Problem 1:

```
TERMINAL    PROBLEMS 31    OUTPUT    DEBUG CONSOLE    PORTS                                    bash

● aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$ ls
  sniffex  sniffex.c
● aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$ gcc -o sniffex sniffex.c -lpcap
● aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$ sudo ./sniffex
  [sudo] password for aaditht:
  sniffex - Sniffer example using libpcap
  Copyright (c) 2005 The Tcpdump Group
  THERE IS ABSOLUTELY NO WARRANTY FOR THIS PROGRAM.

  Device: enp0s1
  Number of packets: 10
  Filter expression: ip

  Packet number 1:
          From: 192.168.64.3
            To: 192.168.64.1
     Protocol: TCP
     Src port: 22
     Dst port: 52737
     Payload (44 bytes):
  00000   8f 7f 23 12 f1 e1 a3 26  39 44 3b 25 4c 71 10 fa   ..#....&9D;%Lq..
  00016   3b ad cb 7d 7f 17 f8 e8  a0 99 ed 5b 56 02 59 c8   ;..}.......[V.Y.
  00032   2f 26 52 bf ca fe c0 2a  7c 7c 51 ac               /&R....*||Q.

  Packet number 2:
          From: 192.168.64.1
            To: 192.168.64.3
     Protocol: TCP
     Src port: 52737
     Dst port: 22

  Packet number 3:
          From: 192.168.64.1
            To: 192.168.64.3
     Protocol: TCP
     Src port: 52737
     Dst port: 22
     Payload (52 bytes):
  00000   6e 2a 87 b4 f0 1d 2b d9  3d 96 ff be 0a 3d 3d e4   n*....+.=...==.
  00016   14 cb 4a 14 7e 15 2a 21  48 8b f1 7d 25 dc 57 49   ..J.~.*!H..}%.WI
  00032   be 17 51 d8 a3 b8 29 7d  cd 6d f2 7b dc 71 85 5d   ..Q...)}.m.{.q.]
  00048   05 76 57 5c                                        .vW\

  Packet number 4:
          From: 192.168.64.1
            To: 192.168.64.3
     Protocol: TCP
     Src port: 52737
     Dst port: 22
     Payload (52 bytes):
  00000   ec 1f f4 81 43 f4 43 46  f3 5d ce 12 bc c8 86 7c   ....C.CF.].....|
  00016   4e 4d 1e d7 e9 67 ed 37  37 db 64 55 e4 db 13 97   NM...g.77.dU....
  00032   81 f3 c8 fe 82 d3 71 60  b8 04 ba c6 34 6f 9a 68   ......q`....4o.h
  00048   da d3 0f a7                                        ....

  Packet number 5:
          From: 192.168.64.3
            To: 192.168.64.1
     Protocol: TCP
     Src port: 22
     Dst port: 52737

  Packet number 6:

SSH: 192.168.64.3   ⊗ 31 △ 0   ⚡ 0                    Ln 228, Col 12   Tab Size: 4   UTF-8   LF   {} C   Linux
```

```
TERMINAL    PROBLEMS 31    OUTPUT    DEBUG CONSOLE    PORTS                                    bash

  00016   4e 4d 1e d7 e9 67 ed 37  37 db 64 55 e4 db 13 97   NM...g.77.dU....
  00032   81 f3 c8 fe 82 d3 71 60  b8 04 ba c6 34 6f 9a 68   ......q`....4o.h
  00048   da d3 0f a7                                        ....

  Packet number 5:
          From: 192.168.64.3
            To: 192.168.64.1
     Protocol: TCP
     Src port: 22
     Dst port: 52737

  Packet number 6:
          From: 192.168.64.3
            To: 192.168.64.1
     Protocol: TCP
     Src port: 22
     Dst port: 52737
     Payload (44 bytes):
  00000   da d3 78 76 62 4b 9d 6f  07 52 14 ab ae c5 85 b0   ..xvbK.o.R......
  00016   60 61 2a a5 0c b5 cf 26  04 7c 33 fd b9 4b e9 e7   `a*....&.|3..K..
  00032   79 0f 76 2f ff c8 4a 60  c2 d9 15 9a               y.v/..J`....

  Packet number 7:
          From: 192.168.64.1
            To: 192.168.64.3
     Protocol: TCP
     Src port: 52737
     Dst port: 22

  Packet number 8:
          From: 192.168.64.1
            To: 192.168.64.3
     Protocol: TCP
     Src port: 52737
     Dst port: 22
     Payload (60 bytes):
  00000   38 f3 7c d8 44 9d 75 53  15 19 0c 3c aa d0 79 f2   8.|.D.uS...<..y.
  00016   88 24 db 76 d6 10 ae ae  03 cb eb 97 51 56 70 1f   .$.v........QVp.
  00032   c1 27 e6 f7 64 73 81 f4  8b 4c 46 91 f9 b5 96 6f   .'..ds..LF....o
  00048   82 6f 66 66 df 90 53 59  35 1f d2 ff               .off..SY5...

  Packet number 9:
          From: 192.168.64.3
            To: 192.168.64.1
     Protocol: TCP
     Src port: 22
     Dst port: 52737
     Payload (68 bytes):
  00000   ec 46 06 d0 ed bb ad e2  fc b2 8a a1 3d ce 37 9a   .F..........=.7.
  00016   c7 7f 03 40 5f 1b 5f 51  3f 06 83 9f b5 3c 64 c1   ...@._Q?....<d.
  00032   9b 55 d0 6c 43 06 fd 27  e6 9f 17 92 89 50 7a f0   .U.lC..'.....Pz.
  00048   b1 ee 1a 46 e2 e4 68 e8  f3 52 18 8f 56 32 24 88   ...F..h..R..V2$.
  00064   11 97 8c 8d                                        ....

  Packet number 10:
          From: 192.168.64.1
            To: 192.168.64.3
     Protocol: TCP
     Src port: 52737
     Dst port: 22

  Capture complete.
○ aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$ []

SSH: 192.168.64.3   ⊗ 31 △ 0   ⚡ 0                    Ln 228, Col 12   Tab Size: 4   UTF-8   LF   {} C   Linux
```

