BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI

SECOND SEMESTER 2021-22

Course Handout (Part II)

Date: 15/01/2022

In addition to Part I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : **BITS F417 / ME F423**
Course Title : **Microfluidics and its Applications**
Instructor-in-charge **: Dr. Satish Kumar Dubey**
Instructor **: Dr. Satish Kumar Dubey and Dr. Sanket Goel Sangam Shrikanth**

1. **Scope and Objective of the Course:**

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

2. **Text Book:**

Fundamentals and applications of microfluidics by Nam-Trung Nguyen and Steven T. Wereley, Artech House, 2002.

Reference Books:

1. Introduction to Microfluidics, by Patrick Tabeling, Oxford University Press, 2005.
2. Theoretical Microfluidcs, by Henrik Bruus, Oxford Master Series in Condensed Matter Physics, 2008.
3. Microfluidics Fundamentals, Devices and Applications, Edited by Yujun Song, Daojian Cheng, and Liang Zhao, Wiley 2018.

3. Course Plan:

#	Learning Objectives	Topics to be covered	Lectures	Chapter in the Text Book
1	Introduction to Microfluidics	Physics at the microscale, role of various intermolecular forces.	2	T Ch 1
2	Dimensional analysis and scaling laws to understand fluid flow	To understand fluid flow in Microfluidic domain. Navier-Stokes equation and application to obtain certain exact solutions.	4	T Ch 2
3	Diffusion, mixing and separation of fluids in Microsystems	Analysis of dispersion phenomena, Passive and active mixing, Chaotic mixing, Hydrodynamics of microfluidic systems, bubbles, droplets	3	R1 Ch 4 R2 Ch 5
4	Electrohydrodynamics of microsystems	Electro-osmosis, Electrophoresis, Dielectrophoresis, Magnetophoresis	3	R1 Ch 5 R2 Ch 8-11
5	Introduction to flow simulation	Meshing, discretization and simulation using relevant software	3	R3 Ch 4
6	Introduction to microfabrication techniques	Photolithography- etching – embossing, Soft-lithographic patterning, mask design, surface modification.	3	T Ch 3 R1 Ch 7

7	Various detection mechanisms in Microfluidics	Electrical, Amperometric, Electrochemical, High-Speed, Colorometric, Fluorescence, Chemiluminiscence, Bioluminiscence	4	Notes
8	Characterization of Microfluidic Devices	Optical & Electronic Microscope, Profilometers, Scanning Probe Microscopy, Raman Spectroscopy, UV VIS Spectroscopy, Confocal Microscopy	3	Notes
9	Microfluidic Experimental flow characterization and External Flow Control	MicroPIV, Fluorescent microscopy Velocity and Laminar flow measurement and its control	2	T Ch 5
10	Microfluidics for Internal Flow Control	Microvalves, Micropumps, Micromixers, Microflow Sensors	2	T Ch 6, 7, & 8
11	Ancillary areas of Microfluidics	Digital Microfluidics, Thermofluidics, Optofluidics, Nanofluidics, Acoustofluidics	3	R2, Ch 12, 15, 16, 17 R3, Ch 5
12	Application of Microfluidics I Biomedical	Biomedical applications	4	Notes
13	Application of Microfluidics II	Biochemical applications	4	Notes
		Total	40	

4. Evaluation Scheme:

Evaluation Component	**Duration (minute)**	**Weightage (%)**	**Marks**	**Date & Time**	**Nature of Component**
Mid Semester Test	90	30	90	10/03 11.00am to12.30pm	**OB**
Lab work *	-	20	60	Evenly spaced throughout the semester	**OB**
Quizes	25 minutes	10	30	Evenly spaced throughout the semester during lecture hour	**OB**
Comprehensive Exam	120	40	120	06/05 AN	CB

5. Lab Experiments

The list of experiments and complete modalities of operation of the laboratory such as the exact titles of experiments, reports submission and evaluation methodology etc. shall be announced at the beginning of laboratory session by the lab instructors.

S. No.	Name of Equipment
1	Introduction to the software COMSOL and its application in Microfluidics
2	Simulation of Microfluidic system using COMSOL

3	Development of Micro-device using FDM based 3D printer.
4	Study the customized filament making for FDM 3D printer
5	Development of Micro-device with the photolithography process using dry film photoresist
6	Development of Micro-device using poly-di-methyl-siloxane (PDMS) based Soft-lithography
7	Development of paper Micro-device using solid wax printer
8	Study of Scanning Electron Microscopy
9	Understanding of Clean room and Electron Beam Deposition
10	Understanding of lithography process
11	Experiment on Droplet microfluidics
12	Experiment on micro fuel cell

NOTE:

1. **Chamber Consultation Hour**: To be announced in the on-line class room.

2. **Notices**: All notices concerning this course shall be displayed on the CMS Students are advised to visit regularly **CMS** (institute's web based course management system) for updates on the course matters.

3. **Make-up Policy**: Make-up shall be given only to the genuine cases with prior intimation. No make-up will be given for the quiz tests.

4. **Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and any type of academic dishonesty is not acceptable.

Instructor-in-charge