XMUT204 Electronic Design

Design Project 2 – Audio Amplifier

Due Date: Performed in the lab, but not for submission

A. Introduction

You are expected to work individually in this electronic design project. The design exercise will be completed over two weeks of lab work after which the design report must be written and submitted.

A1. Introduction to Project

In part A, this design exercise will let you build a prototype of a Class A amplifier that can serve as the pre-amplifier stage to a power amplifier. You will need to perform the basic design and then construct and simulate your circuit in the simulation software. This allows you to play around with various components (resistors and capacitors) and observe the influence of these on amplification and frequency response of the amplifier. When this is completed, the circuit should again be tested extensively to characterise the behaviour. Finally, the project should be written up as a design report (Part B respectively).

A2. Objectives

At completion of this design exercise, student should be able to:

a. Design a Class A audio preamplifier.

b. To prototype this circuit and evaluate the operation of the circuit in simulation software.

c. To test and critically evaluate this circuit.

d. Write a technical report detailing the design, construction and testing of your circuit.

A3. Preliminary Reading

Have a look at your notes on BJT amplifier biasing and design (Sections 3). The section of your textbook on BJT transistor will also contain good information.

Feel free to use the many good (and not so good!) resources available on the web as well. However, do not just try to copy someone else's circuit i.e. follow your own design steps and make your own decisions.

A4. Design Requirements

Basic: You must design, construct and test a preamplifier circuit that can be used to amplify audio signals. It should be based on a BC547 transistor and be able to amplify signals over as wide a part off the audio range as possible. It should be based on a common emitter with feedback resistor configuration and should be able to provide a small signal voltage gain of at least 5 times (no emitter capacitor in place). It should operate from a 9 V supply (battery power supply) and should provide the maximum possible output swing.

Completion: Add an emitter capacitor to your design to increase the small-signal gain. How would this change the gain and the bandwidth of your amplifier? Construct this circuit and test the operation.

Extension: How big is the difference between the Q-point you designed for and the actual Q-point of your circuit? Think what may cause this difference and can you compensate for it? Discuss this as part of your design report and see if you can improve your design.

A5. Testing and Characterising the Circuit

Testing and characterisation of your circuit will be just as important as construction. Remember this is intended as an audio amplifier? So, we will have to evaluate the frequency response of the circuit. It is also worth thinking and calculating what are the expected voltages (DC) in the circuit and what points can be used as good test points if the circuit is not working. Testing should be done for each of the three design stages of the amplifier (e.g. basic, completion and extension) and should include the following:

a. Is it working i.e. does it provide the expected DC operating point?
b. If so, test the small signal gain at a single frequency i.e. is that operating as expected.
c. Now, measure the frequency response (gain and phase) over the audio spectrum. How does it perform?
d. What is the power consumption of your amplifier both under DC conditions and in active operation? Is this within the limits of the transistor?
e. What other tests you think may be relevant.

Ensure that you keep careful record of all your test results, as this need to be included in your report.

B. THE DESIGN REPORT

You must now hand in a short design report that describes your design, construction and testing. This report should be typed and be no more than 1000 words in length (excluding appendices). Put all diagrams and graphs as the appendices. It should also contain the necessary circuit diagrams and other figures needed for illustration and communication of your design and your test results.

B1. Introduction

A short introduction should describe the design specification that had to be met.

B2. Design Description

This section should include:

a. A description of your design procedure and how you selected the different components (resistors and capacitors) that you used.

b. Describe any trade-offs you have to make in the design process.

c. A presentation of your circuit diagram and any comments on these as appropriate.

B3. Simulation and Testing

a. Describe any significant results from your simulation.

b. Describe the construction and testing of your circuit in the simulation software. Ensure that you clearly present all the data from tests to show how your amplifier functioned. Remember it was meant to an audio amplifier – how well does it meet the design specifications?

B4. Discussion and Conclusions

Your discussion should include the following aspects:

a. Any particular problems that you encountered during the design/simulation/testing and how they were solved.

b. Critically evaluate your design and state any way in which it can be improved or how you would do it differently next time.

c. Discuss what were the aspects of the project that you most enjoyed and that you think provided the most benefit. Were there parts that you least enjoyed or found difficult?

B5. Additional Question

a. Explain the purpose of each of the capacitors you used in your circuit. How do you expect the frequency response of your amplifier to change when you change the value of each of these capacitors? Explain.

b. Discuss the difference observed between the designed Q-point and the actual Q-point of your circuit. What is this due to? Can you improve on your design process?

MARKING OF DESIGN PROJECT 2

No	Section	Total	Description
A	Design	20	Design processes, choices, and rationales.
B	Simulation	20	Simulation processes and simulation results
C	Testing	20	Testing processes, testing results, and troubleshooting.
D	Discussion	20	Discuss the project (e.g. problems and their solutions, evaluation of the design and what to improve, and enjoyable and difficult parts of the project).
E	Additional Questions	10	Answers to additional questions.
F	Project Report	10	Quality and quantity of your project report.
	Total	**100**	