

INDIAN INSTITUTE OF TECHNOLOGY BOMBAY



Information Brochure
Ph.D. Admissions
2016-17

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I. Important Guidelines for Ph.D. Application

1	Please read the instructions given in the brochure carefully before filling up the application form.						
2	<p>Online Application Form & Information Brochure (including the admission schedule along with the important dates) is available on the Institute website at the following link. http://www1.iitb.ac.in/newacadhome/phd.jsp.</p> <p>You are required to submit the application ONLINE. No Downloadable Forms will be available. After filling the form, you are advised to take a print of your application and keep the same for the record.</p>						
3	<p>The application fee is as follows,</p> <table><tr><td>Women candidates</td><td>: Rs. 150/-</td></tr><tr><td>SC/ST/PwD category candidates</td><td>: Rs. 150/-</td></tr><tr><td>All other candidates</td><td>: Rs. 300/-</td></tr></table> <p>The fee is to be paid by Debit Card / Credit Card / SBI Internet Banking / Online Payment System / Demand Draft drawn on any Nationalized Bank in favour of "Registrar, IIT Bombay", payable at Mumbai branch.</p> <p>You must write your Name, 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 printed copy of the application. 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 printed copy of the application. Applications without online payment details/ Demand Draft will not be considered.</p> <p><u>APPLICATION FEE IS NON-REFUNDABLE.</u></p>	Women candidates	: Rs. 150/-	SC/ST/PwD category candidates	: Rs. 150/-	All other candidates	: Rs. 300/-
Women candidates	: Rs. 150/-						
SC/ST/PwD category candidates	: Rs. 150/-						
All other candidates	: Rs. 300/-						
4	You can apply for up to THREE disciplines/specialisations.						
5	<p>(i) Along with your application, you have to submit a Statement of Purpose for all academic units.</p> <p>(ii) 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 a research proposal (1500 words) on a topic of your research interest in place of Statement of Purpose. The proposal should contain (a) problem identification, (b) brief review of literature and (c) proposed methodology.</p> <p>(iii) If you are applying to CTARA or CSRE, you need to upload Statement of Purpose as well as a research proposal along with the application form. The SOP for CSRE should refer to one or more topics of interest FROM THE LIST of topics announced on CSRE webpage http://www.csre.iitb.ac.in.</p> <p>(iv). Candidates applying to IDC are required to submit a SOP along with a 1500 word proposal that should specify (a) research area (b) brief review of literature and (c) methodology. The candidates have also to submit a recent work or paper related to their area of research.</p>						
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. • Mark-sheet of the last semester/ Consolidated mark-sheet of the qualifying degree. Result awaited candidates have to upload their latest/previous semester mark-sheet. • Caste Certificate (OBC-NC/SC/ST), if applicable. An affidavit for having applied in case the certificate is not yet received. • PwD Certificate, if applicable. • Sponsorship certificate, if applicable. • Statement of Purpose (SoP), a sample of writing (if applicable), research proposal (if applicable), as a single file irrespective of the number of disciplines/specialisations.
8	<p>The limit of annual income for OBC-NC is Rs. 6 lakhs. The OBC-NC certificate issued for the financial year for 2015-16 by the Competent Authority in the prescribed format must be uploaded in the ONLINE application and submitted at the time of admission.</p>
9	<p>In case of payment by Demand Draft, the printed 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 Deputy Registrar (Academic), IIT Bombay, Powai, Mumbai-400 076 and must be received by the last date as given in the Admission Schedule.</p>
10	<p>You should check the Institute website for results / important announcements.</p>
11	<p>You should check emails sent to the email address provided in your application for all important communications and announcements.</p>
12	<p>Candidates called for written test/interview should bring with them (i) Photo ID Card, (ii) Printed copy of the application submitted online, (iii) Thesis / dissertation / report / publications (iv) copy of certificates and mark-sheets.</p>
13	<p>Candidates having degree from foreign universities should 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) marks or equivalent in qualifying examination.</p>

II) Schedule of Ph.D. Admission - Application form throughout the year

(A) Important Dates: {FIRST SEMESTER}

No	Particulars	Dates
02.	Advertisement (in all leading Newspapers and on website)	Sunday, March 13, 2016
03.	Available of online application forms mode	Thursday, March 17, 2016
04.	Last date for submission of completed application forms	Tuesday, April 5, 2016
04.	Last date for Departments to send the list of candidates to be called for Written Test/Interview	Monday, April 11, 2016
05.	To display the list of candidates called for <u>Entrance Test and/or Interview</u>	Friday, April 15, 2016
06.	<u>Date of Entrance Test and/or Interview (for all categories)</u>	
	Electrical Engineering,	May 5, 2016 (Written Test) May 6 & 7, 2016 (Interview)
	Mathematics, Physics, Earth Sciences	May 9, 2016 (Written Test) May 9 & 10, 2016 (Interview)
	Biosciences & Bioengineering	May 9, 10 & 11, 2016 (Only Interviews)
	Chemistry	May 9 & 10, 2016 (Interview)
	Civil Engineering, Humanities & Social Sciences	May 9 & 10, 2016 (Written Test and/or Interview)
	Aerospace Engineering, Mechanical Engineering, Metallurgical Engineering & Materials Science,	May 9, 2016 (Written Test) May 10 & 11, 2016 (Interview)
	Chemical Engineering.	May 9, 10 & 11, 2016 (Written test and Interview)
	Energy Science & Engineering	May 10, 2016 (Written Test) May 10 & 11, 2016 (Interview)
	Environmental Science & Engineering,	May 10, 2016 (Written Test and/or Interview)
	Computer Science & Engineering	May 11 & 12, 2016 (Written Test and/or Interview)
	Systems & Control Engineering	May 8, 2016 (Written from 2.30 p.m. to 4.30 p.m.) May 9, 2016 (Interview)
	IE&OR	May 9, 2016 (Written Test) May 9 & 10, 2016 (Interview)
	Environmental Science & Engineering, Educational Technology	May 10, 2016 (Written Test and/or Interview)
	Climate Studies, Centre for Technology Alternatives for Rural Areas,	May 11, 2016 (Written Test and Interview)
	Centre of Studies in Resources Engineering, Centre for Research in Nanotechnology & Science, Centre for Urban Science and Engineering, Shailesh J. Mehta School of Management	May 12, 2016 (Written Test and/or Interview)
	Industrial Design Centre	May 11 & 12, 2016 (Presentation and Interview)

07.	Recommendations from Heads of Dept/School/ Centre/ID groups to reach Academic Office	13 to 18 th May, 2016	
08.	Declaration of Result/Payment of fees	Result Announcement	Last date of payment of fees
	1 st offer	May 25,2016	May 31, 2016
	2 nd offer(if required)	June 08, 2016	June 15, 2016
	Final Offer (if required)	June 22, 2016	June 29, 2016
09	Registration and Orientation Programme (tentative)	July 14 2016 to July 16 2016	
10.	Instruction begins (tentative)	July 18, 2016	

**TENTATIVE SCHEDULE OF ADMISSION FOR Ph.D. PROGRAMME2016-17
{SECOND SEMESTER}**

No	Particulars	Dates
01.	Advertisement (on IITB website)	Thursday, September 1, 2016
Mode of Application : Online		
02.	Availability of application forms	Thursday, September 1, 2016
03.	Last date for submission of completed application forms for Spring Semester	Friday, October 14, 2016
04.	Last date for Departments to send the list of candidates for Written Test/Interview	Thursday, October 20, 2016
05.	To display the list of candidates called for <u>Entrance Test and/or Interview</u>	Thursday, October 27, 2016
06.	Date of Entrance Test and/or Interview (for all categories)	
	Aerospace Engineering, Civil Engineering, Computer Science and Engineering, Earth Sciences, Energy Science & Engineering Mathematics, Mechanical Engineering, Metallurgical Engineering & Materials Science, Physics	December 1, 2016 (Written Test) December 1 & 2, 2016 (Interview)
	Biosciences & Bioengineering	December 1, 2 & 3, 2016 (only Interviews)
	Chemical Engineering.	December 1 & 2, 2016 (Written Test/ Interview)
	Chemistry	December 1, 2016 (Written Test) December 1, 2 & 3, 2016(Interview)
	Humanities & Social Sciences	December 5 & 6, 2016 (Written Test & Interview)
	Electrical Engineering	December 8, 2016 (Written Test) December 9 & 10, 2016(Interview)
	Systems & Control Engineering, Industrial Engineering & Operations Research, Climate Studies	December 4, 2016 (Written Test and/or Interview)
	Shailesh J. Mehta School of Management	December 3, 2016 (Written Test and/or Interview)

	Centre of Studies in Resources Engineering, Centre for Research in Nanotechnology & Science, Centre for Technology Alternatives for Rural Areas,	December 4, 2016 (Written Test and/or Interview)
	Environmental Science & Engineering,	December 6, 2016 (Written Test and/or Interview)
	Centre for Urban Science and Engineering	December 6, 2016 (Written Test and/or Interview)
06.	Recommendations to reach Academic office	December 9, 2016
07.	Declaration of Result	December 15, 2016
08.	Payment of fees on or before	December 22, 2016
09,	Registration and Orientation Programme (tentative)	Wednesday, December 28 2016 to Friday, January 31 st , 2017
10	Instruction begins (tentative)	Monday, January 2, 2017

Results will be declared on IIT website: <http://www.iitb.ac.in/newacadhome/phd.jsp>.