Problem 2:

1. In line 530, the program calls *pcap_findalldevs(...)* which creates a linked list of network devices that can then be opened with *pcap_open_live(...)*. We take the first device found on this list for our packet capturing.
2. In line 540, the program calls *pcap_lookupnet(...)*, which determines the IPv4 network number and mask of the device passed into the arguments of the function. We found this device through *pcap_open_live(...)*.
3. In line 553, the program calls *pcap_open_live(...)* which is used to obtain a packet capture handle/object to look at packets on the network based on the device specified in the parameters. We found this device through *pcap_findalldevs(...)*. It essentially opens a live device for sniffing.
4. In line 560, the program calls *pcap_datalink(...)* which returns the link-layer header of the device found through line 530's invocation of *pcap_findalldevs(...)*. We check to make sure that the packets captured are on an Ethernet device.
5. In line 566, the program calls *pcap_compile(...)* which takes a filter expression in string form and formats it into a filter program for what we want to sniff. The filter expression is set to allow IP packets in.
6. In line 573, the program calls *pcap_setfilter(...)* which is the complementary program specified in line 566 that specifies the filter program created by *pcap_compile(...)*.
7. In line 580, the program calls *pcap_loop(...)* which processes a certain number of packets, given in the arguments, from the handle created in line 553.
8. In line 583, the program calls *pcap_freecode(...)* which frees up the allocated memory that the filter program points to.
9. In line 584, the program calls *pcap_close(...)* which closes all files attached to the handle associated with the packet capturing and deallocates any associated resources.

Problem 3:

Programming through the raw socket allows a user to directly send and receive IP packets without any protocol-specific transport layer formatting. Root privilege is required because raw socket programs are executed at the kernel because they need to capture data using hardware. Hackers can do nefarious things when given the ability to craft packet headers.

The program gives this error code: "Couldn't open device enp0s1: enp0s1: You don't have permission to capture on that device (socket: Operation not permitted)". This means that the program fails to open the network device when it is executed without root privilege.

Problem 4:

   The way we would toggle promiscuous mode directly in the code is by modifying the third argument provided to *pcap_open_live(const char *device, int snaplen, int promisc, int to_ms, char *errbuf)*. This is as simple as providing a 0 or 1 to the *promisc* parameter. We can modify the argument and send the resulting code to two text files: *promisc_mode_on.txt* and *promisc_mode_off.txt*. Then, using the diff bash command with the two files as arguments, we can find any notable differences between toggling the promiscuity of the program. There seems to be demonstrable evidence that toggling the mode modifies the behavior of the program. When promiscuous mode is toggled on, there seem to be pretty large packets that are sent across the network.

The terminal on the left displays the output when promiscuous mode is toggled off. The terminal on the right displays the output when promiscuous mode is toggled on.

```
TERMINAL   PROBLEMS 31   OUTPUT   DEBUG CONSOLE   PORTS

Packet number 5:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 6:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (60 bytes):
00000   bb 78 c4 13 86 0f cb b0  49 6e d5 f5 34 75 ba fd   .x......In..4u..
00016   ee 0f 3d 58 b1 8a 6f aa  a7 ed a1 29 8c 3a 29 ec   ..=X..o...).:).
00032   6f 69 b9 d0 c3 c0 2f f5  15 ac b9 aa 27 7d 43 3c   oi.../.....'}C<
00048   57 53 b1 c3 39 2e ea 54  78 09 81 89               WS..9..Tx..

Packet number 7:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000   ad a5 d9 fb ee 03 af ef  d2 57 8c 79 a1 fb ba b5   .........W.y...
00016   ed 78 5e f3 f4 b6 c8 4c  4e 6b d1 78 70 9f 5f 85   .x^....LNk.xp._.
00032   5f 4a d3 ec 1f b0 60 cd  40 f6 93 50 45 c9 9a fc   _J....`.@..PE...
00048   4f d2 d2 9b                                         O...

Packet number 8:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 9:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (60 bytes):
00000   cb b2 86 11 df 1c eb 54  33 12 6e c8 e9 e8 1e 9b   .......T3.n.....
00016   ef f4 9b b0 6f b3 98 d6  95 a7 75 d3 3d 8c 16 60   ....o.....u.=..`
00032   f4 ed 32 8e 4d 56 95 1e  31 af 23 a8 d8 31 67 36   ..2.MV..1.#..1g6
00048   3f 95 fe bf 8d fe 4c fe  12 fb 71 1c               ?.....L..q.

Packet number 10:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000   7d 41 3f c8 00 16 8f bc  c6 5f 00 6f f2 4b 1e 6d   }A?......_.o.K.m
00016   7b c0 d0 8c 43 c3 c9 63  94 1e 9c a9 92 72 76 69   {...C..c.....rvi
00032   cd 30 05 7b 2c 20 ce 9d  9f f7 72 f3 0c 75 9c 42   .0.{, ....r..u.B
00048   15 b2 d9 f1                                         ....
```

