## Course Title: Analog Circuit Design -- Making the Real World Connection

## COURSE DESCRIPTION:

The ability to design and analyze analog circuits has been overlooked in the rush to "digitize" electronic designs. The real world is an analog place, and requires the use of analog circuitry. As accuracies and bandwidths increase, designers of electronic systems need to know how to make the connection between the real analog world and the digital domain. This course will focus on the non-ideal nature of electronic components and integrated circuits, and the analysis and synthesis of circuits, with examples from real product designs. Emphasis will be placed on the practical aspects of the design and implementation of analog circuitry. Applications will be drawn from many fields, including the interface between analog and digital systems using high speed, high resolution converters.

Pre-requisite: Electronics for Scientists and Engineers or equivalent with approval of instructor

## INSTRUCTOR:

Ken Arnold, President of HiTech Equipment Corporation, has designed and implemented a wide range of interfaces between analog and digital systems for applications ranging from communications to scintillation detectors. He has implemented the analog circuit designs that interface external devices to very high speed, high resolution analog to digital and digital to analog conversion systems. As an independent consultant, he has designed mixed signal integrated circuits, and board level systems that digitize and process signals from less than a microvolt to several kilovolts, from DC into the GHz range.

Text: Horowitz and Hill, "The Art of Electronics," 2nd Ed.

Bibliography:
Millman and Halkias, "Integrated Electronics"
Hamilton and Howard, "Basic Integrated Circuit Engineering"
Mead, "Analog VLSI and Neural Systems"
Misc. Application Notes and magazine articles from the semiconductor manufacturers and trade press.

1	Introduction Course Overview, Class Format, Tests, Grading, Project Description Prerequisite: Basic Electronics Prerequisite Test and Solutions Resources Students Need to Complete the Course Analog Circuit Applications Review of Basic Analog circuit concepts
2	Review of Foundations - theoretical models Idealized Discrete Circuits Passive Components Active Components Integrated Circuits
3	Circuit Design and Analysis - Real World Applications Bipolar Junction Transistors Field Effect Transistors Other Active Components Design Examples
4	Feedback and Operational Amplifiers IC Technologies & Applications Basic op-amp feedback circuits Special and Useful Circuits Limitations of real devices, precision Parametric considerations, noise Design Examples
5	Component Limitations A second look at passive components Design examples Errors: gain, offset, age/temperature drift Temperature related effects Parasitic characteristics Noise, Additive White Gaussian and other fairy tales Other oddities
6	ADCs and DACs Making the digital Connection Quantization Accuracy vs. Resolution Sample rates, Bandwidth and Nyquist Filters Errors, Noise, and other realities
7	Instrumentation Analog and Digital Meters: what's in a number. Analog Oscilloscopes, Digital Oscilloscopes and Nyquist Signal, Spectrum and Network Analyzers High speed signal measurement considerations
8	RF/High Frequency Circuits and Construction Circuit Boards: The Forgotten Component Wideband Amplifiers Circuit Design Implications Impedances and Implications of Parasitics Design Examples

- 9 Regulation and Reference Standards Basic voltage regulation References and Standards Power Circuits Battery Operated Circuits Design Examples
- 10 Advanced Topics The loop: Telephone Circuits Video Signals and Circuits Opto-electronics, isolation, communication Design Examples
- Advanced Topics (continued)
   Transducers, Sensors and Antennas
   RF Radio Frequency Circuits
   PLL Phase Locked Loops
   IC design using PCs Analog ASICs and FPAAs
   EMC Electromagnetic Compatibility
   Design Examples
- 12 Final Exam