



Acoustic Engineering – EEE 453

Department of Electrical & Electronics Engineering

Faculty of Engineering

1. Basic Details

Programme: B.ENG

Year: 2014/2015

Total Units: 2

Level: 400L

Taught Semester: First Semester

Instructor:

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Office Hours: Monday, Tuesday and Wednesday 2-4pm, or by appointment

Reading Materials:

<http://eee.fuoye.edu.ng/400l/f-semester/159-engineering-surveying-photogrammetry-3-units.html>

Department: Electrical and Electronics Engineering

Prerequisites: Nil

Lecture Time: Tuesday, 10am – 12am

Total Learning Hours: 24

Course Delivery: Blended/Face to Face

Lecturers: Engr. G. D. Obikoya & Mr. A. K. Babarinde

2. Course Overview

Acoustic Engineering (EEE453) examines the development of basic theoretical concepts of acoustical systems, sound principle and properties, psycho-acoustics, vibration and vibration control, acoustic analogies, transduction, sound reproduction, indoor (architectural) and outdoor acoustic designs, sound absorbers, sound insulation and underwater acoustics.

3. Course Objectives

This course is taught to students for the following objectives:

- To introduce the fundamental concepts of acoustic analysis with emphasis on wave approach.
- To study sound generation, propagation (transmission), reflection, refraction, diffraction, radiation and absorption.
- To under determine sound level and decibel values.
- To understands the mechanism of hearing, characteristics of hearing, articulation index and speech-level interference.

- To understand the concept of vibration system, energy of vibration, types of oscillation and vibration control.
- To understand the vibration characteristics of strings, pipes, ducts, bars, membranes and plates.
- To evaluate electro-mechanical analogies for various transducers.
- To understand various types of microphones, loudspeakers and their advantages in good sound production.
- To understand different forms of sound reproduction and their prospects.
- To understand factors affecting sound quality in an enclosures, and how these factors help in designing good acoustical halls/auditoriums.
- To introduce the concept of outdoor acoustics
- To determine how construction of good partitions and absorbers can improve sound quality.
- To understand the concepts of underwater acoustics.

4. Intended Learning Outcomes (ILO)

Students completing this course will be able to:

- Understand the concepts of sounds.
- Understand the concepts of underwater acoustics.
- Understand vibration principles and vibration control.
- Identify and describe characteristics of the human auditory system.
- Evaluate acoustic system using electrical and mechanical analogies.
- Describe types of speakers, microphones and amplifiers.
- Use audio mixer and reproduce sound.
- Perform room/hall/auditorium acoustic design
- Perform basic noise control design and measurements
- Perform sound field design.

5. Course Content

Fundamentals of Acoustics and Sound Principles, systems sound principle and properties, psycho-acoustics, vibration and vibration control, acoustic analogies, transduction, sound reproduction, indoor (architectural) and outdoor acoustic designs, sound absorbers, sound insulation and underwater acoustics.

6. Course Schedule

| Week | Topics | Reading Assignment |
|------|--|--|
| 1. | <ul style="list-style-type: none"> ▪ Fundamentals of Acoustics and Sound Principles: Acoustic fundamental, measurement and importance, sound generation and propagation, quantification of sound, propagating plane wave, standing waves, Huygens's principles, Doppler's effects, reflection, refraction, diffraction, radiation and absorption of sound. | 2.1-2.2, 3.1-3.10 |
| 2. | <ul style="list-style-type: none"> ▪ Fundamentals of Acoustics and Sound Principles (Contd.): Sound levels and Decibel addition, subtraction and averaging, performances indices for environmental noise. | 3.11-3.19 |
| 3. | <ul style="list-style-type: none"> ▪ Psycho-Acoustics: Mechanism of hearing, characteristics of hearing (threshold, sensitivity, loudness, pitch, masking, frequency weighting), Articulation index, speech-interference level. | 10.1-10.6 |
| 4. | <ul style="list-style-type: none"> ▪ Vibration and Vibration Control: Vibration system modeling, energy of vibration, damped oscillation, forced oscillation, vibration control, damping and damping ratio, vibration measurement (Accelerometer). | 20.1-20.9 |
| 5. | <ul style="list-style-type: none"> ▪ Vibration and Vibration Control (Contd.): vibration (transverse and longitudinal) in strings, pipes, ducts, bars, membranes and plates. | Chapter 4- 9 (Summary) |
| 6. | <ul style="list-style-type: none"> ▪ Acoustics Analogies and Transduction: Electro-mechanical analogies, Electro-acoustic analogies, reciprocal and anti-reciprocal transducers, Transmitter or Loudspeakers (reciprocal source and anti-reciprocal source, types of loudspeakers, loudspeaker cabinets, woofers, subwoofers and tweeters). | 8.1-8.3 14.1-14.7(2 nd Txbk) |

