Indian Institute of Technology Patna Date: 27 April 2025 ENDSEM: CS 548/CS6206: Wireless Networks
DURATION: 3 HOURS. 3-6PM Full Marks 100

Instruction: All questions are compulsory. No Free hand diagrams allowed. If free hand diagrams are seen, you will be penalized 50% of marks. No doubts would be entertained. Write suitable assumptions, if necessary. Students are allowed to use scientific calculators. Each question from Q1 should start on a fresh page. So if the Q1 takes 1/2 page to finish, begin Q2 from the next page. **If two questions are written on the same page, both will be marked 0.**

Master Answer		
Q1		Mbps
Q2		3 decimal
Q3		micro-seconds
Q4		% with 2 decimals
Q5		3 decimal
Q6		% with 2 decimals
Q7a,b		micro-seconds
Q8		% with 2 decimals
Q9a,b		micro-seconds
Q10		micro-seconds
Q11a,b,c		micro-seconds
Q12		% with 2 decimals
Q13		bytes
Q14		micro-seconds

Figure 1: Make this master sheet on the first page of your answer sheet using scale pencil. You need to write the final answers for numericals in this table. However, the complete working of the numericals needs to be shown later also. If this table is **absent**, 50 percent marks will be deducted. If units are different from the ones mentioned, 50 percent marks will be deducted.

Q(1) Given an 802.11g network operating at 48 Mbps. Assume a frame size of 1000 bytes, and the transmission uses RTS/CTS. Calculate the maximum throughput assuming no collisions or retransmissions. **RTS** = 25 μs, **CTS** = 25 μs, **ACK** = 25 μs, **DIFS** = 50 μs, **SIFS** = 20 μs. Final ans in Mbps units only. **[Marks 5]**

Q(2) Assume an 802.11 network with 12 stations. Each station attempts to transmit in a given slot with probability $\tau = 0.2$. What is the probability of a collision? Final ans in 3 decimal units only. **[Marks 5]**

Q(3) Calculate the total transmission time for a 1500-byte data frame in 802.11n using 20 MHz bandwidth and MCS 7 (72 Mbps), assuming no RTS/CTS, but considering PHY overhead of 25 μs and ACK delay of 50 μs. Use SIFS = 16 μs. Ignore DIFS. Final ans in μs units only. **[Marks 5]**

Q(4) Assume an 802.11n transmission aggregates 8 MPDUs, each carrying 1200 bytes. The per-frame overhead is 60 μs, and PHY rate is 65 Mbps. Calculate the total transmission time with and without aggregation. Compute gain obtained due to aggregation. Final ans in % units only with two decimals. **[Marks 5]**

Q(5) In a wireless network with 25 contending stations, each station has a minimum contention window (CWmin) of 31. What is the probability that exactly one station transmits successfully during a given slot? Final ans in 3 decimal units only. **[Marks 5]**

Q(6) In 802.11ac, two 20 MHz channels are bonded to form a 40 MHz channel. If the overhead remains constant at 15 μs, calculate the gain in efficiency when the data size is 6000 bits and the PHY rate is 96 Mbps per 20 MHz channel. Final ans in % units only with two decimals. **[Marks 5]**

Q(7) In 802.11a/g, the OFDM symbol duration is 4 μs (3.2 μs + 0.8 μs guard interval). If a frame occupies 24 symbols, calculate the total time spent on symbols and the guard interval overhead. Final ans in μs units only. **[Marks 5]**

Q(8) Two neighboring BSSs operate on overlapping channels (e.g., channel 5 and 6 in 2.4 GHz). If each BSS occupies 24 MHz and the center frequencies are 4 MHz apart, what percentage of the spectrum overlaps? Final ans in % units only with two decimals. **[Marks 5]**

Q(9) In 802.11 DCF, a station waits DIFS = 36 μs and then selects a random backoff between 0–19 slots (slot = 18 μs). What is the maximum and average channel access delay? Final ans in μs units only. **[Marks 5]**

Q(10) In 802.11g, SIFS = 10 μs, slot time = 20 μs. Calculate DIFS and explain its use in frame transmission. Final ans in μs units only. **[Marks 5]**

Q(11) Given: RTS = 22 μs, CTS = 22 μs, SIFS = 12 μs, ACK = 22 μs Data frame = 1200 bytes at 9 Mbps. Calculate total transmission time with and without RTS/CTS. Also tell the overhead due to RTS/CTS. Ingore DIFS. Final ans in μs units only. **[Marks 5]**

Q(12) Assume that sending RTS, CTS, and ACK each takes 25 μs. The data frame is 1500 bytes, transmitted at 48 Mbps. Calculate the protocol efficiency using RTS/CTS. Ignore DIFS. Assume SIFS 10 μs. Final ans in % units only with two decimals. **[Marks 5]**

Q(13) In a noisy environment, setting the fragmentation threshold to 600 bytes improves retransmission success. If the original frame was 2000 bytes and each fragment has a 40-byte overhead, compute the total bits transmitted. Final ans in bytes units only. **[Marks 5]**

Q(14) A station uses DCF with CWmin = 31. Slot time = 9 μs. Calculate the average backoff delay after DIFS. Final ans in μs units only. **[Marks 5]**

Q(15) Describe using a diagram the 4-Way Handshake process used in Wi-Fi security (WPA/WPA2) to establish a secure connection between a client device (STA = Station) and an access point (AP). Show detailed steps. **[Marks 10]**

Q(16) Describe using a Timeline diagram the launching of evil twin attack in Wifi Networks. Explain the various steps of timeline. No need for showing the solution timeline. **[Marks 10]**

Q(17) Describe using a Timeline diagram the launching of PS-DoS attack in Wifi Networks. Explain the various steps of timeline. No need for showing the solution timeline. **[Marks 10]**