The dates given above are tentative. Any changes in the dates will be indicated on the website.

PS : GATE 2016 qualified candidates may apply after the GATE 2016 results are announced and uploaded on the Institute Admission ONLINE application portal.

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. The Institute was established in 1958. It 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 (B.Tech.), Postgraduate (M.Tech.) and Doctoral (Ph.D.) programmes are offered by the Departments Aerospace Engineering, Chemical Engineering, Civil Engineering, Computer Science and Engineering, Earth Sciences, Energy Science & Engineering, Electrical Engineering, Mechanical Engineering and Metallurgical Engineering and Materials Science. Interdisciplinary groups in Industrial Engineering & Operations Research and Systems and Control Engineering offer M.Tech. and Ph.D. Programmes. A Ph.D. Programme in Climate Studies is offered by the corresponding group.

The Industrial Design Centre 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 Humanities and Social Sciences Department 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 dual-degree M.Sc.+Ph.D programmes and their admissions are through JAM. CTARA offers M.Tech. in Technology and Development and a Ph.D. Programme. Ph.D in Nano Technology is offered by CRNTS. Cross-departmental M.Tech. programme in Materials, Manufacturing & Modeling (MMM) is offered jointly by the Departments of Mechanical Engineering, Met. Engineering & Mat. Sci. and Mathematics. The Shailesh J. Mehta, School of Management offers a 2-year Master of Management programme, doctoral programme and Executive Master of Business Administration (EMBA) in collaboration with Washington University in St. Louis. The Department of Biosciences and Bioengineering offers M.Sc. and Ph.D. programmes in Biotechnology, M.Tech. and Ph.D. programmes in Biomedical Engineering and Dual-Degree M.Sc.+Ph.D. Programme in Biotechnology. The Centre for Urban Science & Engineering (C-USE) offers Ph.D. Programme in Urban Science & Engineering. The Institute also has dual-degree M.Tech.+Ph.D. programmes in several disciplines.

The Institute on an average admits 1191 candidates for the Undergraduate programmes and 1580 candidates for different Postgraduate and Doctoral programmes every year. Students from Bangladesh, Egypt, Ethiopia, Fiji, Iran, Iraq, Pakistan, 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) organizes short, intensive courses in specialized topics both for practicing engineers as well as for teachers from engineering colleges; and also conducts seminar and conferences on current scientific and technological developments. Further, teachers from various engineering colleges also join Institute for the postgraduate and doctoral programmes. under Quality Improvement Programme (QIP).

A.2) RESEARCH FACILITIES

All the Academic Units of the Institute have well equipped research laboratories and workshop facilities. In addition, there are a number of central facilities such as Central Workshop, Central Library and Computer Centre. The Central Library has more than 3 lakhs books, a large collection of back volumes of periodicals, standard specifications and other literature. It subscribes to over 1500 current

journals in Science, Engineering, Humanities and Social Sciences. The Computer Centre provides high-end networked computing facilities.

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

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 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 labs. The Institute is actively collaborating with several organizations of other countries on a bilateral basis.

A.3) STUDENTS AMENITIES

The Institute is fully residential and has 16 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. Some flatlets are available for married research scholars.

Extra-curricular activities are provided by the Students' Gymkhana. These activities include Sports, Cultural programmes and Social Service. 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 (SAC) routinely organizes several vibrant extra curricular events.

A.4) Ph.D. PROGRAMME

With extensive infrastructural facilities and a sound research base, the Institute offers Ph.D. programme in a wide range of areas in Engineering, Sciences and Humanities & Social Sciences. The broad objectives of the Ph.D. programme are to contribute to expanding the frontiers of knowledge and to provide research training.

The academic programme leading to the Ph.D. degree is broad-based and involves a course credit requirement and a research project leading to thesis submission. The Institute also encourages research in interdisciplinary areas through a system of joint supervision and interdepartmental group activities. 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 Engineering, Biosciences and Bioengineering, Chemical Engineering, Chemistry, Civil Engineering, Computer Science and Engineering, Earth Sciences, Electrical Engineering, Energy Science & Engineering, Humanities and Social Sciences, Mathematics, Mechanical Engineering, Metallurgical Engineering and Materials Science, Physics, Industrial Design Centre, Centre for Environmental Science & Engineering, Centre of Studies in Resources Engineering, Centre for Research in Nanotechnology & Science and Centre for Technology Alternatives for Rural Areas, Centre for Urban Science and Engineering, Interdisciplinary Groups in Climate Studies, Educational Technology, Industrial Engineering & Operations Research and Systems & Control Engineering and in Shailesh J. Mehta School of Management.

A.5) ELIGIBILITY CRITERION FOR PH.D. ADMISSION

A.5.1) General eligibility criterion for Admission in all academic units : Departments, Centres, Schools and Interdisciplinary Groups

ONE of the following in appropriate subject areas:

1) Master's Degree in Engineering/Technology or equivalent degree, with First class or 60% marks (55% marks for SC/ST) as described later in A.5.4.

2) One of the following:

- (i) Bachelor's degree in Engineering/Technology with First class or 60% marks (55% marks for SC/ST) as described later in A.5.4.
- (ii) Master's degree in Science or equivalent degree, with First class or 60% marks (55% marks for SC/ST) as described later in A.5.4.
- (iii) Master's degree in Arts/Commerce or equivalent degree with a minimum of 55% marks (50% for SC/ST), only for admission to the Ph.D. programmes offered by the Industrial Design Centre and Department of Humanities & Social Sciences.

Such candidates must also fulfill ONE of the following additional requirements:

- i. Valid GATE/CEED Score
- ii. Junior Research Fellowship (JRF) of CSIR/UGC/NBHM/DBT or DST INSPIRE Fellowship.
- iii. Candidates having UGC-NET Lectureship (LS) are also eligible for Teaching Assistantship in addition to other academic qualifications in Humanities & Social Sciences Department.
- iv. Minimum of 2 years of professional experience (acquired after obtaining the qualifying degree and completed before the starting of the semester in which admission is sought).

In addition to the general eligibility criterion, the applicant must satisfy the eligibility criteria specified for the respective Departments / Centres / Schools / Interdisciplinary Groups, and the eligibility criteria for admission with different types of financial support.

A.5.2) Requirements for Teaching Assistantship (TA/TAP), Research Assistantship (RA/RAP) and Project Staff (PS)

TA/TAP/RA/RAP category (as described later): Candidates with Master's Degree in Engineering/Technology or equivalent degree are eligible for admission under these categories without valid GATE score. Candidates without Master's Degree in Engineering / Technology or equivalent degree are required to have either a valid GATE score or JRF of UGC / CSIR / NBHM / DBT or DST INSPIRE fellowship.

PS category (as described later): In addition to meeting the eligibility criteria for admission, the candidates should have 6 months of service (before the starting of the semester in which admission is sought) in sponsored projects at the Institute. In case of students with B.Tech./M.Sc. or equivalent degree and without GATE score, the six month project experience may be counted as part of two-year professional experience.

A.5.3) Admission for IIT B.Tech. degree holders

Candidate having an IIT B.Tech. Degree and having a minimum CGPA/CPI of 8.00 (on 0-10 scale) and above are exempted from requirement of valid GATE score. They will be admitted to Ph.D. Programme under TA/TAP/RA/RAP positions through written test / interview.

A.5.4) Requirement of First Class/60% for PG admissions at IIT Bombay

For general category candidates and/or for candidates 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% marks in the final academic year of the programme.
- (2) a minimum of 60% 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 Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10,(for example, 4.8 on a scale of 0-8).

For SC/ST category candidates, the corresponding criteria are :

- (1) a minimum of 55% marks in the final academic year of the programme.
- (2) a minimum of 55% 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 Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 5.5 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10,(for example, 4.4 on a scale of 0-8).

A.6) APPLICATION CATEGORIES AND FINANCIAL SUPPORT

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

FULL-TIME RESEARCH SCHOLAR

- i. Teaching Assistantship (TA)
- ii. Teaching Assistantship through Project (TAP)
- iii. Govt./Semi Govt. Fellowship Award (FA: QIP, CSIR, UGC, DAE, DST, DBT, NBHM, etc.)
- iv. Sponsored Candidates (SW)
- v. Self-Financed, including those on Study Leave (SF)
- vi. Foreign Nationals with Indian Council for Cultural Relation Award (ICCR)
- vii. Self-Financed Foreign Nationals (FRN-SF)
- viii. Foreign Nationals with Teaching Assistantship (FRN-TA)

PART-TIME RESEARCH SCHOLAR

- i. Institute Staff of IIT Bombay (IS)
- ii. Project Staff of IIT Bombay (PS)
- iii. Research Assistantship (RA)
- iv. Research Assistantship through Project (RAP)
- v. External candidates sponsored by recognized R & D organizations (EX)
- vi. College Teacher: Candidates working in Colleges / Educational Institutes (CT)

A.6.1) Teaching Assistantship (TA)

Students under this category are entitled to financial support as per MHRD norms.

