ELE 214

Electronics Laboratory - I

Multistage Amplifier Design

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PROJECT GUIDE

PROJECT RULES

- Choose parameter/parameters for the project with your laboratory assistants.
- Your project consists of three parts: Research-Calculation, Simulation and Fabrication-Video.
- **For all parts, prepare a report and upload the report and video (only for part 3) to "HUZEM". All reports will be submitted <u>individually</u>. Reports will be in <u>soft copy</u>.**
- All reports should be written according to the rules given at the end of this guide.
- **You can write your proposal in LATEX. For any information, ask your lab. assistants.**
- **Use LTspice for simulations for simulation part.**
- **Write your design parameters in your report in a table!**

- **Submission Date: 22 May 2021**

PARTS OF DESIGN

PART 1: RESEARCH-CALCULATION

- Answer the following questions with your own words

1. Define

   a) Amplifier
   b) Buffer stage of an amplifier
   c) Equalizer stage of an amplifier
   d) Gain stage of an amplifier
   e) Single stage amplifier
   f) Multistage amplifier
   g) The role of capacitor in amplifier design
   h) Differences between MOSFET, JFET and BJT

2. Give brief information about the transistor you choose in your design.

   - The reason for the choice
   - Type number(s)
   - Transistor parameters

3. Design a single stage audio amplifier with parameters given by your laboratory assistants (frequency, gain). Discuss about the design (is it possible or not? If not, why?).

4. Design a multistage audio amplifier shown in Fig.1 to satisfy a set of specifications given by your laboratory assistants (frequency, gain). Show all the details (calculations, formulas, comments) of your design with the following properties:

   - A generalized multistage amplifier is shown in Fig.1.
   - You are expected to design only **red** boxes in Fig1.
   - The input signal is an **audio** signal.
   - Describe each circuit element you used in your design (what is the role of each element?).
   - Use 9V battery for the DC supply.
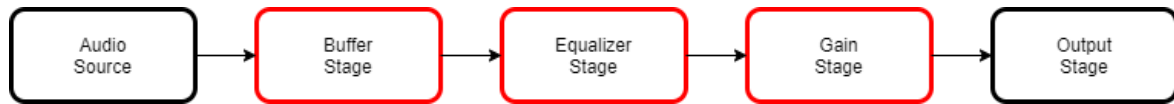   - Comment about the project.

Figure 1: Generalized multistage audio amplifier

Buffer Stage:
- Only JFET and MOSFET are allowed.
- Buffer stage's gain should be 1 (unity).

Equalizer Stage:
- You are expected to build a band pass filter which can be adjustable by potentiometer.
- Maximum adjustable frequency is f_{high}.
- Minimum adjustable frequency is f_{low}.
- The equalizer stage should have the following frequency range (use the last two numbers of your student ID):   *21 28 73 4*

    340 ⟵ f_{low} **= (10 x the last two numbers of your student ID) Hz**

    16600 ⟸ f_{high} **= 20000 – (100 x the last two numbers of your student ID) Hz**   *3 4 0 0*

Gain Stage:

- This stage should be designed with BJT.
- You are expected to set gain with respect to your student ID's last number.
- **If your last number is 0 then gain should be 10, if your last number is 1 then gain should be 11, otherwise, gain is equal to your last number.**
  i.e. 21917788 => Gain: 8, 21917780 => Gain: 10