SSH: 192.168.64.3   ⊗ 31 ⚠ 0   ⚡ 0

```
Packet number 3:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (428 bytes):
00000   2e 71 1f a7 77 4e 43 ee  c8 42 23 a8 ff 08 97 ee   .q..wNC..B#.....
00016   fc a2 db 50 04 76 4d 2b  22 04 44 c8 a3 cc 5d bb   ...P.vM+".D...].
00032   ab ab 62 c4 69 3f c2 fc  30 30 56 03 24 08 d9 a9   ..b.i?..00V.$...
00048   eb a9 47 57 00 ae 77 08  1e f6 cf 40 b6 c8 9c ef   .GW..w....@....
00064   aa 8c 00 63 4a dc 7d 06  6a a0 3a 25 4e 1f 53 fa   ...cJ.}.j.:%N.S.
00080   70 aa f2 e8 c4 b6 e9 a2  2c 57 98 11 da 6f d8 38   p.......,W...o.8
00096   dd 51 78 7e 59 c6 fb 94  12 8b ec 7a 68 df 25 cf   .Qx~Y.....zh.%.
00112   37 4b 1a ca d1 4c ab 39  d3 2d 71 f9 39 05 56 26   7K...L.9.-q.9.V&
00128   ff c2 d8 d4 de bf d2 bc  d8 da cd 1a b0 67 95 11   .............g..
00144   6e c1 c2 19 e3 13 2d c1  e4 2c b1 c3 9a 5b e0 3f   n...-..,...[.?
00160   ba c7 2b c5 db 32 c3 5c  8e 36 69 f9 f6 f7 e0 a4   ..+..2.\.6i....
00176   1a c0 83 a0 c4 f4 80 47  3e 93 f7 cc 7f 6f e0 31   .......G>....o.1
00192   a1 67 06 5a cc 16 87 5c  16 a2 15 84 bc c6 e4 46   .g.Z...\.......F
00208   c7 67 e8 7f ab 32 65 5a  6d 98 ef a1 23 8d ac 97   .g...2eZm...#...
00224   71 47 bb fe f9 16 66 71  78 c0 71 bb 7c a5 34 f8   qG....fqx.q.|.4.
00240   98 2d 85 ab c2 91 78 22  fc 48 b2 af 82 95 56 4a   .-....x".H...VJ
00256   df 4f 71 14 40 e8 f8 64  d6 4b 34 68 87 e4 69 5d   .Oq.@..d.K4h..i]
00272   d8 78 8f 54 bc 54 9f 12  8b 92 17 c1 14 e4 30 1f   .x.T.T........0.
00288   2d b2 e0 27 0e 6d 1b a0  73 03 32 3d ce ae 73 c6   -..'.m..s.2=..s.
00304   77 e2 9b 65 17 b8 b9 db  a8 80 7e aa 2e f8 26 6e   w..e......~..&n
00320   36 b8 59 3a 50 d5 e6 48  94 81 22 ab 97 c2 5e 2c   6.Y:P..H.."..^,
00336   0c ff ad c9 0b 4b 62 7f  ce de 00 7b 9e 5f 82 73   .....Kb...{._.s
00352   b6 6c 26 d9 41 03 c9 eb  82 d5 d9 6f 78 6f 79 0a   .l&.A.....oxoy.
00368   95 86 be b9 18 38 67 ca  4e 1f b5 05 e8 19 a8 58   .....8g.N......X
00384   4a f5 d0 45 ca fb 9b 98  c2 46 53 cd e0 dd f1 c2   J..E.....FS.....
00400   91 f2 5c a0 07 e6 cf 96  be 46 77 f9 a7 0a e0 14   ..\.....Fw.....
00416   2b 77 aa ac ab 30 e4 61  2d 0f 25 9f               +w...0.a-.%.

Packet number 4:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 5:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (52 bytes):
00000   bf 7c 9e 25 b3 c1 6c 8b  d1 eb 02 e2 c3 b3 1e 20   .|.%..l.......
00016   b2 c8 7a 00 34 68 69 f1  30 f7 5b 92 57 0d 50 b9   ..z.4hi.0.[.W.P.
00032   08 73 fc 21 4b c0 cb cc  81 f8 55 e7 34 78 4f 71   .s.!K.....U.4xOq
00048   fe 56 cd c7                                         .V..

Packet number 6:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683

Packet number 7:
        From: 192.168.64.3
```

