
- (4) a minimum CPI of 5.5 (5.0 CPI for SC/ST) on the scale of 10; with corresponding proportional requirements when the scales are other than on 10 – for example, on a scale of 8, the minimum will be 4.4

II. The qualifying degrees are as follows:

M.A. or equivalent degree in Humanities/Social Sciences subjects

OR

Master's degree in Science / Commerce/ Graduate Degree in Engineering / Technology will be considered for research areas consistent with the academic background and special interests.

OR

M.Phil. degree in any of the six disciplines (pertaining to the research areas listed below) or in any allied subjects or in "Humanities and Social Sciences with specialization in Planning and Development" awarded by IIT Bombay.

RESEARCH AREAS

Economics

Applied Econometrics, Banking & Finance, Economic Impacts of Climate Change, Corporate Investment, Environment Economics, Economic Policy, Energy Economics, International Business, International Finance, International Trade Industrial Economics, Monetary Economics, Open Economy Macro Economics, Technology Transfer & Competitiveness.

English

Modern Critical Theory, Indian Writing in English, Drama, Novel, Creative Writing, Women's Studies, Culture Studies, Genre Studies, Film Studies, Intertextuality, Trauma and Literature, Aesthetics, Theoretical Linguistics and Language Acquisition / Learning, English Language Teaching.

Philosophy

Continental Philosophy, Indian Philosophy, Philosophy of Language, Contemporary Western Philosophy, Meta-Ethics, Applied Ethics, Philosophy of Mind, Social and Political Philosophy, Philosophy of AI.

Psychology:

Stress Management, Gender, Social Psychology, Organizational Behavior, Human Resource Development, Social Psychology of Education, Health and Clinical Psychology, Ergonomics, Cognitive Psychology.

Sociology

Political Sociology, Science, Technology and Society, Sociology of Development, Environmental Sociology, Social Movements, Sociology of Religion and Kinship, Urban Studies, Ethnicity and Multiculturalism, Sociology of Caste and Social Stratification, Gender Studies, Sociological Theory, Rural and Urban Planning, Sociology of Contemporary India, Law and Governance, Risk and Vulnerability.

Other areas which pertains to cell for Indian Science and Technology in Sanskrit (CISTS)

Sanskrit language, Paninian Grammar, Philosophy of language, Aesthetics, Astronomy (Jyotisha), Mathematics (Ganita), Logic (Nyaya-sastra), Meta-Physics

B.11 MATHEMATICS:

MA

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in *:

*as specified in the General Eligibility Criterion for admission in this brochure.

- i. M.A. / M.Sc. in Mathematics / Statistics / Computer Science OR
- ii. M.Stat. OR
- iii. Bachelor's degree in Engineering/Technology

Candidates must also have a valid GATE score in Mathematics or must be Govt./Semi-Govt. Fellowship awardees (such as CSIR/UGC(for JRF), NBHM, QIP) to become eligible for the Teaching / Research Assistantship.

RESEARCH AREAS

i. Algebra and Number Theory

Commutative and Homological Algebra (Blowup algebras, Hilbert functions, local cohomology, projective modules, complete intersections, Gorenstein rings). Algebras with involution, Galois cohomology of classical groups. Representations of algebraic groups. Reductive groups and related structures. Automorphic forms, L-functions, Diophantine equations.

ii. Analysis

Functional Analysis (Operator Theory, unbounded subnormals, Hilbert modules, Operator algebras), Numerical Functional Analysis (Approximate solutions of operator equations and eigenvalue problems, spline theory), Real Analysis (Mean periodic functions, generalized integrals).

iii. Combinatorics

Polyhedral combinatorics (approximation algorithms, combinatorial optimization) Enumeration (posets, generating functions, q-analogues), Graphs (colouring problems, eigenvalues, trees), Codes (linear codes

associated to projective algebraic varieties), Design theory (finite geometries, symmetric designs and related structures), Extremal combinatorics. Theoretical computer science (computational complexity, analysis of algorithms).

iv. Geometry & Topology

Algebraic Topology (stable homotopy theory), Differential Topology (harmonic manifolds, matrix varieties). Algebraic Geometry (Schubert varieties, determinantal varieties, varieties over finite fields), Lie groups (discrete subgroups, congruence subgroups, homogeneous spaces, probability measures), Ergodic theory.

v. Partial Differential equations and Numerical Analysis

Partial Differential Equations (Hyperbolic systems of quasilinear partial differential equations, nonlinear waves, partial integro-differential equations, homogenization), viscoelastic fluid flow problems, Shock waves in hyperbolic systems of conservation laws. Numerical Analysis (Finite element methods, finite volume methods).

vi. Statistics and Probability

Computational Biology (Biostatistics, Bioinformatics), Statistical data mining in proteomics (probabilistic optimization problems in Molecular Biology), Reliability Theory, Industrial Statistics, Construction of reliability test plans, Statistical Inference (Geostatistics, modeling bivariate distributions), Stochastic Differential Game Theory (Stochastic Control Theory, Mathematical Finance), Applied Probability, Statistical Inference. Linear and generalized linear models, design of experiments.

