COURSE TITLE	**BIOLOGICAL NETWORK ANALYSIS**
COURSE CODE	**01CB0504**
COURSE CREDITS	**3**

Objective:

1 Understanding Network Theory in Biology
2 Protein Interaction Network Analysis
3 Gene Regulatory Network Reconstruction and Comparison

Course Outcomes: After completion of this course, student will be able to:

1 Apply concepts of biological networks, including protein interaction and gene regulatory networks, to model biological systems.
2 Analyze protein-protein interactions using experimental approaches and computational algorithms.
3 Apply methods for gene regulatory network reconstruction.
4 Analyze network motifs and hierarchical structures of regulatory networks.
5 Evaluate the ethical implications of systems biology.

Pre-requisite of course: Basic knowledge of Bioinformatics.

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
2	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Introduction to Graph & Network** Historical Context of Network Theory in Biology, Types of Networks (Small World, Random, Scale-Free, Hierarchical), Introduction to Biological Networks and their Significance, Types of Biological Networks, Network Parameters: Node Degree, Degree Distribution, Shortest Path, Clustering Coefficient, Network Centrality, Network Decomposition: Subgraphs, Motifs, Modules, Network Robustness: Topological, Functional, and Dynamical Robustness	5
2	**Protein interaction network** Protein-Protein Interactions (PPI): Stable, Transient, Physical, Genetic, Growth Mechanism of Biological Networks, Prediction of PPIs: Experimental and Computational Methods, Database of Biological Networks (STRING, BioGRID, STITCH, KEGG), Designing Network Circuitry (CYTOSCAPE), Practical Component: Application of Network Parameters	7

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Contents : Unit	Topics	Contact Hours
3	**Gene Regulatory Network (GRN)** Methods for Regulatory Network Reconstruction, GRN Models: Ordinary Differential Equation, Boolean, Probabilistic Boolean, Bayesian, Multi-layer Hierarchical Structure of Regulatory Networks, Network Motifs and Integrated Networks, Metabolic and Signaling Networks: Identification Methods, Emerging Technologies in GRN Reconstruction	5
4	**Biological network comparison** Pairwise and Multiple Network Alignment, Network Querying, Case Studies in Network Comparison, Challenges and Limitations in Network Comparison	5
5	**Methods in System Biology** Interaction-based methods, Construction based methods, and Mechanism-based methods. Ethical Considerations in Synthetic Biology and Artificial Gene Circuits, Flux Balance Analysis, Pathway Analysis, Biochemical and Metabolic Pathways Introduction to Cell Designer (Cytoscape etc), Integration of Systems Biology Informatics Infrastructure (SBII), Future Directions and Standards in Computational Systems Biology	6
Total Hours		**28**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Module1:Introduction to Graph & Network** To identify network using Network Analysis Tools	2
2	**Module1: Introduction to Graph & Network** To identify the best suited network parameters	2
3	**Module2: Protein interaction network** To identify the protein network using protein interaction network tool	2
4	**Module2: Protein interaction network** To draw Protein Interaction Network Analysis using online tool	2
5	**Module3: Protein interaction network** To compare PPI Prediction Methods results using sample data	2
6	**Module3: Gene Regulatory Network (GRN)** To compare Gene Regulatory Network Reconstruction tools	2
7	**Module3: Gene Regulatory Network (GRN)** To perform Metabolic Pathway Analysis using online NCBI tools	2
8	**Module3: Gene Regulatory Network (GRN)** To perform Metabolic Pathway Analysis using online KEGG tools	2
9	**Module4: Biological network comparison** To perform Biological Network Comparison using Reactome	2
10	**Module4: Biological network comparison** To perform Biological Network Comparison using IPA	2

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Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
11	**Module4: Biological network comparison** To analyse Biological Network with Cystoscape	2
12	**Module4: Methods in System Biology** To compare Biological Network generated from different tools	2
13	**Module5: Methods in System Biology** To analyze Biological Network Cystoscape using plugins	2
14	**Module5: Methods in System Biology** To compare Biological Network using Blast tools	2
Total Hours		**28**

Textbook :

1 Systems biology: a textbook, Klipp, E., Liebermeister, W., Wierling, C., & Kowald, John Wiley & Sons, 2016

References:

1 Networks, Networks, Newman, Mark, Oxford Academic, 2018

2 Systems Biology: Properties of Reconstructed Networks, Systems Biology: Properties of Reconstructed Networks, Palsson BØ, Cambridge University Press, 2006

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
30.00	30.00	10.00	10.00	10.00	10.00

Instructional Method:

1 The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

2 The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room

3 Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Supplementary Resources:

1 https://www.ebi.ac.uk/training/online/courses/network-analysis-of-protein-interaction-data-an-introduction/types-of-biological-networks/

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Supplementary Resources:

2 https://www.coursera.org/learn/network-biology

3 https://www.cs.ucdavis.edu/~filkov/classes/289l-W11/NetworkResources.html

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