Output Stage:
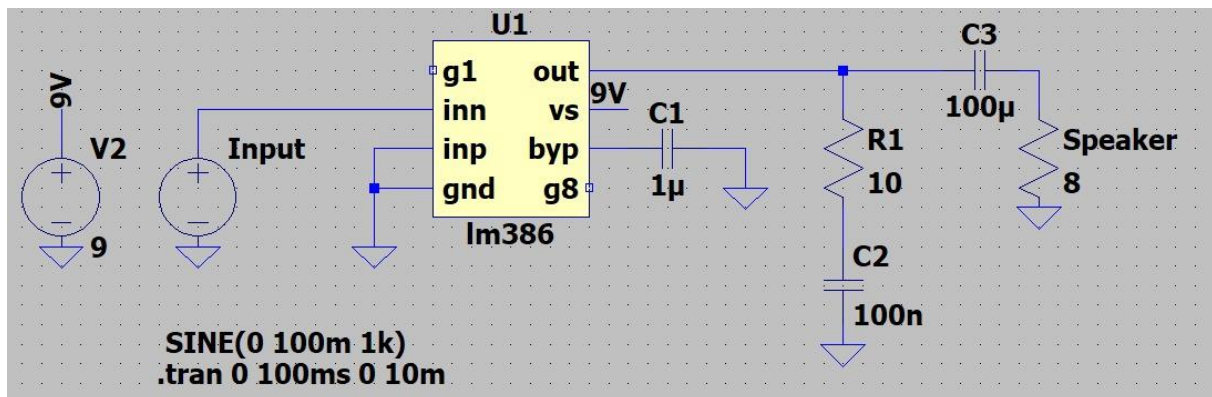
- Output stage should be added to observe the circuit characteristic by speaker.
- For this stage, **your own design or the circuit above** can be used in your project.
- **You will not be graded from your output stage circuit. However, you are responsible to design an amplifier stage in order to drive the speaker. Output stage will make your project more understandable to get best results in lab goals.**

PART 2: SIMULATION

- Show all simulation results for Question 4 using LTSpice (transistor voltage and currents, gain, etc.).
- Compare the input and output of each stage and comment about the results.
- After you found exact results, change some circuit elements within a %10 range. How are your results effected from these changes? (This is called parameter sweep)
- Comment on the results you found from the design and parameter sweep.

PART 3: FABRICATION-VIDEO

- Using your design for Q4, implement the audio amplifier with real circuit elements.
- Show and analyze the measurement results.
- Compare your simulation and real circuit outputs for each stage.
- Comment about the similarities or differences between your simulations and measurements and write them in your report in detail.
- Make a two-minute video to show your output.
- Send the video link in the report.
- Hint: Several apps in android or iOS are producing sinusoidal audio signal for different frequencies which can be used to test your design with this input.

REQUIRED FORMAL PROJECT REPORT CONTENT

- Use formal language.
- Use 12 point Arial or Times New Roman font.
- **All reports will be submitted individually, Reports will be in <u>soft copy</u> (upload your reports to "HUZEM"). Cheating will be punished!!!**
- Include page number except first page.
- Each Chart, Graph, Illustration, Picture, and Table in the report should
    Have number, title and label, including x and y axes.

  - Provide legends and/or annotate completely.
  - Number sequentially and consistently. For example, figures may have a simple numeric representation (Figure 1, Figure 2, etc.) or may include a section identifier (Figure 1.1, Figure 1.2, Figure 2.1, etc.).

TITLE PAGE

- Title of project name
- Course number and name

TABLE OF CONTENTS

- Include page numbers of all major sections of the report using the header titles.
- List Appendices, with page numbers and titles at the bottom of the Table of Contents.

LIST OF FIGURES

- Include titles and page numbers of all figures (charts, graphs, illustrations and pictures) used in report.

LIST OF TABLES

- Include titles and page numbers of all tables used in report.

ABSTRACT (OR SUMMARY)

- One page maximum.
- Single-spaced narrative.
- Succinct statement of what you propose to build.
- Significance of project (why it is useful)

INTRODUCTION

- Definition of problem given in the project.

STATEMENT OF OBJECTIVE

- Appropriately reference all information using the format required.
- Provide a clear and comprehensive description of the purpose and need of the project.
- Use a clearly articulated problem statement to describe the problem that is being solved or the theory being verified and why it is important.
- Include any requirements, constraints and assumptions. Be sure to define and quantify requirements. Explain how they will be measured and/or tested to determine success and/or validate theory.

ANALYTICAL CALCULATIONS AND RESULTS

- Existing solutions to problem
- The solution way that you chose
- Advantages and disadvantages of your solution

CONCLUSION

- Summarize the whole project.
- Discuss the results of your designs.

LIST OF REFERENCES

- Include all references (books, journals and proceedings) cited in the paper including web sites like this:

  Aim of the project is to design an audio amplifier at 1MHz frequency [1].

  REFERENCES (it should be at the end of the report)

  [1] R. L. Boylestad and L. Nashelsky, Electronic Devices and Circuit Theory, Pearson, 2012, (11th ed.).