B.12 MECHANICAL ENGINEERING:

ME

ELIGIBILITY FOR ADMISSION

- i. B.Tech. / M.Tech. or equivalent degree in Mechanical Engineering with first class or 60% marks (55% marks for SC / ST)* at UG & PG levels OR
- ii. B.Tech. / M.Tech. degree or equivalent in Production Engineering / Industrial Engineering / Aerospace Engineering/Chemical Engineering with first class or 60% marks (55% marks for SC / ST) * at UG & PG levels OR
- iii. B.Tech. / M.Tech. Degree in other branches of Engineering / Technology with an outstanding academic record will be considered for research areas consistent with their academic background and special interests of the Department.

Candidates with only a Bachelors degree in Engineering must have a valid GATE score greater than 660 to become eligible for the Teaching / Research Assistantship provided by the Institute.

*as specified in the General Eligibility Criterion for admission in this brochure.

RESEARCH AREAS

i. Heat Transfer and Thermodynamics

Convective and radiative heat transfer, Thermal Insulation, Transport properties, Combustion, Solar energy, Numerical techniques.

ii Refrigeration and Air-conditioning

Refrigeration systems, A.C. systems, Cryogenics, Miniature Cryorefrigerators, Absorption systems, Food preservation, Liquification systems.

iii. Internal Combustion Engineering

Fuel injection problems, Performance studies on petrol and diesel engines, Alternate fuels, Emission studies.

iv. Thermal Power Engineering

Power plant analysis and design, Nuclear engineering, Nuclear reactor heat transfer, Reactor physics problems, Isotope applications and nuclear techniques.

v. Fluid Power

Fluid mechanics, Fluid Machinery, Fluid power control, Microfluidics.

vi. Combustion and Flames

Laminar and turbulent flame propagation, Flame stabilization, Studies with vitiation of combustion air, Combustion in closed vessels, Fluidised bed combustion.

vii. Automatic Control

System modeling, Optimal control, Model reduction techniques, Computer control, Microprocessor based control and automation, Digital control techniques, Computer vision based control in automation and Robotics.

viii. Computer Aided Design

Simulation optimization, Interactive graphics.

ix. Stress Analysis: Photoelasticity, Analytical methods based on complex variables, Numerical methods – Finite element and boundary element methods, etc.

x. Fracture & Fatigue

Linear elastic fracture mechanics, Elastic-plastic fracture mechanics, Fracture of composites, Dynamic fracture, 3-D problems of fracture, Low and high cycle fatigue, Creep, Corrosion, Creep-fatigue interactions, Fatigue-creep-corrosion interactions, Finite element and boundary element method applications.

xi. Vibration, Noise, Acoustics and Dynamics

Linear and non-linear vibrations, Chaotic vibration, Vehicle dynamics, Switchgear dynamics, Rotor dynamics, Acoustics and noise control, Finite element and boundary element method applications, Nondestructive method for crack detection.

xii. Robotics, Kinematics and Control

Analysis and optimal synthesis of planar and spatial mechanisms, Error analysis and calibration of robots, Programmable mechanisms, Identification and nonlinear control of rigid and flexible manipulators, Design issues related to walking and running robots and mechanical logic gates.

xiii. Design Engineering

Gears, Pressure vessel design, Tribology and lubrication, Machinery maintenance, Optimization, CAD, Textile Machinery.

xiv CAD / CAM / CIM, CNC, Computer Assisted Process Planning, Design for Manufacturing and Assembly, Manufacturing Automation & Control, Intelligent Manufacturing Systems, Rapid Prototyping and Tooling.

xv Design, Optimization and Modelling of Manufacturing Processes (Casting, Forming, Machining, and Welding), Precision and Micro-Manufacturing Processes, Computer Aided Tool Design.

xvi Applications of IE & OR in Manufacturing, Logistics, Quality and Maintenance Systems.

xvii. MEMS, Nanotechnology, Miniaturization, Smart structure.

B.13 METALLURGICAL ENGINEERING AND MATERIALS SCIENCE : MM

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in*:

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. B.Tech/ M.Tech in Polymers Science/Technology, Aerospace, Corrosion Science & Engg, Ceramic, Chemical, Electrical, Electronics, Electrochemical, Mechanical/ Production/Manufacturing, Metallurgical Engineering, Materials Engineering, Materials Science.
- ii. M.Sc. degree in Chemistry, Materials Science, Physics are eligible for admission. For those with M.Sc. degree, Mathematics as a subject at B.Sc. degree level is an essential requirement.
- iii. For AMIE/AMIIM candidates Mathematics as a subject is essential.

Candidates with bachelors degree in Engineering or Masters degree in Science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

The candidates are eligible for research areas consistent with their academic background and special interests.

RESEARCH AREAS

Faculty in the Metallurgical Engineering and Materials Science Dept. carry out research on a range of materials:

i Metals

Process analysis, instrumentation and control, Iron and Steel making, deformation behavior and microstructure evolution during creep and superplasticity, mineral processing and extractive metallurgy, metal forming, mechanical behavior, welding, physical metallurgy, phase transformation, structure property relationship, thermomechanical processing and texture analysis.

ii. Ceramics

Electronic ceramics, bioceramics, glass ceramics, ceramic foams, industrial ceramics, IR transmitting glasses, near net shape forming, gel casting, rheology of suspensions.

iii. Semiconductors and magnetic materials

Devices of thin film elemental semiconductors and alloy systems, surface treatment and surface engineering, chemical vapor deposition, structure property correlation in nanocrystalline magnetic materials, magnetoresistor materials

In addition, research into materials for sensors and batteries, superconductors, synthesis and processing of ion conductors, materials for energy generation and storage is going on in the Dept.

iv. Polymers and Composites

Polymer blends, Polymercarbon nanotube composites, metalmatrix composites, structure property relations.

v. Wear and Corrosion

Fracture and failure, nondestructive evaluation, aqueous corrosion, metallurgy of corrosion, oil and gas corrosion, and protective coatings (paints, high temperature coatings etc.).

vi. Modeling and Simulations

Modeling of metallurgical processes, heat and mass transport, modeling of metal forming, Optimization, Monte Carlo simulations, Dislocation dynamics simulations.

