



NPTEL ONLINE CERTIFICATION COURSES

DIGITAL CONTROL IN SMPCs AND FPGA-BASED PROTOTYPING

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Electrical Engineering Department, IIT KHARAGPUR

Module 02: Fixed and Variable Frequency Digital Control Architectures

Lecture 11: Basics of Sampling under Fixed and Variable Frequency Modulation

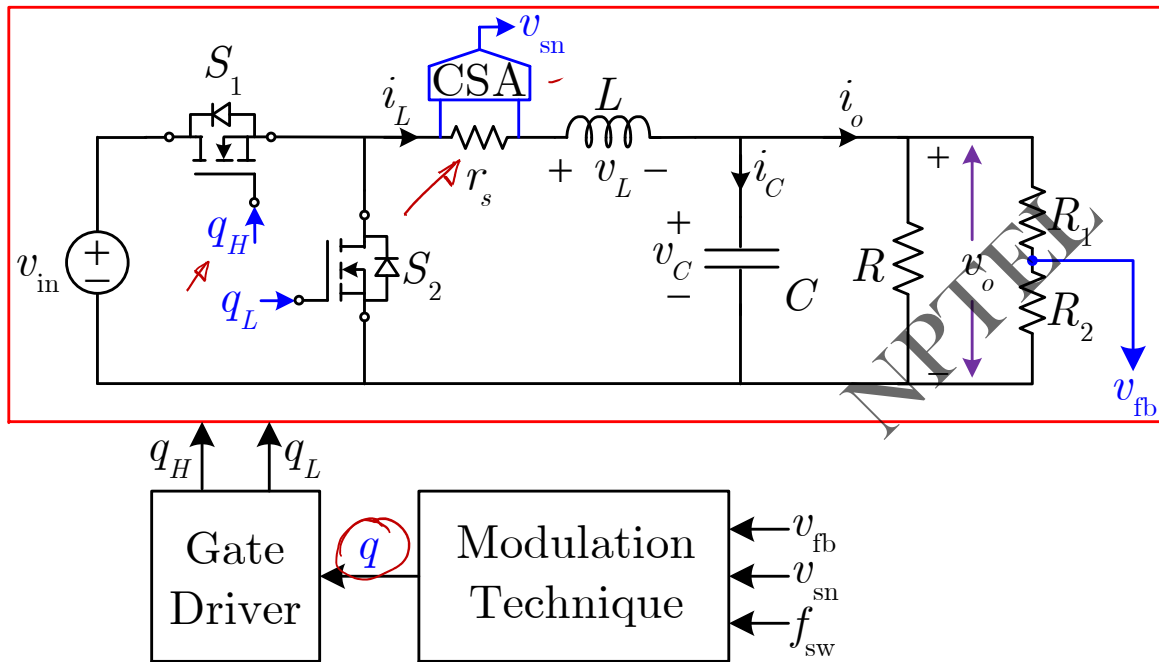


CONCEPTS COVERED

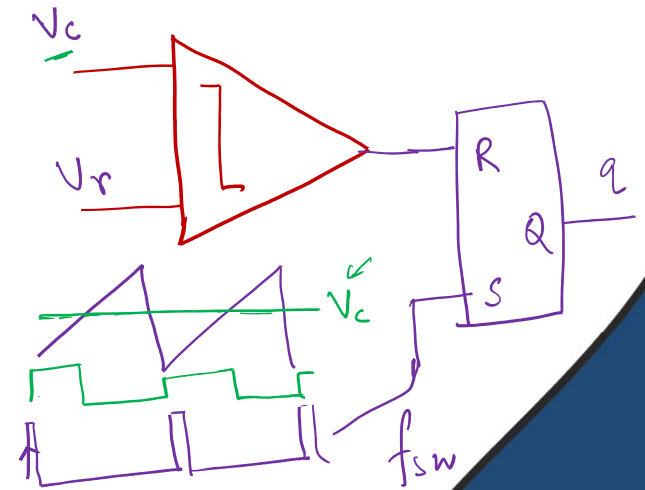
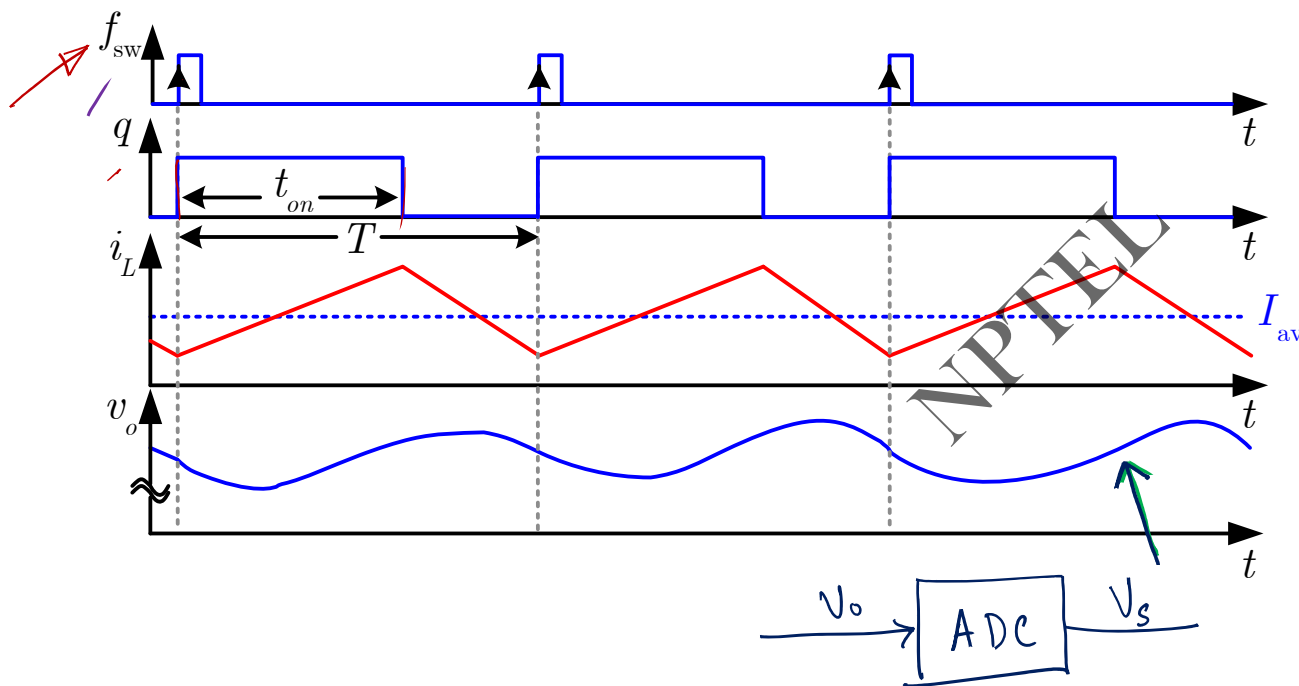
- Steady-state operation of switched mode power converters
- Various fixed and variable frequency modulation techniques
- Understanding sampling methods
- Basics of uniform and event-based sampling methods