- i. For students with M.Tech./M.E. or equivalent degree as the qualifying degree, the assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. At present, the monthly rate of assistantship is Rs. 25,000/- for the first 2 years and enhanced rate of Rs. 28,000/- for the remaining period.
- ii. For students with B.Tech./B.E. or equivalent degree and students with M.Sc./M.A./M.Com. or equivalent as the qualifying degree and having valid GATE score or having Junior Research fellowship (JRF) of UGC/CSIR/NBHM/DBT or DST INSPIRE fellowship, the assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. At present, the monthly rate of assistantship is Rs. 25,000/- for the first two years and enhanced rate of Rs.28,000/- for the remaining period.
- iii. Students in SJMSOM with M.B.A. as the qualifying degree and with B.Tech./B.E. or equivalent degree, the assistantship is same as in (i) above. For other students the amount is as in (ii) above.
- iv. To get Teaching Assistantship, the students concerned must assist in teaching or research, as assigned by the respective Academic Unit to the extent of 8 hours of work per week.
- v. The continuation of the assistantship will be subject to satisfactory performance of the duties assigned by the Academic Units as well as satisfactory academic performance.
- vi. Employees on the rolls (with or without pay) of any organization are not eligible for admission under this category.

As per MHRD directives, the employees of any organizations with or without pay are not eligible for admission under TA category. Such candidates may be considered under SW/SF category, if found

suitable. Students getting assistantships from the Institute may join projects sponsored by external agencies and obtain corresponding fellowships in lieu of TA ship.

A.6.2) Teaching Assistantship Through Project (TAP)

The students under this category receive financial support from sponsored projects. Only some disciplines have TAP seats. The candidates do not have to indicate their preference for TAP separately. The rate of stipend may be same or higher than the TAship. The admission procedure and other requirements are same as applicable to TA.

A.6.3) Fellowship Award (FA)

These students are financially supported under various Govt. / Semi Govt. schemes (CSIR, UGC, DAE, DST, DBT, NBHM, etc.) and some other organizations. The admission procedure and other requirements are same as applicable to TA.

A.6.4) Sponsored Candidate (SW)

These students are sponsored by their employers for doing research work in the Institute. They are expected to be released for full-time course work and research at the Institute for a minimum period of three years. They will not receive any financial support from the Institute. Sponsorship letter (**Appendix C.2**) should be submitted at the time of written test and/or interview.

A.6.5) Self-Financed Indian Nationals, including those on Study Leave (SF)

This category refers to persons who are admitted through the usual admission procedure but are not eligible for financial support from the Institute. Such students are not entitled for hostel accommodation on campus. If admitted, these students have to complete their programme within the prescribed time without any financial support from the Institute.

This category also includes the students 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 for Study Leave (**Appendix C.3**) should be produced at the time of joining, if selected.

A.6.6 Self-Financed Foreign Nationals (FRN-SF)

Foreign Nationals applying under Self-financed (FRN-SF) category should visit the following link for Foreign Students on the website of the IIT Bombay International Relations Office:

<http://www.iitb.ac.in/academic/toadmission.jsp>

A.6.7) Foreign Nationals with Indian Council for Cultural Relations Award (ICCR)

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

A.6.8) Institute Staff of IIT Bombay (IS)

This category is for the persons employed as Institute Staff at IIT Bombay.

- (i) The candidate should have been employed as Institute Staff for at least 2-years (before the starting of the semester in which admission is sought).
- (ii) The concerned academic unit will shortlist the eligible candidates. Admission will be on the basis of written test and interview as applicable to the concerned programme.
- (iii) If selected, the permanency or otherwise of the candidate will not come in the way of admission process.
- (iv) If an employee admitted under this category is not serving as Institute Staff while pursuing the degree, then he/she cannot continue under the IS category but may be considered under the SF category.

- (v) The shortlisted candidates should produce a letter of recommendation from the Head of the Department at the time of interview.

A.6.9) Project Staff (PS)

This category refers to candidates employed at IIT Bombay and working on sponsored projects undertaken by the Institute and admitted to the Ph.D. programme, if the duration of the Project at the time of admission is 3 years or more.

In addition to meeting the eligibility criteria for admission, the candidates should have 6 months of service (before the starting of the semester in which admission is sought) in sponsored projects at the Institute. In case of students with B.Tech./M.Sc. or equivalent degree and without GATE score, the six month project experience may be counted as part of two-year professional work experience.

The shortlisted candidates should produce a letter of recommendation from the Principal Investigator of the sponsored project at the time of interview.

A.6.10) Research Assistantship (RA)

Depending upon the requirements, each Academic Unit may induct ONE Research Assistant every year. The candidates under this category are eligible for Research Assistantship based on the following norms :

- i. For students with M.Tech./M.E. or equivalent degree as the qualifying degree, the assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. At present, the monthly rate of assistantship is Rs. 28,000/- for the first two years and enhanced rate of Rs. 31,500/- for the remaining period.
- ii. For students with B.Tech./B.E./ or equivalent degree and students with M.Sc. / M.A. / M.Com. or equivalent as the qualifying degree and having valid GATE score or having Junior Research fellowship (JRF) of UGC / CSIR / NBHM / DBT or DST INSPIRE fellowship, the assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. At present, the monthly rate of assistantship is Rs.28,000/- for the first two years and enhanced rate of Rs. 31,500/- for the remaining period.
- iii. Students in SJMSOM with M.B.A. as the qualifying degree and with B.Tech./B.E. or equivalent degree, the assistantship is same as in (i) above. For other students the amount is as in (ii) above.
- iv. Ph.D. Research Assistants have to look after the laboratories and also assist in teaching or research or other work assigned by the respective Academic Unit. They are required to work for about 20 hours a week.
- v. The continuation of the assistantship will be subject to satisfactory performance of the duties assigned by the Academic Units as well as satisfactory academic performance.
- vi. Employees on the rolls (with or without pay) of any organization are not eligible for admission under this category.

A.6.11) Research Assistantship Through Project (RAP)

The candidates under this category will be considered for Assistantships supported under Sponsored Research Project being carried out at the Institute. The admission eligibility criteria are the same as for TA. Only some disciplines have RAP seats. The candidates do not have to indicate their preference for RAP separately.

A.6.12) External (EX)

The candidates employed in recognized R&D organizations and desirous of pursuing Ph.D. programme while in employment may apply for admission as external candidates. After fulfilling the residential requirement and completing the course work at the Institute, these candidates will be allowed to register for Ph.D. with a Supervisor (internal) from the Institute and a Co-supervisor (external) from their parent organization where they will be doing the research work. The admissions are based on the following norms:

- i. The competence of these candidates will be assessed along with the regular candidates.
- ii. The candidate should submit at the time of test/interview a Sponsorship Certificate (**Appendix C.4**) from the organization in which he / she is employed giving an undertaking that the candidate would be released from the normal duties to fulfill the residential requirement for the coursework (and qualifier examination, if applicable). The certificate should also provide details of facilities relevant to the research programme and available to the candidate.
- iii. The candidate is required to be at the Institute as a full-time student for the coursework (and qualifier examination, if applicable) of his/her Ph.D. Programme. The minimum residence requirement is one semester for students with M.Tech./M.E. or equivalent degree and two semesters for students with B.Tech./B.E./M.Sc. or equivalent degree. Depending on the student's background and the programme requirements, an additional semester may be needed to complete the coursework/qualifier examination.
- iv. To promote interaction between the internal supervisor and external co-supervisor, meeting between them should be arranged at least once in a year in the Institute or in the sponsoring organization.
- v. 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).
- vi. The option of external registration is for applicants who are working in well-equipped scientific institutions, laboratories, R&D establishments and industrial organizations engaged in research based activities. Persons working in colleges/universities are not eligible under this category (they may apply under CT).
- vii. At the time of joining the programme, the students 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 course work and other academic work at IIT Bombay.

A.6.13) College Teacher (CT)

The candidates employed as faculty members in Colleges and Universities and desirous of perusing Ph.D. Programme while in employment and without availing of study leave may apply for admission under this Category.

- i. After fulfilling the residential requirement (for studying at the Institute as a full-time student) of one semester for M.Tech./M.E. or equivalent and two semesters for B.Tech./B.E./M.Sc. or equivalent, these candidates will be allowed to register for Ph.D. with a Supervisor (internal) from the Institute and a Co-supervisor (external) from their parent organization. Appointment of external co-supervisor is optional based on recommendations of the supervisor and respective DPGC. Sponsorship certificate from the employer (**Appendix C.5**) must be submitted along with the application.
- ii. Candidates admitted under this category will be treated on par with SF category as far as payment of fees and deposits are concerned.
- iii. Place for research will be treated as IIT Bombay even though candidate may be carrying out part of the work at their Institute. These candidates are required to be available with the Supervisor (internal) for interaction during weekends, 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. Merely satisfying the general eligibility criterion as well as criterion set for each admission category is no guarantee for being called for test/interview. Depending on the number of applications

received and considering the constraints of time and other resources for conducting Written Test and Interview, the Academic Units may put additional academic performance based shortlisting criterion.

