Faculty of Engineering & Technology

Electrical and Computer Engineering Department

ENCS3320 Computer Networks

Project Report

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Date: December 13, 20

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Part 1

1.1 Defining the Words Ping, Tracert, Nslookup, and Telnet

- Ping: (Packet internet groper) A command line used to check if a server is reachable by sending a request and waiting for a response, while measuring the round-trip time (RTT) if a response is received, it is also use to test host/server are reachable, internet connection, and adapter functional correctly.

- Tracert: Traceroute is a command line that shows the IP addresses of the routers that are on the path that packets take from source to destination.

- Nslookup: A command line used to get information about the DNS (Domain Name Server) server, either by translating the DNS to its corresponding IP address or vice versa, it is usually used to determine the location of the server.

- Telnet: A command line that allows the user to connect to another computer or server over a network and execute commands remotely, sending data in clear text.

1.2 Running Commands

Figure 1 shows the pinging of a device in the same network. First, an Ubuntu terminal is opened to get the IP address of the Ubuntu computer using the command line 'ifconfig'. As seen in the figure the IP address is 192.168.56.101. Then, a windows terminal is opened, and the command 'ping 192.168.56.101' is used to check if the device with IP address '192.168.56.101' (Ubuntu machine) is reachable or not. From the figure below, it is clear that the device is reachable because a reply was obtained about the packets, such as the round-trip time for each packet, in this case (1ms).

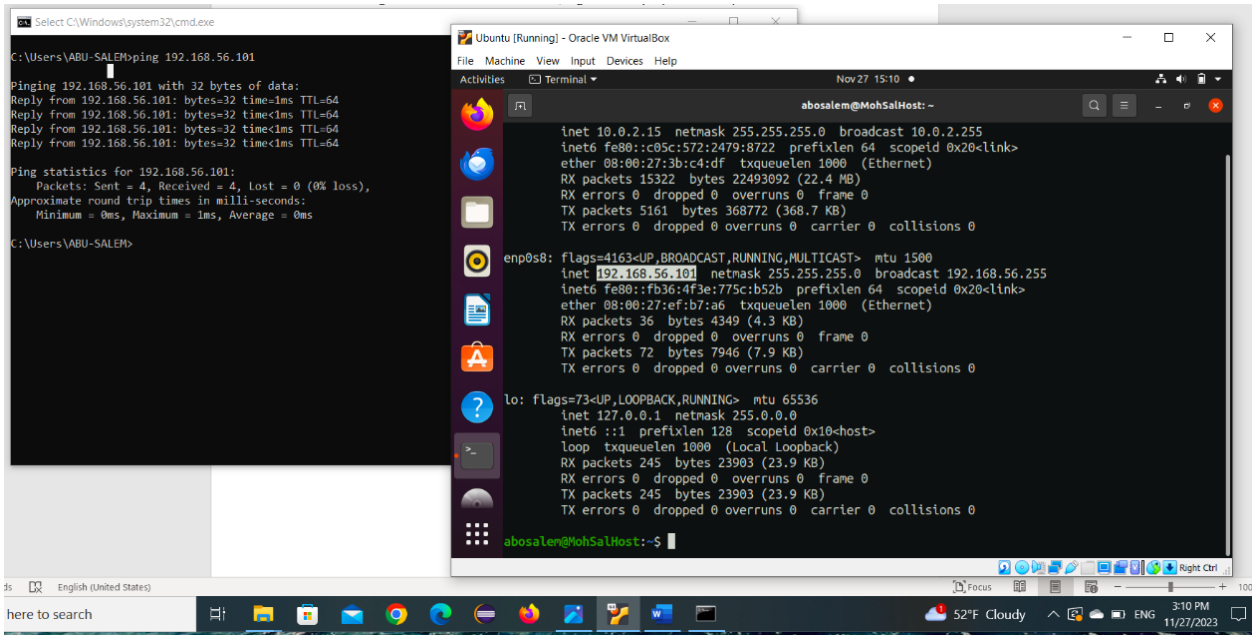


Figure 1: Pinging a Device in Same Network

In figure 2, the command line 'ping www.cornell.edu' will send a request to the domain www.cornell.edu. Since a response was received, the host "www.cornell.edu" is reachable. This number "13.107.213.62" is the IP address of the server that is responding back. The size of the request packet is 32 bytes that is sent from the computer source to the server. The server responds back with each packet being 32 bytes. Each response shows the time to live (TTL) which is the maximum number of routers the packet travels on, in this case 117. Moreover, the round-trip time (RTT) is also shown, which is the time it takes for a packet to travel from the

source to the destination and back, in this case 65ms (in maximum). Ping statistics are shown that present the number of packets being sent (4 packets) and received (4 packets). As seen in the figure, the percentage of the packets lost is 0% and the minimum, maximum and average round trip time is also shown.

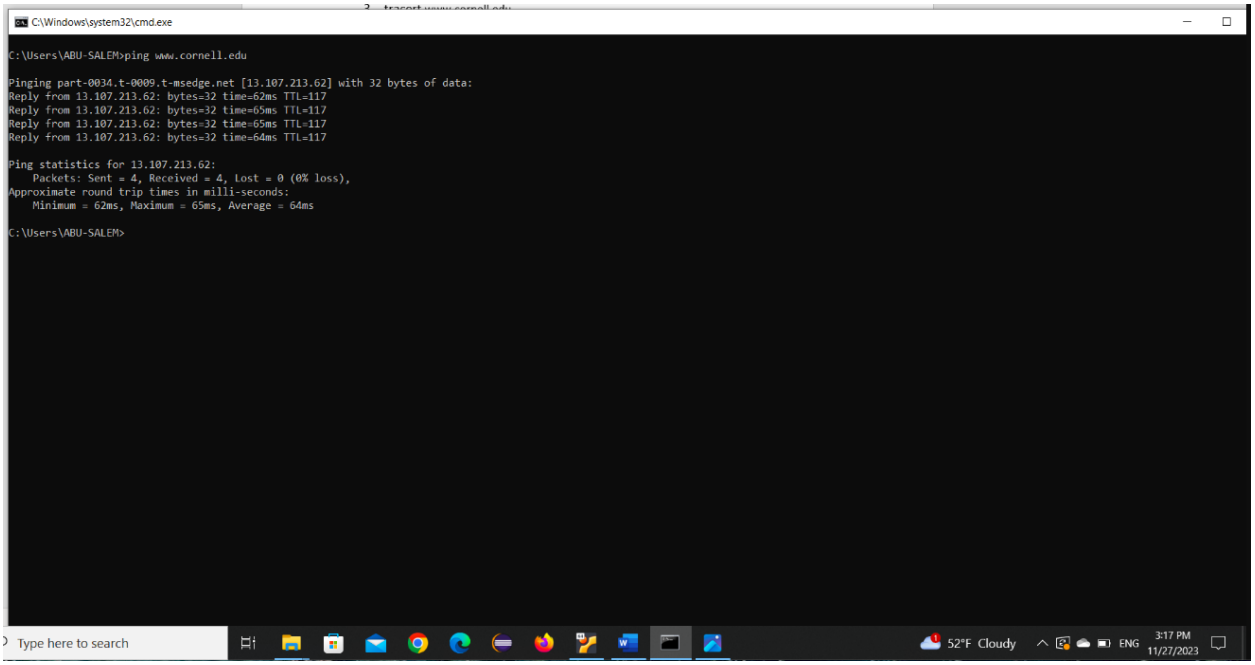


Figure 2: Ping Command

In figure 3, the traceroute command (`tracert`) will trace the route that packets take from the source to destination, measuring the number of hops or routers that packets travel on. However, there is a maximum number of hops on the route as a limit for packets to reach their destination. Each row represents a hop with its IP address and the round-trip time. For Example, at the 4th hop, the router has an IP address of 10.74.42.234, and 3 packets with round trip times 23ms, 20ms and 19ms. As can be seen in the figure, there are some rows that have asterisks instead of the intended information. This means the router is not responding to the request within time. At the end of the command result, a message is displayed “trace complete” that indicates the route was traced successfully.

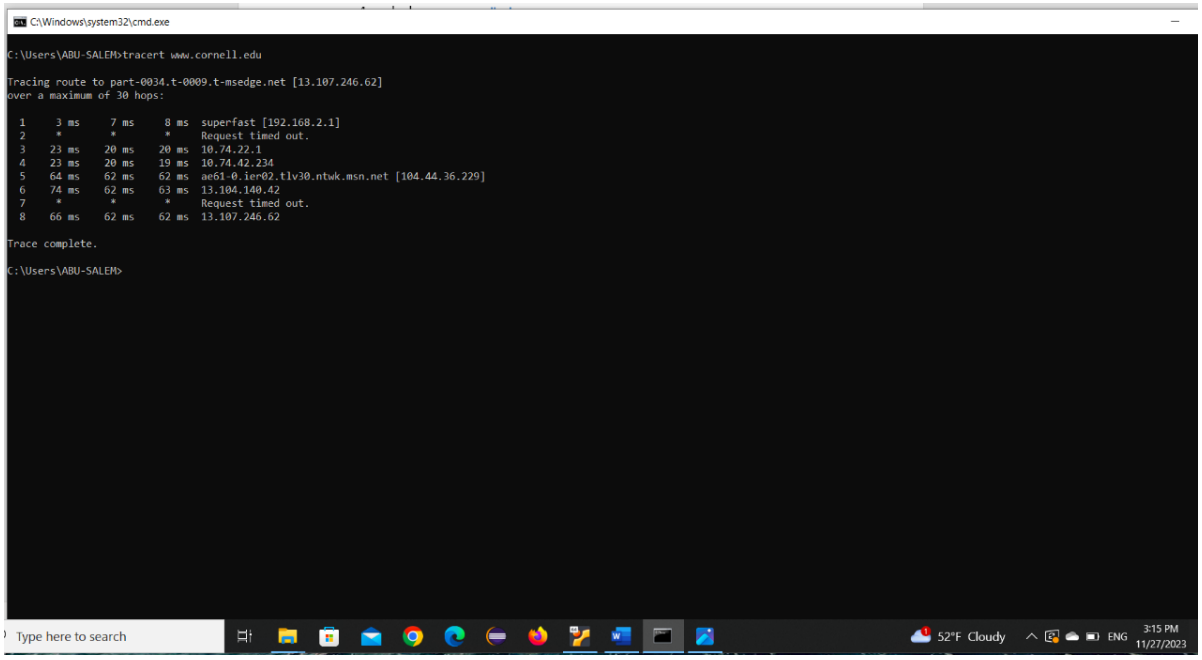


Figure 3: tracert Command

In figure 4, the nslookup command is shown in both Ubuntu and Windows terminal. This command gives more details on the Domain Name System (DNS). First, information about the server is given such as the server and address. In the Ubuntu terminal there were many canonical names for the server www.cornell.edu which are alias names for the domain name. In the Windows terminal this can be seen under the section Aliases. In both terminals, different IP addresses are shown. This can occur if the domain is using clustered servers.

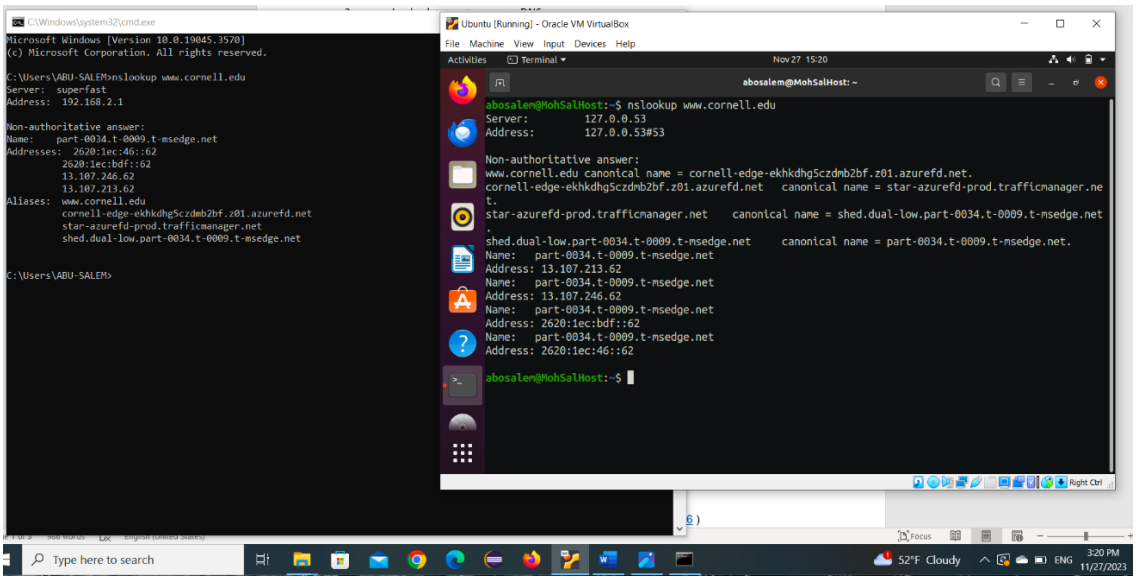


Figure 4: nslookup Command

1.3 Wireshark Capturing DNS messages

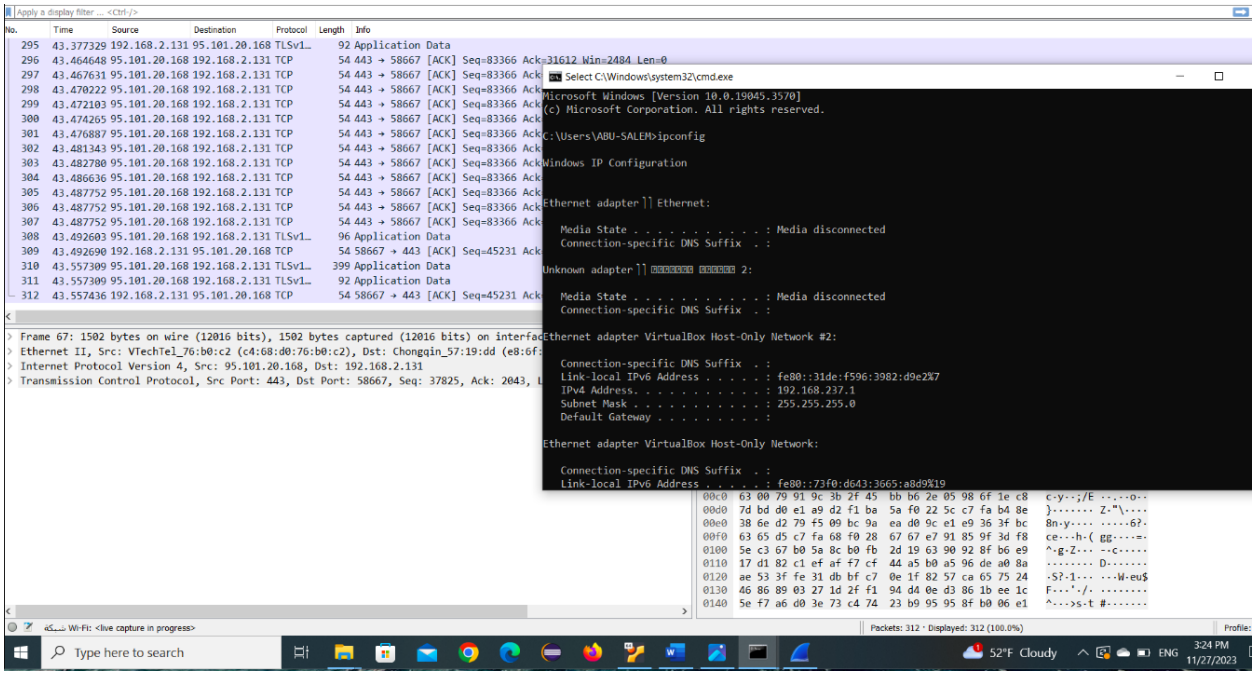


Figure 5: Search for IP address of Device

Wireshark is like an eavesdropper that listens to the messages being sent and received over the network. It helps us understand how devices communicate with each other by showing information about the packets being sent and received in real time. This information includes the packet number, time, IP address of the source and destination, the protocol type, length of the packet in bytes, and finally the info column that provides a description of the packet.

As seen in figure 5, a search for the IP address of the device being used is done on the terminal using ipconfig command. In figure 6, the filter bar on the wireshark program is being used to display only the packets that involve DNS communication, such as DNS queries and responses. As seen in figure 6, the IP address of the device is shown which is 192.168.2.131. In the wireshark program, a packet is being sent to this IP address shown in the destination column of the highlighted line.

