Approved in 39th BoA Meeting (25-03-2021)

Course Number	:	ME514
Course Name	:	Fundamentals of Multiphase Flow
Credits	:	3-0-0-3
Prerequisites	:	ME 210 and ME 303 or equivalent courses
Intended for	:	M.Tech/MS/PhD/UG
Distribution	:	Elective course

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1. Preamble:

Multiphase flow is often encountered in a variety of engineering applications such as power generation, nuclear reactor technology, food production, environmental flows, chemical process, aerospace and automotive industries. This course intends to extend the fundamental knowledge of multiphase flow which is a very vast area and has a wide scope in several fields of engineering. The course emphasizes the preliminary introduction and mathematical formulations of various multiphase flow problems. It also attempts to include the flow specific computational theories along with experimental measurement techniques so that students can be benefited to pursue the research in the relevant area. The last module of the course lists special topics in multiphase flow and the instructor is advised to select the topics and lecture distributions as per his/her interest.

2. Course modules with quantitative lecture hours:

- **Introduction and flow regimes [6hrs]**
  Introduction to multiphase flows, equations of motion, flow regimes in horizontal and vertical pipes, flow regimes with phase change
- **Modelling techniques for multiphase flow [12hrs]**
  Homogeneous flow models, drift flux models, separated flow models, dispersed phase modelling, modelling of annular and stratified flow
- **Computational techniques [10hrs]**
  Introduction to computational modelling of multiphase flow, population balance modelling for dispersed phase, interface tracking methods for multiphase flow (Volume of Fluid and Level set), particle methods for multiphase flow (Lagrangian Point Particle and Smoothed Particle Hydrodynamics), molecular dynamics
- **Experimental techniques [7hrs]**
  Introduction to experimental techniques, importance of measurement and experimentation, calibration, uncertainty analysis, error propagation, pressure, velocity and temperature measurements, measurement of size distribution for dispersed phase, measurement of void-fraction and interface reconstruction, data acquisition and analysis techniques
- **Special topics in multiphase flow [7hrs]**
  Granular flows, slurry transport, lattice Boltzmann method, phase change heat transfer, micro-fluidics, multiphase flow in micro-channels

3. **Text books:**

- Christopher E. Brennen, Fundamentals of Multiphase Flow, Cambridge University Press; 2005.
- S. Mostafa Ghiaasiaan, Two-Phase Flow, Boiling, and Condensation, Cambridge University Press; 2nd Edition, 2007.

4. **References:**

- John G. Collier and John R. Thome, Convective Boiling and Condensation, Oxford University Press; 3rd Edition, 1994.
- L. S. Tong and Y. S. Tang. Boiling Heat Transfer and Two-Phase Flow, CRC Press; 2nd Edition, 2010.
- R. Clift, J. R. Grace and M. E. Weber, Bubbles, Drops, and Particles, Dover Publications, Inc.; 2005.
- Mamoru Ishii and Takashi Hibiki, Thermo-Fluid Dynamics of Two-Phase Flow, Springer; 2nd Edition, 2011.
- J. P. Holman, Experimental Methods for Engineers, Tata McGraw-Hill; 7th Edition, 2001.
- Andrea Prosperetti and Grétar Tryggvason, Computational Methods for Multiphase Flow, Cambridge University Press, 2007.
- Grétar Tryggvason, Ruben Scardovelli and Stephane Zaleski, Direct Numerical Simulations of Gas-Liquid Multiphase Flows, Cambridge University Press, 2011.

5. **Similarity content declaration with existing courses:**

S. No.	Course code	Similarity content	Approx. % of content
1.	ME604	Introduction to experimental techniques, importance of measurement and experimentation, uncertainty analysis	5

6. **Justification for new course proposal if cumulative similarity content is > 30%:** NA