Understanding sound and acoustics is basic, and a central and critical skill for audio recording and engineering. To master and utilize today’s wide array of sophisticated and eclectic recording options and integrate the pieces into a harmonious whole, the recording engineer needs both historical perspective and up to date personal knowledge. The material in this course covers basic acoustics, psychoacoustics, and an overview of audio engineering with an emphasis on practical applications. Topics include the fundamental elements of digital and analog audio; the behavior of audio equipment, such as microphones, amplifiers, and loudspeakers. Upon successful completion of the course, participants should have a foundation for further studies in audio recording technology. Fulfills prerequisite requirements of Certificated Program in Recording Engineering. Elective course in Certificated Program in Film, Television, and Digital Entertainment Media.

Drew Daniels, electroacoustics consultant and professional musician has served twice as chairman of the Audio Engineering Society (AES), Los Angeles section; applications engineer for Tascam, JBL, and Fender; and principal electroacoustics engineer, Disney Imagineering. Mr. Daniels holds numerous patents in the audio field, including the SFX stereo loudspeaker technology licensed to Fender Musical Instruments. His home studio produced and released dozens of CDs in the past few years, including a CD which received Syntrellium Software’s best recording award from over 400 submissions. Roger Kellaway Trio on IPO Records, Dave Frishberg Live At The Jazz Bakery on Arbors Records, and Rob Mullins Live At Steamers, release 2005-6.

Instructor: Drew Daniels  
Course No.  X441.3  
Reg. No.  R8459  
April 3, 2006 — through — June 26, 2006  
7:00 pm—10:00 pm  
325 Botany  
Mondays

4 Units

Course Objectives:

- To familiarize students with the language and basic concepts of Acoustics and Audio.
- To develop basic skills with acoustical elements and materials.
- To develop basic understanding of the elements of audio and their relationship to audio end product.

The course will explore:

- Sound, acoustics, sound capture, sound reproduction, and audio equipment for these purposes.
- Acoustic recording through modern disc-based workstation recording—an history.
- The fundamental behavior of sound and light.
- Human hearing and the science of psychoacoustics.
- Using acoustics and avoiding its pitfalls.
- Using microphones.

Required Items:

- TEXT: The USBORNE ILLUSTRATED DICTIONARY OF PHYSICS. Students are encouraged to bring to class, a basic scientific calculator with at least a pi (π) key and a log key. (Texas Instruments model TI-25X Solar or equivalent—about $8 at stationary stores.)
- Students are also encouraged to record lectures for review, and to make careful notes in class.

Handouts:

All class handouts plus additional information are available online at: http://www.DrewDaniels.com/UCLA.htm
Please note the URL IS TEXT CASE SENSITIVE.

Exams:

Verbal quizzes may be used to help the instructor gauge and adjust the pace of classroom instruction. At week seven, a non-credit midterm exam will be given to help students adjust their pace of study. The last session will include the Final Exam, which will review presented course material.

Grading:

Grading will be based on attendance, class participation, understanding of material and the final exam. Careful note-taking and/or recording of class sessions is highly recommended. Students are encouraged to form study groups or note-exchange groups so that missed class sessions can be studied independently as needed.

Class participation is a highly desirable activity that will help students bring the presented material into focus and give it meaning and make it the basis of a set of useable professional tools. Students are expected to let the instructor know if class lecture or topics are confusing or abstract, and to ask for clarification and to offer ideas into the discussion of class topics. There are no stupid questions in audio, just as there is no “right” or “wrong” way to make art.

Non-USA Resident Students:

While jargon and idiomatic language is minimal in this class, much of the material is based on words and language that may be new to some students. The instructor will make every effort to avoid jargon. Please ask for explanations to help clarify lectures whenever necessary.
COURSE TITLE:  
*Fundamentals of Acoustics and Audio*

PRÉCIS:  
Successful use of today’s audio equipment often means “creative” use. Simply being able to plug and play is not enough. Audio equipment in modern facilities has grown enormously complex and versatile, offering the user so many choices and options that it is possible to produce much nonsense and waste much time in the course of looking for meaningful results. It is well known that too many choices makes any choice more difficult. Thus it becomes important to know how and why to repeat good results even when they are first achieved by accident.

Some background in the physics describing movement, sound and light is helpful in making creative choices with most of the equipment one is likely to find and use in modern production and post-production settings, as well as sound itself. A knowledge of basic electronics is indispensable for those who need to operate, interface or assemble audio and video equipment.

“Fundamentals of Acoustics and Audio” is intended for people who will operate audio electronic equipment in their job. There is no prerequisite and no technical background is required.

Students will discover electrical signals, magnetism, motion, waves, acoustics, power, hearing and psychoacoustics. The course will include review of signal flow with it’s diagrammatic language, and basic equipment techniques with assembly and operation of the basic recording signal chain.