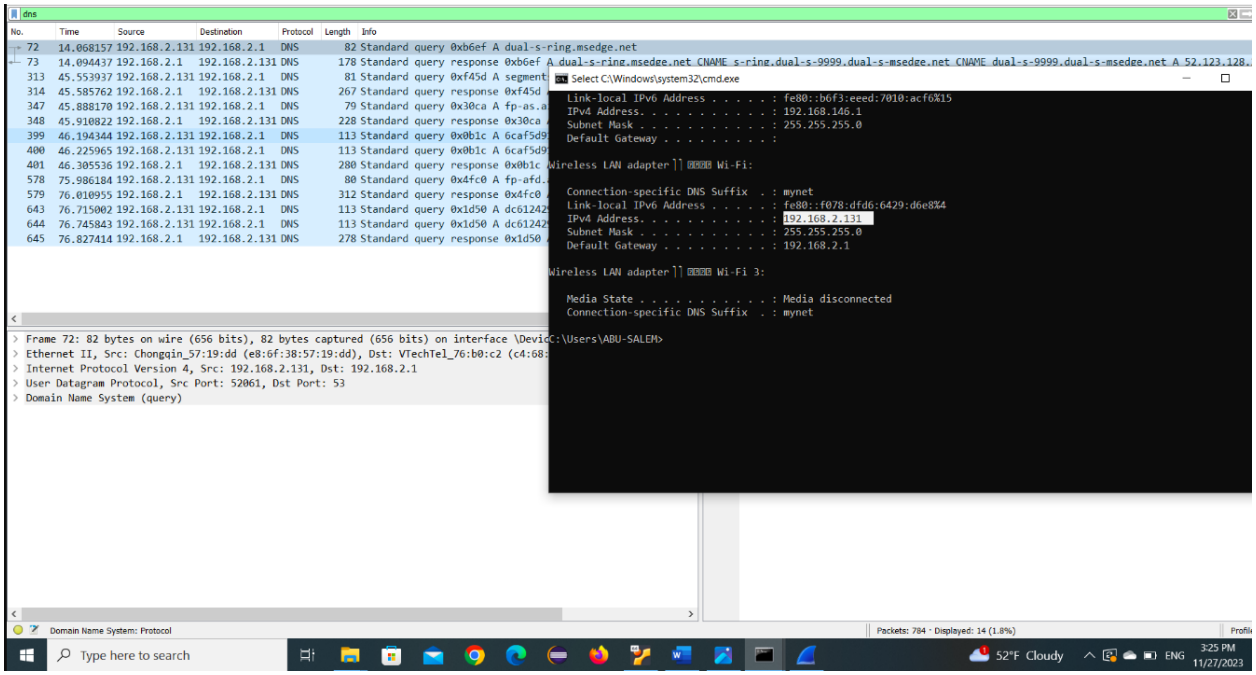


Figure 6: Wireshark Program

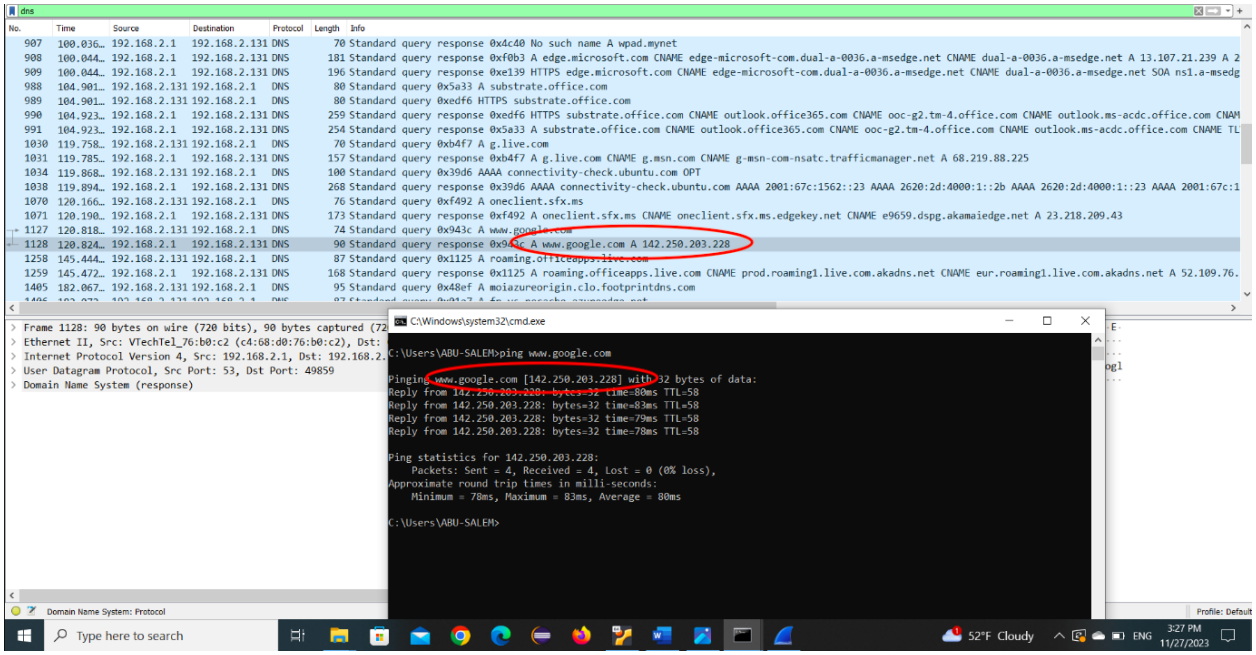


Figure 7: Wireshark DNS query For Google

The function of a DNS server is to translate the domain name to its corresponding IP address and vice versa. This is crucial because humans remember domain names easier than a big number (IP address), and devices on the network operate using IP addresses. It's important to

note that DNS services are not only implemented in proxy servers, but also can be found in home routers. As seen in figure 7, wireshark is capturing DNS messages in real time. Here visiting the Google website (google server IP address of 142.250.203.228) is captured in the wireshark program, shown in the info column. Figure 8 shows another instance where the wireshark program captures DNS messages, in this case visiting W3schools.

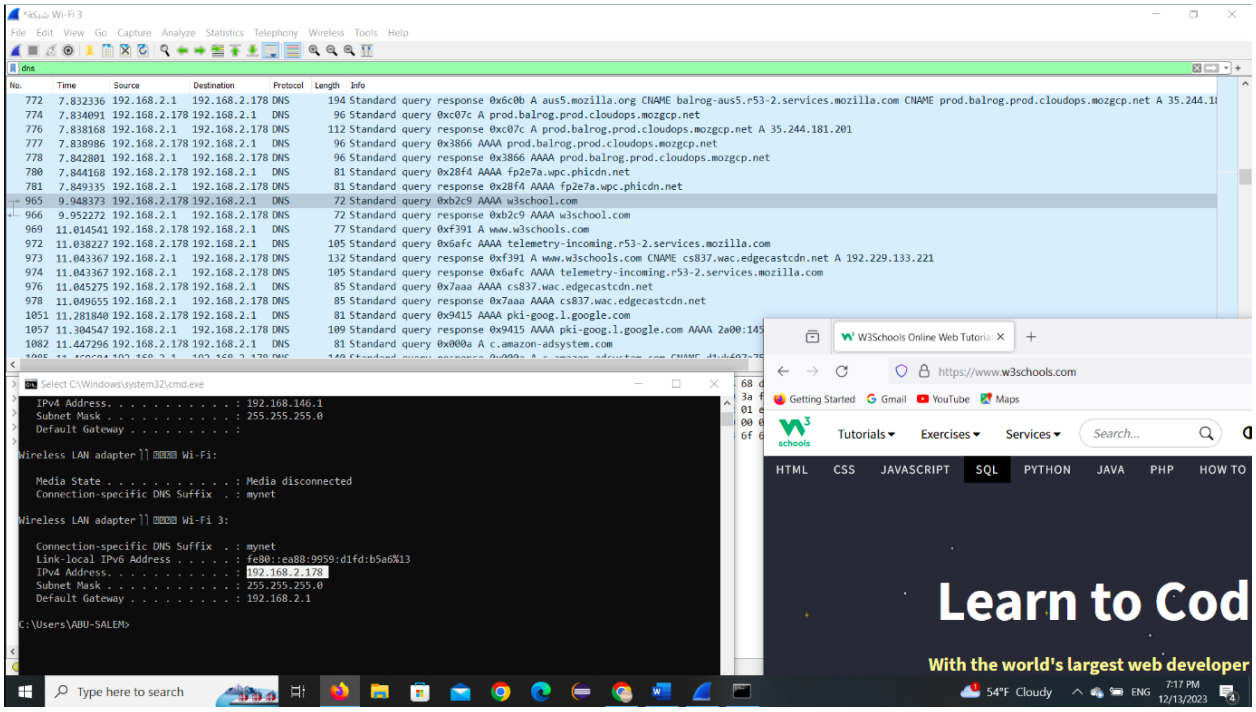


Figure 8: Wireshark DNS query For W3Schools

From the ping results, do you think the response you have got is from the USA? explain your answer briefly

As seen in figure 2, pinging to cornell.edu website takes 117 TTL (Time to Live) which corresponds to 117 routers, whereas pinging to a device locally takes 64 TTL as seen in figure 1. Locally, there are fewer hops (64 TTL) which is a much shorter path than the path when pinging cornell.edu (117 TTL). This suggests that the response from the ping results in figure 2 is in fact from the USA.

Part 2

2.1 Socket Programming- TCP Client and Server Application

Using socket programming, we have implemented a TCP client and server application in Python. The server is listening on port 9955 and the server waits for a message from the client. If the message is with one of our student's ID's, then it will do a series of steps. It will display a message on the server side that the OS will lock the screen in 10 seconds. Then, it sends a message to the client that the server will lock the screen after 10 seconds. It will wait 10 seconds and lock the screen of the operating system.

Here's an explanation of what the code does:

- Imports: It imports the socket module, which provides a low-level interface to network sockets.
- Server Address: It defines the server's IP address ('127.0.0.1') and port number (9955) in the server_address tuple.
- Student IDs: It defines three student IDs (student_id1_Dana, student_id2_Mohammad, student_id3_Masa) that will be sent to the server. In this example, only student_id1_Dana is used.
- Socket Creation and Connection: It creates a new socket using socket.socket(socket.AF_INET, socket.SOCK_STREAM).
  It connects to the server using client_socket.connect(server_address).
- Sending Student ID: It sends the student ID (student_id1_Dana) to the server using client_socket.send(student_id1_Dana.encode()).
  The encode() method is used to convert the string to bytes, as sockets transmit data in bytes.
- Receiving Response: It receives the server's response using response = client_socket.recv(1024).decode().

- The recv(1024) method reads up to 1024 bytes from the socket, and decode() converts the received bytes to a string.
- Printing Response: It prints the received response to the console using print(response).

In the context of a larger client-server application, the server would be designed to handle incoming connections, receive and process the student ID, and send an appropriate response back to the client. The response could be a confirmation, an error message, or any other relevant information.

First, we run the server (in figure 9), then in the specific code snippet, when run, will send the student ID '1200651' to the server, receive a response, and print that response to the console, as shown in figure 10.

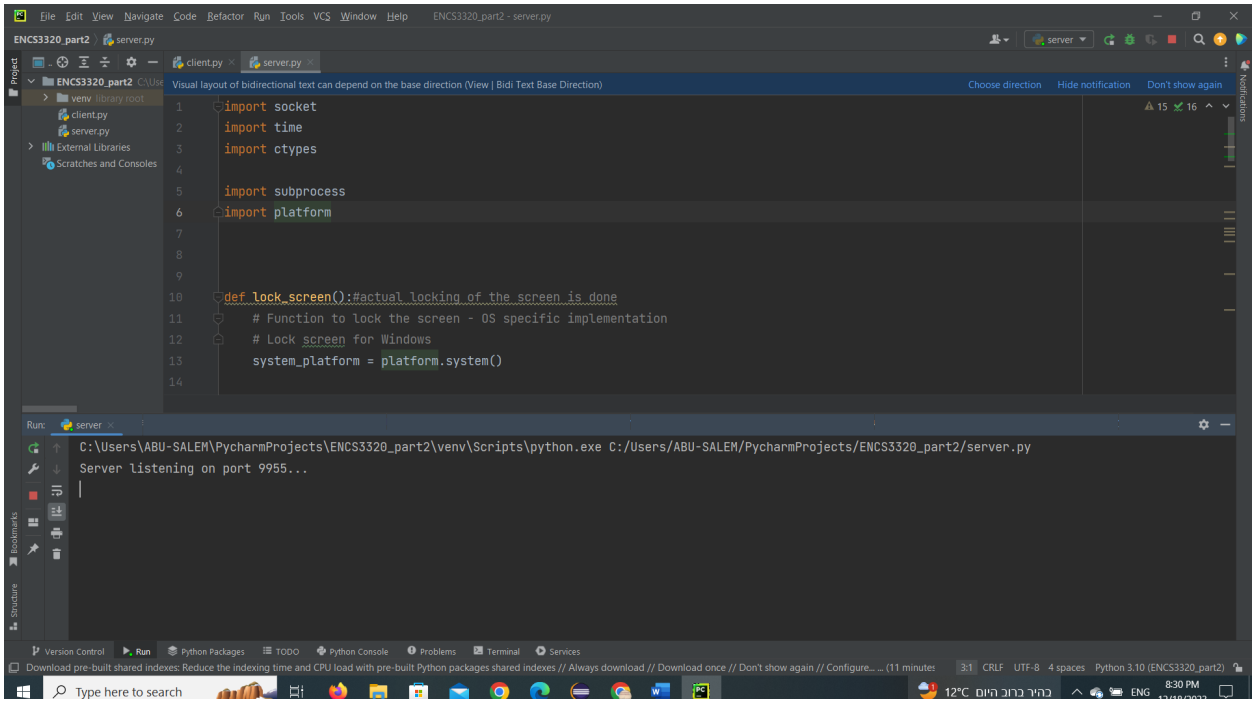


Figure 9: Run the server

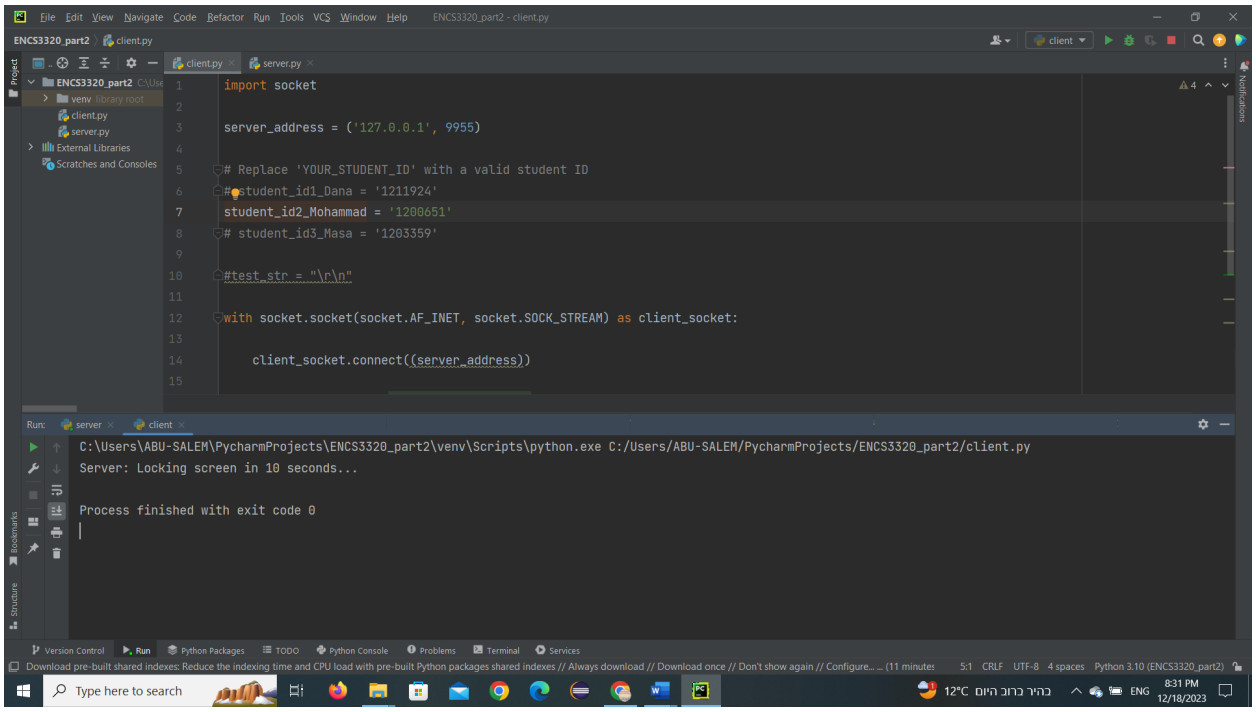


Figure 10: Client

Figure 10 shows the code of the client side creating a socket using 'socket.socket() function'. We also defined the three acceptable student IDs which are 12111924, 1200651, and 1203359. When creating a socket, we used IPv4 (internet protocol version 4) addressing and a TCP connection indicated in the code by socket.AF_INET and socket.SOCK_STREAM respectively.

