IIT INDORE

OPTICAL DEVICE MODELING SYSTEM

FOR

Simulation and Design of optical devices using optical constants and interference effects in thin film

Software Requirements Specification

Version 1.0

31st Jan 2014

Group 10

Arvind Shokal

Batthala Sainath

Juniper Gujral

Shweta Katheria

Prepared for

CS 258—Software Engineering

Instructor: Dr. Abhishek Srivastava, Ph.D.

Spring 2014

REVISION HISTORY

Date	Description	Author	Comments
31st Jan 2014	Version 1.0	Group 10	First Edition

DOCUMENT APPROVAL

The following Software Requirements Specification has been accepted and approved by the following:

Signature	Printed Name	Title	Date
	Arvind Shokal	Author	31st Jan 2014
	Batthala Sainath	Author	31st Jan 2014
	Juniper Gujral	Author	31st Jan 2014
	Shweta Katheria	Author	31st Jan 2014
	Dr. Pankaj Sagdeo	Client	31st Jan 2014
	Dr. Abhishek Srivastava	Instructor	31st Jan 2014

Table of Contents

1. INTRODUCTION

1.1 Purpose

The purpose of this document is to present a detailed description of development of a system (ODMS) for the simulation and design of optical devices by using optical constants and interference effects in thin films. The main aim of this system is to simulate and design optical devices on the basis of experimental data. The developed software will be used to extract the values of optical constants as a function of wavelength and will be used to design optical filters using thin films interference effects. This document will explain the purpose and features of the system, what the system will do, the constraints under which it must operate and how the system will model the optical device based on user requirements. It will also explain the functional features of ODMS, along with interface overview, design constraints and related considerations such as performance characteristics, reliability, usability etc.

1.2 Scope

The system will:

- Take 2 types of data inputs from the user- for substrate transmission and sample transmission.
- Based on the given inputs, the system will plot an interpolated graph between transmission and wavelength and use it to approximate the functions for optical constants.
- The goal of ODMS is to simulate thin film based optical devices based on these functions.

1.3 Definitions, Acronyms and Abbreviations

ODMS(optical device modeling system)	It is software used for simulation and design of optical devices using optical constants and interference effects in thin films.
TS	Substrate transmission
T	Sample transmission
MATLAB(Matrix Laboratory)	MATLAB is a high-level language and interactive environment for numerical computation, visualization, and programming.
GUI	Graphical User Interface
Optical constants	Optical constants are the characteristics of optical behavior of a substance.
Refractive Index	It is the ratio of the velocity of light in a vacuum to its velocity in a specified medium.
Absorption coefficient	It is a measure of the rate of decrease in the intensity of electromagnetic radiation (as light) as it passes through a given substance; the fraction of incident radiant energy absorbed per unit mass or thickness of an absorber; "absorptance equals 1 minus transmittance".
Interference	Interference is a phenomenon in which two waves superpose to form a resultant wave of greater or lower amplitude. Interference usually refers to the interaction of waves that are correlated or coherent with each other, either because they come from the same source or because they have the same or nearly the same frequency

Optical filter	Optical filters are devices that selectively transmit light of different wavelengths, usually implemented as plane glass or plastic devices in the optical path which are either dyed in the bulk or have interference coatings.
Optical device	A device for producing or controlling light.
wavelength	The distance between successive crests of a wave, especially points in a sound wave or electromagnetic wave.
Band gap	A band gap, also called an energy gap or band gap, is an energy range in a solid where no electron states can exist.
Transmission	The action or process of transmitting something or the state of being transmitted.

1.4 References

Some important references for this project are:

1) Methods for the determination of the optical constants of thin films from single transmission measurements: a critical review
Authors: Dirk Poelman and Philippe Frederic Smet
J. Phys. D: Appl. Phys. **36** 1850 (2003)
2) Determination of optical constants and thickness of amorphous GaP thin film- Authors: Pimpabute, Nuwat, Thanusit Burinprakhon, and Weerasak Somkhunthot. Optica Applicata, **41**, 257(2011).
3) Thin film optical filters by H.A. Macleod (CRC Press 4th edition)
4) And for some parts of the document, sample SRS documents from the Internet.

2 Overview

2.1 Overall Description:

The rest of the SRS document provides a general description of the project. It gives us the details about Product Perspective, Product Functions and also describes the types of users for a project, general constraints and all assumptions and dependencies.

2.1.1 Product Perspective

The data taken as the input by the ODMS can be generated through UV visible spectrophotometer using software interface such as Cary WINUV. ODMS software enables the user (through GUI) to estimate the thickness and optical constants of thin films using transmission data.

2.1.2 Product Functions and Features

The crucial function of ODMS software is to design optical devices using approximated optical constants. This will be done by generating an interpolated graph between transmission and wavelength based on the experimental data. The experimental obtained data will be used to approximate the optical constants and generate theoretical graphs as close as possible to the experimental graphs. The approximated constants will be used to estimate the thickness of thin films used in optical devices.

