Modeling, Analysis and Design of Fixed-Frequency Control Methods in DC-DC Converters and MATLAB based Design Automation – Part I		
Session details (Each session of 2 hours duration)		
Sessions	**Session theme**	**Major topics**
S_1	Understanding need for modeling of power converter circuits	• Switched mode power converter – design and control objectives • Understanding modelling requirements and accuracy • Motivations and objectives of modelling – buck converter example • Overview of modelling techniques
S_2	Model development for MATLAB interactive simulation	• Mathematical modelling of a buck converter • MATLAB model development • Step-by-step guidelines for MATLAB interactive simulation • Objectives for developing MATLAB based design automation
S_3	Fixed frequency and variable frequency modulation techniques in CCM and DCM	• Fixed-frequency modulation and control methods in CCM • Variable frequency modulation techniques in CCM • Light load and multimode control methods in DCM • MATLAB model development and interactive simulation
S_4	Formulation of steady-state ripple parameters, RMS current in CCM	• Ripple parameters under fixed- and variable frequency modulation • Derivation of RMS current, current ripple and voltage ripple • Design of power stage based on CCM operating mode • MATLAB simulation and model verifications
S_5	Formulation of steady-state ripple parameters, RMS current in DCM	• Light load control – PWM, PFM, PSM, hysteresis, burst mode • Derivation voltage ripple, current ripple and RMS current under various light load control methods and comparative study • MATLAB simulation and model verifications
S_6	State space averaging and small-signal modelling	• State space modelling and state space averaging technique • Jacobian matrix and Taylor series linearization • Derivation of large-signal and small-signal models
S_7	Circuit averaging and equivalent circuit modelling in CCM	• Introduction to circuit averaging technique • Derivation of large-signal and small-signal models • Equivalent circuit model
S_8	Three terminal modelling in a CCM buck converter	• Basics of three terminal modelling • Average switch modelling • Derivation of large-signal equivalent circuit model
S_9	Average techniques in DCM and derivation of equivalent circuit model	• Approximate averaging techniques in DCM • More accurate averaging technique in DCM • Equivalent circuit model under DCM
S_{10}	DC analysis of fixed-frequency buck converter in CCM, DCM	• Derivation of DC equivalent circuit • DC analysis – voltage gain, current gain and efficiency in CCM • DC analysis – voltage gain, current gain and efficiency in DCM • Model validation using MATLAB

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.