NPTEL ONLINE CERTIFICATION COURSES



# DIGITAL CONTROL IN SMPCs AND FPGA-BASED PROTOTYPING

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Electrical Engineering Department, IIT KHARAGPUR

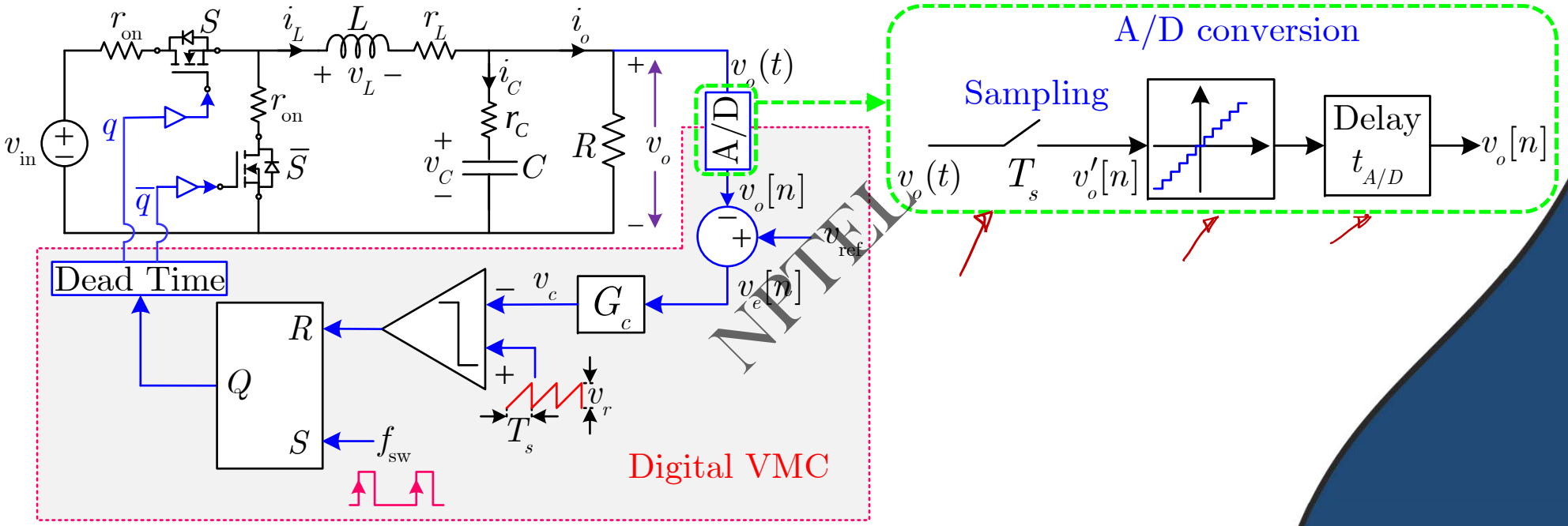
## Module 03: MATLAB Custom Model Development under Digital Control

**Lecture 25: MATLAB Model Development for Digital Voltage Mode Control**

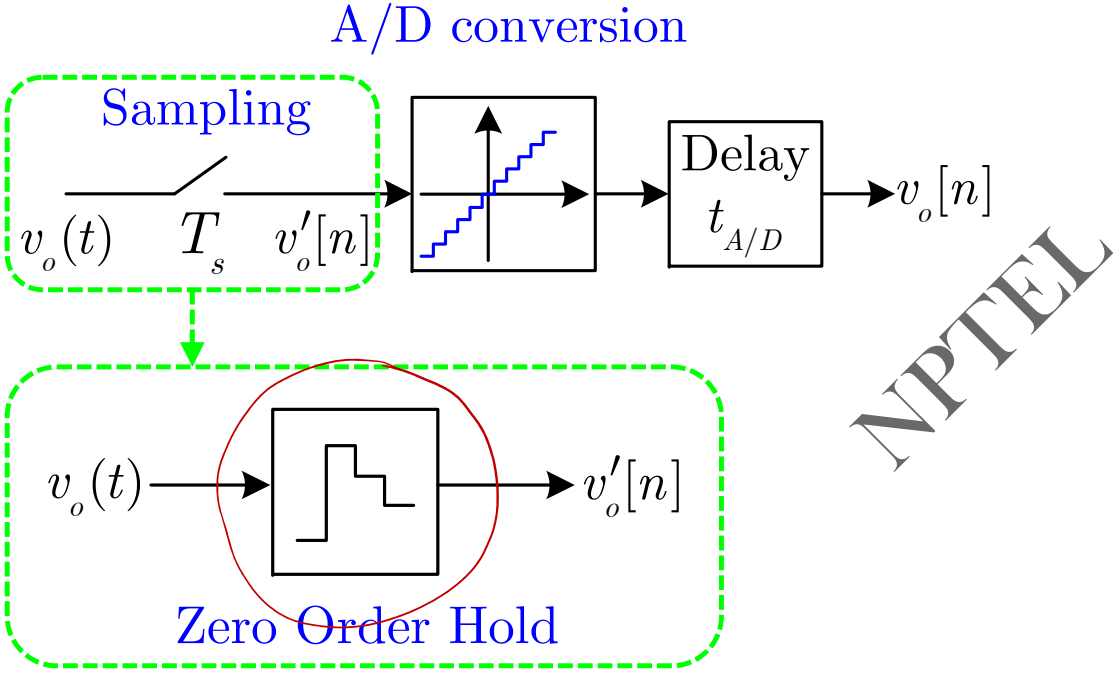
# CONCEPTS COVERED

- Custom MATLAB model development for digital voltage mode control
- MATLAB simulation case studies

