Solutions to Assignment 4

Question 1

(a) TxD is pin 6 and RxD is pin 3 on a Cisco router RJ-45 console (serial) port.

(b) These pins are placed on opposite sides of center so that if the connector is mirrored RxD and TxD are interchanged.

(c) A "rolled" cable that mirrors pins (1-8, 2-7, 3-6, 4-5) can use this symmetry to connect similarly-configured serial ports.

(d) If the router is wired as a DCE and the PC is wired as a DTE, then no "null modem" function is required to connect them and a straight-through cable would be required.

However, the scheme suggested in the referenced web page suggests different types of adapters be used on DTEs and DCEs to ensure any two RJ-45 serial ports can be connected with a "rolled" cable.

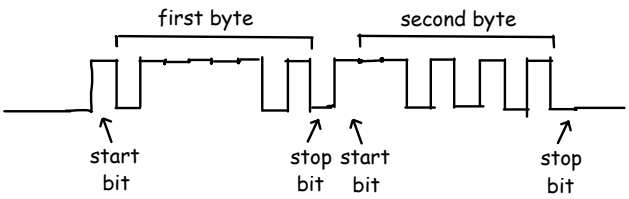
(e) The RJ-45 cable has ground, transmit and receive data and the four handshaking lines (RTS/CTS and DSR/DTR). The DB-9 pin assignment also includes a protective ground pin, Data Carrier Detect (DCD) and Ring Indicator (RI) signals.

Question 2

Following the start bit there must be 7 or 8 data bits. Since the 8th bit is high (0) it cannot be a stop bit so there must be 8 data bits. The last data bit is followed by an optional parity bit. But if a parity bit were present the stop bit would again be high (0) so a parity bit was not used.

The same argument can be applied to determine that the second byte was also sent with 8 data bits.

The bits in the first byte are 1000 0010 (in LS to MS order) (ASCII 0x41 or 'A') and in the second byte 0010 1010 (ASCII 0x54 or 'T').



Question 3

The capacity is given by $C = B\log_2(1 + S/N)$. By doubling the bandwidth, B, the capacity increases by a factor of 2.

By doubling the SNR from 4 (6dB) to 8, the capacity changes by a ratio:

$$\frac{\log_2(1+8)}{\log_2(1+4)} = 1.4$$

For typical SNRs ($\gg 1$) we are better off by doubling the bandwidth than the SNR.

Question 4

A "brick wall" filter with a 4 kHz bandwidth would allow signalling without ISI at a maximum of 8 kHz[1].

At 7 bits per symbol, the bit rate would be $7 \times 8 = 56$ kb/s.

Question 5

(a) If the duration of an OFDM symbol is T then the subcarrier spacing is $\Delta_f = 1/T$ (not given in the lecture notes).

In this case $\Delta_f = 15$ kHz so $T = \frac{1}{15\times10^3}$. Since this corresponds to 2048 samples the sampling rate is $2048 \times 15 \times 10^3 = 30.72$ MHz.

(b) Since the symbol and cyclic prefix are $2048 + 144 = 2192$ samples, the duration will be $\frac{2192}{30.72\times10^6} = 71.4\mu$s.

[1] We can transmit faster than this – potentially without errors – but there would be ISI

(c) The duration of the cyclic prefix is $\frac{144}{30.72\times10^6} = 4.7\mu$s and at the speed of light (300 m/s) a radio signal will propagate 1.4 km. This is the maximum spread of one symbol due to multipath propagation before one symbol starts interfering with the next (ISI).