Candidates called for the written Test/Interview under Teaching Assistantship (TA) category will be paid single second class return railway fare by the shortest route (as per rules) from their place of residence to the Institute. They have to produce evidence (Original/Photocopy of Railway Ticket) in support of their claim. A candidate called for more than one discipline, can submit only one claim.

A.8) PAYMENT OF FEES AND DEPOSITS

Various fees and deposits for the programme are given in **Appendix C.1**.

A.9) 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) 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.10) CONFIRMATION OF REGISTRATION

All Ph.D. Admissions are provisional until the “Confirmation of Registration” is completed. This confirmation takes place after six months to a year after admission, and only if academic performance criterion set by the department is met. Some academic units (departments / interdisciplinary groups / centres / schools) prescribe a qualifier examination for the Ph.D. Programme. These must be completed successfully prior to confirmation of registration. Failure to meet satisfactory performance criterion may lead to termination of studentship.

Ref.: Rules & Regulations for Ph.D. Programme, <http://www.iitb.ac.in/academic/home/rules.jsp>

A.11) 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 student's eligibility for award of the degree of Doctor of Philosophy.

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

In addition to the eligibility requirements as given in A.5, the candidate should also fulfill the requirements for admission in the disciplines and specialisations of their choice.

B.1) AEROSPACE ENGINEERING (AE) [Department of Aerospace Engineering]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- (i) M.Tech./M.E. or equivalent degree in Aerospace Engineering OR in other branches of engineering relevant to the research areas in the department.
- (ii) B.Tech./B.E. or equivalent degree in Aerospace Engineering OR in other branches of engineering relevant to the research areas in the department,
OR
M.Sc. or equivalent degree in Mathematics OR Physics OR in other specializations relevant to the research areas in the department.

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

RESEARCH AREAS

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, Plasma assisted flow control, Thermoacoustics, Morphing Aircraft, Unmanned Aerial Vehicles, and Lighter-Than-Air systems.

II. Dynamics and Control of Aerospace Vehicles: Flight mechanics, Guidance, navigation, tracking and control of launch vehicles, missiles, aircraft, mini aerial vehicles (MAV), integrated navigation systems, Hardware-In-Loop-Simulation, Cooperative 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, Infrared 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, Plasma assisted combustion and flow control, Thermoacoustics, Non-Equilibrium, Thermodynamics of Dissipative Structures.

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) **[Department of Biosciences and Bioengineering]**

The Department of Biosciences and Bioengineering comprises of Biosciences (BS) and Biomedical Engineering (BME) as core academic groups. Eligibility criterion and research areas for the two groups are mentioned below. Under the item No.10(b) of Application Form, the candidate should enter the groups (BS, BME) they wish to join in the order of priority.

B.2.1. Biosciences (BS)

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech. or equivalent degree in Biotechnology.
- ii. M.Sc. or equivalent degree in subjects related to Life Sciences / Physics / Chemistry OR B.Tech. in Biotechnology with one of the following:
 - a) a valid GATE score (for TA/TAP/RA/RAP)
 - b) a valid CSIR/UGC/DBT JRF or a valid ICMR JRF not linked to ICMR project (for FA)
 - d) Experience as specified earlier in A.5 and A.6 (for CT, EX, IS, PS, SF, SW)

RESEARCH AREAS

(A) Biophysics and Computational Biology: Bioinformatics, Glycobiology, Computational Biology, Protein crystallography, NMR based structural Biology, Physics of Biological system and Computational Modeling of bio-molecules, Dynamics of cytoskeletal filaments and Chromatin remodelling, physical properties of the extracellular matrix, protein folding/mis-folding, aggregation and neuro-degeneration.

(B) Biochemistry: Enzyme kinetics and enzyme secretion, microbial metabolism and regulation, aromatic hydrocarbon metabolism and genetic engineering, enzyme inhibitor design, molecular mechanisms of DNA replication, repair and packaging in double-stranded DNA viruses, Molecular Enzymology.

(C) Microbial Biology: Fungi, Viral assemblies, Bacterial Pathogenesis, Host-Pathogen Interactions, molecular parasitology.

(D) Cell Biology: Cellular Biophysics, micro-tubule dynamics, bacterial cell division, Chromosomal and extra chromosomal segregation in fungi, Neurobiology.

(E) Immunology: Molecular immunology and cell signaling, Cellular Immunity, Tumor Immunology, Cancer biomarker.

(F) Genetics and Molecular Biology: Functional Genomics, Epigenetic Regulation, Fungal Molecular Genetics.

(G) Proteomics, System Biology and Biomarkers of infectious diseases.

B.2.2 Biomedical Engineering (BME)

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Biomedical Engineering, Chemical Engineering, Computer Science & Engineering, Electrical Engineering, Electronics/Telecommunications Engineering, Instrumentation Engineering, Mechanical Engineering and Engineering Physics.

OR

MBBS with MD/MS, BVSc with MVSc, BDS with MDS, BPTTh with MPTh, BOTTh with MOTTh.

OR

M.Pharm.

ii. B.Tech./B.E. or equivalent degree in Biomedical Engineering, Chemical Engineering, Computer Science & Engineering, Electrical Engineering, Electronics/Telecommunications Engineering, Instrumentation Engineering, Mechanical Engineering and Engineering Physics.

OR

M.Sc. or equivalent degree in Biochemistry, Biophysics, Biotechnology, Ceramics, Chemistry, Electronics, Ergonomics, Material Science, Mathematics, Molecular Biology, Physics and Physiology.

OR

MBBS/BDS/BPTh/BOTH/BVSc (4-year degree) or equivalent degree in appropriate branch.

OR

B.Pharm. (with entrance examination)

Applicants with qualifying degrees listed in (ii) above and seeking admission under TA/TAP/RA/RAP should have valid scores of GATE (for Engineering and Science graduates) or GPAT (for Pharmacy graduates) or AIIMS / MCI / JIPMER / PGI-Chandigarh / AFMC-Pune postgraduate entrance examinations (for medical graduates). For admission under FA category, the candidate should have a valid CSIR/UGC/DBT JRF or a valid ICMR JRF (not linked to ICMR project).

RESEARCH AREAS

- **Sensors and Devices:** Bioinstrumentation for diagnostics and therapeutics, early detection of carcinoma and tropical diseases, bioMEMS devices, Fluorescent Biosensors, Nanoengineered Sensors, Layer-by-Layer Self-Assembly, Microfluidics for biomedical applications.
- **Biomaterials, Drug delivery and tissue engineering:** Nano-biotechnology, Design of scaffolds for tissue engineering, Controlled Release technologies, Neuroprosthetic devices including aids for the handicapped, Signal processing, Telemedicine and knowledge based systems. Microfabrication for immunotherapy.
- **Computational physiology:** Cardiac electrophysiology and muscle mechanics, Computational Neurophysiology.
- **Movement Neuroscience, Rehabilitation technology**
- **Medical Optics – Optical tomography, Blood flow measurements, Computational Imaging**

B.3) CHEMICAL ENGINEERING (CH) [Department of Chemical Engineering]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Chemical Engineering OR in other branches of engineering with an academic background relevant with the research areas in the department.
- ii. B.Tech./B.E. or equivalent degree in Chemical Engineering OR in other branches of engineering with an academic background relevant with the research areas in the department.

OR

M.Sc. or equivalent degree in disciplines consistent with the research areas of the department.

Candidates applying to the Department of Chemical Engineering, please visit the following link for information : <http://www.che.iitb.ac.in/online/education/phd/phd-admission-information>.

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)

[Department of Chemistry]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

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

Candidates having CSIR/UGS (LS) (Lecturership) only are not eligible for admission to Ph.D. Programme in Chemistry.

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

- Biophysical Chemistry
- Coordination Chemistry
- Bio-inorganic Chemistry
- Organometallic Chemistry
- Bio-organic Chemistry
- Chemistry of Natural Products
- Synthetic Organic Chemistry
- Photochemistry and Spectroscopy
- Polymer Chemistry
- Thermodynamics
- Electrochemistry
- Solid state Chemistry and Physics
- Catalysis
- Theoretical Chemistry

B.5) CIVIL ENGINEERING (CE) [Department of Civil Engineering]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Civil Engineering OR in disciplines consistent with the research areas of the department
- ii. B.Tech./B.E. or equivalent degree in Civil Engineering OR in disciplines consistent with the research areas of the department

OR

M.Sc. or equivalent degree in disciplines consistent with the research areas of the department.

