Student Manual
for
The Art of Electronics

Thomas C. Hayes
Paul Horowitz
Harvard University

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**PART I: ANALOG LABS**

Lab 1. **DC Circuits**
- Ohm's law; A Nonlinear device; The diode; Voltage divider; Thevenin model; Oscilloscope; AC voltage divider

Lab 2. **Capacitors**
- RC circuit; Differentiator; Integrator; Low-pass filter; High-pass filter; Filter example I; Filter example II; Blocking capacitor; LC filter

Lab 3. **Diodes**
- LC resonant circuit; Confirming Fourier series; Half-wave rectifier; Full-wave bridge rectifier; Ripple; Signal diodes; Diode clamp; Diode limiter; Impedances of test instruments

Lab 4. **Transistors I**
- Transistor junctions are diodes; Emitter follower; Transistor current gain; Current source; Common emitter amplifier; Transistor switch

Lab 5. **Transistors II**
- Dynamic diode curve tracer; Grounded emitter amplifier; Current mirror; Ebers-Moll equation; Biasing: good & bad; Push-Pull

Lab 6. **Transistors III**
- Differential amplifier; Bootstrap; Miller effect; Darlington; Superbeta

Lab 7. **Field Effect Transistors I**
- FET characteristics; FET current sources; Source follower; FET as Voltage-controlled resistance; Amplitude modulation; 'Radio broadcast'

Lab 8. **Op Amps I**
- Op-amp open-loop gain; Inverting amplifier; Non-inverting amplifier; Follower; Current source; Current-to-voltage converter; Summing amplifier; Push-pull buffer

Lab 9. **Op Amps II**
- Op-amp limitations; AC amplifier; Integrator; Differentiator; Active rectifier; Active clamp

Lab 10. **Oscillators**
- Comparator; Schmitt trigger; IC relaxation oscillator; Sawtooth wave oscillator; Voltage-controlled oscillator; Wien bridge sine oscillator; Unwanted oscillations: discrete follower & op amp stability problems

Lab 11. **Field Effect Transistors II**
- Analog switch characteristics; Applications: chopper circuit; sample-&-hold; switched-capacitor filters; negative voltage from positive

Lab 12. **Power Supplies**
- The 723 regulator; Three-terminal fixed regulator; Three-terminal adjustable regulator; Three-terminal regulator as current source; Voltage reference; 'Crowbar' clamp
PART II: DIGITAL LABS

Lab 13. Gates
Logic probe; IC gates: TTL & CMOS; Logic functions with NANDs; Gate innards: TTL; CMOS: CMOS NOT, NAND, 3-state

Lab 14. Flip-Flops
Latch; D flop; J-K flop; Ripple counter; Synchronous counter; Shift-register; Digitally-timed one-shot

Lab 15. Counters
8-bit counter; Cascading; Load from keypad; Programmable divide-by-n counter; Period meter; Capacitance meter

Lab 16. Memory; State Machines
RAM; Divide-by-3 (your design); Memory-based state machines: Single-loop; External control added

Lab 17. A/D; Phase-Locked Loop: Two Digital Feedback Machines:
D/A; A/D: Slow motion; Full speed; Displaying search tree; Speed limit; Latching output; Phase-Locked Loop: frequency multiplier.

Lab 18. μ1: Adding CPU
Clock; CPU preliminary test; Fixing busgrant*; Memory enable logic; Memory write logic; Single-step; Test program; Full-speed: timing diagram

Lab 19. μ2: I/O: Output: First small programs
Battery backup; Power-fail detector; I/O decoder; Data displays; Timing program

Lab 20. μ3: Input: More small programs
Delay as subroutine; Improved delay routines; Input hardware: Data input hardware; Input/output program; Ready signal; I/O program with enter/ready function; Decimal arithmetic

Lab 21. μ4: A/D <-> D/A
A/D-D/A wiring details; Programs: confirming that D/A, A/D work; In & Out; Invert, rectify, low-pass;

Lab 22. μ5: ‘Storage scope;’ Interrupts & other ‘Exceptions’
‘Storage scope;’ keyboard control;
Exceptions: A software exception: illegal; Interrupt: hardware to request interrupt; Program: main & service routine; NMI; Applying interrupts

Register-Check: a debugging aid (optional program; install if you choose to)

Lab 23. Applying Your Microcomputer (‘Toy Catalog’)
X-Y scope displays; Light-pen; Voice output; Driving a stepper motor; Games; Sound sampling/generation