Ln 559, Col 7   Tab Size: 4   UTF-8   LF   {} C   Linux

```
00048   02 0b e3 36 f7 22 78 f1  ee 88 48 34 0a 4a d1 f7   ...6."x...H4.J..
00064   67 b4 87 a9                                         g...

Packet number 5:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 6:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (60 bytes):
00000   bb 78 c4 13 86 0f cb b0  49 6e d5 f5 34 75 ba fd   .x......In..4u..
00016   ee 0f 3d 58 b1 8a 6f aa  a7 ed a1 29 8c 3a 29 ec   ..=X..o...).:).
00032   6f 69 b9 d0 c3 c0 2f f5  15 ac b9 aa 27 7d 43 3c   oi.../.....'}C<
00048   57 53 b1 c3 39 2e ea 54  78 09 81 89               WS..9..Tx..

Packet number 7:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000   ad a5 d9 fb ee 03 af ef  d2 57 8c 79 a1 fb ba b5   .........W.y...
00016   ed 78 5e f3 f4 b6 c8 4c  4e 6b d1 78 70 9f 5f 85   .x^....LNk.xp._.
00032   5f 4a d3 ec 1f b0 60 cd  40 f6 93 50 45 c9 9a fc   _J....`.@..PE...
00048   4f d2 d2 9b                                         O...

Packet number 8:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 9:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (60 bytes):
00000   cb b2 86 11 df 1c eb 54  33 12 6e c8 e9 e8 1e 9b   .......T3.n.....
00016   ef f4 9b b0 6f b3 98 d6  95 a7 75 d3 3d 8c 16 60   ....o.....u.=..`
00032   f4 ed 32 8e 4d 56 95 1e  31 af 23 a8 d8 31 67 36   ..2.MV..1.#..1g6
00048   3f 95 fe bf 8d fe 4c fe  12 fb 71 1c               ?.....L..q.

Packet number 10:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000   7d 41 3f c8 00 16 8f bc  c6 5f 00 6f f2 4b 1e 6d   }A?......_.o.K.m
00016   7b c0 d0 8c 43 c3 c9 63  94 1e 9c a9 92 72 76 69   {...C..c.....rvi
00032   cd 30 05 7b 2c 20 ce 9d  9f f7 72 f3 0c 75 9c 42   .0.{, ....r..u.B
```