Buck Converter

Buck Converter

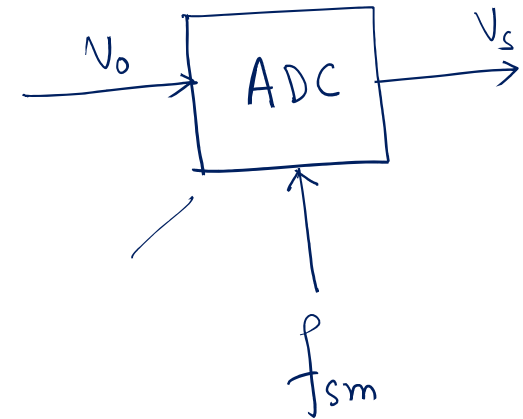
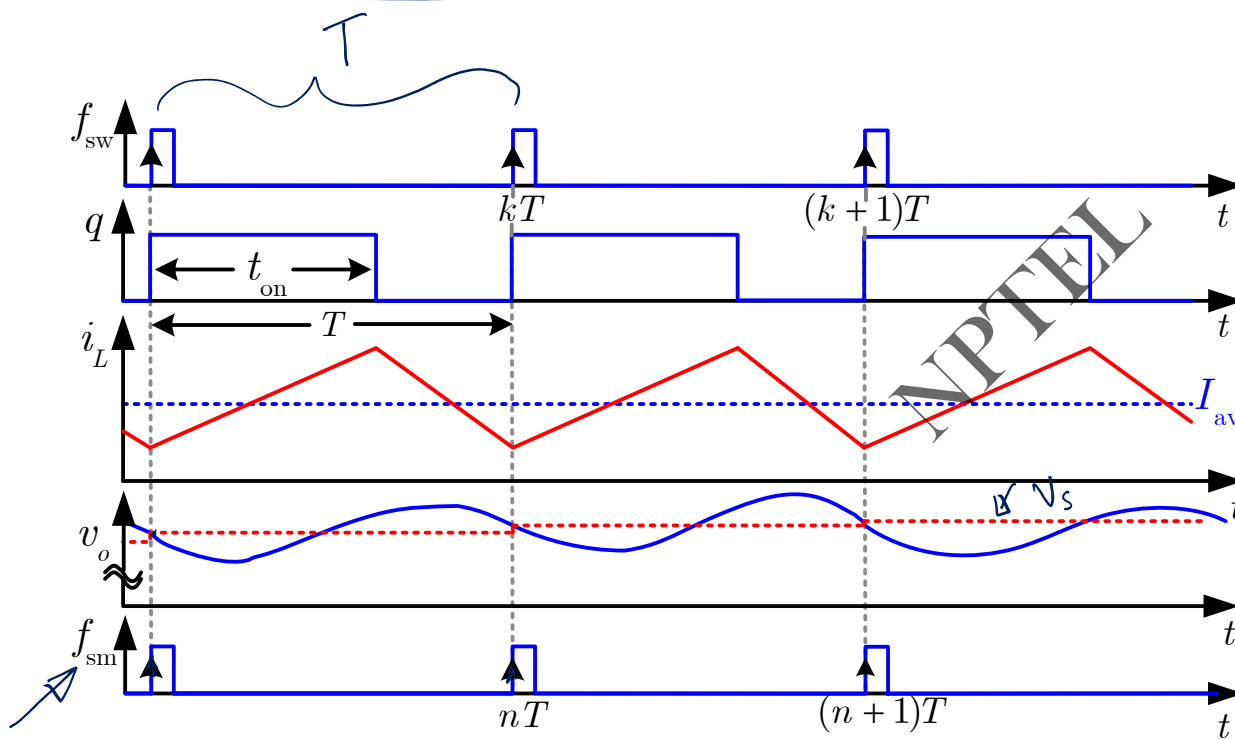