Here's an explanation of what the server.py code does:

- Ports: The code starts by importing necessary modules such as socket, time, ctypes, subprocess, and platform.
- Lock Screen Function: The lock_screen() function locks the screen based on the operating system. It uses platform-specific commands for Windows, Linux, and macOS.
- Handle Client Function: The handle_client() function takes a client socket and data as parameters. It checks if the received data (presumably a student ID) matches the valid

student ID ('1200651'). If it's a valid ID, it prints a message on the server side, sends a message to the client, waits for 10 seconds, locks the screen, and notifies the client that the screen is locked. If the ID is invalid, it prints an error message.

- Server Setup: The main server code sets up a socket, binds it to address ('127.0.0.1', 9955), and starts listening for incoming connections. It enters an infinite loop where it accepts a client connection, receives data from the client, and calls handle_client() to process the data. The client socket is closed after processing each connection.
- Server Execution: When you run this script, the server will continuously listen for client connections on port 9955. When a client connects and sends data (presumably a student ID), the server will process the data based on the conditions outlined in the handle_client() function.

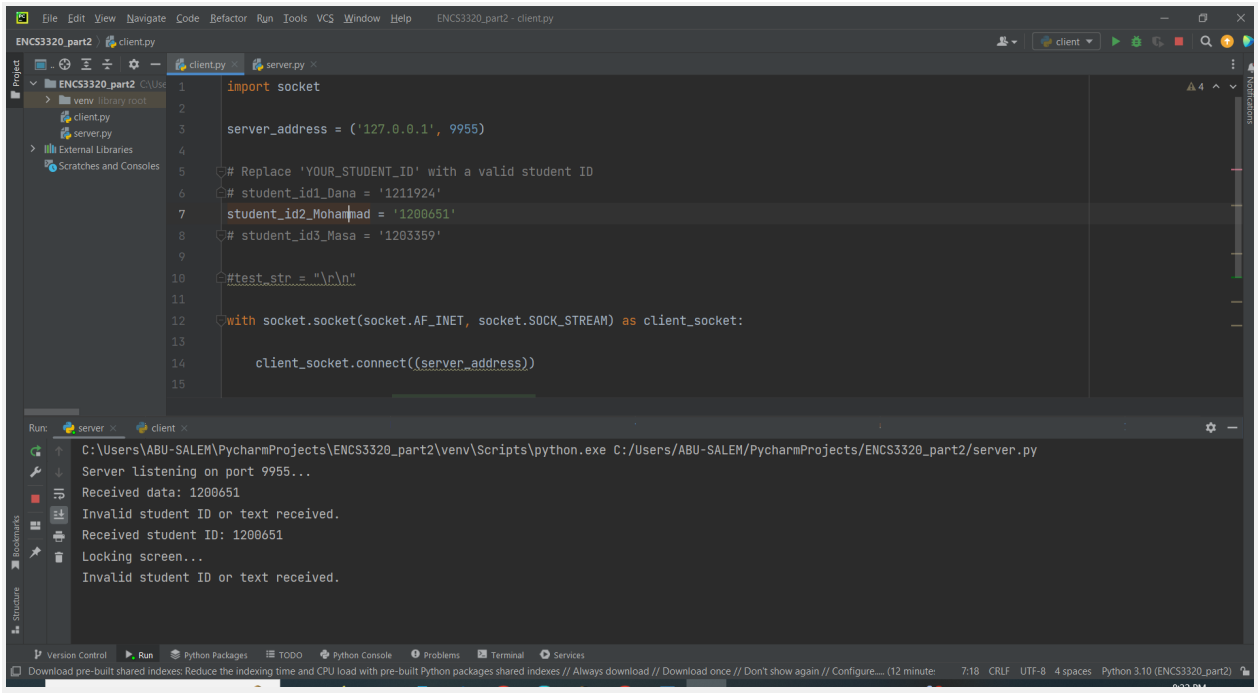


Figure 11: Server console

As can be seen in figure 11, the output shows that the server is listening on port 9955. The received data is the number 1200651 which is also the received student ID. As mentioned above after 10 seconds the screen will print a message saying “locking screen” in which the screen locks.

Part 3

We have created a web server listening to port 9966 using python. In our code we have created a socket using the AF_INET address family and SOCK_STREAM that specifies a TCP connection. Then we used the bind () method to connect the serverSocket with the port 9966. We used the empty string ‘’ to let the server accept any available network. Then we used the listen () method to let the server listen to incoming messages.

When the user types in the browser http://localhost:9966/main_en.html or http://localhost:9966/en the program will check if the request is / or /index.html or /main_en.html or /en then the server sends the main_en.html file with content type: text/html. This code is shown in figure 12.

```
# part3 branch 1
if requestedFile == '/' or requestedFile == '/index.html' or requestedFile == '/main_en.html' or\
        requestedFile == '/en':
    try:
        #print(requestedFile)
        main_en_path = "main_en.html"
        main_en_file = open(main_en_path, "r")
        html_msg = main_en_file.read()

        response = "HTTP/1.1 200 OK\r\n"  # http response
        response += "Content-Type: text/html\r\n"  # the kind of masseg is html masseg or text/plain or imag/png
        response += "\r\n"
        response += html_msg
        connectionSocket.send(response.encode())
        connectionSocket.close()  # to close the sentance => (close Connection)

    except FileNotFoundError:
        print(f"Error: '{main_en_path}' not found. Please check the file path.")
    except IOError as e:
        print(f"Error reading file: {e}")
    ############################
```

Figure 12: Code for main_en.html Request

Figure 12 shows the html file that contains “ENCS3320-My Tiny Webserver 23/24” in the title. It also contains different boxes explaining who we are as students. The decorations on this page are done inside a separate CSS file. As can be seen in the figure, the content type in the

HTTP request is summarized in a box. There are also two links available, one is a local html file, and another is w3schools website.

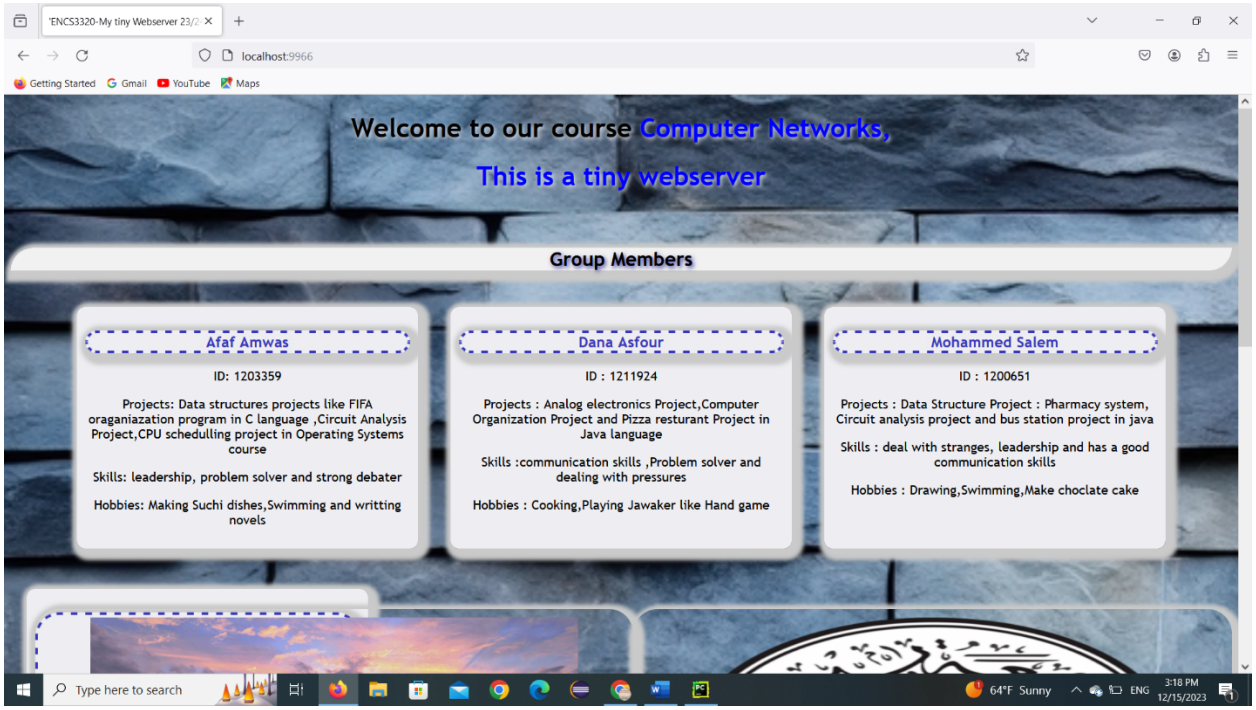


Figure 13.1: Html Webpage

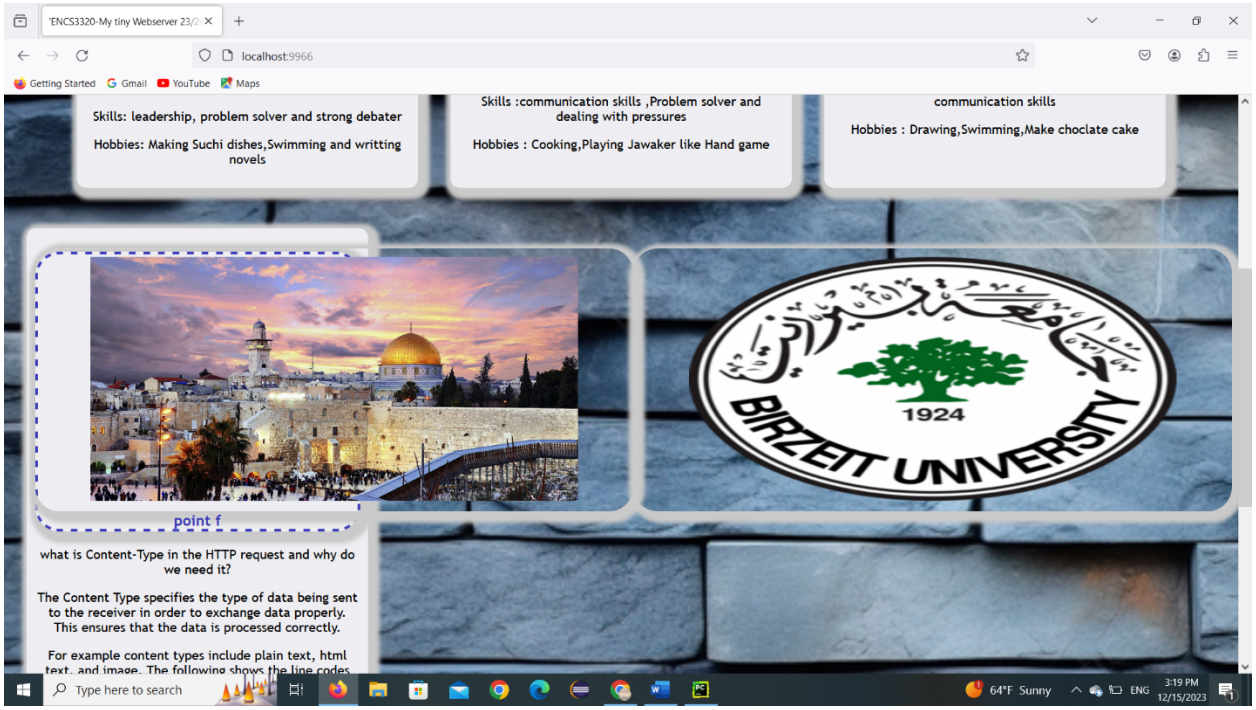


Figure: 13.2: Html Webpage

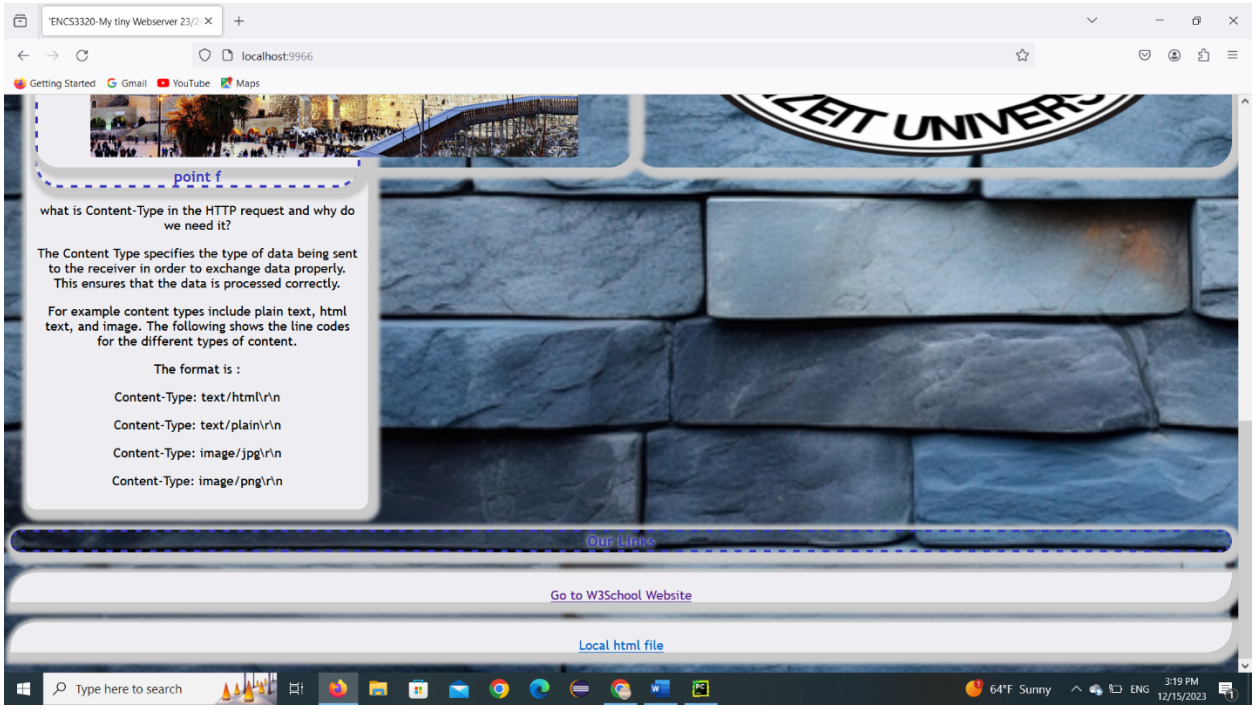


Figure 13.3: Html Webpage

Here http request appears in python console, Firefox request the main_en.html file

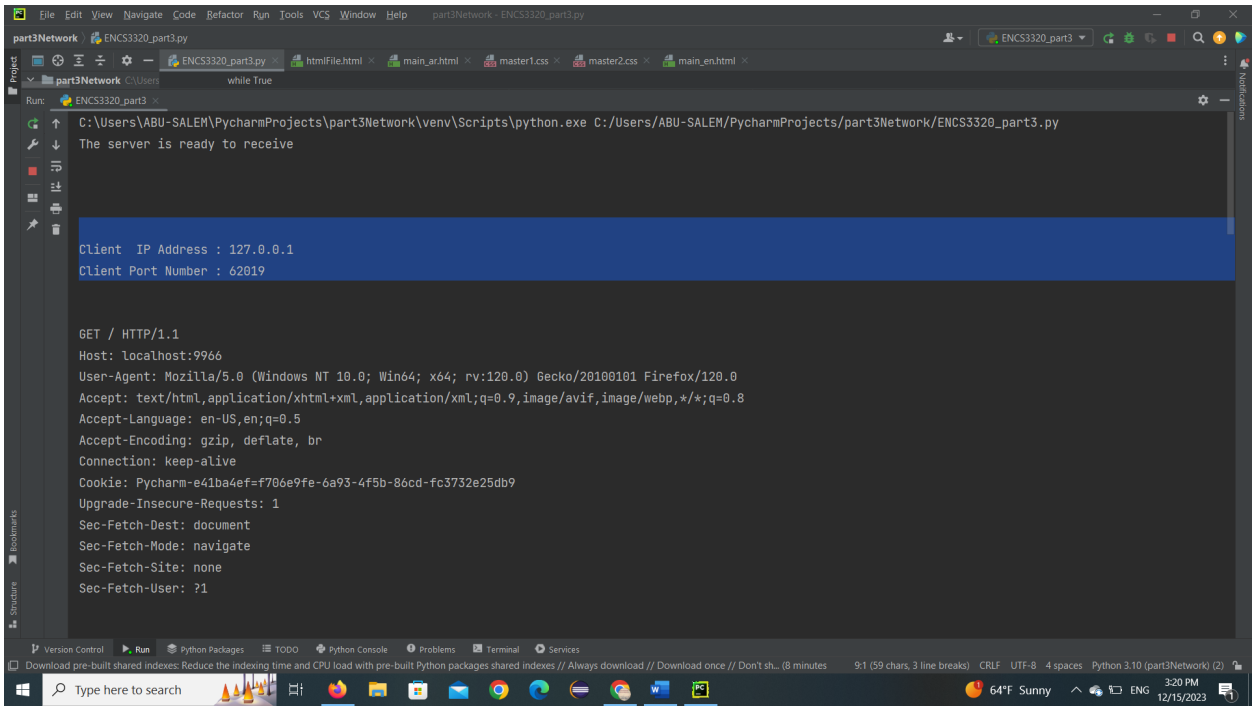


Figure 13.4: Request Html File

Here CSS file request appears in python console, Firefox request the master1.css file