# Digital Voltage Mode Control (VMC) of Buck Converter

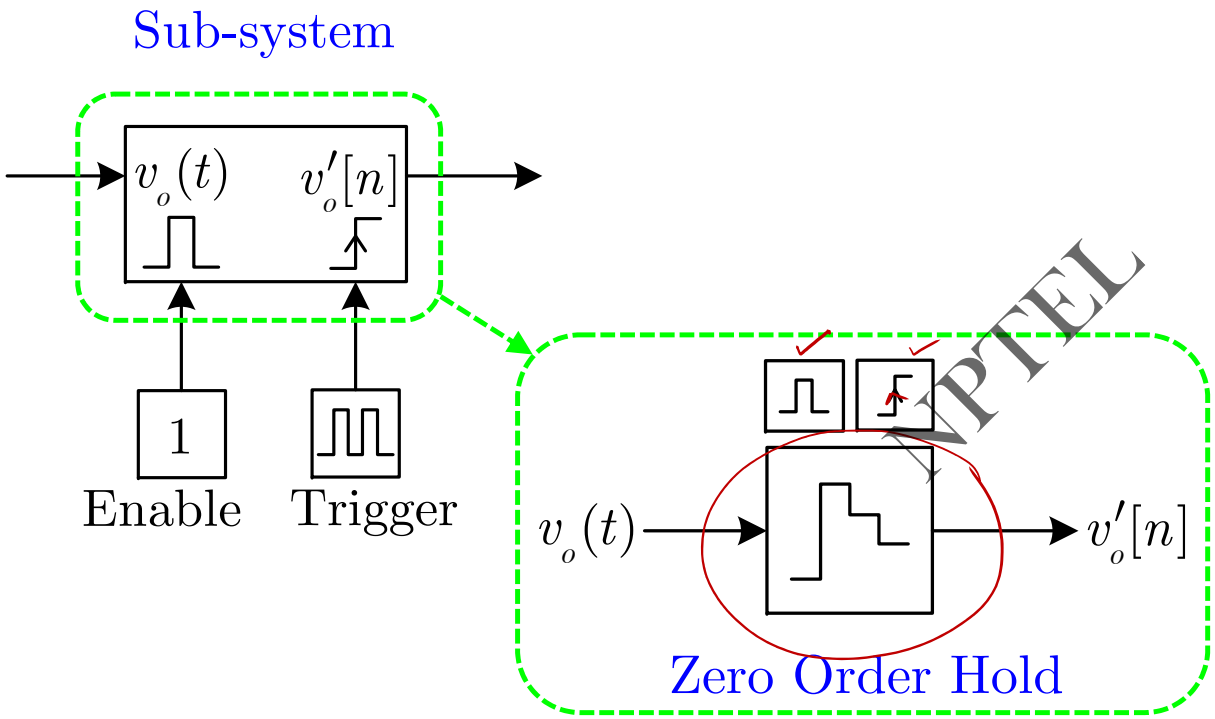


# *Analog to Digital Converter (ADC)*



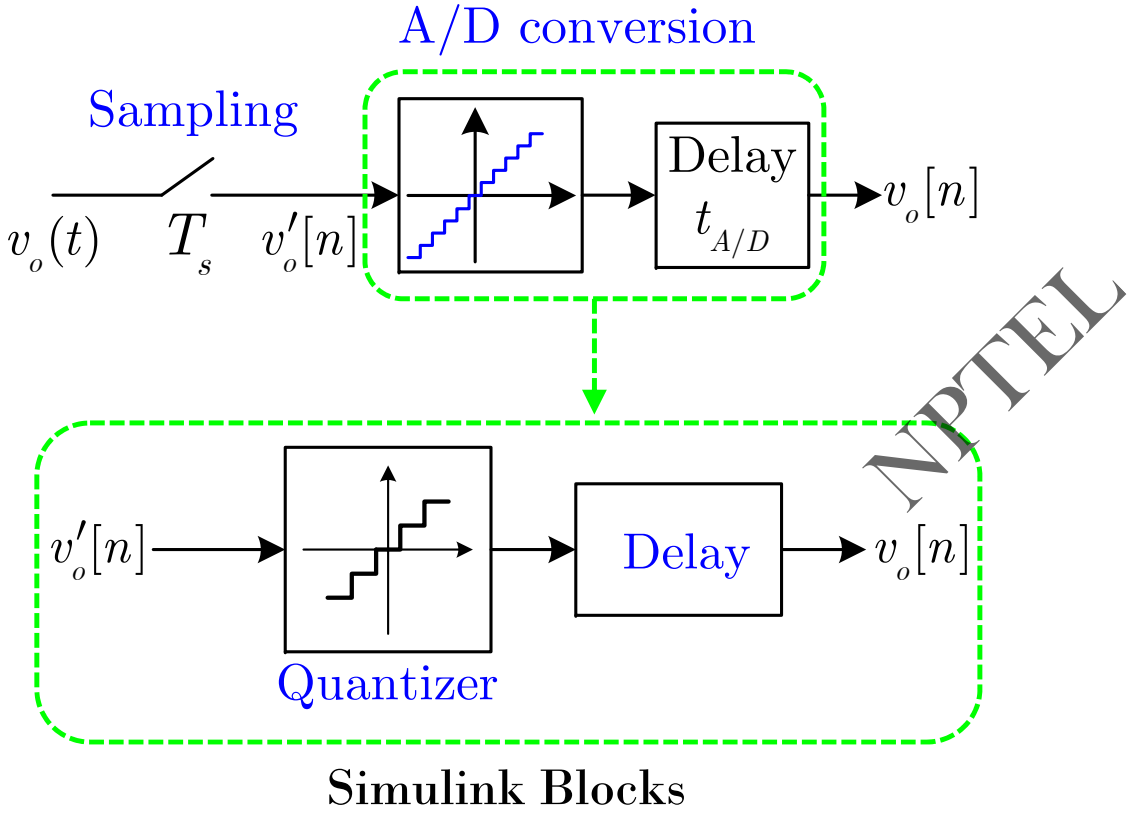

**Simulink Block**

# *Analog to Digital Converter (ADC)*



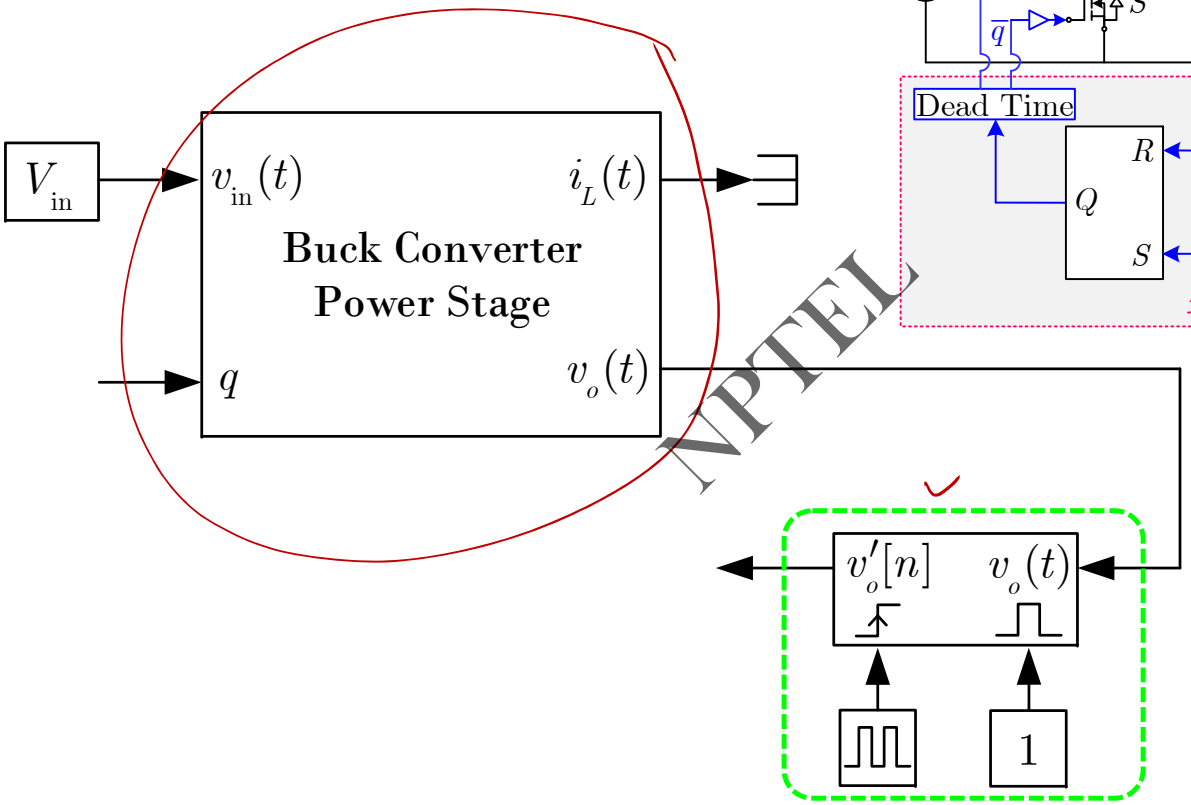

**Enabled and Triggered Simulink Subsystem**

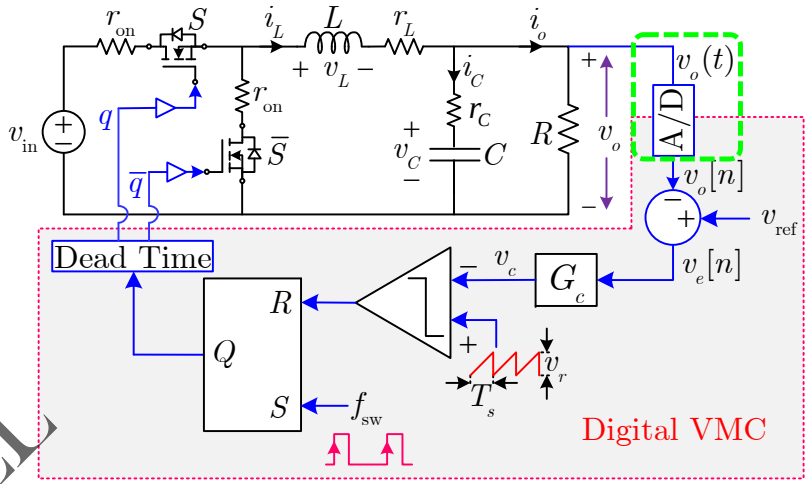