FACILITIES AVAILABLE

- Various facilities are available for research in the department:
- Basic XRD with Xcelerator and thin film attachment
- 1600 Degree Horizontal Single Sample Dilatometer with Accessories
- Image Intensifier System and ExRay Source
- High Temp. Attachment and Texture and Stress Attachment Unit
- Air Vacuum Induction Melting System
- Hitachi Scanning Electron Microscope
- Simultaneous Thermal Analysis System
- R/S SST Plus with Coaxial Cylinder Rheometer
- Atomic Absorption Unit AVANTAP
- Carbon Sulphur Analyser
- High Temp. Furnaces 1700 Deg.C.
- UV Visible Spectrophotometer
- Thin film processing units
- MTS machines
- Vibrating sample magnetometer
- National facility on OIM and stress determination by XRD
- Electrochemical Measurement Systems - The State of the art Model PAR 338.
- Potentiostat model Wenking PSG 581
- Automated 10 Ton/SCC systems.
- Thermogravimetry analysers.
- Computer Facilities.
- Optical & Stereo microscopes

- Acoustic Emission Systems.
- Wear and Corrosion Machines.
- Facilities for testing Paint and Other Coatings.
- Dynamic loop system.
- High temperature high pressure autoclaves

B.14 PHYSICS:

PH

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in* :

***as specified in the General Eligibility Criterion for admission in this brochure.**

- M.Sc. or equivalent degree in Physics / Chemistry / Mathematics OR
- B.Tech. or equivalent degree in Aerospace Engineering / Chemical Engineering / Civil Engineering / Electrical Engineering / Mechanical Engineering / Metallurgical Engineering / Computer Science / Engineering Physics.
- M.Tech. in any of the above branches with first class or 60% marks (55% marks for SC/ST)* in M.Sc. or B.Tech.

Candidates with Bachelors degree in Engineering or Masters degree in Science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

RESEARCH AREAS

i. Condensed Matter Physics

Electron correlation in one and many component quantum fluids, many body effects in inhomogeneous electron systems and metal surfaces. Theoretical studies of magnetic systems and super conductivity, Electronic structures of ordered and disordered alloys, insulators, conjugated polymers, cluster, strongly correlated systems, novel magnetic systems, development of wave-function based ab-initio methods for electronic structure calculations. Biophysics, complex fluids polymers, Stochastic processes, Non-equilibrium dynamics, Slow glassy dynamics, Granular inelastic gases.

ii. High Energy Physics

Properties and interaction of elementary particles, Gauge field theories and applications to cosmology, Neutrino physics and CP violation, String theory, Collider physics and QCD spin physics.

iii. Condensed Matter Physics (Experimental)

Magnetic oxide thin films and metallic multilayers for various applications, Amorphous magnetic materials, Magnetism in intermetallics, Nano magnetism and Bio magnetism, Strongly correlated electron systems, Metal-insulator transition, quasi-1d/2d magnetic systems and doping effects, High T_c superconductivity, Josephson tunneling in superconductors. Dilute magnetic semiconductors, semiconductor nanostructures and spintronics materials. Electrical and optical properties of semiconducting oxide and nitride (GaN, SiC, ZnO) thin films, nanoparticles and nanostructured thin films, Langmuir Blodgett organic multilayers, conducting polymers, Chemical Vapour Deposition (CVD) process; Polycrystalline and single crystal diamond films, Carbon nanotubes (SWNT and MWNTs); their structural and electrical properties. Bilayer GaAs quantum wells & particle Physics (Experimental).

iv. Nuclear Physics

Nuclei at high angular momentum Hadron Physics, Physics beyond standard model and relativistic Heavy ion Physics, next generation detector research & development.

v. Laser, Optics & Spectroscopy (Experimental)

Laser spectroscopy, Fiber optics, Nonlinear optics, Ultra-fast phenomena and near field Optics & nano photonics.

vi. Quantum Computation

INTERDISCIPLINARY GROUPS :

B.15 INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH: IO

The discipline of Industrial Engineering and Operations Research (IEOR) essentially deals with efficient operation of systems and optimal utilization of resources. Concepts and results from the discipline are becoming increasingly important these days in almost all sectors of the economy viz., industrial, transport, service, agriculture, education, communication etc. With present day technology, various types of data, including the transactional type, are available relatively easily and designing appropriate decision making algorithms is becoming a realistic goal, sought by competitive and forward looking organizations in both private and public sector. Also, the role of theory to provide some insight into the tradeoffs involved in decision making becomes significant. There is opportunity to work on interesting problems that involve modeling, analysis and computation.