RESEARCH AREAS

i. Transportation Systems Engineering: Transportation Planning: Sustainable urban transportation planning, Travel survey design and analysis, Travel demand modelling, Travel behaviour and choice modelling, Transport system analysis and economic evaluation, Land use and transport planning models, Air travel demand modelling, Freight transport modelling, public transport planning and design, and Transport network modelling. Traffic Engineering: Traffic flow theory and capacity analysis, Traffic management, operations and control, Pedestrian flow modelling, Intelligent Transportation Systems, and traffic impact assessment and externalities. Highway Planning and Design: Optimal alignment design, Performance based geometric design, Road safety. Pavement Engineering: Characterization and performance tests of pavement materials, Recycled and warm mix asphalt mixes, Asphalt rheology, Constitutive modelling of pavement materials, Pavement maintenance, rehabilitation and management systems, and design and performance evaluation of concrete pavements.

ii. Geotechnical Engineering: Geotechnical earthquake engineering; Geoenvironmental engineering; Energy geotechnics; Computational geomechanics; Foundation engineering; Seismic hazard study; Liquefaction; Constitutive modelling of soil; Soil-structure interaction; Offshore geotechnical engineering; Pipeline geotechnics; Soil Characterization, Foundation for offshore structures, Bio-geo interface study; Earth dam problems; Rock Mechanics and tunnelling; Soil dynamics; Soil stabilization; Expansive soils; Earth retention structures; Slope stabilization; Ground improvement; Reinforced soil structures and geosynthetics; Physical modelling in geotechnics; Centrifuge modelling of geotechnical problems; Optimization techniques and environmental geotechnics; Landslides; GIS applications for geotechnical problems; Earthquake resistant design of geotechnical structures; Reliability analysis; Dynamic soil characterization; Landfills and waste containment engineering; Sea walls.

iii. Water Resources Engineering: a) *Experimental Fluid Mechanics and Computational Fluid Dynamics* - Fluid flow investigation by experimental and numerical studies, Turbulent flows, Sedimentation and erosion problems, Fluid transients in closed conduits, Pipe network analysis; b) *Groundwater Flow, Transport Process and Remediation*- Groundwater movement and recharge, Seawater intrusion in coastal aquifers, Transport of pollutant in aquifers and aquifer remediation; c) *Surface water Hydrology:* River and lake hydrodynamics, Contaminant transport process, River basin and watershed scale modelling of hydrologic processes, Hydraulic structures; d) *Floods and Droughts studies;* e) *Water Resource System and Optimization* - Reservoir operation and management; f) *Urban water management* - Urban water supply, Storm water and wastewater management, Water quality modelling; g) *Hydroinformatics* - GIS and remote sensing applications in water resources, Use of Artificial Intelligence Techniques; h) *Simulation- optimization for water resources environmental engineering problems;* i) *Climate change and Impact Studies* - Detection and attribution of hydrologic change; Modelling of hydroclimatic extremes, Hydrologic statistics

iv. Structural Engineering: Computational Mechanics; Finite element techniques; Composite materials and mechanics; Reinforced and prestressed concrete structures; Steel structures; Strength, stability and dynamics of thin membranes; Plates and shells; Structural optimization; Structural resilience, Structural response to blast, impact and shock loading; Pressure vessels; Reliability analysis; Seismic

vulnerability and fragility assessment of structures; Bridge engineering; Machine learning; Probabilistic design methods; Curved grid; Cable networks; Plastic analysis techniques; Structural dynamics; Earthquake engineering; Earthquake disaster management; Vibration control of structures; Wind effects on structures; Inverse problems and artificial intelligence applications; Offshore structures; Shell foundation; Structural health monitoring;

v. Ocean Engineering: (a) Physical modelling – wave-structure interactions, floating body dynamics, offshore and maritime infrastructures design, nearshore dynamics, nonlinear waves and sediment transport; (b) Numerical modelling – coastal processes, tidal hydrodynamics, pollutant dispersion in coastal waters, wave-current interactions, tsunamis, storms, surges and extreme events, sea level rise, climate change impacts on met-ocean parameters, oil spill dispersions, coastal erosion, shoreline changes; (c) Soft computing techniques – Application of statistical, stochastic and neural networks analysis on ocean parameters; (d) Remote Sensing and GIS – Application of RS and GIS for assessment of coastal vulnerability and nearshore processes.

vi. Remote Sensing: Development of methods and algorithms for digital analysis of Remotely Sensed Data (RSD); Remote Sensing, GIS and DTM in Hydrological Modelling; Decision Support Systems in Watershed Development; Remote sensing for Glacier Studies, Remote sensing data assimilation, Microwave remote sensing; Uncertainty modelling; Digital image processing; Fuzzy logic

vii. Construction Technology and Management: Building materials, Concrete technology; Construction management; Infrastructure project management.

B.6) CLIMATE STUDIES (CM)

[Interdisciplinary Group in Climate Studies]

The mission of the interdisciplinary programme (IDP) in Climate Studies is *to foster a fundamental understanding and problem-centered analysis of climate change science and solutions, from local to global scales*. The IDP in Climate Studies has over 20 faculty participants drawn from 12 departments, across IIT Bombay, with expertise in climate science, technology assessment and policy. The doctoral curriculum in the IDP in Climate Studies includes core courses in two broad tracks of climate science and climate policy, supplemented by elective courses on a broad range of theoretical and practical topics. A Centre of Excellence in Climate Studies supported by the Department of Science and Technology enables building long-term scientific capacity and systems (measurement systems, modelling platforms, assessment tools) for study of regional climate change and climate futures.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Criterion, in the qualifying degree:

i. M.Tech./M.E. or equivalent degree in Aerospace Engineering, Atmospheric Science, Chemical Engineering, Civil Engineering, Computer Science & Engineering, Electrical Engineering, Energy Science & Engineering, Environmental Science/ Engineering/Management, Mechanical Engineering, Resource Engineering.

OR

M.Des./M.Arch./M.Planning or equivalent degree

OR

M.Phil. (awarded by IIT Bombay) or equivalent degree in Social Sciences (Economics, Geography, Sociology, Planning etc.)

ii. M.A. or equivalent degree in Social Sciences (Economics, Geography, Sociology, Planning and similar)

OR

M.Sc. or equivalent degree in Atmospheric Science, Chemistry, Earth Science, Energy Science & Engineering, Environmental Science/Engineering/Management, Geophysics, Physics in valid GATE score or CSIR/UGC JRF

OR

B.E./B.Tech. or equivalent degree in Aerospace Engineering, Chemical Engineering, Civil Engineering, Computer Science & Engineering, Electrical Engineering, Environmental Science/ Engineering/ Management, Mechanical Engineering, with valid GATE score

OR

M.Mgt./MBA or equivalent degree.

WRITTEN TEST

Shortlisted candidates will be called for a written test and interview. The syllabus for the written test can be found on the website of the IDP at www.iitb.ac.in/climate/

RESEARCH AREAS

- 1. Climate change and impacts:** prediction of climate extremes, aerosol transport and radiative processes, factors affecting the Indian monsoon, cloud processes, impacts on hydrology, statistical approaches and scaling models.
 - 2. Technology assessment and mitigation:** competitiveness and sustainability, strategies for low-carbon development, economics of climate change, assessment of climate change policies and mechanisms, multi-criteria mitigation assessment.
 - 3. Vulnerability assessment and Adaptation:** climate sensitive sectors and poverty, natural disaster and human impacts, impacts on cities.
 - 4. Climate mitigation technologies:** enhanced carbon capture systems, photoactive materials.
-

B.7) COMPUTER SCIENCE AND ENGINEERING (CS) [Department of Computer Science and Engineering]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- M.Tech./M.E. or equivalent degree in Engineering/Technology
- B.Tech./B.E. or equivalent degree in Engineering/Technology

OR

M.Sc. or equivalent degree in Science or MCA

Such candidates have to fulfill one of the following additional requirements:

- Valid GATE score
- CSIR / UGC / NBHM / DBT award
- Minimum of 2 years of professional work experience

WRITTEN TEST

Shortlisted candidates will be called for written test and interview. The syllabus for written test can be found on the website of the department at www.cse.iitb.ac.in > Admissions > Ph.D.

WAIVER FOR WRITTEN TEST

Eligible candidates meeting one of the following criteria may apply for a waiver of the written test:

- 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.
- 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.
- 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 to <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.

INDUSTRY SPONSORED FELLOWSHIPS

Industry sponsored fellowships covering tuition fees, generous contingencies, and providing monthly stipends of approximately Rs.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:** Computer-aided 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; Wide area 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. **Real-Time 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. Re-engineering of software; systems analysis and design; MIS systems; Project management; Quality assurance.
-

B.8) DESIGN (ID)

[Industrial Design Centre (IDC)]

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.

The admission for Ph.D. will be held only once a year i.e. in Autumn Semester each year. No applications will be invited during Spring Semester.

ELIGIBILITY FOR ADMISSION

Qualifying degree and eligibility:

- i. M.Des. / M.Arch. / M.Tech. / M.Phil. (2-year degree) / MFA / Postgraduate Diploma in Design of NID, Ahmedabad and equivalent degree with First Class or 60% marks (55% marks of SC/ST) as specified in the General Eligibility Criterion.
- ii. B.Des. / B.Arch. / BFA / MA / M.Sc. / Undergraduate Diploma in Design of NID, Ahmedabad or equivalent degree with First Class or 60% marks (55% marks of SC/ST) as specified in the General Eligibility Criterion and with exceptionally outstanding design related work.

OR

MA or equivalent degree with 55% marks (50% marks of SC/ST) and with exceptionally outstanding design related work.

