Synthetic Biology Circuit Design & Network Regulation — Hands-on

Learn how to think about biology as an engineer: design gene circuits, logic motifs and regulatory networks, then prototype and analyse them in silico. This module covers synthetic biology design principles, common circuit patterns, modeling and simulation workflows, and network based views of control and regulation with practical R, Python and modeling tool usage.

Synthetic Biology Circuit Design & Network Regulation

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Session Index

Session 1

Fee: Rs 8800 Apply Now

Synthetic Biology & Circuit Design Foundations

Synthetic biology design mindset and abstraction levels

parts, devices and systems view | **promoters, RBS and coding regions (concept)** | **standardisation and modularity ideas**

Circuit design goals and use cases in biology

switches, pulses and oscillators (concept) | **sensing**

and actuation logic **metabolic and signaling control**

Toolchain overview for in silico circuit work

diagram and model editors (concept view) **SBML and rule based formats at high level** **R / Python for data handling and plotting**

Session 2

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Network Motifs, Logic & Design Patterns

Common synthetic biology network motifs and behaviours

toggle switches and bistable circuits **repressilators and oscillatory motifs** **feedforward and feedback loops**

Logic implementation with gene and protein regulation (concept)

AND / OR / NOT style regulatory logic **input integration by promoters and operators** **multi input sensing ideas**

Design patterns and specification of simple circuits

from truth tables to circuit sketches **mapping desired behaviour to motifs** **documenting design assumptions and choices**

Session 3

Fee: Rs 14800 Apply Now

Modeling, Simulation & Circuit Regulation

Formulating simple dynamical models for circuits (concept level)

ODE style rate equations and Hill terms **activation and repression functions** **time scales and parameter roles**

Simulating circuit behaviour and exploring regimes

time course simulations of motifs **dose response and bifurcation style views** **identifying bistability and oscillations qualitatively**

Network regulation perspectives on circuit design choices

placing circuits inside larger networks (concept) **robustness and cross talk considerations** **control levers and tunable parameters**

Session 4

Fee: Rs 18800 Apply Now

Mini Capstone: Circuit Design & In Silico Prototype

Specify a small synthetic circuit for a chosen behaviour

Theory + Practical

Build, simulate and refine an in silico prototype design

from design sketch to model implementation **parameter exploration and tuning ideas** **summarising behaviour across scenarios**

Deliverables: design document, model files & simulation summary

R or Python notebook for simulations **model file in a standard format (concept)** **PDF/HTML circuit design and results report**