INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

Information Brochure
Ph.D. Admissions
2023-24

CONTENTS

[Department of Metallurgical Engineering and Materials Science]

B.21) Nanotechnology & Science (NT)
[Centre for Research in Nanotechnology & Science (CRNTS)]

B.22) Physics (PH)
[Department of Physics]

B.23) Policy Studies [PS]
(Ashank Desai Centre for Policy Studies)

B.24) Systems & Control Engineering (SC)
[Interdisciplinary Group in Systems & Control Engineering]

B.25) Technology and Development (TD)
[Centre for Technology Alternatives for Rural Areas(CTARA)]

B.26) Urban Science & Engineering (US)
[Centre for Urban Science & Engineering (CUSE)]

B.27) Digital Health (DH)
[Koita Centre for Digital Health (KCDH)]

B.28) Machine Intelligence and Data Science (MInDS)
[Center for Machine Intelligence and Data Science (CMInDS)]

B.29) Economics
[Department of Economics]

C) APPENDICES

C.1) Sponsorship letter for full-time candidates
C.2) Employer's Letter in case of candidates joining Ph.D. programme on Study Leave
C.3) Sponsorship Certificate for External Registration
C.4) No Objection Certificate for College Teacher
C.5) Statement of Purpose for Ph.D. Application (SoP)

I. Important Guidelines for Ph.D. Application

1 Please read the instructions given in the brochure carefully before filling up the application form.

2 **Online** Application Form & Information Brochure (including the admission schedule along with the important dates) is available on the Institute website at the following link,
http://www.iitb.ac.in/newacadhome/phd.jsp

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.

3 The application fee is as follows,

Women candidates	: Rs. 150/-
SC/ST/PwD category candidates	: Rs. 150/-
All other candidates	: Rs. 300/-

The fee is to be paid by SBI Internet Banking/ Online Payment System and you do not have to submit the printed copy of the application. **Applications without online payment details will not be considered.**

APPLICATION FEE IS NON-REFUNDABLE.

4 You can apply for up to **THREE** disciplines/specialisations.

5 (i) Along with your application, you have to submit a Statement of Purpose or a Research Proposal as required by an academic unit.

(ii) If you are applying to the Ashank Desai Centre for Policy Studies (ADCPS) you need to specifically upload a research proposal (in place of a Statement of Purpose), along with the application form, that will be graded for admission purpose. The Research Proposal (in 2000 words or less excluding reference) for applying to the Ashank Desai Centre for Policy Studies, PhD programme must contain: (a) clear problem identification(see LIST of clearly identified topics announced on ADCPS webpage-must choose from this list only) (www.cps.iitb.ac.in/academics/doctoral-programme), (b) brief review of relevant literature (c) a clear proposed methodology, (d) recent reference.

(iii) If you are applying to Management (SJMSOM), you are required to submit research proposal (1500 words) on a topic of applicants' interest in place of Statement of Purpose. It should contain a) problem identification, b) brief review of literature, and c) methodology.

Applications without research proposal will not be considered**.**

(iv) If you are applying to Department of Humanities & Social Sciences, Policy Studies, CTARA or CSRE, you need to upload Statement of Purpose as well as a research proposal along with the application form. The Research Proposal for applying to Policy Studies, Technology & Development (CTARA) should contain (a) problem identification, (b) brief review of literature and (c) proposed methodology. The SOP for CSRE should refer to one or more topics of interest FROM THE LIST of topics announced on CSRE webpage https://www.csre.iitb.ac.in/phdTopics.php

(v). Candidates applying to IDC are required to submit a Statement of Purpose (SOP) along with a research proposal (~1500 words) that contains (a) the research area, (b) a brief review of the literature and (c) proposed methodology. The candidates must also submit a recent work or paper related to their area of research. A link to the design portfolio (drive folder/website/online documentation), if available, can be provided along with the SOP document.

(vi). Candidates applying to Educational Technology are required to submit a Statement of Purpose containing (a) your interests and motivation for applying to ET

(max. 50 words), (b) relevance of your recent and current activities (max. 200 words), (c) details about your academic interests including (but not limited to) your areas of interest, a problem that interests you, and what you plan on doing after completing your Ph.D. (max. 250 words).

6 You should complete the application form in all respects. Incomplete application will not be considered.

7 You **MUST** upload the following while submitting the Ph.D. Application.

- 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.
- **E**conomically Weaker Sections(EWS) candidates needs to submit EWS certificate issued by the Competent Authority in the prescribed format.
- PwD Certificate, if applicable.
- Sponsorship certificate, if applicable.
- (please upload Sponsorship Certificate, If not available then attach Self- Declarant letter stating that the sponsorship certificate will be given at the time of Interview/ Admission).
- 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 OBC candidates may note that the limit of annual income is Rs. 8 lakhs for determining the creamy layer among Other Backward Classes (OBCs) candidates.

The OBC-NC certificate issued for the financial year 2023-24 by the Competent Authority in the prescribed format must be uploaded in the ONLINE application form and submitted at the time of admission.

The OBC reservation update Information is available in the public domain http://www.iitb.ac.in/newacadhome/phd.jsp under OBC Reservation Update.

9 Economically Weaker Sections(EWS) candidates may note that the limit of annual income is Rs. 8 lakhs for determining the eligibility for benefit under Economically Weaker Sections(EWS) reservation.

The EWS certificate issued by the Competent Authority in the prescribed format must be uploaded in the ONLINE application form and submitted at the time of admission.

The EWS reservation update Information is available in the public domain http://www.iitb.ac.in/newacadhome/phd.jsp under EWS Reservation Update.

10 PwD candidates will be given extra time, as per GOI rules on request by the candidate. Such requests need to be addressed to Head of the concerned academic units through email/hard copy well in advance.

11 Seats are reserved for Economically Weaker Sections(EWS)/ Other Backward Class Non-Creamy Layer (OBC-NCL)/ Scheduled Caste (SC)/ Scheduled Tribe (ST) and Person with Benchmark Disability (PwD) Categories , as per Government of India rules.

12 You should check the Institute website for results / important announcements.

13 You should check emails sent to the email address provided in your application for all important communications and announcements.

14 Merely fulfilling eligibility criteria doesn't entitle a candidate to be called for the test and/or interview. Admission is based on GATE/Written test/Interview performance in addition to general eligibility criterion, the applicants must also satisfy the eligibility criteria

specified for the respective Departments / Centres / Schools / Interdisciplinary Groups.

15 Candidates, if called for written test/interview should show/ 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.

16 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/PwD) marks or equivalent in qualifying examination.

17 Read the Frequently Asked Questions (FAQ) given on Institute website http://www.iitb.ac.in/newacadhome/phd.jsp for more details.

18 Contact Details for - Ph.D. - phd_unit5@iitb.ac.in

19 Students must submit self-attested copies of his/her qualifying degree certificate & final transcripts on or before **31st August, 2023 (admitted in Autumn Semester)**, failing which admission will stand cancelled.

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

- as available on the webpage
https://www.iitb.ac.in/newacadhome/phd.jsp

(A) Important Dates: {AUTUMN SEMESTER}

(B) Important Dates: {SPRING SEMESTER}

No admission for spring semester 2023-24 for Ashank Desai Centre for Policy Studies , Educational Technology, Management,

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

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

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 at IIT Bombay on the Institute website https://www.iitb.ac.in/newacadhome/toadmission.jsp

The listing of all the Masters' programmes and Ph.D. programmes offered in various academic units are given below,

Programmes	Discipline [Academic Unit : Department, Centre, Interdisciplinary Group]
M.Tech./M.Tech. +Ph.D.(Dual Degree)	Aerospace Engineering, Biomedical Engineering, Chemical Engineering, Civil Engineering, Computer Science & Engineering, Earth Sciences, Electrical Engineering, Energy Systems Engineering, Environmental Science & Engineering, Geoinformatics and Natural Resources Engineering, Industrial Engineering & Operations Research, Mechanical Engineering, Metallurgical Engineering & Materials Science,Materials, Manufacturing and Modeling, Systems and Control Engineering, Technology and Development, Educational Technology, Urban Systems
M.Des.	Industrial Design Centre
MBA	Shailesh J. Mehta School of Management
MBA (Executive)	Shailesh J. Mehta School of Management
M.Sc.-Ph.D. (Dual Degree) in Energy	Energy Science and Engineering
MPP	Centre for Policy Studies
M.S. by Research	Computer Science & Engineering, Data Science and Artificial Intelligence
MA+Ph.D. (Dual Degree) in Philosophy	Humanities & Social Sciences
Master of Arts by Research (MA.Res.)	Humanities & Social Sciences
Master in Development Practice (MDP)	Centre for Technology Alternatives for Rural Areas
Ph.D.	Aerospace Engineering,Biosciences and Bioengineering, Chemical Engineering, Chemistry, Civil Engineering, Climate Studies, Computer Science and Engineering, Industrial Design Centre, Earth Sciences, Educational Technology, Electrical Engineering, Energy Science & Engineering, Environmental Science and Engineering, Economics,Geoinformatics and Natural Resources Engineering Humanities and Social Sciences, Industrial Engineering & Operations Research, Management, Mathematics, Mechanical Engineering, Metallurgical Engineering and Materials Science, Nanotechnology & Science, Physic, Policy Studies, Systems & Control Engineering,Technology and Development, Urban Science & Engineering, Digital Health,Machine Intelligence and Data Science,

The Institute on an average admits 1415 candidates for the Undergraduate programmes and 1717 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, which include Computer Centre, Central Library and Central Workshop. The Central Library has a very large collection of books, back volumes of periodicals, standards specifications and other literature in print and electronic format. The Library now holds more than 5 lakh books and bound volumes, 20,000 e-books, and subscriptions to more than 20,000 current journals in the domains of science, engineering, humanities and social sciences, management, and associated fields. More than 30 databases, including financial, bibliographical, and citation databases, are also subscribed by the Central Library. Additionally, the Central Library offers users access to use research-supporting technologies like grammarly, overleaf, Turnitin, Urkund plagiarism detection tools, and provides access to millions of electronic theses.

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

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

A.3) STUDENTS AMENITIES

The Institute is fully residential and has 18 hostels for students. Each hostel is an independent entity with its own mess facilities, recreation areas, etc. 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, Environmental Science and Engineering Department, Economics, 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:

Qualifying Degree:

1. Master's or equivalent degree in Engineering/Technology
2. Bachelor's degree in Engineering/Technology
3. Master's or equivalent degree in science
4. Master's or equivalent degree in Arts/Commerce (or allied subjects)

For qualifying degree listed under (2), (3) & (4), candidates must also fulfil ONE of the following additional requirements:

a) Valid GATE/CEED/ score

b) Selected through National Eligibility Test – UGC NET including lectureship (Assistant Professorship)

c) Selected through a National level examination conducted by MHRD or its agencies /Institutions such as UGC/ IIT/ IISc./ IISER/ IIIT etc.

(d) Selected provisionally for the DST-INSPIRE Fellowship (provisional award letter to be produced)

e) Minimum of TWO years of professional experience (acquired after obtaining the qualifying degree and completed before the starting of the semester in which admission is sought)

Marks / CGPA / CPI requirement in Qualifying Degrees (listed above):

For GN/EWS/OBC (NC) category

(a) a minimum of 60% marks in aggregate, OR
(b) a First Class as specified by the University, OR
(c) a minimum Cumulative Grade Point Average (CGPA) / Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10, OR
(d) an equivalent to 6.0 on other corresponding proportional requirements when the scales are other than 0-10.
(e) For master's or equivalent degree in Arts/Commerce (or allied subjects, a minimum of 55% marks

will be considered for admission to the Ph.D. programmes offered ONLY by Industrial Design Centre

and Department of Humanities & Social Sciences.

For SC/ST/PwD category

(f) a minimum of 55% marks in aggregate, OR

(g) a First Class as specified by the University, OR

(h) a minimum Cumulative Grade Point Average (CGPA) / Cumulative Performance Index (CPI) of

5.5 on the scale of 0-10, OR

(i) an equivalent to 5.5 on other corresponding proportional requirements when the scales are

other than 0-10.

(j) For master's or equivalent degree in Arts/Commerce (or allied \subjects, a minimum of 50% marks will be considered for admission to the Ph.D. programmes offered ONLY by Department of Humanities & Social Sciences.

A.5.2) All Bachelor's degree undergraduate course leading to a Bachelor's, Integrated Master's or Bachelor-Master Dual Degree in Engineering, Sciences or Architecture offered by IITs (admitted through JEE) having a CGPA/CPI score of 8.00 (on 10 scale) and above from an Indian Institute of Technology or any of the CFTIs is exempted from the requirement of a valid GATE score for the consideration of General Eligibility Requirement for admission.