Industrial Engineering and Operations Research (IEOR) at IIT Bombay conducts research in a unique and insightful manner in today's economic context. The programme offers a blend of theory, modelling and application, drawing from traditional as well as modern areas of operations research, together with a systems view derived from long-standing principles of industrial engineering. The programme is unique in its contemporary flavor, with specialized courses in Integer Programming, Game Theory, Markov Decision Processes, Services Management, Supply Chain Management, Financial Engineering, Knowledge-based systems, Neural Networks, System Dynamics to name a few. The programme is equally strong in background building with updated courses in Optimization Techniques, Stochastic Models and Simulation. Broad areas of application are in manufacturing systems, supply chains, logistics, transport including railways, finance, communication networks, services, infrastructure and other industrial systems; application of quantitative methods in quality and maintenance management systems; development and application of decision support, intelligent and knowledge-based systems.

The website <http://www.ieor.iitb.ac.in/> has details on the faculty, students, research, teaching, academics, admissions, and other activities of the programme.

ELIGIBILITY FOR ADMISSION

First class or 60% marks (55% marks for SC/ ST) in*:

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. Master's degree in any branch of Engineering with adequate exposure to Industrial Engineering and Operations Research OR
- ii. M.Sc. in Mathematics, Statistics or Operations Research with an excellent academic record OR
- iii. Bachelor's degree in any branch of Engineering with an excellent academic record.

Candidates with Bachelor's degree in Engineering or Master's degree in Science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

RESEARCH AREAS

Research in IEOR includes a breadth of techniques and application areas; an illustrative list is shown below:

(i) Optimization: Models, Theory and Algorithms

Large-scale linear optimization; Mixed-integer, integer and conic programming; Combinatorial optimization; Polyhedral theory; Nonlinear optimization; Dynamic programming.

(ii) Stochastic Models

Queueing models; Resource sharing; Parameter optimization.

(iii) Stochastic Control

Stochastic dynamic programming (MDPs); Sensitivity analysis; Reinforcement learning; Diffusion equations; Viscosity solutions; Auctions.

(iv) Simulation Modeling and Analysis

Discrete-event simulation; System dynamics methodology; Hybrid (discrete-continuous) modeling; Distributed and parallel simulations; Statistical data analysis; Simulation-optimization; Multi-level Monte Carlo methods.

(v) Artificial intelligence based methods

Search methods; Meta-heuristics; Neural networks; Fuzzy logic; Model predictive control; Neuro-dynamic programming.

(vi) Game Theory

Mechanism design; Dynamic and stochastic games; Deterministic and stochastic differential games; Games with stopping; Approximate equilibria.

(vii) Logistics, Inventory and Transportation

Transport operations planning (road, rail, air, and sea); Network design; Capacity planning; Operations scheduling and routing; Fleet and crew planning and rostering; Timetabling and rake allocation of rail services.

(viii) Supply Chain Analysis

Information sharing; Coordination; Contract analysis and design; Real-time decision making; Performance and stability analysis; Reverse logistics and closed loop supply chains; Decision-making under uncertainties; Quality of service.

(ix) Financial Engineering

Mathematical finance; Modeling and pricing of derivatives; Insurance and asset pricing; Portfolio management; Pricing; Revenue sharing and revenue management.

(x) Planning, Scheduling and Control in Manufacturing Systems

Operations management; Project management; Quality management; Hierarchical production planning; Facilities planning; Reconfigurable and flexible systems; Enterprise resource planning; Product variety management; Dynamic, reactive and proactive scheduling.

B.16 SYSTEMS AND CONTROL ENGINEERING:

SC

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in:*

***as specified in the General Eligibility Criterion for admission in this brochure.**

(i) Masters degree in any branch of Engineering OR Mathematics OR Physics OR

(ii) Bachelors degree in any branch of Engineering OR Mathematics OR Physics

Candidates with Bachelors degree in Engineering must have a valid GATE score to become eligible for the Teaching/Research Assistantship provided by the Institute.

RESEARCH AREAS

Large Scale Systems, System Reduction, Nuclear Reactor Control, Sliding Mode Control (Continuous & Discrete), Power Systems – Stability and Control, Modeling, Control & Implementation of Smart Structures, Space Launch Vehicles - Stability & Control, Gas Turbines – Stability & Control, Flexible manipulators, Stability & Control Multirate Output Feedback based Control (POF/FOS).

Robust Stability and Control especially using quantitative feedback theory (QFT) techniques, Nonlinear System Analysis and Control, and Reliable Computing using interval analysis techniques.

Optimal control, Constrained and optimization based control, in particular, stochastic model-predictive/receding- horizon control;

Nonlinear and adaptive control, geometric mechanics, Lagrangian and Hamiltonian mechanics.

Cooperative control of multi-agent systems, resource allocation, team theory and its application, decentralized control, cooperative and network control,

Game theory, economics, optimization, variational inequalities, coding theory, information theory, operations research, stochastic control, systems biology, team decision theory

Reconfigurable hardware, embedded control systems, robotic path planning algorithms, hardware/software co-design.

Switched and hybrid systems; control under communication and computation constraints; stochastic control; applications of probability in engineering systems.

Application Areas

Nuclear Reactor Control, Control & Implementation of Smart Structures, Space Launch Vehicles – Stability & Control, Gas Turbines – Stability & Control, Flexible manipulators, Stability & Control Multirate Output Feedback based Control (POF/FOS), robotics, aerial launch vehicles, spacecraft, electrical power system networks, attitude control of spacecraft, biomechanical systems, dynamics and control of power systems, autonomous vehicles, formation flying and consensus.