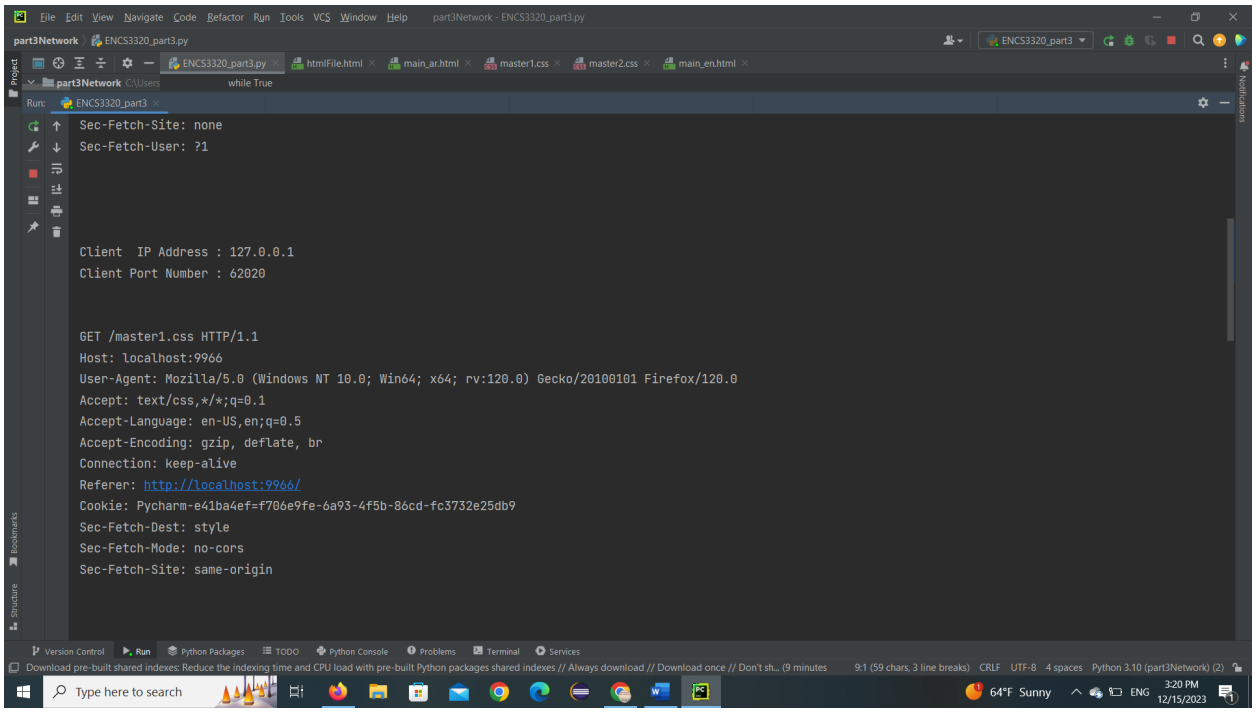


Figure 13.5: Request master1 CSS file

Here jpg image request appears in python console, Firefox request the alquds11.jpg

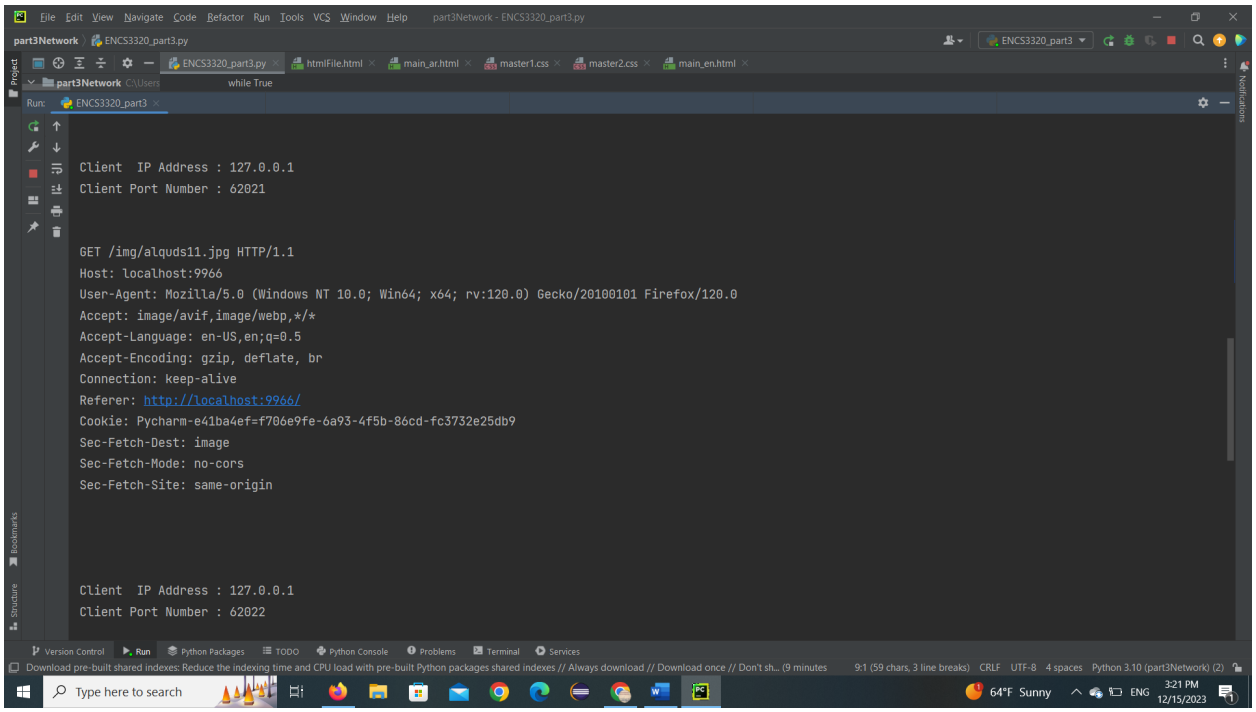


Figure 13.6: Request Image

Here png image request appears in python console, Firefox request the bzu_logo.png

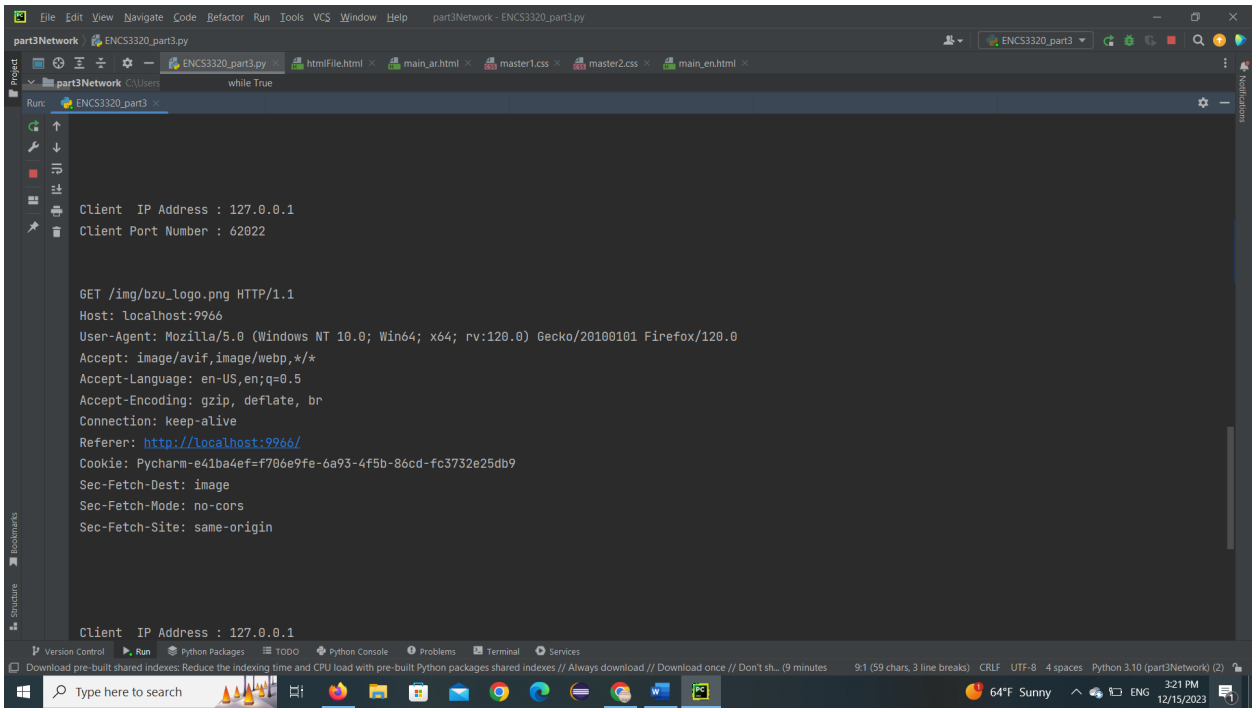


Figure 13.7: Request Birzeit Image

Here image request appears in python console, Firefox request the background.png

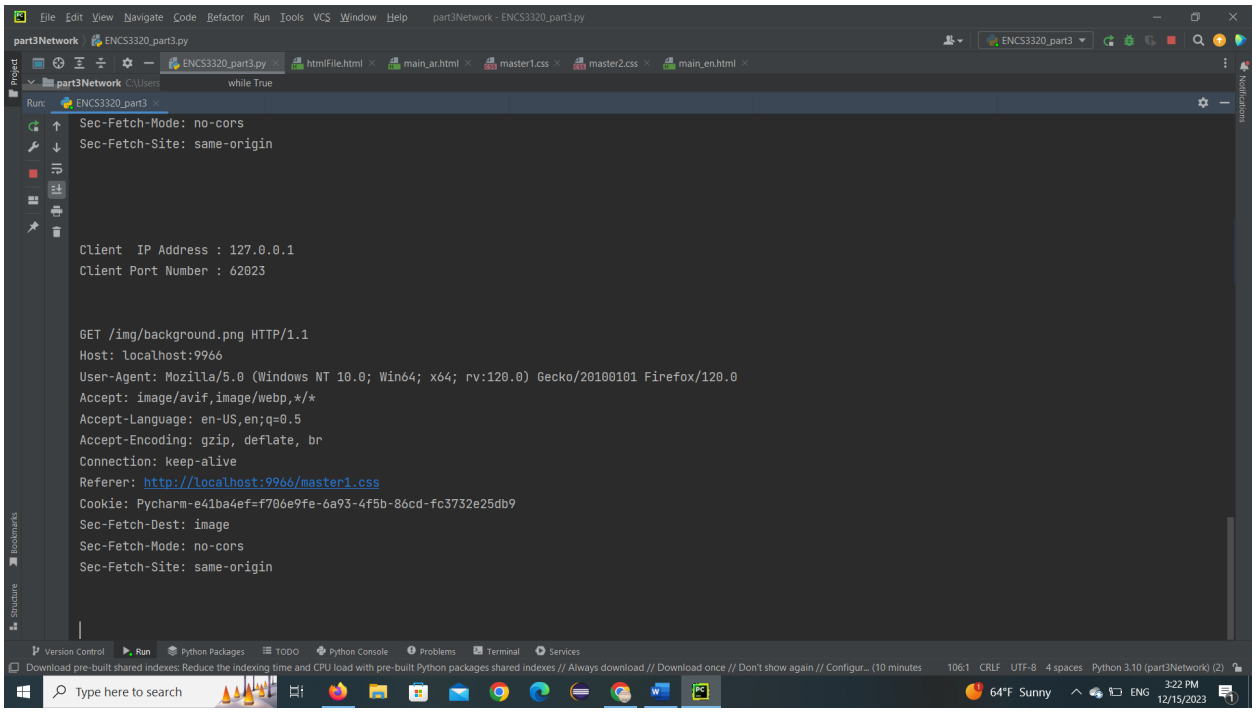
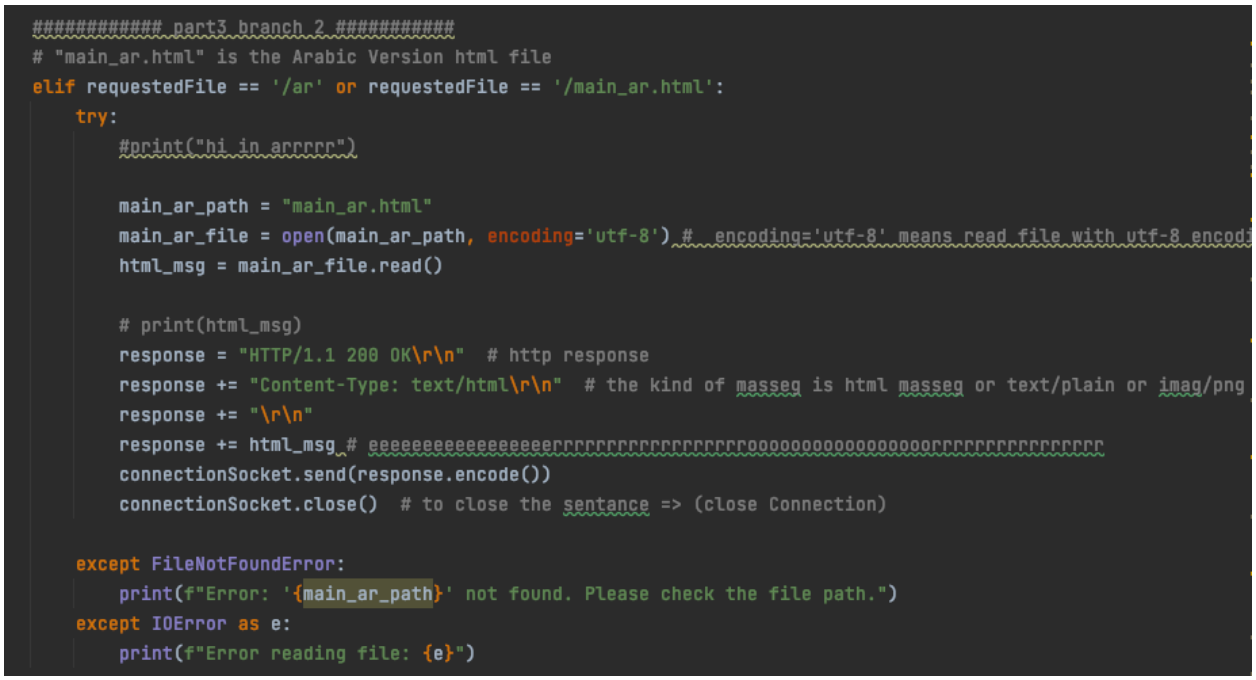


Figure 13.8: Request Background Image

When the user types in the browser http://localhost:9966/main_ar.html or http://localhost:9966/ar the program will check if the request is /main_ar.html or /ar then the server sends the main_ar.html file with content type: text/html. This code is shown in figure 14.



```
############ part3 branch 2 ###########
# "main_ar.html" is the Arabic Version html file
elif requestedFile == '/ar' or requestedFile == '/main_ar.html':
    try:
        #print("hi in arrrrr")

        main_ar_path = "main_ar.html"
        main_ar_file = open(main_ar_path, encoding='utf-8') #  encoding='utf-8' means read file with utf-8 encodi
        html_msg = main_ar_file.read()

        # print(html_msg)
        response = "HTTP/1.1 200 OK\r\n"  # http response
        response += "Content-Type: text/html\r\n"  # the kind of masseg is html masseg or text/plain or imag/png
        response += "\r\n"
        response += html_msg # eeeeeeeeeeeeeeeeerrrrrrrrrrrrrrrrrrrrrrooooooooooooooooorrrrrrrrrrrrrrrr
        connectionSocket.send(response.encode())
        connectionSocket.close()  # to close the sentance => (close Connection)

    except FileNotFoundError:
        print(f"Error: '{main_ar_path}' not found. Please check the file path.")
    except IOError as e:
        print(f"Error reading file: {e}")
```

Figure 14: Code for main_ar.html Request

Figure 14 shows the code for the Arabic version of the html file. First, we opened the file using the open () method with the path and the utf-8 encoding as parameters to this method. The variable html_msg holds the contents that are read from the html file. The http response header initializes the response with the 200 OK status and then the content type which is text or html. Then the http response is sent to the client using the send () method, and the connection closes.

If the request is /ar then the server responds with a main_ar.html file which is an Arabic version of the previous html file that contains information about us as students. This can be seen in Figure 15.