In addition to general eligibility criterion, the applicants must also satisfy the eligibility criteria specified for the respective Departments / Centres / Schools / Interdisciplinary Groups.

Over and above the general eligibility criteria for admission, candidates need to satisfy additional criteria for financial support / fellowship, as specified under specific admission categories [Please refer section 6.0].

The final selection process to Ph.D. programme to any Departments / Centres / Schools / Interdisciplinary Groups at IIT Bombay will be through written test and/or interview as specified by individual Department / Centre / Schools / Interdisciplinary Groups.

A.6) APPLICATION CATEGORIES AND FINANCIAL SUPPORT

A.6.1) Teaching Assistantship (TA) [Financial support as per MHRD norm]

A candidate, selected for the Ph.D. Programme, at IIT Bombay will be eligible for the financial support
under the TA category subject to the fulfilment of any one of the following three criteria.

(I) M.Tech./M.E. or an equivalent degree as the qualifying degree,

(ii) M.B.A (with B.Tech./ B.E. or an equivalent an degree) as the qualifying degree,

(iii) B.Tech./B.E./M.Sc./M.A./M.Com. or an equivalent degree as the qualifying degree

AND

a valid GATE/JEST (for Physics) score or a valid Junior Research fellowship (JRF) award letter from UGC/CSIR/NBHM/DBT/ or a national eligibility test /UGC NET including lectureship (assistant professorship)

A B.Tech./B.S./B.E. (or equivalent) degree from any Indian Institute of Technology (IIT) with a
CGPA/ CPI score of 8.00 (on 0-10 scale) and above is exempted from the mandatory requirement of a valid GATE score.

The assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. The monthly rate of assistantship is Rs. 31,000/ for the first 2 years and enhanced rate of Rs. 35,000/ for the remaining period.

The continuation of assistantship under TA category will be subject to serving as a teaching assistant in a course / laboratory for 8 hours per week as assigned by the concerned academic unit as well as satisfactory academic performance. The assistantship will be paid on the basis of monthly attendance.

As per MHRD directives, the employees on the rolls (with or without pay) of any organization are not eligible for admission under this category.

A.6.2) Research Assistantship (RA)

A candidate, selected for the Ph.D. Programme, at IIT Bombay will be eligible for the financial support under the RA category subject to the fulfilment of any one of the following three criteria.

(I) M.Tech./M.E. or an equivalent degree as the qualifying degree,
(ii) M.B.A (with B.Tech./ B.E. or equivalent an degree) as the qualifying degree,
(iii) B.Tech./B.E./M.Sc./M.A./M.Com. or an equivalent degree as the qualifying degree

AND

a valid GATE/JEST (for Physics) score or a valid Junior Research fellowship (JRF) award letter from UGC/ CSIR/NBHM/DBT/ or a national eligibility test / UGC NET including lectureship (assistant professorship)

A B.Tech./B.S./B.E. (or equivalent) degree from any Indian Institute of Technology (IIT) with a
CGPA/ CPI score of 8.00 (on 0-10 scale) and above is exempted from the mandatory requirement of a valid GATE score.

The assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. The monthly rate of assistantship is Rs. 35,000/ for the first 2 years and enhanced rate of Rs. 39,000/ for the remaining period.

The information of availability of RA seats will be available with / published by individual academic units.

Students admitted under RA category will have to look after the laboratories and also assist in teaching or research or other related academic work for about 20 hours per week as assigned by the concerned academic unit. Continuation of assistantship will remain subject to the satisfactory performance in assigned duties as well as satisfactory academic performance. The assistantship will be paid on the basis of monthly attendance.

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

A.6.3) Teaching / Research Assistantship Through Project (TAP/RAP)

The financial support under this category is provided from sponsored projects as per the norms approved by the sponsoring agency and IITB. In case a specified norm is not available, the same approved by MHRD/DST will apply.

(i) M.Tech./M.E. or an equivalent degree as the qualifying degree,
(ii) M.B.A (with B.Tech./ B.E. or equivalent an degree) as the qualifying degree,
(iii) B.Tech./B.E./M.Sc./M.A./M.Com. or an equivalent degree as the qualifying degree

AND

a valid GATE/JEST (for Physics) score or a valid Junior Research fellowship (JRF) award letter from UGC/ CSIR/NBHM/DBT/ or a national eligibility test / UGC NET including lectureship (assistant professorship)

A B.Tech./B.S./B.E. (or equivalent) degree from any Indian Institute of Technology (IIT) as well

as from any of the CFTIs with a CGPA/CPI score of 8.00 (on 0-10 scale) and above is exempted

from the mandatory requirement of a valid GATE score.

The assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier.

The information of availability of TAP/RAP seats will be available with / published by individual academic units.

The continuation of assistantship under TAP / RAP category will be subject to serving for the project as assigned by the concerned project investigator(s) as well as satisfactory academic performance.

The assistantship is paid from the office of Dean,IRCC. As per MHRD directives, the employees on the rolls (with or without pay) of any organization are not eligible for admission under this category.

A.6.4) Fellowship Award (FA)

The financial support under this category is provided by various Govt. / Semi Govt. schemes (CSIR, UGC, DAE,DST, DBT, NBHM, etc.) and some other organizations.

A valid Junior Research fellowship (JRF) award letter from the Govt. / Semi Govt. agencies (e.g. CSIR/UGC /DAE /DST/ DBT NBHM etc.) is required for the execution of this fellowship.

The amount and duration of the fellowship will be as specified by the awarding agency. The disbursement and continuation of the fellowship will be subject to as per the norms specified by the awarding agency or specified by IIT Bombay for TA category, as deemed fit.

A.6.5) Sponsored Candidate (SW)

The students admitted under this category are not eligible for any financial support from the Institute (IIT Bombay) and are sponsored by their employers. They are expected to be released for fulltime course work and research at the Institute for a minimum period of three years.

An appropriate sponsorship letter (Appendix C.1/C.2) should be submitted at the time of written test and/or interview. Students admitted under this category are not generally entitled for hostel accommodation on campus.

A.6.6) Self-financed Indian Nationals, including those on Study Leave (SF)

The students admitted under this category are not eligible for any financial support from the Institute
(IIT Bombay). Students admitted under this category are not entitled for hostel accommodation
on campus.

Candidate with the provisional DST-INSPIRE fellowship award letter may apply under Self-Finance (SF) category. After successful admission, if the candidate subsequently clears the final round of selection of DST-INSPIRE, s/he would be allowed to convert from the Self-Finance (SF) to Fellowship
Award (FA) category.

Candidates who are released from the Governmental or educational Institutions on study leave for a period not less than three years for doing research work at IITB, can seek for admission under this

category. Employer's Letter for Study Leave (Appendix C.3) should be produced at the time of joining, if selected.

A.6.7) 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:

https://www.iitb.ac.in/newacadhome/toadmission.jsp

A.6.8) 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 only for the 'permanent' persons employed as Institute Staff at IIT Bombay.

(i) The candidate should have been employed as Institute Staff for at least 2years (before the starting of the semester in which admission is sought). The candidate must produce a letter of work experience at the time of application.

(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. The candidates need to submit NOC, from the Head/Office-In-Charge, at the time of application.

(iii) If an employee admitted under this category is not serving as an Institute Staff while pursuing the degree, then he/she cannot continue under the IS category but may seek for changing his/her category to self-financed (SF) category through proper channel.

A.6.9) Project Staff (PS)

Candidate who are employed at IIT Bombay (IITB) in a sponsored project undertaken by the Institution (IITB) can seek for admission under this category provided the duration of the project, in which the candidate is employed, is 3 years or more at the time of admission. In addition, the candidates should have completed six months of service (before the starting of the semester in which admission is sought) in a sponsored project at the Institute (IITB).

In case the candidate has B.Tech./B.S./B.E./M.Sc. or equivalent degree as the qualifying degree and is without a valid GATE score, the six months project experience may be counted as part of the two year mandatory professional work experience (as per the requisite general eligibility criteria).

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

A.6.10) External (EX)

The candidates employed in recognized R&D organizations, well-equipped scientific institutions, laboratories, and industrial organizations engaged in research based activities, and desirous of pursuing Ph.D. programme while in employment may apply for admission as external candidates.

These candidates must have a Supervisor (internal) from the Institute (IITB) and an external supervisor from their parent organization where they will be doing the research work. The admissions are based on the following norms:

The competence of these candidates will be assessed along with the regular candidates. After joining, the rules and regulations as specified by the Institution (IITB) for regular candidates with regard to academic performance will remain applicable for candidates under EX category also.
The candidate should submit, a Sponsorship Certificate (Appendix-C.4) from the organization, in which s/he is employed, at the time of application giving an undertaking that s/he would be released from the normal duties to fulfil the course-work requirement (and qualifier examination, if applicable). The certificate should also provide details of facilities relevant to the research programme and available to the candidate.

The candidate has to complete the course-work (and qualifier examination, if applicable) immediately after joining the programme within a period of one to two semesters. Depending on the student's background and the programme requirements, an additional semester may be needed to complete the coursework/qualifier examination. After fulfilling the course-work (and qualifier examination, if applicable) at the Institute, these candidates will be allowed to register for Ph.D.

To promote interaction between the internal and external supervisors, regular meetings between them should be arranged at least once in a year in the Institute or in the sponsoring organization.
Persons working in colleges/universities are not eligible under this category and rather apply under college teacher (CT) category.

At the time of joining the programme, the selected candidate will have to produce a the "**Relieving Certificate**" from his / her employer that s/he has been fully relieved from the normal duties to complete the course(and qualifier examination, if applicable) at IITBombay.

A.6.13) College Teacher (CT)

Candidates employed as faculty members in Colleges and Universities and desirous of pursuing Ph.D. Programme, while in employment and without availing study leave may apply for admission under this category.

These candidates must have a Supervisor (internal) from the Institute (IITB) and an external supervisor from their parent organization where they will be doing the research work. The appointment of external supervisor is optional based on recommendations of the supervisor and the respective DPGC. The admissions are based on the following norms:

The competence of these candidates will be assessed along with the regular candidates. After joining, the rules and regulations as specified by the Institution (IITB) for regular candidates with regard to academic performance will remain applicable for candidates under CT category also.

The candidate should submit, a No-Objection Certificate (Appendix-C.5) from the College / University, in which s/he is employed, at the time of application giving an undertaking that s/he would be released from the normal duties to fulfil the course-work requirement (and qualifier examination, if applicable). The certificate should also provide details of facilities relevant to the research programme and available to the candidate.

The candidate has to complete the course-work (and qualifier examination, if applicable) immediately after joining the programme within a period of one to two semesters. Depending on the student's background and the programme requirements, an additional semester may be needed to complete the coursework/qualifier examination. After fulfilling the course-work (and qualifier examination, if applicable) at the Institute, these candidates will be allowed to register for Ph.D.

Candidates admitted under CT category is treated on par with SF category as far as payment of fees and deposits are concerned.

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, as applicable.

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, only candidates belonging to SC/ST and PwD categories 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 **- as available on the following webpage https://www.iitb.ac.in/newacadhome/FeesStructure.jsp under https://www.iitb.ac.in/newacadhome/PGNewEntranceFeeStructureAutumnSem2022-23.pdf & https://www.iitb.ac.in/newacadhome/HostelFeeCircular.pdf**

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 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/academichome/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 with any one of the following :

(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 follow the web page https://www.aero.iitb.ac.in/home/admission-announcement for most admissions-related updates, instructions, and information about the faculties considering guiding new students. Candidates are free to reach out to the listed faculty members if they need to learn more about the available research topics and the corresponding background expected.

RESEARCH AREAS

I. Aerodynamics : Experimental Aerodynamics, Experimental Hypersonic Aerothermodynamics, Shock Waves and their applications, Computational Hypersonic Aerothermodynamics, Computational Fluid Dynamics, Computational Electromagnetics, Computation of incompressible multi-phase flow, Vortex and particle methods, Smoothed Particle Hydrodynamics, Vortex flows, Aeroacoustics, Aircraft Design, Air Transportation, Evolutionary Optimization Techniques, 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 LighterThan Air Systems, Helicopter aerodynamics.

II. Dynamics and Control: Flight mechanics, guidance, trajectory optimization, navigation, state and parameter estimation, tracking and control of launch vehicle , missiles, aircraft, manned and unmanned aerial vehicles, mini aerial vehicles(MAVs), satellites, multi-agent systems, nonlinear adaptive and robust flight control, integrated navigation systems, air-breathing and gas turbine engine control, swarm, path planning and formation flying of aerial vehicles, hardware–in-loop-simulation, co-operative missions for MAVs.

III. Aerospace 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, Computational studies of high enthalpy flows, Plasma assisted combustion and flow control, Thermoacoustics,

Non- Equilibrium , Thermodynamic of Dissipative Structures, Entropy Generation Studies in Micro-Flows, Fuel atomization and sprays, Optical diagnostics of combustion systems.

