



THE FEDERAL UNIVERSITY OF TECHNOLOGY, AKURE

Department of Architecture

ARC 507 – Building Services III

COURSE PARTICULARS

Course Code: ARC 507

Course Title: Building Services III

No. of Units: 2

Course Duration: One hour of lecture and three hours of practical/studio per week for 15 weeks.

Status: Compulsory

Course Email Address: ???????

Course Webpage: ???????

Prerequisite: NIL

COURSE INSTRUCTORS

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COURSE DESCRIPTION

This course introduces the student to architectural acoustics. Topics covered include basic acoustics, the hearing mechanism, measurement of sound, causes of hearing damage, noise control indoors, noise control outdoors, industrial noise control, engineering noise control, room and auditorium acoustics, recommended acoustic standards, analysis of sound and acoustics guidelines for architectural and urban designs.

Basic concepts in architectural acoustics include absorption, diffraction, echo, insulation, masking, reverberation and transmission of sound. The process of hearing involving the ear and frequency discrimination and the thresholds of audibility and pain are discussed. Also covered is

the measurement of sound including measuring instruments, sound scales and sound chambers. The noise induced causes of hearing damage include acoustic trauma, temporary threshold shift, permanent threshold shift and tinnitus. Non-noise-induced causes of hearing damage include ototoxic agents, noise-induced hearing loss, presbycusis and sociocusis.

Internal noise is controlled by reduction at source, use of absorbent screens and surfaces, insulation and building design. External noise is controlled by screening, planning, building design and insulation. Industrial noise control in new and existing workplaces as well as engineering noise control is discussed. Auditorium acoustics is influenced by reverberation, loudness of the original sound, as well as the size and shape of the room. Acoustic standards vary for different types of buildings and spaces. The course also covers the analysis of sound indoors and outdoors for architectural and urban projects and proposes acoustic guidelines for architectural and urban designs.

COURSE OBJECTIVES

The objectives of this course are to:

- introduce students to basic concepts in architectural acoustics and methods of noise control ; and
- provide students with opportunities to develop basic skills with respect to measurement and analysis of sound indoors and outdoors for architectural and urban projects.

COURSE LEARNING OUTCOMES / COMPETENCIES

Upon successful completion of this course, the student will be able to:

(Knowledge based)

- explain the relationship between acoustics, sound and noise;
- understand the hearing process and causes of hearing damage;
- understand the sources of noise indoors and outdoors, and different means of controlling noise;
- discuss the acoustics regulations in the Nigerian National Building code and recommend acoustic standards based on function, daytime and night-time acoustic standards;

(Skills)

- use sound meter to measure sound level;
- record sound data;
- analyse sound and noise indoors and outdoors;
- recommend effective means of controlling noise indoors and outdoors;
- appraise the acoustic performance of a room and auditorium.

GRADING SYSTEM FOR THE COURSE

This course will be graded as follows:

Class Attendance	10%
Assignments	30%
<u>Final Examination</u>	<u>60%</u>
<u>TOTAL</u>	<u>100%</u>

GENERAL INSTRUCTIONS

Attendance: It is expected that every student will be in class for lectures. Attendance records will be kept and used to determine each person's qualification to sit for the final examination. Failure to meet the minimum University requirement of 65% attendance will disqualify the student from writing the final examination.

Academic Integrity: Violations of academic integrity, including dishonesty in assignments, examinations, or other academic performances are prohibited. You are not allowed to make copies of another person's work and submit it as your own; that is plagiarism. All cases of academic dishonesty will be reported to the University Management for appropriate sanctions in accordance with the guidelines for handling students' misconduct as spelt out in the Students' Handbook.

Assignments and Group Work: Students are expected to submit assignments as scheduled. Failure to submit an assignment as at when due will earn the student a minus mark for every additional day. Instructors attach importance to originality of assignment. Only assignment submitted using the prescribed format will be accepted and marked.

Code of Conduct in Lecture Rooms and Laboratories: Students should turn off their cell phones or put it in silent mode during lectures. Students are prohibited from engaging in other activities (such as texting, watching videos, *etc.*) during lectures. Food and drinks are not permitted in the studio during lecture.

READING LIST

^{1,4} Allen, E. & Swoboda, D. (2005). *How Buildings Work: The Natural Order of Architecture*. Oxford University Press, USA.

^{1,4} Cavanaugh, W. J., Tocci, G. C. & Wilkes, J. A. (2009). *Architectural Acoustics: Principles and Practice*, 2nd Edition. John Wiley and Sons.

^{3,4} Davidson, G. (2012). *How to Identify a Good Performance Hall*. Retrieved from http://home.onemain.com/~home_range/perf_ctr/.

^{3,4} University of Maryland (2012). *Room and Auditorium Acoustics*. Retrieved from <http://www.physics.umd.edu/lecdem/misc/phys102/PH102chap08.ppt>.

^{3,4} Egan, M. D. (2007). *Architectural Acoustics*. J. Ross Publishing.

