ELE 491
Senior Design Project Proposal

These slides are loosely based on the book Design for Electrical and Computer Engineers by Ford and Coulston. I have used the sources referenced in the book freely and without re-attribution. Please see the book for full source attribution

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Senior Design Project Proposal

Class 8 – Functional Decomposition

Functional Decomposition

Overview

- Project Flow
  - Identify problems
  - Create requirements
  - Generate/evaluate conceptual solutions
  - Decomposition
  - Modeling and Design
  - Validation
  - Delivery

Functional Decomposition

Descriptive Design Process

- Design
  - Hierarchical system design
  - Up/Down sub-system design
  - Detailed block, module, circuit, and software design
  - Heavy reliance on models and simulation tools
  - Tight feedback with prototyping phase

Functional Decomposition

Definition

- Functional Decomposition
  - Recursive process that iteratively describes the functionality of all the systems components
  - Breaks the system into manageable pieces
  - Allows for multiple design teams to work independently
  - Crosses HW/SW boundaries
  - Utilizes a wide range of descriptive systems
  - Hierarchical
    - Top level – level 0
    - Bottom level – detail level – level N

Functional Decomposition

Definition

- Functional Decomposition
  - Three primary elements describe each block/module within the functional decomposition
    - Inputs
    - Outputs
    - Function (transformation, transfer function, operation performed)
  - Inputs/Outputs can be described by:
    - Voltages, currents, impedances, logic levels, …
    - Complex signals, data items, parameters, …
  - Function can be described by:
    - Words, block diagrams, flow charts, state diagrams, circuits, …

Functional Decomposition

Implementation

- Implementation
  - Quality module definitions can make or break a project
    - Reduce work due to clear specifications and targets
    - Reduce rework due to misunderstandings
      - Between modules
      - Between teams
    - Allow the system to be developed independent of any physical or logical constraints
      - Reduces time wasted waiting
      - Maximizes use of resources

Functional Decomposition

Implementation

- Implementation
  - Iterative
  - Up → Down and Down → Up
  - Takes time
  - Right sized – not too much detail
  - Look for innovation at every level
  - Maximize Cohesion to minimize Coupling

Functional Decomposition

Application

Audio Power Amplifier

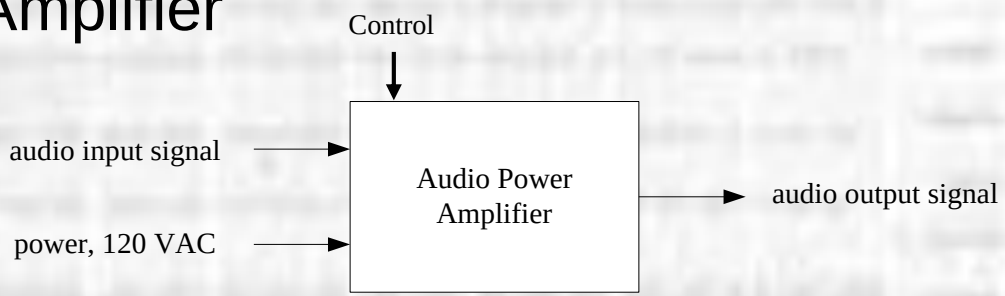
- System Requirements
  - Accept an audio input signal source with a maximum input voltage of 0.5V peak
  - Have adjustable volume control between zero volume and the maximum volume level
  - Deliver a maximum of 50W to an 8Ω speaker
  - Be powered by a standard 120V 60Hz AC outlet

