# Make-up Homework Solutions

## Problem 1:

A single T3 line has a data bandwidth of 45 Mbps. On average, a month has $365.25/12$ days, and since each day has 24 hours, a total of $2.6298 \times 10^6$ seconds for a total capacity of transferring $1.47926 \times 10^{13}$ bytes. This is 14.7926 TB of data. We can pick a safer number as 14TB per month.

Without compression, we have to transfer per month a 100 TB base set and about 30 delta records of 100GB each, for a total of 130TB. We would need to lease eight T3 lines. A T3 line costs about 3000$ per month, so we would spend 24 000$ per month only on networking.

With compression, we have to transfer per month 100/200 TB base set and about 30 delta records of 100/50 GB each, for a total of 0.56 TB each. This can easily done with a single T3 line link, which costs 3000$ per month.

Thus, we can spend up to $21000 in licensing fees to still come ahead by using compression.

## Problem 2:

According to the Shannon Capacity Formula, the capacity $C$, the bandwidth $B$, and the Signal to Noise ratio $SNR$ are related by $C = B \times \log_2(1 + SNR)$. Since $C$ = 10 Mb/sec and $B = 3$ Mb/sec, we get $\log_2(S) = 10/3$ or $SNR = 9.07937$. To convert into decibel, we calculate $10 \times \log_{10}(SNR) = 9.58056$ db.

## Problem 3:

We use three bits to encode the difference between the current and the previous value. This allows us to express a range of 8 in variation. If we use signed integer representation, this would give us -4, -3, -2, -1, 0, 1, 2, 3. Thus, we cannot express all deltas and often have to adjust. The set of values

```
20 20 15 10 7 5 5 5 5 10 15 20 20 20
```

could be approximately encoded as

```
0  -4 -4 -4 -3  0 0 3  3  3  3  3  0
```

giving us

```
20 20 16 12 8 5 5 5 8 11 14 17 20 20.
```

## Problem 4:

Since H@[0, 1, 0, 0, 0, 1, 1, 1, 0, 1, 1, 1, 0, 0, 1] %2 gives us the zero array, this message was transmitted without error. The encoding of the array is [0100 1110 011].