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

1. **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.

1. **Learning outcomes**
2. Dimensional and scaling analysis of fluid flow.
3. Fabricating micron scale structures using soft-lithography.
4. Analyzing microfluidic flow using COMSOL - computer simulation.
5. Surveying the various application of microfluidics.
6. **Text Books:**
7. *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. **Course Plan:**

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| --- | --- |
| 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 |

1. **Evaluation Scheme:**

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| --- | --- | --- | --- | --- |
| 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 |

1. **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.

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

1. **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.

Instructors, BITS F417