Modeling, Analysis and Design of Fixed-Frequency Control Methods in DC-DC Converters and MATLAB based Design Automation – Part II		
Session details (Each session of 2 hours duration)		
Sessions	**Session theme**	**Major topics**
S_1	Derivations of various transfer functions and model validation using MATLAB AC transient simulation	• Derivation of small-signal transfer functions (TFs) • Comparing TFs obtained from various modelling techniques • Step-by-step guidelines to develop model validation platform • MATLAB interaction simulation platform • Model validation using MATLAB – DC and AC transient analysis
S_2	Design of voltage mode control in a buck converter and model validation of closed-loop buck converter	• Loop gain analysis • Loop shaping objectives • Design and tuning of voltage mode control using PID controller • Need for a type-III compensator and its design method • Model validation of closed-loop system using MATLAB • Design VMC with input voltage feedforward and model validation
S_3	Small-signal modelling techniques with closed current loop	• Approximate first-order modelling technique • More accurate modelling techniques • Derivation of small-signal transfer functions
S_4	Sub-harmonic instability in CMC – its existence and impacts	• Understanding sub-harmonic instability • Concept of bifurcation and nonlinear dynamics • Smooth bifurcation and non-smooth bifurcation
S_5	Discrete-time modelling for analysing sub-harmonic instability	• Introduction to discrete-time modelling • State space modelling and solution vector • Steps-by-steps guidelines for derivation of discrete-time models • Poincare map for understanding sub-harmonic instability
S_6	Discrete-time large and small-signal modelling in CCM and model validation	• Discrete-time small-signal modelling – graphical approach • Discrete-time small-signal modelling – analytical approach • Derivation of various transfer functions • Model validation using MATLAB simulation
S_7	Understanding Sampling effect in analog CMC and Ridley modelling	• Understanding natural sampling effect in analog CMC • Modeling sampling effect in current loop • Derivation of Ridley small-signal model • Model validation under CMC
S_8	Design methods for CMC buck converter in CCM	• Design of CMC using approximate SSM • Validation of approximate, accurate and Ridley SSM • Current mode control design with load current feed-forward
S_9	Design of buck converter using small and large-signal approaches	• Derivation large-signal tuning for time optimal performance • Implementation of CMC and VMC buck converter • Comparative performance study – small-signal vs large-signal
S_{10}	Discrete-time modelling under DCM and stability analysis under light load control methods – PWM, PFM, PSM techniques	• Approximate discrete-time modelling under DCM • Discrete-time modelling under PWM control in DCM • Discrete-time modelling under PFM control in DCM • Discrete-time modelling under PSM control in DCM • Model validation using MATLAB simulation

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.