Department of Chemical Engineering
Indian Institute of Technology Kanpur

ChE 454A: Unit Operations Involving Particulate Solids for Chemical Engineers
(3-0-0-0) (9 credits)

Instructor: Dr. Raju Kumar Gupta, Department of Chemical Engineering
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Timings: *Lectures:* All online lectures *via* zoom platform (Th 09:45-11:00 AM and M 11:00-12:15 PM)
PDF, video files will be released weekly
Online Platform: MOOKIT

Objective

The spread of chemical engineering skills into industries such as pharmaceuticals, minerals, biotechnology, food, ceramics and cement are ones in which solids can be even more dominant. The traditional chemical engineering curriculum lacks a structured approach to particulate science and technology due to inherent complexity of the subject. The aim of this course is to impart process engineering knowledge concerned with the production and processing of particulate solids. This course will provide knowledge on particle size analysis, size reduction and separation of solid particles from fluids.

Course contents

1. **Particles Size Analysis:** Sieve analysis, size distribution, size averaging and equivalence, size estimation in sub-sieve range, effectiveness of screen, description of shape and morphology of particles (flocs, porous particles, surface texture etc.)
2. **Size Reduction:** Theory of crushing and grinding, laws of crushing and grinding, crushing and grinding equipment and their selection
3. **Nanoparticles:** Synthesis, characterization and potential applications, enlargement of particles by agglomeration and other methods
4. **Storage of Solids:** Angle of slide and repose, general design consideration for bins, silos and hoppers
5. **Particle Mechanics:** Motion of particle in fluid, pressure-drop calculations for solid-liquid slurry flow, effect of particle shape, Stoke's law, hindered settling and jigging
6. **Sedimentation and Flotation:** Gravity and centrifugal sedimentation, design of sedimentation tank and continuous thickeners, mechanism of flotation, flotation agents and flotation equipment
7. **Fluidization:** Fluidization characteristics, aggregative and particulate fluidization, voidage and minimum fluidization velocity, voidage correlation, liquid-solid and gas-solid fluidization characteristics, industrial applications of fluidization
8. **Filtration:** Flow through filter cake and medium, washing and drying of cake, filter aids, selection of filtration equipment, constant rate and constant pressure filtration

9. **Other Separation Equipment:** Cyclone separator, air filter, electrostatic separator, and their design consideration
10. **Conveying of Solids:** Pneumatic and hydraulic conveying of solids, general characteristics and flow relations, mechanical conveyers

Grading: *Grading will be relative. For an A* grade, exceptional performance is necessary.*

Mid semester examination (closed book/notes)	25 points
Three announced quizzes (closed book/notes) *(best two will be considered)*	25 points
Participation during online discussions	10 points
End semester examination (closed book/notes)	40 points

Taking the End Semester Examination is a must to get a passing grade.

Missing Quizzes: Special consideration will be given on a case-to-case basis.

Cheating of any kind would result in severe punishment. It is assumed that you are truthful to your duty during the examination and otherwise. Please sign undertaking so that you will take all efforts to conduct yourself with the honour and dignity befitting a student of IIT Kanpur. Send signed undertaking to guptark@iitk.ac.in. Lastly, cheating of any kind (copying or taking help during examinations) would result in severe punishment including F grade.

All efforts will be made to conduct this course in a fair manner. In case of any ambiguity, the instructor's decision will be final.

Books Recommended:

1. McCabe, W.L., Smith, J. C. and Harriott, P., "Unit Operations of Chemical Engineering", 7th Ed., McGraw Hill, 2005.
2. Richardson, J. F., Harker, J. H. and Backhurst, J. R. and "Coulson and Richardson Chemical Engineering", Vol. II", 5th Ed., Butterworth-Heinemann, 2002.
3. Brown, G.G. and Associates, "Unit Operations", CBS Publishers, 1995.
4. Geankoplis, C. J., Transport Processes and Separation Process Principles, 4th Ed., Prentice Hall, 2003.
5. Perry, R. H., Green, D. W., Maloney, J. O., Perry's Chemical Engineers' Handbook, 7th Ed., McGraw-Hill Book Company, USA, 1997.