# *Analog to Digital Converter (ADC)*



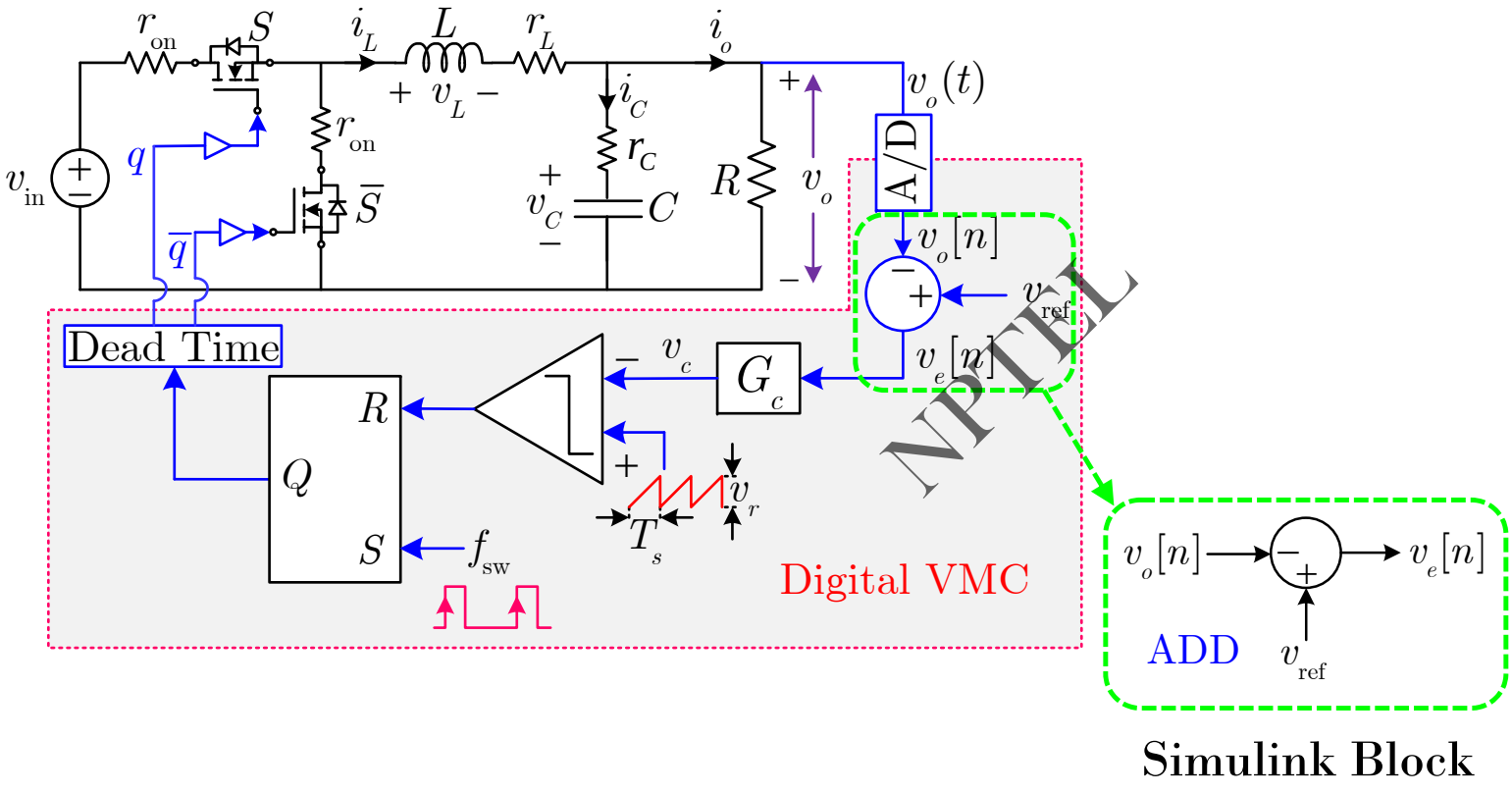

**Simulink Blocks**

# MATLAB Model for VMC



# Voltage Error

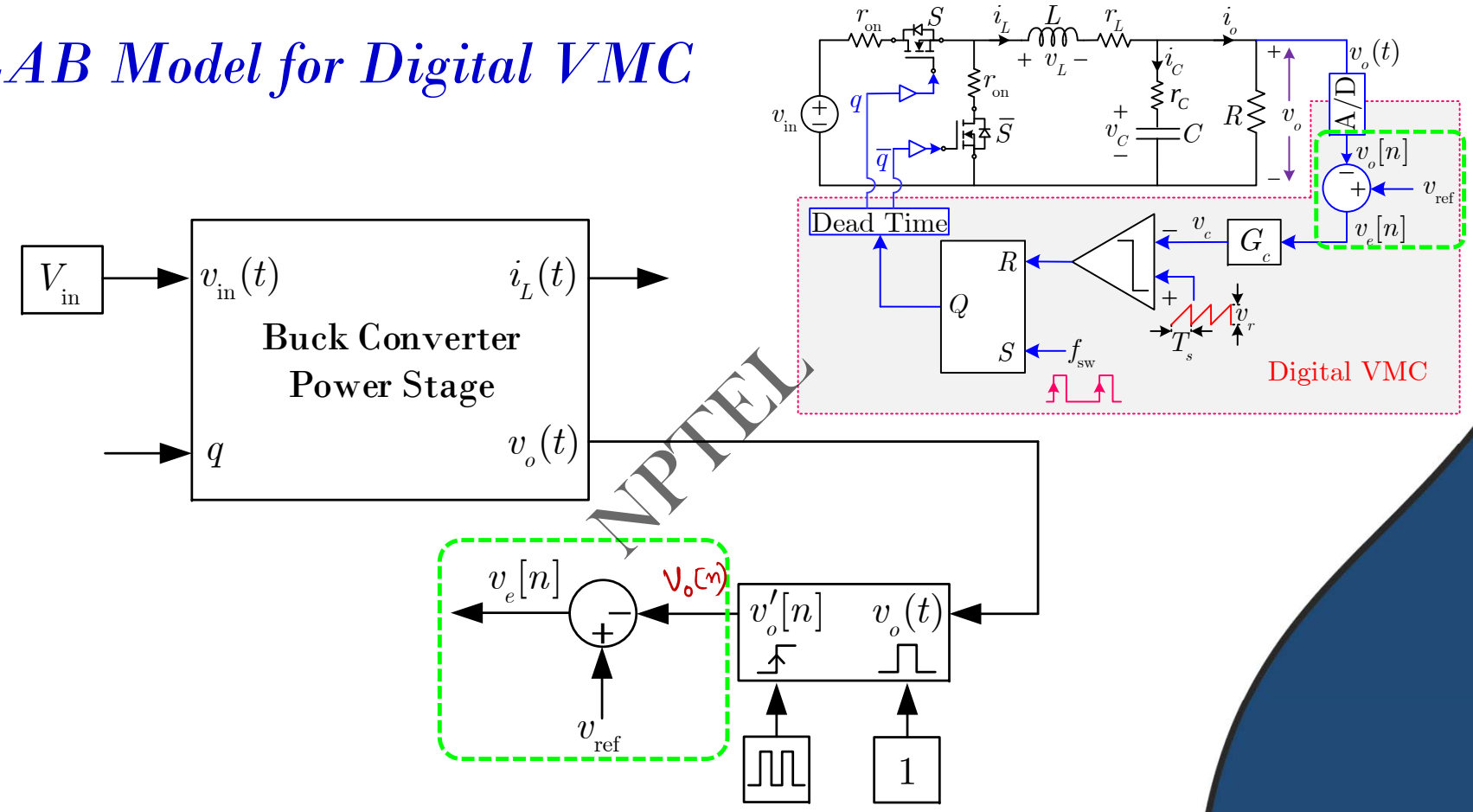




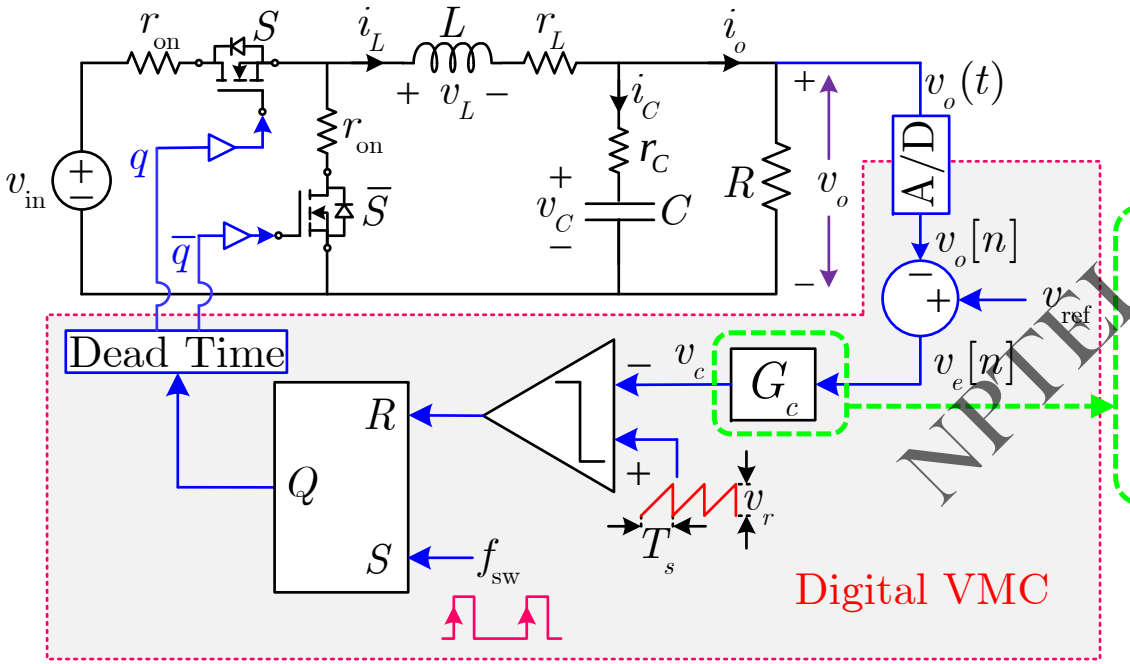


Simulink Block

# MATLAB Model for Digital VMC



# Digital Compensator



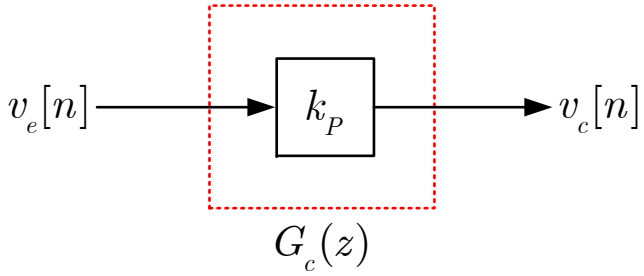



