**Part 1: IEEE 802.11 MAC (10 points)**

An Ad Hoc network using IEEE802.11 has 4 nodes: N1, N2, N3, N4. Assume that SIFS is 1 unit of time, PIFS 2 units of time, DIFS 3 units of time, and slot time is 2 (these value are not the real values but are taken to simplify the packets scheduling).

Assume that at the beginning the channel is idle (no transmission), and that at instant 1, N2 has a packet to be sent to N4. At instant 2, both N1 and N3 have a packet to be sent to N4. Assume that the random number generator (for backoff) will give the following values for N1: 2, 5, ... and for N2: 4, 3, … and for N3: 1, 4, ... Assume that we don’t use RTS/CTS nor fragmentation, and that all data packets have the same length: 6 units of time and that the Ack packet has length 3 units of time. Furthermore the channel Bit Error Rate is assumed to be 0. Show the execution of the DCF mode of IEEE802.11.

At time unit 1 packet is sent from N2 to N4. Following events takes place

1. **Time unit 1**: N2 senses free channel and waits for DIFS time units
2. **Time unit 2**: At time unit 2 both N1 and N3 has a packet to send. Both sense channel is idle and waits for DIFS time unit
3. **Time unit 4**: N2 transmits the packet noting that the channel is free. Also here N1 and N3 selects back off time, which is Slot Time \* Random Number (2\*2 = 4 for N1 and 1\*2 = 2 for N3)
4. **Time unit 10**: At 10 units N2 completes transmitting packet. N4 waits for SIFS time unit to send the ACK
5. **Time unit 11**: N4 sends the ACK
6. **Time unit 14**: N2 receives ACK
7. **Time unit 17**: DIFS time units have passed since the transmission of last packet. So back off counter begins for N1 and N3
8. **Time unit 19**: N3’s counter has timed out so it begins transmission. N1 freezes its counter sensing that channel isn’t idle
9. **Time unit 25**: N3 completes its transmission. N4 waits SIFS before transmitting ACK
10. **Time unit 26**: N4 transmits ACK
11. **Time unit 29**: N3 receives ACK and N1 resumes it’s clock
12. **Time unit 31**: N1’s timer times out so N1 begins transmission
13. **Time unit 37**: N4 receives N1’s packet and waits DIFS before sending ACK
14. **Time unit 38**: N4 transmits ACK
15. **Time unit 41**: N1 receives ACK