B.17 EDUCATIONAL TECHNOLOGY :

ET

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST) in *:

***as specified in the General Eligibility Criterion for admission in this brochure.**

1. M.Tech./M.Des.(or equivalent) degrees in any branch of Engineering OR
2. M.Phil. in Social Sciences OR
3. M.A./M.Sc./M.Phil.(1year) OR
4. M.Ed. Degree with interest in technology adoption and assessment studies

Requirements for TAship/RAship/Project positions

1. Candidates with Master's Degree in Engineering/Technology/Design or M.Phil. in Social Sciences are eligible for TAship/RAship/project positions.
2. Candidates with M.A./M.Sc./M.Phil.(1year) or M.Ed. Degree* MUST also fulfill one of the following additional requirements:
 - i. a valid GATE score
 - ii. a valid CSIR/UGC Award letter.
 - iii. Two years of research experience in fields related to educational technology .
3. UGC/CSIR (Lectureship) students are eligible only for project positions.

RESEARCH AREAS

The research focus of the inter-disciplinary programme in Educational Technology is in the area of technologies to promote education. This includes both the development of the technology itself, as well as research into effective pedagogy that integrates the technology. The following are the research areas of the faculty members in the IDP -

- Development of technologies relevant to to education (design and delivery).
- Interplay between technology and pedagogy.
- Content development and instructional design.
- Assessment and evaluation of technologies, e-content and pedagogical techniques.

ACADEMICS

The IDP in Educational Technology offers a Ph.D. Programme.

Students admitted to the Ph.D. Programme will be required to do coursework in the first few semesters. Courses include introduction to Educational Technology, Instructional Design, Research Methods and so on. As part of the Ph.D. Programme, students will engage in research projects and submit a dissertation.

PEOPLE

The IDP in Educational Technology consists of faculty members from the engineering, science, humanities and social sciences departments and the SJM School of Management of the Institute. Please see the website <http://www.et.iitb.ac.in>, for details of faculty members, students, and the other activities in the IDP in ET.

B.18 CLIMATE STUDIES :

CM

The Climate Studies IDP is aimed at undertaking inter-disciplinary, problem-driven research and teaching for end-to-end analysis of Climate Change problems. Research activities in the IDP focus on key areas within climate change, such as regional climate perturbation and impact, assessment of technologies for mitigation, and evaluation of vulnerability and adaptation to climate change. About 40 faculty members are participating in the IDP. Students in the PhD programme will be exposed to a broad range of theoretical and practical issues related to Climate Change. Courses are organized around two broad tracks- climate science and climate policy. The following research areas have been identified:

1. Climate science and technology

Terrestrial carbon sources and sinks, Prediction of climate extremes, Aerosols and regional climate (GCM/CTM simulations, Statistical approaches and Scaling models), Cloud formation, Energy use and emissions modeling, Climate mitigation technologies (enhanced carbon capture systems, photoactive materials and devices, non-carbon energy technologies, biorefineries, negative net-carbon technologies).

2. Technology evaluation and assessment

Competitiveness and sustainability, Strategies for low-carbon development, Economics of Climate Change, Assessment of climate change policies and mechanisms.

3. Impacts, Vulnerability and Adaptation

Decision support systems for emissions and impacts, Climate change impacts on hydrology (watershed, coastal and urban scales), Climate sensitive sectors and poverty, Natural disaster and human impacts.

ELIGIBILITY ADMISSION

First Class or 60% marks (55% marks for SC/ST) in *:

*as specified in the General Eligibility Criterion for admission in this brochure.

- i. M.E./M.Tech (in Aerospace, Chemical, Civil, Computer Sci. Engg., Electrical, Energy, Environmental Sci. Engg./ Mgmt., Mechanical, Resources Engg. and Atmospheric Science), M.Des./ M.Arch./ M.Planning (or equivalent) degrees will be eligible per norms in the IITB PhD brochure.
- ii. M.Phil. in Social Sciences (Economics, Geography, Sociology, Planning and similar)/M.Mgt/MBA will be eligible to apply. Relevant CSIR/UGC score and other IITB norms as per IITB PhD brochure will be required.
- iii. M.A. (Economics, Geography, Sociology, Planning and similar) / M.Sc. (Atmospheric Sci., Earth Sci., Environmental Sci., Geophysics, Physics) with appropriate GATE/CSIR/UGC will be eligible to apply. Relevant CSIR/UGC score and other IITB norms as per IITB PhD brochure will be required.
- iv. In special cases, students with a B.E./B. Tech or equivalent (in Aerospace, Chemical, Civil, Computer Sci. Engg., Electrical, Mechanical), with eligibility subject to specified admission procedure, would be considered. A valid GATE score and other IITB norms as per IITB PhD brochure will be required. Students with M.A., M.Sc. or B. Tech degrees will need to take additional credits to fulfill IITB requirements.

CENTRES

B.19 CENTRE FOR ENVIRONMENTAL SCIENCE AND ENGINEERING (CESE) Environmental Science and Engineering : EV

ELIGIBILITY FOR ADMISSION

In view of the interdisciplinary nature of the Environmental Science and Engineering subject, students from diverse areas of sciences, engineering and medical sciences are permitted to apply for Ph.D. However, students who do not have adequate background knowledge will have to take additional courses to enable them to successfully pursue research in Environmental Science and Engineering.

First Class or 60% marks (55% marks for SC /ST) in* :

*as specified in the General Eligibility Criterion for admission in this brochure.

