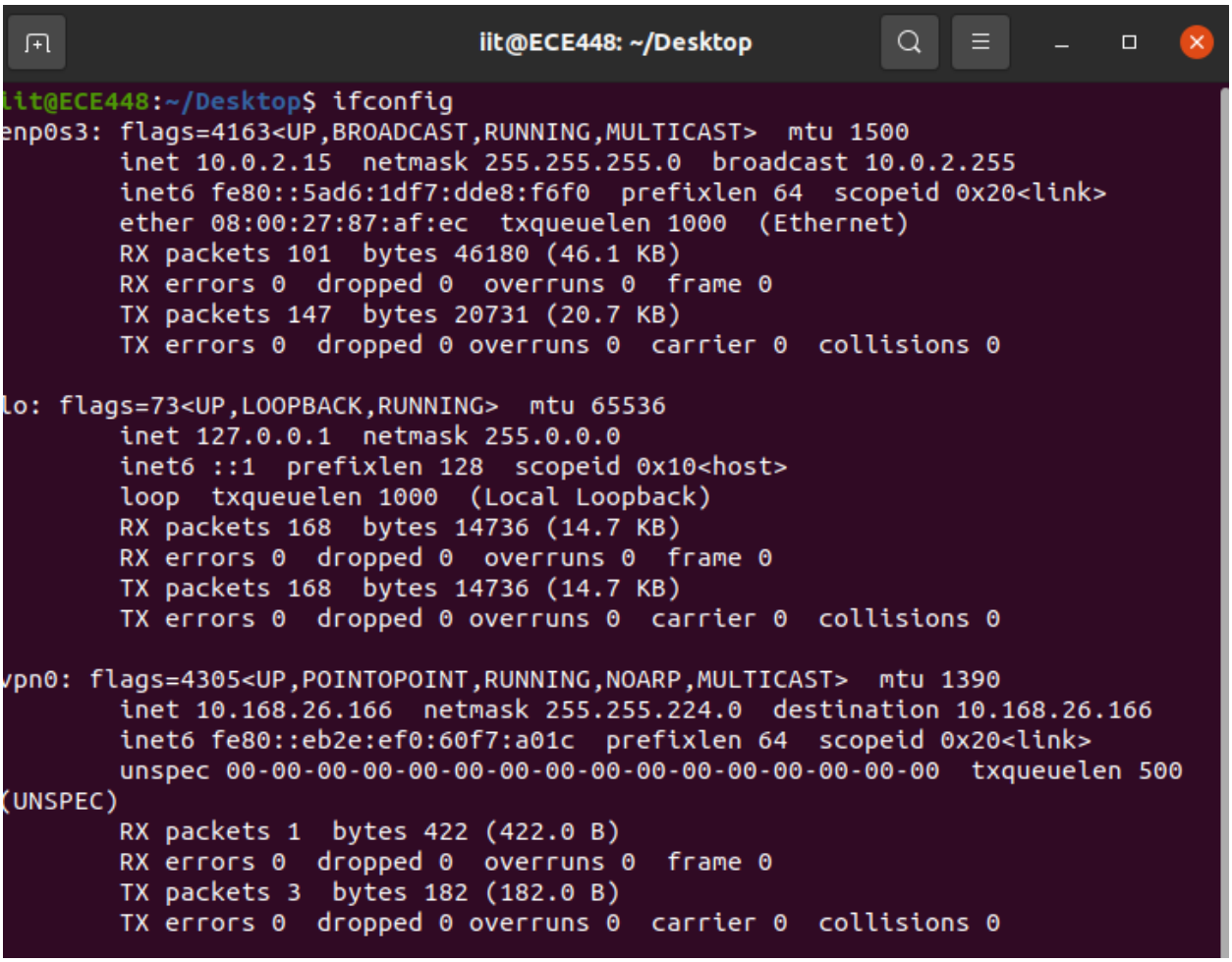
ECE 448/528 – Application Software Design

