PHY124 Course Spring 2016

Chapter I : dc regime Jan to March (B.U.)
Chapter II : transient and ac regime (B.U. + Grenoble students) March to May
Chapter I' : Introduction to Op-amps (B.U. Students only)

Chapter I : dc regime
- I Charge, current, potential
  - I-1 : Evidence for the existence of charges and current
  - I-2 : Electric charge
  - I-3 : Electric current
  - I-4 : Electric potential
  - I-5: dc current regime
  - I-6 : current density
- II Ohm's law
  - II-1 Experimental evidence
  - II-2 Microscopic origin
  - II-3 Macroscopic resistance
  - II-4 Electromotive force (emf)
  - II-5 Generalised Ohm's law
- III Electric circuits
  - III-1 Node,branch and loop
  - III-2 Dipoles and Powers (Maximum Power Transfer Theorem)
- IV : Linear circuits
  - IV-1 : Kirchhoff's current law (KCL)
  - IV-2 : Kirchhoff's voltage law (KVL)
  - IV-3 : Dipoles in series and in parallel (and neither case)
  - IV-4 : Solving Circuits
    - Drawing, Naming, Arrowing, KCL, KVL, linear equations system.
  - IV-5 : Superposition theorem
  - IV-6 : Thévenin and Norton's theorems
  - IV-7 : Non linear dipoles
    - Diode I-V characteristic
    - Load-line solving technique

Chapter I' : Introduction to OpAmps :
- I- OpAmp : a voltage differential amplifier
  - Drawing model (Input+, Input-, Output)
  - Gain (open-loop gain)
  - Power supplies (bipolar, unipolar)
  - Output Saturation (rail-to-rail or less)
- **Circuit 1 :** Voltage comparator
  - applications : process control (On/Off)
- III-Real Opamp vs Ideal OpAmp
  - Input resistance
  - Output resistance
  - Gain
  - Time response (slew rate, G(frequency))
  - OpAmp Design Golden Rules :
    - 1st rule : no input currents
    - 2nd rule : no differential voltage if negative feedback)

IV- Negative feedback loop
Gain with negative feedback
Circuit 2 : Voltage follower
Circuit 3 : Amplifier (inverting)
Circuit 4 : Amplifier (non inverting)
V- Advanced operations
Circuit 5 : Summator
(application to Digital to Analog Conversion)
Circuit 6 : (derivator) (no complex numbers, diff. equation calculation).

Homework : Integrator circuit, hysteretic comparator (Schmitt trigger) and spontaneous oscillator (multivibrator).

Chapter II : transient and ac regime
I-Time-dependent electricity
I-1 Quasi-steady state
Frequency limit vs Circuit characteristic lengthscale.
Safety issue – transient duration (protect user, protect component)
I-2-Two new dipoles : C and L
I-3- RLC series
I-4- Energy conservation (stored vs lost electrical energy)
II Transient regime
II-1 RL circuit + characteristic time
II-2 RLC circuit
aperiodic, quasiperiodic, critical solutions
(reminder about 2nd order diff. Equations)
(reminder about complex numbers for the quasi-periodic regime)
II-3 Comparison with a mechanical system (damped spring)
III a.c. regime
III-1 Why restricting to sine-waves ? (50Hz/60Hz regimes and Fourier transforms).
III-2 Fresnel diagram+Fresnel vectors : Phasors
III-3 Complex impedance
III-4 Resonance, Quality factor (RLC-series)
III-5 Energy/Power (instantaneous, average, effective(rms), power factor)
III-6 Admittance, parallel circuits
III-7 Filters (transfer function, cut-off frequencies, bandwidth, decibel, Bode plots)
III-8 Impedance matching