2.1.3 General Constraints

- The ODMS shall be designed to run on Microsoft Windows based computer with the following minimal requirements:
  - Intel Core i3 CPU
  - 512 MB RAM
  - 500MB Hard Disc Space available.
- The software requires MATLAB platform and editor for its compilation and functioning.
- The data input can be in any standard format eg.txt,xls etc.

2.1.4 User Characteristics

The ODMS shall be capable of being used by a user who possesses the ability to use a Personal Computer and should have the ability to run a User friendly GUI application.

2.1.5 Assumptions and Dependencies

The ODMS shall recognize the following environmental characteristics being present for full functionality.

- The application administrator will have installation rights on the host computer.
- It will be able to run and execute once installed to the computer with or without Internet connectivity and also without relying on newer upgrade versions.

3 Specific Requirements

3.1 External Interface Requirements

3.1.1 User Interfaces

No explicit user interface requirements. The Minimum requirements are that the user will be able to interact with a User Friendly GUI generated in MATLAB.

3.1.2 Hardware Interfaces

No hardware interface is required. But the data taken as the input by ODMS can be generated through experiments on UV visible spectrophotometer.

3.1.3 Software Interfaces

The software is developed and run in MATLAB environment. Thus the software will work only on systems having pre installed MATLAB and will use data recorded by Cary WINUV software.

3.1.4 Communication Interfaces

No communication interfaces are required. The software can run on standalone machine without any network connectivity.

3.2 Functional Requirements

The software broadly performs two major functions:

- Determination of optical constants.
- Designing and simulation of thin film based optical devices.

3.2.1 Determination of optical constants

- **Taking data input**
  The software takes two types of data input from the user-one for substrate transmission (ST) and the other for sample transmission (T). The entire functioning of ODMS and the calculations done depend upon this data**.**

- **Display of experimental graph**
  The experimental data taken as the input is interpolated and converted into an experimental graph. This graph forms the basis of comparison with theoretical graphs generated by the software.

- **Generation of maxima and minima curves**
  The software automatically generates and displays maxima and minima curves of the sample transmission (T) graph. The values of these curves are used to approximate functions for optical constants.

- **Approximation of optical constants**
  The software through an iterative algorithm approximates the functions for optical constants: Refractive index (η), Absorption coefficient (α) and band gap (β). This algorithm uses the generated maxima and minima curves to determine the optical constants as a function of wavelength.

- **Display of theoretical Graph**
  ODMS generates and displays the theoretical graph of sample transmission based on the values of calculated optical constants. This graph is simultaneously displayed with the experimental graph, which gives the user an idea of accuracy of generated optical constants.

3.2.2 Designing and simulation of thin film based optical devices

- **Taking user requirements**
  The software takes in two types of user inputs for the simulation of required thin film based optical device
  1.) Type of optical filter:
  The user is required to input the type of wavelength filter He/she wants to model

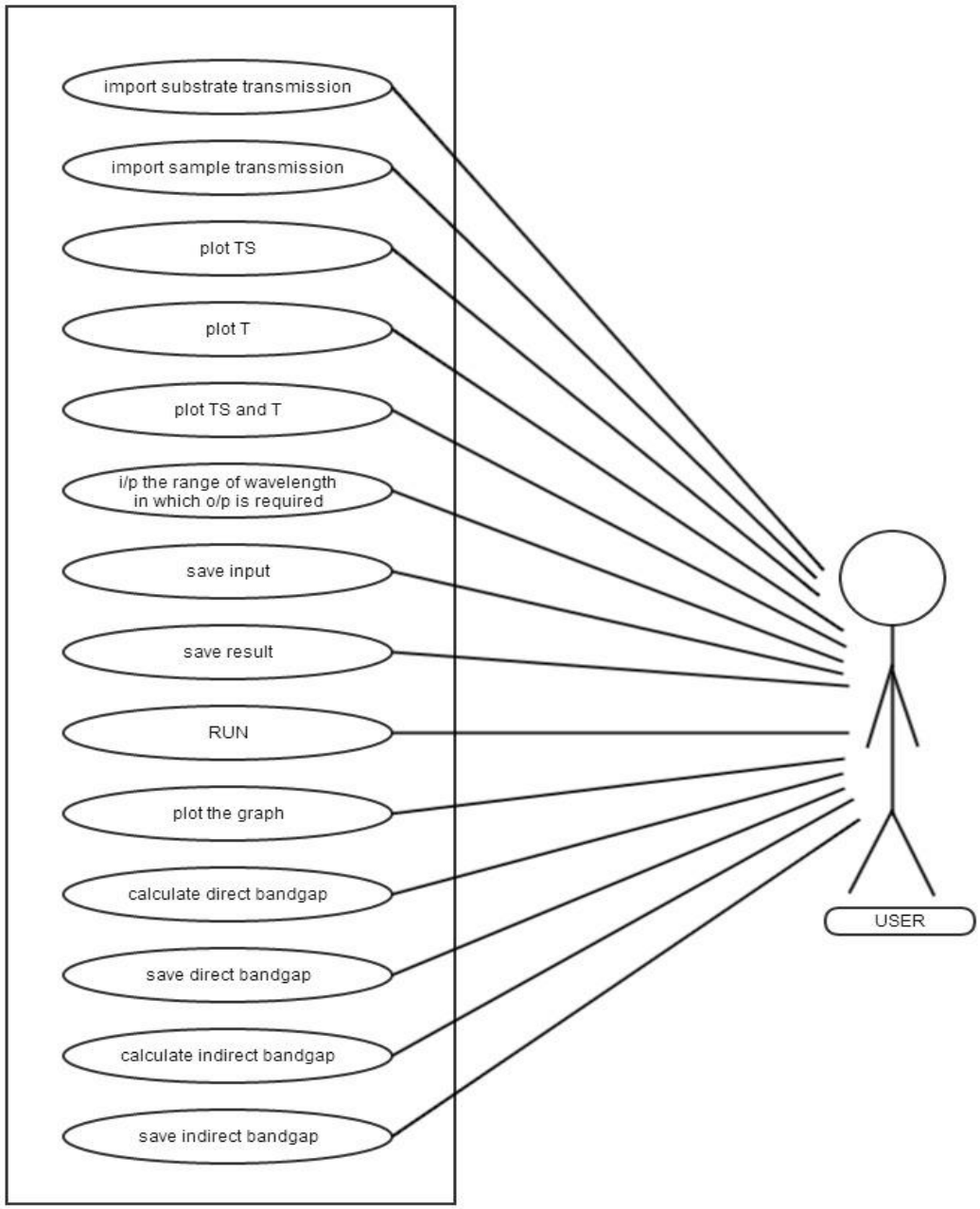
2.) Range of wavelength:
Based on the type of filter the user is supposed to input the range of working wavelength of the device.
3.) Number of materials with names:
The user has to specify the number of thin films to be used to design a multi layer optical device. He also has the facility to choose the materials to be used in the device.

- **Determination of individual thickness of thin films**
  Based on the user requirements, the software simulates the required filter by calculating the thickness of each material used in the multi-layered optical device.

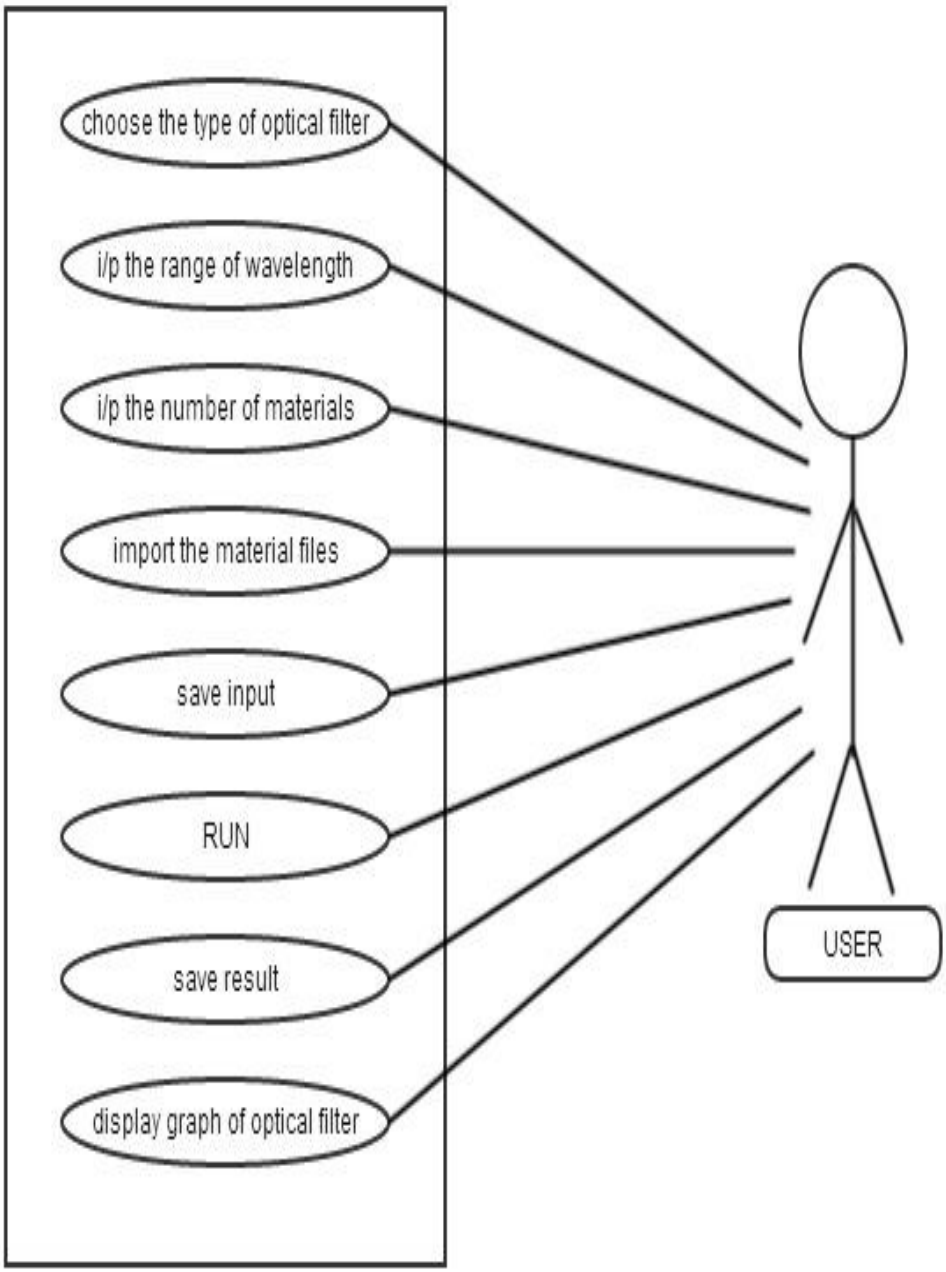
- **Display of graph of simulated filter**
  The software displays a graph between wavelength and transmission specific to the optical device simulated using ODMS.

3.3 Use cases

3.3.1 Case 1: EXTRACTION OF OPTICAL CONSTANTS



3.3.2 Case 2: DESIGN OF OPTICAL FILTERS



3.4 Non functional requirements

3.4.1 Usability

- The Required training time for a user is around half an hour.
- This software can be efficiently used by the person having basic knowledge of thin film based optical devices.
- The user should have the required experimental data in one of the standard formats which can be interpreted by the software (ODMS).
- The user should have the basic knowledge of using a standalone machine and perform basic operations like browsing, saving, selecting files etc.
- The user should have basic knowledge of using a GUI.

3.4.2 Reliability

- This Software would run continuously for days and can be used anytime.
- **Mean Time between Failures**: The mean time between failures would be around 1 hour.
- **Mean Time between Repairs**: The mean time between repairs can't be estimated.
- The accuracy of the results generated by ODMS depends upon the size of interval between two experimental data points.

3.4.3 Performance

- **Capacity:** We can't run this software for two or more samples simultaneously.
- This Software also gives the real time plotting between Transmission and wavelength.

3.4.4 Supportability

- **Naming Convention:** All the code will be written according to MATLAB naming Conventions.
- **Coding Standards:** All the code will be written according to MATLAB coding standards.

3.4.5 Design Constraints

- It shall be a 32 bit or 64 bit Application only.
- System architecture (32 bit or 64 bit) compatible version of MATLAB should be pre installed.
- The Software will be implemented using a User friendly GUI built by coding the software in Matrix Laboratory (MATLAB).
- All Definable options shall have default values supplied by the application.
- No error condition shall cause the application to exit prematurely.
- This Software will run on Windows Operating System. The platform used is Matrix Laboratory (MATLAB) for Coding Conventions.

3.4.6 Maintainability

The software does not require any kind of manual maintenance.

3.4.7 Portability

The software is highly portable and can run on any windows operating system (windows XP or higher) having MATLAB compiler and editor.

3.4.8 Online User Documentation and Help System requirements

Online user documentation and help system for this software is not necessary.

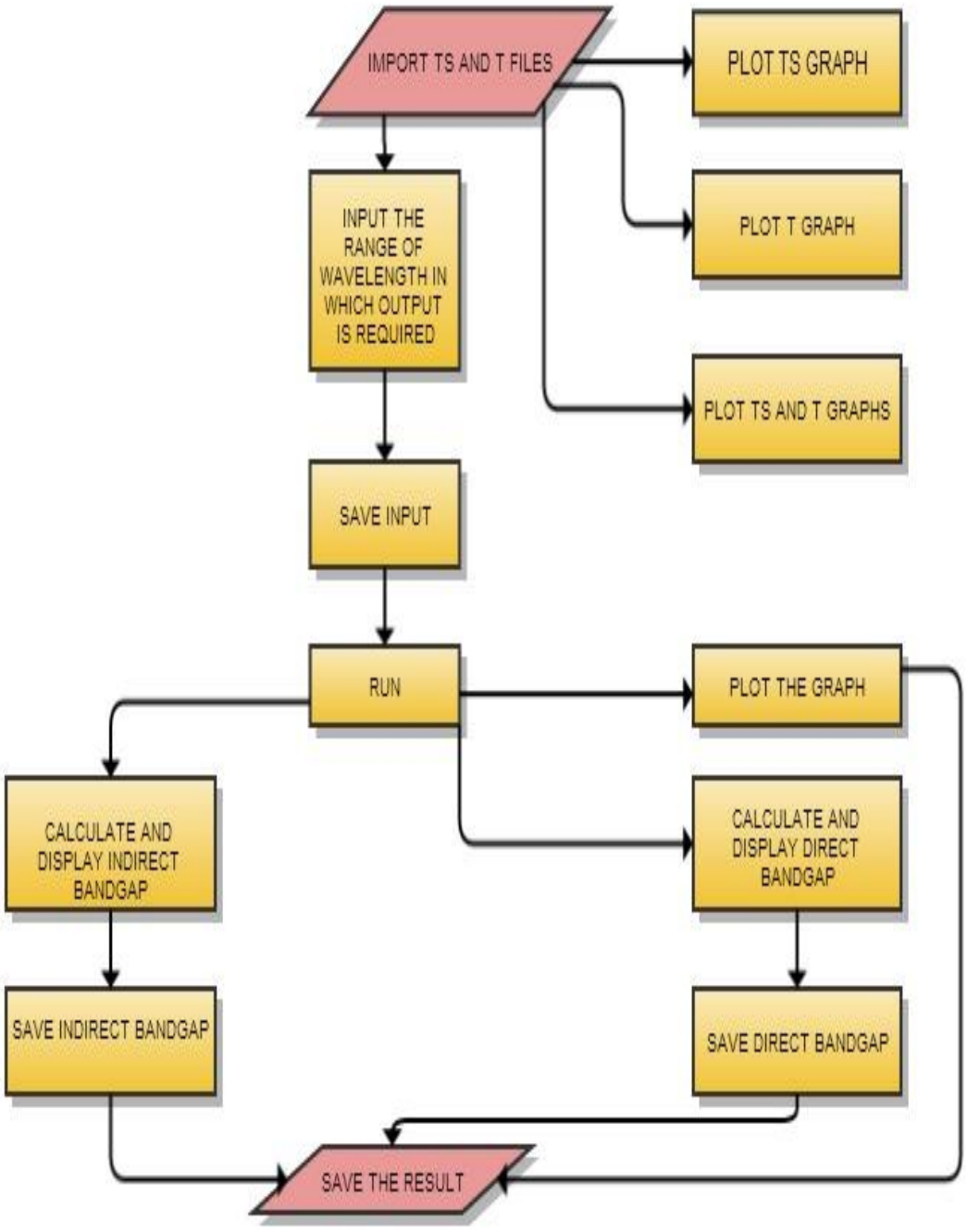
4 Analysis Model

Mixed model:

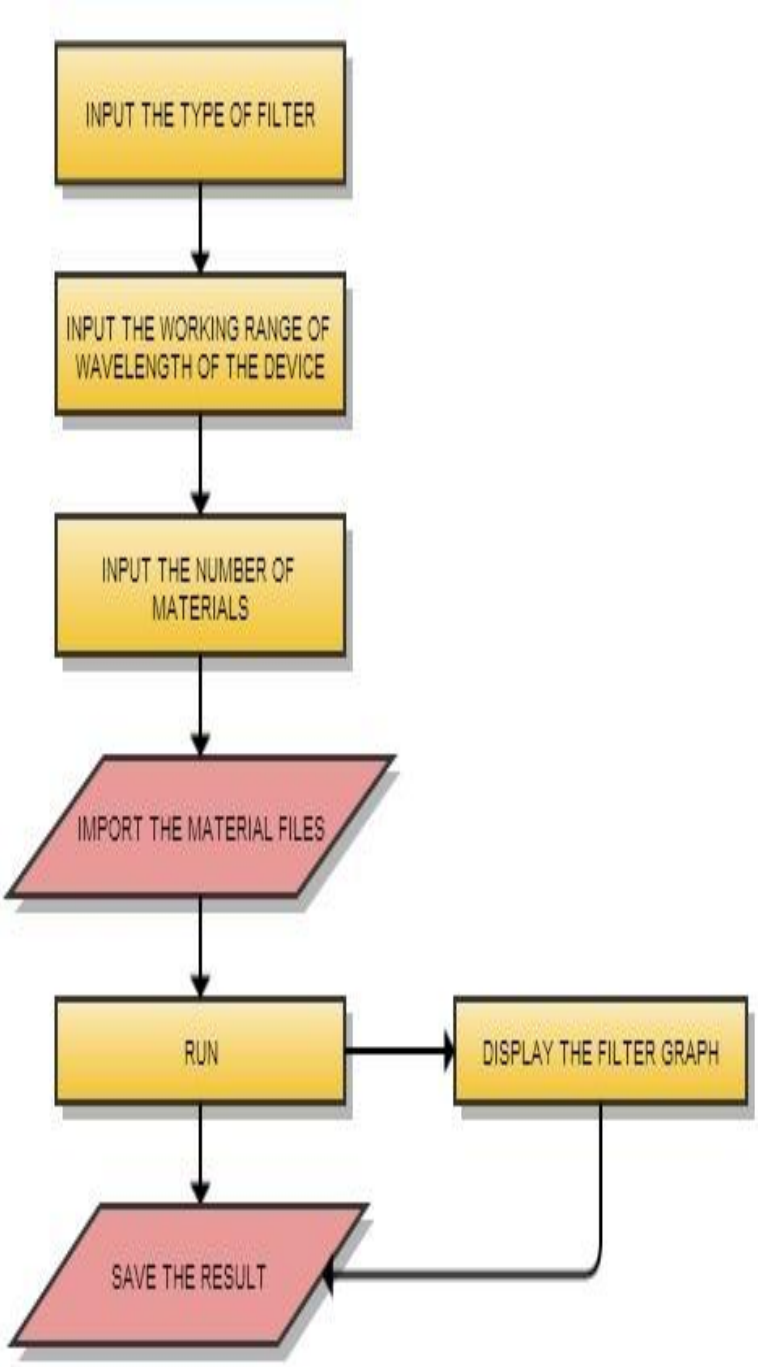
The requirement elicitation phase of this project is guided by waterfall model and incremental model. Thus this document has been generated by iterative interaction with the client to gather user requirements.

4.1 Sequence Diagrams:

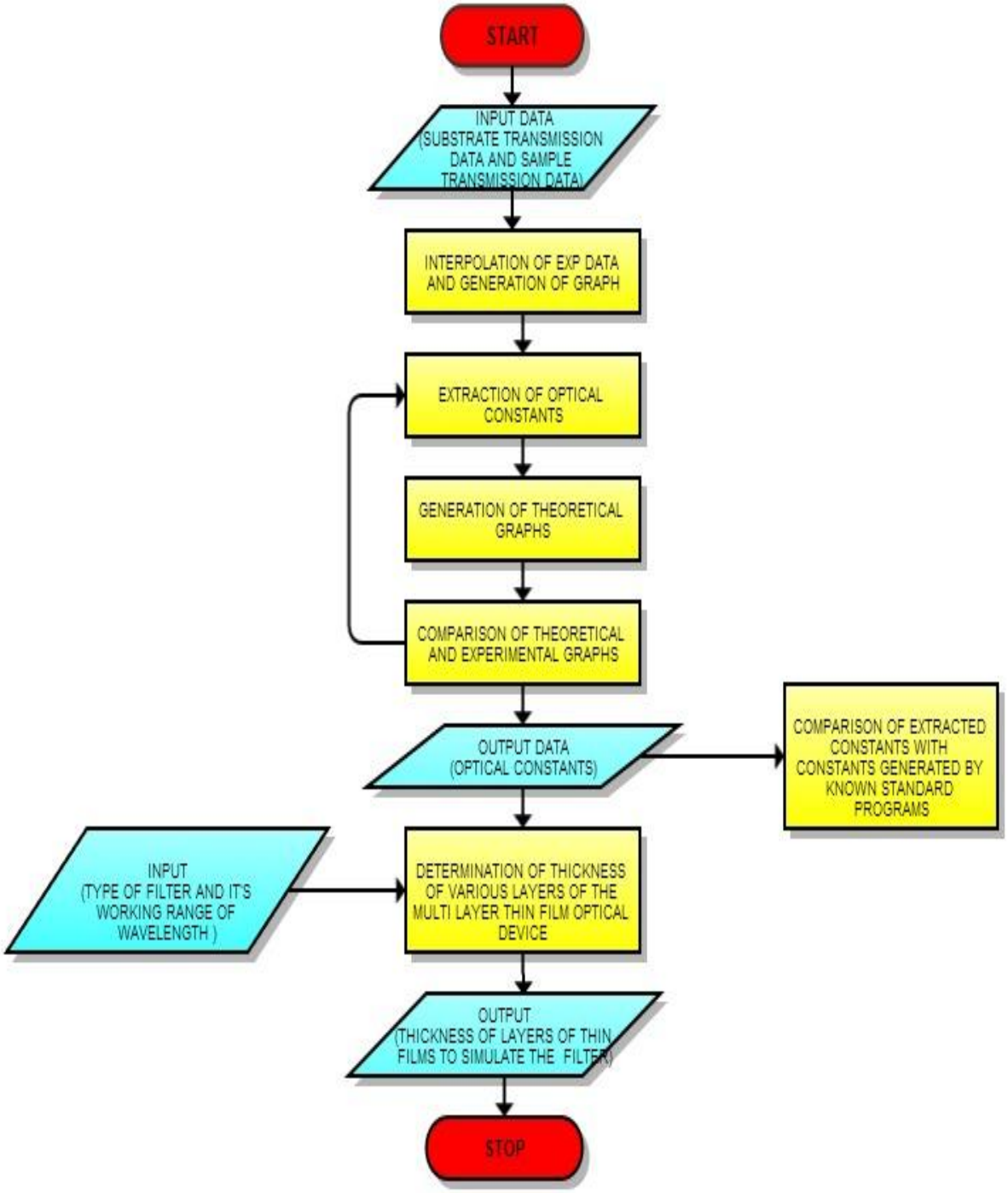
PART 1 (EXTRACTION OF OPTICAL CONSTANTS):



PART 2(DESIGN OF OPTICAL FILTERS):

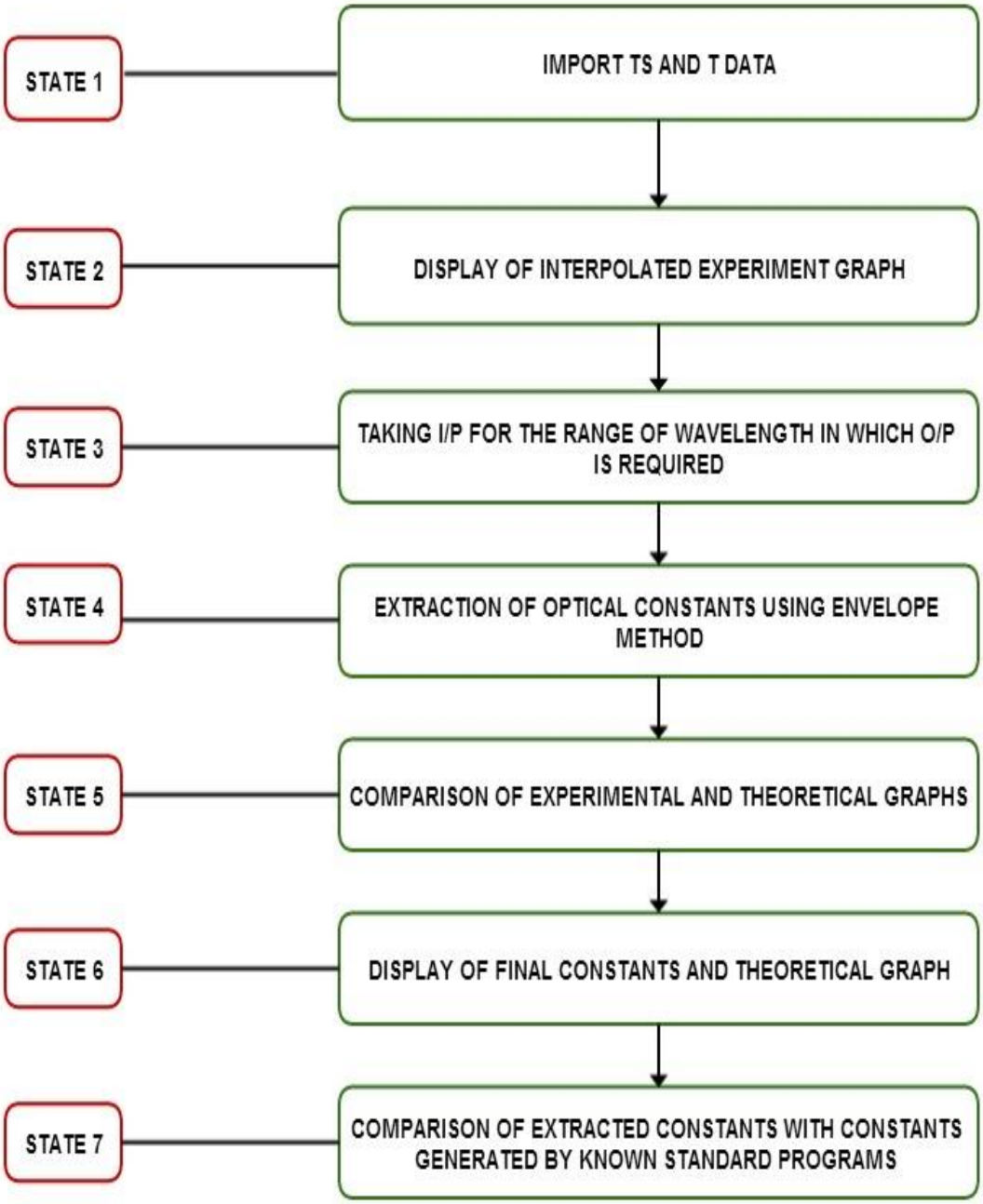


4.2 Data Flow Diagram (for the entire project):

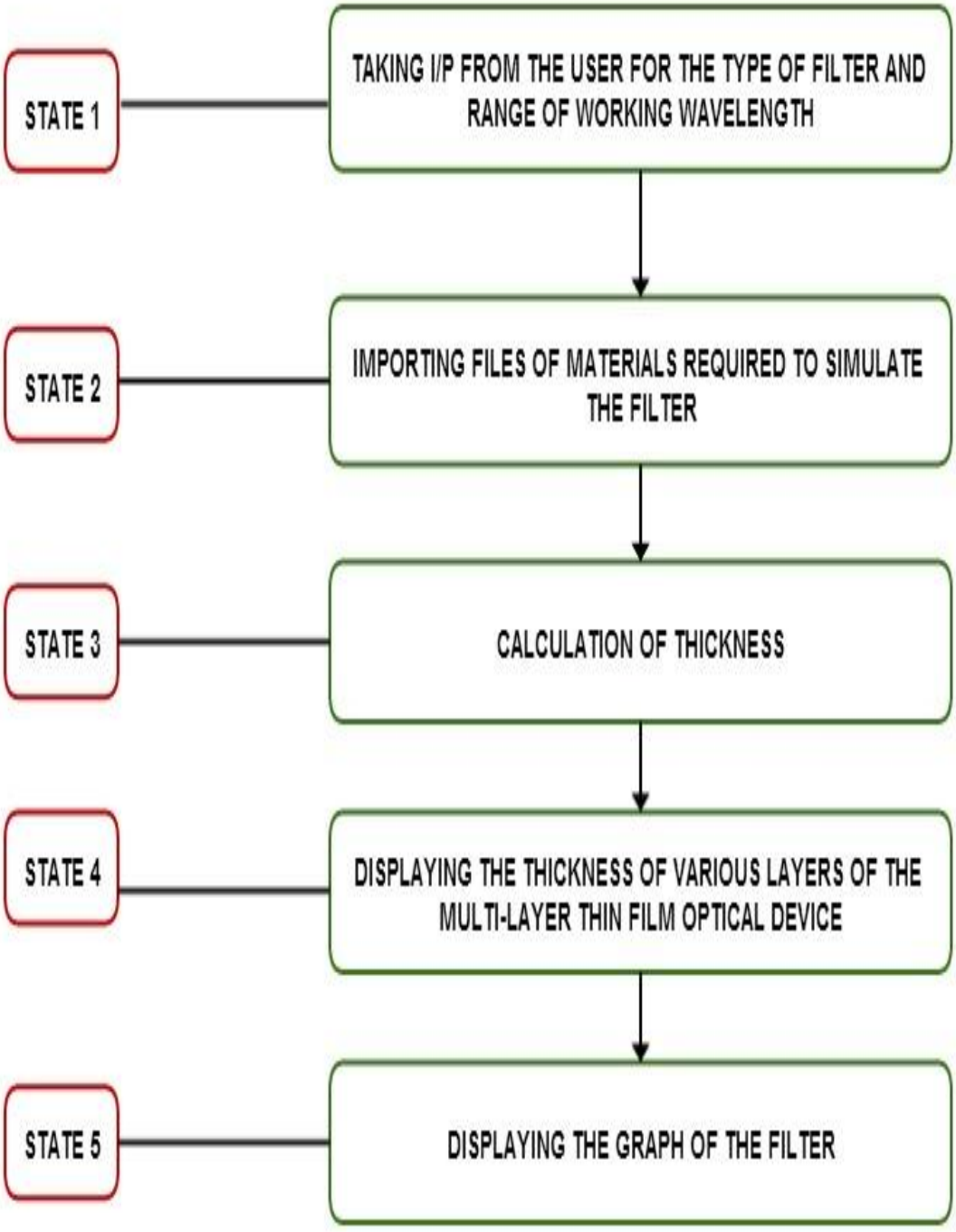


4.3 State-Transition Diagrams

PART 1 (EXTRACTION OF OPTICAL CONSTANTS):



PART 2(DESIGN OF OPTICAL FILTERS):



5 Change Management Process

Any change in the srs document can be suggested by any individual to the authors of the project. But final amendments/changes to the document will be incorporated only after the consent of the client and the instructor of the project.

6 Licensing Requirements

This software is licensed to IIT Indore.

7 Legal, Copyright and Other Notices

Copyright © 2013 by Group 10.

This software is designed and developed by Arvind Shokal, Batthala Sainath, Juniper Gujral and Shweta Katheria.

You must not sell, rent, lease or sublicense all or any portion of the Software; modify or prepare derivative works of the Software; reverse engineer, decompile or disassemble the Software without prior written permission from all of the above said developers. The installation and the usage of the Software mean the acceptance of these terms and conditions of the license. If you do not agree with the terms of this license you must stop the usage of the Software and uninstall it.