Figure 15.1: Arabic Html Webpage

Figure 15.2: Arabic Html Webpage

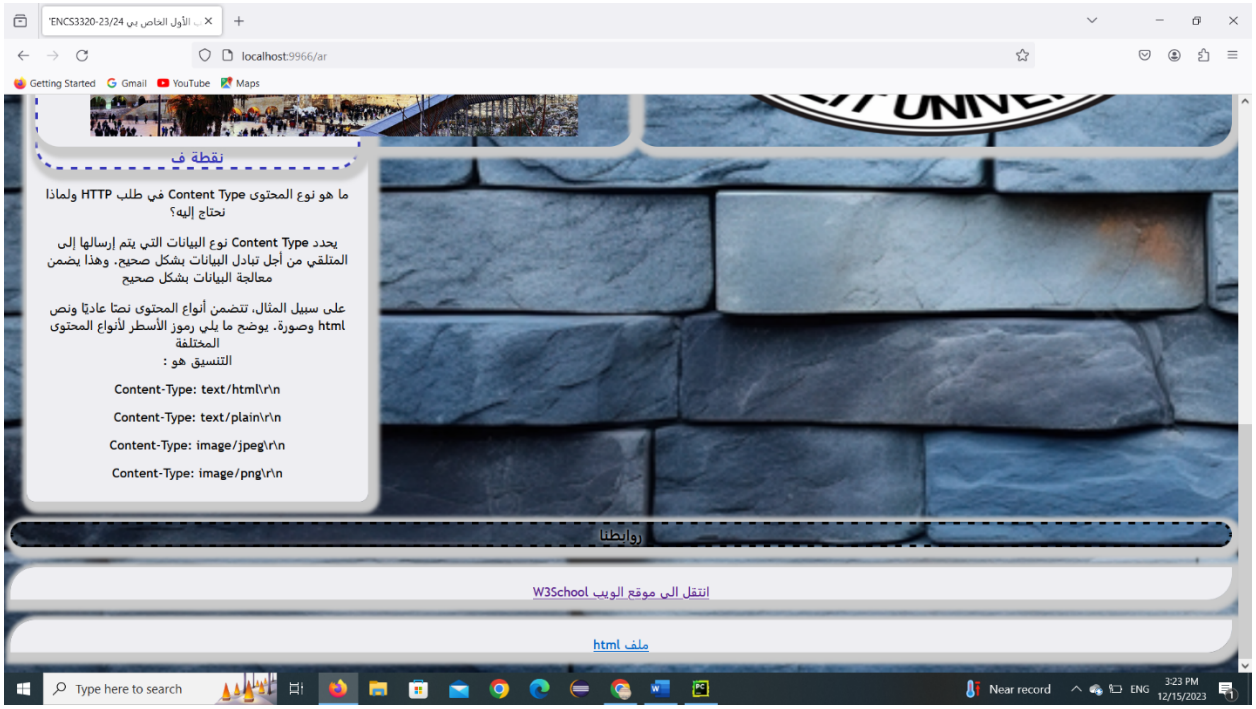


Figure 15.3: Arabic Html Webpage

Here http request appears in python console, Firefox request the main_ar.html file

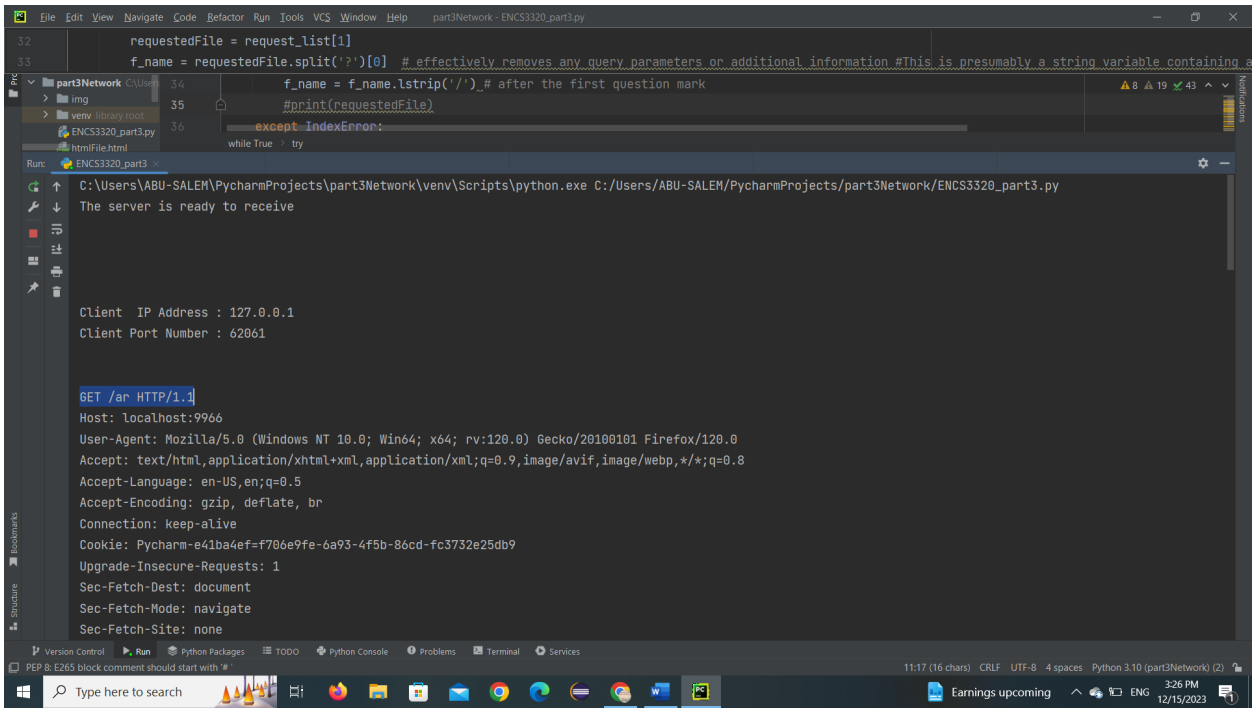


Figure 15.4: Request Arabic Html File

Here CSS file request appears in python console, Firefox request the master2.css file

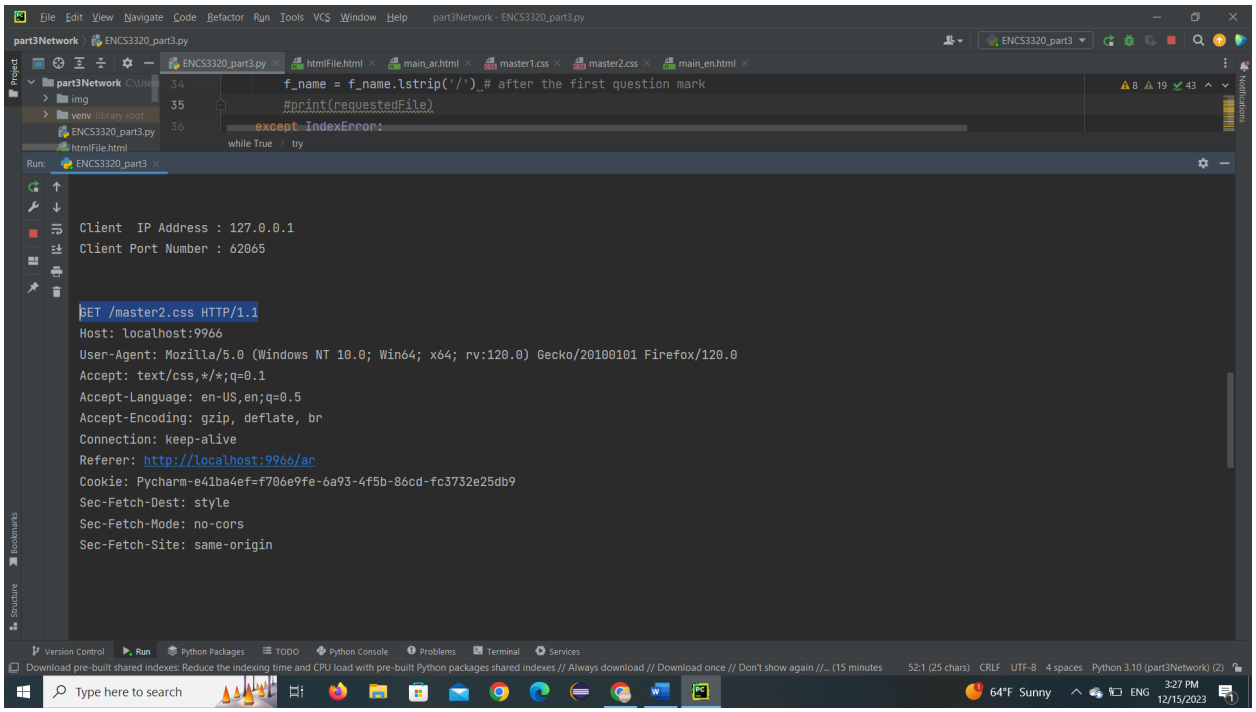


Figure 15.5: Request master2 CSS File

Here image request appears in python console, Firefox request the bzu_logo.png

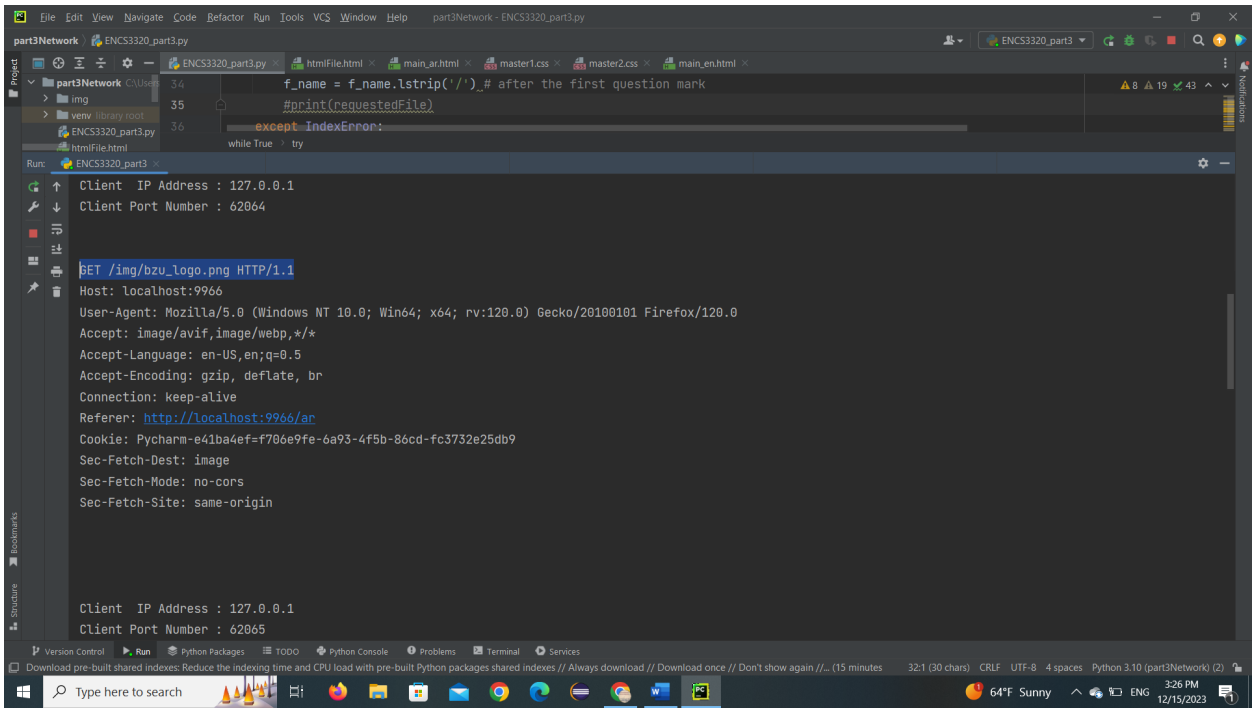


Figure 15.6: Request Image 2

Here image request appears in python console, Firefox request the alquds11.jpg

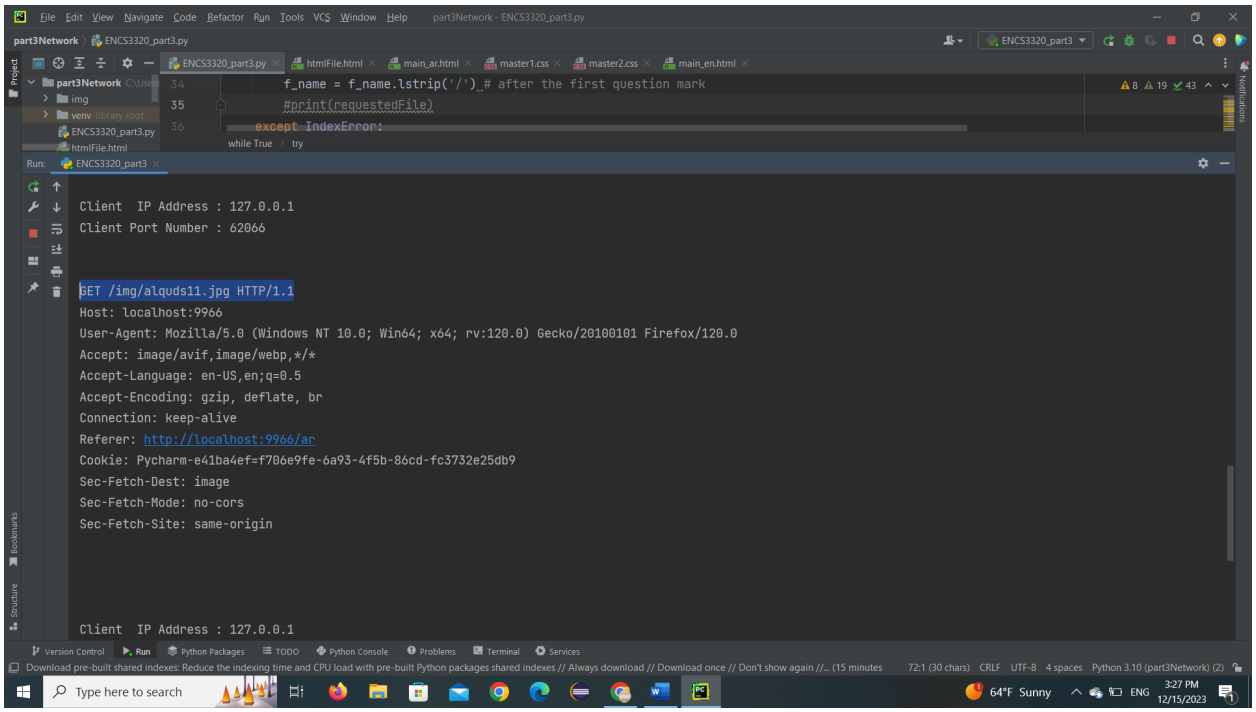


Figure 15.7: Request Al-Quds image

Here image request appears in python console, Firefox request the background.png

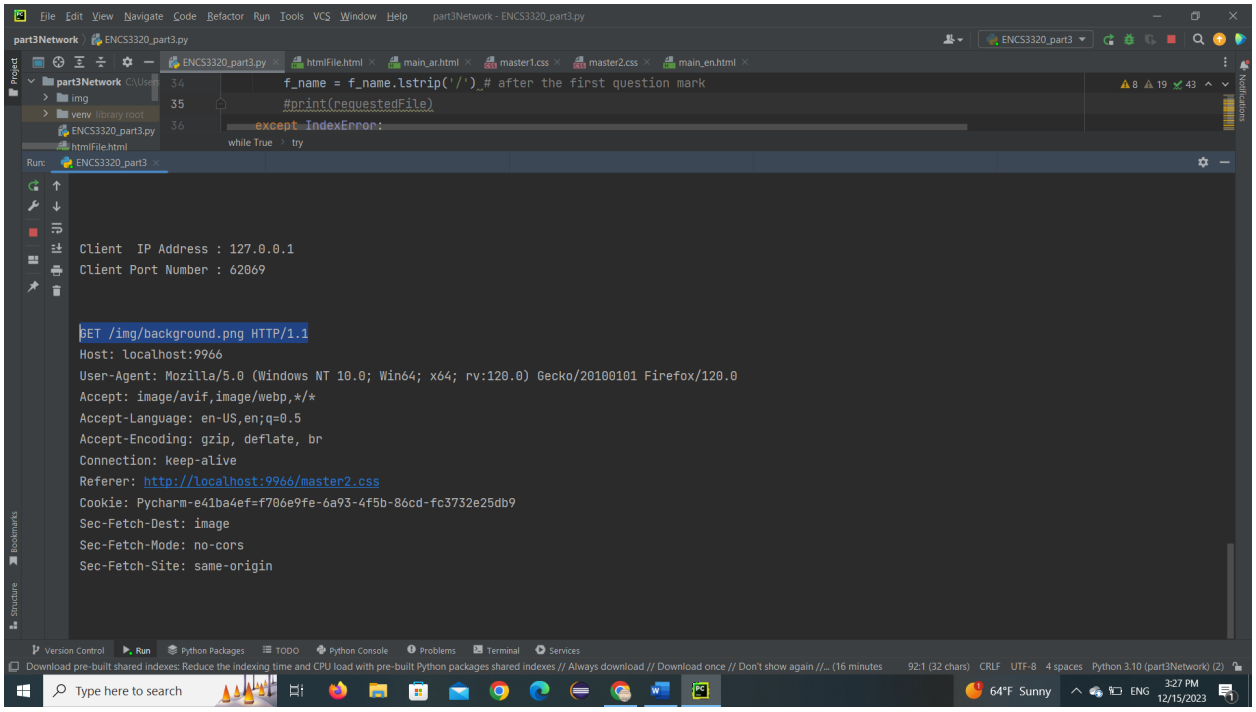


Figure 15.8 Request Background Image 2

If the request is an html file, then the server sends the requested html file with content type: text/html. Figure 16 shows the code for this part. A printing statement “Error: not found” is included to let the user know if the html file was not found, as well as, an html code to display an error message, our names and IDs. Figure 16 shows the html file with this content.

```
############ part3 branch 3 ############
elif requestedFile.endswith(".html"):
    try:
        print("hiiii in .html case")
        #print(requestedFile)

        htmlf_path = str(f_name)
        with open(htmlf_path, "r") as html_file:
            html_msg = html_file.read()

            response = "HTTP/1.1 200 OK\r\n"  # http response
            response += "Content-Type: text/html\r\n"  # the kind of masseg is html masseg or text/plain or
            response += html_msg
            response += "\r\n"
            connectionSocket.send(response.encode())
            connectionSocket.close()  # to close the sentance => (close Connection)

    except FileNotFoundError:
        print(f"Error: '{htmlf_path}' not found. Please check the file path.")
        connectionSocket.send(f"HTTP/1.1 404 Not Found\r\n".encode())
        responseMessage = (
                '<html><title>Error 404</title><body><center><h1 style = "color : red ;">The file is not '
                'found => Error 404 <= </h1><hr><p style= '
                '"font-weight: '
                'bold;">Afaf Amwas: 1203359 </p><p style="font-weight: bold;"> Mohammed Salem: 1200651 '
                '</p><p style="font-weight: bold;"> Dana Asfour: 1211924 '
                '</p><hr><h2>IP: ' + str(IPAddress) + ', Port: ' + str(PortNumber) +
                '</h2></center></body></html>').encode('utf-8')
        connectionSocket.send(f"\r\n".encode())
        connectionSocket.send(responseMessage)
        connectionSocket.close()
```