Waveforms of Buck Converter under PWM : Trailing-edge Modulation



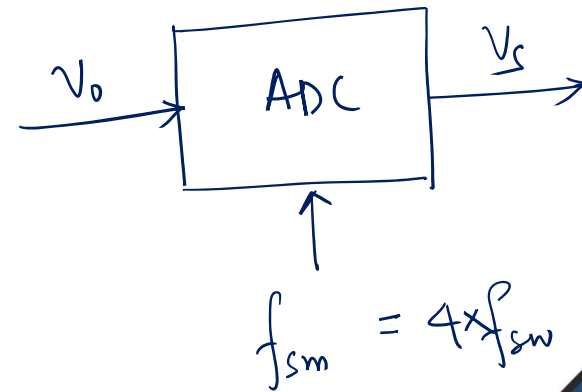
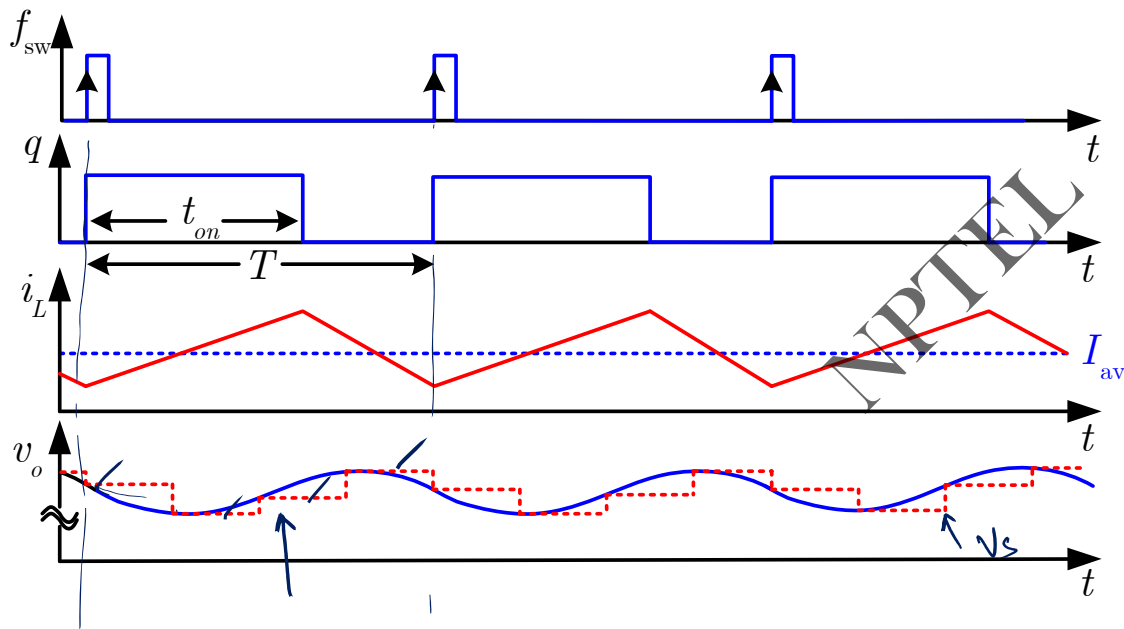
Trailing-edge Modulation : Uniform Sampling

Case 1: One sampling per cycle



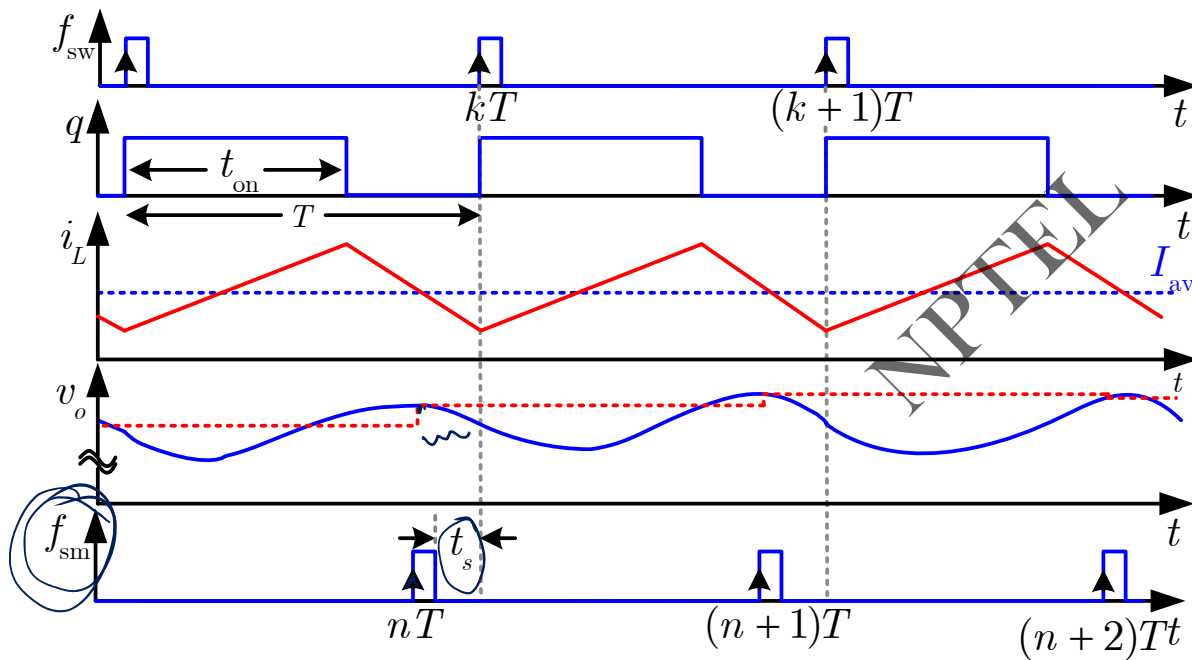
Different Sampling Case Studies : Uniform sampling

Case 2: Four samples per switching cycle

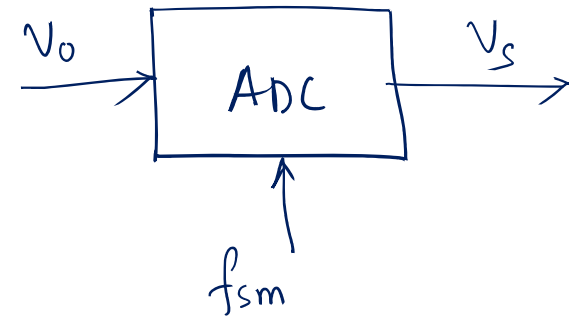


Trailing-edge Modulation : Uniform Sampling (contd...)

