Control Techniques in Switched Mode Power Converters (SMPCs) Part I (May 2021)		
Day 1		
Session	**Session theme**	**Major topics**
S_{11}	Power Management Converters for Emerging Applications	• Power management (PM) network for mobile processors • Introduction to linear regulators and switched capacitor converters • Hybrid switched capacitor PM converters • Inductive switching DC-DC converters
S_{12}	Steady-State Analysis of Switched Mode Power Converters (SMPCs)	• Continuous conduction mode and discontinuous conduction mode • Inductor voltage-second balance and capacitor charge balance • Formulation of steady-state voltage gain and ripple parameters • Power stage design of buck, boost, three-level buck converters
S_{13}	DC Equivalent Circuit Analysis of Practical SMPCs	• Formulation of average switch model • DC equivalent circuits of various converters • DC analysis - voltage gain and loss analysis with parasitic
S_{14}	Modulation Techniques in SMPCs	• Fixed-frequency: Trailing-edge, leading-edge, double-edge PWM • Variable-frequency: Constant on-time & constant off-time modulation • Modulation under light load: Pulse freq., pulse skipping, burst-mode
Day 2		
Session	**Session theme**	**Major topics**
S_{21}	Control Methods based on Feedback Interconnection	• Feedback and feedforward control methods • Voltage mode control and current mode control • Ripple based control methods
S_{22}	Averaging Methods and Small-Signal Modeling	• State space averaging technique • Circuit averaging technique and equivalent circuits • Small-signal transfer functions and model validity
S_{23}	Small-Signal Model under Current Mode Control (CMC)	• Circuit averaging technique under CMC and model validity • Discrete-time modelling techniques • Ridley model technique in CMC
S_{24}	Design of Voltage Mode and Current Mode Control	• Design of voltage mode control • Design of CMC for a buck converter • Design of CMC of a boost converter and performance limits
Day 3		
Session	**Session theme**	**Major topics**
S_{31}	Modeling, Analysis and Design of Ripple based Control Techniques	• Large-signal and small-signal modelling of ripple based control • Design of hysteresis current control technique • Design of constant on-time CMC technique • Design of constant off-time CMC technique
S_{32}	Fastest Control in SMPCs and Performance Limits	• Time optimal performance and slew rate limits • Implementation methods of time optimal control • Performance comparison using linear and nonlinear control
S_{33}	Light Load and Multimode Control Methods in SMPCs	• Losses in CCM and DCM and Voltage gain in DCM • Constant on-time PFM and PSM methods under DCM • Multimode control for wide operating range

S_{34}	Digital Pulse Width Modulation in SMPCs	• Need for Digital Control in SMPCs • Closing the Digital Feedback Loop • Digital Pulse Width Modulator Architectures

Reference book and material:

[1] R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, 3rd Ed., Springer, 2020.

[2] S. Kapat and P. T. Krein, "A Tutorial and Review Discussion of Modulation, Control and Tuning of High-Performance DC-DC Converters based on Small-Signal and Large-Signal Approaches" *IEEE Open Journal of Power Electronics*, vol. 1, pp. 339 - 371, Aug. 2020.