Switch-Mode DC-DC Converters – Course Outline

Part 0. Introduction
   a. Scope of course
   b. Linear Regulator
   c. Modern Power Conversion Systems Requirements

Part 1. PWM
   a. Inductor

Part 2. Basic topologies: BUCK, BOOST, BUCK-BOOST, DCM operation
   a. Buck converter
      i. Operation modes
      ii. Voltage transfer function
      iii. Current modes (CCM, DCM)
   b. Capacitor current
   c. Boost converter
      i. Operation modes
      ii. Voltage transfer function
   d. Buck-Boost converter
   e. Comparison between topologies
   f. Average Simulation of PWM Converters
      i. The Switched Inductor Model (SIM) (CCM)
      ii. The Generalized Switched Inductor Model (GSIM) Model
      iii. Implementation (BUCK, BOOST, BUCK-BOOST)
      iv. Parasitics
      v. SPICE compatibility
      vi. Discontinuous Model (DCM)
      vii. Combined GSIM model

Part 3. Magnetics Design
   a. Important magnetic equations
      i. Faraday’s law
      ii. Ampere’s law
   b. Magnetic losses
c. Ideal Transformer
d. Skin effect
e. Proximity effect
f. Transformer design
g. Inductor design
h. Cores
i. Distributed gap core

Part 4. Isolated Converters (FORWARD and FLYBACK)

a. DC current issue
b. Forward Converter
   i. Voltage transfer function
   ii. Magnetizing Inductance Problem
   iii. Transformer Reset
   iv. Reset of Forward

c. Coupled inductor
d. Flyback converter
   i. Voltage across primary
   ii. Voltage transfer function
   iii. Multiple outputs
   iv. Features

Part 5. Losses and Efficiency

a. Conduction Losses
b. Switching Elements
c. Diodes
   i. Conduction losses
   ii. Recovery
   iii. Power Switches
   iv. MOSFET
   v. IGBT
d. Capacitors
   i. Practical Caps
ii. Philips ceramic capacitors
iii. Specifications
iv. Implications
v. Losses

Part 6. Output Voltage Ripple, Parasitic Effects, Snubbers
   a. Output voltage ripple
   b. Diodes reverse recovery
   c. Diode forward recovery
   d. Parasitic effects: Internal delay
   e. Snubbers
      i. Designing the Snubber Components
      ii. Diode Snubber (clamp)
      iii. Switch Snubbers
      iv. Reset
      v. Lossless snubbing

Part 7. Advanced topologies (Half Bridge, Full Bridge, Push-Pull, C’uk, SEPIC)
   a. Half Bridge - HB
   b. Full Bridge - FB
   c. Reset of Forward, HB, FB
   d. Push-Pull
   e. Forward, HB, FB, PP
   f. C’uk Converter and Isolated C’uk
   g. SEPIC Converter

Part 8. Drivers
   a. Driver Requirements
   b. Required Drive
   c. Gate Drivers
      i. Commercial drivers
      ii. High-Side Drive
      iii. Potential offset + floating C supply
      iv. Turn “off”
Part 9. Current Sensing
   a. Resistor
   b. Current transformer
   c. Pulse Current transformer Design
      i. Resistor reset
      ii. Reset – Clamp
      iii. Measuring DC current
   d. DC Current transformer

Part 10. Power Converters Control Technique
   a. The Dynamic Problem
      i. Control
      ii. Modulator
      iii. Oscillator
   b. Complete controller Voltage Mode (VM)
   c. Bode Plot
      i. Design problem
      ii. Stability
   d. Current Feedback
   e. PCM & ACM
   f. Parasitic effects: PCB trace resistance
      i. Interfering signal injection
      ii. Inductive coupling
      iii. Stray inductance