**Digital Compensator $G_c(z)$**

- P
- PI
- PID

# *Digital Compensator (contd..)*

- Proportional

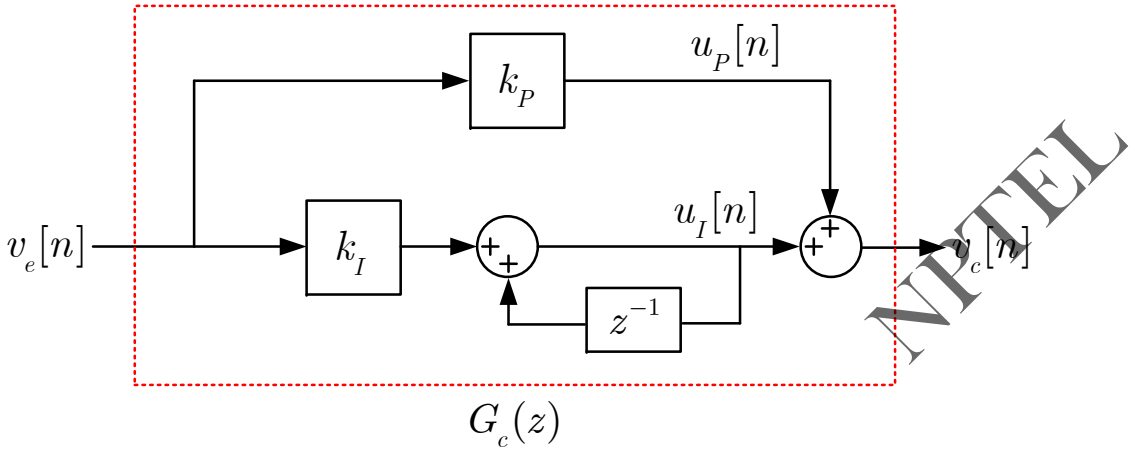





$$G_c(z) = k_P$$

# Digital Compensator (contd..)

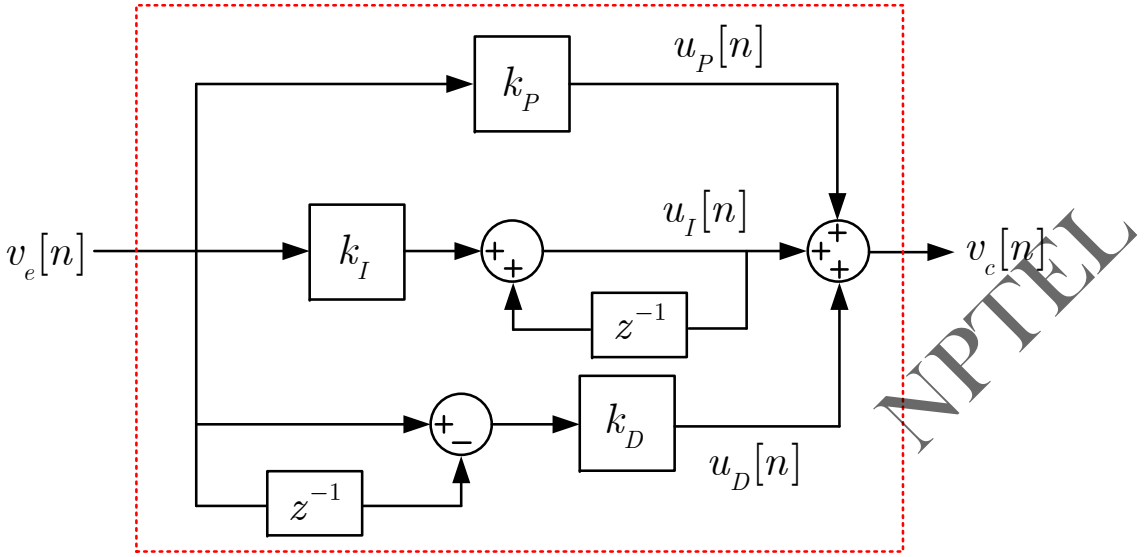
- Proportional-Integral




$$G_c(z) = k_P + \frac{k_I}{1 - z^{-1}}$$

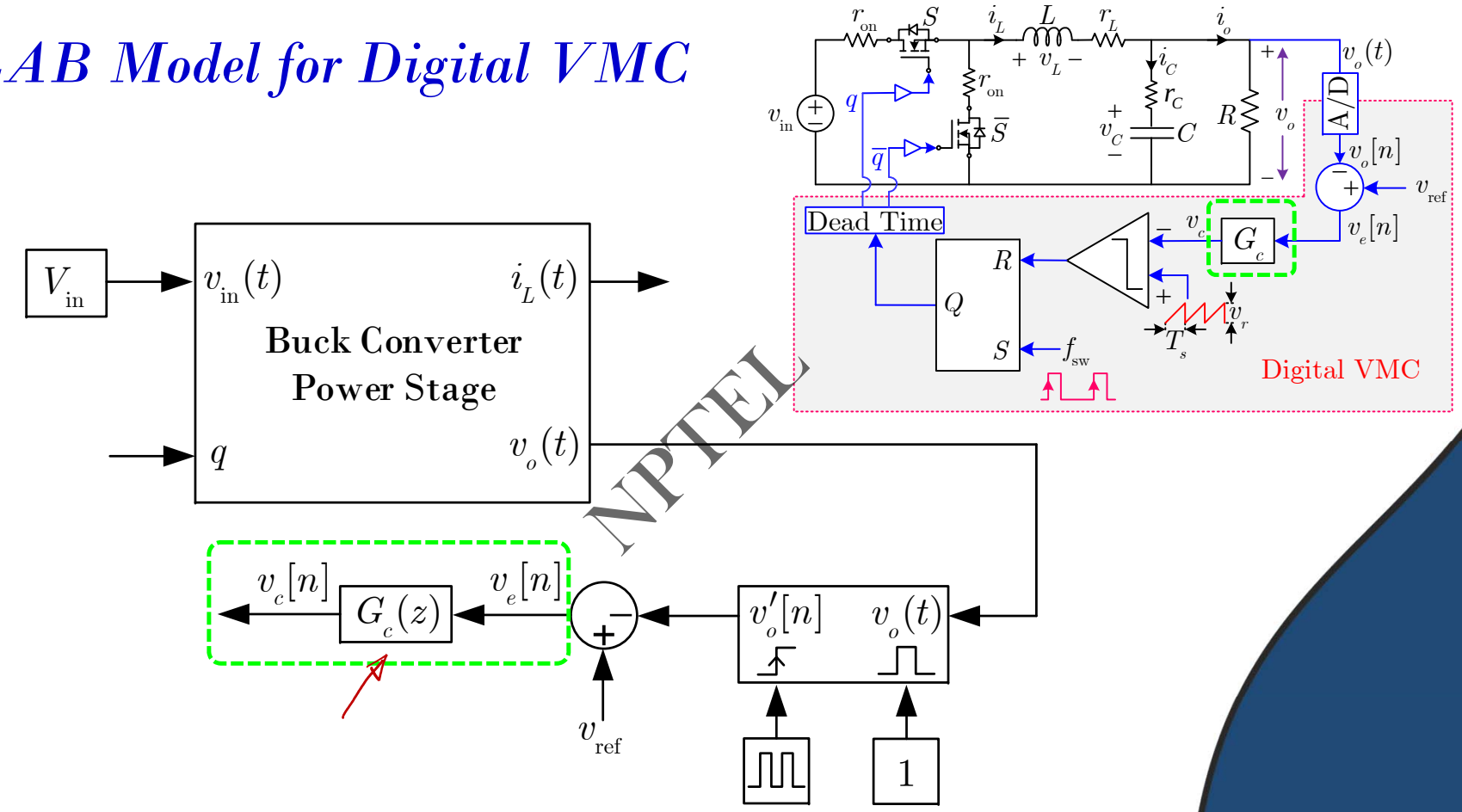
# Digital Compensator (contd..)