IV. Aerospace Structures: Structural Health Monitoring, Machine Learning Assisted Uncertainty Quantification, Defects and Damages in Composites, Additive Manufacturing, Wave Propagation in Structures, Aeroelasticity, Aerothermoelasticity, Aeroservoelasticity, Reduced-order Modeling, Structural Dynamics & Stability, Multidisciplinary Optimization, Mechanics of Materials, Computational Materials Science, Experimental Mechanics, Continuum and Computational Mechanics, Electromagnetic Interactions with Solids, Biomechanics, Multiscale modeling of materials, 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, or Biorelated engineering subjects

ii) MD/MS in Health Sciences including AYUSH

iii)M.Sc. or equivalent degree in subjects related to Life Sciences/Physics/ Chemistry/Mathematics

iv)B.Tech. in Biotechnology, Chemical Engineering, Computer science and Engineering, Electrical Engineering/ Electronics and Telecommunications, Mechanical engineering, Engineering Physics.

Candidates with qualifying degrees in [iii and iv] must fulfill 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)/BINC any fellowship that will provide scholarship for 5 years.

(c) Experience as specified earlier in A.5 and A.6 (for CT, EX, IS, PS, SF,SW category)

RESEARCH AREAS

(A) Biophysics and Computational Biology: Protein crystallography, NMR based structural biology, and single particle cryo-EM; Bioinformatics and computational biology; Physics of biological systems and computational Modeling of biomolecules; Dynamics of cytoskeletal filaments and chromatin remodelling; Physical properties of the extracellular matrix; Protein folding/misfolding, aggregation and neurodegeneration; Time-resolved techniques; Cellular Biophysics, cellular biophysics in microfluidic systems.

(B) Biochemistry: Molecular enzymology; Microbial metabolism and regulation; Aromatic hydrocarbon metabolism and genetic engineering; Molecular mechanisms of DNA replication, repair and packaging in double stranded DNA viruses

(C) Microbial Biology: Fungi, viral assemblies, bacterial Pathogenesis, host-pathogen Interactions, molecular parasitology.

(D) Cell Biology: Microtubule dynamics; Bacterial cell division; Chromosomal and extra chromosomal segregation in fungi; Neurobiology; Motor proteins

(E) Immunology: 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

(H) Developmental Biology: Early vertebrate development using zebrafish as a model system, cell movements during gastrulation, Motor neuron disease biology.

(I) Breast cancer, Cancer Biomarkers, Oncogenic signalling, disease modelling.

(J) Vesicular trafficking, G-protein coupled receptor (GPCR) signalling, cilia biology and ciliopathies

B.2.2 Biomedical Engineering (BME)

ELIGIBILITY FOR ADMISSION
First Class or 60% marks (55% marks for SC/ST), as specified in theGeneral 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.

(ii) M.Tech. Photonics/optics and MSC photonics/optics.

(iii) M.Pharm. OR MBBS with MD/MS, MVSc, MDS, MPTh, MOTh, MS/MD Health sciences AYUSH.

(iv) 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, Data Science.

(v) M.Sc. or equivalent degree in Biochemistry, Biophysics, Biotechnology, Ceramics, Chemistry, Electronics, Ergonomics, Material Science, Mathematics, Molecular Biology, Physics, Bioinformatics, Data science and Physiology.

(vi) Health Sciences (such as MBBS (Medicine) / BDS (Dental), B.Pharm/B.V.Sc.,B.P.Th., B.O.Th.,B.ASLP, Pharma D (Duration 4 years or more)". All India level post graduate entrance examination for corresponding disciplines such as INI_CET/NEET-PG/NEET-MDS/JIPMER/PGI Chandhigarh/AFMC-Pune/DNB Part I/AIIPMR for MBBS/ BDS, GPAT/ All India level selection examination for B.Pharm., All India level post graduate entrance examinationsuch as AIIPMR for M.V.Sc., M.P.Th., M.O.Th. and M.ASLP, GATE examination for all such health science background where applicable. Eligibility/ rank certificates for all such All India level entrance examinations are required. The candidate should have qualified the entrance exam (as per the qualification criterion of
the respective exam for that exam year and category) and the score obtained should be valid (as per
the duration of validity for the respective exam) at the time of application to the M.Tech. program.

Candidates with qualifying degrees in [iv and v] must fulfill one of the following:

a valid GATE score (for TA/TAP/RA/RAP)
a valid CSIR/UGC/DBT JRF or a valid ICMR JRF not linked to ICMR project (for FA)/BINC any fellowship that will provide scholarship for 5 years.
Experience as specified earlier in A.5 and A.6 (for CT, EX, IS, PS, SF, SW category)

RESEARCH AREAS
(A) 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; Robotics for Healthcare applications and devices; IoT for healthcare applications and devices.

(B) Application of AI/ML in health care applications and devices.

(C) Biomaterials, Drug delivery and tissue engineering, Nanobiotechnology, Design of scaffolds for tissue engineering, Controlled Release technologies, Neuroprosthetic devices including aids for the handicapped, Signal processing, Telemedicine and knowledge based systems. Microfibrication for immunotherapy

(D) Computational physiology, Cardiac electrophysiology and muscle mechanics, Computational Neurophysiology

(E) Movement Neuroscience, Rehabilitation technology; Neural signal processing, Neuroimaging, Neuromodulation, Neurofeedback. Human motor control, motor learning, biomechanics of human movement, non-invasive brain stimulation, assistive devices, geriatric (aging) and neurological rehabilitation.,

(F) Biomedical Optics: Cerebral blood flow imaging in humans, Laser and diffuse speckle imaging, Microscopy, small animal imaging, functional near infrared spectroscopy in humans and animals, Biomedical instrumentation (system development), imaging and other computational aspects, towards commercialization of imaging systems.

(G) Computational Biology and Bioinformatics: Bioinformatics and computational biology approaches to study protein-protein, protein-drug interactions etc., in cancer, neurodegenerative and endocrine diseases. Biosciences (BS)

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 with any one of the following :

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: Biosystems Engineering, Metabolic & Genetic Engineering, Bio-separations, Bioinformatics, Systems Biology, Drug Discovery, Enzymology, Bioprocess Development, and Food Engineering.

Materials Engineering: Polymer materials, Polymer Reaction Engineering, Polymer Processing, Polymer Physics, Polyurethane, Rubber, Polymer Rheoloyg, Ceramics, Polymers, Biomaterials, Drug Delivery, 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, Flow through porous media, and Microfluidics.

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

B.4) CHEMISTRY (CH)
[Department of Chemistry]

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

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

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 and Computational Chemistry

Please visit the following web page regularly for all relevant information and announcements,__https://www.chem.iitb.ac.in/phdadmissions/

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 with any one of the following :

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

OR

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

OR

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

Candidates with qualification listed in (ii) or (iii) need to fulfil the additional requirements of minimum Valid GATE score of **700 (GN/EWS) out of 1000 (630 OBC-NC, 467 SC/ST/PwD) OR "minimum of 2 years of professional work experience from any reputed organization with proof".**

The Institute reserves the right to call for interview only those candidates shortlisted on the basis of their qualification, academic background and requirements

RESEARCH AREAS

Fulfilling other eligibility criteria, applicant will be shortlisted only for any ONE of the following seven major research areas in Civil engineering

1. Transportation Systems Engineering (CE1)

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. Next-generation pavements (pervious concrete, geopolymer, precast); Industrial and agricultural wastes in concrete pavements

2. Geotechnical Engineering (CE2)

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.

3.Water Resources Engineering (CE3)

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

4. Structural Engineering (CE4)
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; Deployable structures and Metamaterials.

5. Ocean Engineering (CE5)
(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, tsunami, 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.

6. Remote Sensing (CE6)
Development of methods and algorithms for digital analysis of Remotely Sensed Data (RSD); Remote Sensing and GIS Applications for Hydrology Water Resources; Decision Support Systems in Watershed Development; Remote sensing for snow and glacier Studies, Ocean Sensing, Remote Sensing of Vegetation (Agriculture & Forests); Thermal Remote Sensing; Microwave remote sensing; Remote sensing data assimilation; **Uncertainty modelling in Geospatial datasets** and Unmanned Aerial Systems (UAS) based applications in Civil Engineering.

7. Construction Technology and Management (CE7)
Building materials, Concrete technology; Construction management; Infrastructure project management.
For PhD admission in specialization CE7, applications are invited for TA and TAP categories only.

B.6) CLIMATE STUDIES (CM)
[Interdisciplinary Group in Climate Studies]

The interdisciplinary programme (IDP) in Climate Studies was initiated at the Indian Institute of Technology Bombay, in January, 2012, at the doctoral level. The mission of the 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 30 faculty participants drawn from 10 departments, across IIT Bombay, with expertise in climate science, vulnerability assessment and adaptation and mitigation and policy. The doctoral curriculum in the IDP in Climate Studies includes an introductory course and advanced courses in two broad tracks of climate science and climate policy, on a broad range of theoretical and practical topics.

ELIGIBILITY FOR ADMISSION

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

i. M.Tech./M.E. or equivalent degree in Aerospace Engineering, Atmospheric Science, Chemical Engineering, Civil/ Construction Engineering, Computer Science Engineering/ Information Technology, Electrical/ Instrumentation Engineering, Energy Science & Engineering, Environmental Science /Engineering/ Management, Mechanical Engineering, Resource Engineering, Geoinformatics, Agricultural Engineering, Materials Engineering, Mining Engineering, or any other related Engineering discipline.
   OR
   M.Des./M.Arch./M.Planning or equivalent degree.
   OR
   M.Phil.(2-year) or equivalent degree in Social Sciences (Economics, Geography, Sociology etc.)
   OR
   M.Mgt./MBA or equivalent degree.

ii. M.Sc/MA or equivalent degree in Atmospheric Science, Chemistry, Earth Science, Energy Science, Environmental Science, Geophysics, Physics, Social sciences (Economics, Geography, Sociology, Planning etc.) or any other related discipline with
   valid GATE score
   or CSIR/UGC JRF
   or DST INSPIRE Fellowship
   or 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).

iii. B.E./B.Tech. or equivalent degree in Aerospace Engineering, Atmospheric Science, Chemical Engineering, Civil/ Construction Engineering, Computer Science Engineering/ Information Technology, Electrical/ Instrumentation Engineering, Energy Science & Engineering, Environmental Science/ Engineering/ Management, Mechanical Engineering, Resource Engineering, Geoinformatics, Agricultural Engineering, Materials Engineering, Mining Engineering, or any other related Engineering discipline with valid GATE score or 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).

The IDP in Climate Studies (CM) reserves the right to call for subsequent selection steps only those candidates shortlisted on the basis of their qualification, academic background and requirements. Details regarding the admission process will be provided to the eligible candidates along with the Message from HoD in due course of time.

RESEARCH AREAS

i. Climate Science: Detection, attribution and prediction of climate extremes,, factors affecting the Indian monsoon, aerosol radiative processes, LES of cloud processes,

causality analysis and data assimilation, impact on hydrology and water resources, climate change impact on ocean processes, ocean mixing dynamics.

ii. Vulnerability Assessment and Adaptation: Climate change impacts on cities, drivers and costs of adaptation; vulnerability analysis at national, sub-national and community levels; social & economic implications of climate change.

iii. Mitigation and Policy: Climate mitigation, strategies for low-carbon development, assessment of climate change policies and mechanisms, enhanced carbon capture systems, multi-criteria mitigation assessment.

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 with any one of the following :

i. M.Tech./M.E. or equivalent degree in Engineering/Technology

ii. 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 https://www.cse.iitb.ac.in/admission/phd.php.

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.

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.

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

i. Theoretical Computer Science: Algorithms, Combinatorial Optimization, Combinatorics, Complexity Theory, Cryptography and Graph Theory.

ii. Natural Language Processing: Natural language understanding; Machine translation, Semantics Extraction; Document understanding; Cross lingual information Retrieval; Intelligent interfaces.

iii. Visual Computing: Computer graphics, Geometry processing, Image and signal processing, Computer vision and medical image computingRendering (photorealistic, non-photorealistic, real-time, immersive); animation (character, physics-based); sketch-based systems; augmented and virtual reality; camera and imaging systems. Image and geometry reconstruction; restoration; compressed sensing; compression; pattern recognition; localization; segmentation; tracking; registration; quantization; shape analysis; group analysis; retrieval; affective computing. Machine learning methods; deep learning; matrix analysis; statistical methods.

iv. Computer Security and Applied Cryptography: Information flow-based security modeling, language and OS security, web and browser security, security analytics, secure multi-party communication, verification of cryptographic protocols, side channel attacks and hardware security, computation on encrypted data.

