Indian Institute of Technology, Kanpur

Proposal for a New Course

1. Course No: AEXXX 631

2. Course Title: Multidisciplinary Design Optimization

3. Per Week Lectures: 2 (L), Tutorial: 0 (T), Laboratory: 3 (P), Additional Hours[0-2]: 0 (A),
Credits (3*L+2*T+P+A): 9 Duration of Course: Full Semester

4. Proposing Department/IDP: Aerospace Engineering 2-0-3-0-(9)

Other Departments/IDPs which may be interested in the proposed course: All Departments/IDP
Other faculty members interested in teaching the proposed course: --

5. Proposing Instructor(s): Prof. Prabhat Hajela, Dr. Pradeep Moise

6. Course Description:

A) Objectives: The main objective of the course is to introduce students to Multidisciplinary Design Optimization (MDO) emphasizing its role in integrating multiple disciplines for effective design solutions. It further aims to engage them in hands-on projects to learn concepts and explore MDO principles using available software tools in Lab sessions.

B) Contents (*preferably in the form of 5 to 10 broad titles)*:

S. No.	Broad Title	Topics	No. of Lectures
1.	Overview of Multidisciplinary Design Optimization	• Definition • Historical Perspective • Applications	1
2.	Fundamentals of Optimization	• Optimization problem formulation • Optimization algorithms • Gradient-based Methods • Multi-objective Optimization • Evolutionary Algorithms • Other Heuristic Search Methods	8
3.	Multidisciplinary Analysis (MDA)	• Nature of Coupled Analysis • Design Structure Matrix (DSM) • Ordering of Analysis for Computational Efficiency • Approximations in Analysis – Response Surfaces, Kriging, Neural Networks	4
4.	Sensitivity Analysis	• Sensitivity Analysis Methods	5

5.	Multidisciplinary Design Optimization Frameworks	• Overview of MDO Frameworks • Decomposition Methods for Optimization • Hierarchical and Collaborative Optimization	4
7.	Emerging Trends and Future Directions in MDO	• Integration of Artificial Intelligence and Machine Learning • Optimization under Uncertainty • Digital Twins	4
		Total	**26**

(C) Pre-requisites: None

(D) Short summary for including in the courses of Study Booklet: The course provides a comprehensive exploration of optimization principles applied to complex engineering systems. It begins with an introduction to the importance and significance of MDO, emphasizing its role in integrating multiple disciplines for effective design solutions. The course includes a brief overview of optimization methods, including important gradient-based methods and non-traditional/heuristic methods for optimization such as genetic algorithms and particle swarm optimization. The course also examines multidisciplinary systems analysis, emphasizing modeling techniques and sensitivity analysis to understand system behavior. MDO frameworks and algorithms are reviewed, showcasing hierarchical, collaborative, and concurrent approaches. Design space exploration strategies are discussed, emphasizing Pareto optimization and decision-making under uncertainty. The role of machine learning and artificial intelligence in multidisciplinary design optimization will be examined. Students will engage in hands-on projects to learn concepts and explore MDO principles using available software tools. Completion of a team-based project that examines some aspect of MDO in greater detail will be required of all students.

7. Recommended Books:

1. Engineering Design Optimization, Joaquim R.R.A. Martins, Cambridge University Press, 2022. Free PDF version is available: https://mdobook.github.io
2. Numerical Optimization Techniques for Engineering Design: With Applications, G.N. Vanderplaats, VR&D Press.

8. Any other remarks: --

Dated: 27/5/2024 Proposer: Prof. Prabhat Hajela, Dr. Pradeep Moise

Dated:_____ DUGC/DPGC Convener:_____

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____

AE

O/C scan 27/8/24

INDIAN INSTITUTE OF TECHNOLOGY KANPUR
POSTGRADUATE OFFICE

No. A(P)/IITK/course approval/
August 27, 2024

The Convener, DPGC
Departments of AE/SEE/CHE/SPASE
IIT Kanpur

I am directed to communicate the concurrence of the SPGC (2023-24) in its 10th meeting held on 15/07/2024 for the approval of new PG course proposal. After detailed discussion the following courses were approved.

Course No	Title	Credits	Instructor	SPGC Decision
SPA626	Space Environments and Space Systems	3-0-0-0-(9)	Dr. Rohit Sharma Dr. Soumyabrata Chakrabarty	Approved
AE631	Multidisciplinary Design Optimization	2-0-3-0-(9)	Dr. Prabhat Hajela, Dr. Pradeep Moise	Approved
AE632	Structural Vibration and Control	(3-0-0-0-9)	Dr Tanmay Mathur Dr Dipak Giri	Approved
AE651	System Identification Techniques for Aerial Vehicles	3-0-0-0-(9)	Dr. Subrahmanyam Saderla	Approved
SEE618	Heating, Ventilation, and Air-conditioning of Buildings	3-0-0-0-(9)	Dr. Aakash Chand Rai	Approved
CHE669	"Chemical Kinetics: Reaction Rate Theories and Rare-Event Simulations	3-0-0-0-(9)	Dr. Vishal Agarwal	Approved

Assistant Registrar
Academic Affairs

CC: OARS (DOAA Office) For necessary action