- Proportional-Integral-Derivative

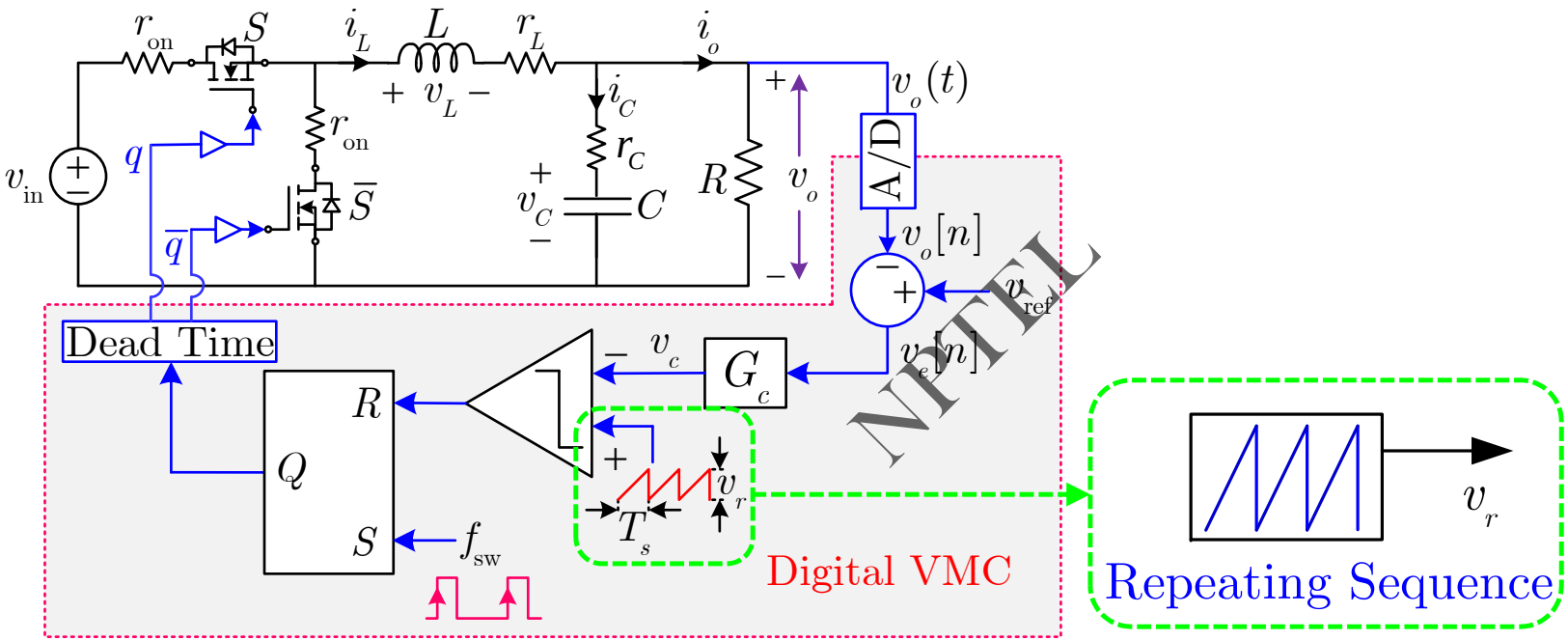



$$G_c(z) = k_P + \frac{k_I}{1 - z^{-1}} + k_D(1 - z^{-1})$$

# MATLAB Model for Digital VMC



# External Ramp