EE1205: Signals and Systems

Questionnaire - Audio Amplifier

I. Marking scheme

1) Lab Report - 1
2) Circuit Demo - 1
3) Viva - 3

There is no bonus score for a stereo amplifier. Answers need not be precise, but an understanding of the working, and the reasons for it has to be demonstrated. A maximum of three questions can be asked per student, each carrying 1 mark.

II. Questions

1) **Why are you using LM386 over LM741?**
The LM386 is a power amplifier designed for low-voltage consumer applications. The gain is internally set to 20 to keep the external part count low, but the addition of an external resistor and capacitor between pins 1 and 8 increases the gain to any value from 20 to 200.

2) **Has your circuit used any feature to control gain? What is the gain your circuit gives?**
If yes - $A_v \approx 20$ to 200 depending upon R and C between pins 1 and 8. If not, the op-amp's inbuilt/default gain of 20 is expected.

3) **Express a gain of 20 in decibels. Take** $\log 2 = 0.301$**. Do not use paper/pen.**

$$\begin{aligned}\text{Gain (dB)} &= 20\log 20 \\ &= 20\times(1+0.301) \\ &= 26.02 \text{ dB}\end{aligned}$$

4) **A signal of** $\cos(\omega t)+0.1\cos(100\omega t)$ **is passed through your circuit. Model it as a system having a gain of 20 till a cutoff frequency of** 10ω**, and then falling at -20 dB per decade. What is the maximum value of output? Assume the phase response is zero for all frequencies.**
Output signal is $20\cos(\omega t) + 0.2\cos(100\omega t)$. Thus, the maximum value is 20.2.

5) **What is the biasing voltage used for LM386? Why is it required? Why can you not simply use linear (R, L, C elements) to make an amplifier?**
Linear elements (R, L, C) are passive and can only dissipate energy. They can not produce it. Thus, a biasing voltage and active elements are required.

6) **What is the cause of high noise in the circuit? (At least one reason)**
Breadboard and wires are not soldered and thus have gaps between metal and metal, leading to many parasitic capacitances. In addition, unused stubs in the breadboard also create undesired inductances. (Other valid reasons acceptable)

7) **Increase or decrease in a certain capacitor or resistor leads to what.....**
Refer to other questions.

8) **What is the use of the potentiometer?** It can be used to customize the gain by acting as voltage divider. So any gain from 0 to 20 can also be achieved.

9) **If your system has a gain of 20 till a cutoff frequency of** 10ω**, then it falls at -20 dB per decade, does it have a pole or a zero at the given frequency?**
A pole.

10) **Why is a large capacitor used in series with the output? How does it work**
To filter/smoothen the output waveform. The output acts as a resistor. Thus, it is an RC circuit with output across R. This is a high-pass filter with a small cutoff frequency $\frac{1}{2\pi RC}$ where C is large (OR) gives high impedance at low frequencies.

11) **Why is a small capacitor used parallel to the output?**
To filter out high-frequency noise.

12) **What is the purpose of the decoupling capacitor?** [0.5]
To filter out low-frequency noise.

13) **Is the circuit linear for all inputs? Why?**
No. Due to various filtering capacitors and the finite bandwidth of op-amp, the gain varies with frequency (at least one reason).

14) **What is the role of capacitor at the input of LM386?**
It blocks DC signals and only allows AC signals to pass through.

15) **Which capacitor reduces low-frequency noise and how?**
Series capacitor of large value (in series with output). It offers high impedance for low-frequency signals.

16) **What is the difference between stereo and mono outputs?**
Mono (monophonic) sound is single-channel audio where all the instruments are mixed into one signal, intended to be heard as if emanating from one position. Stereo (stereophonic) sound is achieved using two audio channels feeding 2 separate speakers.

17) **Can we change parameters in the circuit to eliminate noise? If yes, then how?**
Refer to previous questions

18) **What changes do you need to make in a mono audio file to make it a surround sound? (Bonus question if a student is good but loses a mark somewhere else)**
Tweak the amplitudes of outputs to left and right speakers separately. Increase or decrease the amplitudes to give spatial significance to sound.