ECE 40020 – Sound Reinforcement System Design

Course Syllabus
Course Description: An introduction to computational tools used in the measurement and analysis of electro-acoustic systems, and their application to sound reinforcement system engineering. Two design projects provide the context for application of sound reinforcement system design principles and practices.

Course web site: https://engineering.purdue.edu/ece40020

Instructor: Prof. David G. Meyer, meyer@purdue.edu, Office: MSEE 238, Phone: 494-3476, Hours: Tuesdays and Thursdays, 10:30 am – noon.


Required: Standard 5-button iClicker


Prerequisite: ECE 255 or consent of instructor

Pre- or Co-requisite: ECE 301 or consent of instructor

Prerequisites by topic: Basic electronic components and circuit design principles

Co-requisites by topic: Basic understanding of signals and systems

Loudspeaker Spectral Divider/Amplifier Design Project: Working in teams of three or four, students will design an active spectral divider (“crossover”) for a (pre-built) 3-way labyrinth loudspeaker system. This design should preferably be DSP-based, and will include power amplification modules for all three drivers. Each team will present their results to the class and submit a final written report documenting their completed design.

Sound Reinforcement Design Project: Working in teams of three or four, students will design a complete sound reinforcement system for a specified application, including: simulation of loudspeaker coverage; determination of fill and delay zones (if required); estimation of gain before feedback and system intelligibility; power amplifier choice based on headroom, SPL, and zone-related requirements; specification of the signal processing chain (including EQ, delay, and feedback suppression); design/layout of the equipment rack(s); choice of mixing console based on I/O specifications; selection of microphones (both wired and wireless); and total system cost estimate. Each team will present their results to the class and submit a final written report documenting their completed design.

Engineering Design Content: Elements of the engineering design process addressed in this course include testing, measurement, analysis, and synthesis.

Engineering Design Considerations: The primary engineering design considerations addressed in this course include economic, safety, reliability, social, and ethical.

Class Attendance: Attendance at all class meetings is required. You must be present to earn credit for class participation exercises using iClickers – no exceptions will be made.
**Course Grade:**
Your grade for this course will be based on the following:

- **Loudspeaker Spectral Divider/Amplifier Design Project**
  - Report (team – 15%)
  - Finished system performance/integration/workmanship (team – 10%)
  - Poster and *Spark Challenge Design Showcase* participation (team/individual – 5%)

- **Sound Reinforcement System Design Project**
  - Report (team – 15%)
  - Formal presentation (team – 15%)

- **Exams**
  - Exam 1 over Chapters 1-3 (individual – 15%)
  - Exam 2 over Chapters 4-9 (individual – 15%)

- **Homework Assignments** (individual – 5%)
- **Class participation** (individual – 5%)
- **Bonus for creating custom printed circuit board (PCB) for loudspeaker project** (team – 5%)

**Course Outcomes:**
A student who successfully fulfills the course requirements will have demonstrated:

- i. an ability to apply knowledge obtained in earlier coursework and to obtain new knowledge necessary to design a sound reinforcement system
- ii. an understanding of the engineering design process
- iii. an ability to function on a multidisciplinary team
- iv. an awareness of professional and ethical responsibility
- v. an ability to communicate effectively, in both oral and written form

*You will receive 1% bonus credit for each course outcome that is successfully demonstrated.*
The threshold for successfully demonstrating each course outcome is 60% (if multiple evaluation instruments are used for a given outcome, this threshold can be achieved on based on the average of each set). The following instruments will be used to assess course outcome demonstration:

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Evaluation Instrument(s) Used</th>
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<tbody>
<tr>
<td>(i)</td>
<td>Hourly exams (over course text and supplemental notes)</td>
</tr>
<tr>
<td>(ii)</td>
<td>Engineering design process score on project reports</td>
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<tr>
<td>(iii)</td>
<td>Design constraint satisfaction score on project reports</td>
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<td>(iv)</td>
<td>System design constraint analysis score on project reports</td>
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<td>(v)</td>
<td>Writing style/professionalism score on project reports, presentation, and poster</td>
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**Course Outline:**

