PHY3116: INTRODUCTION TO SOFT MATTER PHYSICS

Effective Term
Semester A 2022/23

Part I Course Overview

Course Title
Introduction to Soft Matter Physics

Subject Code
PHY - Physics

Course Number
3116

Academic Unit
Physics (PHY)

College/School
College of Science (SI)

Course Duration
One Semester

Credit Units
3

Level
B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
PHY3290 Thermodynamics or equivalent

Part II Course Details

Abstract
The present course aims to teach the students about soft matter systems from the viewpoint of physics. This course covers a variety of soft matter systems, including polymer, protein & DNA structures, liquid crystals, surfactants, and colloids. This course describes many physical concepts and phenomena that are common in soft matter systems, including conformational entropy, self-assembly, phase transitions, glass transitions, and Brownian motions.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Understanding polymers: chain conformation, thermodynamics, dynamics, complex systems, etc.			x	
2	Understanding DNA and protein structures			x	
3	Understanding liquid crystal structures and liquid crystal phase transition			x	
4	Understanding surfactants			x	
5	Understanding self-assembly			x	
6	Understanding colloid systems and their phase transitions			x	
7	Understanding Brownian motions and the diffusion process			x	
8	Understanding soft matter characterization methods			x	

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Teaching and Learning Activities (TLAs)

	TLAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Including teaching of lecture materials, tutorial and problem solving sessions	1, 2, 3, 4, 5, 6, 7, 8	

2	Tutorials	Questions and answers sessions, during which students will be asked questions and can ask questions, and there will be time for discussion. Numerical problems will also be given to the students to solve. If needed, the lecturer and/or TA will give information or hints to help the students solve the problems.	1, 2, 3, 4, 5, 6, 7, 8	
3	Assignments	Individual works to be done by the students. The students will apply concepts and skills learned in the class to solve the assignment problems.	1, 2, 3, 4, 5, 6, 7, 8	

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Quizzes	1, 2, 3, 4, 5, 6, 7, 8	20	
2	Assignments	1, 2, 3, 4, 5, 6, 7, 8	10	

Continuous Assessment (%)

30

Examination (%)

70

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)

Assessment Task

1. Quizzes

Criterion

The student can understand and calculate the entropic elasticity in polymer conformations, polymer dynamics, physical interactions in DNA and proteins, translational and orientational entropies in liquid crystal structures, self-assembly of surfactants, phase transition in colloids, and Brownian motions. The student can explain the working principles of different characterization methods.

Excellent (A+, A, A-)

High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
2. Assignments

Criterion
The student can understand and calculate the entropic elasticity in polymer conformations, polymer dynamics, physical interactions in DNA and proteins, translational and orientational entropies in liquid crystal structures, self-assembly of surfactants, phase transition in colloids, and Brownian motions. The student can explain the working principles of different characterization methods.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)
Moderate

Marginal (D)
Basic

Failure (F)
Not reaching marginal level

Assessment Task
3. Examination

Criterion
The student can understand and calculate the entropic elasticity in polymer conformations, polymer dynamics, physical interactions in DNA and proteins, translational and orientational entropies in liquid crystal structures, self-assembly of surfactants, phase transition in colloids, and Brownian motions. The student can explain the working principles of different characterization methods.

Excellent (A+, A, A-)
High

Good (B+, B, B-)
Significant

Fair (C+, C, C-)

Moderate

Marginal (D)

Basic

Failure (F)

Not reaching marginal level

Part III Other Information

Keyword Syllabus

- Polymer:
  - Ideal chain, real chain, worm-like chain, entropic elasticity, mixing, solutions, network, gelation, glass transition, crystallization, etc.
- DNA and protein structures
  - Primary structure, secondary structure, tertiary structure, protein folding, DNA melting
- Liquid crystal
  - Isotropic, nematic, smectic, translational entropy, orientational entropy
- Surfactants
  - Surface tension, phase behaviours, membrane, applications of surfactants, etc.
- Self-assembly
  - Intermolecular forces, aggregation, active matter, etc.
- Colloids
  - Phase transitions, elasticity, Brownian motions, and diffusion.

Reading List

Compulsory Readings

	Title
1	Nil

Additional Readings

	Title
1	Polymer Physics by Michael Rubinstein and Ralph H. Colby, Oxford University Press
2	Soft Matter Physics by Masao Doi, Oxford University Press
3	Introduction to Biopolymer Physics by Johan van der Maarel, World Scientific
4	Fundamentals of Soft Matter Science by Linda S. Hirst, CRC Press