Generation

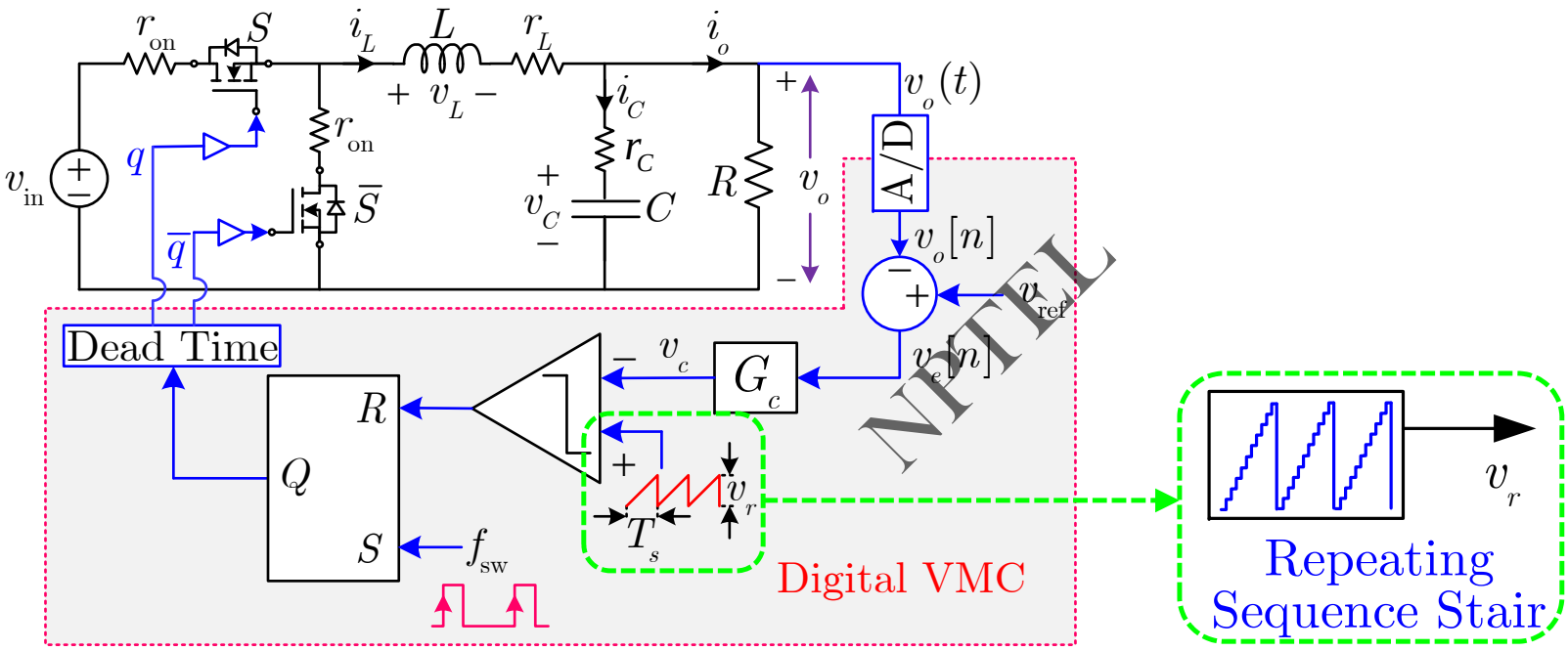




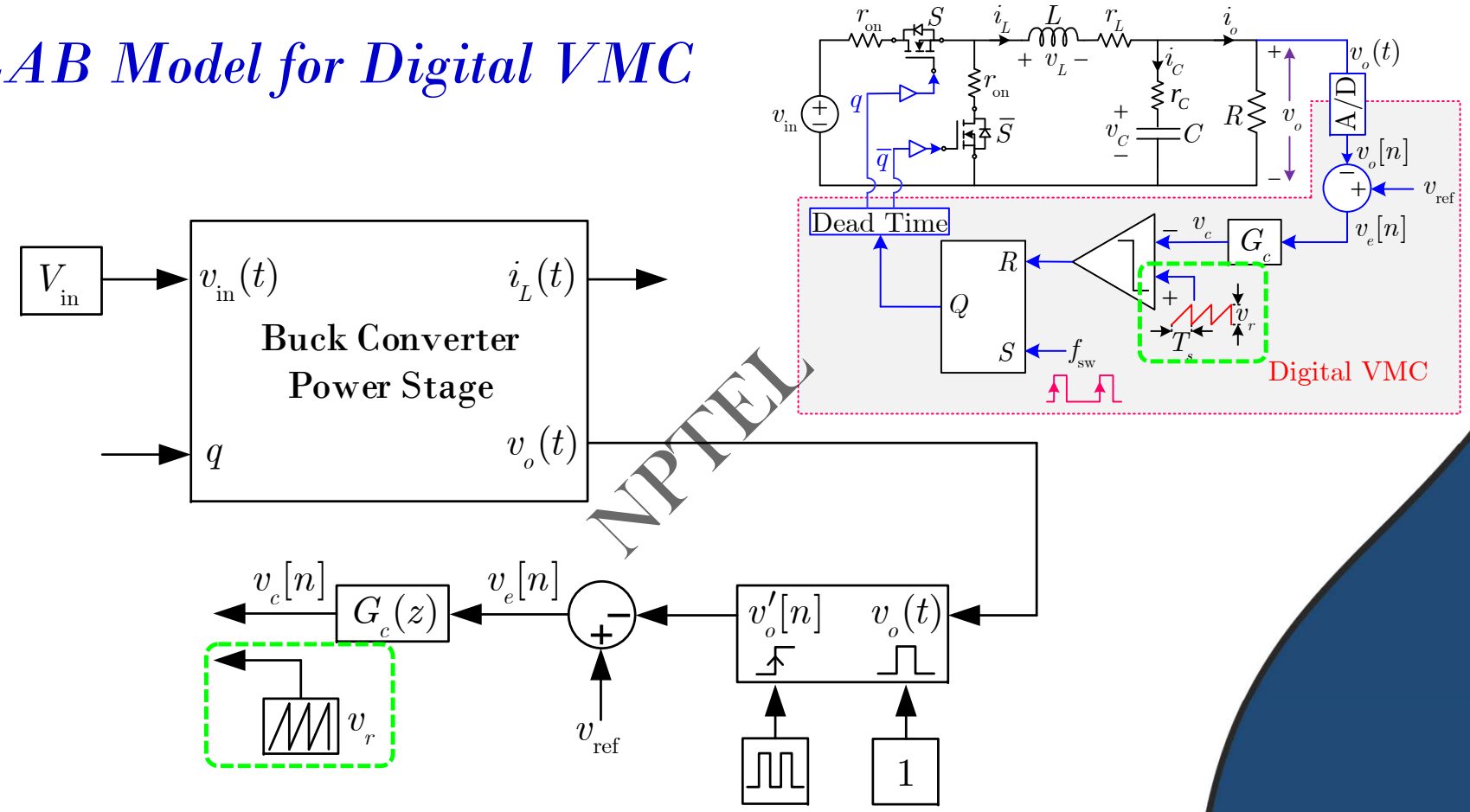


Simulink Block

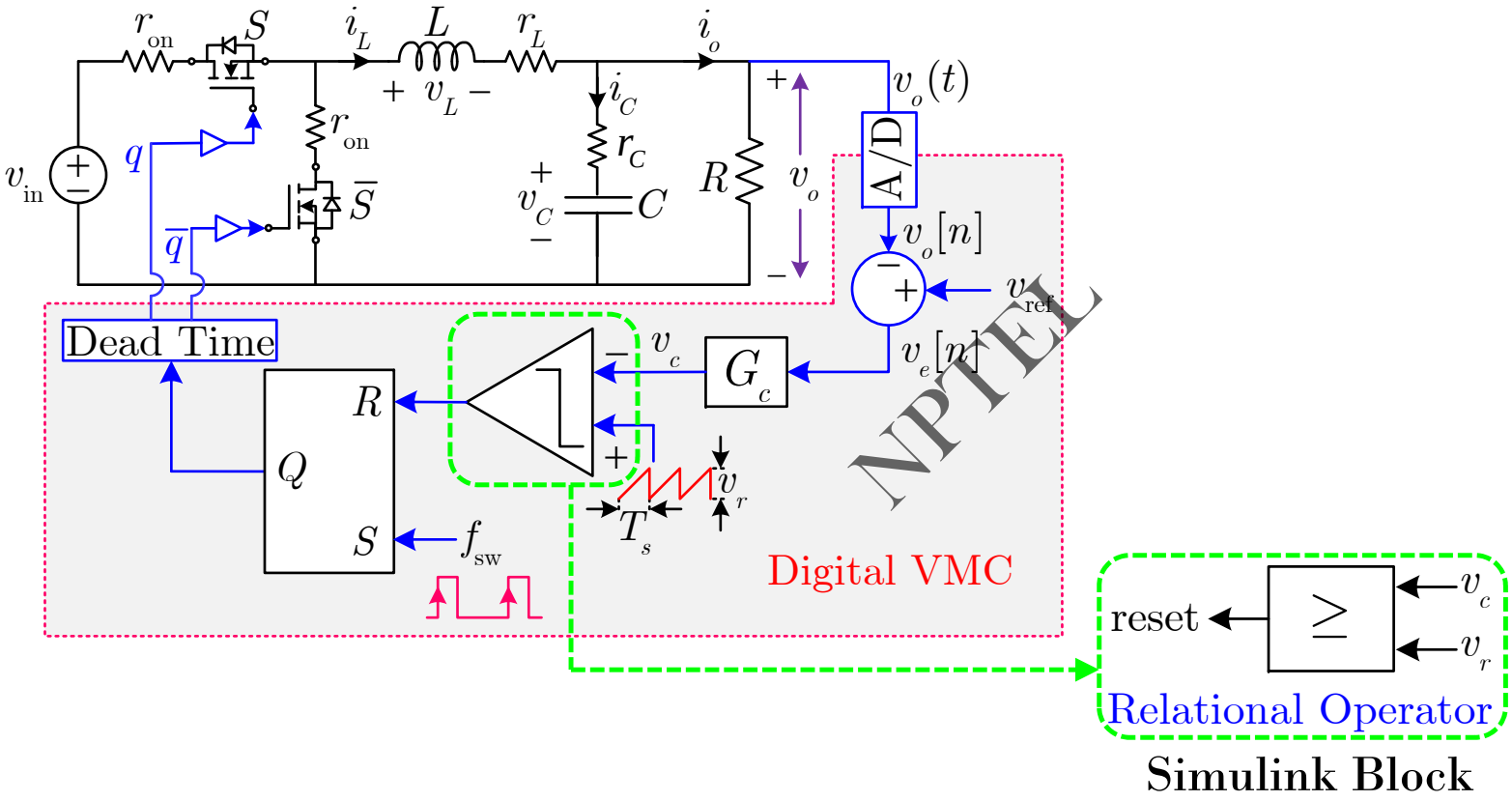
# External Ramp Generation (contd…)