<table>
<thead>
<tr>
<th>Week(s)</th>
<th>Lecture Topics</th>
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<tbody>
<tr>
<td>1-4</td>
<td>Sound systems: transmission, summation, reception</td>
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<tr>
<td>5</td>
<td>Exam 1 over Chapters 1-3</td>
</tr>
<tr>
<td>5-9</td>
<td>Design: evaluation, prediction, variation, combination, cancellation, specification</td>
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<tr>
<td>10</td>
<td>Exam 2 over Chapters 4-9</td>
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<tr>
<td>11-13</td>
<td>Optimization: examination, verification, calibration, application</td>
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<tr>
<td>14-15</td>
<td>Equipment selection for EASE project: loudspeakers, power amplifiers, signal processing, mixing consoles, microphones, racks, cabling <em>Spark Challenge Design Showcase</em></td>
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<tr>
<td>16</td>
<td>Project Presentations and Loudspeaker Soundoff™ Competition</td>
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Borderline Cases: A “borderline” is officially defined as being within 0.5% of a cutoff when the final grade calculation is performed. Before course grades are assigned, the instructor will carefully examine all such cases and determine if the next higher grade is warranted. A special bonus, IDPPB (Instructor Discretion Posi-Points Bonus), will be used to facilitate borderline adjustments; note, however, that the “next higher grade” is NOT automatically guaranteed.

Incompletes and Conditional Failures: A grade of “I” or “E” will be given only for cases in which there are documented medical or family emergencies that prevent a student from completing required course work by the end of the semester. Note that University Regulations stipulate that a student must be passing in order to qualify for a grade of “I” or “E”.

Campus Emergencies: In the event of a major campus emergency, course requirements, deadlines, and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor’s control. Should such an emergency occur, information will be posted on the course web site Message Board.

Professionalism and Academic Honesty: The temptation to cheat is particularly prevalent in large enrollment courses such as this one. In the long run, short-cuts in school work breed short-cuts in careers, i.e., the less you invest in your education, the less you will have to show for it later in life. A large part of the educational process is simply developing the discipline and mindset required to contribute in a given technical area once you graduate. If for nothing other than your own benefit, do not copy the work of any other student (past or present). Further, be advised that any documented case of “cheating” will result in a FAILING GRADE for the course as well as possible disciplinary action. All cases of academic dishonesty will be reported to the ECE Associate Head as well as to the Dean of Students. A professional person does not take credit for the work of someone else.

Examples of Cheating: Contrary to the beliefs of the post-modern “situational ethics” crowd, there are indeed absolutes that apply to integrity and honesty. Examples of activities that will be construed to be “cheating” include (but are not limited to) the following:

- copying the work of another student (past or present) and representing that work as your own
- obtaining information about an exam prior to taking it
- having someone else take an exam for you
- bringing “cheat sheets” in any shape/form with you to an exam
- using a cell phone or other electronic device to share information during an exam
- using a pen camera, cell phone, or any other device to photograph exam materials
- modifying a graded homework paper and submitting it for reevaluation
- sharing homework solutions with other students
- using another student’s (past or present) homework files
- using an iClicker that belongs to someone else to “fake” their class attendance
- copying and/or redistributing any of the copyrighted materials posted on the course web site
- publically posting solutions to homework problems

Mediocrity: One of the biggest problems facing our educational system today is mediocrity – too many students want to learn merely (often barely) enough to “get by”. In fact, higher education is probably the only “commodity” from which consumers want to get the least amount for their money! Clearly, if our country is to be competitive in an expanding world market, a renewed commitment to excellence is absolutely essential. To quote C. R. Swindoll, “The greatest waste of natural resources is the number of people who never achieve their potential.”

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