1. Bachelor or Master of Engineering degree in Aeronautical / Aerospace, Agricultural, Atmospheric Science, Chemical, Civil, Energy, Biotechnology, Environmental, Mechanical, Metallurgical, Mining OR
2. Master of Science degree in Atmospheric Sciences, Biochemistry, Biotechnology, Chemistry, Earth Sciences, Environmental Toxicology, Environmental Science, Meteorology, Microbiology, Physics, Public Health & Statistics are eligible for Ph.D. Admission. However, Mathematics at 10+2 level is a mandatory requirement.

Candidates with Bachelors degree in Engineering or Masters degree in science must have a valid GATE score to become eligible for the Teaching / Research Assistantship provided by the Institute.

RESEARCH AREAS

The research and developmental activities of the CESE encompass a wide spectrum of areas in Environmental Science and Engineering such as environmental monitoring, industrial air and water pollution control, solid and hazardous waste management, air and water quality modeling, environmental systems optimization, environmental microbiology and biotechnology, bioremediation, indoor air quality, aerosol science and technology, environmental impact assessment and global issues. For further details, visit www.cese.iitb.ac.in

B.20 INDUSTRIAL DESIGN CENTRE (IDC) (Design) : ID

Over the past few years, the need of research and knowledge generation in design has been growing which resulted in starting the Ph.D. program in Design at IDC. Apart from the core areas of design, designers are expected to work in many interdisciplinary areas such as management, information technology, engineering, sociology, psychology, media, education, etc. throwing up new challenges.

ELIGIBILITY FOR ADMISSION

I. For general category students and/or for students where no concession in academic performance is called for, eligibility requires meeting ANY ONE of the following criteria as regards performance in the qualifying degree:

- (1) a minimum of 55 percent marks (50% marks for SC/ST) in the final academic year of the programme
- (2) a minimum of 55 percent marks (50% marks for SC/ST) in aggregate or as specified by the university (any one of them)
- (3) a first class as specified by the university
- (4) a minimum CPI of 5.5 (5.0 CPI for SC/ST) on the scale of 10; with corresponding proportional requirements when the scales are other than on 10 – for example, on a scale of 8, the minimum will be 4.4

II. The qualifying degrees are as follows:

- i. M.Des. / M.Arch. / M.Tech. / M.Phil. / MFA / Post-Graduate Diploma in Design of NID, Ahmedabad and equivalent
OR
- ii. B.Des. / B.Arch. / BFA / MA / M.Sc. / Under-Graduate Diploma in Design of NID, Ahmedabad or equivalent degree with exceptionally outstanding design related work with a valid CEED score. Candidates with a minimum of three years of relevant professional experience without CEED scores can also be considered. However, such candidates will not be awarded Teaching / Research Assistantship. These candidates may have to register for additional courses as per the rule once they are selected.

RESEARCH AREAS

The faculty at IDC besides working on application and project oriented research, also works in depth on various topics mentioned below:

Themes

Design theory, education pedagogy
Design tools
Design management
Typography, script, calligraphy, lettering, type design
Interaction design
Visual language
Storytelling
Information design
Sustainability
Product semantics
Mental imagery in design thinking
Biomimetics
Manual Material Handling
Ergonomics at Home

Domains of research

Design for development
Education
Healthcare
Design for children
Design for elderly/special people
Women and occupational health
Control, display and motion stereotype
Ergo-Design

Research methods

Qualitative methods
Semiotics
Active people watching, visual ethnography
Visual narratives, static visual narratives
Cluster analysis

Eye movement studies
Historical methods
Philosophical analysis
Protocol analysis
Psycho-Physiological analysis of Product
User Centred Behavioral analysis

It is desirable that the research area of the candidate overlaps one or more of the above themes, domains, and/methods. Candidates are advised to refer to the department web page for updates to these areas. Candidates are encouraged to visit/discuss their research interests with individual faculty members of IDC before applying.

B.21 CENTRE OF STUDIES IN RESOURCE ENGINEERING(CSRE)

Geoinformatics & Natural Resources Engineering: GNR

Geoinformatics & Natural resources engineering is an interdisciplinary area encompassing of diverse issues in exploration and management of natural resources such as land, water, mineral, forest, soil and ocean resources; socio-economic aspects of sustainable development with respect to environmental impact of natural resources exploitation; renewable energy resources management; global warming and climate change. Contemporary techniques of scientific assessment using satellite remote sensing , GIS and GPS are evolved and used in the study of natural resources. The researchers come from diverse backgrounds of science and engineering and work may be of applied or theoretical nature as in the fields listed below.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST) in* :

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. Bachelor or Master of Engineering/Technology degree in Agriculture/ Civil/Environmental/Mining/ Electrical/Electronics/Electronics and Telecommunication/Computer Science/InformationTechnology/ Remote Sensing/ GeoInformatics/Geomatics/Architecture and Town Planning.
- ii. M.Sc. in Earth Science/Environmental Science/Geology/Geophysics/Marine Sciences/ Agriculture/ Physics/ Mathematics/Computer Science/Information technology.
(Mathematics at 10+2 level is a mandatory requirement).

Candidates with Masters degree in Engineering/ Technology are eligible for Teaching Assistantship.

Candidates with Bachelors degree in Engineering or Masters degree in Science MUST also have one of the following additional requirements:

- i. a valid GATE score
- ii. CSIR/UGC fellowship
- iii. Minimum of 2 years of professional work experience (for SW/SF/IS category)
- iv. Minimum 6 months project work experience in IIT Bombay (for PS category)

Candidates with Bachelors degree in Engineering or Masters degree in Science must have a valid GATE score /CSIR/UGC fellowship to be eligible for Teaching Assistantship.