SSH: 192.168.64.3   ⊗ 31 ⚠ 0   ⚡ 0

```
Packet number 6:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683

Packet number 7:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (1380 bytes):
00000   98 6c cb d6 f8 35 36 7b  ae 41 bc 97 6b a0 bf 09   .l..56{.A..k...
00016   98 74 97 00 ca d3 e8 86  12 0a 61 1c 45 42 a2 11   .t.......a.EB..
00032   ff 00 4d 63 f3 0f d8 be  d9 70 e6 8c 83 6d d3 cb   ..Mc.....p...m..
00048   3d 46 98 0c a3 fe 97 22  81 7c 50 38 16 f2 14 58   =F....".|8...X
00064   2c 39 a9 14 56 f7 59 8f  ff d4 26 9a 22 cd 8b 4b   ,9..V.Y...&."..K
00080   39 2e 8f cd ec 01 98 9d  0f 6e dd f0 9c 7e 9e d4   9........n...~..
00096   c9 a0 c5 cf ce 43 9b 65  cd 32 38 71 6f fa cc 1e   .....C.e.28qo...
00112   62 b3 bd 58 ba ca 7a dd  0e 81 24 01 e8 3d 0b 88   b..X..z...$..=..
00128   0b ab 03 89 0c 4d 41 48  3d 5d 80 6b ec 89 32 9e   .....MAH=].k..2.
00144   77 bf ff 91 1b 1a 16 8c  6a c0 27 c5 58 29 03 de   w.......j.'.X)..
00160   12 88 fd 86 5c 44 ff 66  83 83 e2 74 2b ad 15 f5   ....\D.f...t+...
00176   96 ef c5 4f ec 65 a0 84  f5 3a 61 b2 f6 08 00 1b   ...O.e...:a.....
00192   7b 5a df f1 19 22 0b 48  2c 76 ab 03 13 b0 68 de   {Z..."..v....h.
00208   83 3a 7d 20 0f 8c 75 7b  28 75 94 18 d6 05 9f ee   .:} ..u(u.......
00224   1b d0 ca 0d 66 43 fa 7a  c0 55 02 cf 8f ec f8 78   ...fC.z.U......x
00240   a6 09 04 77 79 20 9e b3  74 6b ab 9b 6c 6b 1c 29   ...wy ..tk...k.)
00256   b3 6f f1 7b 25 4d 06 05  a3 27 f5 5f 03 b2 2e cd   .o.{%M...'._...
00272   49 78 f1 67 4f f6 62 73  e5 7c 78 10 26 ec 8d 56   Ix.gO.bs.|x.&.V
00288   3c f4 38 8d 2d d0 27 79  79 78 4b 1c 2b 78 8f be 02   <.8.-.'yyxK.+x...
00304   25 81 41 18 15 a0 91 88  60 d8 ea 15 2e 0f 6c 46   %.A.....`.....lF
00320   86 aa 72 19 f9 93 b7 c9  d4 51 2e fe 50 75 32 ca   ..r....Q..Pu2.
00336   85 f6 e4 de e7 f4 f3 6c  0a 05 fd 90 ba 72 e6 1d   .......l....r..
00352   68 1a 6a af 66 06 79 17  78 b7 9b 61 ce 59 d4 13   h.j.f.y.x..a.Y.
00368   54 0e 83 1d 65 4e 4d 18  b5 9c 3b 59 49 8e 5c 94   T...eNM...;YI.\.
00384   0e ef 16 33 8b 5c 6d 34  ee ff 58 63 ec 74 c8 0a   ...3.\m4...c.t..
00400   17 0b 55 b1 dc 85 f9 2c  4b 14 d2 41 8f 4e ad f2   ..U....K..A.N..
00416   f9 cf 9a 20 97 b5 9e e3  f0 cb 64 a5 77 0d df e8   ... ......d.w...
00432   6d d0 7d 7d 1c 79 07 ec  b2 1d cc 23 c0 d4 bc 35   m.}}.y....#..5
00448   54 f2 22 5c d9 d4 0f 55  48 ca de e9 40 63 2d a3   T."\...UH...@c-.
00464   13 7c 4f ff c7 42 da 4f  c4 ac 33 c7 fb 53 e0 60   .|O..B.O..3.....
00480   82 d4 dc 10 b3 6f 16 aa  8c 82 9f 65 59 23 e4 54   .....o....Y#.T
00496   0f 85 b0 47 e5 c7 4e 68  73 c4 ab a0 1f 9f 8c a2   ...G..Nhs.....
00512   ed cf 50 ed f6 a1 42 00  c6 ed b1 00 c7 2e 29 c9   ..P...B......).
00528   b6 ad f2 19 4f d5 c3 a3  21 d1 23 bc 80 be 1e 08   ....O...!.#.....
00544   b9 d3 c3 32 7e 65 f7 cb  ad f4 ce 03 26 da 99 d4   ...2~e.....&...
00560   3f f0 f4 6a af 09 4e 0d  59 d9 87 55 c1 33 b0 bb   ?..j..N.Y..U.3..
00576   a5 74 4a 7c 6a 51 7b f7  0d bf ee d1 59 52 c4 ad   .tJ|jQ{.....YR..
00592   ba 1e 20 dd e6 bf be 1f  34 f8 9a 68 cf 89 8e 66   .. .....4..h...f
00608   56 ab 9b a6 b8 7c dd 2e  6a 5b 70 c2 52 7e b4 4b   V....|..j[p.R~.K
00624   bf 0e 8c b9 33 dd 7b 0d  f3 47 cf 48 45 c0 0c fd   ....3.{.G.HE...
00640   b9 07 a0 fc 41 4b 4b c2  50 a1 4c 12 30 a4 d0 91   ....AKK.P.L.0...
00656   75 9a 2e 98 68 0f 0f 2c  9e 58 f1 a8 7e 66 07 d0   u..h...,.X..~f..
00672   f0 01 c3 10 6e 24 1e 86  19 e8 db ee bc 63 62 56   ...n$....cbV
00688   7d 25 06 1d 59 38 f8 e7  b5 ce c1 30 b7 c0 63 ac   }%..Y8.....0..c.
00704   dc 1e 2d 5c 13 7e 15 62  bd 8e 1e a3 d9 9a e0 bd   ..-\.~.b........
00720   0b a7 ce cf 28 1d 7c b8  59 f7 2a 2c e9 2c b0 b5   ....(.|.Y.*,,..
00736   0e 5f 1c 07 0a 32 36 d1  58 9d ac cc bc cc de 23   ._...26.X......#
00752   41 fc 88 a6 3f 0e 82 b3  69 f8 4c 44 f4 01 2c 48   A...?...i.LD..,H
```