| | | |
|-----|---|---|
| 7. | <ul style="list-style-type: none"> ▪ Acoustics Analogies and Transduction (Contd.): Receivers or Microphones (reciprocal receiver and anti-reciprocal receiver, microphone directivity and sensitivity, types of microphones, calibration of receivers). | 9.3-9.5 14.8-14.12 (2 nd Txt) |
| 8. | <ul style="list-style-type: none"> ▪ Sound Reproduction: Historical overview, magnetic recording, digital recording, voice recognition, playback audio equipment, portable audio playback equipment (e.g. MP3, iPod), future of sound reproduction. | 19.1-19.3, 19.5-19.6 |
| 9. | <ul style="list-style-type: none"> ▪ Indoor (Architectural) and Outdoor Acoustics: Sound in enclosures, growth and decay of sound field in a room, reverberation time (Sabine's formula) and reverberation effect, factors affecting reverberation, absorption and reflection of sound, absorption coefficient, direct and reverberant sound field (critical distance, room constant and room coefficients, Acoustic energy density and directivity). | 11.1-11.13 |
| 10. | <ul style="list-style-type: none"> ▪ Indoor (Architectural) and Outdoor Acoustics (Contd.): Acoustic factors in architectural design, room/hall/auditoriums acoustical design, outdoor acoustical gain, influence of directional microphones and loudspeakers on system maximum gain, band shells and outdoors auditoriums. | 11.14-11.17 |
| 11. | <ul style="list-style-type: none"> ▪ Sound Absorbers and Sound Insulations: Different types of sound absorbers, sound transmission loss and transmission coefficients, mass control case, field incidence mass law, effect of frequencies on sound transmission through panels, coincidence effect and critical frequency, single leaf construction, double leaf construction (or double-panel partition), flanking transmission, noise insulation (ratings and insulation requirements), noise reduction of a wall, sound pressure level from a distance from the wall, enclosures, acoustic barriers. | 12.1-12.17 |
| 12. | <ul style="list-style-type: none"> ▪ Underwater Acoustics: Basic concepts, sound propagation in water, speed and velocity profiles in water, transmission loss, absorption, refraction, mixed layer, deep sound channel and reliable acoustic path, surface interference, Sonar transducer and their properties, Sonar equation, Noise, Echo, Reverberation level and Bandwidth consideration, transmission loss model for normal mode propagation. | 15.1-15.13, 15.5-15.16 |
| 13. | <ul style="list-style-type: none"> ▪ Tests and Revision | |

7. Course Learning & Teaching Methods

- Lecture 1: 2hrs (Tuesday, 10:00am-12pm).
- Formative phase tests and Group tutorials/discussions.