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: Query Optimization, with a focus on parallel and distributed databases (aka Big Data systems), Holistic optimization of database applications, data generation for testing and grading SQL queries, Real time databases, Database support for Embedded and IoT systems, Spatial databases.

vii. Machine Learning and Information Retrieval: Data integration models and algorithms, Graphical models, Information extraction and retrieval, Forecasting and smart e-business, 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, Self-configuration 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. 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.

xi. Real-Time, Embedded, Cyber Physical Systems: Functional Programming Applications, Reconfigurable computing, Automobile Telematics, Embedded control units, Design and development of robots and sensor platforms, temporal constraints, time critical applications

xii. Software Engineering and Paradigms: Software Architecture, Program Synthesis and Analysis, Design, Evolution and Re-engineering of Programs, Conceptual Models of Programs, Abstractions and Paradigms, Design Quality of Program Structure.

xiii Computer Architecture :Data and instruction cache optimizations for emerging (server, desktop, mobile, domain-specific) workloads, microarchitecture optimizations for address translation in virtualized environments, memory hierarchy for persistent memory systems, Energy-efficient memory hierarchy for mobiles and servers, transient execution and timing attacks, secure processor and memory hierarchy, trusted execution environments like Intel SGX and ARM TrustZone, attack detectors, security-performance tradeoffs.

Refer to the department web page (www.cse.iitb.ac.in) 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.

B.8) DESIGN (ID)

[Industrial Design Centre (IDC)]

IDC School of Design invites candidates to apply for PhD in the following core domains: Industrial Design, Communication Design, Interaction Design, Animation and Film, Mobility and Vehicle Design, Human Factors and Ergonomics.

Eligibility Criteria and Qualifying Degree for PhD admission (any of the following):

1. MDes / MTech / MPhil (2year course) / MFA / MArch / MURP / MA (Design) / Postgraduate Diploma in Design (2year course), or equivalent degree with First Class or 60% marks (55% marks for SC/ST) as specified in the General Eligibility Criterion.

2. Any other Masters degree with First Class or 60% marks (55% marks for SC/ST) as specified in the General Eligibility Criterion; has demonstrated competence in design-related areas and has substantial design-related work.

3. BDes / BTech / BArch / BFA / Undergraduate Diploma in Design, or equivalent degree with First Class or 60% marks (55% marks for SC/ST) as specified in the General Eligibility Criterion, and has demonstrated competence in design-related areas.

Eligibility Criteria for TA/TAP/RA/RAP:

(a) Candidates in Eligibility Criteria 1 are eligible for TA/TAP/RA/RAP.

(b) Candidates in Eligibility Criteria 2 and 3 will be eligible for TA/TAP/RA/RAP if they also have a valid CEED / GATE score.

To understand the different full-time and part-time PhD categories available at IIT Bombay, the candidates must read the section 'Application Categories and Financial Support' of the Information Brochure.

Besides these core domains, the PhD programme fosters an open interdisciplinary approach involving the disciplines such as engineering, social sciences, media and education. Refer to the section below on Research Areas & Topics' for more details.

RESEARCH AREAS
1. Biomimetics
2. Cinema
3. Cognitive & Physical Ergonomics
4. Comics Studies
5. Data Visualization
6. Design for Craft
7. Design for Health
8. Design Forecasting / Design for Future

9. Design Theory
10. Game Design
11. Human-Computer Interaction
12. Human Factors and Socio-technical Systems
13. Human-Machine Interaction / Human-Automation Interaction
14. Immersive Media Design (VR/AR/XR)
15. Information Design
16. Design Innovation and Entrepreneurship
17. Instruction Design
18. Interaction Design
19. Mobility Design / Future Mobility / Vehicle Form & Aesthetics
20. Sustainable Design
21. Systems Thinking and Design
22. Typography / Calligraphy / Type Design
23. Visual Language & Storytelling

Before applying, the candidates are strongly suggested to check the research areas of the faculty members at IDC School of Design and the research topics that are suggested for this intake, by visiting this link: http://www.idc.iitb.ac.in/admission/phd-research-areas

Candidates are strongly encouraged to contact and discuss their research interests with individual faculty members of IDC School of Design before applying, to gain a better understanding of the current research focus. Candidates are also encouraged to work with the faculty member, for a few months, and develop their research areas before the application.

Admission Process -
To know more about the PhD admission process of IDC School of Design please visit:
http://www.idc.iitb.ac.in/admission/phd-admission

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

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

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, Material 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, and with relevance to the research areas advertised online for a particular round of admission.

OR

B.Tech./B.E. or M.Tech./M.E. in Civil Engineering, Mining Engineering, Electrical Engineering, Chemical Engineering or Computer Science and Engineering with relevance to the research areas advertised online for a particular round of admission.

RESEARCH FACILITIES

Ar–Ar mass spectrometer, fission-track dating facility, electron probe micro-analyzer (EPMA), quadrupole inductively coupled plasma - mass spectrometer (ICP-MS), X-ray fluorescence spectrometer (XRF), X-ray diffractometer (XRD), scanning electron microscope (SEM), heating-freezing stages for fluid inclusion studies, micro-laser Raman spectrometer, gas chromatograph - mass spectrometer (GC-MS), rock-eval pyrolyser,

ASD spectroradiometer, airborne spectrometer and radiometric thermal camera, high precision GPS, geomechanical and engineering geological testing equipments, broadband seismographs, gravimeter, magnetometers, magnetotelluric instrument, multi-electrode resistivity imaging system.

RESEARCH AREAS

Active Tectonics and Tectonics
Electromagnetism
Economic Geology
Earthquake Seismology
Engineering Geology
Exploration Seismology
Geochemistry
Geostatistics
Geomagnetism
GPS and Geodesy
Gravity and Magnetic
Hydrogeology
Ichnology
Isotope Geology
Igneous Petrology
Mineralogy
Micropalaeontology
Metamorphic Petrology
Ore Petrology and Ore deposit modeling
Organic Geochemistry
Petroleum Geology
Petrophysics
Sedimentology
Structural Geology
Stratigraphy
Vertebrate Palaeontology
Volcanology
Numerical modeling in Geophysics
Geophysical Signal Processing
Geochronology and Thermochronology
Geomechanics

Faculty members of the Department pursue research in the above broad areas. However, for admission to the Ph.D. programme, research areas/topics only on a subset from the above will be offered for each round of admission and this information will be displayed in the Department's web site (www.geos.iitb.ac.in) as and when online application form is available in the Institute's web page. Candidates should check this information before applying.

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

The Interdisciplinary Programme in Educational Technology (IDP-ET) at IIT Bombay is actively involved in research and education in the area of technologies to improve the teaching-learning process. IDP-ET focuses on designing learning environments leveraging effective pedagogy and innovative technology scaffolds for supporting individual and collaborative learning in formal and informal contexts. IDP-ET is composed of core faculty members with additional associate members from various disciplines across IIT Bombay covering engineering, sciences, humanities and social sciences, design, and management.

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
OR
MBA

(ii) M.A./M.Sc./M.Phil. (1 year)
OR
M.Ed. (with technology adoption and assessment studies)

For applicants with degrees in (ii) above, one of the following will be required in addition :

- a valid GATE score (eligible for Institute TA/RA) OR
- a valid CSIR/UGC JRF (eligible for Institute TA/ RA) OR
- a valid UGC/CSIR Lectureship (eligible only for project positions) OR
- Two or more years of research experience in fields related to educational technology (eligible only for project positions)

For other admission-related details, please visit the Admissions page of the IDP in Educational
Technology: https://www.et.iitb.ac.in/academics/admission/

A ONE page (~500 words) document containing the Statement of Purpose (SoP) must accompany the application. The Statement of Purpose should contain (a) your interests and motivation for applying to ET (max. 50 words), (b) relevance of your recent and current activities (max. 200 words), (c) details about your academic interests including (but not limited to) your areas of interest, a problem that interests you, and what you plan on doing after completing your Ph.D. (max. 250 words)

RESEARCH AREAS

The thrust areas of research of the IDP in Educational Technology are:

i. Technology-enhanced learning of disciplinary practices such as estimation skills, decision
making, design thinking, computational thinking, troubleshooting, and so on
ii. Frameworks for teacher-use of educational technology tools and strategies
iii. Development of AI & ICT based tools for above teaching-learning goals
iv.. Educational data analytics using technologies such as GSR, EEG and eye tracking to understand
teaching-learning processes

Please visit **http://www.et.iitb.ac.in** for details regarding the research group and recent activities.

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
6. Integrated Circuits & Systems EE 6
7. Solid State Devices EE 7

Additional Information:

1. There will be two categories of candidates as given below:
   a. Category A: Those candidates who satisfy the Eligibility Criteria for admission (A.5), but do not fall in Category B.
   b. Category B: Those candidates who satisfy the Eligibility Criteria for admission, and who also satisfy any of the following criteria,

   i. They are in the pre-final semester of the BTech degree programme from the IITs with a minimum CPI of 8.0 (on scale of 10) at the end of the most recently completed semester.
   ii. They are in the pre-final semester of the MTech degree programme from the IITs with a minimum CPI of 8.5 (on a scale of 10) at the end of the most recently completed semester.
   iii. They are in the pre-final semester of a BE/BTech or ME/MTech degree programme, and have a GATE score* in the EE or in the EC discipline, obtained in a GATE exam conducted within the past one year.

   * GATE score cut-off will be decided before the start of the admission process.

2. Admissions for Category A will continue to be done as per the current schedule.

3. Students in Category B will be eligible to apply in the December round of PhD admissions and will be eligible for early offers of admission (the joining date will be in July of the following year).

4. The students admitted under Category B may be in Teaching Assistant (TA) or Teaching Assistant – Project (TAP) or PS category.

5. The number of early admission offers to Category B candidates in December will be decided by the department. This number will be adjusted under the departmental TA quotas of the academic year in which they are to join, with due regard to their birth category.

ELIGIBILITY FOR ADMISSION

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

i. 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.

ii. 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
- Machine Learning and Data Science

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 Nonconventional Energy Sources
- Reliability in Power Systems and Power Electronic Systems
- Smart Grids for Energy Harvesting
- Power System Planning, Operations and Control
- Power System Economics
- Use of wide band gap devices in Power Electronic converters
- Electric Vehicles
- Insulation diagnostics

Electronic Systems (EE5)

- Electronic Instrumentation
- Signal Processing Applications
- Speech and Audio Processing

- Biomedical Electronics
- Embedded System Design

Integrated Circuits & Systms (EE6)

- Development of microprocessor architectures along with design, test and verification methodologies
- RF and millimeter wave IC (integrated circuit) design for communication, navigation and imaging applications
- Electronic and photonic IC design for high-speed wireline and optical interconnects
- Power amplifiers for wireless communications
- CAD (computer aided design) techniques for VLSI design
- Integrated circuits for biomedical, agricultural and IoT applications
- FPGA based designs and techniques for hardware acceleration and AI/ML applications.
- ICs for power management and energy harvesting

Solid State Devices (EE7)

- Non-volatile memory technologies (Flash, RRAM, FERAM, MRAM, etc.)
- Device Fabrication (CMOS, Solar cells, Detectors, etc.)
- Theory, modeling, and simulation of Electronic devices
- Novel materials and devices (III-V, Graphene, 2D, etc.)
- Spintronics, Quantum Computing, Quantum sensing, and related technologies
- Photonics, MEMS, Neuromorphic Engineering
- Photovoltaics - c-Si, Organics, Perovskite, quantum dots, etc.
- Reliability of semiconductor devices and systems (e.g., Solar panels, PV systems)
- Nanoscale energy conversion
- Flexible devices and sensors (bio, chemical, and quantum)
- Light emitting diodes (III-Nitride UV) and photodetectors (quantum dot, etc)
- Wide Bandgap Power Devices

B.12) ENERGY SCIENCE AND ENGINEERING (EN)
[Department of Energy Science & Engineering]

Energy is critical for the development of society and the economy. There are numerous issues in conventional and sustainable/renewable energy that need to be addressed to enable large-scale development and sustainable/renewable energy deployment. In the short run, India has to pursue energy efficiency and demand-side management aggressively. This will improve the efficiency of supply and utilization devices and systems. The development of new energy technologies offers several technological challenges as well as significant business opportunities. In order to help meet these challenges, the Department of Energy Science and Engineering (DESE) was established with a mission to develop sustainable energy systems and solutions for the future. There is a substantial unfulfilled requirement for high quality trained manpower in the energy sector. There is also room for engineering innovators/entrepreneurs. The department has various experimental laboratories and computational facilities to cater to teaching and research requirements in various research areas in conventional and non-conventional energy. In addition to this, DESE students are actively involved in varied research and development activities. DESE faculty have been organizing a biennial international conference on research advances in energy as well as several continuing education programmes on renewable energy, energy management, process integration, passive solar architecture, etc. DESE has established links with industries like Thermax, Forbes Marshall, BSES, Mahindra & Mahindra, BHEL, and organizations such as Atomic Energy Regulatory Board, Ministry of Newand Renewable Energy, International Energy Initiative, and The Energy and Resource Institute which have sponsored MTech/PhD projects. This has ensured sustained relevance of the department’s 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 with any one of the following :

i. M.Tech./M.E. or equivalent degree in Aeronautical/Aerospace Engineering, Chemical Engineering, Petroleum 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, Petroleum 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

Renewable / Sustainable Energy: industrial solar thermal concentrators, Stirling engine systems, testing of solar collectors and systems, passive solar architecture, development of photovoltaic (PV) cells, thin film solar cells, perovskite solar cells, flexible PV devices, reliability and performance of PV, characterization, modelling, and simulation of defects and degradation in solar cells and modules, thermal non-destructive evaluation by infrared thermography, grid integration of distributed and decentralized energy resources,smartgrids / microgrids, converter topologies and control, hybrid systems for rural electrification, wind energy, low cost solar driers, fuel cells, solar photovoltaic concentrators, development of engines for vegetable oil, biodiesel, dual fueling, etc., biodiesel manufacturing processes, biomass gasifiers: design, development and testing, liquid fuels from biomass, complex fluid dynamics for granular materials and multiphase flows, molecular dynamic simulation of particulate flows .