Such candidates should have valid CEED score. Candidates with a minimum three years of relevant professional experience without CEED score can also be considered, but will not be eligible for TA/TAP/RA/RAP

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.9) EARTH SCIENCES (ES)
[Department of Earth Sciences]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.Phil. (2-year degree) or equivalent degree in Geology, Geophysics or in any other related Geosciences field.
- ii. M.Sc. or equivalent degree in Geology, Geophysics, or in any other related Geosciences field.

OR

M.Sc. or equivalent degree in Physics, Chemistry, Mathematics, Oceanography, Life Sciences, Marine Sciences, Atmospheric Sciences or equivalent and having Geology / Physics /Mathematics/Chemistry at the Bachelors level as principal subjects.

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 modeling in Geophysics
 - Geophysical Signal Processing
-

B.10) EDUCATIONAL TECHNOLOGY (ET) **[Interdisciplinary Group in Educational Technology]**

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. 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.

The admission for Ph.D. will be held only once a year i.e. in Autumn Semester each year. No applications will be invited during Spring Semester.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in any branch of Engineering
OR
M.Des.
OR
M.Phil. (2-year degree) in Social Sciences
- ii. M.A./M.Sc./M.Phil.(1year)
OR
M.Ed. (with technology adoption and assessment studies)

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.
-

B.11) ELECTRICAL ENGINEERING (EE) **[Department of Electrical Engineering]**

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 |

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- M.Tech./M.E. or equivalent degree in Biomedical Engineering, Computer Science, Computer Science and Engineering, Electrical Engineering, Electronics/Telecommunications Engineering, Instrumentation Engineering, Engineering Physics, Materials Science and Engineering.
- B.Tech./B.E. or equivalent degree in Biomedical Engineering, Computer Science, Computer Science and Engineering, Electrical Engineering, Electronics/Telecommunications Engineering, Instrumentation Engineering, Engineering Physics, Materials Science and Engineering.

OR

M.Sc. or equivalent degree in Mathematics, Physics, Electronics / Electronic Sciences.

RESEARCH AREAS

Communication Engineering (EE1)

- 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 (EE2)

- 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 (EE3)

- 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 (EE4)

- 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 (EE5)

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

B.12) ENERGY SCIENCE AND ENGINEERING (EN)

[Department of Energy Science & Engineering]

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), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Aeronautical/Aerospace Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Energy Science & Engineering, Mechanical Engineering, Metallurgical Engineering or equivalent disciplines relevant to energy.
 - ii. B.Tech./B.E. or equivalent degree in Aeronautical/Aerospace Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Energy Science & Engineering, Mechanical Engineering, Metallurgical Engineering or equivalent disciplines relevant to energy.
- OR
- M.Sc. or equivalent degree in Chemistry, Physics, Mathematics or equivalent disciplines relevant to energy.

RESEARCH AREAS

- **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.

B.13) ENVIRONMENTAL SCIENCE AND ENGINEERING (EV)

[Centre for Environmental Science & Engineering CESE]

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. For further details, visit www.cese.iitb.ac.in

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Aeronautical/Aerospace Engineering, Agricultural Engineering, Atmospheric Science, Chemical Engineering, Civil Engineering, Energy Science & Engineering, Biotechnology, Environmental Science & Engineering, Mechanical Engineering, Metallurgical Engineering & Materials Science, Mining Engineering.
- ii. B.Tech./B.E. or equivalent degree in Aeronautical/Aerospace Engineering, Agricultural Engineering, Atmospheric Science, Chemical Engineering, Civil Engineering, Energy Science & Engineering, Biotechnology, Environmental Science & Engineering, Mechanical Engineering, Metallurgical Engineering & Materials Science, Mining Engineering.

OR

M.Sc. or equivalent degree in Atmospheric Science, Biochemistry, Biotechnology, Chemistry, Earth Sciences, Environmental Toxicology, Environmental Science, Meteorology, Microbiology, Physics, Public Health & Statistics. Mathematics at 10+2 level is a mandatory requirement.

RESEARCH AREAS

The major focus areas of research at CESE are: Water Supply; Water & Wastewater Treatment, Tertiary treatment options, Urban and Industrial Solid Waste Management, Environmental Management; and Environmental Systems Modelling & Optimization, GIS for Environment, Industrial Effluent and Sludge Management Nanotechnology, Air pollution monitoring of indoor and outdoor environments, Aerosol and air quality, Health impact of air pollutants, Carbon dioxide sequestration methods, Detection of pathogenic microbes in drinking water, Evaluation of disinfection processes and by-products, Detection of trace and emerging contaminants in treated water and wastewater, Chemical and biological processes for the removal of trace and emerging contaminants from water

List of current research topics:

- Advanced oxidation processes for the removal of persistent organic and inorganic compounds from industrial wastewaters
- Reductive remediation of organic pollutants such as chlorinated pesticides, textile dyes using zero-valent metals and bimetallic systems
- (N & P) removal from wastewater using a combination of physico-chemical and biological process,
- Development of technologies for arsenic removal from water
- Treatment of leachate (generated from municipal solid waste landfill) using physico-chemical processes
- Application of natural coagulants for water and wastewater treatment
- Treatment of textile wastewater by biological and physicochemical processes
- Eco-centric and low-cost wastewater treatment systems
- Fate and transport of pollutants in aquatic and subsurface systems
- Biotransformation and biodegradation of oily sludge and toxicity evaluation
- Biodegradation of endocrine disrupting chemicals such as lower and higher phthalate esters and chlorinated pesticides,
- Bacterial cellulose: An alternative greener approach for the production of cellulose
- Application of biochemical processes (enzyme catalyzed processes) for cleaner production technologies
- Hazardous waste minimization and pollution prevention
- Biomonitoring and microbial bioassays for toxicity testing
- Detection and monitoring of bacteria and viruses in potable water
- Mechanical biological treatment of municipal solid waste (MSW)
- Energy recovery from solid recovered fuel (derived from MSW) and sludge generated from sewage treatment plants and industries
- Hazardous, municipal & biomedical waste management
- Air pollution dispersion modelling

- Air quality monitoring and management,
- Indoor and integrated air pollution exposure assessment
- Aerosol and air quality
- Environmental health assessment
- Environmental noise assessment
- Health impacts of air pollutants
- Hot gas clean-up (thermal gasification)
- Satellite remote sensing for air quality
- Nano-powder synthesis, Nanotechnology for the treatment of wastewater and disinfection processes
- Environmental statistics and design of experiments
- Environmental Impact assessment of construction activities and industrial activities
- Eco-industrial networking
- Environmental policy and preventive environmental management
- Environmental and Water Resources Systems: development of optimization models for surface water quality management, irrigation water management, floodplain planning and management, landfill leachate contamination risk assessment, optimal design of water & wastewater conveyance systems, design & evaluation of water quality monitoring network
- Uncertainty Modeling and Decision Science for Environmental Systems: probabilistic, fuzzy and interval approaches; multi-attribute decision making Hydro-climatic Extremes and Flood Management: multivariate flood and drought frequency analyses
- Non-stationary modeling of hydro-climatic extremes, mapping vulnerability to natural and human-induced hazards using GIS, flood risk mapping, near-real-time flood forecasting,
- Environmetrics: multivariate statistical surface water quality assessment, evaluation of trophic states, rationalization of water quality monitoring stations.

B.14) GEOINFORMATICS & NATURAL RESOURCES ENGINEERING (GNR) [Centre of Studies in Resources Engineering (CSRE)]

Geoinformatics & Natural Resources Engineering is an interdisciplinary area encompassing diverse issues in exploration and management of natural resources such as land, water, mineral, forest, soil and ocean resources; socioeconomic 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. Researchers in this area 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), as specified in the General Eligibility Criterion, in the qualifying degree:

- M.Tech./M.E. or equivalent degree in Agricultural Engineering, Civil Engineering, Environmental Science & Engineering, Mining Engineering, Electrical Engineering, Electronics/Telecommunication Engineering, Computer Science & Engineering, Information Technology, Remote Sensing, Geoinformatics, Geomatics, Architecture and Town Planning.
- B.Tech./B.E. or equivalent degree in Agricultural Engineering, Civil Engineering, Environmental Science & Engineering, Mining Engineering, Electrical Engineering, Electronics/Telecommunication Engineering, Computer Science & Engineering, Information Technology, Remote Sensing, Geoinformatics, Geomatics, Architecture and Town Planning.

OR

M.Sc. or equivalent degree in Earth Sciences, Environmental Science, Geology, Geophysics, Marine Sciences, Agriculture, Physics, Mathematics, Computer Science, Information Technology (Mathematics at 10+2 level is a mandatory requirement).

WRITTEN TEST

A pre-interview written test will be conducted for screening. The written test will consist of questions related to the selected PhD topic. Shortlisted candidates after the written test will be interviewed.

The interested applicants are advised to visit CSRE webpage www.csre.iitb.ac.in/PHDtopics.html, for a detailed and updated list of topics/ RESEARCH AREAS.