SYLLABUS:

**SESSION 1**  
April 3, 2006

Class Orientation, Course Description and Overview  
Session includes printed handouts. A list of recommended books and materials will be discussed. The important link between musical instruments and their underlying physical principles will be discussed as time permits.

**SESSION 2**  
April 10, 2006

Basic Acoustics begins.  
VIDEO: Harmonic Motion  
Video program will be screened and discussed. Lecture may include printed handouts and/or demonstrations of common examples of the topics shown. Musical instruments and their sound production will receive the remaining time.

**SESSION 3**  
April 17, 2006

VIDEOS: Waves Optics  
We examine waves. Sound propagation follows wave principles. So does radio and television transmission and light. We will discuss wave propagation, reflection, dispersion, refraction and absorption. These concepts are all central to understanding sound and acoustics, and other principles that can boost creativity in audio production or post-production. Also covered are wave dimensions vs. frequency and the interactions with rooms that result from their size.
SESSION 4
VIDEO: Resonance
April 24, 2006
Resonance is the engine of musical instruments. Resonance drives the design of musical instruments, and drives microphone and loudspeaker designers to avoid resonance. To make the best use of most audio tools, it is critical to understand resonance. A review and discussion of basic acoustics will also be presented.

SESSION 5
Acoustics
May 1, 2006
Previous screenings will be available as we discuss acoustics in greater depth. Acoustics is widely regarded as black art in the Audio and Video technical communities, because it involves abstractions not generally examined in engineering schools and because it plagues people who use loudspeakers to judge audio quality for a living. My axiomatic “every good loudspeaker comes with a room to ruin it” will be discussed in depth. As we will see, acoustics is in fact, understandable and even manageable. We will discuss human hearing and its impact on various other aspects of perception based on the use of loudspeakers in rooms.

SESSION 6
Hearing and the Ear-brain
May 8, 2006
To understand how we hear and process what we hear, is to understand how to manipulate the recording’s ultimate listener. Insights into hearing can be a powerful tool for the audio producer or engineer.

SESSION 7
Midterm Exam
May 15, 2006
The midterm exam will give students a status check on their grasp of material presented so that they may adjust their study schedule as needed. Remaining time will be used for a free-form question and answer period. Although the midterm exam session will not count for course credit, it will offer students an opportunity to exchange observations with the instructor.

SESSION 8
Psychoacoustics
May 22, 2006
The influence of our perception on recorded end product is discussed. The human ear is not a microphone and the extent of it’s influence on musical judgement might surprise you. Also in this session; we learn about typical pitfalls and dirty tricks psychoacoustics can play on a listener, and how to employ psychoacoustics to meet your goal of conveying artistic intent to the listener.

SESSION 9
The Recording Chain
June 5, 2006
Electrical audio is about a century old. In that time, the advances have come as fast and furious as the developments in most technologies—up to a point. We will examine the changes and growth and the sticking points nature imposes on us all. We examine the parts of the system from microphones to loudspeakers, and why our grandchildren will still be seeing similar devices a century from now.

SESSION 10
The Recording Studio with a Carrying Handle?
June 12, 2006
Much of the gear in the traditional recording studio has been or is being replaced by personal computers and miniaturization. How far can it go? How economical can it get. Will performance improve or suffer? We discuss how to assemble the gear for a no-compromise studio on a budget.
SESSION 11  
June 19, 2006

REVIEW and FINAL EXAM PREPARATION  
This session will feature the class quizzing the instructor. This class session will be review and discussion of the entire quarter's topics.

SESSION 12  
June 26, 2006

Final exam.  
The final exam will consist of questions culled from the entire course. The exam will be printed in advance and done at the class session. The test will contain fill-in, simple computation, multiple-choice and essay questions. Spelling, grammar and punctuation will not be taken into account in grading. The tests will be collected after 2½ hours and graded. Special circumstances requiring a student to make up the test or take it elsewhere must be arranged with the instructor no later than week 11. Grading of the final exam will be done on the basis of a simple percentage of the questions answered over a predetermined minimum number of correct answers.

Percentage for grades: A= >90%, B=80%—89%, C=70%—79%, D=60%—69%, Fail= <59%.

Overall course grading will be based 20% on attendance, 30% on class participation and individual student comprehension, and 50% on the final exam score.

