# COMP3234B Computer and Communication networks
# Assignment 4 (10%)
# Sample Solution

Total mark is 100.

**1. (13 marks) [Parity checks (LO3)]**

**(1 mark for each parity bit)**

100111 | 1
101000 | 1
100101 | 0
010100 | 1
111001 | 1
111001 | 1

———————
000001 | 0

**2. (18 marks) [Checksum (LO 3)]**

The 16-bit integers representing the 18 bytes is as follows:
1010101110101011 (integer 1) **(0.5 mark for each byte)**
1010101110101011 (integer 2) **(0.5 mark for each byte)**
1010101110101011 (integer 3) **(0.5 mark for each byte)**
1010101111011110 (integer 4) **(0.5 mark for each byte)**
0011101100000110 (integer 5) **(0.5 mark for each byte)**
1000001101110011 (integer 6) **(0.5 mark for each byte)**
0100110111011111(integer 7) **(0.5 mark for each byte)**
0011011000101011(integer 8) **(0.5 mark for each byte)**
1000011011011101 (integer 9) **(0.5 mark for each byte)**

The sum of integer 1 and integer 2 is 0101011101010111 (carryout from the most significant bit is added); **(1 mark)**
adding integer 3, we get: 0000001100000011 (carryout from the most significant bit is added); **(1 mark)**
adding integer 4, we get: 1010111011100001; **(1 mark)**
adding integer 5, we get: 1110100111100111; **(1 mark)**
adding integer 6, we get: 0110110101011011 (carryout from the most significant bit is added); **(1 mark)**
adding integer 7, we get: 1011101100111010; **(1 mark)**
adding integer 8, we get: 1111000101100101 **(1 mark)**
adding integer 9, we get: 0111100001000011 (carryout from the most significant bit is added); **(1 mark)**

Checksum (1s complement of the sum) is 1000 0111 1011 1100 **(1 mark)**

**3. (15 marks) [CRC (LO3)]**

(1) 0101111 **(5 marks)**

(2) 0010110 **(5 marks)**

(3) 1111000 **(5 marks)**

**4. (12 marks) [Multiple Access (LOs 2, 3)]**

1. A creates IP datagram with source address 192.168.1.001 and destination address 192.168.3.003. (**1 mark)**
2. A uses ARP to get the MAC address associated with router 1's interface 192.168.1.002: Host A broadcasts an ARP query frame containing IP address 192.168.1.002, with source MAC address 11-11-11-22-22-22 and destination MAC address FF-FF-FF-FF-FF-FF; Router 1 receives the query packet and sends to Host A an ARP response frame, with source MAC address 22-22-22-22-22-22 and destination MAC address 11-11-11-22-22-22; A caches this IP-MAC mapping in its ARP table. **(3 marks)**
3. A creates a link-layer frame with source MAC address 11-11-11-22-22-22 and destination MAC address 22-22-22-22-22-22, containing the A-to-F IP datagram (**1 mark)**
4. A sends the frame via interface 192.168.1.001 to router 1's interface 192.168.1.002. (**1 mark)**
5. Router 1 removes IP datagram from frame, sees it destined to F. (**1 mark)**
6. Router 1 generates a link-layer frame carrying the A-to-F IP datagram, with source MAC address 33-33-33-33-33-33 and destination MAC address 55-55-55-55-55-55, and sends from its interface 192.168.2.002 to router 2's interface 192.168.2.003. (**2 marks)**
7. Router 2 removes IP datagram from frame, sees it destined to F. (**1 mark)**
8. Router 2 generates a link-layer frame carrying the A-to-F IP datagram, with source MAC address 88-88-88-88-88-88 and destination MAC address 99-99-99-99-99-99, and sends from its interface 192.168.3.002 to F's interface 192.168.3.003. **(2 marks)**