Figure 16: Code for .html Request

Here html request appears in python console, Firefox request the htmlFile.html

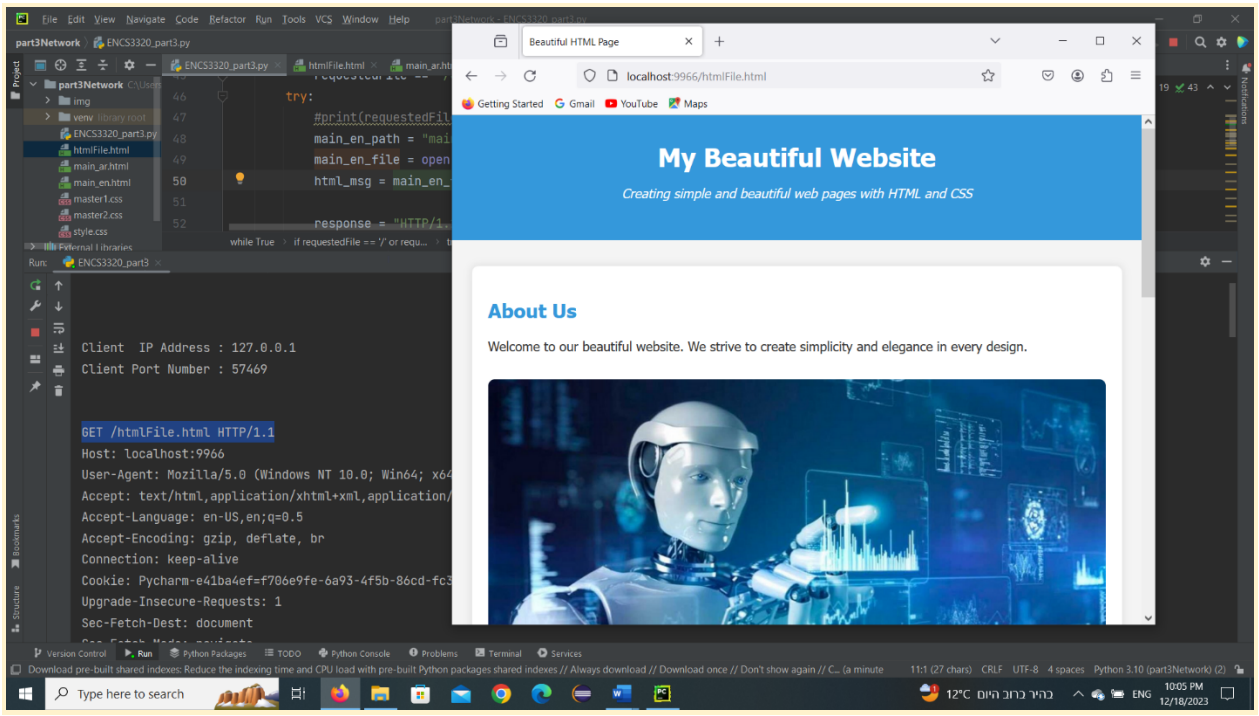


Figure 16.1: Request Html File 2

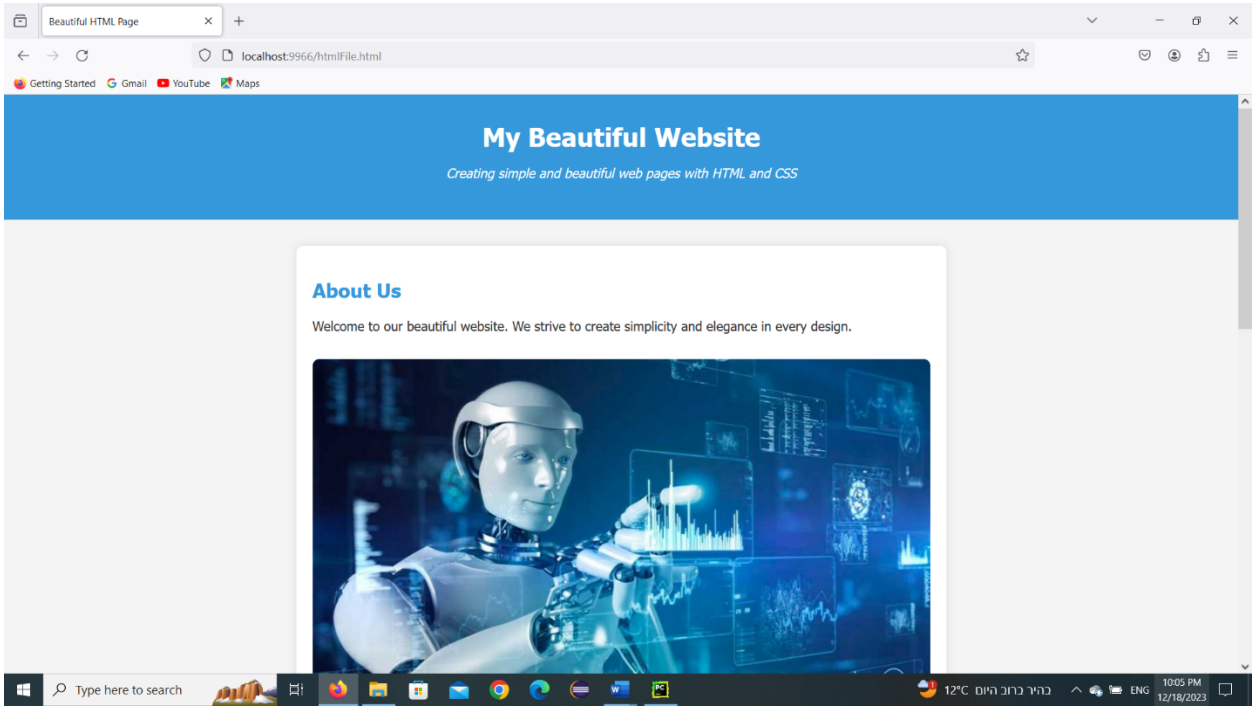


Figure 16.2: Request Html File 2

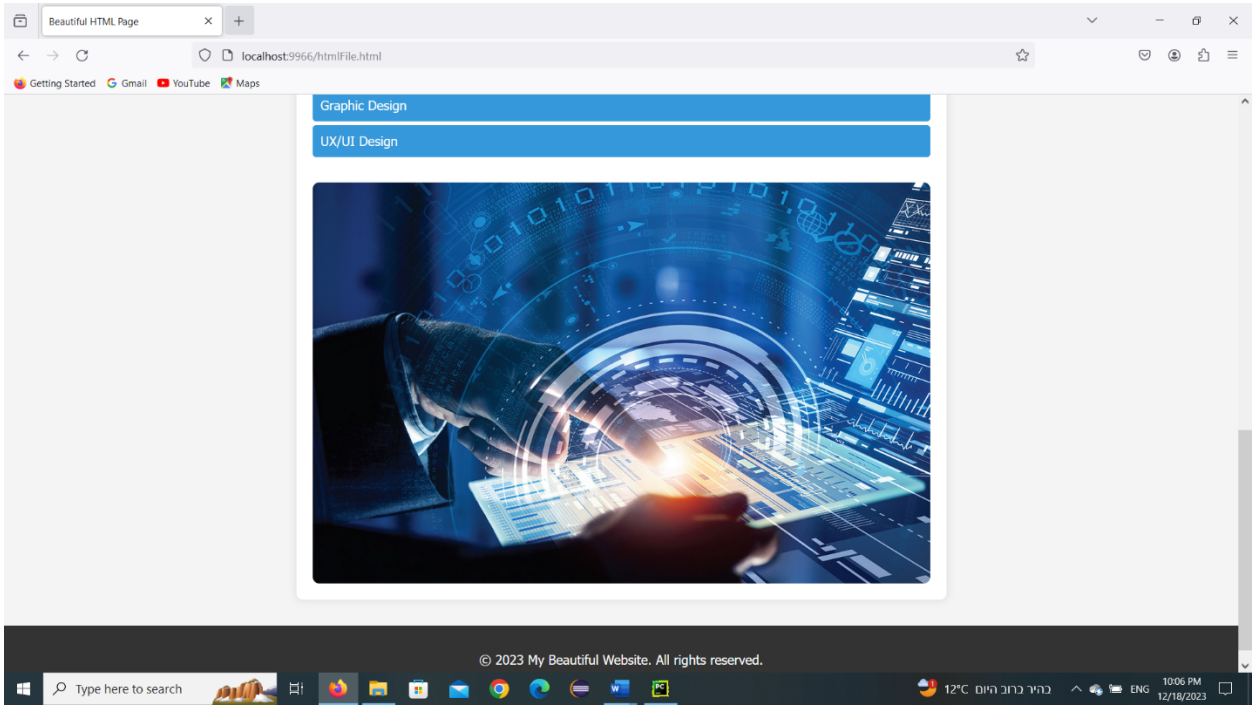
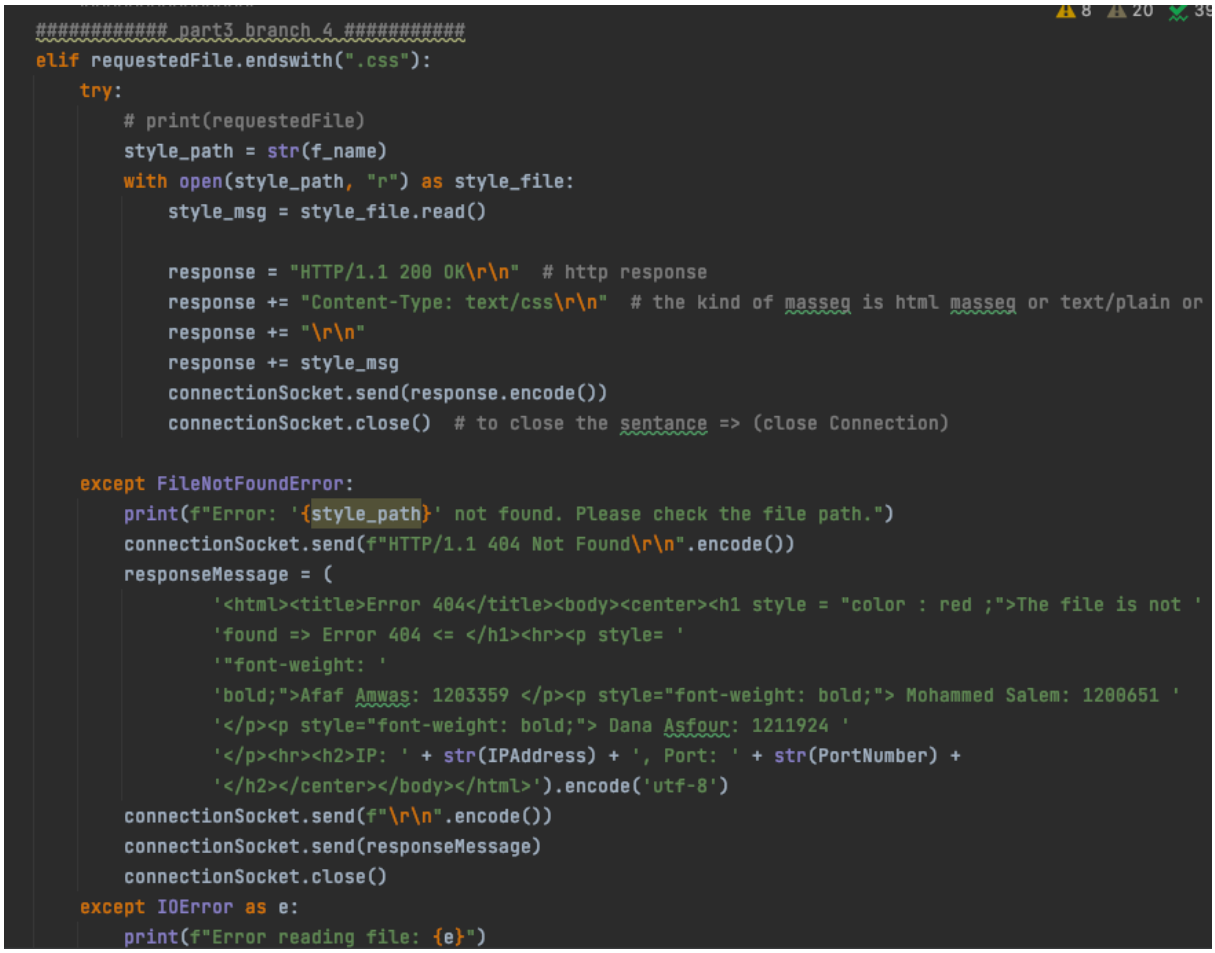


Figure 16.3: Request Html File 2

If the request is a .css file then the server sends that css file with content type: text/css as seen in figure18. The Figure below shows the css file for this part.



```
############ part3 branch 4 ############
elif requestedFile.endswith(".css"):
    try:
        # print(requestedFile)
        style_path = str(f_name)
        with open(style_path, "r") as style_file:
            style_msg = style_file.read()

            response = "HTTP/1.1 200 OK\r\n"  # http response
            response += "Content-Type: text/css\r\n"  # the kind of masseg is html masseg or text/plain or
            response += "\r\n"
            response += style_msg
            connectionSocket.send(response.encode())
            connectionSocket.close()  # to close the sentance => (close Connection)

    except FileNotFoundError:
        print(f"Error: '{style_path}' not found. Please check the file path.")
        connectionSocket.send(f"HTTP/1.1 404 Not Found\r\n".encode())
        responseMessage = (
                '<html><title>Error 404</title><body><center><h1 style = "color : red ;">The file is not '
                'found => Error 404 <= </h1><hr><p style= '
                '"font-weight: '
                'bold;">Afaf Amwas: 1203359 </p><p style="font-weight: bold;"> Mohammed Salem: 1200651 '
                '</p><p style="font-weight: bold;"> Dana Asfour: 1211924 '
                '</p><hr><h2>IP: ' + str(IPAddress) + ', Port: ' + str(PortNumber) +
                '</h2></center></body></html>').encode('utf-8')
        connectionSocket.send(f"\r\n".encode())
        connectionSocket.send(responseMessage)
        connectionSocket.close()
    except IOError as e:
        print(f"Error reading file: {e}")
```

