

Chapter 2: Exercises for dB, bandwidth, and channel capacity (Solutions)

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1. Derive the dB values of the following power ratios:

(a) 12345

Solution: $10 \times \log_{10}(12345) \approx 40.9dB$

(b) 0.00005

Solution: $10 \times \log_{10}(0.00005) \approx -43.0dB$

2. Derive the power ratios of the following dB values:

(a) $-50dB$

Solution: $10^{\frac{-50}{10}} = 10^{-5} = 0.00001$

(b) $33dB$

Solution: $10^{\frac{33}{10}} = 10^{3.3} \approx 1995.3 \approx 2000$

3. Derive the dBm values of the following power values:

(a) $5W$

Solution: $10 \times \log_{10} \frac{5000mW}{1mW} \approx 37.0dBm$

(b) $0.007mW$

Solution: $10 \times \log_{10} \frac{0.007mW}{1mW} \approx -21.5dBm$

4. Derive the power values of the following with unit watt:

(a) $-66dBm$

Solution: $10^{\frac{-96}{10}} = 10^{-9.6} \approx 2.5 \times 10^{-10}W$

(b) $-33dBW$

Solution: $10^{\frac{-33}{10}} = 10^{-3.3} \approx 5 \times 10^{-4}W$

5. Given a signal waveform in the time domain, what are the three components to determine its bandwidth?

Solution:

- (a) The power spectrum density (PSD) of the signal.
 - (b) The reference power level (e.g., $1W$).
 - (c) The threshold for power (e.g., $-3dB$ or $-10dB$).
6. Read the article in the link (<http://www.afar.net/tutorials/fcc-rules>), answer the following questions:
- (a) What is the maximal transmission power fed into the antenna?
Solution: $30dBm = 1W$
 - (b) What is the meaning of EIRP?
Solution: Maximum Effective Isotropic Radiated Power
 - (c) What is dBi?
Solution: dB(isotropic) is the power gain of a directional antenna, i.e., the ratio of power on a direction to the transmission power of an isotropic (omnidirectional) antenna
 - (d) What kind of antenna can achieve 30dBi?
Solution: Many, example: parabolic dish antenna
 - (e) How much it cost?
Solution: Varying, example: 150\$
7. Download the latest IEEE 802.11 standard (attached), answer the following questions
- a) How IEEE specify the requirements for power spectral density for a 20 MHz channel?
 - b) Why some people claim that the same channel has a bandwidth 22MHz?
- Solution:** To be re-assigned
8. If a binary signal is transmitted through a $16kHz$ noiseless channel, what is the maximum data rate?
- Solution:** Using the Nyquist theorem, the maximum data rate is

$$2 \times 16000 \times \log_2(2)bps = 32Kbps$$

9. If the SNR of a $14kHz$ channel is $26dB$, what is the maximum data rate?

Solution: $26dB$ means the power ratio is about 400. Using the Shannon theorem, the maximum data rate is

$$14000 \times \log_2(1 + 400)bps \approx 121Kbps$$