Case 3: Interval-2 sampling (t_s time delay)



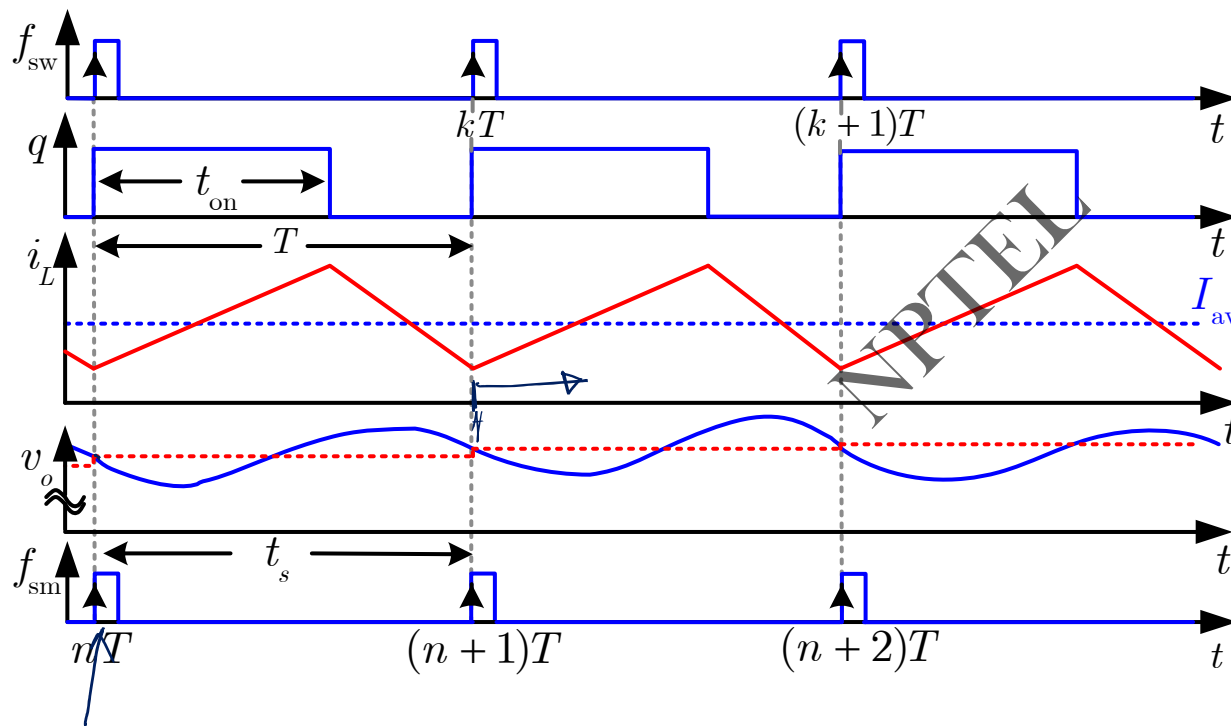
$$f_{sm} = f_{sw} \quad \text{freq. of } f_{sm} = \text{freq. of } f_{sw}$$



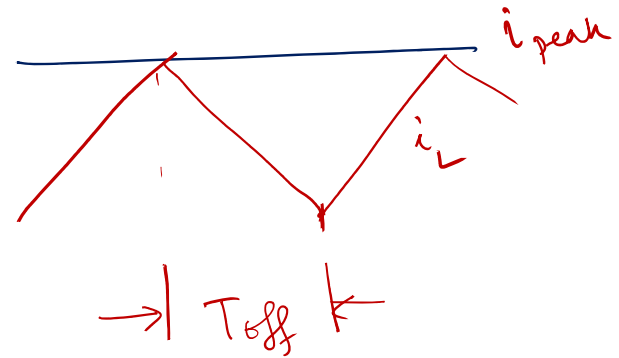
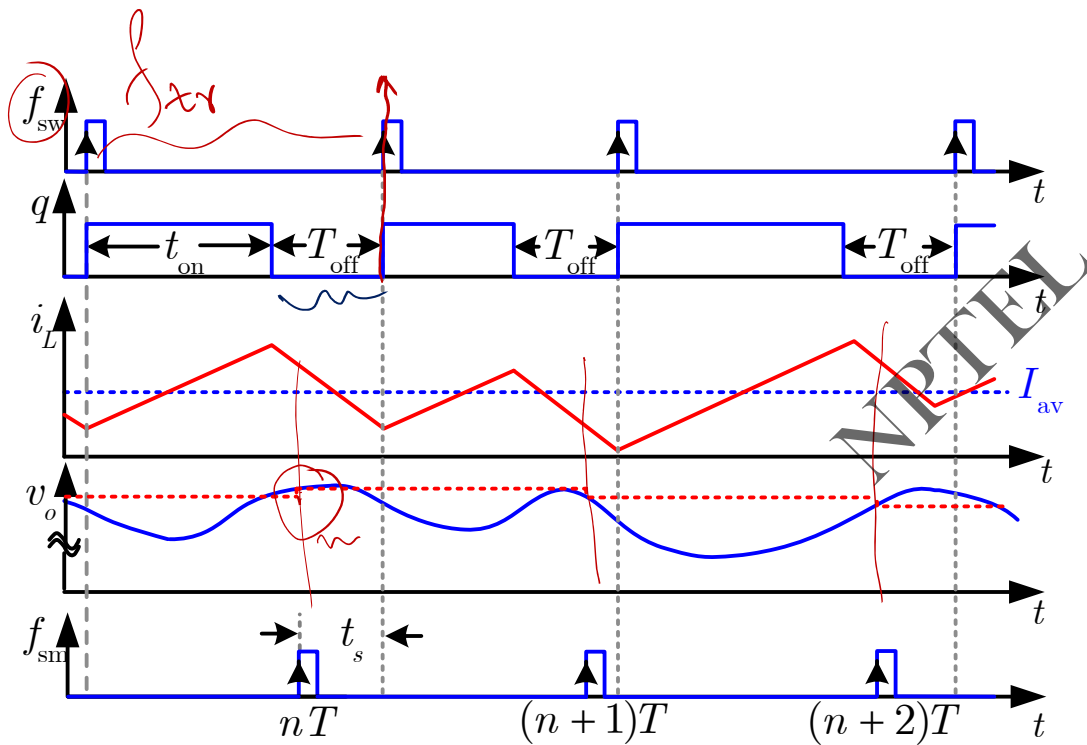
Conversion time
+ computational
time

