

Course Requirements for Ph. D. Candidates in Mechanical Engineering

Introduction

The Ph. D. program at the Department of Mechanical Engineering, IIT Kanpur is committed to developing researchers and academicians capable of independent and original research of the highest possible quality. Thus, in addition to completing a Ph. D. thesis in keeping with global research standards, care is taken to ensure that Ph. D. students develop a broad-based firm grounding in at least one of the **four research areas**: Solid Mechanics & Dynamics; Robotics, Optimization & Design; Fluid & Thermal Sciences; and Manufacturing Science. Additionally, we make sure that the student is exposed to other scientific and research areas by providing a set of electives unmatched by any other Mechanical Engineering Department within the country.

Course Requirements

1. A Ph. D. student will do eight (8) courses as part of the requirements of the Ph. D. program in Mechanical Engineering, except when the Exception Clause (see below) is deemed to apply in select individual cases.
2. These eight (8) courses will comprise
 - a. four (4) major courses; see description in the following section,
 - b. three (3) electives that may be chosen from across the institute, and
 - c. one (1) technical communications course.
3. It is expected that the student will finish his major coursework within one year of his joining, and all eight courses within two years.

Major Courses:

1. The Department has constituted the core course template of four major research areas:
 - a. *Solid Mechanics & Dynamics*, b. *Robotics, Optimization & Design*, c. *Fluid & Thermal Sciences*, and d. *Manufacturing Science*.
2. A sequence of four major courses will consist of one applied mathematics course and any three courses chosen from one (and only one) research area's core course template.
3. The Applied Mathematics courses available currently are
 - i. ME 681: Mathematics for Engineers
4. The core course templates for the four research areas are
 - a. *Solid Mechanics & Dynamics*
 - i. ME 621: Introduction to Solid Mechanics
 - ii. ME 622: Theory of Elasticity
 - iii. ME 625: Applied Dynamics and Vibrations
 - iv. ME 626: Vibration of Continuous Systems
 - b. *Robotics, Optimization & Design*
 - i. ME 621: Introduction to Solid Mechanics OR ME 625: Applied Dynamics and Vibrations
 - ii. ME 751: Computer Aided Engineering Design OR ME 752: Optimization Methods in Engineering Design
 - iii. ME 623: Finite Element Methods in Engineering Mechanics
 - iv. ME 762: Introduction to Robotics OR ME 763: Robot Manipulators: Dynamics and Control
 - c. *Fluid & Thermal Sciences*
 - i. ME 631: Viscous Flow Theory
 - ii. ME 641: Conduction and Radiation
 - iii. ME 642: Convective Heat and Mass Transfer
 - d. *Manufacturing Science*
 - i. ME 661: Manufacturing Science I
 - ii. ME 662: Manufacturing Science II
 - iii. ME 663: Metal Forming
 - iv. ME 698M: Meso-Micromanufacturing (provisional course number).
 - v. ME 658: Numerical Control of Machine Tools OR ME 761: Computer Aided Manufacturing OR ME 764: Computer Integrated Manufacturing Systems OR ME 779: Rapid Prototyping and Tooling Technology

Important Remarks:

1. In any core course template above, only one of the courses separated by "OR" will be counted towards the major course requirement.
2. Mixing courses from the course template of any two research areas in order to complete the major course requirement is not permitted.
3. An incoming Ph. D. student selects a research area from which to complete his major course requirement before selecting an advisor. Thus, he should make this selection carefully, keeping in mind his research interest and possible future advisor(s).

Electives:

Post-graduate level elective courses may be taken from anywhere in the Institute. Courses from within the core course template may also be electives, provided the major course requirement is complete. Some electives offered regularly by the department are:

ME 623: Finite Element Methods in Engineering Mechanics

ME 624: Calculus of Variations

ME 629: Stability of Engineering Systems

ME 726: Hamiltonian Mechanics and Symplectic Algorithms

ME 671: Experimental Stress Analysis

ME 721: Plasticity

ME 725: Granular Materials

ME 727: Composite Materials

ME 729: Modeling Mechanical Properties of Materials

ME 724 Theory of Martensitic Phase Transformations

ME 728: Fracture and Fatigue

ME 698I: Contact Mechanics

ME 627: Nonlinear Vibrations

ME 723: Wave Propagation in Solids

ME 756: Vibration Control

ME 650: Solar System Mechanics

ME 660: Space Mechanics

ME 654: Mechanics of Ground Vehicles

ME 778: Engineering Acoustics and its Control

ME 698A: Advanced Topics in Engineering Optimization

ME 767: Evolutionary Algorithms in Search and Optimization

ME 639 Liquid-Vapour Phase Change Phenomena

ME 649: Experimental Methods in Thermal Science

ME 690: Alternate Fuels and Advances in IC Engines

ME 691: Engine Management

ME 647: Introduction to Turbulent Fluid Mechanics

ME 630: Numerical Fluid Flow and Heat Transfer

ME 634: Advanced Computational Fluid Mechanics

ME 673: Flow, Heat and Mass Transfer Through Porous Media

ME 685: Programming and Numerical Analysis

ME 689: Microscale Thermal Engineering

ME 743: Fuel Cells

ME 744: Combustion and Reacting Flow

ME765: Advanced Topics in Non-traditional Machining Processes

ME 698E: Bio-MEMS & Micro-Systems

Exception Clause:

1. The DPGC may decide to waive one or more of the major courses for a candidate if it accepts that he/she has taken an exactly equivalent course at the Masters' level.
 - a. However, if all four of the core courses are waived, these four will need to be replaced by one elective, so as to satisfy the Institute's minimum requirement of four courses for Ph. D. students.
2. The technical communications course may also be waived if an analogous course was done earlier.
3. Candidates with non-mechanical backgrounds may be accepted by the DPGC as Inter-disciplinary candidates. In these cases, the DPGC shall prescribe at least two major courses selected with a view to increase the candidate's exposure to Mechanical Engineering. In this spirit, these two courses may be chosen from any of the four major research areas' core template. The remaining major courses will be replaced by electives.
4. In the case of QIP candidates, the DPGC may agree to waive at most one elective. The technical communications course may also be waived, if an equivalent course has been previously done.
5. In the case of external candidates, the current norms of four elective course will continue to apply.