- ^{3,4}Long, M. (2006). Architectural Acoustics. Available from <http://eu133-get.uploadbox.com/get/ZkXu09VmSj/Architectural%20Acoustics.rar>. Elsevier Academic Press.
- ^{3,4}Massachusetts Institute of Technology OpenCourseWare (2011). Introduction to Building Technology: Noise Insulation. Available from <http://ocw.mit.edu/courses/architecture/4-401-introduction-to-building-technology-spring2006/lecture-notes/lec16.pdf>.
- ^{3,4}Massachusetts Institute of Technology OpenCourseWare (2011). Introduction to Building Technology: Room Acoustics. Available from <http://ocw.mit.edu/courses/architecture/4-401-introduction-to-building-technology-spring-2006/lecture-notes/lec17.pdf>.
- ^{1,2,3,4}Ogunsote, O. O. (1993). An Introduction to Building Climatology - A Basic Course for Architecture Students. Ahmadu Bello University Press, Zaria.
- ⁴Szokolay, S. V. (2008). Introduction to Architectural Science: The Basis of Sustainable Design. 2nd Edition. Elsevier/Architectural Press, London.
- ⁴Maekawa, Z., Rindel, J. H. and Lord, P. (2011). Environmental and Architectural Acoustics. Spon Press.

Legend

- 1- Available in the University Library
- 2- Available in Departmental/School Libraries
- 3- Available on the Internet.
- 4- Available as Personal Collection
- 5- Available in local bookshops.

COURSE OUTLINE

Week	Topic	Remarks
1	Introduction and Course Overview	During this first class, the expectation of the students from the course will also be documented.
2	Basic Concepts in Architectural Acoustics <ul style="list-style-type: none"> • Property of Sound • Nature of Sound • Sound Waves Terminologies • Propagation of Sound • Sound Fields • The Inverse Square Law of Sound • Masking, Diffraction, Transmission and Absorption of Sound • Sound Power, Sound Intensity, Pitch. 	
3	The Hearing Mechanism <ul style="list-style-type: none"> • Introduction • The Process of Hearing • The Ear: The External, Middle and Inner Ear, Frequency Discrimination • Psychoacoustic Analysis • Loudness Contours • Threshold of Audibility • Threshold of Pain 	
4	Measurement of Sound <ul style="list-style-type: none"> • The Sound Level Scale • The Phon Scale • Instruments Used to Measure Sound • Recording Sound Data • The Sound Chamber • The Anechoic and Varechoic Chambers 	
5	Noise Control Indoors <ul style="list-style-type: none"> • Sources of Internal Noise • Control of Internal Noise • Case Studies 	
6	Noise Control Outdoors <ul style="list-style-type: none"> • Sources of External Noise • Control of External Noise • Case Studies 	

7	<p>Industrial Noise Control</p> <ul style="list-style-type: none"> • Introduction • New Workplaces • Existing Workplaces • Case Studies 	
8	<p>Engineering Noise Control</p> <ul style="list-style-type: none"> • Engineering Vibration Control at Source • Active Noise Control • Modification of Noise Transmission Path • Additional Noise Control Measures • Case Studies 	
9	<p>Modification of Noise Transmission Path</p> <ul style="list-style-type: none"> • Increasing the distance, • Enclosing noisy machines, • Separating noisy and quiet areas by partitions, • Use of sound absorbing materials on surfaces, • use of control rooms, • Additional noise control measures. • Case studies. 	
10	<p>Room and auditorium acoustics</p> <ul style="list-style-type: none"> • Basic room acoustics, • Room acoustics, • Behaviour of sound in an enclosed space, • noise control, • Acoustics and speech privacy, intelligibility of sound, • Reducing building noise: sound absorption. • Electro-acoustics: loudspeaker design, microphones. 3D sound. • Amphitheatre acoustics. • Acoustic design of performance halls. 	
11	<p>Recommended Acoustic Statndard</p> <ul style="list-style-type: none"> • Acoustics Properties of Building Materials • Acoustic Standards based on Function • Daytime and night-time based Acoustic 	

	<p>Standard</p> <ul style="list-style-type: none"> • Indoors and Outdoors Acoustic Standard 	
12	<p>Acoustic Regulations in the Nigerian National Building Code</p> <ul style="list-style-type: none"> • Introduction • Sound transmission control • Airborne noise • Structure borne noise • Acceptable noise levels. 	
13	<p>Analysis of Sound</p> <ul style="list-style-type: none"> • Sound and noise analysis indoors and outdoors. • Sound and noise analysis of proposed architectural designs. • Simulated concert hall acoustics. • Sound and noise analysis of proposed urban designs. • Environmental acoustics. • Computer software for acoustics analyses. • Case studies. 	
14	<p>Acoustics Guidelines for Architectural and Urban Designs</p> <ul style="list-style-type: none"> • Guidelines for Architectural Designs • Guidelines for Urban Designs • Designs Checklist 	
15	REVISION	<p>This is the week preceding the final examination. At this time, evaluation will be done to assess how far the students' expectations for the course have been met.</p>