Trailing-edge Modulation : Uniform Sampling (contd...)

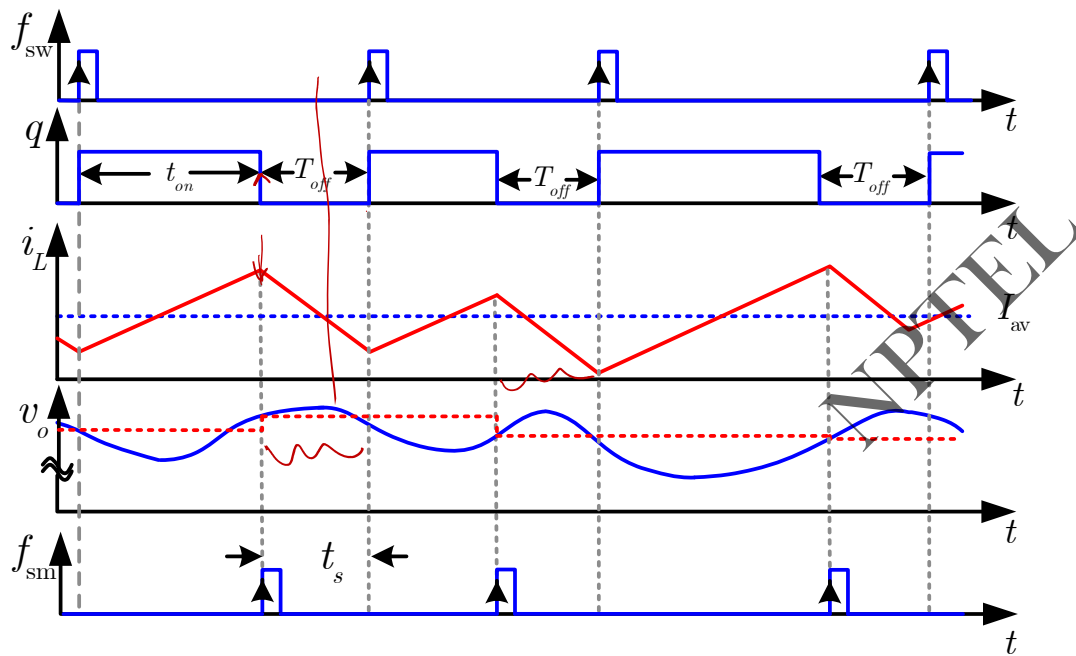
Case 4: Interval-2 sampling (one cycle delay)



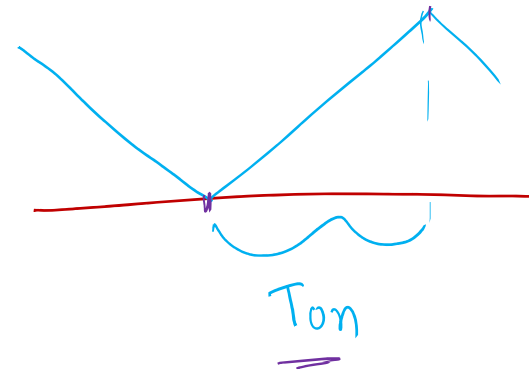
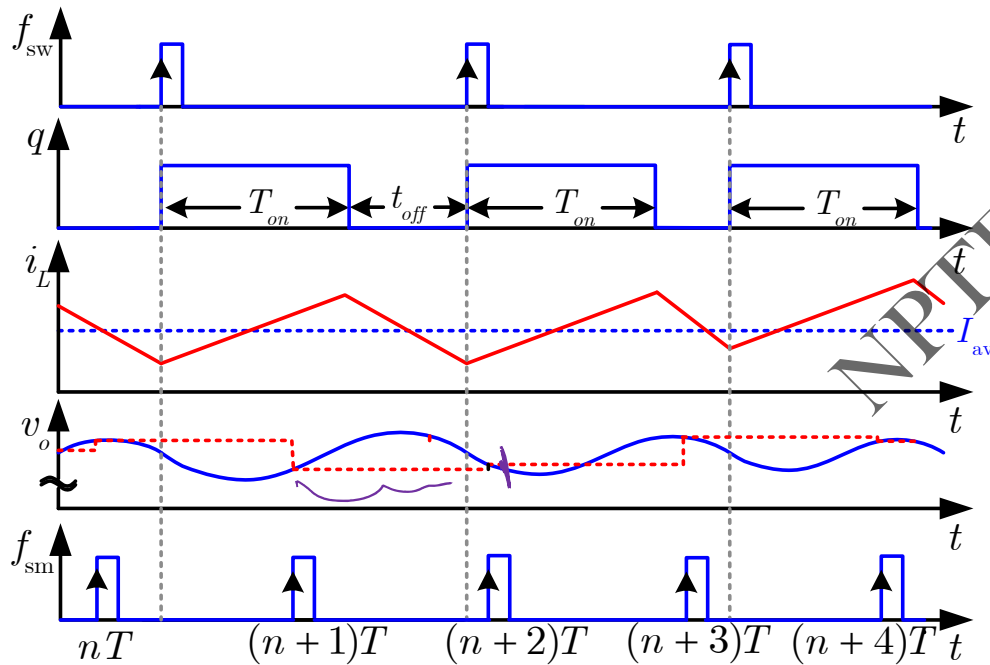
Constant Off-time Modulation : Uniform Sampling