8. Learning & Teaching Activities

| Activity Type | Percentage | Hours |
|-----------------------------|-------------|-----------|
| Lectures & Class Exercises | 27% | 24 |
| Group Tutorials/Discussions | 9% | 8 |
| Guided independent study | 64% | 58 |
| Total | 100% | 90 |

9. Course Assessment Method

| | |
|-----------------------------|---------------------|
| Requirement: | 2 Hours Examination |
| Status: | Compulsory Course |
| Written Examination: | 60% |
| Quiz/Test: | 25% |
| Homework: | 10% |
| Attendance: | 5% |

| Level of Performance | Grade | Rating (credit points per unit) |
|----------------------|------------------|---------------------------------|
| 70-100% | A = Excellent | 5.0 |
| 60-69% | B = Very Good | 4.0 |
| 50-59% | C = Good | 3.0 |
| 45-49% | D = Satisfactory | 2.0 |
| 40-44% | E = Poor | 1.0 |
| 0-39% | F = Failure | 0.0 |

10. Industry Relevance

- Broadcasting;
- Sound system production;
- Ultrasonic in medical and commercial applications;
- Marine applications;
- Space applications;
- Musical instruments;
- Hall/Auditorium acoustic design;
- Environmental noise reduction.

11. Required Text

- Daniel R. Raichel, “*The Science and Applications of Acoustics*,” 2nd Edition, © 2006 Springer + Business Media, Inc., USA.
- Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens, James V. Sanders, “*Fundamentals of Acoustics*,” 4th Edition, © 2000 John Wiley & Sons, Inc.

(1) Recommended Texts

- Prof. Colin H. Hansen, “*Fundamental of Acoustics*”, University of Adelaide.
- Finn Jacoben, T. Poulsen, J. H. Rindel, “*Fundamental of Acoustic & Noise Control*” Technical University of Denmark, 2011
- Sound System Manual: Reference Manual.
- Wikibooks, “Engineering Acoustics”, available at http://en.wikibooks.org/wiki/Engineering_Acoustics

(2) Attendance Policy

Attendance is strictly mandatory. The University policy stipulates that in order to be eligible for a course examination, a student shall be expected to attend a minimum of 65% of the lecture, tutorials, practical and classes for the course in which he/she is registered [**Ref. Students’ Handbook of Information, pg. 52**]. Any student, therefore, whose attendance rating falls below the required 65% shall not be eligible to write the course exam. In this regard, students will be notified of their eligibility status for a course examination prior to the exam.

(3) Calculator Policy

Programmable calculators will not be allowed in the quizzes or final exam. The University policy prohibits the use of mobile phone, electronic programmable calculator, information storage devices, etc. in the quizzes or final exam [**Ref. Students’ Handbook of Information, Pg. 49**]. A “programmable calculator” is one that can store program steps or text at any level of sophistication and the rule applies irrespective of whether or not there appears to be anything stored. If you are in any doubt as to the eligibility of your calculator, please see me well before the quiz/exam.

(4) Exemption from Quizzes/Exam

Dated medical documentation is required for exemption from a quiz; in this case the weighting will be moved to the final. Makeup quizzes will not be offered under any circumstances. The University policy prohibits a student from absenting from exam except on acceptable medical grounds, and in consultation with the HOD and the Dean of the faculty. Any student absent on the ground of illness must produce a certified medical report, and students who absent from quizzes/exams for reasons other than illness, accident or some exceptional circumstances shall be deemed to have failed the course [**Ref. Students' Handbook of Information, Pg. 52**].

(5) Ethical and Unethical Conduct

The preliminary purpose of Homework is to help students learn and gain practical experience in the subject matter. Allowing and encouraging collaborations with fellow students best serves this purpose. Modern engineering is, after all, almost exclusively a team effort. However, fairness requires us to be able to assess your *own* contribution. Therefore, the written material that you hand in *must* be your *ownwork*, and any discussions or collaborations with fellow students must be identified in writing on your solution (e.g. noting “the solution to problem #5 was worked out together with Mark Davison”, or “the solution to problem #2 was benefited from discussions with Ruth Peters”). Nearly identical solutions from different students who do not cross-reference each other will be viewed as statistically “unlikely”, thus worthy of further examination.

This policy is intended to help you make the most out of the course by allowing you to freely work with your classmates. If you are in any doubt as to what constitutes ethical or unethical conduct, please see any member of staff for assistance. Violations of this policy will be handled with maximum severity.