Exam II

Chapter 4: Complex Vibrations and Waveform Analysis (67)

- Complex vibration (68)
  - The composition of a complex vibration (69)
- Waveform analysis and spectrum (73)
- Complex vibrating systems (76)
  - Strings (76)
  - ~~Membranes and plates (79)~~
- ~~Mechanic impedance (80)~~
- ~~Mechanic admittance (85)~~
- ~~Impedance matching (86)~~

Chapter 5: The Nature of Sound (89)

- ~~Mechanic waves (90)~~
- ~~Atmospheric pressure (92)~~
- ~~Speed of sound~~ (just need eq. p.95) (93)
- ~~Wavelength (96)~~
- ~~Types of sound sources (97)~~
- Sound pressure and particle velocity (98)
- Acoustic impedance (99)
- Sound intensity (100)
- The relationship between sound intensity and sound pressure (101)
- ~~Taxonomy of sounds (102)~~

Chapter 6: Sound Propagation (107)

- Acoustic effects (108)
  - Sound absorption (108)
  - Sound reflection (110)
  - Sound refraction (110)
  - ~~Sound and wind (112)~~
  - Reverberation time and echo (112)
  - Sound diffraction (116)

Chapter 6: Sound Propagation (continued)

  - ~~Sound interference (117)~~
  - ~~Standing waves (117)~~
  - ~~Beats (118)~~
  - Doppler effect (119)
  - Shock waves and sonic boom (121)
- ~~Sound field (122)~~
- ~~Signal-to-noise ratio (123)~~
- ~~Acoustic systems (124)~~
  - ~~Helmholtz resonator (124)~~
  - ~~Air columns (125)~~

Chapter 7: The Decibel (129)

- Absolute and relative measurement (130)
- Logarithmic units (130)
- The decibel (131)
- Sound intensity level and sound pressure level (133)
- Reference point and zero level (133)
- Operations on sound intensity and sound pressure levels (136)
  - Combining sound levels: Equal sound levels (139)
  - Extracting the sound level of a single sound source (141)
  - Combining sound levels: groups with equal sound levels (142)
  - Combining sound levels: Unequal sound levels (143)
- Converting sound levels into sound pressure and sound intensity (145)
- (Human hearing and loudness p.224)
- ~~Applications of the decibel scale (145)~~

Equations that will appear on the exam:

Doppler Effect

$$f_{\text{listener}} = f_{\text{source}}\left(\frac{c_{\text{air}} \pm v_{\text{listener}}}{c_{\text{air}} \mp v_{\text{source}}}\right)$$

top sign: approaching
bottom sign: receding

$$c_{\text{air}} = 331.4 + 0.589T_{\text{C}} \text{ m/s}$$

T_{C} = air temperature °C

$$c_{\text{air}} = f\lambda$$

Attenuation

$$L = L_0 - ax$$

L = sound level after absorption
L_0 = original sound level
a = absorption coefficient, dB/km
x = distance in km

$$\alpha = \frac{I_{\text{absorbed}}}{I_0}, \quad \beta = \frac{I_{\text{reflected}}}{I_0}, \quad \alpha + \beta = 1$$

$$RT = k\frac{V}{A}$$

RT = reverberation time, s
k = constant = 0.161 for T = 22°C
V = volume of room, m^3
A = total absorption

Intensity

$$I = \frac{\text{power}}{\text{area}} = \frac{P}{A} = \frac{p_0^2}{2Z}$$

P = power = energy/time, watts
p_0 = pressure amplitude, Pa
Z = impedance

$$I_{\text{point source}} = \frac{P}{4\pi r^2}$$

$$L = 10\log\left(\frac{I}{I_r}\right) \quad \Rightarrow I = I_r 10^{L/10}$$

L = sound level in dB IL, $I_r = 1.0\times10^{-12}$ W/m^2

$$L = 20\log\left(\frac{p}{p_r}\right) \quad \Rightarrow p = p_r 10^{L/20}$$

L = sound level in dB SPL,

$p_r = 20\times10^{-6}$ Pa = 20 μPa

Human hearing: +10 dB twice as loud

Diffraction

$$\theta_{\text{central maximum}} \propto \frac{\lambda}{D} = \frac{\text{wavelength}}{\text{width of opening}}$$