Functional Decomposition

Application

Audio Power Amplifier

- Level 0



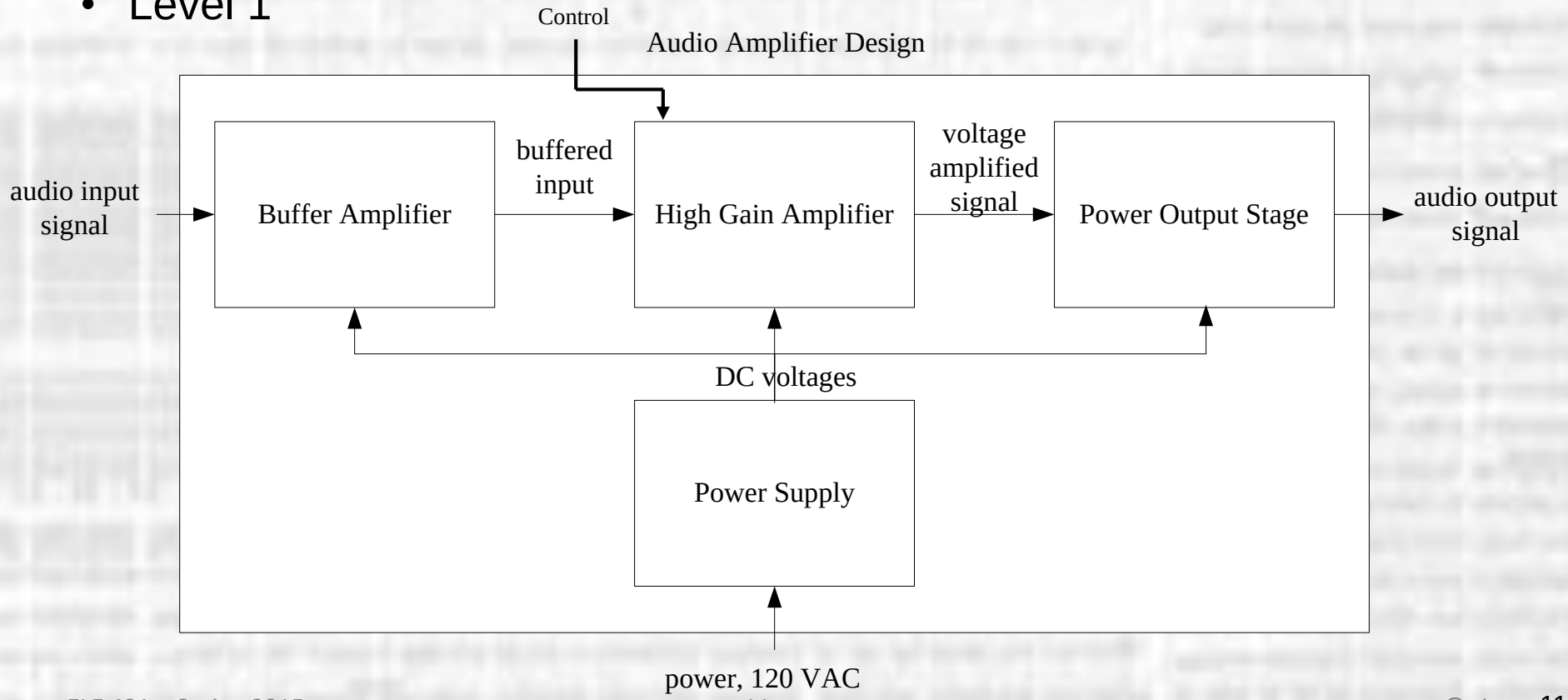
Module	Audio Power Amplifier
Inputs	Audio input signal: 0.5V peak. Power: 120 volts AC rms, 60Hz. User volume control: variable control.
Outputs	Audio output signal: ?V peak value.
Functionality	Amplify the input signal to produce a 50W maximum output signal. The amplification should have variable user control. The output volume should be variable between no volume and a maximum volume level.

