Problem 1
Output corresponding to bit $d_1 = [-1,1,-1,1,-1,1,-1,1]$ 
Output corresponding to bit $d_0 = [1,-1,1,-1,1,-1,-1,1]$

Problem 2
Sender 2 output = $[1,-1,1,1,-1,1,1]$; $[1,-1,1,1,-1,1,1]$ 

Problem 3
$$d_2^1 = \frac{1 \times 1 + (-1) \times (-1) + 1 \times 1 + 1 \times 1 + 1 \times 1 + (-1) \times (-1) + 1 \times 1 + 1 \times 1}{8} = 1$$
$$d_2^2 = \frac{1 \times 1 + (-1) \times (-1) + 1 \times 1 + 1 \times 1 + 1 \times 1 + (-1) \times (-1) + 1 \times 1 + 1 \times 1}{8} = 1$$

Problem 4
Sender 1: (1, 1, 1, -1, 1, -1, -1, -1) 
Sender 2: (1, -1, 1, 1, 1, 1, 1, 1) 

Problem 8
a) 1 message/2 slots 
b) 2 messages/slot 
c) 1 message/slot 
e) i) 1 message/4 slots 
   ii) slot 1: Message $A \rightarrow B$, message $D \rightarrow C$ 
      slot 2: Ack $B \rightarrow A$, Ack $C \rightarrow D$ 
            = 2 messages/2 slots or 1 message/slot 
   iii) (Repeat) 
      slot 1: Message $C \rightarrow D$, Ack $B \rightarrow A$ 
      slot 2: Ack $D \rightarrow C$, message $A \rightarrow B$ 
            = 2 messages/2 slots or 1 message/slot
Problem 10

a) 10 Mbps if it only transmits to node A. This solution is not fair since only A is getting served. By “fair” it means that each of the four nodes should be allotted equal number of slots.

b) For the fairness requirement such that each node receives an equal amount of data during each downstream sub-frame, let \( n_1, n_2, n_3, \) and \( n_4 \) respectively represent the number of slots that A, B, C and D get.

Now, data transmitted to A in 1 slot = 10t Mbits
(assuming the duration of each slot to be t)

Hence, Total amount of data transmitted to A (in \( n_1 \) slots) = 10t \( n_1 \)

Similarly total amounts of data transmitted to B, C, and D equal to 5t \( n_2 \), 2.5t \( n_3 \), and t \( n_4 \) respectively.

Now, to fulfill the given fairness requirement, we have the following condition:

\[
10t n_1 = 5t n_2 = 2.5t n_3 = t n_4
\]

Hence,\[
\begin{align*}
    n_2 &= 2 n_1 \\
    n_3 &= 4 n_1 \\
    n_4 &= 10 n_1
\end{align*}
\]

Now, the total number of slots is \( N \). Hence,\[
\begin{align*}
    n_1 + n_2 + n_3 + n_4 &= N \\
    \text{i.e. } n_1 + 2 n_1 + 4 n_1 + 10 n_1 &= N \\
    \text{i.e. } n_1 &= N/17
\end{align*}
\]

Hence,\[
\begin{align*}
    n_2 &= 2N/17 \\
    n_3 &= 4N/17 \\
    n_4 &= 10N/17
\end{align*}
\]

The average transmission rate is given by:

\[
\frac{(10t n_1+5t n_2+ 2.5t n_3+t n_4)tN}{tN} = \frac{(10N/17 + 5 * 2N/17 + 2.5 * 4N/17 + 1 * 10N/17)}{N} = 40/17 = 2.35 \text{ Mbps}
\]

c) Let node A receives twice as much data as nodes B, C, and D during the sub-frame.

Hence,\[
\begin{align*}
    10t n_1 &= 2 * 5t n_2 = 2 * 2.5t n_3 = 2 * t n_4 \\
    \text{i.e. } n_2 &= n_1 \\
    n_3 &= 2n_1 \\
    n_4 &= 5n_1
\end{align*}
\]
Again,
\[ n_1 + n_2 + n_3 + n_4 = N \]
i.e. \( n_1 + 2n_1 + 5n_1 = N \)
i.e. \( n_1 = \frac{N}{9} \)

Now, average transmission rate is given by:
\[
\frac{(10n_1+5n_2+2.5n_3+n_4)}{tN} = \frac{25}{9} = 2.78 \text{ Mbps}
\]

Similarly, considering nodes B, C, or D receive twice as much data as any other nodes, different values for the average transmission rate can be calculated.