Sample Equation Sheet

This is a closed book, closed notes exam. Calculators are permitted, but no saved equations may be used. Please let me know if a necessary equation does not appear below. Point assignments are noted throughout the exam. Partial credit is awarded *when work is shown*.

Useful Geometric Relations

For circles: $C = 2\pi R$, $A = \pi R^2$
For Spheres: $A = 4\pi R^2$, $V = \frac{4}{3}\pi R^3$

Physical Relations

Fundamental

$$v \equiv \frac{d}{t} \qquad v_{wave} \equiv \lambda \cdot f \qquad f \equiv \frac{1}{P} \qquad pressure \equiv \frac{Force}{Area}$$

Under Certain Conditions

$$v_{sound} = 344\,{}^m\!/_s + 0.6\,{}^m\!/_{(s \cdot {}^\circ C)} \cdot \left(T_C - 20°C\right) \qquad v_{sound} = 344\,{}^m\!/_s + \frac{1}{3}\,{}^m\!/_{(s \cdot {}^\circ F)} \cdot \left(T_F - 68°F\right)$$

$$P = 2\pi\sqrt{\frac{m}{k}} \qquad f_n = nf_1, \ \ n = 1, 2, 3,\ldots \qquad \frac{Force_1}{Force_2} = \frac{x_2}{x_1}$$

Vocabulary & Ideas
- **Ch 6 The Human Ear**
  - JND (just noticeable difference)
  - Outer Ear
    - Its function
    - Pinna
    - Ear canal
    - Eardrum
  - Middle Ear
    - It's function
    - Ossicles
      - Malleus
      - Incus
      - Stapes
    - Oval window
    - Eustachian tube
  - Inner Ear
    - It's functions
    - Semicircular canals
    - Cochlea
      - Scala vestibuili
      - Scala timpani
      - Helicotrema
      - Cochlear Duct
        - Reissner's membrane
        - Basilar Membrane
        - Organ of Corti
        - Hair cells
- **Ch 8 Sound spectra and Electronic synthesis**
  - Voltage and Current
  - Sine, square, pulse, triangular, and saw tooth waves
  - Random noise
  - Periodic wave
  - Harmonic series
  - Fourier synthesis
  - Fourier analysis
  - Fourier component
  - Fourier spectrum = vibration recipe
  - Amplitude and phase

- **Ch 9 Percussion Instruments**
  - Natural Modes
- **Ch 16 Sound Reproduction**
  - Electron
  - Charge
  - current
  - voltage
  - magnet
  - transducer
  - reciprocity
  - microphone
  - loudspeaker
  - dynamic range
  - frequency response
  - electroacoustice / electromechanical transducer types
    - electrostatic (a.k.a. condenser, capacitor)
    - piezoelectric (a.k.a. crystal, ceramic)
    - dynamic (a.k.a. electromagnetic, moving-coil)
  - Amplifiers
    - Principle of operation
    - Imperfections
      - Clipping
      - Amplitude dependence (harmonic distortion)
      - Frequency dependence
- **Ch 17   The Ear Revisited**
  - Telephone theory
    - The basic idea
  - Place theory
    - The basic idea
    - How it works mechanically
    - What evidence we have
  - Periodicity theory
    - The basic idea
    - How it works
    - What evidence we have (excluding the 'pitch judgment' argument since Pattern Recognition provides an alternative)
  - Pattern Recognition
    - The basic idea
    - What evidence we have
  - Critical Bands & Masking

Assignments you've done
Ch 8 Sound Spectra and Electronic Synthesis
- Given a list of frequencies, what is the frequency of a complex wave composed of them? What is the period?
- Graphically combine pure tones to produce complex tone
- Given a period for a complex wave, what is the family of pure tones that can be combined to produce it?
- Correlate the qualitative appearance of a Fourier Spectrum with the corresponding complex wave with the sound of that wave.

Lab 7
- Translate between a Fourier Spectrum and a simple (not necessarily pure) waveform.
- Correlate the qualitative character of the Spectrum – waveform – sound.

Ch 9 Percussion Instruments and Natural Modes
- Identify N possible modes for system of N masses

Ch 16 Sound Reproduction
- Relate transducer diaphragm size, sound wave length, and frequency.
- Relate the wavelength of patterns on a magnetic tape to the tape speed and the frequency with which the pattern is read.
- Consider diffraction for speakers

Lab 8 Electronic Amplification
- The imperfections of real amplifiers – clipping, amplitude dependence and frequency dependence – the effects on the spectrum and on what you hear

Ch 6 The Human Ear
- Does the diffraction of high or low frequency waves about the pinna help you to localize sound?
- Relate pressure on eardrum to eardrum displacement; relate eardrum displacement to oval-window displacement.

Ch 17 The Ear Revisited
- Pros and cons of different theories
- Place theory – the location of excitation for specific frequencies
- Pitches for combinations of harmonically-related frequencies
- Masking
- Difference Tones

Qualitative Questions to be ready for
- **Ear**
    o How does it work
        ▪ What are the general roles of the three regions
        ▪ What are the roles of the individual pieces
        ▪ How does masking work
    o Given names and diagrams, be able to put the two together.
- **Transducers**
    o How do they generally work
        ▪ How does a specific one work
    o Microphones
        ▪ What are the two criteria for a good microphone & why is there a trade-off
- **Amplifiers**
    o What would be ideal performance, in what ways does a real amplifier fall short of the ideal and what does that sound like
- **Synthesis**
    o What are the three types of synthesis & what are their basic elements
    o The three pieces of a synthesized sound: attack, sustain, decay. How must they differ?
- **Fourier Analysis**
    o How do steady and transitory sounds' spectra differ?
    o How do spectra of qualitatively different sounds differ?