ECE 557- Analog Test and Product Engineering

Course Outline

A. Introduction to Test and Product Engineering (1 week - notes and 1.3)
   - A.1. Description of a Test and Product engineer (notes)
   - A.2. Fabrication process and typical fabrication errors (notes and 1.3)
   - A.3. Characterization versus production testing (1.3)

B. ATE instrumenation (1 week - 5.2, 5.3, 5.4, 6.2)
   - B.1. ATE test equipment (I/V sources, Kelvin connections, multimeters, PGAs, quantization noise, AWG's, digitizers, relay control lines)
   - B.2. High precision measurement techniques
   - B.3. Measurement accuracy versus test time

C. Typical DC tests (3 weeks - Chapt 3)
   - C.1. Methods presented for both op-amps requiring feedback to stabilize and instrumentation amps/PGAs not requiring feedback
   - C.2. Continuity
   - C.3. low precision tests: I_Q current and impedence
   - C.4. high precision tests: leakage current (I_B), open-loop gain, offset, PSRR, CMRR (included are the use of nulling amps and false-summing amplifiers)

D. Typical AC tests (3 weeks - Chapt 6, 7, and 8)
   - D.1. generation of multi-tone signals and sampling theory (6.3, 6.4, Chap 7)
   - D.2. Single Tone Tests: Absolute gain, gain tracking error, THD, (8.2)
   - D.3. Multi-tone tests: frequency response, phase response, Intermodular Distortion (Chapt 8)
   - D.4. Noise tests: crosstalk, idle channel noise, SFDR (Chapt 8)

E. Measurement accuracy and data analysis (2 weeks - Chapt 4 and 15)
   - E.1. Accuracy, repeatability, reproducibility (Chapt 4)
   - E.2. Test equipment calibration (4.2)
   - E.3. Variability distributions / statistical analysis (Chapt 15)
   - E.4. Guardbanding and impact on yield (Chapt 4 and Chapt 15)
   - E.5. Six sigma statistical process control: GRR, Cp, Cpk (Chapt 15)
   - E.6. Product engineering tools: Pareto charts, Scatter Charts, Control Charts (Chapt 15)

Topics Covered in Lab

A. Lab 1 - ATE demonstration: device-interface-board example and schematic, creating a program in the ETS system, analog resources, UserInit

B. Lab 2 - Continuity: Purpose of the continuity function, how to create a function, use of analog resources, datalogging, running test on ATE and receiving results. Prelab presents the creation of a test plan.

C. Lab 3 - I_Q: Let the students develop a new function on their own to obtain practice using the resources, datalogging, and using the ATE.

D. Lab 4 - V_{OS}: Test the offset voltage using the false-summing junction.

E. Lab 5 - Gol: Test open-loop gain using a nulling amp. Shows an alternative method to performing similar tests.

F. Lab 6 – CMRR and PSRR: Test common-mode rejection ration and power-supply rejection ratio using pattern-based testing. A pattern to modify the rails will be used to test both of these tests (and the offset test) to see another alternative test method.

G. Lab 7 - AC Test: Prelab: Students create a multi-tone signal in matlab to use in a gain- bandwidth test. Lab: Students use an AWG to drive multi-tone signal, digitize results, FFT results, and perform calculations on results. Students learn about ETS clocking scheme, mapping ATE clocking and storage capability to multi-tone signal, AWG, and digitizer.

H. Lab 8-10 - Projects: Students are given a new op-amp datasheet and asked to develop all the production-level DC tests and 1 AC test. Students must consider the time-accuracy trade-offs in their solutions. Students perform a repeatability study on the results, calculating GRR, to determine if their program measurement accuracy is sufficient. If not, the program must be modified to obtain full credit. Students then do a minor reproducibility study on two sites and two DIBs using 5 different chips. Students use line charts to see if the measurements for the same chips are tracking for different testing conditions. Students present results and discuss testing strategies to obtain the performance.