Digital Control Techniques in Switched Mode Power Converters (SMPCs) – Part II (May 01 to May 28, 2021)		
Module number	Major topics & hours	Content overview
Module#M_{21}	Linear and Nonlinear Control Methods in SMPCs **(4 hrs)**	• PWM voltage mode and current mode control (CMC) • Peak CMC, valley CMC and average CMC techniques • Constant on-time, constant off-time current mode control • Hysteresis control and sliding mode control • MATLAB based simulation case studies
Module#M_{22}	Digital Modulation and Mixed-Signal Implementation **(6 hrs)**	• Digital redesign of analog control and further possibilities • Digital pulse width modulator (DPWM) architectures • Selection of sampling rate and aliasing effects • Effect of sapling delay on stability • Effect of quantization and existence of limit cycle oscillation • Methods for stability enhancement • MATLAB based simulation case studies
Module#M_{23}	Digital Current Mode Control Techniques in High Frequency SMPCs **(4 hrs)**	• Fixed frequency mixed-signal and fully digital CMC implementation • Variable frequency mixed-signal and fully digital CMC implementation • Mixed-signal hysteresis current mode control implementation • MATLAB custom coding and simulation case studies
Module#M_{24}	Modelling, Analysis and Design of Digitally Controlled SMPCs **(6 hrs)**	• Continuous-time small-signal model and discrete equivalent • Discrete-time small-signal model • Small-signal and fast-scale stability analysis • Indirect and direct design methods • MATLAB based design case studies
Module#M_{25}	Digital Control of AC/DC Converters and Power Factor Correctors **(5 hrs)**	• Boost power factor corrector (PFC) under CCM, CrM and DCM • Modulation and feedback/feedforward control techniques • Digital current mode control architectures • Advanced digital control techniques • MATLAB based simulation case studies
Module#M_{26}	Digital Control and Modeling Techniques in LLC Converters **(4 hrs)**	• Zero current and zero voltage switching and operating regions • Digital modulation techniques and frequency regulation aspects • Modeling, analysis and digital control design techniques • Digital control methods for fast transient and high light load efficiency • MATLAB based case studies
Module#M_{27}	Digital Control Implementation using Verilog HDL & Aspects of FPGA Prototyping **(5 hrs)**	• Fixed point implementation of a digital PID controller • Introduction to Verilog HDL and modelling techniques • Top down design methodology • Verilog HDL implementation of a digital PID controller • Introduction to FPGA device and interfacing circuits • A video demonstration of FPGA based rapid prototyping

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.