BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
SECOND SEMESTER 2019-20
Course Handout (Part II)

Date: 12/12/2019

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**

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**	**Topic**	**Lectures**	**Chap. Sec.**
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,	4	Notes

		Chemiluminiscence, Bioluminiscence		
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:

Component	Duration	Weightage		Date &Time	Remarks
		%	Marks		
Midterm	1Hr30m	20	60		Closed Book
Comprehensive Exam	3 Hr.	30	90	12 May 2020, AN	Closed Book
Quizzes[1]		10	30	During Lecture	Closed Book
Lab[2]		20	60		Open Book
Project[3]		20	60	To be announced	Open Book
Total		**100**	**300**		

5. Lab Experiments

i. Introduction to the software COMSOL and its application in MEMS/Microfluidics.
ii. Simulation of MEMS Sensors/Actuators using COMSOL
iii. Microfluidic simulations using COMSOL: Laminar Flow; Convection diffusion; Conjugate heat transfer.
iv. Development of Micro-device using FDM based 3D printing.
v. Development of electrically conductive polymers using CO2 Laser.
vi. Development of PCB/μ-devices using dry film resist based photolithography.
vii. Development of Micro-device using poly-di-methyl-siloxane (PDMS) based Soft-lithography.
viii. Development of micro-devices using liquid photoresist based Direct Laser Writing (DLW).
ix. Fundamentals of Clean room and demonstration of Electron Beam Vapour Deposition.
x. Study of Scanning Electron Microscopy

6. **Chamber Consultation Hour:** To be announced in the class.

7. **Make-up Policy:** There will no make-ups unless for genuine reasons. Prior Permission of the Instructor-in-Charge is required to take a make-up for any component.

8. **Notices:** CMS

Instructor-In-Charge

[1] Total 8 quizzes will be taken and the best 6 will be considered for the final evaluation
[2] The marks will be based on the lab reports and lab performance
[3] Evaluation: Project Outline - 20%, Project Report - 30%, Presentation and Demo - 50%