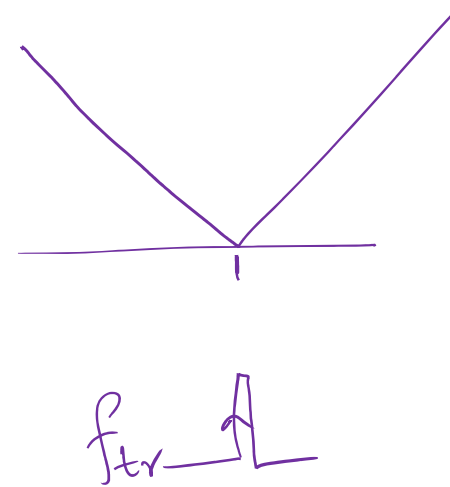
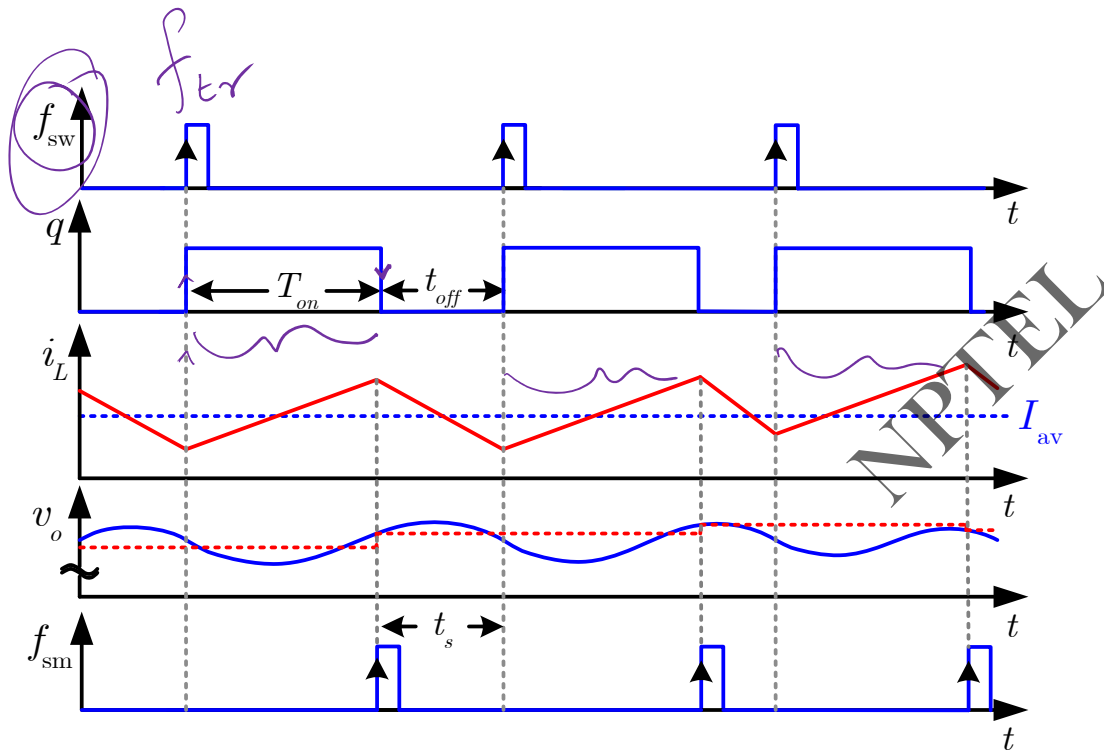
Constant Off-time Modulation : Event Based Sampling