Energy Efficiency/Improving Conventional Energy Systems: heat pumps, energy integration, process integration for resource optimization, population balance modeling, 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, electronic 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, IC engines, combustion, exhaust after-treatment systems, coal gasification, thermal management of living spaces

Energy Storage Devices and Systems: Li-ion and Na-ion batteries: electrode materials, electrolyte, fabrication, metal sulfur batteries for electric vehicles and stationary applications, commercial scale battery prototyping research and analysis, thermal management of batteries, flow battery modelling and design, supercapacitors, materials for hydrogen storage, hydrogen storage systems, thermal management in metal hydride beds, applications of metal hydride based hydrogen storage systems, carbon nano-tubes for hydrogen storage

Oil and Gas: Oil-water separation, wax deposition in petroleum flow, pipeline shut-in and restart processes, bulk and interfacial rheology, mechanism of gas hydrates formation

Nuclear Energy: 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 solutions of multilayer heat conduction problems.

B.13) ENVIRONMENTAL SCIENCE AND ENGINEERING (EV) [Environmental Science and Engineering Department (ESED)]

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 Department (ESED) For further details, visit www.esed.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 with any one of the following :

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.

Candidates with qualifying degrees in {“ii” above] must fulfill 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/BINC any fellowship that will provide scholarship for 5 years.

c) Experience as specified earlier in A.5 and A.6 (for CT,EX,IS,PS,SF,SW category)

* The applications from other specializations in field of Environment (not listed above) may also be considered depending upon the academic profile.

As per the last degree obtained, the candidates must also fulfil the additional requirements mentioned in "Eligibility criterion for Ph.D. admission" under Section A ('General').
Please note that merely fulfilling eligibility criteria doesn't entitle a candidate to be called for the test and/or interview.

Broad areas of research and sub-themes (indicative only) in ESED are as follows:

• Air Quality Management and Pollution Control

Air quality assessment, source identification and mitigation; satellite remote sensing for air quality; emission measurements and emission factor estimation; particulate matter characterization; air pollution exposure modelling and health effects.

• Environmental & Water Resources Systems Modelling

Modelling of hydro-climatic extremes at a national-scale; mapping vulnerability to natural and human-induced hazards using GIS; development of optimization models for surface water quality monitoring and management; design and evaluation of water & wastewater conveyance systems.

• Solid and Hazardous Waste Management

Municipal solid waste (MSW) treatment and recycling by biological and hydrothermal processes; energy from waste through incineration and gasification processes; life cycle assessment for prediction of environmental impacts; management of hazardous industrial waste.

• Water and Wastewater Treatment, Reuse and Management

Removal of geogenic contaminants from groundwater; biological processes in engineered and natural treatment systems for removal of carbonaceous organics pollutants and nutrients from wastewater; advanced oxidation processes for treatment of recalcitrant industrial effluents and micropollutants; greywater recycling and reuse; treatment and reuse of sewage and industrial sludge.

For more details, please visit http://www.esed.iitb.ac.in/research-areas

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B.14) GEOINFORMATICS & NATURAL RESOURCES ENGINEERING (GNR)

[Centre of Studies in Resources Engineering (CSRE)]

Geoinformatics and 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 with any one of the following:

(I) 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. Applicants who carried out M.Tech./M.E. after M.Sc. Must have studied mathematics at 10+2 level, which is a mandatory requirement.

(ii) 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 for all applicants with M.Sc. degree).

SELECTION PROCESS

Candidates will be shortlisted based on an interview for assessing their preparedness for a Ph.D. in the field of Geoinformatics and Natural Resources (GNR) in general, and on the topic selected by them in particular. Factors that contribute to shortlisting include knowledge of the PhD topic selected, relevance of background, knowledge academic performance in the qualifying degree, papers published in the qualifying program, work experience, if relevant, and a statement of purpose that demonstrates an understanding of the area the applicant wishes to work in.

The interested applicants are advised to visit CSRE webpage https://www.csre.iitb.ac.in/phdTopics.php for a detailed and updated list of topics / research areas.

RESEARCH THEMES

Water resources
Terrain evaluation
Land-use planning and monitoring
Agro-informatics and precision agriculture
Geologic remote sensing and mineral exploration
Planetary remote sensing
Natural Hazards
Snow, Glaciers and cryospheric studies
Machine learning, image processing, computer vision
Digital Photogrammetry, GPS

Faculty members of CSRE pursue research within the above broad themes. It may be noted that for admission to the Ph.D. programme purposes, topics will be offered covering only a subset from the above themes for any round of admissions. The list of actual topics offered by the faculty members for the current round of admissions may be found on the CSRE website at https://www.csre.iitb.ac.in/phdTopics.php Interested applicants must refer to this link while applying for the Ph.D. programme offered by CSRE. A statement of purpose must be enclosed along with the application in the specified format (available at the same link as above) in which the title of topic of candidate's interest should be mentioned with a detailed justification how the candidate's academic background is suitable to pursue research in that area. (Mathematics at 10+2 level is a mandatory requirement for applicants with M.Sc. as one of the degrees). Applicants who have M.Sc. as one of the degrees must clearly declare in the application the subjects they studied at 10+2 level.

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

ELIGIBILITY FOR ADMISSION

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, Design, Architecture, Management and Engineering/ Technology or candidates with two years of PGDM from recognised Govt. Institution will be considered for research areas consistent with their academic background.

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

RESEARCH AREAS

English - Autumn and Spring Semester 2023: All areas in **Literature, Linguistics, Performance Studies** and **Cinema studies**. Applicants are required to submit a **Research Proposal** along with the application. The format, content and other details needed for the proposal will be available on the H&SS website at https://www.hss.iitb.ac.in/en/phd-admissions

Psychology - Autumn and Spring Semester 2023: Developmental Neuropsychology;Child Development; EEG /Event Related Potential; Visual Perception; Memory; Attention; Cognitive / Perceptual Load; Response Inhibition; ODD; Decision-making; Delay Aversion; Perception; Cognition and Emotion; ValueLearning;Reward and PunishmentProcessing; ConsciousnessUnconsciousness; VisualAwareness; Cognitive Neuroscience; TaskSwitching; Meditation; Child Development; Cognitive Disorders; ADHD; Autism; Depression; ErrorMonitoring;TimePerception; Face Processing.

Sociology - only in Autumn semester 2023 : Urban Studies; Development Studies; Rural/Agrarian Sociology; Law and Governance; Legal Pluralism; Vulnerability and

Adaptation to Climate Change; Gender and Development; Disaster Studies; Ethnicity and Multiculturalism;; Sociological Theory; Anthropology of corruption; Constitutional Law; Sociology of Higher Education; Sociology of Religion and Kinship; Conversion; Christianity in India; Caste today; Religious Institutions; Hierarchy/Stratification; Sociology in/of India; Contemporary Karnataka; Sociology of Development and Environment; Natural Resource Conflicts; Issues of Livelihoods and Problems of Marginalized Class; Resource Rights; Subaltern Resistance and Movements and Political Ecology; Sociology and political economy of Finance; Political Economy of Development; Indian Political Economy; Theories of Money; Classical Political Economy; New and Old Institutionalism and History of Economic Thought; Issues of Gender and Sexuality; Medical Anthropology; Anthropology of the Body and Embodiment; Post-Colonial Studies; Post-Modern Feminist Studies and Southern Theories; Caste: Civility and Democracy; Civil Society, Ethnography Studies; Inclusion and Exclusion; Environmental Sociology; Social and Environmental Movements; Environmental Politics with a focus on Social inequality and Natural Resource Conflicts especially in Rural India; Issues of Livelihood and Problems of Marginalized Class and Political Ecology; Science and Technology Studies; Sociology of Medicine and Public Health.

Philosophy - Autumn and Spring semester 2023 : Philosophy of Mind, Analytic Philosophy, Classical Indian Philosophy (Buddhism, Sankya and Vedanta), Philosophy of Religion and Comparative Philosophy, Epistemology and Science, Analytic Philosophy, Existentialism, Phenomenology, Continental Philosophy, Applied Ethics, Philosophy of Language Contemporary Indian Philosophy, Existentialism, Phenomenology, Continental Philosophy, Applied Ethics, Twentieth Century Continental Philosophy, Philosophy of Artificial Intelligence, Philosophy of Mind, Cognitive Science, Wittgenstein, Alfred Korzybski, Philosophy and Popular Culture, Ethics, Ethics and Social-Political Philosophy, Feminist Philosophies, American philosophy, Continental philosophy, 20th Century Continental Philosophy: Heidegger, Foucault, Husserl, Gadamer, Phenomenology and Hermeneutics, Epistemology: Implications of the Historicity of Knowledge for its Universal Validity, Metaphysics: Implications of an Ontology of Events for Political Philosophy, History of Western Philosophy, Classical Indian Philosophy, Philosophical hermeneutics of Abhinavagupta, Indian Philosophy of Language, Indian Aesthetics and the Philosophy of Art.

Cell for Indian Science and Technology in Sanskrit - Autumn and Spring semester 2023
Indian Science and Technology; Indian Philosophy; Logic and Epistemology; Sanskrit language; Panini and Grammar; Philosophy of Language.

History - Autumn and Spring semester 2023**:** Archeology, Modern History- Subaltern history, migration history, maritime history and histories of anticolonialism and decolonization.

B.16) INDUSRIAL ENGINEERING AND OPERATIONS RESEARCH (IO) [Interdisciplinary Group in Industrial Engineering & Operations Research]
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, modeling 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 program has a 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, Neural Networks, Deep Learning, System Dynamics, Data Analytics, Machine Learning and core courses like Optimization Techniques, Probability theory, Stochastic Models, and Simulation. Broad areas of application are in manufacturing systems, health care, supply chains, logistics, railway networks, 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, computer vision, text and multi media analytics and robotics.

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

ELIGIBILITY FOR ADMISSION

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

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 and conic programming; Combinatorial optimization; Polyhedral theory: Nonlinear optimization; Dynamic programming; Theory, Algorithms and Computational methods for Mixed-Integer Linear and Nonlinear Optimization, convex and non-convex optimization, stochastic optimization, search methods, metaheuristics

ii. Stochastic Models: Queuing Theory; Queuing models; Branching Processes; Resource sharing; Parameter optimization; Performance Analysis; Polling systems; Applications in wireless communications and social networks.

iii. Optimal Control: deterministic and stochastic control, Markov decision processes, Reinforcement learning, Diffusion control; Stochastic Approximation, Sparse Control, Model predictive control.

iv. Simulation Modeling and Analysis: Discrete-event simulation; Monte Carlo methods, System dynamics methodology; Hybrid (discrete-continuous) modeling; Distributed and parallel simulations; Statistical data analysis; Simulation - optimization; Bayesian methods.

v. Game Theory: static and dynamic games, differential games, mechanism design, network games, auctions and market design, learning, incomplete and partial information games, cooperative games, resource allocation problems.

vi. Data Science, Machine Learning and Artificial Intelligence: Supervised, semi-supervised and unsupervised machine learning models, Optimization for emerging machine learning problems, developing new and efficient machine learning models and algorithms for novel applications, transfer and continuous learning, statistical learning theory, online learning, reinforcement learning, multi-armed bandit problems, longitudinal data analysis, time series modeling and analytics.

vii. Deep Learning: Theoretical aspects of deep learning models, new deep learning tools for modern applications involving text, image, audio and video data, deep learning for industrial and business applications, deep learning for operations research.

viii. 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 rolling stock management in rail services.

ix. Supply Chain Analysis: Information sharing; Coordination; Contract analysis and design; Realtime decision making; Performance and stability analysis; Reverse logistics and closed loop supply chains; Decision- making under uncertainties; Quality of service.

x. Financial Engineering: Mathematical finance; Modeling and pricing of derivatives; Insurance and asset pricing; Portfolio management; Pricing; Revenue sharing and revenue management, systemic risk analysis.

xi. 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.

xii. Social Networks: Recommendation systems, menu design, diffusion of information on networks, online auctions.

