

# Indian Institute of Technology Dharwad

## Department of Mechanical Engineering

### Ph.D. Admission for Autumn Semester, 2018

#### A. SCHEDULE OF PH.D. ADMISSION

S. No.	Particulars	Dates
1	Last date for submission of completed application forms	15 <sup>th</sup> May, 2018
2	List of shortlisted candidates for the Selection Process <sup>1</sup>	31 <sup>st</sup> May, 2018
3	Dates for the Selection Process	4 <sup>th</sup> and 5 <sup>th</sup> of July, 2018
4	Declaration of Result <sup>1</sup>	9 <sup>th</sup> July, 2018
5	Last date for Fee Payment (at IITDh)	20 <sup>th</sup> July, 2018
6	Date of Joining	23 <sup>rd</sup> July, 2018
7	Last date of withdrawal	25 <sup>th</sup> July, 2018

#### B. ELIGIBILITY FOR ADMISSION

**General Criteria:** M.Tech./M.E. or equivalent degree with specialization in either Machine Design or Thermal and Fluid Sciences of Mechanical Engineering Department.

##### B.1. Minimum score in the qualifying degree

For General/OBC category candidates and/or for candidates where no concession in academic performance is called for, the eligibility criteria in the qualifying degree (M.Tech./M.E.) is

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<sup>1</sup> Will be announced on the institute webpage

**First Class** as specified by the University. If the University doesn't specify the division/class, then either:

1. a minimum of 60% marks (without round off) in aggregate.
2. a minimum Cumulative Grade Point Average (CGPA) or Cumulative Performance Index (CPI) of 6.0 on the scale of 0-10; with corresponding proportional requirements when the scales are other than on 0-10, (for example, 4.8 on a scale of 0-8).

For SC/ST category candidates, a relaxation of 5% in the qualifying degree is applicable.

## **C. GUIDELINES FOR SHORTLISTED APPLICANTS**

The following are the important guidelines of the institute on 4<sup>th</sup> of July, 2018 at 8 AM.

1. Shortlisted candidates should report the institute on 4<sup>th</sup> of July, 2018 at 8 AM
2. No accommodation will be provided in the campus during the written/interview
3. Applicants should bring:
  - a. Photo ID card
  - b. Printed copy of the application
  - c. Thesis/dissertation/report of M.Tech. or equivalent degree
  - d. Copy of certificates and mark-sheets
  - e. Two passport size photographs
  - f. Non-programmable scientific calculator

### **C.1. DO NOT'S**

- a. Mobiles are not allowed in the examination hall or onto the interview room
- b. Department's decision is the final regarding any disciplinary matters
- c. Institute doesn't take any responsibility of your luggage/items that you leave before entering the examination hall.

## **D. MODALITY OF WRITTEN TESTS AND INTERVIEW**

The selection process consists of two written rounds and an interview. The written tests comprise of an objective and a subjective test, and are referred to as First round and Second round, respectively. The interview is Third round.

Candidates shortlisted based on the selection criteria have to attend First round based on the syllabus given in Section G. Only candidates selected in First round are allowed to write Second round in the area of specialization chosen in the PhD application form. No change in specialization will be allowed. Second round comprises of a subjective test appropriate to their chosen specialization in the PhD application form, and the syllabus for the test is detailed in Section G. Candidates selected in Second round are required to attend Third round comprising of technical interview. The details of the tests/interview are given in the following sections.

#### **D.1. Details of first round**

1. There is a 90-minute objective test to all the applicants
2. Syllabi for Fluid and Design fields are given in Section 0
3. A user name and a password is given to you to login and start the exam.
4. Basing on the choice of your problem statement, your question paper will be either from Fluid-Thermal field or from Design Field.
5. You cannot change your field.
6. There is negative marking for all answers that are wrongly marked.
7. Submit your answers and logout after your examination.
8. After the examination, wait till the shortlisting for the second round of selection will be displayed on the notice board
9. Second round of selection follows immediately after announcing the result.
10. It is the responsibility of the applicant to be inside the campus till the result is announced.
11. No personal information will be given.

#### **D.2. Details of second round**

1. The examination contains 90 minutes of subjective paper
2. Syllabi for Fluid-Thermal and Design fields are given in Section 0.
3. All answers should be written in clear hand writing
4. Assumptions made should be written down
5. No additional sheet will be provided
6. The results will be announced for the third round of selection process.

### **D.3. Details of third round of selection**

1. A personal interview is conducted to each applicant.
2. The applicant is advised to read some material regarding the topic that he/she has chosen in the application form
3. Faculty from all fields and from other departments will present in the interview panel
4. The final list of selected applicants will be announced for pre-spot registration

## **E. APPLICATION CATEGORIES AND FINANCIAL SUPPORT**

The Department of Mechanical Engineering admits Ph.D. candidates under the full time research scholarship, Teaching Assistantship (TA) only.

### **E.1. Teaching Assistantship (TA)**

Funded by MHRD, the TAs are expected to assist in the academic/administrative work for smooth functioning of the Institute. Students under this category are entitled to financial support as per MHRD norms.