SSH: 192.168.64.3   ⊗ 31 ⚠ 0   ⚡ 0

Ln 559, Col 7   Tab Size: 4   UTF-8   LF   {} C   Linux

```
00048    02 0b e3 36 f7 22 78 f1  ee 88 48 34 0a 4a d1 f7    ...6."x...H4.J..
00064    67 b4 87 a9                                         g...

Packet number 5:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 6:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (60 bytes):
00000    bb 78 c4 13 86 0f cb b0  49 6e d5 f5 34 75 ba fd    .x......In..4u..
00016    ee 0f 3d 58 b1 8a 6f aa  a7 ed a1 29 8c 3a 29 ec    ..=X..o....).:).
00032    6f 69 b9 d0 c3 c0 2f f5  15 ac b9 aa 27 7d 43 3c    oi..../.....'}C<
00048    57 53 b1 c3 39 2e ea 54  78 09 81 89                WS..9..Tx...

Packet number 7:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000    ad a5 d9 fb ee 03 af ef  d2 57 8c 79 a1 fb ba b5    .........W.y....
00016    ed 78 5e f3 f4 b6 c8 4c  4e 6b d1 78 70 9f 5f 85    .x^....LNk.xp._.
00032    5f 4a d3 ec 1f b0 60 cd  40 f6 93 50 45 c9 9a fc    _J....`.@..PE...
00048    4f d2 d2 9b                                         0...

Packet number 8:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 9:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22
    Payload (60 bytes):
00000    cb b2 86 11 df 1c eb 54  33 12 6e c8 e9 e8 1e 9b    .......T3.n.....
00016    ef f4 9b b0 6f b3 98 d6  95 a7 75 d3 3d 8c 16 60    ....o.....u.=..`
00032    f4 ed 32 8e 4d 56 95 1e  31 af 23 a8 d8 31 67 36    ..2.MV..1.#..1g6
00048    3f 95 fe bf 8d fe 4c fe  12 fb 71 1c                ?.....L..q.

Packet number 10:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000    7d 41 3f c8 00 16 8f bc  c6 5f 00 6f f2 4b 1e 6d    }A?......_.o.K.m
00016    7b c0 d0 8c 43 c3 c9 63  94 1e 9c a9 92 72 76 69    {...C..C.....rvi
00032    cd 30 05 7b 2c 20 ce 9d  9f f7 72 f3 0c 75 9c 42    .0.{, ....r..u.B
```

```
00848    11 cb ba c8 57 37 cd da  ba fa 9a 0d 61 cf 65 85    ....W7......a.e.
00864    a0 f1 f9 f0 7b 1d 30 4a  db a9 fd 64 33 44 53 8f    ....{.0J...d3DS.
00880    73 bc 3e 52 c3 72 8b ca  9c b8 68 61 8d 5e d1 ff    s.>R.r...ha.^..
00896    7a fc 91 8a ff 1c 8e b7  17 cf 43 7f aa aa 69 74    z.........C...it
00912    6c f2 41 14 2f 25 75 b5  db 9a a7 04 ea c4 f1 3e    l.A./%u........>
00928    1e ae 96 0e 6f 1d 89 b1  e6 1a f4 af d7 ba cf 35    ...o.o.........5
00944    ce 3a 59 3a 0b 67 b6 96  1c1 c2 47 3c 8b 83 e6 e7   .:Y:.g...G<....
00960    8f 51 a2 c0 ed d3 19 2f  aa 95 de 35 e9 57 ce 01    .Q...../...5.W..
00976    c8 d6 34 c4 85 07 4d 94  6e 99 83 33 af 84 fe ed    ..4...M.n..3....
00992    59 27 1e ae 0b af b6 00  8d 1a 61 54 68 3d 8b 1c    Y'.......aTh=..
