Solutions to Midterm Exam 1

Question 1

(a) A signal at 240 MHz is a downstream (forward) signal because, as stated in Lecture 3: *Signals above a certain frequency (either 54 or 108 MHz) propagate from the head end to the subscriber. This is called the forward or down- stream (D, DS) direction.*

(b) The power level in mW can be calculated from the power level in dBm:

$$P_{mW} = 10^{\frac{P_{dBm}}{10}}$$

There were two versions of the question with power levels of -50 and -60 dBm resulting in power levels of 10^{-5} mW (10 nW) and 10^{-6} mW (1 nW) respectively.

(c) Since we know the impedance and the power, the signal level can be calculated using the relationship $P = V^2/R$ or $V = \sqrt{PR}$.

For $R = 75\ \Omega$, $V = \sqrt{75 \times 10^{-8}} = 0.867$ mV or $V = \sqrt{75 \times 10^{-9}} = 0.274$ mV.

The signal level in dBmV is $20 \log_{10} V_{mV}$. A level of 0.867 mV is -1.2 dBmV and a level of 0.274 mV is -11.2 dBmV.

(d) According to Table 2-1 of the DOCSYS specification, *Downstream RF Channel Transmission Characteristics* (given in the lecture notes) the minimum level at the CM (cable modem) input is -5 dBmV and the maximum is 17 dBmV.

The level -1.2 dBmV is within the allowable range but -11.2 dBmV is too low (below the -5 dBmV lower limit).

Question 2

A PON system uses OLTs with a transmitter output power of 0 (or +5) dBm, 8:1 splitters that have a loss of 10 dB between the input and each output port, and optical fiber cable with a loss of 0.25 dBm/km. The ONUs have a sensitivity of -27 (or -22) dBm. Each transmitter services 64 users.

(a) If each transmitter services 64 users and only 1:8 splitters are used then two splitters would be required in each path – the first splits the signal 8 ways and the second splits each of those a further 8 ways for a total of $8 \times 8 = 64$ paths (users).

(b) The received power is the transmit power minus the losses. In this example there are only splitter and cable losses so the received signal level in dBm is $P_R = 0$ dBm (transmit power) - 2×10 dB (splitter losses) - $0.25 \times d$ (cable loss with d in km) $= 0 - 20 - 0.25d$. The received power must be greater than or equal to the sensitivity (-27 dBm) so we can solve for the maximum distance $d = \frac{0-2\times10+27}{0.25} = 28$ km. For the second version of the exam the distance is $d = \frac{5-2\times10+22}{0.25} = 28$ km.

(c) A link margin of 2 dB would require increasing the received power by 2 dB and the distance would decrease by $\frac{2}{0.25} = 8$ km to 20 km.