Figure 18: Code for .css Request

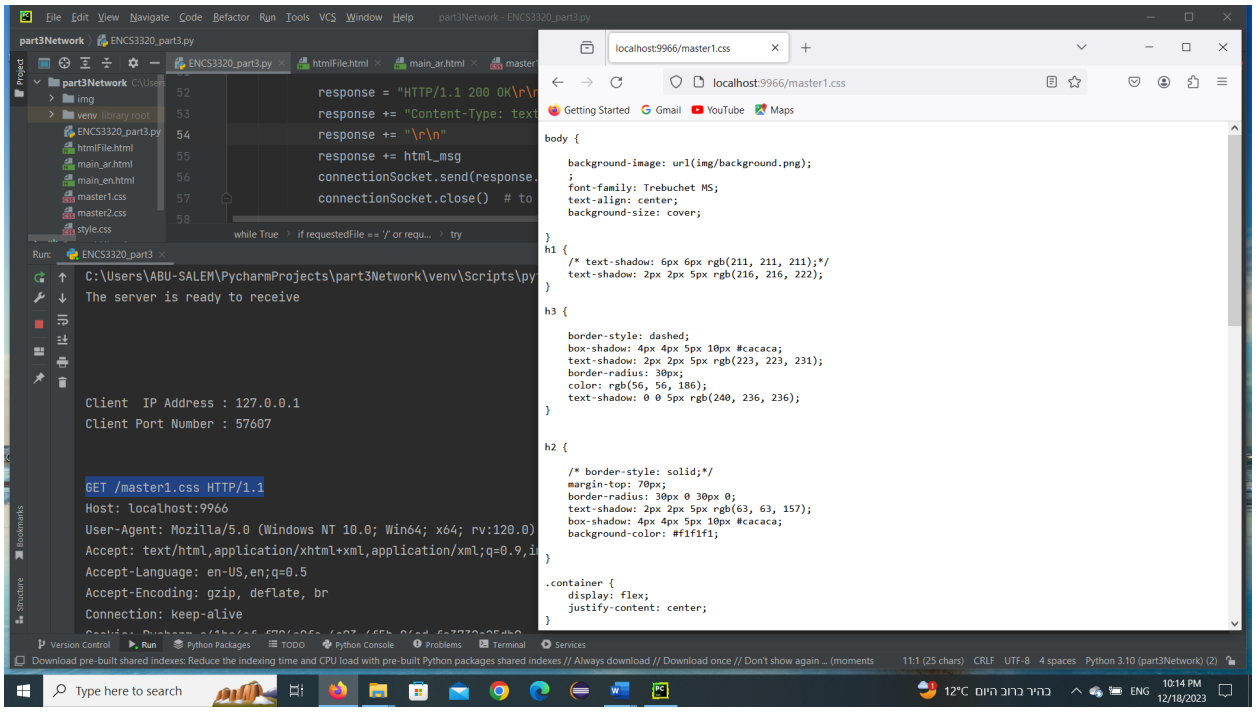


Figure 18.1 CSS Code

If the request is a .png image then the server sends that png image with content type: image/png as seen in figure 19.

```
############ part3 branch 5 ############
elif requestedFile.endswith(".png"):
    try:
        png_path = str(f_name)
        with open(png_path, "rb") as png_file:
            png_msg = png_file.read()

        response = "HTTP/1.1 200 OK\r\n"  # http response
        response += "Content-Type: image/png\r\n"  # the kind of masseg is html masseg or text/plain or imag/
        response += "\r\n"
        connectionSocket.send(response.encode())
        connectionSocket.send(png_msg)
        connectionSocket.close()  # to close the sentance => (close Connection)

    except FileNotFoundError:
        print(f"Error: '{png_path}' not found. Please check the file path.")
        connectionSocket.send(f"HTTP/1.1 404 Not Found\r\n".encode())
        responseMessage = (
                '<html><title>Error 404</title><body><center><h1 style = "color : red ;">The file is not '
                'found => Error 404 <= </h1><hr><p style= '
                '"font-weight: '
                'bold;">Afaf Amwas: 1203359 </p><p style="font-weight: bold;"> Mohammed Salem: 1200651 '
                '</p><p style="font-weight: bold;"> Dana Asfour: 1211924 '
                '</p><hr><h2>IP: ' + str(IPAddress) + ', Port: ' + str(PortNumber) +
                '</h2></center></body></html>').encode('utf-8')
        connectionSocket.send(f"\r\n".encode())
        connectionSocket.send(responseMessage)
        connectionSocket.close()
    except IOError as e:
        print(f"Error reading file: {e}")
##########################################
```

Figure 19: Code for .png Request

If the request is a .jpg image then the server sends that png image with content type: image/jpg as seen in figure 20.

```
############ part3 branch 6 ###########                    ⚠ 8  ⚠ 20  ✓ 39
elif requestedFile.endswith(".jpg"):
    try:
        jpg_path = str(f_name)
        with open(jpg_path, "rb") as jpg_file:
            jpj_msg = jpg_file.read()

        response = "HTTP/1.1 200 OK\r\n"  # http response
        response += "Content-Type: image/jpg\r\n"  # the kind of masseg is html masseg or text/plain or imag
        response += "\r\n"
        connectionSocket.send(response.encode())
        connectionSocket.send(jpj_msg)
        connectionSocket.close()  # to close the sentance => (close Connection)

    except FileNotFoundError:
        print(f"Error: '{jpg_path}' not found. Please check the file path.")
        connectionSocket.send(f"HTTP/1.1 404 Not Found\r\n".encode())
        responseMessage = (
                '<html><title>Error 404</title><body><center><h1 style = "color : red ;">The file is not '
                'found => Error 404 <= </h1><hr><p style= '
                '"font-weight: '
                'bold;">Afaf Amwas: 1203359 </p><p style="font-weight: bold;"> Mohammed Salem: 1200651 '
                '</p><p style="font-weight: bold;"> Dana Asfour: 1211924 '
                '</p><hr><h2>IP: ' + str(IPAddress) + ', Port: ' + str(PortNumber) +
                '</h2></center></body></html>').encode('utf-8')
        connectionSocket.send(f"\r\n".encode())
        connectionSocket.send(responseMessage)
        connectionSocket.close()
    except IOError as e:
        print(f"Error reading file: {e}")
```

Figure 20: Code for .jpg Request

The below figure shows the code for how we used the status code 307 Temporary Redirect to redirect to cornell.edu, stackoverflow.com, and ritaj website depending on the type of request which are /cr, /so, and /rt respectively.

```
################## part 3 branch 7 ###############
elif requestedFile == "/cr":
    connectionSocket.send(f"HTTP/1.1 307 Temporary Redirect\r\n".encode())
    connectionSocket.send(f"Location: https://www.cornell.edu/ \r\n".encode())
elif requestedFile == "/so":
    connectionSocket.send(f"HTTP/1.1 307 Temporary Redirect\r\n".encode())
    connectionSocket.send(f"Location: https://stackoverflow.com/ \r\n".encode())
elif requestedFile == "/rt":
    connectionSocket.send(f"HTTP/1.1 307 Temporary Redirect\r\n".encode())
    connectionSocket.send(f"Location: https://ritaj.birzeit.edu/register/ \r\n".encode())
################ part 3 branch 8 ################
else:
    connectionSocket.send(f"HTTP/1.1 404 Not Found\r\n".encode())
    responseMessage = (
            '<html><title>Error 404</title><body><center><h1 style = "color : red ;">The file is not '
            'found => Error 404 <= </h1><hr><p style= '
            '"font-weight: '
            'bold;">Afaf Amwas: 1203359 </p><p style="font-weight: bold;"> Mohammed Salem: 1200651 '
            '</p><p style="font-weight: bold;"> Dana Asfour: 1211924 '
            '</p><hr><h2>IP: ' + str(IPAddress) + ', Port: ' + str(PortNumber) +
            '</h2></center></body></html>').encode('utf-8')
    connectionSocket.send(f"\r\n".encode())
    connectionSocket.send(responseMessage)
    connectionSocket.close()
```

Figure 21: Code for Temporary Redirect

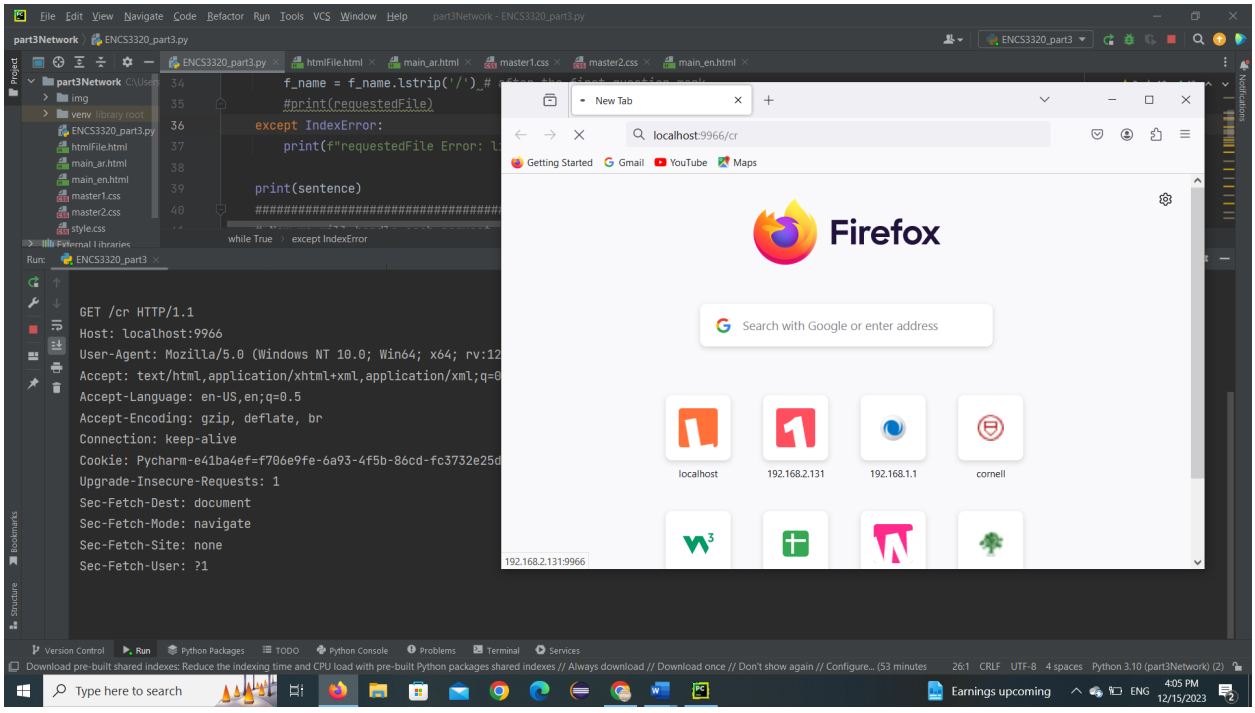


Figure 21.1: Firefox Redirect

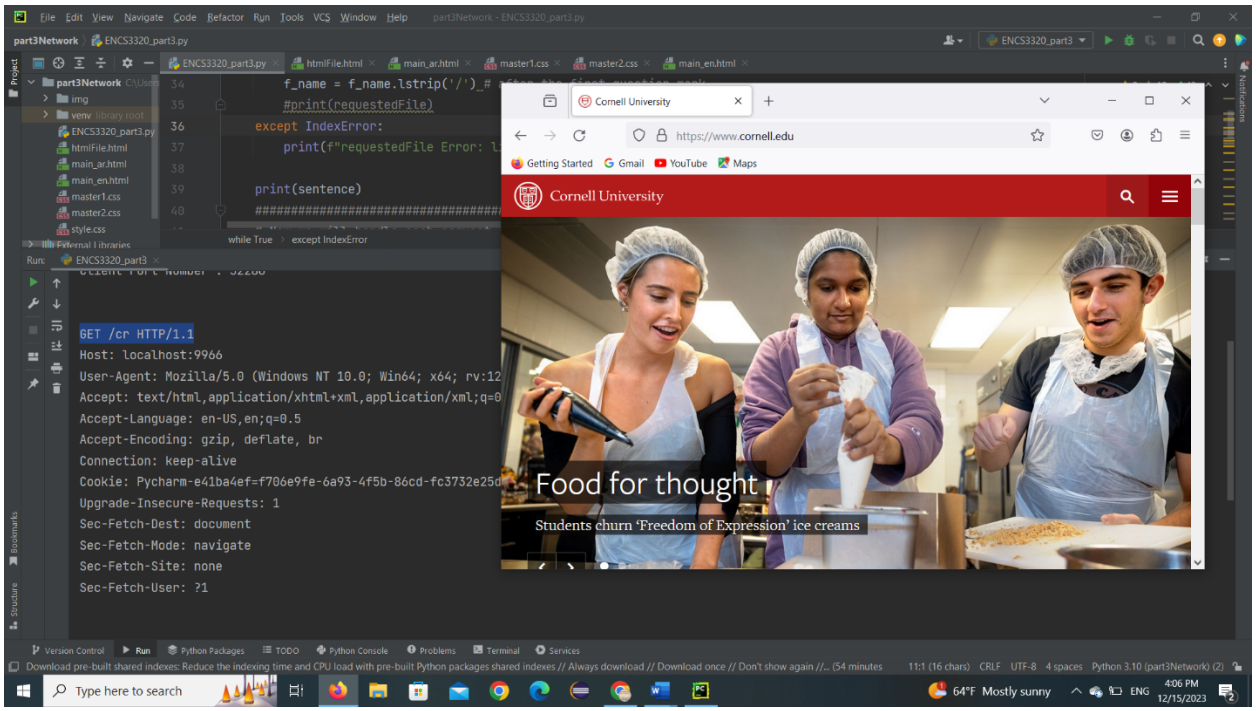


Figure 21.2: Cornell Redirect

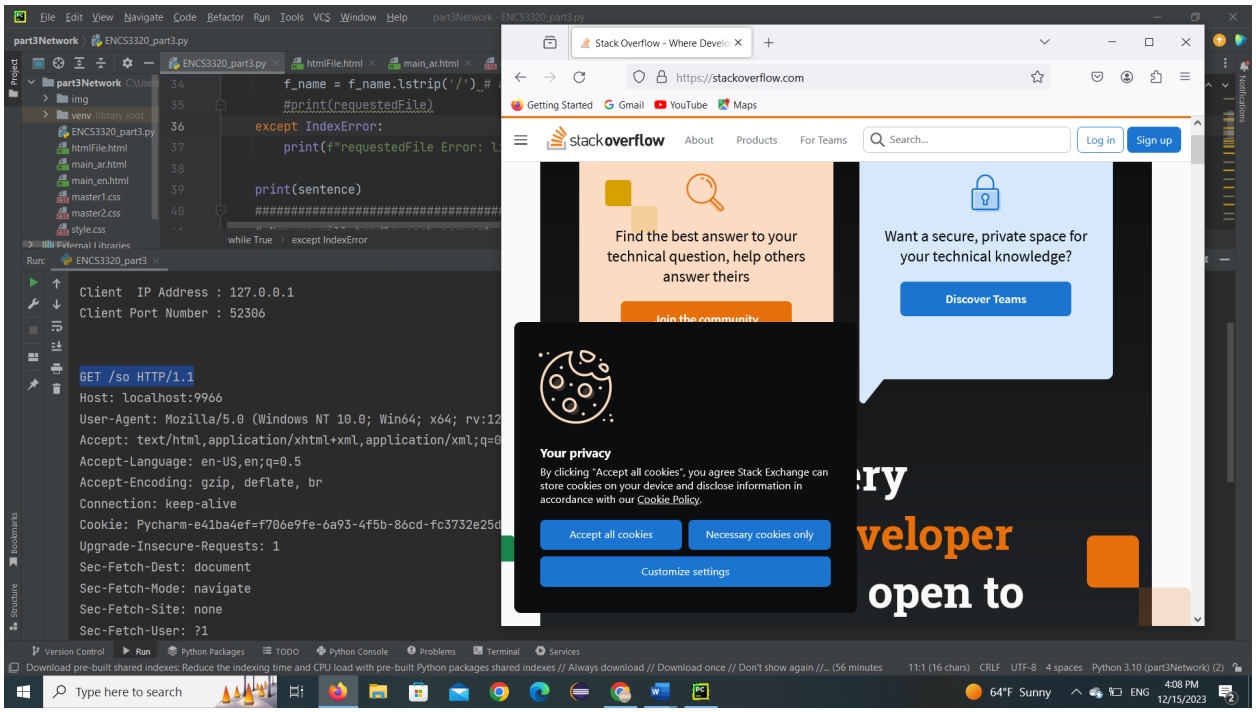


Figure 21.3: StackOverflow Redirect

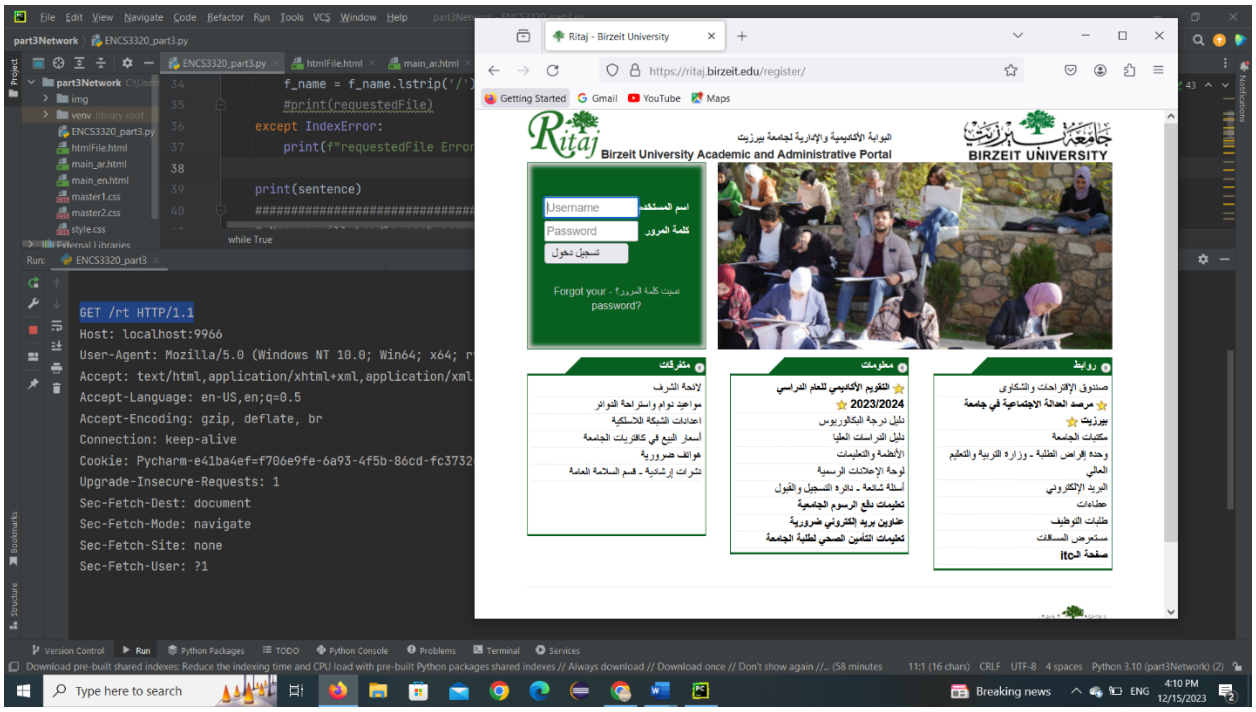


Figure 21.4: Ritaj Redirect

As seen in all these requests, if the request is wrong or the file doesn't exist the server returns a simple html web page that contains content type: text/html. This webpage shown in figure 22 shows the response status (404 Not Found), an error message in the title, a message in the body, our names and IDs, and finally the IP and port number of the client.