B.17) MANAGEMENT (MG)
[Shailesh J. Mehta School of Management]

ELIGIBILITY FOR ADMISSION

A. Educational qualifications

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/6.0 CPI for SC/ST) and at least two years of work experience.
(ii) Master of Management /ME / M.Tech / M.Pharm/ M.Phil/2 years MBA or 2 year PG Diploma in Management from any institute recognized by a Government body (AICTE / UGC/AIU) with 60% marks/ 6.5 CPI (55% marks/ 6.0 CPI for SC/ST).
(iii) Executive MBA of at least one year duration from IITs/IIMs or any institute recognized by a Government body (AICTE/ UGC / AIU) with 60% marks/6.5 CPI (55% marks/ 6.0 CPI for SC/ST)
(iv) 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 postgraduation level.
(v) Chartered Accountants and Company Secretaries with 60% marks/ 6.5 CPI (55% marks/ 6.0 CPI for SC/ST) in the preceding degree/Bachelors Degree (B.Com/ B.Com/ BA/B.Sc).
AND
B. Aptitude test scores
i) Should have qualified in: UGC-JRF/UGC-NET/ CSIR-JRF/ CSIR-NET during last 5 years.
OR
ii) Should have taken GATE/CAT/GMAT/GRE during last 5 years and scored minimum percentiles /marks as specified below:
GATE:75 percentile overall; CAT: 75 percentile overall, GMAT:600 marks, GRE:300 marks.

Note: Applicants with MBA/PGDM/M Tech from the institutes of national importance awarded in the last 5 years will be exempted from the requirements under B.
AND
C. Research proposal
A research proposal (1500 words) on a topic of applicants' interest in place of Statement of Purpose. It should contain a) problem identification, b) brief review of literature, and c) methodology.
Applications without research proposal will not be considered.
Note: Criteria for awarding Teaching Assistantship and other application categories are as per the guidelines mentioned in section A.6 of this Brochure.

RESEARCH AREAS
1. Decision Sciences & Quantitative Methods
2. Finance & Accounting

3. Information Systems/Information Technology
4. Marketing
5. Entrepreneurship
6. Operations & Supply Chain Management
7. Technology & Innovation Management
8. Strategic Management & competitiveness
9. International Business

B.18) MATHEMATICS (MA)
[Department of Mathematics]

ELIGIBILITY FOR ADMISSION : In addition to the General Eligibility Criterion prescribed by the Institute as given in A.5, the candidate should also fulfill the following:
First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree with any one of the following :

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
OR
M.Tech./M.E. or equivalent degree in Engineering/Technology

Shortlisted candidates will be called for written test and interview. There will be separate written tests and interviews for students in Mathematics and Statistics. For syllabi of written tests please check the website of the Mathematics Department at http://www.math.iitb.ac.in/Academics/doctoral.php

RESEARCH AREAS

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, F-singularities, Hilbert-Kunz multiplicity.

Analysis:
Functional Analysis (Operator Theory, Hilbert modules, Operator algebras), Several Complex Variables (Function theory of holomorphic functions of several variables), Harmonic Analysis (Harmonic analysis on Lie groups, Hypergeometric functions associated with root systems).

Combinatorics and Theoretical Computer Science:
Combinatorial Optimization, Algebraic Combinatorics (representation theory, spectral graph theory), Enumerative Combinatorics, Graph and Hypergraph Theory (colouring problems), Extremal and Probabilistic Combinatorics, Theoretical Computer Science (Computational Complexity, Derandomization).

Geometry & Topology:
Algebraic Topology (stable homotopy theory), Algebraic Geometry (Schubert varieties, determinantal varieties, varieties over finite fields, Algebraic cycles, Moduli spaces of vector bundles), Lie groups (discrete subgroups, congruence subgroups, homogeneous spaces, probability measures), Affine Algebraic Geometry, Principal bundles and their stacks, Topological Combinatorics.

Partial Differential equations and Numerical Analysis:
Hyperbolic systems of quasilinear partial differential equations, nonlinear waves, homogenization, Control theory, viscoelastic fluid flow problems, Navier-Stokes equations, Shock waves in hyperbolic systems of conservation laws.
Geometric analysis, prescribing-curvature type problems and partial differential equations in conformal geometry, blow-up analysis and compactness issues, geometric and functional inequalities, nodal geometry of high energy eigenfunctions, quantum ergodicity and mass concentration problems, spectral theory. Finite element methods, finite volume methods, Invisibility cloaking and meta-materials, Mathematical statistical mechanics.

Statistics and Probability:
Statistical Inference, Statistical Modelling, Design of Experiments, Reliability Theory, Industrial Statistics, Statistical Data Mining in Computational Biology, Spatial Methods in Statistics, Time Series Analysis, Statistical Signal Processing, Non-parametric regression, Curve registration, Big data inference, Compressed sensing, Stochastic Differential Game Theory, Stochastic Control Theory, Mathematical Finance, Applied Probability, Random Matrices, Free Probability, Change point analysis and Stochastic networks, Extreme value theory, Branching random walks, Robust estimation for heavy-tailed random variables, Stable random fields, Point processes, Asymptotic properties of the random walks, Branching processes, Random graphs, Bootstrap, High dimensional Statistics, Rates of Convergence to CLT, Edgeworth Expansions.

Candidates are advised to visit the department webpage: http://www.math.iitb.ac.in for additional details on research topics.

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, in the qualifying degree with any one of the following :

i. M.Tech./M.E. or equivalent degree in Mechanical Engineering, Production Engineering, Industrial Engineering, Aerospace Engineering, Chemical Engineering,Metallurgical Engineering, Mechatronics, Instrumentation & Controls, Laser Technology, Engineering materials technology, Biomechanics.

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. .

iii. For Additional department criteria please visit :
https://www.me.iitb.ac.in/?q=Ph.%20D.%20Admissions
RESEARCH AREAS

ME1- Thermal and Fluids Engineering
ME2 – Design Engineering
ME3 – Manufacturing Engineering
(Please refer to the department websitehttp://www.me.iitb.ac.in, under Research, for more details)

B.20) METALLURGICAL ENGINEERING AND MATERIALS SCIENCE (MM)
[Department of Metallurgical Engineering and Materials Science]

ELIGIBILITY FOR ADMISSION

The general eligibility criteria prescribed by IIT Bombay are bare minimum and mere possessions of same will not entitle the applicants to be called for written test/interview, The Department may restrict the number of applicants to be called for written test/interview to a reasonable limit, on the basis of qualifications and experience higher than that of the minimum prescribed in the advertisement. The candidate must satisfy the eligibility criteria in either one of the following qualifying degree:

i. M.Tech./ M.E. or equivalent degree in Engineering/Technology.
ii. B.Tech./B.E. or equivalent degree in Engineering/ Technology.
iii. M.Sc. Or equivalent degree in Chemistry, Materials Science, Physics and related science streams. Mathematics as a subject at the B.Sc. Level is mandatory.

Please visit the Department website (https://www.iitb.ac.in/mems/en) for additional details, where a dedicated webpage will be created prior to the initiation of the PhD admission process.

RESEARCH AREAS

Physical and Mechanical Metallurgy:
microstructure, microstructure evolution, phase equilibrium, phase transformation, structure property relationship, thermomechanical processing and texture analysis, metal forming, superplasticity, mechanical behavior- creep, fatigue, micromechanics, fracture mechanics

Process Metallurgy and Manufacturing:

process modelling, process analysis, iron and steel making (including clean steel production), non-ferrous extractive metallurgy, welding, powder metallurgy, additive manufacturing, E-waste processing refractories, Non-ferrous production, Sustainable metal production, powder metallurgy and additive manufacturing

Structural Ceramics:
high temperature ceramics, inorganic glasses and glass-ceramics, ceramic foams, ceramic coatings, industrial ceramics, ceramic synthesis/processing, sintering, near net shape forming, gel casting, rheology of suspensions, mechanical and tribological behavior.

Electronic, Magnetic and 2D Materials:
electrical and optical properties, magnetic properties, dielectric and piezoelectric properties, electrochemical behavior, 2D materials, quantum and correlated materials, thin films synthesis/processing/devices

Energy Materials:
materials and devices for photovoltaic, advanced battery, supercapacitor, fuel cell, thermoelectric and sensing applications, nanoscale materials synthesis/processing/devices

Polymers and Soft Matter:
crystallization and self-assembly in soft matter (polymers, proteins) systems, polymer blends and polymer nanocomposites, polymer thin films and membranes, polyelectrolytes, surface and interfacial phenomena in soft materials, dynamics in polymer confinement, thermodynamic, mechano-rheological, mechanical properties of polymers, responsive, functional and conjugated polymers

Corrosion and Coatings:
Aqueous corrosion, the metallurgy of corrosion, corrosion in oil and gas, atmospheric corrosion, corrosion inhibitors, and protective coatings (functional organic coating, galvanization, electroplating, and high-temperature coatings), electrochemistry, interface degradation

Modelling and simulation:
First principles-DFT, Monte Carlo, molecular dynamics, CALPHAD, phase field, phase field crystal, cellular automata, dislocation dynamics, crystal plasticity, plastic deformation and material flow, finite element

Departmental common facilities available (in addition to those available in individual research groups' laboratories)**:**
- X-Ray Diffractometers
- Scanning probe microscope-AFM, KPFM included
- Confocal Raman/PL system
- Dual-beam SEM/FIB microscope
- Transmission Electron Microscopy Facility (300 kV)
- Sample preparation facility for transmission electron microscopy
- Nanoindenter
- Metallography sample preparation setup
- Optical Image analyser system
- Vickers Microhardness Tester
- Scanning Electron Microscope
- Environmental scanning electron microscope
- simultaneous TG-DTA Thermal Analysis
- Scanning electrochemical Microscope
- Multi-channel potentiostat/Galvanostats
- Gleeble 3800

- UTM Machines
- Differential Scanning Calorimetry
- Differential Scanning Calorimetry
- Thermogravimetric Analyzer
- Hot-dip Galvanization (HDG) Simulator
- Corrotherm 610 Salt Spry
- BET
- DLS-Nano C particle analyzer
- Dilatometer
- High temperature furnaces
- High Performance Computingfacility, along with CALPHAD and standard open Source scientific software
- UV Visible Spectrophotometer
- Dynamic loop system
- High temperature high pressure autoclaves
- Vibrating sample magnetometer

B.21) NANOTECHNOLOGY AND SCIENCE (NT)

[Centre for Research in Nanotechnology & Science (CRNTS)]

Nanotechnology research provides immense challenges and opportunities in the world of today. IIT Bombay has identified Nanosciences and Nanotechnology as thrust areas that enable cutting edge research traversing the boundaries of established disciplines. The Centre for Research in Nanotechnology and Sciences (CRNTS) was established to coordinate and consolidate such research happening in various academic and research units at IIT Bombay, as well as to foster the creation of new research areas.

More than fifty faculty members from various departments of the IIT Bombay with active research interest in the domain of nanotechnology and sciences are associated with the interdisciplinary program at CRNTS.

Realizing the importance of cross disciplinary, multidisciplinary and interdisciplinary interactions in this domain, this program requires the association of two research supervisors, preferably from two different academic entities (viz. departments or centres within IIT Bombay), to supervise the research of each Ph. D. candidate enrolled in CRNTS. This unique approach is envisaged to generate the specialized 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 with any one of the following :

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 – 200kV and 300 kV) with EELS, STEM, EDS, Field Emission Gun Scanning Electron Microscope (FEGSEM) with EDS and WDS, Cryo SEM, Environmental Scanning Electron Microscope, Time of Flight Secondary ion Mass

Spectrometer (TOF-SIMS), Laser ablation inductively coupled Mass spectroscope (LA-ICPMS), Laser Raman spectrometer, FTIR microscope, FACS cell sorter, Small Angle X-Ray Scattering, Atom Probe Tomography, CHN analyser, Thermal Gravimetry Analyzer, Gas Chromatograph With High Resolution Mass Spectrometer (GC-HRMS), Liquid Chromatography Mass Spectrometer (LCMS), High Resolution -Liquid Chromatography Mass Spectrometer (HR-LCMS), Orbitrap Liquid Chromatograph Mass Spectrometer (HR-LCMS Orbitrap), Electron Spin Resonance Spectrometer, Nuclear Magnetic Resonance Spectrometer, Inductively Coupled Plasma-Atomic Emission Spectroscopy, Two-Dimensional Gas Chromatography with Time-of-Flight Mass Spectrometer (GC-GC-TOF-MS) exist in CRNTS. These instruments are being used by about 2500 users from IIT Bombay, other academic institutions from the country, and industry. CRNTS Ph. D. students get the opportunity to use these facilities first hand and to get a unique understanding of application of these sophisticated instruments in a large variety of scientific and engineering fields.
In addition to this, IIT Bombay has excellent facilities for the fabrication and characterization of various nanoelectronics devices, photovoltaic devices, and sensors.