Functional Decomposition

Application

Audio Power Amplifier

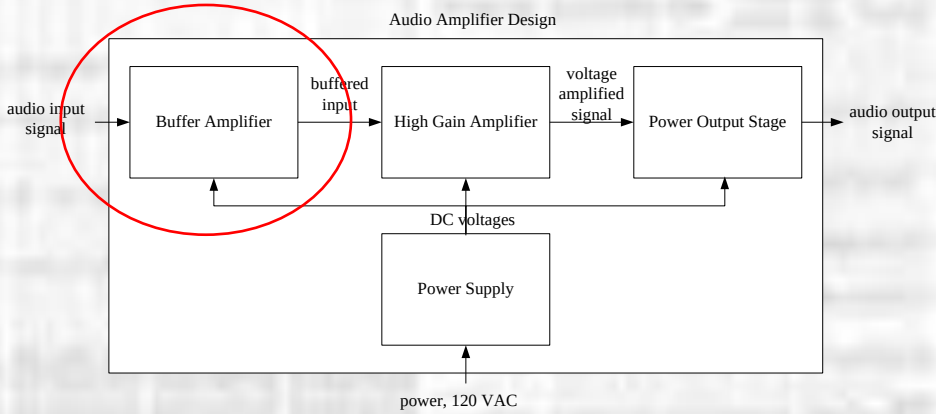
- Level 1



Functional Decomposition

Application

- Audio Amplifier
  - Level 1 – Buffer amp

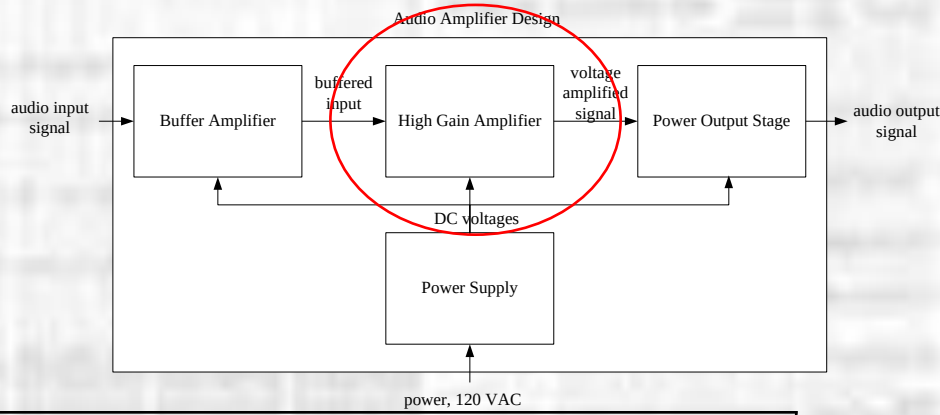


Module	Buffer Amplifier
Inputs	- Audio input signal: 0.5V peak. - Power: ± 25V DC.
Outputs	- Audio signal: 0.5V peak.
Functionality	Buffer the input signal and provide unity voltage gain. It should have an input resistance >1MΩ and an output resistance <100Ω.

Functional Decomposition

Application

- Audio Amplifier
  - Level 1 – High gain amp

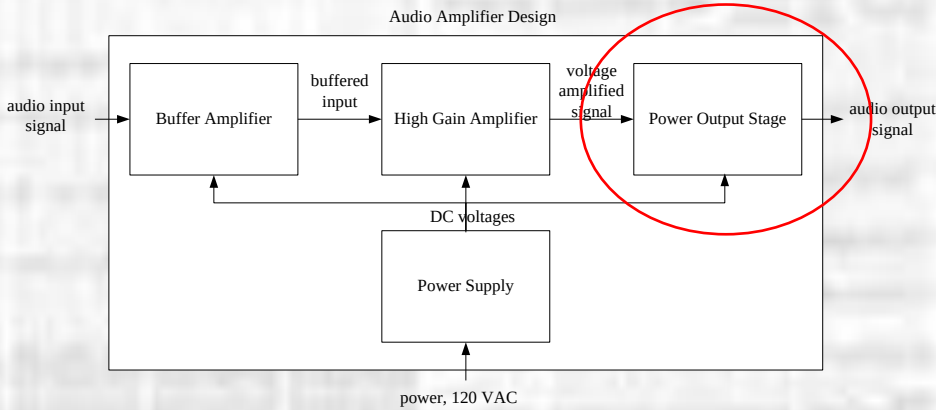


Module	High Gain Amplifier
Inputs	- Audio input signal: 0.5V peak. - User volume control: variable control. - Power: ± 25V DC
Outputs	- Audio signal: 20V peak.
Functionality	Provide an adjustable voltage gain, between 1 and 40. It should have an input resistance >100kΩ and an output resistance <100Ω.