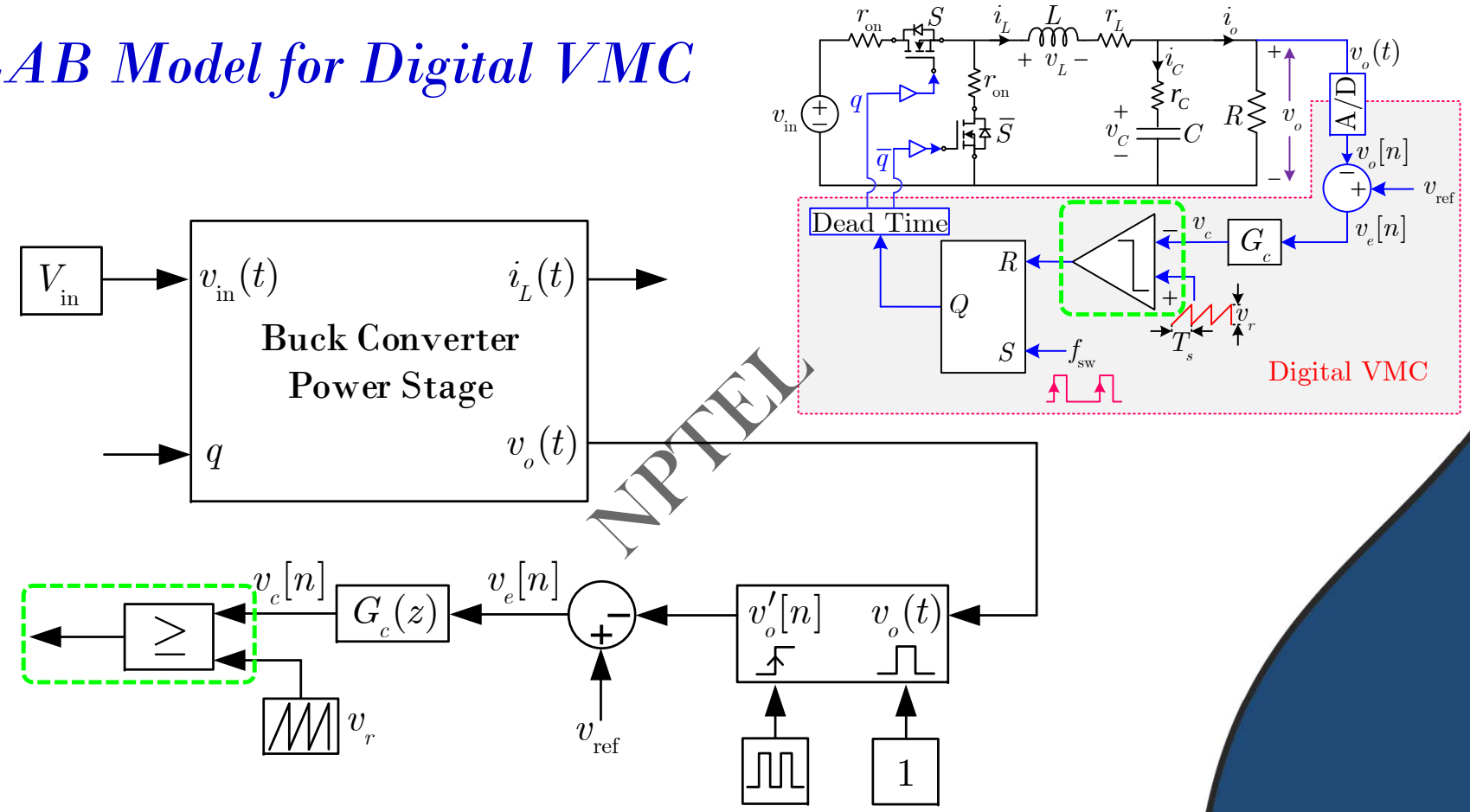
# MATLAB Model for Digital VMC



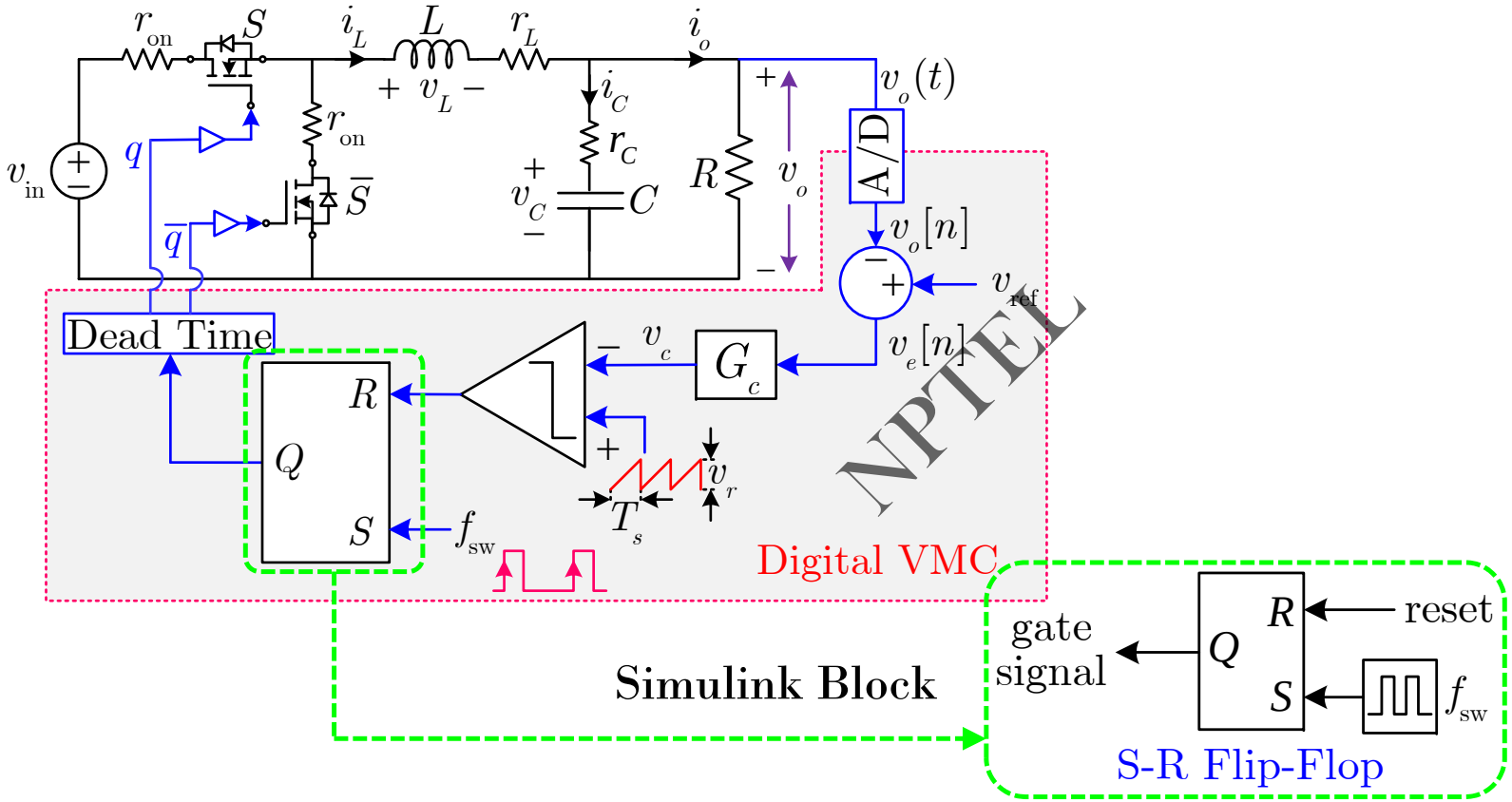
# Voltage Comparator



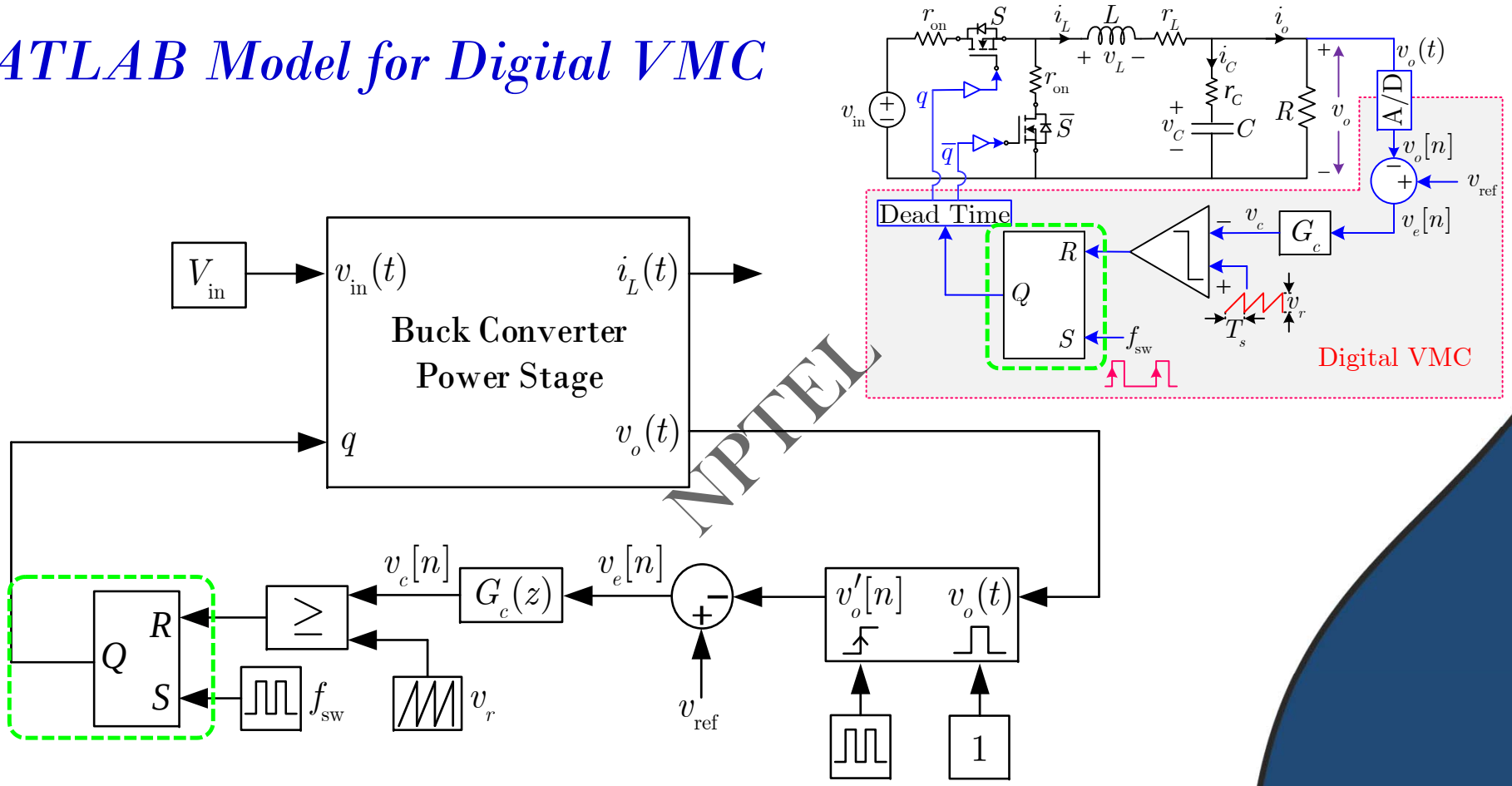
# MATLAB Model for Digital VMC



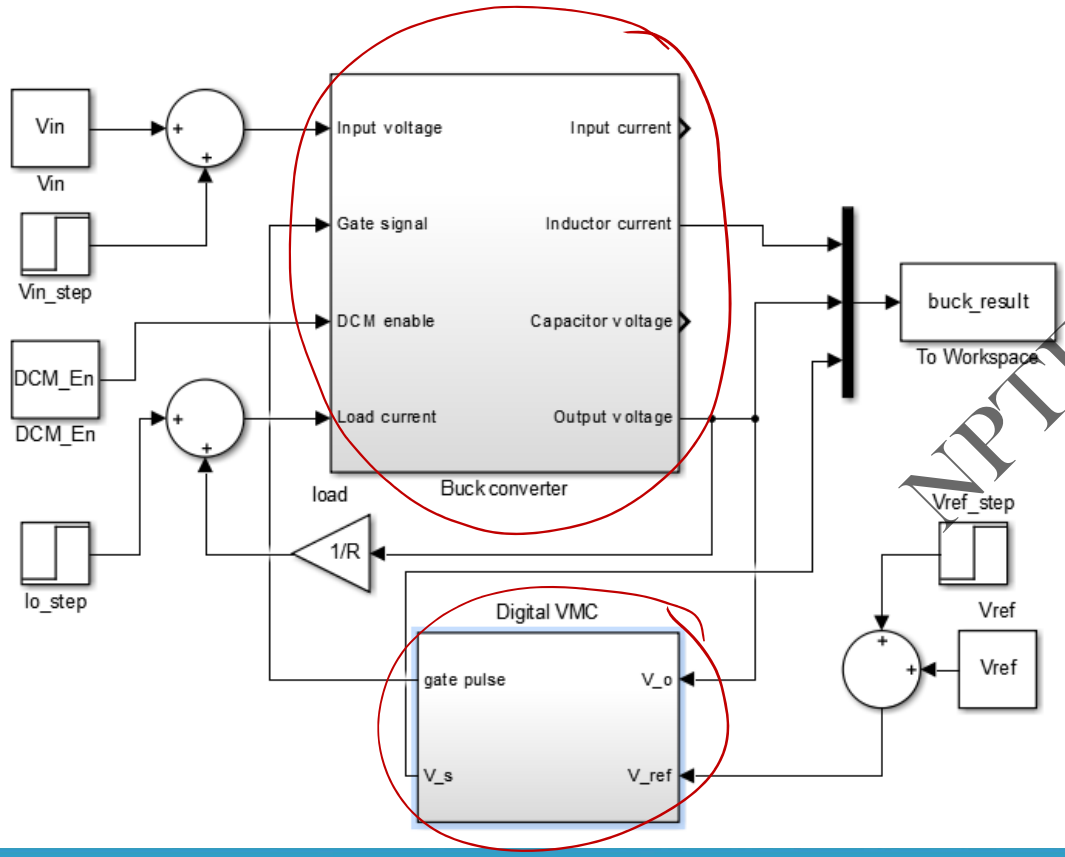
# SR Latch

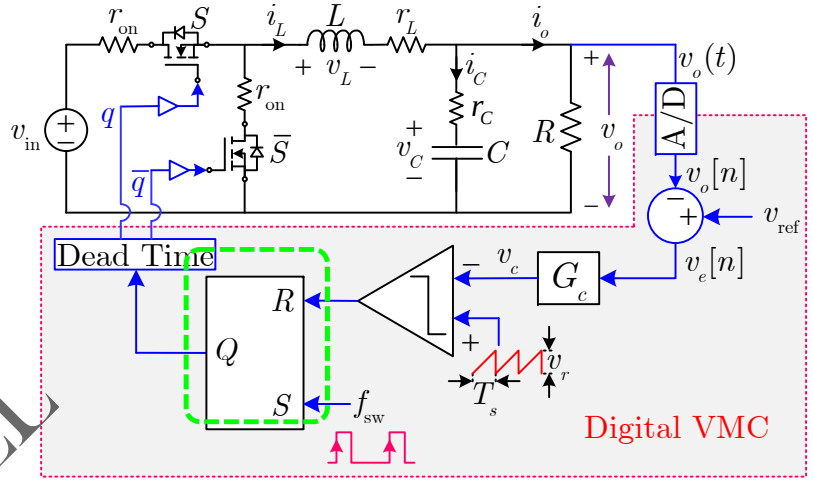

$r_{on}$
$S$
$i_L$
$L$
$r_L$
$i_o$
$+\ v_L\ -$
$i_C$
$r_C$
