Part1

1. After you complete Steps 1-1

a) Can h2 ping h3? Briefly explain why or why not. (5%)

　　Yes 因為 h2 跟 h3 在同一個子網路內，不須經過 router 就可以聯繫到對方

b) Can h2 ping h4? Briefly explain why or why not. (5%)

　　No 因為 h2 跟 h4 在不同子網路內，因此 h2 需要 default gateway 幫他但 router 的 configure 都還沒有做。

```
wc@wc-VirtualBox:~/Lab2$ sudo python topology.py
h1 doesn't have connectivity to 192.168.1.65
h1 doesn't have connectivity to 192.168.1.66
h1 doesn't have connectivity to 192.168.3.1
h1 doesn't have connectivity to 192.168.3.2
h2 doesn't have connectivity to 192.168.3.1
h2 doesn't have connectivity to 192.168.3.2
h3 doesn't have connectivity to 192.168.3.1
h3 doesn't have connectivity to 192.168.3.2
h4 doesn't have connectivity to 192.168.1.65
h4 doesn't have connectivity to 192.168.1.66
h5 doesn't have connectivity to 192.168.1.65
h5 doesn't have connectivity to 192.168.1.66
WRONG ANSWER
```

2. Take screenshot to show that your topology configuration is correct. (10%)

```
wc@wc-VirtualBox:~/Lab2$ sudo python topology.py
h1 doesn't have connectivity to 192.168.1.65
h1 doesn't have connectivity to 192.168.1.66
h1 doesn't have connectivity to 192.168.3.1
h1 doesn't have connectivity to 192.168.3.2
WRONG ANSWER
```

Part2

3. Capture DHCP messages and show the IPs and MACs (10%)

```
 6 14.244694848  0.0.0.0          255.255.255.255    DHCP    342 DHCP Request  - Transaction ID 0xbcf7b927
 7 14.245095030  192.168.1.4      255.255.255.255    DHCP    342 DHCP NAK      - Transaction ID 0xbcf7b927
13 23.471569977  0.0.0.0          255.255.255.255    DHCP    342 DHCP Discover - Transaction ID 0x8d65755f
15 24.473542066  192.168.1.4      192.168.1.2        DHCP    342 DHCP Offer    - Transaction ID 0x8d65755f
16 24.474195765  0.0.0.0          255.255.255.255    DHCP    342 DHCP Request  - Transaction ID 0x8d65755f
18 24.493629851  192.168.1.4      192.168.1.2        DHCP    342 DHCP ACK      - Transaction ID 0x8d65755f
```

```
mininet> h1 ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.1.2  netmask 255.255.255.192  broadcast 192.168.1.63
        inet6 fe80::a0ed:e3ff:feec:3bb6  prefixlen 64  scopeid 0x20<link>
        ether a2:ed:e3:ec:3b:b6  txqueuelen 1000  (Ethernet)
        RX packets 60  bytes 6412 (6.4 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 24  bytes 2388 (2.3 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 20  bytes 1000 (1000.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 20  bytes 1000 (1000.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

4. Can hosts other than h1 acquire IP addresses from DHCP server? Briefly explain your answer. (5%)

不行，因為 DHCP 的第一步 Discovery 是由 client 送出的 broadcast 封包，而這個封包只能在同一個 subnet 內傳遞，無法通過 router 到另一個 subnet，而 DHCP server 只跟 H1 在同一個 subnet，其他 host 都沒跟 DHCP server 在同一個 subnet，因此拿不到 IP。
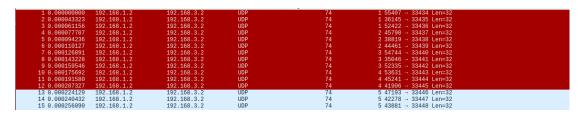
Part3

5. What does r1 do on the packets from h1 to h5, and h5 to h1, respectively? Capture packets to explain your answers. (5%)

因為 h1 跟 h5 不在同一個 subnet，所以 h1 會先將封包送到 gateway，但 h1 沒有 gateway 的 mac address 所以 h1 會發 arp broadcast 去詢問 gateway 的 mac address，等拿到 gateway 的 mac address 後就會送 ICMP packet

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000000	fe80::7c7e:4eff:fe4…	ff02::2	ICMPv6	70	Router Solicitation from 7e:7e:4e:47:f2:b3
2	2.131659362	a2:ed:e3:ec:3b:b6	Broadcast	ARP	42	Who has 192.168.1.62? Tell 192.168.1.2
3	2.131678384	7e:7e:4e:47:f2:b3	a2:ed:e3:ec:3b:b6	ARP	42	192.168.1.62 is at 7e:7e:4e:47:f2:b3
4	2.131777823	192.168.1.2	192.168.3.2	ICMP	98	Echo (ping) request id=0x21c5, seq=1/256, ttl=64 (reply i
5	2.131904661	192.168.3.2	192.168.1.2	ICMP	98	Echo (ping) reply id=0x21c5, seq=1/256, ttl=60 (request

6. Capture all ICMP messages received by h1 and explain why h1 can only derive only 1st, 2nd, and 5th hops details. (10%)

因為 h1 故意發送 time to live 比較短的 UDP packet，以我測試的結果他總共從 TTL 為 1 到 TTL 為 7 個發送了三個 TTL 為 8 發送了一個，packet 的 TTL 每經過一個 router 都會少 1，當 router 收到 TTL 為 0 的 packet 時，他會回傳一個 ICMP 封包回去給 Source，所以 h1 才可以收到 1st, 2nd and 5th 的 detail。

1	0.000000000	192.168.1.2	192.168.3.2	UDP	74	1 55407 → 33434 Len=32
2	0.000043323	192.168.1.2	192.168.3.2	UDP	74	1 36145 → 33435 Len=32
3	0.000061156	192.168.1.2	192.168.3.2	UDP	74	1 52422 → 33436 Len=32
4	0.000077707	192.168.1.2	192.168.3.2	UDP	74	2 45790 → 33437 Len=32
5	0.000094236	192.168.1.2	192.168.3.2	UDP	74	2 38819 → 33438 Len=32
6	0.000110127	192.168.1.2	192.168.3.2	UDP	74	2 44461 → 33439 Len=32
7	0.000126891	192.168.1.2	192.168.3.2	UDP	74	3 54744 → 33440 Len=32
8	0.000143228	192.168.1.2	192.168.3.2	UDP	74	3 35046 → 33441 Len=32
9	0.000159546	192.168.1.2	192.168.3.2	UDP	74	3 52335 → 33442 Len=32
10	0.000175692	192.168.1.2	192.168.3.2	UDP	74	4 53631 → 33443 Len=32
11	0.000191580	192.168.1.2	192.168.3.2	UDP	74	4 45241 → 33444 Len=32
12	0.000207327	192.168.1.2	192.168.3.2	UDP	74	4 41906 → 33445 Len=32
13	0.000224129	192.168.1.2	192.168.3.2	UDP	74	5 47193 → 33446 Len=32
14	0.000240432	192.168.1.2	192.168.3.2	UDP	74	5 42278 → 33447 Len=32
15	0.000256090	192.168.1.2	192.168.3.2	UDP	74	5 43881 → 33448 Len=32

7. H1 uses some ICMP messages to derive 1st and 2nd hop details. What are the type(s) and sender(s) of the ICMP messages? (5%)

UDP with TTL=1, UDP with TTL=2   ICMP with time to live exceed

8. H1 uses some ICMP messages to derive 5th hop details. What are the type(s) and sender(s) of the ICMP messages? (5%)

UDP with TTL=5,   ICMP with port unreachable