EECE 598, Homework 01

Try to solve the problems by yourselves. Compare with your solutions after you are done.
Exams will be similar formats as these.

1. **Problem 1-2.**

2. **Problem 1-3.**

3. **Problem 1-6.**

4. **Problem 1-7.**

5. **Problem 1-8.**

6. **Problem 1-9.**

7. **Problem 1-10.**

8. **Problem 1-11.**

No submission is required. The solutions to select problems will be uploaded a week later.

PROBLEMS

1.1 (a) What are the energies in electron volts (eV) of light at wavelengths 850, 1310, 1490, and 1550 nm?

    (b) Consider a 1-ns pulse with a 100-nW amplitude at each of these wavelengths. How many photons are in such a pulse at each wavelength?

1.2 A WDM optical transmission system is designed so that each channel has a spectral width of 0.8 nm. How many wavelength channels can be used in the C-band?

1.3 Three sine waves have the following periods: 25 μs, 250 ns, 125 ps. What are their frequencies?

    (b) Convert the following decibel power gains to absolute power gains: −30 dB, 0 dB, 13 dB, 30 dB, 10n dB.

1.8 (a) Convert the following absolute power levels to dBm values: 1 pW, 1 nW, 1 mW, 10 mW, 50 mW.

    (b) Convert the following dBm values to power levels in units of mW: −13 dBm, −6 dBm, 6 dBm, 17 dBm.

1.9 A signal travels from point A to point B.

    (a) If the signal power is 1.0 mW at point A and 0.125 mW at point B, what is the attenuation in dB?

    (b) What is the signal power at point B if the attenuation is 15 dB?

1.10 A signal passes through three cascaded amplifiers, each of which has a 5-dB gain. What is the total gain in dB? By what numerical factor is the signal amplified?

1.11 A 50-km long optical fiber has a total attenuation of 24 dB. If 500 μW of optical power get launched into the fiber, what is the output optical power level in dBm and in μW?

1.4 A sine wave is offset 1/6 of a cycle with respect to time zero. What is its phase in degrees and in radians?

1.5 Consider two signals that have the same frequency. When the amplitude of the first signal is at its maximum, the amplitude of the second signal is at half its maximum from the zero level. What is the phase shift between the two signals?

1.6 What is the duration of a bit for each of the following three signals which have bit rates of 64 kb/s, 5 Mb/s, and 10 Gb/s?

1.7 (a) Convert the following absolute power gains to decibel power gains: 10^{-3}, 0.3, 1, 4, 10, 100, 500, 2^n.

1.12 Based on the Shannon theorem, the maximum data rate R of a channel with a bandwidth B is $R = B \log_2(1+S/N)$, where S/N is the signal-to-noise ratio. Suppose a transmission line has a bandwidth of 2 MHz. If the signal-to-noise ratio at the receiving end is 20 dB, what is the maximum data rate that this line can support?

1.13 (a) At the lowest TDM level of the digital service scheme, 24 channels of 64 kb/s each are multiplexed into a 1.544-Mb/s DS1 channel. How much is the overhead that is added?

    (b) The next higher multiplexed level, the DS2 rate, is 6.312 Mb/s. How many DS1 channels can be accommodated in the DS2 rate, and what is the overhead?

    (c) If the DS3 rate that is sent over a T3 line is 44.376 Mb/s, how many DS2 channels can be accommodated on a T3 line, and what is the overhead?

    (d) Using the above results, find how many DS0 channels can be sent over a T3 line. What is the total added overhead?