The applicant should have a relevant background to carryout research in the fields of **Remote Sensing, GIS, Satellite Image Processing Global Positioning, Systems OR the applications of the above** to Natural Resources Engineering. For more details please visit (www.csre.iitb.ac.in)

RESEARCH AREAS

a. Application Areas

- i. Water Resources
- ii. Terrain Evaluation, Landuse Planning and Monitoring
- iii. Agro-informatics and Rural Development
- iv. Precision agriculture and wireless sensor network
- v. Mineral Systems studies and Mineral Exploration
- vi. Natural Hazards of Droughts, Desertification, Landslide,Avalanche, Earthquake, Tsunami etc.
- vii. Marine Resources and Ecology.
- viii. Snow, Glaciers and Atmosphere
- ix. Applications of Microwave Remote Sensing

b. Theoretical Areas

- i. Digital Image Processing
- ii. Digital Photogrammetry and Cartography
- iii. Geospatial Technologies
- iv. Synthetic Aperture Radar Information Analysis and Polarimetry

B.22 CENTRE FOR RESEARCH IN NANOTECHNOLOGY AND SCIENCE (CRNTS)

Nanotechnology and Science: NT

Description :

About fifty faculty from across most of the Departments of the Institute are pursuing their research interests in Nanotechnology and Science and are associated with the Interdisciplinary programme in this area. The Institute has identified Nanotechnology to be a thrust area. Focused research in Nanotechnology is being carried out at the Centre for Research in Nanotechnology and Science (CRNTS) and the Centre of excellence in Nanoelectronics by the associated faculty. Realising the importance of cross disciplinary nature of this domain, this programme requires the association of two research supervisors, preferably from two different departments, to supervise the research of each Ph.D. Candidate. This unique approach is envisaged to generate the specialised manpower required to contribute in this important area that is being nurtured by the Nanomission of the Government of India.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST) in* :

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. M.Tech. in Electrical, Mechanical, Civil, Metallurgical, Materials, Chemical, Biomedical Engineering, Energy Science and Engineering and Environmental Science and Engineering OR
- ii. M.Sc. in Physics, Chemistry, Biological and Environmental Science OR Bachelors Degree in above mentioned Engineering Discipline with valid GATE score or award of CSIR/ UGC/DBT Research Fellowship or INSPIRE FELLOWSHIP from Govt. of India/DST

Candidate who are admitted to the Ph.D. Programme will be required to pass a “comprehensive exam” to continue to stay in the programme. The exam will be based on five subjects out of which three can be chosen by the candidate in consultation with the IDPC and RPC. Mathematics and Statistics will be compulsory. The examination will be conducted during the second (post M.Tech./ME entrants) or third semester (post B.Tech./B.E./M.Sc. Entrants) and may be in the oral and/ or written mode.

RESEARCH FACILITIES

Facilities for advanced characterization such as High Resolution transmission electron microscope (FEGTEM), High resolution scanning electron microscope (FEGSEM) with EDS and WDS, Cryo-SEM, Scanning transmission electron microscope (STEM) with EDS, FTIR microscope, Secondary ion Mass Spectrometry (SIMS), Laser ablation inductively coupled Mass spectroscope (LA ICPMS), Confocal laser Raman spectrometer, Dip pen lithography, FACS cell sorter, dynamic light scattering particle size analyzer, X-ray fluorescence Spectrometer and several Clean rooms exist in CRNTS. A complete range of state of the art device processing facilities exist in the Centre for Excellence in nanoelectronics. Further, the Institute has established central facilities such as Cryo-TEM with all sample preparation tools, Confocal laser scanning microscope, Nanoscope IV AFM, ESCA and excellent computational laboratories.

Research Areas

The research in the areas may be broadly classified as Nanomaterials, Nanoelectronics, Nanobiotechnology, Nanomanufacturing, Nanofluidics, and Computational research in nanosystems are being pursued.

B.23 CENTRE FOR TECHNOLOGY ALTERNATIVES FOR RURAL AREAS(CTARA)

Technology & Development: TD

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST) in* :

***as specified in the General Eligibility Criterion for admission in this brochure.**

- i. Admission will be restricted to students having B. Tech./M.Tech (or equivalent) degrees in any branch of Engineering or M.Sc degree in any discipline.
- ii. Adequate Exposure/Experience in carrying out Field Work and /or Technology Transfer/Project Management and to Contemporary International issues related to Technology and Development is considered desirable.

- iii. Eligible candidates should apply on the format prescribed by the Institute. A clear Statement of Purpose (SoP) along with a research project proposal (~1000 words) must accompany the application. Admission will be made through a written-test followed by an interview.