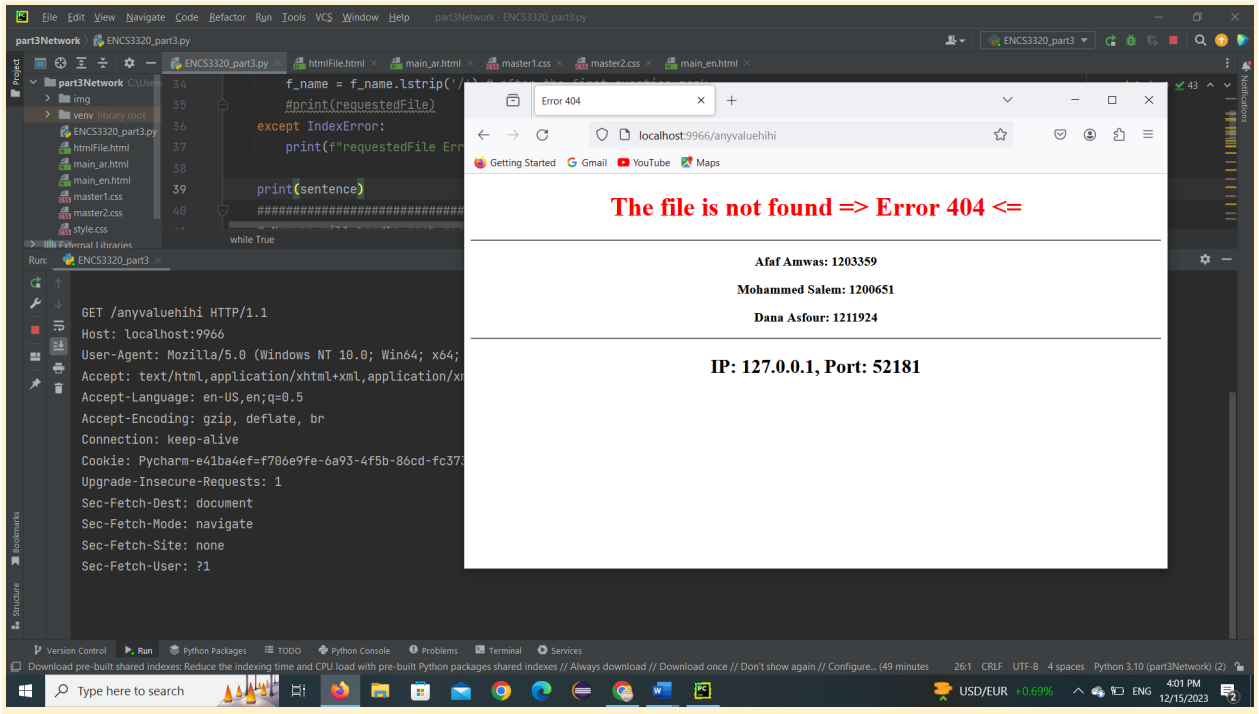


Figure 22.1: Error Webpage

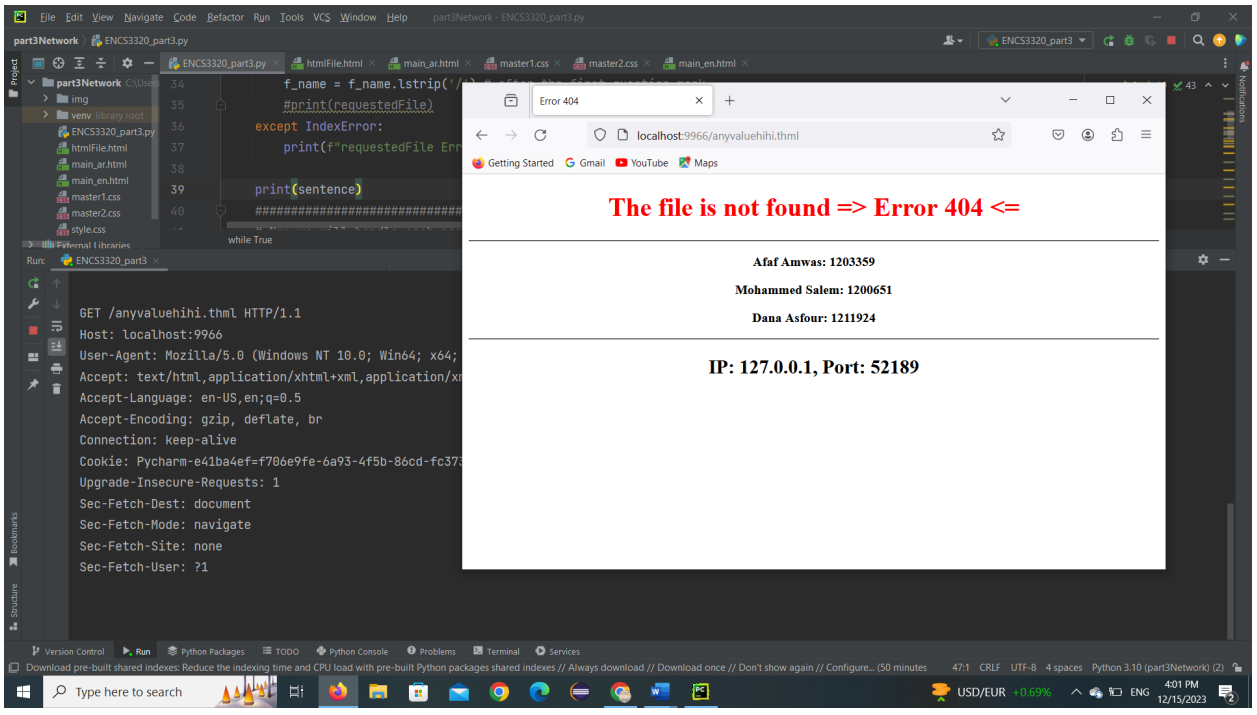


Figure 22.2: Error Webpage

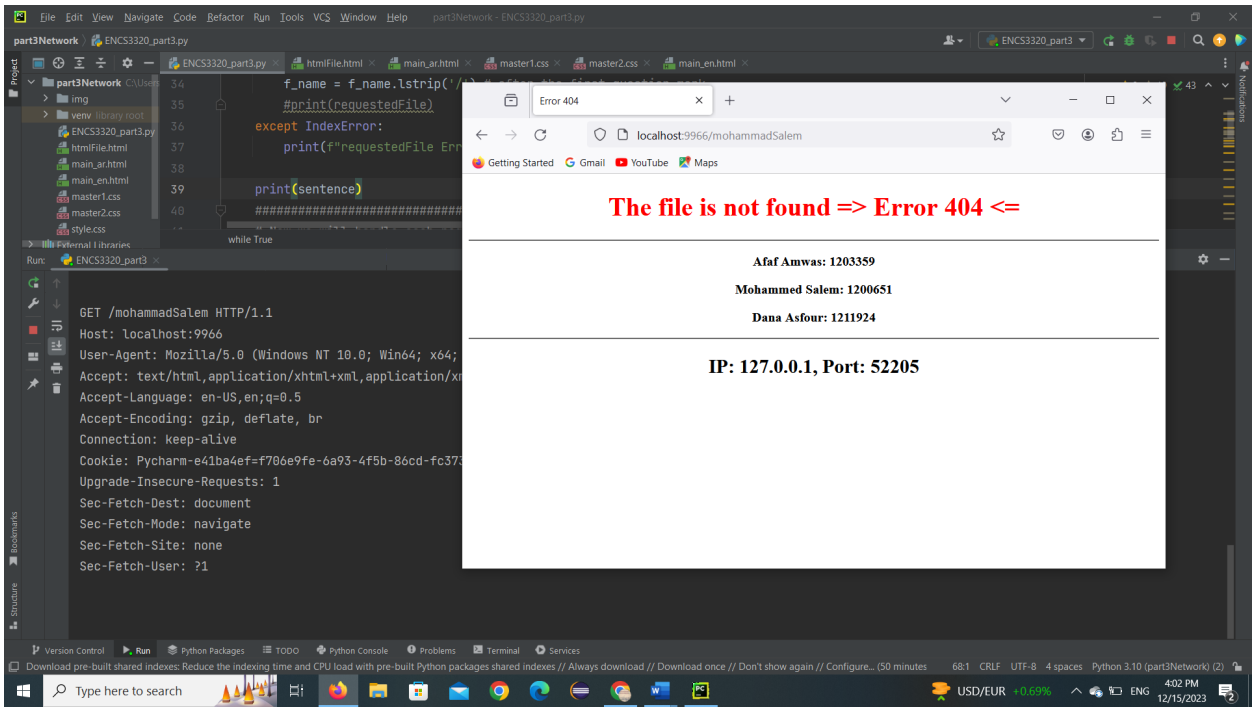


Figure 22.3: Error Webpage

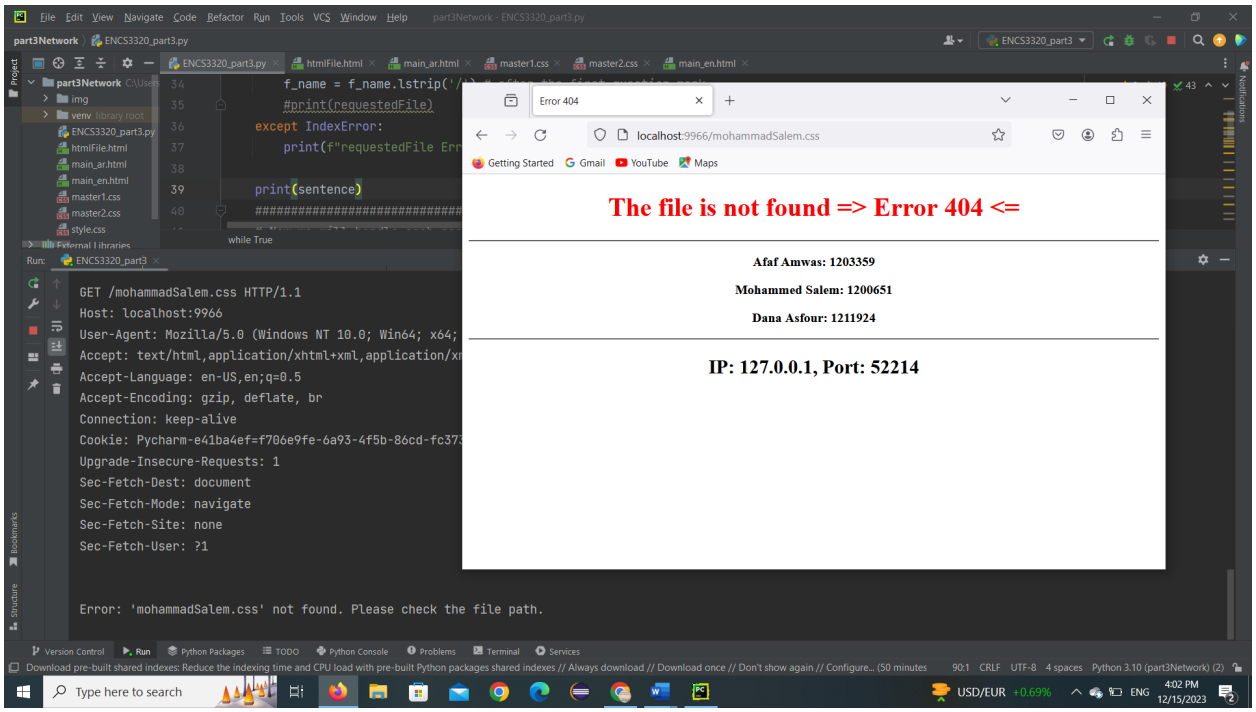


Figure 22.4: Error Webpage

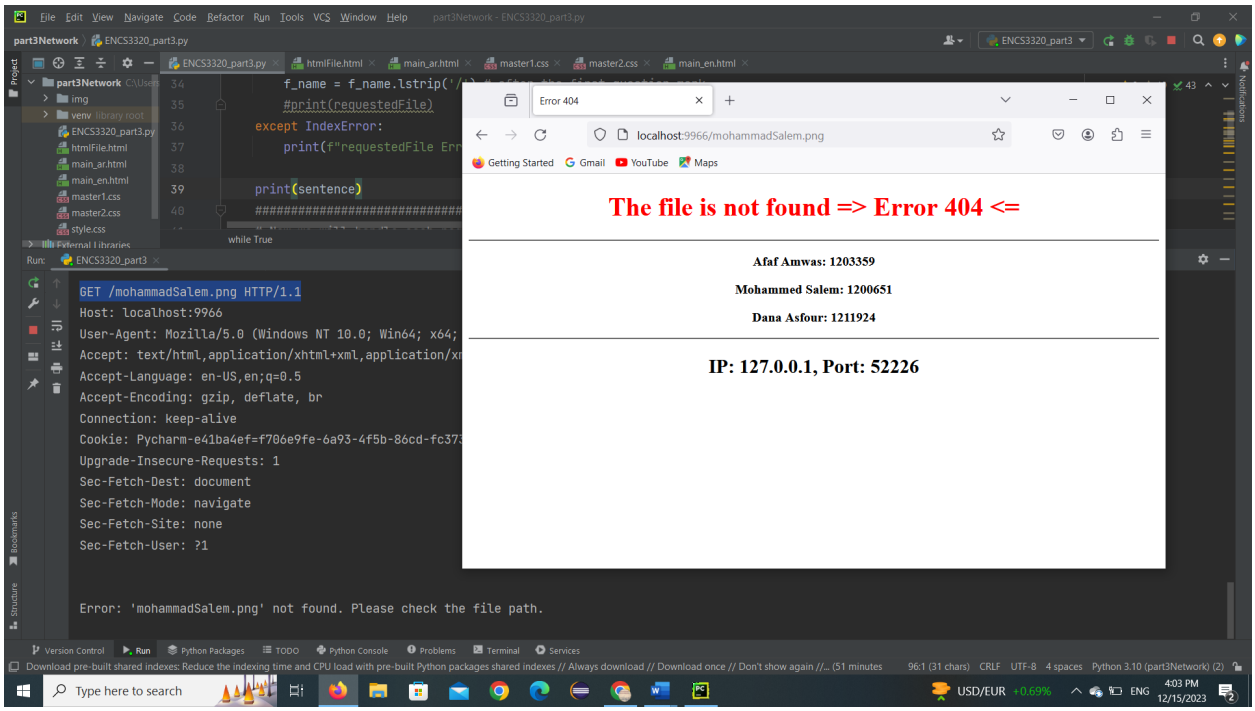


Figure 22.5: Error Webpage