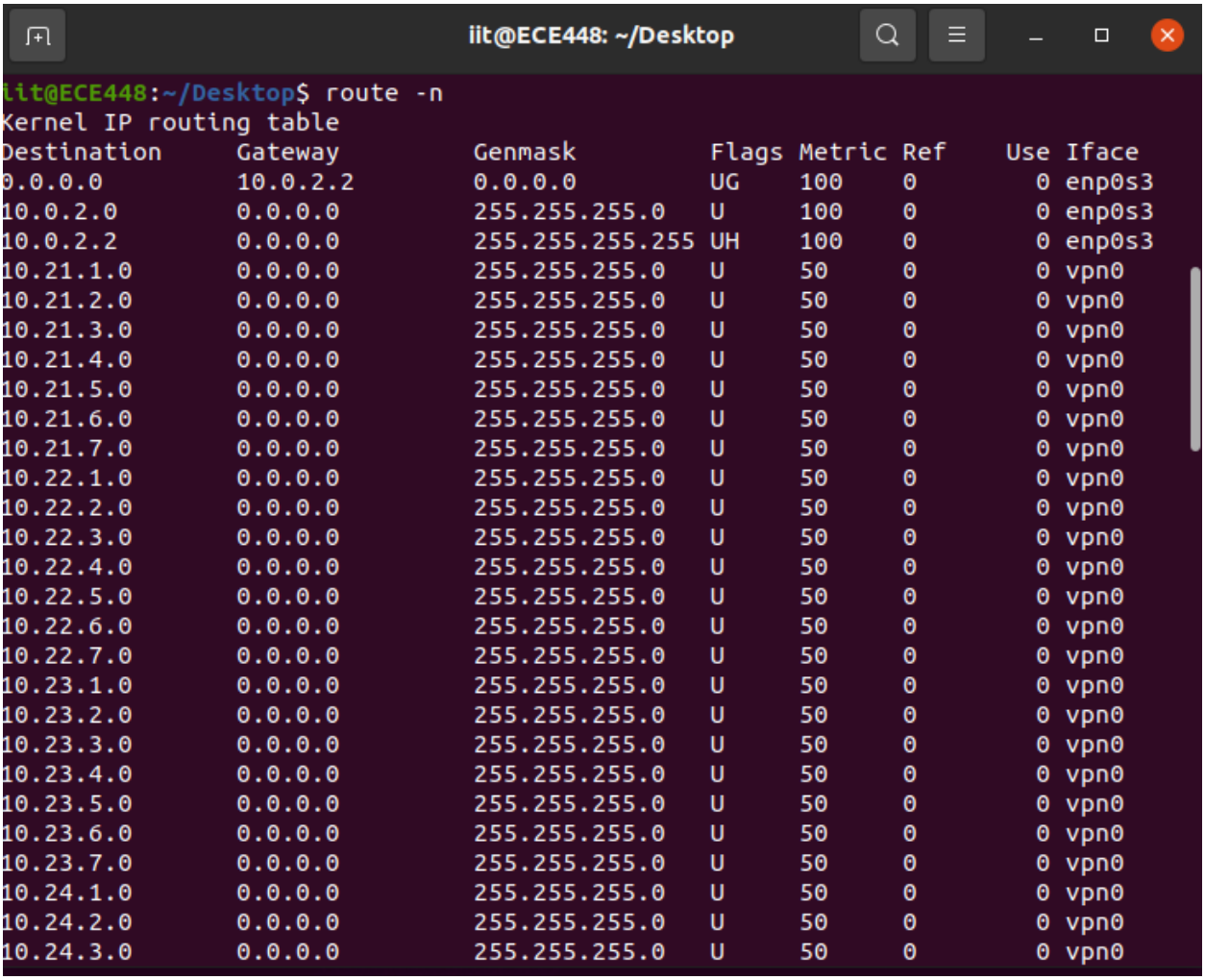
HOMEWORK #1 SOLUTION

1. Execute the commands ifconfig and route -n inside the course VM. Answer the following questions based on the output *(10 points)*

When the IIT-VPN is disconnected, after executing ifconfig and route -n, results are as shown in below figure. You may see more interfaces if the IIT-VPN is connected, and more entries in the routing table. This is how exactly the VPN works at the network layer – packets to the IIT network will be routed differently than the one shown in the below figure.



Ifconfig output



route -n output

i) How many network interfaces are there and what are their names?

The enp prefix represents the Ethernet network Peripheral, typically seen on Ubuntu machines. VirtualBox provides an interface to our VM that is recognized by Ubuntu as epn0s3. VirtualBox simulates all interface functionalities so that our VM can communicate through the host network to the Internet.

The lo is the loopback interface which allows the host to communicate with itself.