Research Areas

- Technology and Development
- Rural/Agro-based Industries
- Natural Resources (Energy, water, Land use)
- Environment, Climate Change and Development
- Public Policy and Governance
- Agriculture and Biodiversity
- Rural and regional planning

SCHOOLS

B. 24 SHAILESH J. MEHTA SCHOOL OF MANAGEMENT (SJMSOM)

Management:

MG

ELIGIBILITY FOR ADMISSION

- i. B.E./B.Tech or equivalent with 70% marks/7.5 CPI (65% marks/7.00 CPI for SC/ST) and a valid score in GATE/CAT/GMAT/UGC-CSIR JRF examination OR
- ii. B.E./B.Tech or equivalent (having at least two years of work experience) with 60% marks/6.5 CPI (55% marks/6.00 CPI for SC/ST) and a valid score in GATE/CAT/GMAT/UGC-CSIR JRF examination OR
- iii. ME/M.Tech/M.Phil or equivalent degree with 60% marks/6.5 CPI (55% marks/6.0 CPI for SC/ST) at post graduation level OR
- iv. Master of Management /MBA or equivalent with 60% marks/6.5 CPI (55% marks/6.0 CPI for SC/ST) at post graduation level OR
- v. M.Sc./ M.A./ M.Com/ LLM/MCA or equivalent with 60% marks/6.5 CPI (55% marks/6.0 CPI for SC/ST) at post graduation level and a valid score in GATE/ CAT/GMAT/ UGC-CSIR JRF examination OR
- vi. CA/CFA(US) with 60% marks/6.5 CPI (55% marks/6.0 CPI for SC/ST) in the preceding degrees and a valid score in GATE/CAT/GMAT/UGC-CSIR JRF examination.

RESEARCH AREAS

- i. Accounting
- ii. Economics
- iii. Entrepreneurship
- iv. Financial Management
- v. General Management
- vi. Human Resource Management
- vii. Information Systems
- viii. Intellectual Property Rights
- ix. International Business
- x. Management of Information Technology
- xi. Marketing Management
- xii. Operations Management
- xiii. Organization Behaviour
- xiv. Project Management
- xv. Quality Management
- xvi. Statistics and Operations Researchers
- xvii. Strategy and Business Policy
- xviii. Technology Management

FINANCIAL SUPPORT

In addition to the Institute Teaching Assistantships, the School has Shailesh J. Mehta Endowment which provides fellowships. Students admitted to full-time Ph.D. Programme at the School are eligible to apply for National Doctoral Fellowship (NDF) awarded by All India Council for Technical Education (AICTE).

(C) APPENDICES

Appendix C.1

Sponsorship Letter for full-time Ph.D. candidates

(To be typed on letterhead of the sponsoring organization)

To

The Director,
Indian Institute of Technology, Bombay
Mumbai – 400 076.

Sub: Sponsoring of an Employee for Ph.D. programme

Dear Sir,

We hereby sponsor the candidature of _____ who is an employee in our organization, for joining Ph.D. programme in _____ at your Institute as a FULL-TIME candidate.

We shall bear the total expenses of his/her studies. We shall fully relieve him/her of his/her duties in the organization during the entire period of the Ph.D. programme to enable him/her to devote full time to the studies.

Signature and seal of the Sponsoring Authority

=====

Appendix C.2

Employer’s Letter in case of Ph.D. Candidates joining on Study Leave

(To be typed on letterhead of the Institution)

To

The Director,
Indian Institute of Technology, Bombay
Mumbai – 400 076.

Sub: Relieving an employee on Study Leave

Dear Sir,

We hereby relieve Shri / Smt. / Kum. _____ an employee of this Institute on full / half / no pay leave for joining Ph.D. programme at IIT Bombay, for a period of _____ years. (at least three years)

Signature of Head of the Institute and seal of the Institution

=====

Appendix C.3

Sponsorship Certificate for Ph.D. External Registration

(To be typed on letterhead of the Sponsoring Organization)

1. Name of the sponsoring organization : _____
2. Address : _____
3. Present Designation of the applicant : _____
4. Present status of the applicant: _____
5. (Permanent/Quasi Permanent/Temporary)
6. Division where research work is proposed to be done: _____
7. Name of supervisor from the sponsoring organization: _____
(Bio-data of supervisor to be enclosed giving details of designation, qualification, research experience etc.)
8. Details of facilities relevant to the research problem which will be made available to the candidate by the organization.
9. Statement of External Supervisor.

If Shri / Kum. / Smt. _____ is registered for the doctorate degree I agree to act as his/ her research supervisor jointly with the research supervisor form the Institute.

Signature of External Supervisor

If Shri / Kum. / Smt. _____ is admitted to the Ph.D. programme, we shall allow him/ her to undergo the programme of studies and also to fulfill the residential requirement of the Institute, as per rules.

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

We also give our consent to _____ of our organization to supervise the Ph.D. Project, jointly with Dr. / Prof. _____ of IIT Bombay.

Signature and Seal of the
Sponsoring Authority

Appendix C.4

No Objection Certificate from University for Ph.D. Candidates under College Teacher Category

(To be typed on letterhead of the Institution/University)

Dear Sir,

This is to certify that our Institution has no objection to the candidature of Mr / Ms _____, who is working as _____ in the _____ College, to join the Ph.D. Programme at IIT Bombay, under College Teacher Category.

Signature & Seal of the Head of the University/ Institution.

[Bio-data of External Supervisor (which is optional) to be enclosed giving details of designation, qualification, research experience, etc]

STATEMENT OF PURPOSE (for Ph.D. Admission at IIT Bombay)

Statement of Purpose (SOP) is your opportunity to share with the admission committee your thoughts and feeling about Postgraduate studies at IIT Bombay including your preparation for the same. Briefly describe past project/ research work done by you. Restrict yourself to 500-600 words. The personal SOP will aid the admission committee in evaluating your application.

1. **Name:**

2. Ph.D. Programme in i) _____
ii) _____
iii) _____

Date: _____

Signature with Name