RESEARCH AREAS

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

SELECTION PROCEDURE
Selection is by a 2-stage interview and written test. First stage interview/written test will be in a department specified by prospective guides. Second stage interview will be in CRNTS. Ph.D. topics being offered are available at http://www.saif.iitb.ac.in/crnts/phd_topics.pdf along with names of supervisors, co-supervisors, eligibility criteria and departments in which the first round of interview is to be conducted. Candidates are required to apply directly to these departments. In case they are shortlisted, according to the criteria of the departments, they should mention at the time of interview that they are interested in Ph. D. Topics offered by CRNTS. Second round of interview of further shortlisted candidates will be conducted in CRNTS as given in the schedule. Note that the candidates *should* apply to the department(s) mentioned http://www.saif.iitb.ac.in/crnts/phd_topics.pdf **and NOT to CRNTS.**

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 with any one of the following :

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
1. Condensed Matter Physics-Theory
Electron correlation in one and many component quantum fluids, Many body effects in inhomogeneous electron systems and metal surfaces, Quantum magnetism, Algorithms for condensed matter theory, Theoretical studies on magnetism and superconductivity, Electronic structure of ordered and disordered alloys, insulators, conjugated polymers and clusters, Strongly correlated electron systems, Novel magnetic systems, Development of wave function based ab-initio methods for electronic structure

calculations, Study of control and thermodynamics of driven quantum systems with quantum information theory tools, ultrafast electron dynamics in solids.

2. Condensed Matter Physics-Experimental
Magnetic oxide thin films and metallic multilayers for various applications, Spintronic materials, Nano and bio magnetism, Strongly correlated electron systems, Quantum magnetism, Low-dimensional magnets, Metal-insulator transitions, Quasi 1d/2d magnetic systems and doping effects. Dilute magnetic semiconductors, Semiconductor nanostructures. Electrical and optical properties of semiconducting oxide and nitride thin films, Nanoparticles and nanostructured thin films, Langmiur- Blodgett organic multilayers, Conducting polymers. Bilayer GaAs quantum wells, Organic semiconductors, Perovskite semiconductors, Optoelectronics, Photodetectors & photovoltaics, Solar cells, 2D and other materials for energy applications

3. Optics/Photonics/spectroscopy-Theory:
Theoretical plasmonics and photonic bandgap crystals, Topological Photonics, PT symmetry in optics, Nonreciprocal optics, Theory of Metamaterials and metasurfaces, Computational optoelectronics of two-dimensional crystals and their heterostructures, Numerical Methods & Simulation Techniques for Nanophotonics, Complex Nanophotonic Device Design, Study of control and thermodynamics of driven quantum systems with quantum information theory tools, Quantum Optics Theory: Study of quantum synchronization of optical and opto-mechanical systems, EIT and other effects in unconventional systems using quantum information theory tools, Femto second and attosecond electron dynamics in atoms, molecules and solids. Time-resolved x-ray processes in matter.

4.Optics/Photonics/Light-matter interactions/Nano-photonics/Ultrafast phenomena/
Spectroscopy -Experimental
Light-matter interactions in various types of nanostructures and other materials like organic molecules, Graphene, MoS_2, Quantum wells, Quantum dots and their hybrid nanostructures, Plasmonics, Sensing, Nanoscale light sources (lasers/LEDs), Solar cells, All-optical switching,

Highly spatially and temporally resolved (ultrafast) spectroscopic investigations of optical response using various techniques, Development of 2D materials based nanoscale light sources, Photodetectors and data communications, Photovoltaic materials and devices for energy, Metamaterials, Metasurfaces, Magneto-optics, Micro-spectroscopy

5. High Energy Physics – Theory
Properties and interactions of fundamental particles, Gauge field theories and applications to cosmology, Neutrino physics and CP violation, String theory, Collider physics and QCD spin physics.

6. High Energy Physics and Nuclear Physics-Experimental
Properties of heavy ion collisions at ultra-relativistic energies involved in ALIC and CMS experiments at CERN. Experimental Nuclear Physics and Nuclear Medicine

7. Astronomy, Cosmology, Gravity – Theory
Cosmology and Gravity

8. Astronomy, Cosmology, Gravity – Experimental
Cosmology and Gravity, Gravitational Wave Physics, Multi-messenger and observational astronomy, Astronomical instrumentation

9. Statistical Physics/Bio Physics/Soft Matter Physics/ Non-Linear Dynamics - Theory
Biophysics, complex fluid polymers, Stochastic processes, Non-equilibrium dynamics, Slow glassy dynamics, Granular inelastic gases

10. Bio Physics/Soft Matter Physics/ Non-Linear Dynamics -Experimental
Bulk/interfacial Rheology, Synchrotron X-ray scattering, Particle tracking

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B. 23) POLICY STUDIES [PS]
(Ashank Desai Centre for Policy Studies)

The PhD Programme Structure:

The Ashank Desai Centre for Policy Studies (ADCPS) at IIT Bombay was conceived as a centre for research, education, training, and practice. In order to meet a growing need and demand for policy professionals in India, it was thought necessary that ADCPS have a Master's in Public Policy (MPP) programme as well as a PhD programme. ADCPS launched its PhD in Public Policy (MPP) programme from the Autumn semester of 2017.

ADCPS envisions myriad ways in which its PhD and MPP programmes and graduates from these programmes can contribute to IIT Bombay's intellectual expansion as well as to India's polity and society. The aim is to produce professionals or academics who seek to serve or lead in the interest of the public. These academic programmes will reflect the changing dynamics in today's world and the need for policy to keep up with technological advancements, globalization, nuanced and complex public debates, and the growing trend of building rights-based democracies. Policy can no longer be contained within the realm of government and bureaucracy; it has percolated into civil society, academic institutions, and the private sector. Through the programmes, ADCPS aims to give its students tools which are applicable in diverse situations and teach students how to adapt to various fields, contexts, or situations. Students of the programmes can then find themselves fitting into and contributing to the public or private sectors, working within the government, or in the not-for-profit/ NGO sector. They may choose to work for large corporations as analysts or lobbyists, or may do policy research in international organization,, think tanks, or universities. Finally, ADCPS in its academic programmes aims to capitalize on IIT Bombay's existing institutional strengths and build a department that can be a hub for public policy research and expertise. ADCPS's academic programmes integrates public policy, social sciences, and technology.

ELIGIBILITY FOR ADMISSION
At least one of the following criteria must be met:

1) B.E/B.Tech or *equivalent degree with 60% marks/6.0 CPI (55% marks/5.5 CPI for SC/ST).
2) M.Sc/M.A/M.Com/LLM/MCA or *equivalent degree with 60% marks/6.0 CPI (55% marks/5.5 CPI for SC/ST) at post-graduation level.
3) MBA/ME/M.Tech/M.Phil/ from any institute recognized by a Government body (AICTE/ UGC/ AIU) with 60% marks/6.0 CPI (55% marks/5.5 CPI for SC/ST).

* All equivalent degrees must be certified by their respective institution (s).

Candidates must also fulfill ONE of the following additional requirements for items 1 and 2 above:

(a) VALID CAT/GMAT/GRE score.
(b) Qualified in GATE/UGC-NET (Lectureship)/UGC-JRF/CSIR-NET (Lectureship)/CSIR-JRF/**DAE/** DST/DBT/ICMR/NBHM/ etc.)
(c) At least two years of work experience (acquired after obtaining the qualifying degree and completed before the starting of the semester in which admission is sought).

Criteria for awarding Teaching Assistant positions are as per IIT Bombay guidelines. [Please visit IIT Bombay PhD TA position guidelines]
Each student will need to indicate a research topic as stated here (www.cps.iitb.ac.in/academics/doctoral-programme/), in which they wish to carry out

doctoral research on policy related aspects. The prospective candidate is required to submit:

1. A research proposal on one of the above stated topics of policy relevant research. The proposal should contain (a) problem identification, (b) brief review of literature (c) proposed methodology, (d) reference (2000 words maximum, excluding reference). The research proposal will be graded for admission purpose.

A written examination and interview will be conducted for all students who meet the above criteria.

PROGRAMME STRUCTURE

The programme is structured to keep half of the credit load in the Policy area, and the other half is to be divided between (i) the courses in the sectoral area of interest e.g. water, energy, gender, communication etc. and (ii) Institute electives which would complement the policy courses and the domain courses, taking into account the student's background.

RESEARCH AREAS

A candidate must identify a problem from the following list of identified topics at ADCPS and indicate as such in the research proposal (please carefully read https://www.cps.iitb.ac.in/academics/doctoral-programme) :

i Digital Societies and Governance ii. Social Policy [Education, Ageing, Identity] iii. Water, Sanitation, Energy and Climate Change iv. Urban Policy v. Technology and Policy

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B.24) 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 with any one of the following :

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

Systems Theory: PDEs, mechanics, dynamical systems, optimization, game theory, systems theory, probabilistic methods, information theory, AI and learning theory
Control Theory: optimal, robust, stochastic, adaptive, linear and nonlinear, geometric, quantum, embedded

Robotics and Automated Systems: air-ground-water-space vehicles, drones, industrial automation, autonomous systems, reconfigurable and flexible structures

Connected and Information Systems: networked systems, social systems, multi-agent systems, quantum systems, analytics and data science, internet-of-things

All applicants are advised to look at the faculty webpage (https://www.sc.iitb.ac.in/coreFaculty.html) and the corresponding research areas before applying.

B.25) 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 with any one of the following :

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.

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
Sustainable materials & rural infrastructure

B.26) Urban Science & Engineering (US)
[Centre for Urban Science & Engineering (CUSE)]

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 planning and design, policy and governance, built environment and social and physical infrastructure while mitigating the effects of natural disasters and climate change. The centre combines 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 with any one of the following:

i. M.Tech./M.E./ 2-year MBA (following B. Tech/B.E or equivalent) or equivalent degree in any branch of Engineering/Medicine consistent with the research areas of the Centre

OR

Master's degree in Architecture, Urban Planning, or equivalent degree consistent with the research areas of the Centre

ii. B.Tech./B.E./MBBS or equivalent degree in any branch of Engineering/medicine consistent with the research areas of the Centre*

OR

Bachelor's degree in Architecture, Urban Planning, or related disciplines*

OR

M.Sc./MA/ MBA (following B.Com/B.Sc. or equivalent) or equivalent degree in Environmental Sciences, Energy Sciences, Geography, Social Sciences, Economics, Applied Mathematics, Statistics, or related disciplines*.

For qualifying degree listed under ii, candidates must also fulfil ONE of the following additional requirements:

1. Valid GATE/CEED score (for TA/TAP/RA/RAP)
2. Selected through National Eligibility Test – UGC NET including lectureship (Assistant Professorship)
3. A valid CSIR/UGC/DBT JRF or a valid ICMR JRF not linked to ICMR project (for FA)/BINC any fellowship that will provide scholarship for 5 years.
4. Experience as specified earlier in A.5 and A.6 (for CT, EX, IS, PS, SF, SW category)
5. Selected through a National level examination conducted by MHRD or its agencies/Institutions such as UGC/ IIT/ IISc./ IISER/IIIT etc.

* Minimum of TWO years of professional experience
relevant to the research areas of the Centre (acquired after obtaining the qualifying degree and completed before the starting of the semester in which admission is sought)

Criteria for awarding Teaching Assistantship is as per the guidelines mentioned in section A.6 of this brochure.
**B.Tech./B.S.degree/BE/B.Arch./B.Plan.(or equivalent)holders having a CGPA/ CPI score of 8.0 and above (on 0-10 scale) from an Indian Institute of Technology or any of the CFTIs is exempted from the requirement of a valid GATE score for the consideration of General Eligibility Requirement for admission

RESEARCH AREAS

Ph.D. students will be engaged in interdisciplinary research that will focus on urban challenges in India. They will work with Centre faculty in the following domains, including but not limited to:

Planning and Design
Policy and Governance
Social and Physical Infrastructure
Built Environment and Buildings
Informatics

All applicants are advised to visit the webpage of CUSE (https://www.cuse.iitb.ac.in) for more details on research areas before applying.

