**Chapter 2 – Sound and Hearing (Modern Recording Techniques)**

The examination of sound is divided into four areas…

1. Basics of sound
2. Characteristics of the ear
3. How the ear is stimulated by sound
4. Psychoacoustics of hearing

**The Basics of Sound**

* SOUND-PRESSURE WAVES:
  + Sound arrives at ear in the form of periodic variations in atmospheric pressure
* An analogy of how sound waves travel in air can be demonstrated by bursting a balloon in a silent room
* As vibrating mass moves outwards from normal resting state
  + It squeezes air molecules in to a compress area away from sound source
* COMPRESSION:
  + This causes area to have greater than normal atmospheric pressure
* As vibrating mass moves inwards from normal resting state
* RAREFRACTION:
  + Area with lower than normal atmospheric pressure is created
* Molecules font move through air at velocity of sound
  + Only sound wave moves through the atmosphere in form of high pressure compression waves that pushes across lower pressure
* WAVE PROPAGATION:
  + Outward pressure motion

**Waveform Characteristics**

* WAVEFORM:
  + Graphical representation of a sound-pressure level or a voltage level as it moves through a medium over time
  + Has the following fundamental characteristics;
    - Amplitude
    - Frequency
    - Velocity
    - Wavelength
    - Phase
    - Harmonic content
    - Envelope
      * These allow one waveform to be distinguished from another
      * The most fundamental are AMPLITUDE & FREQUENCY
* It is very important to grasp the basic principles of acoustics

Amplitude

* Distance above and below centerline of a waveform reps amp level
* The greater the distance from centerline the more intense the…
  + Pressure variation
  + Electrical signal level
  + Physical displacement
* Waveform amp can be measure in a few ways…
  + PEAK AMPLITUDE VALUE or PEAK VALUE
    - Measure of either the max positive or negative signal level of a wave
  + PEAK-TO-PEAK VALUE
    - Total measurement of positive and negative peak signal levels
  + ROOT-MEAN-SQUARE (RMS) VALUE
    - Determine a meaningful average level of a waveform over time

Frequency

* Rate at which an acoustic generator, electrical signal or vibrating mass repeats within a cycle of positive and negative amplitudes
* CYCLE:
  + One complete excursion of a wave
* Number of cycles that occur within a second is measured in hertz (Hz)

Wavelength

* Physical distant in a medium between the beginning and the end of a cycle
* PERIOD of waves:
  + The time it takes to complete 1 cycle

Phase

* OUT-OF-PHASE
  + Two waveforms that have equal AMP & FREQ but start cyclic periods at different times
* IN-PHASE
  + Measures in degrees
  + Two waveforms line up perfectly

Harmonic Content

* PARTIALS
  + Factors that help differentiate between instrument voicing is the presence of frequencies
* UPPER PARTIALS or OVERTONES
  + Partials higher than the fundamental frequency
* HARMONICS
  + Overtone frequencies that are whole number multiples of the fundamental frequency
    - Frequency that corresponds to Concert A is 440Hz
      * First Harmonic – 440 Hz
        + 1 time the fundamental frequency
      * Second Harmonic – 880 Hz
        + 2 times the fundamental frequency
      * Third Harmonic – 1320 Hz
        + 3 times the fundamental frequency

Envelope

* Characteristic variations in levels that occur in time over duration of a played note
* Composed by four sections
  + ATTACK
    - The time it takes a sound to up to its full volume
  + DECAY
    - How quickly the sound levels off to a sustain level after the initial attack peaks
  + SUSTAIN
    - Duration of the ongoing sound that’s generated following the initial attack decay
  + RELEASE
    - How quickly the sound will decay once the note is released