ME 794 **Statistical Design of Experiments** **Spring 2023**

Course Objectives:

Design of experiments (DOE) is an essential part of any engineering or scientific study that enables understanding of the relationship between multiple input variables, or factors and the key responses, or product/process performance. DOE techniques are based on probability theory and statistical tools. In-depth knowledge of these tools is equally quintessential in scientific research while conducting scientific experiments.

This course presents concepts blended with hands-on tutorials for the design of experiments to emphasize proper methods for data collection, defining quality parameters, diagnostic tools, quality analysis, and interpretation for process/product improvement.

Instructors:	Prof. Soham Mujumdar S23, Mechanical Engineering Phone (O): 022 2576 7512, Email: sohammujumdar@iitb.ac.in
TAs:	Ratan Ahuja (ratanahuja@iitb.ac.in), Rajendra Hodgir (rajendra.hodgir@iitb.ac.in)
Lecture Hours:	(Slot 14) Tuesdays and Fridays, 5:30 pm to 6:55 pm
Venue:	CL 111 ESE
Office Hours:	Wednesdays, 3 pm to 4 pm by appointment, at S23, ME
Online Platform:	MS Teams, Team Code: '**8aax5v3**' (https://www.cc.iitb.ac.in/attachments/onlinemeetings/RegisteringLDAP.pdf) **Please enroll yourself in the class using your IITB LDAP ID**. How to use MS Teams: https://www.cc.iitb.ac.in/attachments/onlinemeetings/howto_use_mtm.pdf
Content Delivery:	Lectures will be delivered in person during the regular lecture slots, *which you are required to attend*. *You will be required to take your own notes during the lectures.* Only some parts of the lectures will be made available later in the form of slides.

Grading Scheme*: (*This is tentative and may change based on how things develop)		
	Quizzes	40%
	Assignments	20%
	Final Exam	25%
	Team Project	15%

Quiz:	You will be given five (5) long quizzes throughout the semester, out of which the best four (4) will be considered toward the final grade. The quizzes will be pre-announced. **No request for a re-quiz will be entertained (no exceptions).**

Project: A course project in the broad area of statistical design of experiments or quality control is expected. Teams of a maximum of FOUR students will be allowed to work together and present their work in the form of a presentation and *a well-written report*. As the project will constitute 15% of the total grade, **I expect a decent amount of time to be put into it.** You are encouraged to work with senior graduate students to perform the experiments and collect the data for your projects.

Honor Code: **This class has a ZERO tolerance policy toward plagiarism.** Any student/group found to have ***committed or aided and abetted*** the offense of plagiarism will receive ***ZERO marks*** for the relevant assignment/quiz ***without any exceptions.***

Tentative Syllabus:

Fundamental Concepts and Methods

- Quality philosophy and conceptual framework
- Statistical Methods and Probability Concepts for Data Characterization

Classical Design of Experiments

- Nature of variability, probability distributions
- Empirical models (regression, hypothesis testing, confidence intervals, applications)
- Two-level factorial designs (factor effects, ANOVA, residual analysis, interactions)
- General 2^k factorial designs
- Two-level fractional factorial designs

Response Surface Methodology

- First and second-order models and surfaces
- Central composite designs
- Multiple response analysis, Design rotatibility, Box-Behnken design

Robust Design Method

- Quality loss function, signal, noise and control factors, product life cycle
- Matrix experiments using orthogonal arrays, analysis of means and variance, error prediction
- Steps in robust design: noise factors and testing, signal-to-noise ratio, degrees of freedom, selection of orthogonal arrays
- Conducting matrix experiments: randomization, confounding, result interpretation, verification
- Factor interactions, dynamic problems

Reference Books:

1. Devor, R. E., T. Chang, and J. W. Sutherland., "Statistical Quality Design and Control: Contemporary Concepts," Pearson, 2007, ISBN: 9780130413444.

2. **Montgomery, D. C., "Introduction to Statistical Quality Control," 5th Ed., Wiley, 2004. ISBN: 9780471656319**

3. Box, G. E. P., Hunter J. S., Hunter W. G., "Statistics for Experimenters: Design, Innovation, and Discovery," 2nd Ed., Wiley, 2005, ISBN: 0471718130

4. Montgomery, D. C., "Design and Analysis of Experiments," 8th Ed., John Wiley and Sons, 2012, ISBN: 1118146927

5. Phadke, M. S, “Quality Engineering using Robust Design”, Prentice Hall, 1995, ISBN: 9780137451678