# **Title**: Power Management Circuits, Modelling, Control, Analysis, and Design

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| Day 1 (March 02, 2020) | |
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| **Morning Session** (9:00 am to 12:30 pm) | **Afternoon Session** (2:00 to 5:30 pm) |
| **Theme:** Introduction to power management (PM) converters | **Theme:** Steady-state analysis of PM converters |
| **Details:**<br>• Power delivery network in VLSI systems<br>• Power management (PM) applications<br>• Need for energy-efficient PM converters<br>• Different types of PM converters<br>• Switching DC-DC converters | **Details:**<br>• Overview of step-down/up DC-DC converters<br>• Power switching devices and filter networks<br>• Inductor volt-second and capacitor charge balance<br>• Steady-state voltage gains and ripple parameters<br>• Discontinuous conduction mode (DCM) |

| Day 2 (March 03, 2020) | |
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| **Morning Session** (9:00 am to 12:30 pm) | **Afternoon Session** (2:00 to 5:30 pm) |
| **Theme:** Modelling of PWM DC-DC converters in CCM | **Theme:** Impedance analysis using equivalent circuit models |
| **Details:**<br>• State-space modelling of DC-DC converters<br>• State-space averaging and linearization<br>• Average switch modelling<br>• Equivalent circuit models<br>• DC analysis of practical PM converters | **Details:**<br>• AC equivalent circuits of buck and boost converters<br>• Derivation of various transfer functions of PM converters<br>• Analysis of audio-susceptibility and input/output impedances<br>• Pole/zero analysis of control-to-output transfer functions<br>• Need for feedback and feed-forward control methods |

| Day 3 (March 04, 2020) | |
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| **Morning Session** (9:00 am to 12:30 pm) | **Afternoon Session** (2:00 to 5:30 pm) |
| **Theme:** Control methods in DC-DC converters | **Theme:** Design of voltage mode control (VMC) in PM converters |
| **Details:**<br>• Feedback control methods in DC-DC converters<br>• PWM voltage mode control method<br>• PWM current mode control method<br>• Variable frequency control methods<br>• Control methods in commercial PMICs – Introduction | **Details:**<br>• Loop gain and stability analysis using PWM VMC<br>• Closed-loop audio-susceptibility and input/output impedances<br>• Identifying desired closed-loop performance<br>• Design of feedback compensator<br>• Need for input voltage feed-forward in VMC |

| Day 4 (March 05, 2020) | |
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| **Morning Session** (9:00 am to 12:30 pm) | **Afternoon Session** (2:00 to 5:30 pm) |
| **Theme:** Current mode control (CMC) and stability analysis | **Theme:** Design of CMC in DC-DC converters |
| **Details:**<br>• Current sensing techniques in DC-DC converters<br>• Approximate equivalent circuit models in CMC<br>• More accurate equivalent circuit models in CMC<br>• Sub-harmonic instability and compensation in CMC<br>• Ridley modelling approach and analysis in CMC | **Details:**<br>• Loop gain and stability analysis using PWM CMC<br>• Closed-loop audio-susceptibility and input/output impedances<br>• Design of feedback compensator<br>• Need for load current feed-forward in CMC<br>• Design of ripple-based CMC in DC-DC converters |

| Day 5 (March 06, 2020) | |
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| **Morning Session** (9:00 am to 12:30 pm) | **Afternoon Session** (2:00 to 5:30 pm) |
| **Theme:** Light load control method in DC-DC converters | **Theme:** Advanced topics in DC-DC converters |
| **Details:**<br>• Limitations of PWM control under light load conditions<br>• Pulse skip modulation for improving light load efficiency<br>• Constant on-time control (COT) in DCM and design<br>• An overview of other light load control methods<br>• Need for multi-mode control methods over wide load current | **Details:**<br>• DC-DC converters for low-voltage-high-current applications<br>• DC-DC converters for multi-output low power applications<br>• DC-DC converters for 5G communication<br>• GaN power devices for high power density DC-DC converters<br>• Digital control in PM converters – Challenges and opportunities |