1. For students with M.Tech./M.E./M.Phil. or equivalent degree as the qualifying degree, the assistantship is payable for a maximum duration of 5 years or up to the thesis submission, whichever is earlier. At present, the monthly rate of assistantship is ₹ 25,000 for the first 2 years and enhanced rate of ₹ 28,000/- for the remaining period.
2. To get Teaching Assistantship, the students concerned must assist in teaching, research and/or administrative work as assigned by the respective Academic Unit to the extent of 8 hours of work per week.
3. The continuation of the assistantship will be subject to satisfactory performance of the duties assigned by the Departments as well as satisfactory academic performance.
4. Employees on the rolls (with or without pay) of any organization are not eligible for admission under this category.

As per MHRD directives, the employees of any organizations with or without pay are not eligible for admission under TA category. Candidates selected in this category have to resign from the current job and submit a relieving letter from their employer before joining the programme. Students getting assistantships from the Institute may join projects sponsored by external agencies and obtain corresponding fellowships in lieu of TA ship.

## F. PROBLEM STATEMENT WITH BRIEF DESCRIPTION

There are four topics floated in the department for the PhD program in this semester. Applicant has to choose one of these topics and fill in the application form.

### 1. Impingement of fluid jet on the particle bed

- **Statement:** A significant local scour is observed when fluid jets impinge upon material (e.g. the plunging water flow found under dam spillways leading to the erosion of the channel bed and to the possible weakening of engineered structures, erosion of hydraulic turbines due to silt). Jet-induced scour may also be desirable, e.g. high-velocity water jets to mobilize accumulated sediment particles, abrasive-jet machining, removal of layers (sometimes selective layers) of coatings from substrate surfaces. Hence, it is important to understand the erosion of material (e.g. that of loose or bonded bed of granular particles), by the action of fluid jet impingement.
- **Methodology:** Here, simulation studies on impingement of fluid jet (with/without suspended particles) on the particle bed is proposed in order to characterize erosion. For this purpose, a high performance algorithm is to be developed which comprises of the kinetic theory based numerical technique, referred as the lattice Boltzmann method (LBM). It is then necessary to be coupled with the particle based discrete element method (DEM) representing the finite size of particles in the problem. Thus, the DEM-LBM coupled simulations are proposed to be employed to understand wet impact (i.e. fluid jet to the DEM particle bed), wherein it is necessary to model the two phases (liquid phase for the jet fluid and solid phase corresponding to the particle bed).

### 2. Impact of hydrophilic and hydrophobic bodies onto a liquid-air interface

- **Statement:** It is important to analyze effects when a solid or deformable body (hydrophilic or hydrophobic) impact onto a liquid surface. Analysis of splash, crater or cavity formation bubble trapped is important in many applications such as industrial coating. A combined experimental and numerical investigations of the impact is proposed. This work shows a good potential for fluid mechanics analysis in natural phenomena.

- **Methodology:** For the experimental part of the research, simple table-top set-up using flow visualizations techniques (high-speed camera) and PIV software to obtain the instantaneous velocity field is proposed. For the simulation part of the research work, a two-phase (air and water) LBM algorithm with a correct representation of the liquid interface (sharp or diffused) coupled with DEM type algorithm is proposed for this class of fluid-structure interaction problems.

### **3. Design and development of multi-fingered robotic hand for manipulation**

- **Methodology:** Survey of kinematics, statics and control of kinematic linkages that emulate hand, Developing a low cost prototype of multi-fingered hand, Exploring novel mechanisms for robotic hand and novel applications.

### **4. Reconfigurable mechanisms**

- **Methodology:** Survey of the field of reconfigurable mechanisms which has prominently emerged in last decade, Exploring novel connections with compliant mechanisms and static balancing.

## G. SYLLABUS FOR THE WRITTEN TEST

### Engineering Mathematics: Common for Fluid-Thermal and Design Streams

- **Linear Algebra:** Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.
- **Calculus:** Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.
- **Differential equations:** First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.
- **Complex variables:** Analytic functions; Cauchy-Riemann equations; Cauchy's integral theorem and integral formula; Taylor and Laurent series.
- **Probability and Statistics:** Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.
- **Numerical Methods:** Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.

### Design Stream

- **Engineering Mechanics:** Free-body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations, collisions.
- **Mechanics of Materials:** Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.

- **Theory of Machines:** Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope. Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.
- **Machine Design:** Design for static and dynamic loading; failure theories; fatigue strength and the S-N diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.

### **Fluid-Thermal Stream**

- **Fluid Mechanics:** Fluid properties; fluid statics, manometry, buoyancy, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes and bends, flow in convergent-divergent channels, vorticity and stream-functions, elementary Computational Fluid Dynamics, finite-difference approximation to the first and second order partial derivatives.
- **Heat-Transfer:** Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan- Boltzmann law, Wien's displacement law, black and grey surfaces, view factors radiation network analysis.
- **Thermodynamics:** Thermodynamic systems and processes; properties of pure substances, behaviour of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.
- **Applications Power Engineering:** Air and gas compressors; vapour and gas power cycles, concepts of regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and



dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes.

- **Turbomachinery:** Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines.