Sakshi_Luchoo_23314771_ISEReport.pdf

Cover Page

Student Name: Sakshi Luchoo
Student ID: 23314771
Practical Class: Cl 0.5, Tuesday group (12.30 - 14:30)

Introduction

This report documents the completed development of a 'Electromagnetic(EM) spectrum' system that identifies and verifies colour visibility of frequencies among other identification tools that performs various calculations related to the electromagnetic spectrum and color analysis. This documentation contains an in-depth description of the program modules implemented(data_calculation.py, frequency_colours.py, stone_and_music_notes.py, main.py). The software was developed following modularity principles. The system has undergone thorough testing using black-box and white-box approaches. Furthermore, Git version control was maintained throughout the development process.

Module Descriptions

1. data_calculation.py

Purpose: Calculates given frequency's wavelength and given wavelength's frequency

Methods:

- calculate_wavelength_of_freq(freq_in_THz)
- calculate_freq_of_wavelength(wavelength_in_nm)

```
# Function to find the wavelength of the frequency given
def calculate_wavelength_of_freq(freq_in_THz):
  conversion = 300000000   # c = 3 * 10^8 m/s (conversion forumla)
  wavelength = conversion / freq_in_THz   # Calculating wavelength
  return wavelength
```

```
# Function to find the frequency of the wavelength given
def calculate_freq_of_wavelength(wavelength_in_nm):
  conversion = 300000000
  freq_in_Hz = conversion / wavelength_in_nm    # Calculating frequency
  return freq_in_Hz
```

Inputs/Outputs:

- calculate_wavelength_of_freq(freq_in_THz)

  Input: calculate_wavelength_of_freq(39,999)

  Output: 7500.187504687618nm (float)

- calculate_freq_of_wavelength(wavelength_in_nm)

  Input: calculate_freq_of_wavelength(2000)

  Output: 150000.0THz (float)

2. frequency_colours.py

Purpose: Details about colour names and their frequencies ranges used for comparisons

Methods:

- get_colour_freq(colour)
- freq_colours(freq_value)
- get_visible_colours(freq_value)
- compare_two_freq(freq_val1, freq_val2)

```
# Dictionary containing colour options and their upper and lower bound frequency values
colour_freq_bounds = {'violet': (670, 790),
             'blue': (620, 669),
             'cyan': (600, 619),
             'green': (530, 599),
             'yellow': (510, 529),
                      'orange': (480, 509),
                      'red': (400, 479)}
min_visible_light = 400
max_visible_light = 790


# Function to return colour from colours available
def get_colour_freq(colour):
    colour = colour.lower()
    if colour not in colour_freq_bounds:
        raise ValueError(f'Unavailable colour: {colour}')     # Raises an error if the user has input an invalid colour choice
    return colour_freq_bounds[colour]


# Function to find and return colour produced by frequency given by user
def freq_colours(freq_value):
    if freq_value < min_visible_light:
        return 'Frequency value is below the Visible Light range (lower than frequency of Red)'
    elif freq_value > max_visible_light:
         return 'Frequency value is above the Visible Light range (higher than frequency of Violet)'


    # For loop created to access color name, min and max boundary values for frequency(in the dictionary)
    for colour, (min, max) in colour_freq_bounds.items():
        if min <= freq_value <= max:        # Freq value is user input value for frequency
            return f'Corresponding colour is: {colour}'
```

```
# Function to return visible colour names
def get_visible_colours(freq_value):
    for colour, (min, max) in colour_freq_bounds.items():
        if min <= freq_value <= max:
            return colour     # Colour is visible so colour name is returned
    return None      # Colour is not in the Visible Light range


# Function to compare the two frequency values to find if both represent a single colour or two different colours
def compare_two_freq(freq_val1, freq_val2):
    val1_visible = get_visible_colours(freq_val1)     # Get colour frequencies(min and max) for comparison process
    val2_visible = get_visible_colours(freq_val2)


    if not val1_visible and not val2_visible:
        return (f'Neither frequency is visible: {freq_val1}THz, {freq_val2}THz')
    if not val1_visible:
        return (f'Frequency {freq_val1}THz is not within the Visible Light range')
    if not val2_visible:
        return (f'Frequency {freq_val2}THz is not within the Visible Light range')


    colour1 = get_visible_colours(freq_val1)
    colour2 = get_visible_colours(freq_val2)


    # Find if both represent the same colour or not
    if colour1 == colour2:
        return 'Both frequencies represent the same colour'
    else:
        return 'Both frequencies represent different colours'
```

Inputs/Outputs:

- get_colour_freq(colour)

  Input: get_colour_freq("violet") (string)

  Output: (670, 790)

- freq_colours(freq_value)

  For colour name

  Input: freq_colours(400)

  Output: "Corresponding colour is: red"

  For out-of-range message

  Input: freq_colours(300)

  Output: "Frequency value is below the Visible Light range (lower than frequency of Red)"

- get_visible_colours(freq_value)

  Input: get_visible_colours(610)

  Output: "cyan"

- compare_two_freq(freq_val1, freq_val2)

  In range example

  Input: compare_two_freq(500, 500)

  Output: "Comparison results are: Both frequencies represent the same colour"

  Out-of-range example

  Input: compare_two_freq(300, 600)

  Output: "Comparison results are: Frequency 300THz is not within the Visible Light range"

3. stone_and_music_notes.py

Purpose: Provides color associations with stones, music notes, and emotions

Methods:

- get_colour_facts(colour)

```
# Outer dictionary(colour names) containing inner dictionaries(colour facts)

colour_notes = {'violet':{'Matching Stone':'Amethyst',

               'Matching Music note':'B',

               'Matching Emotion':'Bravery'},


         'blue':{'Matching Stone':'Opal',

              'Matching Music note':'A',

              'Matching Emotion':'Calm'},


         'cyan':{'Matching Stone':'Turquoise',

              'Matching Music note':'G',

              'Matching Emotion':'Calm'},


         'green':{'Matching Stone':'Emerald',

              'Matching Music note':'F',

              'Matching Emotion':'Peaceful'},


         'yellow':{'Matching Stone':'Topaz',

              'Matching Music note':'E',

              'Matching Emotion':'Happy'},


         'orange':{'Matching Stone':'Moonstone',

              'Matching Music note':'D',

              'Matching Emotion':'Happy'},


         'red':{'Matching Stone':'Garnet',
            'Matching Music note':'C',
            'Matching Emotion':'Confidence'}}


# Function to check whether user has entered a colour that is available in the dictionary
def get_colour_facts(colour):
  colour = colour.lower()
  if colour not in colour_notes:
    raise ValueError(f'Colour {colour} is not available to obtain facts')
  return colour_notes[colour]
```

Inputs/Outputs:

- get_colour_facts(colour)

  Input: get_colour_facts("orange")

  Output: "Stone association": "Moonstone", "Musical note association": "D", "Emotion association": "Happy"

4. main.py

Purpose: User interface and main program execution

Methods:

- start_up_menu()
- main()

Control Flow:

1. Menu display
2. Prompt user input (1-8)
3. Call module functions needed
4. Output appropriate results

Inputs:

- User selections (1-8)
- Corresponding data inputs

Outputs:

- Menu display
- Calculation results

Design Explanation:

- Separated concerns into logical and flexible modules
- Used dictionaries to keep record of color data for easy lookups
- Implemented input validation and error handling(try..except, raise)
- Followed single responsibility principle for functions
- Used clear and meaningful names for variables and functions

---

Modularity Implementation

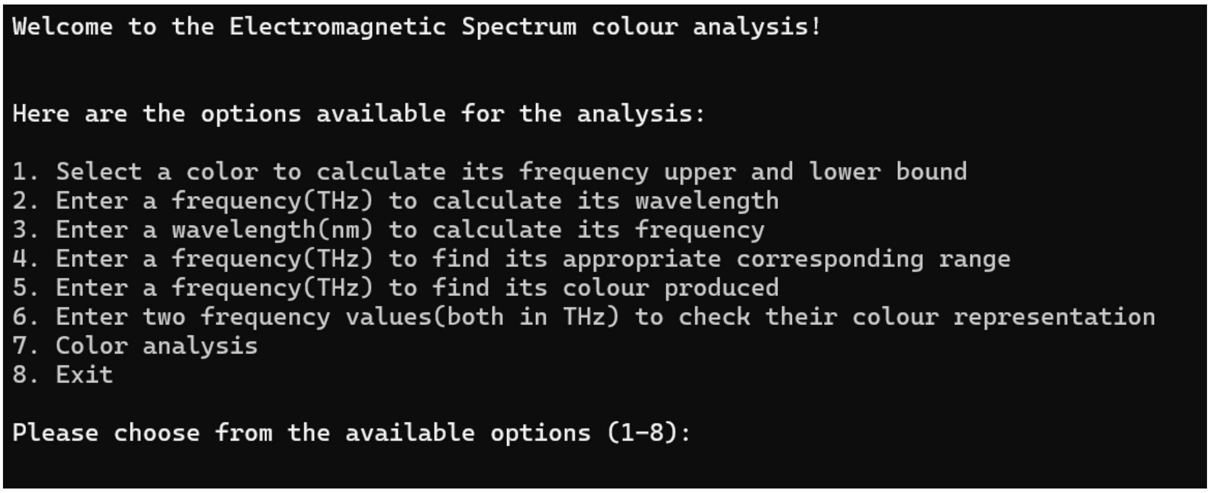
Running and Testing the Production Code

Execute the program by running the following in your command prompt terminal:

```
cd code    # To enter code file folder
python3 main.py  # Run the main program
```

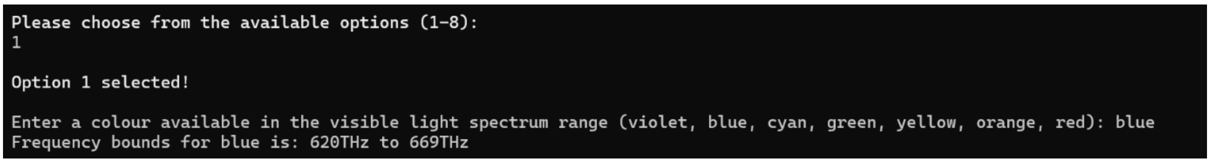
Sample Output:

Sample output screenshot showing menu display



```
Welcome to the Electromagnetic Spectrum colour analysis!


Here are the options available for the analysis:

1. Select a color to calculate its frequency upper and lower bound
2. Enter a frequency(THz) to calculate its wavelength
3. Enter a wavelength(nm) to calculate its frequency
4. Enter a frequency(THz) to find its appropriate corresponding range
5. Enter a frequency(THz) to find its colour produced
6. Enter two frequency values(both in THz) to check their colour representation
7. Color analysis
8. Exit

Please choose from the available options (1-8):
```

Sample output screenshot showing frequency color calculation result



```
Please choose from the available options (1-8):
1

Option 1 selected!

Enter a colour available in the visible light spectrum range (violet, blue, cyan, green, yellow, orange, red): blue
Frequency bounds for blue is: 620THz to 669THz
```

Checklist Review

Criteria	**Yes/No**	**Comments**	**Action Needed/Notes**
Single responsibility	Yes	Does each module have a single responsibility? ✓	Each module handles a specific functionality/task
Input/Output clarity	Yes	Are inputs and outputs clearly defined? ✓	Clear parameter passing and return values used
Reusability	Yes	Is there minimal dependence across modules? ✓	Functions used for calculations and to store and search data are independent
Separation of concerns	Yes	Are functions small and focused? ✓	Each function handles one specific task
Meaningful names	Yes	Are meaningful names used throughout? ✓	Consistent, meaningful, clear and descriptive naming followed
Error handling	Yes	Is error handling	Thorough input validation and exception

Criteria	Yes/No	Comments	Action Needed/Notes
		implemented? ✓	handling included
Encapsulation	Yes	Are there no code duplications? ✓	No duplication of code. Implementation details are well encapsulated as all data needed are accessed through functions
Testing ready	Yes	All criteria met for testability	Modules can be tested independently

Changes made: Code tweaks and small changes in variable names in modules, main.py, frequency_colours.py, data_calculation.py and stone_and_music_notes.py

Refactoring Decisions

No major refactoring was needed, only minor improvements:

- Added more specific error messages
- Consistent function and variable names
- Ensured standardized return types

Test Design

A) Black-Box Test Case Design

1. ***Equivalence Partitioning:***

Module being tested	**Function**	**Test Case**	**Input**	**Expected Output**	**Actual Output**	**Pass/Fail**
data_calculation.py	calculate_wavelength_of_freq	Valid frequency	5000	60000.0nm	60000.0nm	✓
	calculate_freq_of_wavelength	Valid frequency	7000	42857.142857142855THz	42857.142857142855THz	✓
stone_and_music_notes.py	get_colour_facts	Invalid colour choice input	"pink"	"Unavailable colour option! Please try again"	As expected	✓
frequency_colours.py	compare_two_freq	Neither frequencies are visible	900, 900	"Comparison results are: Neither frequencies are visible: 900THz, 900THz"	As expected	✓
		Valid frequencies	400, 700	"Comparison results are: Both frequencies represent	As expected	✓

Module being tested	Function	Test Case	Input	Expected Output	Actual Output	Pass/Fail
				different colours"		
frequency_colours.py	freq_colours	Within Visible Light range	771 (Last 3 digits of student ID)	"Corresponding colour is: violet"	"Corresponding colour is: violet"	✓
main.py	main	Invalid choice input	"Luchoo"	"Invalid choice Luchoo. Please choose from the options available (1-8)"	As expected	✓

2. ***Boundary Value Analysis:***

Module	Function	Test Case	Input	Expected Output	Actual Output	Pass/Fail
frequency_colours.py	freq_colours	Lower boundary	400	"red"	"red"	✓

Module	Function	Test Case	Input	Expected Output	Actual Output	Pass/Fail
		Upper boundary	790	"violet"	"violet"	✓
		Just below	791	"Frequency value is above the Visible Light range (higher than frequency of Violet)"	As expected	✓
data_calculation.py	calculate_wavelength_of_freq	Lower boundary	1	"Wavelength is: 300000000.0nm"	As expected	✓
	calculate_wavelength_of_freq	Upper boundary	40000	"Wavelength is: 7500.0nm"	As expected	✓

B) White-Box Test Cases

Tested Modules

1. ***frequency_colours.py***

- get_visible_colours()

2. ***data_calculation.py***

- calculate_freq_of_wavelength()

Module	Function	Path Test Case (Input values)	Path Covered	Expected Result	Actual Result	Pass /Fail
frequency_colours.py	get_visible_colours	Freq 450	'If' selection statement path for red	"red"	"red"	✓
data_calculation.py	calculate_freq_of_wavelength	Wavelength 600	Calculation path	500000.0THz	500000.0THz	✓

Test Implementation

To run the test module, write the following in your terminal:

```
python3 unit_test.py
```

Test code

```
import unittest

from frequency_colours import *


class MyTestCase(unittest.TestCase):

  # Function to test in the two colours are visible
```

```
    def test_visible_range(self):
        # Testing red edge in visible light range
        assert freq_colours(400) == "Corresponding colour is: red"  # Min red freq
        assert freq_colours(479) == "Corresponding colour is: red"  # Max red freq
        # Testing violet edge in visible light range
        assert freq_colours(670) == "Corresponding colour is: violet"  # Min violet freq
        assert freq_colours(790) == "Corresponding colour is: violet"  # Max violet freq

    # Function to test the two colours going out of range
    def  test_visible_outrange(self):
        # Above visibility range
        assert freq_colours(791) == "Frequency value is above the Visible Light range (higher than frequency of Violet)"  # Upper boundary is 790
        # Below visibility range
        assert  freq_colours(399) == "Frequency value is below the Visible Light range (lower than frequency of Red)"  # Lower boundary is 400

if __name__ == '__main__':
    unittest.main()
```

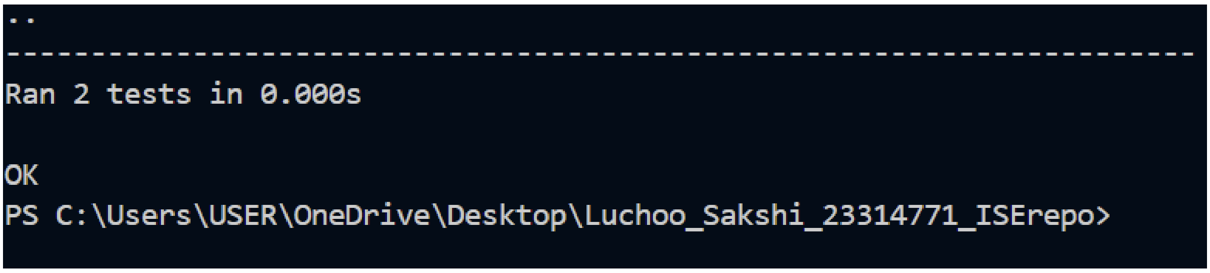
Results:

- Black-box test cases passed
- White-box test cases passed

1 test failure encountered: Assertion error

It was fixed by changing the code structure (use of a class to create methods instead of independent functions)

Test results after correcting test error:



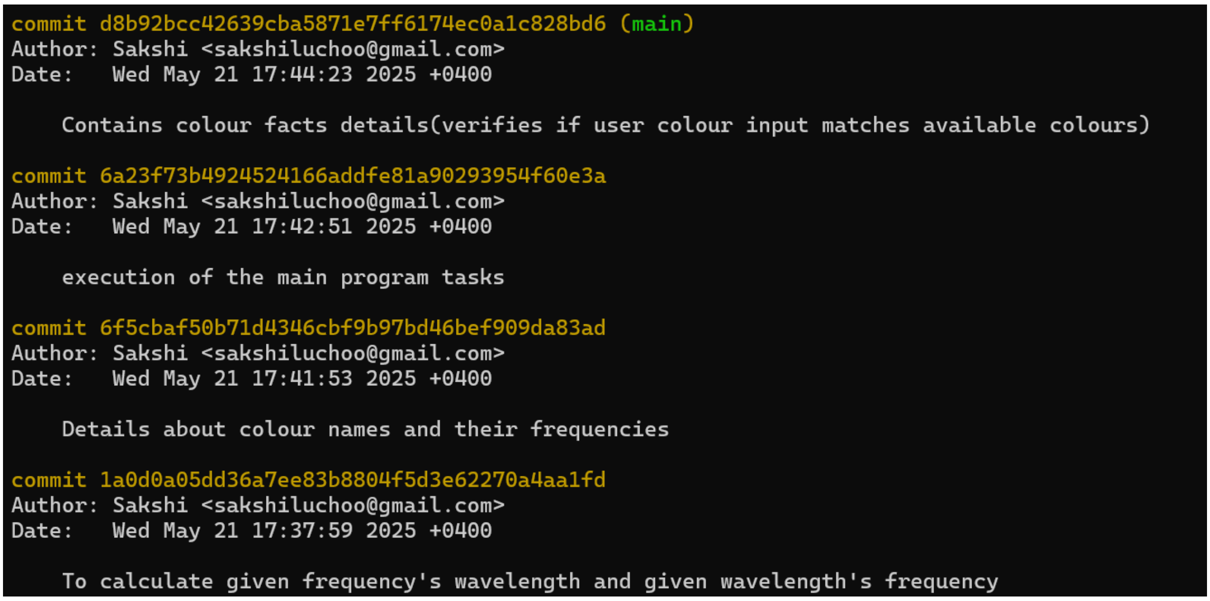
```
..
----------------------------------------------------------------------
Ran 2 tests in 0.000s

OK
PS C:\Users\USER\OneDrive\Desktop\Luchoo_Sakshi_23314771_ISErepo>
```

Traceability Matrix

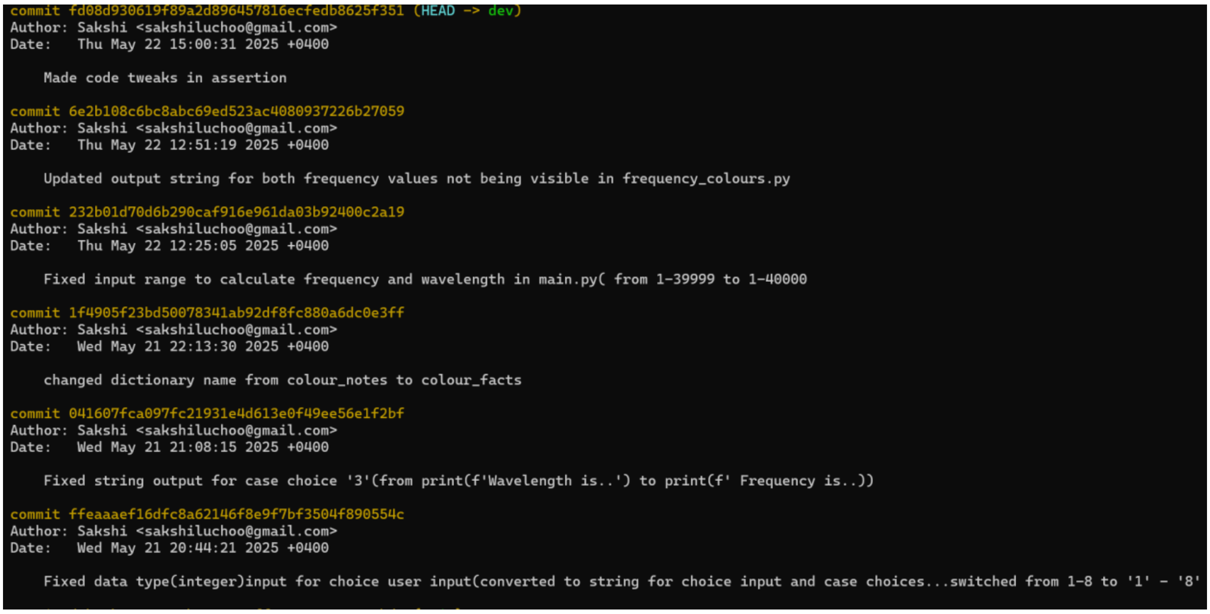
Module name	Black -Box (EP)	Black -Box (BVA)	White -Box	Data Types	Input/Output method
data_calculation.py	done	done	done	integer, float	parameter/return
frequency_colours.py	done	done	done	integer, str	parameter/return
stone_and_music_notes.py	done	not done	not done	string	parameter/return
main.py	done	not done	not done	integer, string	console I/O

Version Control System

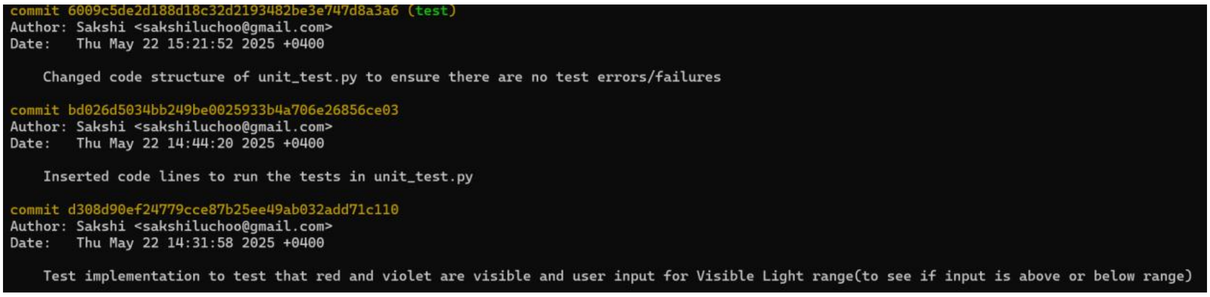
Git log commit history:-



```
commit d8b92bcc42639cba5871e7ff6174ec0a1c828bd6 (main)
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 17:44:23 2025 +0400

    Contains colour facts details(verifies if user colour input matches available colours)

commit 6a23f73b4924524166addfe81a90293954f60e3a
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 17:42:51 2025 +0400

    execution of the main program tasks

commit 6f5cbaf50b71d4346cbf9b97bd46bef909da83ad
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 17:41:53 2025 +0400

    Details about colour names and their frequencies

commit 1a0d0a05dd36a7ee83b8804f5d3e62270a4aa1fd
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 17:37:59 2025 +0400

    To calculate given frequency's wavelength and given wavelength's frequency
```

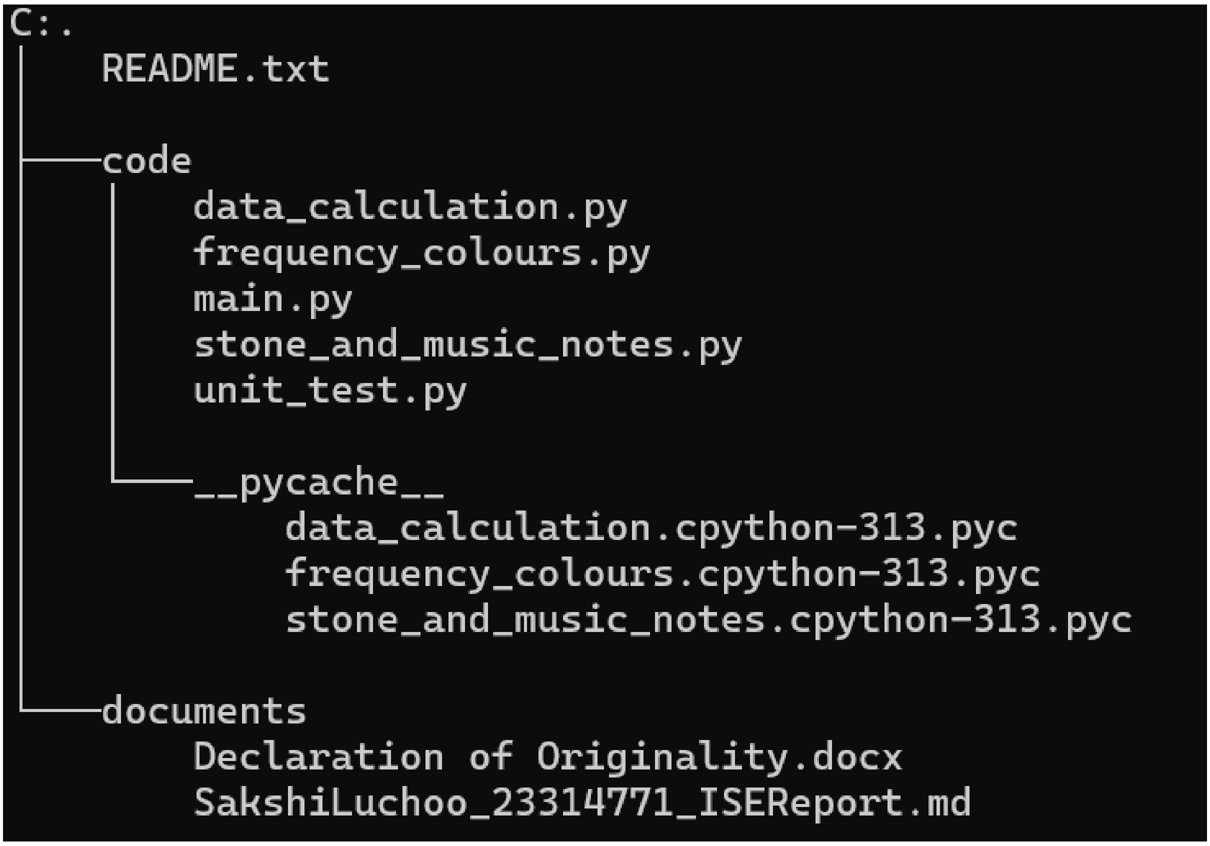


```
commit fd08d930619f89a2d896457816ecfedb8625f351 (HEAD -> dev)
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Thu May 22 15:00:31 2025 +0400

    Made code tweaks in assertion

commit 6e2b108c6bc8abc69ed523ac4080937226b27059
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Thu May 22 12:51:19 2025 +0400

    Updated output string for both frequency values not being visible in frequency_colours.py

commit 232b01d70d6b290caf916e961da03b92400c2a19
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Thu May 22 12:25:05 2025 +0400

    Fixed input range to calculate frequency and wavelength in main.py( from 1-39999 to 1-40000

commit 1f4905f23bd50078341ab92df8fc880a6dc0e3ff
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 22:13:30 2025 +0400

    changed dictionary name from colour_notes to colour_facts

commit 041607fca097fc21931e4d613e0f49ee56e1f2bf
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 21:08:15 2025 +0400

    Fixed string output for case choice '3'(from print(f'Wavelength is..') to print(f' Frequency is..))

commit ffeaaaef16dfc8a62146f8e9f7bf3504f890554c
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Wed May 21 20:44:21 2025 +0400

    Fixed data type(integer)input for choice user input(converted to string for choice input and case choices...switched from 1-8 to '1' - '8'
```



```
commit 6009c5de2d188d18c32d2193482be3e747d8a3a6 (test)
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Thu May 22 15:21:52 2025 +0400

    Changed code structure of unit_test.py to ensure there are no test errors/failures

commit bd026d5034bb249be0025933b4a706e26856ce03
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Thu May 22 14:44:20 2025 +0400

    Inserted code lines to run the tests in unit_test.py

commit d308d90ef24779cce87b25ee49ab032add71c110
Author: Sakshi <sakshiluchoo@gmail.com>
Date:   Thu May 22 14:31:58 2025 +0400

    Test implementation to test that red and violet are visible and user input for Visible Light range(to see if input is above or below range)
```

Repository Structure:



```
C:.
│   README.txt
│
├───code
│   │   data_calculation.py
│   │   frequency_colours.py
│   │   main.py
│   │   stone_and_music_notes.py
│   │   unit_test.py
│   │
│   └───__pycache__
│           data_calculation.cpython-313.pyc
│           frequency_colours.cpython-313.pyc
│           stone_and_music_notes.cpython-313.pyc
│
└───documents
        Declaration of Originality.docx
        SakshiLuchoo_23314771_ISEReport.md
```

Branch Strategy:

- main: Stable production code
- dev: Development branch
- test: Test code branch

Discussion

Achievements

- Fully functional color analysis tool
- Clear interface documentation
- Efficient modular design

Challenges faced

- Handling in frequency/wavelength calculations with rounding off values
- Ensuring consistent user experience across menu options
- Correct error handling

- Maintaining correct match-case structure

Limitations

- Limited predefined color set
- Simple integer and string inputs

Future Improvements

The requirements of this project were met while successfully implementing professional software engineering practices and ethics. This modular design proved to be efficient by running multiple test cases/test implementations. Furthermore, the program has a good version control system as there is easy tracking of changes made to files through the history of modifications and there is a clear progression of code across the software development lifecycle. Although good programming and software engineering practices ere used, the structure of the porgram modules could be improved by expanding the color database and supporting decimal inputs as well.