ACOUSTICS NOISE AND VIBRATION CONTROL

John O'Keefe

Reference Text:

Noise and Vibration Control
Leo L. Beranek
McGraw Hill
ISBN: 0-9622072-0-9

Noise and Vibration
Frank Fahy, John Walker
E & FN Spon
ISBN: 0-419-27700-8

Auditorium Acoustics and Architectural Design
Michael Barron
E & FN Spon
ISBN-10: 9780419245100
ISBN-13: 978-0419245100

Lecture Hours: Tuesdays 6:00 pm to 8:00 pm

Course Objectives:
The purpose of the course is to introduce the theory and practical application of acoustics noise and vibration control. While the emphasis of the study will be on the built environment, both indoor and outdoor, the methods taught can also apply to other industries, e.g. the automotive industry. Both the physics and perception of sound will be discussed covering such wide ranging topics as concert hall design, speech intelligibility, HVAC noise control design and building isolation from rail noise, to name a few. The course combines theoretical introductions to the subjects of acoustics, noise and vibration and follows them up with case studies from industry.

Course Evaluation:		
	Assignment	50%
	Exam	50%

Detailed Course Content:

1. Derivation of the acoustic wave equation and the speed of sound, Doppler Effect, wave interference effects, coherent addition of sound, beating, addition of incoherent sounds (addition in decibels).
2. Propagation of sound, spherical and cylindrical divergence. Sound power, sound pressure and sound intensity derivations.
3. Sound and noise measurement parameters: the decibel, A-weighted decibels, HVAC noise quantifiers such an Noise Criterion (NC), noise Transmission Loss (TL) of building components, octave, 1/3 octave and narrowband (FFT) description of sounds.
4. Human perception of sound including speech intelligibility, loudness, perception of room acoustics for music, hearing and hearing loss, etc.
5. Architectural noise control, including floating floor and noise barrier ceiling design, single and multi-layer walls calculations, area ratio Transmission Loss calculation, e.g. a window inside a wall.
6. Mechanical noise control, starting with propagation in wave guides, modes in ducts, attenuation of sound in ducts (ASHRAE), design and calculation of the performance of plena and the theory and design of mufflers.

7. Environmental noise control, including noise barrier design, temperature and wind gradient phenomena, road and rail noise control.
8. Room acoustics including the energy balance derivation the Reverberation Time formula.
9. Acoustic absorption methods including porous, panel and tuned (Helmholtz) absorbers.
10. Vibration isolation theory and design.
11. Computer acoustic modelling techniques, method of images, ray tracing and computer based signal processing to enhance physical scale model measurements.
12. Case studies of concert hall design, (Queen Elizabeth Theatre, Vancouver) HVAC noise control design (Four Seasons Centre for Performing Arts, Toronto) and building isolation (Telus Centre, Royal Conservatory of Music, Toronto), Schreyer Award Lecture (2007, Scale Model Signal Conditioning, HVAC displacement system noise control).

Prepared by: John O'Keefe, B.A.Sc., M.Sc., P.Eng., FIOA