Project 99 Mini-Paper: Waves and Reflection

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*Abstract*— *Project reports may not exceed one page.* This report summarizes Project 99: whatever title it is. In this project, reflection of waves was investigated for tubes with both ends open, addressing the main items required for this report: 1) figures showing setup including both tubes, and scope traces showing n=1 fundamental frequency for both tubes, 2) formula for n=1 mode, 3) table showing tube dimensions and theoretical n=1 mode and measured n=1,2,3 modes for both tubes. ..

# Theory

The formula for the fundamental mode frequency in Hz of a tube of length l with both ends open is

(1)

where f is in Hz, l is length in m, ... describe ALL variables in the formula!

# Experiment

Our experimental setup is shown in Fig. 1, where we used ??? microphone, ??? speakers, and the two tubes tested were xx m diameter and yy m long.



Fig. 1. Measurement setup showing laptop, microphone, speaker, and **BOTH tubes** Fix all captions!!

We first measured the frequency response of the longer tube, with the fundamental mode frequency of xx Hz measured as shown in Fig. 2. This measured value was 12.3% lower than the theoretical value of xx Hz. More description of the figure, more description, more description, more description, more description, more description, more description, more description.

We hen measured the frequency response of the shorter tube, with the fundamental mode frequency of xx Hz measured as shown in Fig. 3. This measured value was 12.3% lower than the theoretical value of xx Hz. More description of the figure, more description, more description, more description, more description, more description, more description, more description.



Fig. 2. Measurement of xx m long yy m diameter acoustic transmission line, showing measurement of fundamental mode at xx Hz.. Fix all captions!!



Fig. 3. Measurement of xx m long yy m diameter acoustic transmission line, showing measurement of fundamental mode at xx Hz.. Fix all captions!!

Table I describes the dimensions of the tubes, theoretical fundamental mode frequencies, and measured mode n=1, 2,3 frequencies. more description, more description, more description, more description, more description, more description, more description, more description, more description, more description, more description, more description, more description, more description,

1. Measured Values

| Parameter | Longer Tube | Shorter Tube |
| --- | --- | --- |
| Tube diameter (m) | xx | xx |
| Tube length (m) | xx | xx |
| Theoretical  Tube Funadmental mode (Hz) | xx | xx |
| Measured  Tube Funadmental mode (Hz) | xx | xx |
| Measured  n=2 mode (Hz) | xx | xx |
| Measured  n=3 mode (Hz) | xx | xx |

# Discussion

Discuss any particular issues, especially if you believe your experiment failed or measurements were more than 20% different than theory

##### References

*Not required*

1. *FRDM-K64F Freedom Module User’s Guide*. [Online]. Available: http://cache.freescale.com/files/32bit/doc/user\_guide/FRDMK64FUG.pdfh
2. T.P. Weldon, J.M.C. Covington III, K.L. Smith, and R.S. Adams ``Performance of Digital Discrete-Time Implementations of Non-Foster Circuit Elements,'' *2015 IEEE Int. Sym. on Circuits and Systems*, Lisbon, Portugal, May 24-27, 2015.
3. T.P. Weldon, J.M.C. Covington III, K.L. Smith, and R.S. Adams, ``Stability Conditions for a Digital Discrete-Time Non-Foster Circuit Element,'' *2015 IEEE Int. Symposium on Antennas and Propagation*, Vancouver, BC, Canada, July 19-25, 2015.
4. Wikipedia contributors, “Waveguide,” Wikipedia, The Free Encyclopedia, <https://en.wikipedia.org/wiki/Waveguide>, accessed 10 August 2018.