

# 97.455 Telecomm Circuits Lab 3 Phase-Locked Loops

This is a long, and somewhat complicated lab, running over two sessions. For the first lab period you should finish characterizing the VCO and Phase Detectors. If you are ahead after finishing this part, start the next part. Assignment 2 will cover some of the theoretical calculations required for the second part of the lab. Come into the second session with filter values calculated. Don't include unnecessary extra theory, and make sure the text is legible.

## PART 1

1. The VCO [10marks]
  - [3] Chose resistor/capacitor values for the VCO. Adjust to get the right frequency range.
  - [4] Plot of VCO frequency vs. DC tuning voltage.
  - [3] Calculate KVCO.
2. The Three Phase Detectors: [20marks]
  - [6] Plot  $V_{avg}$  vs. phase difference.
  - [6] Compare to theory. State theoretical value for slope.
  - [4] Compute the  $K_{phase}$  for each phase detector.
  - [4] Which phase detector is also a frequency detector? How do you know?

## PART 2

3. The PLL Theory: [10marks] (also covered in Assignment 2)
  - [3] Derive the transfer function of the filter.
  - [3] Derive the PLL phase error transfer function (with  $R_1, R_2, R_3, C_1$  not  $F(s)$ ).
  - [4] Size all the components in the filter.
4. The PLL measurements [30marks]
  - [5] Look at input/output of PLL. Do they have the same freq? Plot phase variation vs input freq.
  - [5] Explain the  $w_n$  connection.
  - [5] Plot VCO control voltage vs. signal frequency. How does it compare with the earlier measurements?
  - [5] Reduce gain to 1. How did you do this?
  - [5] Explain why lock range is what it is. Explain phase variation.
  - [5] Plot phase variation.

## PART 3

5. The PLL Synthesizer: [20marks]
  - [5] Are the VCO and reference synchronized?
  - [5] Vary the reference and watch the VCO. What happens?
  - [5] Plot VCO control while the  $/N$  is switching.
  - [5] What would the transient look like if it didn't lose lock?

## Other

6. Discretionary Marks [10marks]
7. Demos: Part 1-Oct 22,23,24 Part 2 - Nov. 5,6,7 [50marks]

**Total Marks 150**