B.27) Digital Health (DH) [Koita Centre for Digital Health (KCDH)]

Koita Centre for Digital Health (KCDH) at IIT Bombay is the first of its kind in India, focused on driving academic programs, research, and industry collaborations in Digital Health.
Keeping in mind the interdisciplinary nature of the domain, the PhD program encourages the association of two research supervisors, preferably from two different academic entities (viz. departments or centres within IIT Bombay), to supervise the research of each Ph. D. candidate enrolled in KCDH. Also, collaborations with clinicians are encouraged for each research project.

ELIGIBILITY FOR ADMISSION

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

A. M..E./M.Tech/MS degrees in Engineering/ Technology

B. MS (Master of Surgery) / MD / MVSc / MDS / MPTh/MPharm/M.O.Th

C. MBBS, BDS, BPharm, BVSc, BPTh, BOTh (degree programme to be of 4 years or more) with 60 percent aggregate AND qualifying All India level post graduate entrance examination for corresponding disciplines such as AIIMS/NEET-PG/MCI/JIPMER/ PGI Chandigarh/AFMCPune/ for MBBS/BDS or GPAT (for Pharmacy graduates) or a valid CSIR/UGC/DBT/ICMR JRF not linked to ICMR project (for FA any fellowship that will provide scholarship for 5 years.

D, M.Sc./ M.S./ Integrated BS-MS in Physical sciences (Physics, Chemistry or equivalent disciplines), M.A./M.Sc./Integrated BS-MS in Mathematical sciences (Mathematics, Statistics, Biostatistics, Applied Statistics, Applied/Computational Mathematics or equivalent disciplines). M.Sc./ M.S. / Integrated BS-MS in Life sciences (specifically Biochemistry, Biophysics, Biotechnology, Physiology, Molecular Biology or equivalent disciplines)

E. B.E./B. Tech (Bachelor's degree in Engineering /Technology)/ 4 year BS (Mathematics, Applied/Computational Mathematics, Economics, Statistics or equivalent disciplines), with eligibility subject to specified admission procedure, would be considered. A valid GATE score and other IITB norms as per IITB PhD brochure will be required.

The candidates with qualifying degrees as mentioned in 'C, D & E' must fulfill one of the following:

(i) A valid GATE score
(ii) a valid CSIR/UGC/DBT/ICMR JRF not linked to ICMR project (for FA any fellowship that will provide scholarship for 5 years

(iii) Experience as specified earlier in A.5 and A.6 for CT, EX, IS, PS, SF, SW category

RESEARCH AREAS

1. Healthcare Applications
- EHR, EMR and clinical applications
- Medical imaging
- Medical devices software
- Payers and life sciences application

2. Healthcare Data Management
- Data interoperability and standards
- Data Privacy and Security
- Healthcare data warehousing & management
- Federated data management

3. Healthcare Analytics and AI/ML.
- Healthcare AI/ML
- Medical image analytics
- Clinical decision support
- Preventive & prescriptive analytics

4. Consumer Health & Tele-medicine
- Consumer health devices
- Mobile Health applications
- Tele-medicine applications
- Remote patient monitoring

5. Computational Biology and Bioinformatics
- Proteomics
- Genomics
- Pathway analysis
- Disease diagnosis

6. Population Health & Public Health Policy
- Disease surveillance & analytics
- Population health analytics

- Epidemiology & disease management
- Public health policy

B.28) Machine Intelligence and Data Science (MInDS)
[Center for Machine Intelligence and Data Science (CMInDS)]

The Center for Machine Intelligence and Data Science (CMInDS) at IIT Bombay, established in March 2020, is aimed at advancing the fields of Artificial Intelligence and Data Science, as well as their application domain through cutting-edge research and specialized education programs. More than seventy-five faculty members from fifteen departments are associated with the Center, with twenty-five of them actively involved in the direct functioning of the center.

The PhD program comprises an elaborate course-work for learning the required foundations and advanced concepts related to ML and AI, R&D projects, and a PhD thesis.

ELIGIBILITY FOR ADMISSION

First Class or 60% marks (55% marks for SC/ST), as specified in the General Eligibility Criterion, in the qualifying degree with any one of the following

1. Master's or equivalent degree in Engineering/Technology
2. Four years Bachelor's degree in Engineering/Technology/Science
3. Master's or equivalent degree in Science/Statistics/Mathematics
4. MBA (with B.Tech/B.E or an equivalent degree)

Note: The MCA (Master of Computer Applications) degree will be considered as being equivalent to a four-year BTech degree.

For candidates qualifying under (2) or (3), one of the following additional requirements must also be fulfilled:

a. Valid GATE score
b. A four-year Bachelor's degree from the IITs (BTech), IISc (BS), IISERs (BS-MS) or a Master's degree from ISI (any two year Master's degree), with CPI (normalized to a 10 point scale) >= 8

c. Minimum of TWO years of professional experience (acquired after obtaining the qualifying degree and completed before the starting of the semester in which admission is sought)

Minimum marks/CGPA/CPI in qualifying degree would be as per current Institute norms. *Among students admitted under criterion (b) above without a GATE score, only IIT BTech holders will be eligible for Teaching Assistantship.*

The Center will additionally conduct a written test and an interview to shortlist candidates. The written test will include topics such as general aptitude, programming, probability & statistics, calculus, and linear algebra. The syllabus can be found in the Admissions section of the CMInDS website: www.minds.iitb.ac.in

Course requirements

Given the diverse academic backgrounds of the students, five breadth topics have been defined, and the students are required to obtain proficiency in each of them. The topics are:

- Computing
- Probability & Statistics
- AI/ML
- Linear Algebra

- Optimization

A basket of IIT Bombay courses that provide the requisite background in each of these areas has been created.

PhD Qualifier
In order to qualify for the PhD program, students will have to fulfill the following criteria:

- For students with a Master's degree in Engineering/Technology (respectively, for those without), a CPI >= 8 averaged over 3 (respectively, 5) CMInDS courses taken at IITB within two semesters (respectively four semesters) of the start of joining. (By CMInDS courses, we mean courses that belong to our breadth/elective baskets.)
- A grade >= 8 in the PhD seminar

Students unable to meet these qualifying criteria will be offered an exit option (M.S. by Research) as per prevailing Institute norms.

Further details about the program can be found in the Academics section of the CMInDS website: www.minds.iitb.ac.in

Research themes (not limited to):
AI/ML theory: Concept learning, generalization bounds, handling data imbalance, learning from noisy labels, memory networks, adversarial attacks and preventions, interpretable AI, Bayesian modeling, uncertainty quantification in deep learning, causality and counterfactual reasoning, domain adaptation and generalization, robustness, human-machine interaction.

AI/ML in Finance: Risk Analytics, Consumer Analytics, Customer Data Analytics, Real-Time Analytics, Financial Fraud Detection, Personalized Services, Algorithmic Trading, Data Auditing, and Currency Note Salvage Automation, Game theory in Finance, Anomaly detection, and data quality.

Speech and language technologies specifically for Indian languages: Machine (and Spoken) Translation, Speech Recognition, Models for Code-Switching, Cross-Lingual Audio-Visual Learning, Sentiment and Emotion Recognition, Information Extraction, Explainable and Human-in-the-Loop Systems, Natural language interfaces to data, Conversational data analysis

AI in transportation: Automation in Highway and Railway Alignment Design, Predicting Road Runoff Crashes from Vehicle Dynamics Data, As-Built Geometric Features of Highways from Instrumented Vehicle Data, Driving Style Recognition from Vehicle Dynamics Data, Security Ratings of Transportation Facilities using Multi-Source User Data, Safety Evaluation of Transportation Infrastructure using Multi-Source User Data

AI in visual computing: Image classification, segmentation, object detection, weakly-supervised image classification, zero-shot and few-shot learning, continual learning, transfer learning and domain adaptation, multi-modal learning, multi-task learning, human activity analysis from videos, 3D computer vision using deep learning, image retrieval, medical image analysis, image rendering, Shape analysis from image sequences, remote sensing image analysis

AI & ML in Manufacturing: IoT / IIoT framework, performance analytics, fault detection & diagnosis, prognostics & diagnostics, condition-based monitoring, performance monitoring, physics assisted knowledge representation, filtering and estimation theory, distributed decision making, advanced and large scale optimization for prescriptive analytics, Regulation and Control, scheduling and decision support systems.

B.29) Economics
[Department of Economics]

ELIGIBILITY FOR ADMISSION

i. M.Phil. (awarded by IIT Bombay or equivalent 2 year degree) in Economics in 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 Economics,with 55% marks(50%for SC/ST). OR
Master's degree in Commerce with 55% marks(50%forSC/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

BS/B.Tech./B.E. or equivalent degreei in Economics/ 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, Design, Architecture, Management and Engineering/Technology or candidates with two years of PGDM from recognised Govt. Institution will be considered for research areas consistent with their academic background. Candidates having UGC-NET Lectureship(LS)/GATE are also eligible for Teaching Assistantship in addition to other academic qualifications

RESEARCH AREAS

Economics : Open-economy Macroeconomics; Environmental Economics, Socio-Economic Impacts of Climate Change; Energy Economics; Green Accounting; Development Policy; Natural resource and environmental economics; Water resource Economics; Climate change; Environmental Policy; Strategic Trade Theory and Policy; International Finance; Indian Economy; Analysis of Economic Policies; Productivity Measurement Comparisons and Determinants; Development Economics; Industrial Economics; International Business, Financial Economics; Monetary Economics and Macroeconomics; Corporate Investment; Health Economics; Applied Econometrics; Corporate governance; Labour economics; Microeconomic-Game Theory; Behavioural Economics; Experimental Economics; Agricultural Economics;Nonlinear time series analysis.

Appendix C.1

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

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Appendix C.2

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

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Appendix C.3

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 at IIT Bombay.

Further, if Shri. / Kum./ Smt. _____ is admitted to the Ph.D. programme, we shall fully relieve him/her from normal duties to complete the course work requirement (and qualifier examination, if applicable) at IIT Bombay.

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.

Any Intellectual Property developed by Shri. / Kum. / Smt. _____ during the course of his / her doctorate degree / Ph.D. programme will be owned by IIT Bombay, unless the sponsoring organization enters into a separate MoU/Agreement with IIT Bombay specifying the terms of IP ownership, before the enrolment of the candidate.

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

Appendix C.4

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

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

Dear Sir,

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

Our College/University has no objection to his/her application in the _____ (department) to join the Ph.D. Programme at IIT Bombay, under College Teacher (CT) category.

Further, if selected, the College/University has 'NO OBJECTION" to allow Shri./Smt./Kum. _____ to undergo the programme of studies and also to fulfill the coursework requirements (and qualifier examination, if applicable) at IIT Bombay.

Signature & Seal of the Head of the College/University

[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) Along with your application, you have to submit a Statement of Purpose or a Research Proposal as required by an academic unit.

(ii) If you are applying to the Ashank Desai Centre for Policy Studies (ADCPS) you need to specifically upload a research proposal (in place of a Statement of Purpose), along with the application form,that will be graded for admission purpose. The Research Proposal (in 2000 words or less excluding reference) for applying to the Ashank Desai Centre for Policy Studies, PhD programme must contain: (a) clear problem identification (see LIST of clearly identified topics announced on ADCPS webpage- must choose from this list only) (www.cps.iitb.ac.in/academics/doctoral-programme), (b) brief review of relevant literature (c) a clear proposed methodology, (d) recent reference.

(iii) If you are applying to Management (SJMSOM), you are required to submit research proposal (1500 words) on a topic of applicants' interest in place of Statement of Purpose. It should contain a) problem identification, b) brief review of literature, and c) methodology.

Applications without research proposal will not be considered.

(iv) If you are applying to Department of Humanities & Social Sciences, Policy Studies, CTARA or CSRE, you need to upload Statement of Purpose as well as a research proposal along with the application form. The Research Proposal for applying to Policy Studies, Technology & Development (CTARA) should contain (a) problem identification, (b) brief review of literature and (c) proposed methodology. The SOP for CSRE should refer to one or more topics of interest FROM THE LIST of topics announced on CSRE webpage https://www.csre.iitb.ac.in/phdTopics.php

(v). Candidates applying to IDC are required to submit a Statement of Purpose (SOP) along with a research proposal (~1500 words) that contains (a) the research area, (b) a brief review of the literature and (c) proposed methodology. The candidates must also submit a recent work or paper related to their area of research. A link to the design portfolio (drive folder/website/online documentation), if available, can be provided along with the SOP document.

(vi). Candidates applying to Educational Technology are required to submit a Statement of Purpose containing (a) your interests and motivation for applying to ET (max. 50 words), (b) relevance of your recent and current activities (max. 200 words), (c) details about your academic interests including (but not limited to) your areas of interest, a problem that interests you, and what you plan on doing after completing your Ph.D. (max. 250 words).

1. Name:
_____

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