Constant On-time Modulation : Uniform Sampling

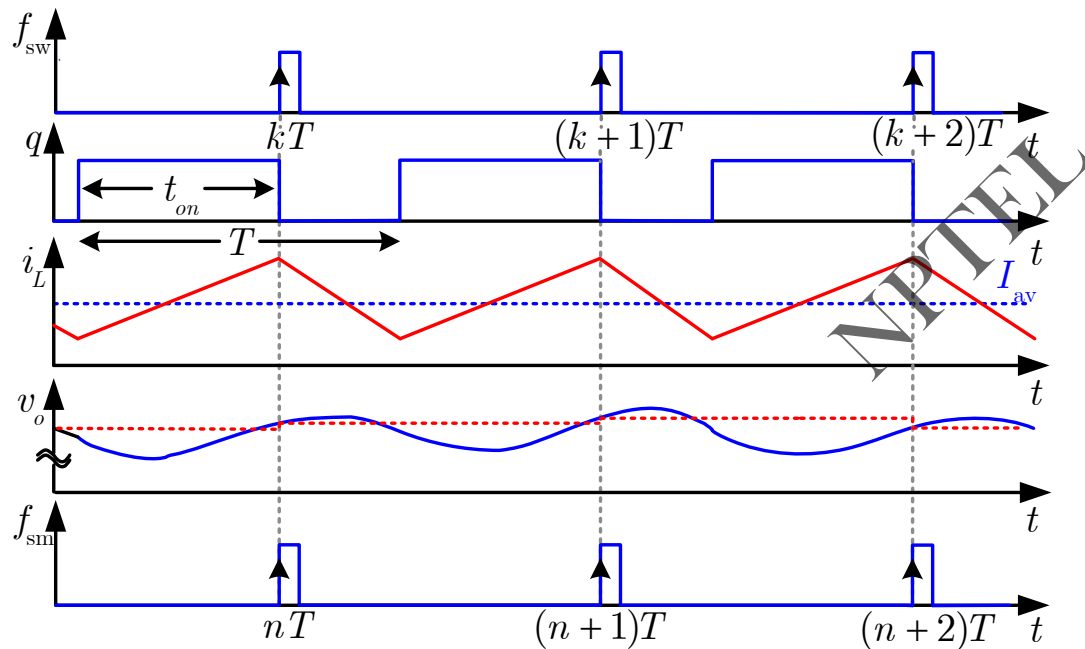


Constant On-time Modulation : Event Based Sampling



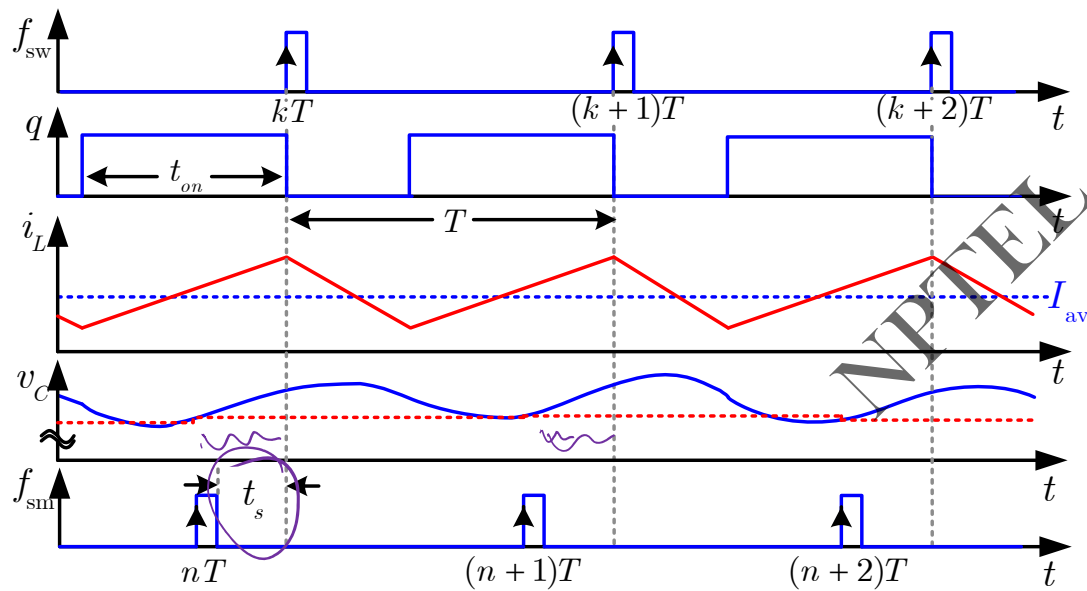
Leading-edge Modulation: Uniform Sampling

Case 1: One sampling per cycle



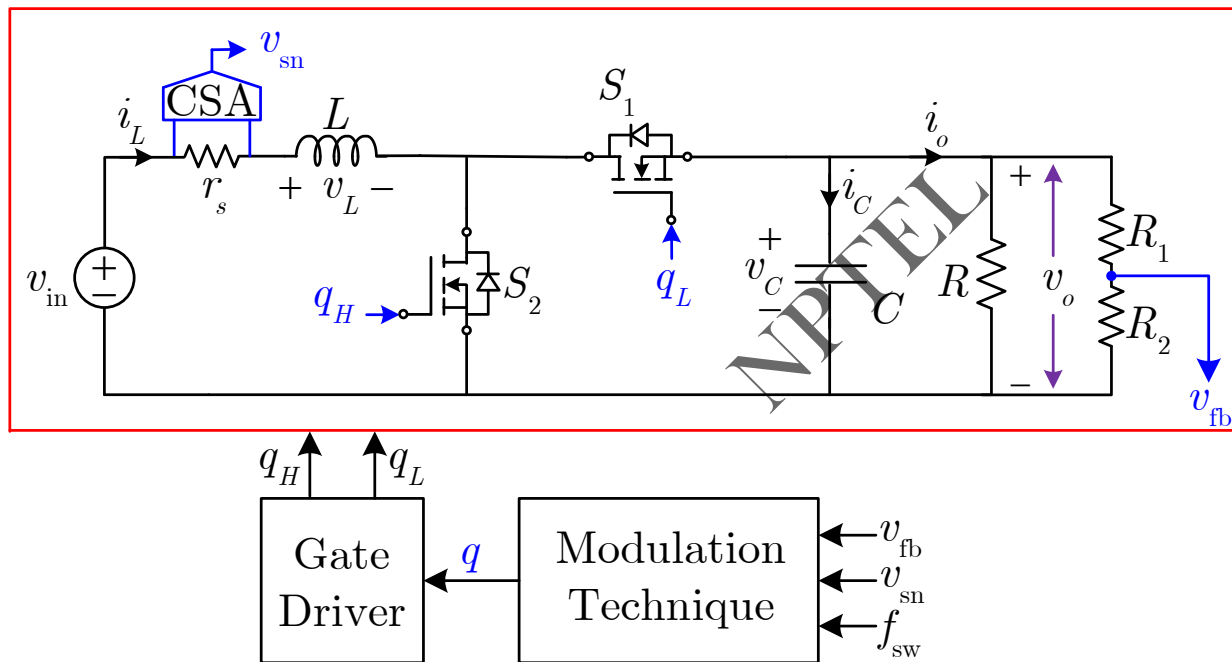
Leading-edge Modulation: Uniform Sampling (contd...)