Functional Decomposition

Application

- Audio Amplifier
  - Level 1 – Power Output Stage

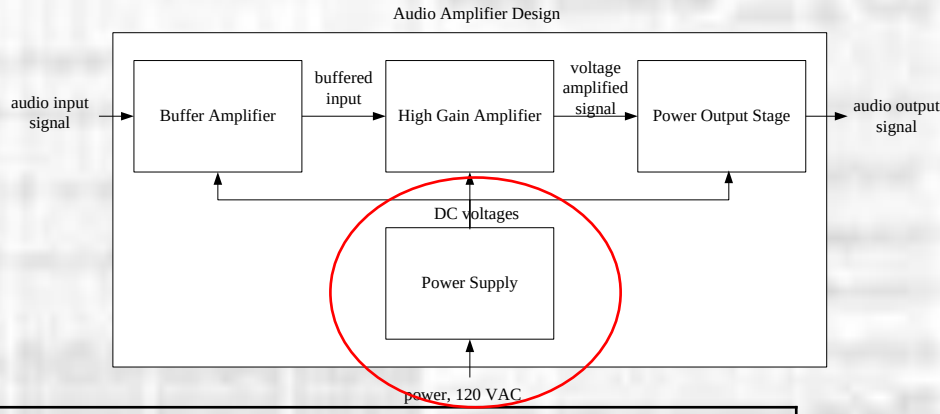


Module	Power Output Stage
Inputs	- Audio input signal: 20V peak. - Power: ± 25V DC
Outputs	- Audio signal: 20V peak at up to 2.5A
Functionality	Provide unity voltage gain with output current as required by a resistive load of up to 2.5A It should have an input resistance >1MΩ and an output resistance <1Ω.

Functional Decomposition

Application

- Audio Amplifier
  - Level 1 – Power Supply

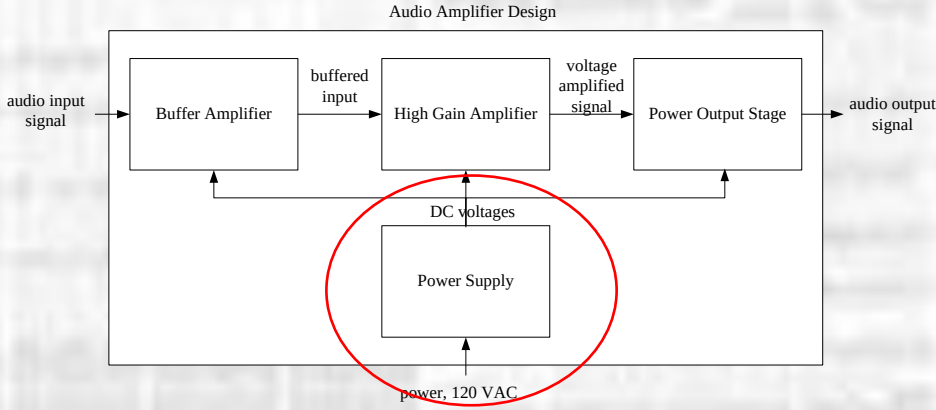


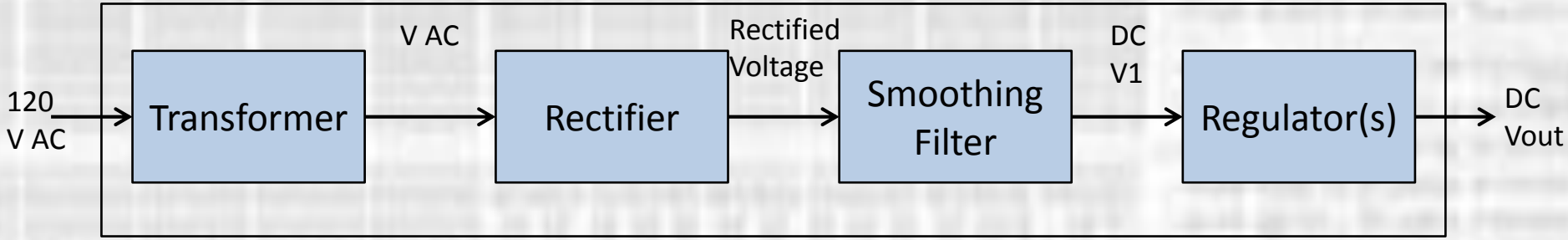
Module	Power Output Stage
Inputs	- 120V AC rms
Outputs	- Power +/- 25V DC with up to 3.0A of current with a regulation of <1%
Functionality	Convert AC wall outlet voltage to positive and negative DC output voltages, and provide enough current to drive all amplifiers

Functional Decomposition

Application

- Audio Amplifier
  - Level 2 – Power Supply





In Class Activity