To receive later notification of grades you must turn in or mail a stamped grade card to the instructor no later than five days after the final exam, sent to:

Drew Daniels  
Fundamentals of Acoustics & Audio, Class X448.59  
UCLA Extension - Room 437  
P.O. Box 24901  
Los Angeles, CA  90099-6137
Optional reading recommendations:

**FOR AUDIO NOVICES:**

**BOOKS:**


“Building Speaker Enclosures,” David B. Weems, Radio Shack publication, stock# 62-2309

“Designing, Building & Testing Your Own Speaker System,” David B. Weems, Tab Books #1364
(this is the same as the Weems book above)

“Dictionary of Film & Television Terms,” Oakey, Barnes & Noble, New York  1983

“The CAMEO Dictionary of Creative Audio Terms,” Creative Audio & Music Electronics Organization, 10 Delmar Avenue, Framingham, MA 01701


“Hi-Fi Loudspeakers and Enclosures,” Abraham B. Cohen, Hayden Book Co., 0721

“Introduction to Professional Recording Techniques,” Bartlett, Bruce, Howard W. Sams & Co., Indianapolis 1987

“How to Build Speaker Enclosures,” Alex Badmaieff and Don Davis, Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268


“Questions & Answers About Tape Recording,” Burstein, Herman, Tab Books, Blue Ridge Summit  1974

“Recording Demo Tapes at Home,” Bartlett, Bruce, Howard W. Sams, Inc., Indianapolis


“Telling the Story,” Josephson, Larry (ed), Kendall Hunt, Dubuque  1983

“Yamaha Sound Reinforcement Handbook,” Gary Davis and Ralph Jones, Hal Leonard Publishing, 7777 W. Bluemound Road, P.O. Box 13819, Milwaukee, WI 53213

**PAPERS:**


“Using the enclosure design flow chart,” Drew Daniels, JBL Professional, 8500 Balboa Blvd., Northridge, CA 91329
FOR EXPERIENCED AUDIO PRACTITIONERS AND HOBBYISTS:

BOOKS:


“Acoustic Noise Measurement,” Jens Trampe Broch, Bruel & Kjaer Instruments, Inc., 185 Forest Street, Marlborough, MA 01752 (617) 481-7000


“Audio Equipment,” Green, Michael, DMR Publications 1978

“Audio Production Techniques for Video,” Huber, David M., Howard W. Sams & Co., Indianapolis


“Building A Recording Studio,” Cooper, Jeff, Synergy Group Inc., Los Angeles 1984

“Basic Disc Mastering”, Boden, Larry, Full Sail Recording Workshop, Orlando 1981


“Handbook of Noise Measurement,” Arnold P. Peterson and Ervin E. Gross, Jr., General Radio, 300 Baker Avenue, Concord, MA 01742


“Microphones,” Clifford, Martin, Tab Books, Blue Ridge Summit 1982


“Music Physics and Engineering,” Harry F. Olson, Dover Publications, 180 Varick Street, New York, NY 10014


“Practical Techniques for the Recording Engineer," Keene, Sherman, Sherman Keen 1981
“Sound Recording & Reproduction,” Akin, Glyn, Focal Press 1981
“Sound Recording Practice” (3rd ed.)(Anthology), Borwick, John (ed), Oxford University Press, New York 1987
“Sound Recording for Motion Pictures,” Fratari, Charles, A. S. Barns, 1979
“Sound Tape Recording, TV Tape Recording & Film,” International Telecommunications Union, Geneva 1985
“Stereo TV: Production of Multidimensional Audio,” Olearczuk, Roman, Howard W. Sams & Co., Indianapolis
“Sound System Engineering,” Don and Carolyn Davis, Howard W. Sams & Co., Inc., 4300 West 62nd Street, Indianapolis, IN 46268
“Successful Sound System Operation,” F. Alton Everest, Tab Books #2606, Tab Books, Blue Ridge Summit, PA 17214

PAPERS:
“Notes on 70-volt and distributed system presentation,” Drew Daniels, for the National Sound Contractors Association Convention, September 10, 1985, JBL Professional, 8500 Balboa Blvd., Northridge, CA 91329


FOR ENGINEERS:

BOOKS:
“Acoustical Designing in Architecture,” Vern Knudsen & Cyril Harris, American Institute of Physics for ASA
“Compact Disc Troubleshooting & Repair,” Heller and Bentz, Howard W. Sams, Inc., Indianapolis


“Digital Audio Engineering” (Anthology), Strawn, John (ed), William Kaufmann, Los Altos  1986


“Measuring Microphones,” Bruel & Kjaer, Nærum, Denmark  1982


“Science of Sound,” Rossing, Thomas, Addison Wesley, Reading, MA  1982


PAPERS:


"Disk Recording Volume 1” (Anthology), Audio Engineering Society, New York   1980

"Disk Recording Volume 2” (Anthology), Audio Engineering Society, New York   1981


"Quadraphony" (Anthology), Audio Engineering Society, New York   1975

"Sound Reinforcement" (Anthology), Audio Engineering Society, New York   1978

"Stereophonic Techniques" (Anthology), Audio Engineering Society, New York   1986
MANUFACTURER’S TECHNICAL NOTES:

The following are available from JBL Professional:

Volume 1, Number 1  “Performance Parameters of JBL Low-Frequency Systems”
Volume 1, Number 2  “70-Volt Distribution Systems Using JBL Industrial Series Loudspeakers”
Volume 1, Number 3  “Choosing JBL Low-Frequency Transducers”
Volume 1, Number 4  “Constant Directivity Horns”
Volume 1, Number 5  “Field Network Modifications for Flat Power Response Applications”
Volume 1, Number 6  “JBL High-frequency Directional Data in Isobar Form”
Volume 1, Number 7  “In-Line Stacked Arrays of Flat-front Bi-Radial™ Horns”
Volume 1, Number 8  “Characteristics of High-Frequency Compression Drivers”
Volume 1, Number 9  “Distortion and Power Compression in Low-frequency Transducers”
Volume 1, Number 10  “Use Of The 4612OK, 4671OK, And 4660 Systems In Fixed Installation Sound Reinforcement”
Volume 1, Number 11  “Controlled Power Response: Its Importance in Sound Reinforcement System Design”
Volume 1, Number 12  “Polarity Conventions of JBL Transducers and Systems”
Volume 1, Number 13  “JBL Concert Series Complete Sound Systems”
Volume 1, Number 14  “Basic Principles for Suspending Loudspeaker Systems”
Volume 1, Number 15  “Choosing the Right Studio Monitor for Specific Applications, A Discussion of JBL and UREI Monitor Loudspeakers”
Volume 1, Number 16  “Power Ratings of JBL Loudspeakers and JBL/UREI Amplifiers”
Volume 1, Number 17  “Measurement and Interpretation of Loudspeaker Polar Data: A Comparison of JBL Constant Coverage Bi-Radial™ Horns and EV HP Large Format Horns”
Volume 1, Number 18  “Vented Gap Cooling™ in Low Frequency Transducers”
Volume 1, Number 19  “Sub-Bass Systems Using Triple Chamber Bandpass™ (TCB) Technology”
Volume 2 Number 1A  “1/3 Octave Equalization and The JBL/UREI 5547A and 5549A”
Volume 2, Number 2  “JBL/UREI Power Amplifier Design Philosophy”
Volume 2, Number 3  “Applications for the JBL/UREI 7922 Digital Audio Delay”

Marketing White Paper:  “The Relationship Between the Sound Contractor and Religious Organizations”

“Cinema System Design Manual”

“Speaker Power Requirements, Answers To Some Often Asked Questions”

“JBL Sound System Design Reference Manual” ($15) or free by modem at 1-209-787-2955

AUDIO ON THE INTERNET:

http://asa.aip.org/  Acoustical Society of America
http://www.apogeedigital.com/  Apogee Electronics
http://www.aes.org/  Audio Engineering Society, Inc.
http://www.aes.org/sections/la/home.htm  Audio Engineering Society Los Angeles Section
http://www.bk.dk/1200.htm  Brüel & Kjær Sound & Vibration
http://soli.inav.net/~jebraun/mikes.htm  Classic Microphones
http://www.event1.com/  Event Electronics
http://www.eviaudio.com/  EVI Audio (Electrovoice and Altec)
http://www.livesoundint.com/  Live Sound magazine
http://www.thx.com/thxmain.html  Lucasfilm THX
http://www.mixmag.com/  MIX magazine online
http://www.nsca.org/  National Systems Contractors Association
http://www.rane.com/  Rane Corporation
http://www.sennheiserusa.com/  Sennheiser
http://www.sonic.com/  Sonic Solutions
http://www.syntrillium.com/index.htm  Syntrillium Software (inexpensive DAWs)
CIRCLE or WRITE IN your best answer, estimate or guess:

2. What does the “VU” designation on audio meters stand for? ________________________________
3. Studio Monitor loudspeakers should first: [A] be accurate or [B] sound good
4. Microphones are transducers [A] true [B] false
5. Loudspeakers are transducers [A] true [B] false
7. Should recording engineers do “proper engineering” regardless of the particular music? ______________
8. How many record producers does it take to change a light bulb? ________________________________
9. What is a panorama potentiometer? _______________________________________________________
10. Five-point-one (5.1) stereo refers to what common system _________________________________
11. What is a “subwoofer” for? _______________________________________________________________
13. How far away is the moon? [A] 250 miles [B] 250,000 miles [C] 2.5 million miles (if you don’t know, guess.)
14. If I.Q. was proportional to weight, fat people would be: [A] dumber [B] smarter [C] lighter
15. Name one example each of a sound absorbent material and a sound reflective material __________________
__________________________________________________________

16. Which will hold more water?
The four smaller containers are each 6 cm diameter and 6 cm high. Large container is 12 cm diameter and 6 cm high.

Answer: [A] one container [B] same volume [C] four containers