RESEARCH AREAS

a. Application Areas

- i. Water Resources
- ii. Terrain Evaluation, Landuse Planning and Monitoring
- iii. Agroinformatics 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
- vii. Marine Resources and Ecology.
- viii. Snow, Glaciers and Atmosphere
- ix. Applications of Microwave Remote Sensing
- x. Internet of Things for Agriculture

b. Theoretical Areas

- i. Digital Image Processing and Alaysis
- ii. Digital Photogrammetry and Cartography
- iii. Geographic Information Science, Geospatial Data Mining, Big Data, High Performance Computing, Internet of Things
- iv. Synthetic Aperture Radar Information Analysis and Polarimetry
- v. Global Positioning Systems

B.15) HUMANITIES AND SOCIAL SCIENCES (HSS) [Department of Humanities and Social Sciences]

ELIGIBILITY FOR ADMISSION

Qualifying degree and eligibility:

- i. M.Phil. (awarded by IIT Bombay or equivalent 2-year degree) in any of the disciplines pertaining to the research areas in the Department, with First Class or 60% marks (55% marks for SC/ST) as specified in the General Eligibility Criterion.
- ii. M.A. or equivalent degree in Humanities & Social Sciences subjects, with 55% marks (50% for SC/ST).

OR

Master's degree in Commerce with 55% marks (50% for SC/ST).

OR

M.Sc. or equivalent degree in Science, with First Class or 60% marks (55% marks for SC/ST) as specified in the General Eligibility Criterion.

OR

B.Tech./B.E. or equivalent degree in Engineering/Technology, with First Class or 60% marks (55% marks for SC/ST) as specified in the General Eligibility Criterion.

Candidates with degrees in Science, Commerce, Engineering/Technology will be considered for research areas consistent with their academic background.

Candidates having UGC-NET Lectureship (LS) are also eligible for Teaching Assistantship in addition to other academic qualifications.

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.

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.16) INDUSTRIAL ENGINEERING AND OPERATIONS RESEARCH (IO)

[Interdisciplinary Group in Industrial Engineering & Operations Research]

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 longstanding principles of industrial engineering. The programme is unique in its contemporary flavor, with specialized courses in Integer Programming, Game Theory, Markov Decision Processes, Analysis and Control of Queues, 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), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in any branch of Engineering with adequate exposure to Industrial Engineering & Operations Research
- ii. B.Tech./B.E. or equivalent degree in any branch of Engineering
OR
M.Sc. or equivalent degree in Mathematics, Statistics, Operations Research

RESEARCH AREAS

- i. Optimization: Models, Theory and Algorithms:** Large-scale linear optimization; Mixed-integer, integer and conic programming; Combinatorial optimization; Polyhedral theory; Nonlinear optimization; Dynamic programming; Theory, Algorithms and Computational methods for Mixed-Integer Linear and Nonlinear Optimization.
- ii. Stochastic Models:** Queuing Theory; Queuing models; Resource sharing; Parameter optimization; Performance Analysis; Polling systems; Applications in wireless communication.
- iii. Stochastic Control:** Stochastic dynamic programming (MDPs); Sensitivity analysis; Reinforcement learning; Diffusion equations; Viscosity solutions; Optimal control; Stochastic Approximation.
- iv. Simulation Modeling and Analysis:** Discrete-event simulation; System dynamics methodology; Hybrid (discrete-continuous) modeling; Distributed and parallel simulations; Statistical data analysis; Simulation-optimization; Multilevel Monte Carlo methods.
- v. Game Theory:** Mechanism design; Dynamic and stochastic games; Deterministic and stochastic differential games; Games with stopping; Approximate equilibria; Auctions.
- vi. Artificial intelligence based methods:** Search methods; Metaheuristics; Neural networks; Model predictive control; Reinforcement learning.
- 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.17) MANAGEMENT (MG)

[Shailesh J. Mehta School of Management]

ELIGIBILITY FOR ADMISSION

At least one of the following criteria must be met :

- (i) B.E./B.Tech. or equivalent degree with 60% marks / 6.5 CPI (55% marks / 6.00 CPI for SC/ST) and at least two years of work experience and qualified in GATE/UGC- NET(Lectureship)/UGC-JRF/CSIR-NET (Lectureship)/CSIR-JRF or having CAT/GMAT/GRE score within the last five years.

- (ii) Master of Management /ME/M.Tech./M.Phil./ 2 years MBA or 2 years PG Diploma in Management from any institute recognized by Government body (AICTE/UGC/AIU) with 60% marks/6.5 CPI (55% marks / 6.0 CPI for SC/ST).
- (iii) M.Sc. / M.A. / M.Com. / LLM / MCA or equivalent degree with 60% marks / 6.5 CPI (55% marks / 6.0 CPI for SC/ST) at post graduation level and qualified in GATE/UGC– NET(Lectureship)/UGC-JRF/CSIR-NET (Lectureship)/CSIR-JRF or having CAT/GMAT/GRE taken within the last five years.
- (iv) CA with 60% marks / 6.5 CPI (55% marks / 6.0 CPI for SC/ST) in the preceding degree.

RESEARCH AREAS

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

B.18) MATHEMATICS (MA)

[Department of Mathematics]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

M.Sc. / M.A. or equivalent degree in Mathematics / Statistics / Computer Science

OR

M.Stat. or equivalent degree

OR

B.Tech./B.E. or equivalent degree in Engineering/Technology

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.19) MECHANICAL ENGINEERING (ME) [Department of Mechanical Engineering]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC / ST), as specified in the General Eligibility Criterion for admission in this brochure in :

i. M.Tech./M.E. or equivalent degree in Mechanical Engineering, Production Engineering, Industrial Engineering, Aerospace Engineering, Chemical Engineering, Metallurgical Engineering

OR

M.Tech./M.E. or equivalent degree in other branches of Engineering / Technology with an outstanding academic record for research areas consistent with the academic background of the candidates.

ii. B.Tech./B.E. or equivalent degree in Mechanical Engineering, Production Engineering, Industrial Engineering, Aerospace Engineering, Chemical Engineering, Metallurgical Engineering

OR

B.Tech./B.E. or equivalent degree in other branches of Engineering / Technology with an outstanding academic record for research areas consistent with the academic background of the candidates. .

RESEARCH AREAS

i. **Heat Transfer and Thermodynamics:** Convective and radioactive heat transfer, Thermal Insulation, Transport properties, Combustion, Solar energy, Boiling, Condensation, Nanofluids.

ii **Fluid Mechanics:** Computational Fluid Dynamics, Turbulent flows, Compressible Flows, Microflows, Rarefied Gas Dynamics, High Performance Computing, Geophysical Fluid Dynamics, Fluid-structure interaction, Surface tension driven flows, Laser based experimental techniques.

iii. **Refrigeration and Air-conditioning:** Refrigeration systems, A.C. systems, Cryogenics, Miniature Cryorefrigerators, Absorption systems, Food preservation, Liquefaction systems.

iv. **Internal Combustion Engineering:** Fuel injection problems, Performance studies on petrol and diesel engines, Alternate fuels, Emission studies.

v. **Thermal Power Engineering:** Power plant analysis and design, Nuclear engineering, Nuclear reactor heat transfer, Reactor physics problems, Isotope applications and nuclear techniques.

vi. **Fluid Power:** Fluid mechanics, Fluid Machinery, Fluid power control, Microfluidics.

- vii. Combustion and Flames:** Laminar and turbulent flame propagation, Flame stabilization, numerical study of reactive flows, turbulence and combustion modelling, Studies with vitiation of combustion air, Combustion in closed vessels, Fluidised bed combustion.
- viii. Combustion and Emissions in Gas Turbine:** Fuel injection problems, Performance studies, Alternate fuels, Emission studies, combustion chamber design, stability limits.
- ix. 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.
- x. Computer Aided Design:** Simulation optimization, Interactive graphics.
- xi. Stress Analysis:** Photoelasticity, Analytical methods based on complex variables, Numerical methods – Finite element and boundary element methods, etc.
- xii. 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.
- xiii. 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.
- xiv. 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.
- xv. Design Engineering:** Gears, Pressure vessel design, Tribology and lubrication, Machinery maintenance, Optimization, CAD, Textile Machinery.
- xvi. CAD / CAM / CIM, CNC, Computer Assisted Process Planning, Design for Manufacturing and Assembly, Manufacturing Automation & Control, Intelligent Manufacturing Systems, Rapid Prototyping and Tooling.**
- xvii. Design, Optimization and Modelling of Manufacturing Processes (Casting, Forming, Machining, and Welding), Precision and Micro-Manufacturing Processes, Computer Aided Tool Design.**
- xviii. Applications of IE & OR in Manufacturing, Logistics, Quality and Maintenance Systems.**
- xix. MEMS, Nanotechnology, Miniaturization, Smart structure.**
- xx. Computer Aided Engineering (CAE), Numerical Modeling and Experimental Studies on Manufacturing Processes (Casting, Bulk and Sheet Metal Forming processes, Thermal and athermal Welding/joining process, Powder Metallurgy, Metal Injection Moulding, Conventional & Non-Conventional Machinery processes).**
- xxi. Precision and micromanufacturing**
- xxii. Tool design and Development.**
-

B.20) METALLURGICAL ENGINEERING AND MATERIALS SCIENCE (MM)

[Department of Metallurgical Engineering and Materials Science]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Polymers Science/Technology, Aerospace Engineering, Corrosion Science & Engineering, Ceramic Engineering, Chemical Engineering, Electrical Engineering, Electronics Engineering, Electro-chemical Engineering, Mechanical Engineering, Production/Manufacturing Engineering, Metallurgical Engineering, Materials Engineering, Materials Science.
- ii. B.Tech./B.E. or equivalent degree in Polymers Science/Technology, Aerospace Engineering, Corrosion Science & Engineering, Ceramic Engineering, Chemical Engineering, Electrical Engineering, Electronics Engineering, Electro-chemical Engineering, Mechanical Engineering, Production/Manufacturing Engineering, Metallurgical Engineering, Materials Engineering, Materials Science.

