BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
Second Semester 2018–2019
Course Handout (Part II)

Date: 7.01.2019

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 : V. Meenakshi
Co-instructor : Aravinda Raghavan

I. Course Description :

Microfluidics is about manipulating fluids in miniaturized systems at the micro/ nano liter scale. This subject is now one of the frontiers in interdisciplinary research that has many applications; for example, in developing novel health care devices. An important advancement that has propelled research in this area is the ability to build micron scale structures using soft-lithography which doesn't require clean room facility. In this course, a student will learn the physics behind microfluidic devices through lectures, computer simulations, and lab work.

Here is a glimpse of the topics in this course: Dimensional analysis and scaling laws, Navier-Stokes equation, simulation of fluid flow in micro-channels, diffusion, mixing and separation of microfluids, controlling flows – pumps and valves, soft-lithography, principle behind microfluidics-enabled technologies such as ink-jet technology, lab-on-a-chip devices.

II. Learning outcomes

A. Dimensional and scaling analysis of fluid flow.
B. Fabricating micron scale structures using soft-lithography.
C. Analyzing microfluidic flow using COMSOL - computer simulation.
D. Surveying the various application of microfluidics.

III. Text Books:

1. *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.

III. Course Plan:

Lecture No.	Topics to be covered
1-2	Introduction to microfluidics – Physics at the microscale, role of various intermolecular forces.
3-6	Dimensional analysis and scaling laws to understand fluid flow.
7-13	Navier-Stokes equation and application to obtain certain exact solutions.
14-20	Introduction to flow simulation using computers - Meshing, discretization and simulation using COMSOL multiphysics software
20-25	Diffusion, mixing and separation of fluids in Microsystems - Analysis of dispersion phenomena, Passive and active mixing, Chaotic mixing.
25-30	Introduction to microfabrication techniques - Photolithography- etching – embossing, Soft-lithographic patterning, mask design
30-35	Experimental flow characterization – MicroPIV, Fluorescent microscopy
35-41	Application of microfluidics - Micropumps and microvalves, Lab-on-a-chip devices, micromixers
42	Conclusion

IV. Evaluation Scheme:

Component	Duration	Weightage (%)	Date & time	Nature of Component
Mid-semester exam	90 min	30%	13/3 3.30 - 5.00 PM	Closed Book
Lab project and Simulation assignment		35%		Experimental work (Open Book) and Take home
Comprehensive exam	3 hours	35%	07/05 AN	Closed Book

V. Make-up policy:

It is applicable to the following two cases and it is permissible on production of evidential documents.

(i) Debilitating illness.
(ii) Out of station with prior permission from the Institute.

VI. All notices will be displayed on the Physics Group Notice Board.

VII. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

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Instructors, BITS F417