01008    f5 a6 cd 57 db 57 26 ac  63 c9 44 68 9f 7e b4 a1    ...W.W&.c.Dh.~..
01024    cd f5 26 66 3f b5 22 ab  dd b3 df 1f ca df 64 ac    ..&f?."......d.
01040    a3 62 bf 54 e3 91 5c 34  51 77 18 f6 90 54 23 8c    .b.T..\4Qw...T#.
01056    42 15 29 00 de 49 ea a7  42 a3 c4 f4 c3 bc 97 1b    B.)..I..B.......
01072    99 18 ef d4 59 00 a9 3d  fa 7a 31 aa 0a 39 29 15    ....Y..=.z1..9).
01088    12 ca 44 ec 61 d0 4f 6a  0b b9 e0 c2 7e e0 85 f7    ..D.a.0j....~...
01104    cf be b3 d5 63 85 3d c5  87 fb 93 22 73 65 8b 73    ....c.=..."se.s
01120    cf f5 cf f3 50 00 6e 2f  b5 cb d6 35 02 77 8c c7    ....P.n/...5.w..
01136    00 d8 59 e1 57 06 a4 6d  10 2b 10 a0 ee 83 ff 36    ..Y.W..m.+.....6
01152    3c 38 88 5d 71 f2 c8 a9  d4 c6 db ed 71 f6 ff d1    <8.]q.......q...
01168    a4 37 dc 70 e7 14 3d 43  cc 1d 86 0d 06 08 bb 7e    .7.p..=C.......~
01184    3b 3a d2 77 06 7d 38 10  1d 42 0b f8 1c 1c 43 17    ;:.w.}8..B....C.
01200    c3 72 cc ca 51 9f 22 de  09 d0 3e 47 7b 10 ba dd    .r..Q.".->G{...
01216    31 cf 95 96 30 5d 31 4e  45 c5 d4 c8 bc 4c 7f c5    1...0]1NE....L..
01232    ca ba 2d 32 f3 ad 89 4c  3f c5 40 4a 56 99 99 d3    ..-2..L7.@JV...
01248    57 9c 6a 43 e6 e5 80 4d  34 fd f2 42 b4 2a f1 9b    W.jC..M4..B.*..
01264    50 d0 e9 15 8e ba dd 11  53 cf 12 09 6c e6 dd 7f    P......S...l...
01280    1b 26 b7 1d ab 63 31 48  49 bf 2e 71 e6 3a 9f be    .&...c1HI..q.:..
01296    d1 b6 51 65 3e 52 9e d3  c0 6c 76 39 9a 6e a9 60    ..Qe>R...lv9.n.`
01312    28 f7 30 14 a9 e9 b7 63  a8 5d 1d d5 13 22 62 41    (.0...c.]..."bA
01328    6c 0e b0 73 17 f9 30 86  df b7 7c 77 e7 97 ba d1    l..s..0...|w....
01344    13 b9 b5 d7 ad ba f8 e4  88 38 d2 31 d5 0d 8a c7    .........8.1...
01360    09 f8 a5 73 d2 9d 49 18  91 14 a5 25 9a 94 df 30    ...s..I....%...0
01376    55 11 1d 98                                         U...

Packet number 8:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Packet number 9:
        From: 192.168.64.3
          To: 192.168.64.1
    Protocol: TCP
    Src port: 22
    Dst port: 55683
    Payload (52 bytes):
00000    b9 86 2c ca a6 7f 17 0d  19 1b 68 d4 b9 e2 98 56    ..,......h....V
00016    fb 6d 9c 9f 3b f3 27 dd  2a 2d 86 d7 fa 59 76 ba    .m.:.'.*-...Yv.
00032    5a 80 0b 30 88 40 58 e9  84 e4 55 e2 55 89 6c 9b    Z..0.@X...U.U.l.
00048    be 69 29 e1                                         .i).

Packet number 10:
        From: 192.168.64.1
          To: 192.168.64.3
    Protocol: TCP
    Src port: 55683
    Dst port: 22

Capture complete.
aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$
```
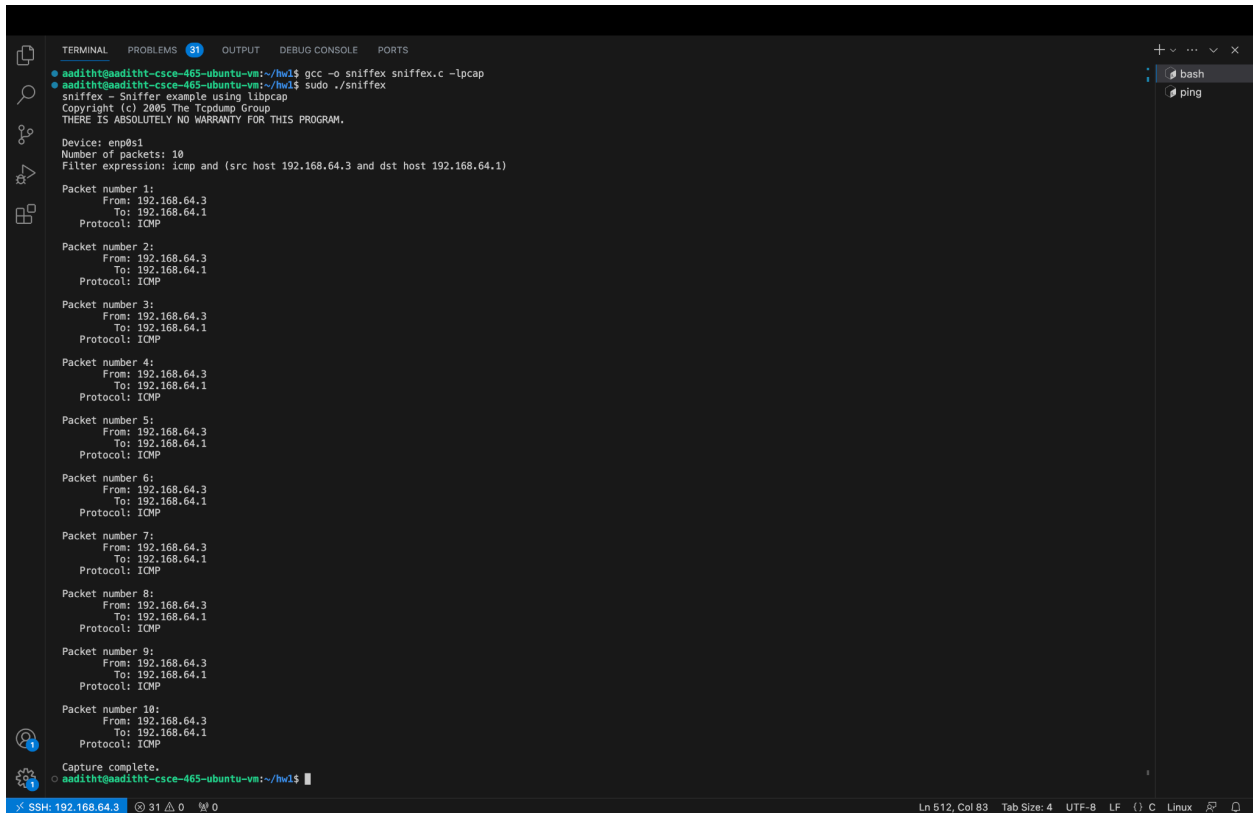
Problem 5:

Capturing the ICMP packets between two specific hosts:

Capturing the TCP packets that have a destination port range from to port 10 - 100:


```
TERMINAL    PROBLEMS  31    OUTPUT    DEBUG CONSOLE    PORTS

● aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$ gcc -o sniffex sniffex.c -lpcap
● aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$ sudo ./sniffex
sniffex - Sniffer example using libpcap
Copyright (c) 2005 The Tcpdump Group
THERE IS ABSOLUTELY NO WARRANTY FOR THIS PROGRAM.

Device: enp0s1
Number of packets: 10
Filter expression: tcp and dst portrange 10-100

Packet number 1:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Packet number 2:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22
   Payload (68 bytes):
00000   62 b8 48 fc 90 56 0e 0d  88 10 65 b6 3a 85 4f 23    b.H..V....e.:.O#
00016   cb 37 45 f0 b0 e2 01 4f  1f 97 b5 93 3a 07 46 3f    .7E....O....:.F?
00032   1f 46 b6 62 ff 25 de dd  1c 4b 33 91 80 4a ae 8e    .F.b.%...K3..J..
00048   3b 6f 48 d9 59 dc 07 90  15 1b 15 4a 76 74 90 c0    ;oH.Y......Jvt..
00064   fb 33 41 84                                          .3A.

Packet number 3:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Packet number 4:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22
   Payload (60 bytes):
00000   5e e5 8a 4a f1 9f 04 51  64 5e d3 f7 f3 0d 35 05    ^..J...Qd^...5.
00016   12 ed 5b 54 f2 82 37 2c  3a 2b b5 e0 3f e7 73 a8    ..[T..7,:+..7.s.
00032   2f 0d 45 a0 fb 70 52 c3  33 ac a2 8d e5 e1 85 ed    /.E..pR.3.......
00048   8b c2 da 2b 6b 18 45 4a  e3 13 be 0c                ...+k.EJ....

Packet number 5:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Packet number 6:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

SSH: 192.168.64.3    ⊗ 31 ⚠ 0    ⌘ 0                                Ln 513, Col 5   Tab Size: 4   UTF-8   LF   {} C   Linux
```



```
TERMINAL    PROBLEMS  31    OUTPUT    DEBUG CONSOLE    PORTS

   Protocol: TCP
   Src port: 55683
   Dst port: 22
   Payload (60 bytes):
00000   5e e5 8a 4a f1 9f 04 51  64 5e d3 f7 f3 0d 35 05    ^..J...Qd^...5.
00016   12 ed 5b 54 f2 82 37 2c  3a 2b b5 e0 3f e7 73 a8    ..[T..7,:+..7.s.
00032   2f 0d 45 a0 fb 70 52 c3  33 ac a2 8d e5 e1 85 ed    /.E..pR.3.......
00048   8b c2 da 2b 6b 18 45 4a  e3 13 be 0c                ...+k.EJ....

Packet number 5:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Packet number 6:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Packet number 7:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22
   Payload (60 bytes):
00000   ba c8 46 73 9b 78 ff 76  cf 3d 7d 6e 88 97 41 15    ..Fs.x.v.=}n..A.
00016   3b e8 a4 29 fc 04 7c aa  0c 9d 1b e4 dc 9f 53 f1    ;..)..|.......S.
00032   f2 ea ab 12 44 79 8e f5  c0 58 3e da ee 9b 77 a0    ....Dy...X>...w.
00048   f2 29 36 dd 7a 77 91 73  25 c8 ae e9                .)6.zw.s%...

Packet number 8:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Packet number 9:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22
   Payload (60 bytes):
00000   d9 3c 12 f8 d6 d2 c5 cf  ca 46 a1 ea 11 c5 7f 43    .<.......F.....C
00016   75 37 b9 de 73 70 27 cf  af f5 c8 47 21 c1 58 f9    u7..sp'....G!.X.
00032   b5 c8 5f 05 1d a9 2a f9  ff f1 bb ed 2d a7 9d fe    .._...*.....-...
00048   97 a6 5b b5 1b fd cc 6f  56 78 84 4b                ..[....oVx.K

Packet number 10:
       From: 192.168.64.1
         To: 192.168.64.3
   Protocol: TCP
   Src port: 55683
   Dst port: 22

Capture complete.
○ aaditht@aaditht-csce-465-ubuntu-vm:~/hw1$

SSH: 192.168.64.3    ⊗ 31 ⚠ 0    ⌘ 0                                Ln 513, Col 5   Tab Size: 4   UTF-8   LF   {} C   Linux
```

Problem 6:

Due to there being no encryption present, using the command "telnet localhost" while the sniffer is running and filtering in all packets following a TCP protocol on port 23, allows us to observe the raw packets being sent to and from. This includes the password for the device.