

# Final Project Report

## Systems and Synthetic Biology: 499C Bioengineering

### Sample Template

Your final term project will involve the design and simulation of a synthetic network which many involve genetic, protein and/or metabolic systems but doesn't have to include all these types. The design should contain a minimum of four genes and should also include at least two identifiable modules. A module is defined as a system with a well defined function that contains more than one gene. The project should be written into a final report (see below for details) and a short 15min PowerPoint (or beamer) presentation.

In the written report, a minimum font size of 10pt should be used. Any standard font is acceptable. Do not however use script or ornamental fonts. Make consistent use of font types and font sizes in your report. Make sure section, subsections etc are clearly marked. Text should use single spacing and all pages should be numbered. The final report should be provided in paper format and, where possible, in electronic form.

The structure of your final report is described as follows:

Title Page:

Title of Project

Author Names and department affiliations

Date

Example Title:

The Design of a Switchable Oscillator Circuit.

Sections should include the following:

1. Abstract

2. Introduction

A. An introduction to Synthetic Biology: up to two pages, minimum one page. Highlight the scope of field and its possible impact in both pure and applied sciences.

B. Methodologies employed in synthetic biology including both computational and experimental, two to four pages.

3. Overview of the project: Up to one page

4. Product Design Specification

This section will describe what the synthetic circuit is intended to do. In a real-life engineering project, the product design spec would ensure that the product meets the needs of the end user. This description may be quite short in this project, but complex projects may have quite lengthy design specifications.

5. Internal Design Specification

This section, in two parts (see below), will describe in the detail the internal workings of the proposed synthetic network. If the design is composed of multiple modules, then each module should be described separately. In addition you should also provide an overview of the system in terms of the modules.

A. Overall design view. This section should give the overview of the design without reference to detailed component parts (i.e what parts you would **actually** use in the fabrication) or kinetics. The design can be given as text but should also include figures illustrating the design. This section will also include a description of any modules in the design.

B. Specification of the proposed kinetic responses, that is whether some steps will be assumed to be mass-action, hyperbolic, sigmoid etc.

The length of this section will depend on the complexity of your proposed design but should be no less than one page.

6. Computer Simulation Test Implementation.

This section will take the internal design spec and translate it into a working computer simulation to illustrate the operation of the proposed design. If the design includes modules (which it will), individual modules should be simulated to show their operation. Finally the complete system should be modeled and the input/output characteristics given to show that the design satisfies the product design specification. All model codes should be provided in the report so that a third-party can also carry out the simulations. Code should be supplied in some suitable format such as Jarnac, SBML, Matlab etc. If a human readable script like Matlab or Jarnac is used, the code should be heavily documented and all parameters commented. In addition, if the model is supplied in Matlab format (or any other non-Jarnac like reaction input format), the rate equations **MUST** be separated from the differential equations. This will allow the model to be converted to other formats if necessary. If you submit the model in other formats such as R or Python (including Matlab), **DETAILED** instructions on how to test the model **MUST** be given. The instructions **must** also include details on how to install the application (eg

for R or Python, but not Matlab), and include instructions on where to where to get the software.

## 7. Implementation Details.

Provide a detailed list of all parts that would be required to build the product (Genes, RBS, Terminators, Promoters, Operators etc). In a real specification you would give actual parts (i.e catalog entries etc), however since we currently have limited parts in synthetic biology, this may not be possible. However, if you do use well known parts, use the Biobricks id for reference. By assuming average sizes for genes, promoters, terminators and RBS sites, give estimates for the final size of the genomic material that will be required to build the network. By assuming a cost of 66c per base, give an estimate cost for synthesizing the design by a DNA fabrication company.

Cite any references at the end in a separate references section.

## *Example Design*

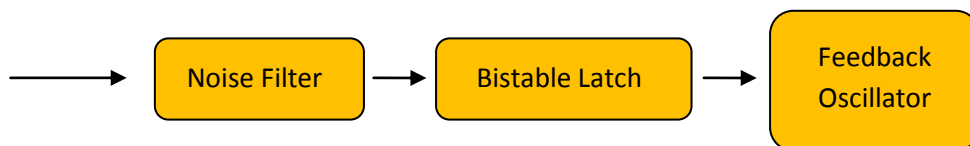
Title: The Design of a Switchable Oscillator Circuit.

### 4. Product Design Specification

The proposed design is intended to act as a noise immune switchable oscillator. Users of the network will be able to apply a pulse to the input of the circuit which, in turn, will permanently switch on an oscillator. The circuit will not be susceptible to transient signals or noise at the input which could inadvertently switch on the oscillator.

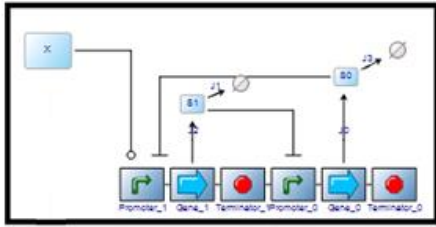
### 5. Internal Design Specification

A. The design of the network comprises of three modules. An overview of the network is given in the figure below:



Follow this with a description of each module.

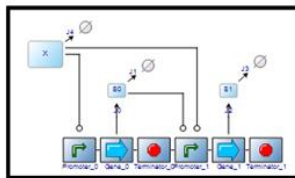
### **Noise Filter**



The noise filter is composed of....and operates on the principle of....etc

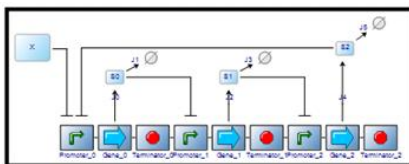
### Bistable Switch

The bistable switch is composed of....etc



### Feedback Oscillator

The feedback oscillator is composed of....etc



B. Description of the design kinetics.

6. Computer Simulation Test Implementation.

Describe each module in turn. Show that the noise filter, bistable latch and feedback oscillator work as expected. Combine all three and show that the entire system works as expected.

7. Implementation Details