OR

M.Sc. or equivalent degree in Chemistry, Materials Science, Physics (with Mathematics as a subject at B.Sc. degree level).

RESEARCH AREAS

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

- 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.21) NANOTECHNOLOGY AND SCIENCE (NT) **[Centre for Research in Nanotechnology & Science (CRNTS)]**

The importance of Nanotechnology research cannot be denied in the world of today. IIT Bombay, accordingly, has identified Nanosciences and Nanotechnology as a thrust areas that enables cutting edge research traversing the boundaries of established disciplines. The Centre for Research in Nanotechnology and Sciences was established to coordinate and consolidate such research happening in various academic and research units in the institute, as well as to foster the creation of new research areas. About fifty faculty from across most of the departments of the institute have active research interest in the domain of nanotechnology and sciences, and are associated with the Interdisciplinary programme in this area. The centre also has close interaction with the Centre of Excellence in Nanoelectronics established using funds from DeitY (Dept. Of electronics and information technology-GOI).

Realising the importance of cross disciplinary, multi-disciplinary and inter-disciplinary interactions in this domain, this programme requires the association of two research supervisors, preferably from two different academic entities (viz. department centres, institutes and universities), 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.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Electrical, Mechanical, Civil, Metallurgical, Materials, Chemical, Biomedical Engineering, Energy Science and Engineering and Environmental Science and Engineering
- ii. B.Tech./B.E. or equivalent degree in Electrical, Mechanical, Civil, Metallurgical, Materials, Chemical, Biomedical Engineering, Energy Science and Engineering and Environmental Science and Engineering

OR

M.Sc. or equivalent degree in Physics, Chemistry, Biological and Environmental Sciences

RESEARCH FACILITIES

Facilities for advanced characterization such as Field Emission Gun Transmission Electron Microscope (FEGTEM), Field Emission Gun Scanning Electron Microscope (FEGSEM) with EDS and WDS, CryoSEM, 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, Nanolithography and nanodeposition, FACS cell sorter, Dynamic Light Scattering (DLS) 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, etc., that aid in the area of research.

RESEARCH AREAS

Nanomaterials, Nanosensors, Nanoelectronics, Nanobiotechnology, Nanomanufacturing, Nanofluidics, and Computational research in nanosystems.

B.22) PHYSICS (PH)

[Department of Physics]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in Engineering Physics, Aerospace Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Metallurgical Engineering, Computer Science.
- ii. M.Sc. or equivalent degree in Physics / Chemistry / Mathematics

OR

B.Tech./B.E. or equivalent degree in Engineering Physics, Aerospace Engineering, Chemical Engineering, Civil Engineering, Electrical Engineering, Mechanical Engineering, Metallurgical Engineering, Computer Science.

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 Tc 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, Langmiur 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**

B.23) SYSTEMS AND CONTROL ENGINEERING (SC) **[Interdisciplinary Group in Systems & Control Engineering]**

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in any branch of Engineering
- ii. B.Tech./B.E. or equivalent degree in any branch of Engineering
OR
M.Sc. or equivalent degree in Mathematics or Physics

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.24) TECHNOLOGY & DEVELOPMENT (TD)

[Centre for Technology Alternatives for Rural Areas(CTARA)]

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in any branch of Engineering
- ii. B.Tech./B.E. or equivalent degree in any branch of Engineering
OR
M.Sc. or equivalent degree in any discipline.

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 desirable. 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
-

B.25) Urban Science & Engineering (US)

[Centre for Urban Science & Engineering (C-USE)]

The Centre for Urban Science and Engineering is an interdisciplinary centre for research, teaching and skilled manpower development with the primary mandate of creating innovative and holistic solutions to deliver urban services related to housing, infrastructure, energy, health and cultural enlightenment, while mitigating the effects of natural disasters and climate change. The centre will combine the latest advances in science and technology with sustainable, equitable and human-friendly design, to create new products and solutions that would ultimately lead to the betterment of life for the rapidly increasing urban population in the developing world.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree:

- i. M.Tech./M.E. or equivalent degree in any branch of Engineering
OR
Master's degree in Architecture, Urban Planning or related disciplines.
- ii. B.Tech./B.E. or equivalent degree in any branch of Engineering
OR
Bachelor's degree in Architecture, Urban Planning or related disciplines.

RESEARCH AREAS

Ph.D. students will be engaged in interdisciplinary research that will focus on urban challenges of megacities. They will work with faculty and researchers from various departments and centres at IIT Bombay in the following domains, including but not limited to :

- **Planning and Design:** Housing, Land use policies, Public Spaces, Risk Management

- **Policy and Governance:** Housing Economics, Health (Diagnostics, Awareness), Education Employment, Environment
 - **Infrastructure:** Transportation and Land use, Urban water, Waste Management, Smart Energy Buildings
 - **Informatics:** Citizen Science, Urban Knowledge Banks, Geo-Spatial Technologies
-

**Fees, Deposits & Hostel Rent for Ph.D. students
(subject to revision as per MHRD/BoG decision)**

Sr. No.	Particulars	Fee payable (Rs.)			
		TA/TAP, RA/ RAP, FA		PS, SW, EX, CT, SF	IS
		GN/OBC	SC/ST/PwD		
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	00	25000	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 Maintenance Fees*	00	00	00	00
	Total (B) .	19750	14750	39750	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) .	29076	24076	49076	7600

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

*Contribution to Hostel Subsidy is variable every year.

- External students who have completed the course work and joined the parent organization are required to pay Rs. 5126/- as continuation fee (Rs. 2176/- for SC/ST/PwD).

- 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.

Sponsorship Letter for Full-time Ph.D. Candidates (SW)
(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 Shri./ Smt./ Kum _____, employed in our organization as _____ (designation) for joining his / her Ph.D. Programme in _____ at your Institute as a full-time candidate.

He/ She is employee of our organization since _____. 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 his/ her studies in the Institute.

Signature and Seal of the Sponsoring Authority

=====

Employer's Letter for Ph.D. candidates joining on Study Leave (SF)
(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. _____, employed in this Institute as _____ (designation) on _____ (full-pay/ half-pay/ 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

=====

Sponsorship Certificate for Ph.D. External Registration (EX)

(To be typed on letterhead of the Sponsoring Organization)

Name of the sponsoring organization : _____

Address : _____

Present Designation of the applicant : _____

Present status of the applicant: _____

(Permanent/Quasi Permanent/Temporary)

Division where research work is proposed to be done: _____

Name of supervisor from the sponsoring organization: _____

(Bio-data of supervisor to be enclosed giving details of designation, qualification, research experience etc.)

Details of facilities relevant to the research problem which will be made available to the candidate by the organization.

Statement of proposed Co-supervisor (external)

If Shri / Kum. / Smt. _____ is registered for the doctorate degree, I agree to act as his/ her research Co-supervisor along with the research Supervisor from IIT Bombay.

Signature of proposed Co-supervisor (external)

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 be the Co-supervisor (external) of the Ph.D. thesis, along with a faculty member of IIT Bombay as the Supervisor.

Signature and Seal of the
Sponsoring Authority

=====

**No Objection Certificate from University for Ph.D. Applicant
under College Teacher Category (CT)**

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

Dear Sir,

This is to certify that Shri./Smt./Kum. _____ is an employee of our Institute since _____ and is currently serving as _____ (designation).

Our Institution has no objection to his/her application in the _____ (department) 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 proposed Co-supervisor (external), which is optional, to be enclosed giving details of designation, qualification, research experience, etc.]

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STATEMENT OF PURPOSE FOR ALL ACADEMIC UNITS

Statement of Purpose (SOP) is your opportunity to share with the admission committee your thoughts and feelings 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.

(i) If you are applying for more than one academic discipline, you may include separate SoP for each discipline.

(ii) If you are applying to **CTARA or CSRE**, you need to upload Statement of Purpose as well as research proposal. The SOP for CSRE should refer to one or more topics of interest FROM THE LIST of topics announced on CSRE webpage <http://www.csre.iitb.ac.in>.

(iii) 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 **research proposal (1500 words) on a topic of your interest in place of Statement of Purpose**. The proposal should contain a) problem identification, b) brief review of literature, and c) methodology.

(iv). Candidates applying to IDC are required to submit a SOP along with a 1500 word proposal that should specify (a) research area (b) brief review of literature and (c) methodology. The candidates have also to submit a recent work or paper related to their area of research.

1. Name:

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