Case 2: Interval-1 sampling



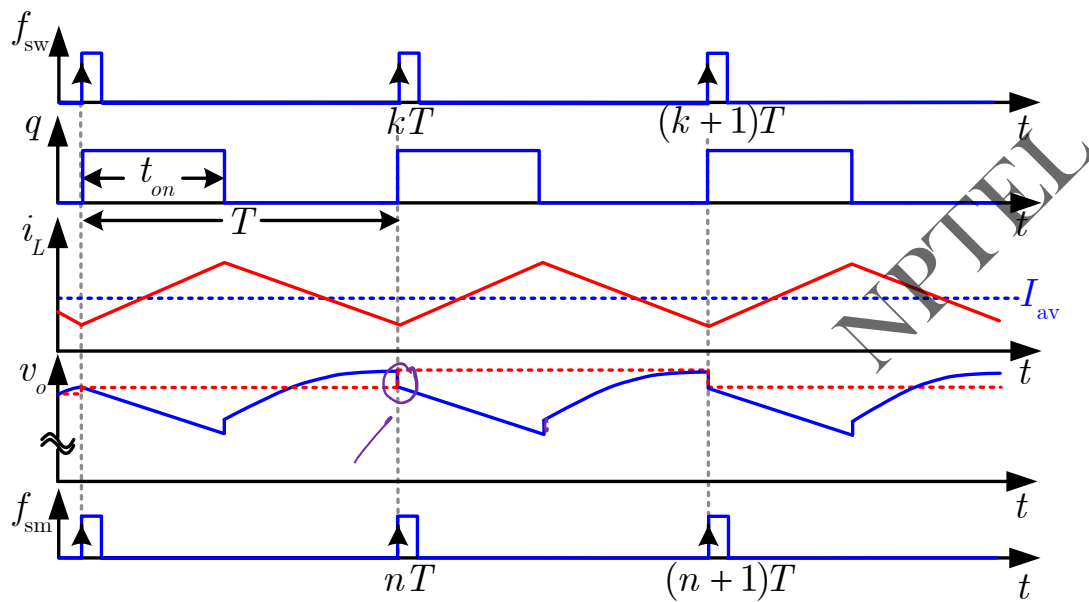
Boost Converter

Boost Converter



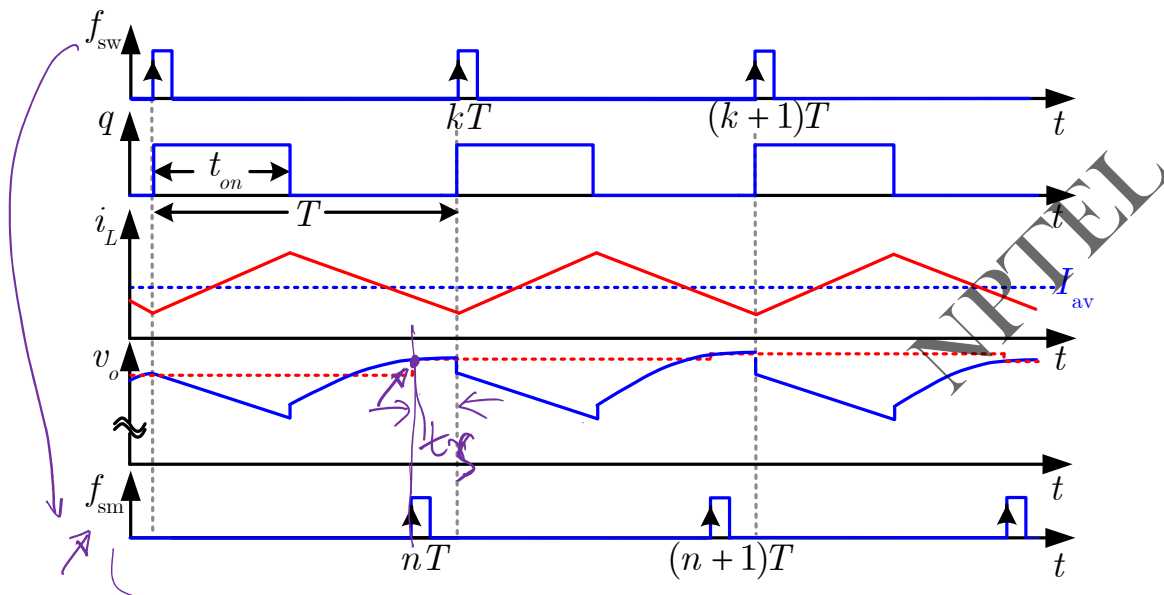
Trailing-edge Modulation : Uniform Sampling

Case 1: One sampling per cycle



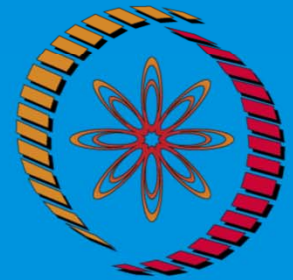
Trailing-edge Modulation : Uniform Sampling (contd...)

Case 2: Interval II sampling (t_s time delay)



CONCLUSION

- Steady-state operation of switched mode power converters
- Various fixed and variable frequency modulation techniques
- Understanding sampling methods
- Basics of uniform and event-based sampling methods



**THANK
YOU !**