The vpn0 presents the network interface to be enabled when Illinois Tech VPN is enabled on the VM. The IP address assigned to this interface depends on the DHCP server of the Illinois Tech VPN service.

ii) List the MAC addresses of the network interfaces if there are any

The enp0s3 has the MAC address of 08:00:27:87:af:ec as indicated by the "ether" field as shown in the above figure. There is no MAC address associated with the lo or vpn0 interfaces as it is a loopback interface and a VPN interface.

iii) What are the IP addresses and subnet associated with each interface?

enp0s3 → IP: 10.0.2.15; Subnet: 255.255.255.0

lo → IP: 127.0.0.1; Subnet: 255.0.0.0

vpn0 → IP: 10.168.26.166; Subnet: 255.255.224.0

iv) How many rules are there in the routing table? What is the address of the default gateway?

route is used to show or manipulate the IP routing table and -n is to show numerical addresses, instead of determining symbolic hostnames. This is useful to determine why the route to your nameserver has disappeared.

When Illinois Tech VPN is enabled, there are many rules in the routing table to let your VM to enter internal IP addresses of Illinois Tech Network. Deafult gateway specified as 10.0.2.2 is for your VM's gateway to the Internet. 0.0.0.0 means it is unspecified.

v) Which rule will apply if we need to send a packet to the default gateway?

By default, all traffic will be routed to 10.0.2.2 by looking at the 1st and 2nd rule, based on the route -n outcome result above.

2. Research TCP and UDP header formats and explain why UDP is considered a lighter protocol than TCP in terms of packet size. *(10 points)*

TCP header is typically 20 bytes without any options, where this can be extended to a maximum size of 60 bytes with extra 40 bytes in the TCP header. In contrast, UDP header is fixed at 8 bytes as it does not have features what TCP offers, such as sequence numbers, acknowledgements, and other connection-oriented mechanisms.

3. Why is DHCP required on a network? In what type of network would DHCP be beneficial? Research and explain how DHCP efficiently allocates IP addresses on a network. *(10 points)*

DHCP service or server is required in a network to efficiently assign IP addresses, typically in a network setting where devices connect and disconnect from the network frequently. Also, it would be beneficial to a network where bandwidth is limited and quality of service (QoS) control is critical to provide flawless network service to all devices connected to the network.

DHCP service or server typically allocates the IP addresses based on the availability of the IP addresses within the network along with discover service, IP lease renewal and expiration protocols.

4. Assume that StringBuilder is unavailable for reversing the string (refer to the ReverseString class in Lecture 5). Write Java code to reverse the string without utilizing any libraries. Your function should identify the encoding scheme of the string. Assume there are only two types: UTF-8 and UTF-16. *(10 points)*

UTF-8 byte-order mark (BOM) is the byte sequence of 0xEF, 0xBB, 0xBF. UTF-16 BOM is the byte sequence of 0xFE, 0xFF. Thus, your program should check these first 3 bytes (UTF-8) or 2 bytes (UTF-16) to determine the encoding scheme of the string. UTF-8 uses at least 1 byte per character and UTF-16 uses at least 2 bytes per character depending on the language. In this assignment, we will assume ASCII characters for coding, and assume that either first 3 bytes or 2 bytes will be already set to the input string.

```java
public class ReverseString {

    public static String reverseString(String inputStr) {
        // Check the encoding scheme by examining the first few characters
        boolean isUTF8 = (inputStr.charAt(0) & 0xFF) == 0xEF
            && (inputStr.charAt(1) & 0xFF) == 0xBB
            && (inputStr.charAt(2) & 0xFF) == 0xBF;

        boolean isUTF16 = (inputStr.charAt(0) & 0xFF) == 0xFE
            && (inputStr.charAt(1) & 0xFF) == 0xFF;

        // String to store the reversed String
        String reversedStr = "";

        if (isUTF8) // each character will be 1 byte per ASCII character
        {
            for (int i = inputStr.length() - 1; i >= 0; i--)
            {
                reversedStr += inputStr.charAt(i);
            }
        }
        else if (isUTF16) // each character will be 2 bytes per ASCII character
        {
            for (int i = inputStr.length() - 1; i >= 0; i-=2)
            {
                reversedStr += inputStr.charAt(i-1);
                reversedStr += inputStr.charAt(i);
            }
        }
        else {
            System.out.println("Undefined Encoding Scheme.");
            return null;
        }

        return reversedStr;
    }
```