**5. (20 marks) Multiple Access [ILOs 2, 3]**

(1) **(7 marks)**
A will first start its transmission of first frame at: 396 bit time **(1 mark)**
A will finish its transmission of first frame at: 396 + 800 × 8 = 6796 bit time **(1 mark)**
Solving 512 × (1 + 2 + . . . + y) ≥ 6796, we get y = 5 **(1 mark)**
B will start its transmission of first frame at: 512×(1+2+3+4+5)=7680 bit time **(1 mark)**
A will make its first attempt to transmit its second frame at 6796 + 900 = 7696 bit time, when it will detect B's transmission and will abort. **(2 marks)**
So B's transmission starting at 7680 bit time will be successful. **(1 mark)**

(2) **(8 marks)**

B will finish its transmission of first frame at: 7680 + 800 × 8 = 14080 bit time **(1 mark)**, and then B will attempt to transmit its second frame at 14080 + 900 = 14980 bit time **(1 mark)**.
Solving 6796 + 900 + 396 × (1 + 2 + . . . + y) >= 14080, we get y = 6 **(1 mark)**. When A attempts to transmit its second frame at 6796 + 900 + 396 × (1 + 2 +3+4+5+ 6) = 16012 bit time, B has started its transmission of the second frame, and A will back off further **(2 marks)**, while B's second frame transmission will be successful and finish at 14980 + 800×8=21380 bit time **(1 mark)**.
Solving 6796 + 900 + 396 × (1 + 2 + . . . + y) >= 21380, we get y = 8 **(1 mark)**. A's transmission of second frame will start at 6796 + 900 + 396 × (1 + 2 + . . . + 8) =21952 bit time and will be successful **(1 mark)**.

(3) **(5 marks)**
A will finish its transmission of second frame at: 21952 + 800 × 8 = 28352 bit time **(2 marks)**
Channel efficiency= 4×(800×8)/ 28352 = 0.903 **(3 marks)**

**6. (22 marks) [Wireless Network (Learning Outcomes 2, 3)]**

(1) **(17 marks)**
1 bit time = $10^{-7}$seconds=$10^{-1}$microseconds
DIFS = 500 bit time **(0.5 marks)**
SIFS= 100 bit time **(0.5 marks)**
Node A's frame's transmission time = 128*8 bit time=1024 bit time **(0.5 marks)**
Node C's frame's transmission time = 250*8 bit time=2000 bit time **(0.5 marks)**

The time A finishes the first transmission is 500+1024=1524 bit time **(1 mark)**
The time C finishes the first transmission is 500+2000 =2500 bit time **(1 mark)**

The time A starts the first retransmission is 1524 +5+100+100+5+500+512=2746 bit time **(1 mark)**
The time A finishes the first retransmission is 2746 +1024 =3770 bit time **(1 mark)**
The time C starts the first retransmission is 2500 +10+100+100+10+500+512=3732 bit time **(1 mark)**
The time C finishes the first retransmission 3732 +2000 =5732 bit time **(1 mark)**
The first retransmissions from A and C still collide at B. **(1 mark)**

The time A starts the second retransmission is 3770 +5+100+100+5+500+512*3=6016 bit time **(1 mark)**
The time A finishes the second retransmission is 6016 +1024 =7040 bit time **(1 mark)**
The time C starts the second retransmission is 5732 +10+100+100+10+500+512*3=7988 bit time **(1 mark)**
The time C finishes the second retransmission 7988 +2000 =9988 bit time **(1 mark)**

The time A starts the second retransmission is after C's first retransmission and the time B sent ACK to A's second retransmission is 7040 +5+100+100=7245 bit time which is earlier than the time it starts to receive C's second retransmission. Therefore, the second retransmissions of A and C will be successful. **(2 marks)**

The start time of the successful retransmission from A is 6016 *$10^{-1}$microseconds= 601.6microseconds **(1 mark)**

The start time of the successful retransmission from C is 7988 $*10^{-1}$microseconds= 798.8microseconds **(1 mark)**

(2) **(5 marks)**
T=9988 +10+100+100+10=10208 bit time **(2 marks)**
Channel efficiency=(1024+2000)/10208 =0.296 **(3 marks)**