Indian Institute of Technology Guwahati
Proposal for a New Course / Revision of a Course

Course Number & Title: BT 612 & Systems Biology	
L-T-P-C:3-0-0-6	
Type of Letter Grading (Regular Letter Grades / PP or NP Letter Grades): Regular Letter Grades	
Kind of Proposal (New Course / Revision of Existing Course): Revision of Existing Course	
Offered as (Compulsory / Elective):Electives	
Offered to: B Tech/M Tech/PhD	
Offered in (Odd/ Even / Any):Any	
Offered by (Name of Department/ Center):BSBE	
Pre-Requisite: BT 101 (Introductory Biology) or equivalent, MA101 and MA102 (Calculus and Linear algebra) or equivalent.	
Preamble / Objectives (Optional): This course is designed to introduce students to key ideas and mathematical tools of Systems Biology. Concepts of Systems Biology have their origin in Dynamical Systems Theory and associated mathematical developments. Biologists use both traditional and high-throughput experimental techniques to explore those concepts. Mathematical modeling is used to supplement those experimental observations and to generate new testable hypotheses.The mathematical aspects of Systems Biology fall in three broad categories - a) deterministic models, b) stochastic models for cellular and molecular processes and c) graph theory-based analysis of biological networks. This course will introduce students to all three approaches.	
Course Content/ Syllabus Introductions to systems biology: Key concepts of systems biology- dynamic systems,network, self-organization, emergent properties,homeostasis, robustness.Analysis of dynamical systems: Basic concepts of modeling biological systems using ordinary differential equations; Numerical methods of solving ordinary differential equations- Euler method;Graphical analysis of ordinary differential equation based models - direction field, phase plane; stability analysis of linear and non-liner systems of ordinary differential equations; Concept of Bifurcation.Modeling molecular network: Concept of molecular network and network motifs; Mathematical formulations for elementary molecular processes – Law of Mass Action, ligand binding, enzymatic reaction,transcription, translation; Analysis of biochemical switches, positive feedback, negative feedback,transcriptional circuits; Bifurcation, and hysteresis in network motifs.Stochasticity biochemical networks: Basic concepts of probability and random variables; Probability distributions-Binomial, Poisson, Uniform and Exponential distributions; Poisson Process – basic concept and numerical simulation; Numerical method for stochastic simulation of biochemical network-Gillespie's algorithm. Stochasticity in gene expression and non-genetic heterogeneity.Analysis of large networks: Basic concepts of Graph theory - degree distribution, clustering coefficient,pathlength, shortest path, Betweenness centrality;Random Networks - Erdös-Rényi Model. Properties of scale free networks; Barabási-Albert (BA) model;Network by duplication and divergence; Properties of large protein-protein interaction network, genetic network, and metabolic networks	
Books (In case UG compulsory courses, please give it as “Text books” and “Reference books”. Otherwise give it as “References”.	
Texts book and References: (Format: Authors, *Book Title in Italics font,* Volume/Series, Edition Number, Publisher, Year.)	
1.	Ingalls, Brian P. Mathematical Modeling in Systems Biology: An Introduction (1st edition). MIT Press, 2013.
2.	Wilkinson, Darren J. Stochastic Modelling for Systems Biology. Chapman & Hall, 2006.

3.	Junker, Bjorn H.; Schreiber, Falk (ed).Analysis of Biological Networks. John Wiley & Sons, 2008.
4.	Alon, Uri. An Introduction to Systems Biology-Design Principles of Biological Circuits. CRC Press, 2007.
5.	Szallasi, Zoltan; Stelling, Jörg; Periwal,Vipul (ed). System Modeling in Cell Biology,From Concepts to Nuts and Bolts. The MIT Press, 2006.