

## Research topics for graduate students for 2023

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Acceptable course(s)

- Master's Degree
- Doctoral Degree



#### Research Topics

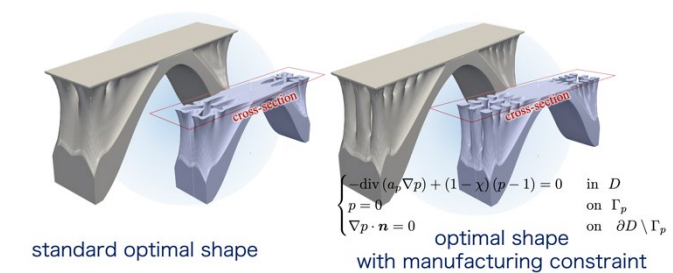
The main topic of research is the mathematical theories and applications of topology optimization. Following are a few research topics.

**Keywords:** *topology optimization, functional analysis, computational mechanics, partial differential equations, numerical analysis, sensitivity analysis*



#### 1. Partial Differential Equation (PDE) for manufacturability evaluation in topology optimization

Optimal shapes obtained by topology optimization are mechanically optimal, but the shape is often difficult to manufacture. To overcome the issue, we are working to develop mathematical models for manufacturability. The relationship between geometrical features and solutions of partial differential equations is studied theoretically.



#### 2. Design of meta-devices and meta-materials using topology optimization

We study design theories that exploit the expression of unusual properties to achieve unusual characteristics and functions or significantly higher performance.

#### 3. Mathematical theories related to optimal design

We study homogenization methods based on asymptotic expansions, and regularization theories for optimal design methods and its numerical analysis.

#### Articles Related to Research Topics

- [1] Yamada, T. *et al.*, Topology optimization with a closed cavity exclusion constraint for additive manufacturing based on the fictitious physical model approach, *Additive Manufacturing*, Vol.52, (2022), p.102630. [ArXiv](#) [DOI](#)
- [2] Oka, T., *et al.*, Nesterov's acceleration for level set-based topology optimization using reaction-diffusion equations. [ArXiv](#)
- [3] Matsushima, K., *et al.*, Unidirectional invisibility in a PT-symmetric structure designed by topology optimization, *Optics Letters*, Vol.47(13), (2022), pp.3315-331. [DOI](#)

Lab. Web page: <https://www.mid.t.u-tokyo.ac.jp/en/introduction/index.html>