Solutions to Assignment 2

Question 1

We could look up each character in the Unicode character tables (e.g. at unicode.org) and convert to UTF-8. More simply we can paste the characters into a UTF-8 encoded file (the default encoding in most cases) and view the values of the bytes with a hex editor such as `hexedit`.

The following command does the same under Unix:

```
echo -n "Правда" | od -t x1
```

which prints the following hex values:

```
d0 9f d1 80 d0 b0 d0 b2 d0 b4 d0 b0
```

Question 2

An 8B/10B outputs 10 bits for every 8 input bits.

According to the referenced encoding method, the LS 5 bits are encoded to 6 bits and the MS 3 bits are encoded to 4 bits.

For an output of `110101 1100` the 6b output (abcdei) is `110101` which corresponds to D.04 for RD=-1 and corresponds to input (EDCBA) of `00100` (m.s. to l.s. bit). The 3b/4b output (fghj) for RD=-1 is `1100` D.x.3 which corresponds to an input (HGF) of `011`. Thus the input was 011 00100 or 0x64.

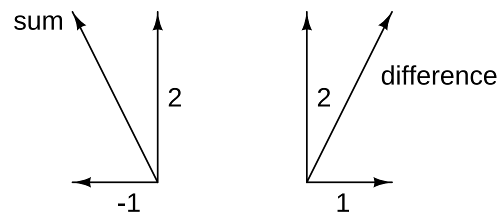
For an output of `011000 0100` the 5b/6b output, `011000` is D.00 for RD=+1 and corresponds to input of `00000`. The 3b/4b output for RD=+1 is `0100` D.x.0 which corresponds to an input of `000`. Thus the input was 000 00000 or 0x00.

Question 3

The voltage relative to ground on the first conductor can be represented as the vector $2\angle 90°$ and the second as $1\angle 180°$.

The common-mode signal is the average of the two. Using vector addition as shown below the common mode signal is $\sqrt{\frac{5}{4}}\angle 117°$.

The differential signal is the difference between the two. Using vector addition as shown below the differential signal is $\sqrt{5}\angle 63°$:



For the equation $A\cos(2\pi ft+\theta)$ with $f = 100$, the common-mode signal has $A = \sqrt{\frac{5}{4}}$ and $\theta = 117°$. For the difference signal $A = \sqrt{5}$, and $\theta = 63°$.

Question 4

(a) The entropy of the source in bits per message is:

$$\sum_{i=1}^{8} -P_i \log_2 P_i = \sum_{i=1}^{8} \frac{i}{2^i}$$

which can be evaluated in Octave:

```
i=1:8
sum(i./2.^i)
ans =  1.9609
```

(b) If each message is encoded using 3 bits per message and 1 million messages per second are transmitted, the data rate over the channel is 3 Mb/s.

(c) If the best possible compression method is applied before the data is transmitted over the channel then the data rate will be the information rate, or 1.96 Mb/s.

Question 5

If one user uses half of of the time slots, then the remaining three users share one time slot per 200 μs, or one time slot per user per 600 μs. With 10% of the slots lost and 96 bits per slot, each low-priority user would see a throughput of $0.9\times 96/600\ \mu\text{s} = 114$ kb/s.