

EE1002 Principles of Electronic Engineering
Semester A 2016-17
Part 3: Electromagnetic Waves and Applications

Tutorial 2

1. A 540 kHz carrier is amplitude-modulated by a voice signal whose highest frequency component is 3.4 kHz. What are the frequency range and the bandwidth of the modulated signal?
2. The commercial AM radio channels are separated by 10 kHz. What is the maximum bandwidth of the base-band signal each of these channels can carry?
3. Which frequency components are present in the AM-modulated signal $A(t) = [1 + a \sin(2\pi f_m t)]A_0 \sin(2\pi f_c t)$, where $a < 1$? What are their relative strengths? Sketch the amplitude spectrum of the signal, which is a plot with the horizontal axis for the frequency and the vertical axis for the amplitude.
4. Consider the FM-modulated signal $A(t) = A_0 \sin[2\pi f_c t + \frac{\Delta f}{f_m} \sin(2\pi f_m t)]$. What will be the bandwidth of the signal, if the peak frequency deviation Δf is much smaller than the modulating frequency f_m (i.e., $\Delta f/f_m \ll 1$)? Sketch the amplitude spectrum of the signal. [Note: $\sin x \cong x$ and $\cos x \cong 1$ for x (in radian) $\ll 1$]
5. A voice signal with a frequency spectrum varying from 300 Hz to 3.4 kHz is to be converted into a digital signal. What is the minimum rate at which the voice signal should be sampled? If the sampled signal is quantified into 32 regular levels, how many binary bits will be needed?
6. Draw the constellation diagram for 4-QAM that consists of one amplitude and four phases (also known as QPSK – Quadrature Phase Shift Keying). Sketch the wave forms of the four states of the modulation scheme and label their binary representations. What is the number of bits per symbol?