$v_C$
$C$
$R$
$v_o$
$v_o(t)$
A/D
$v_o[n]$
$v_{ref}$
$v_e[n]$
$G_c$
$v_c$
$v_r$
$T_s$
$f_{sw}$
$v_{in}$
$q$
$\bar{q}$
$\bar{S}$
Dead Time
$R$
$Q$
$S$
Digital VMC
NPTEL
Simulink Block
gate signal
reset
S-R Flip-Flop

# MATLAB Model for Digital VMC

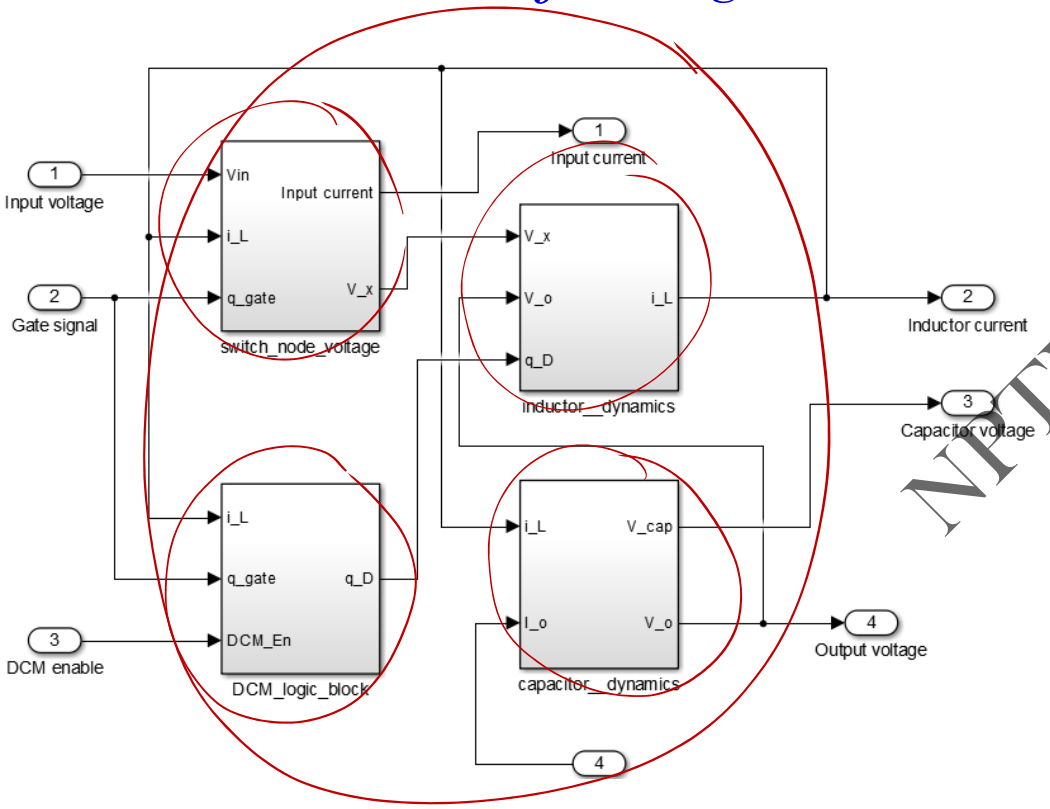


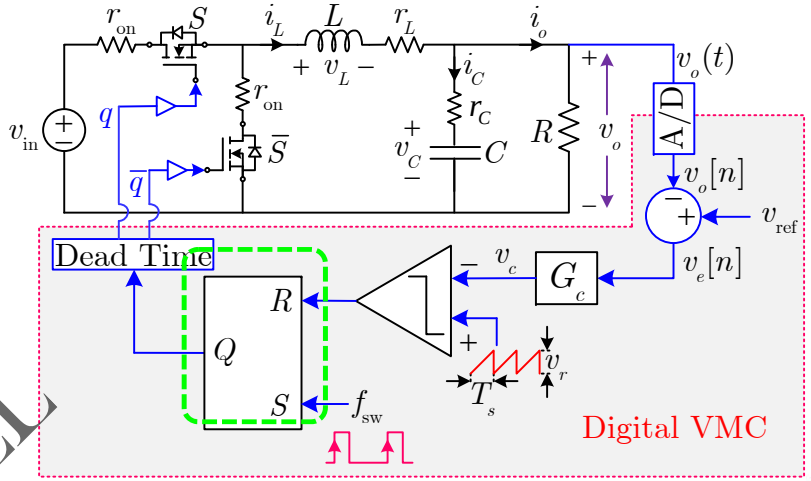
# MATLAB Model for Digital VMC



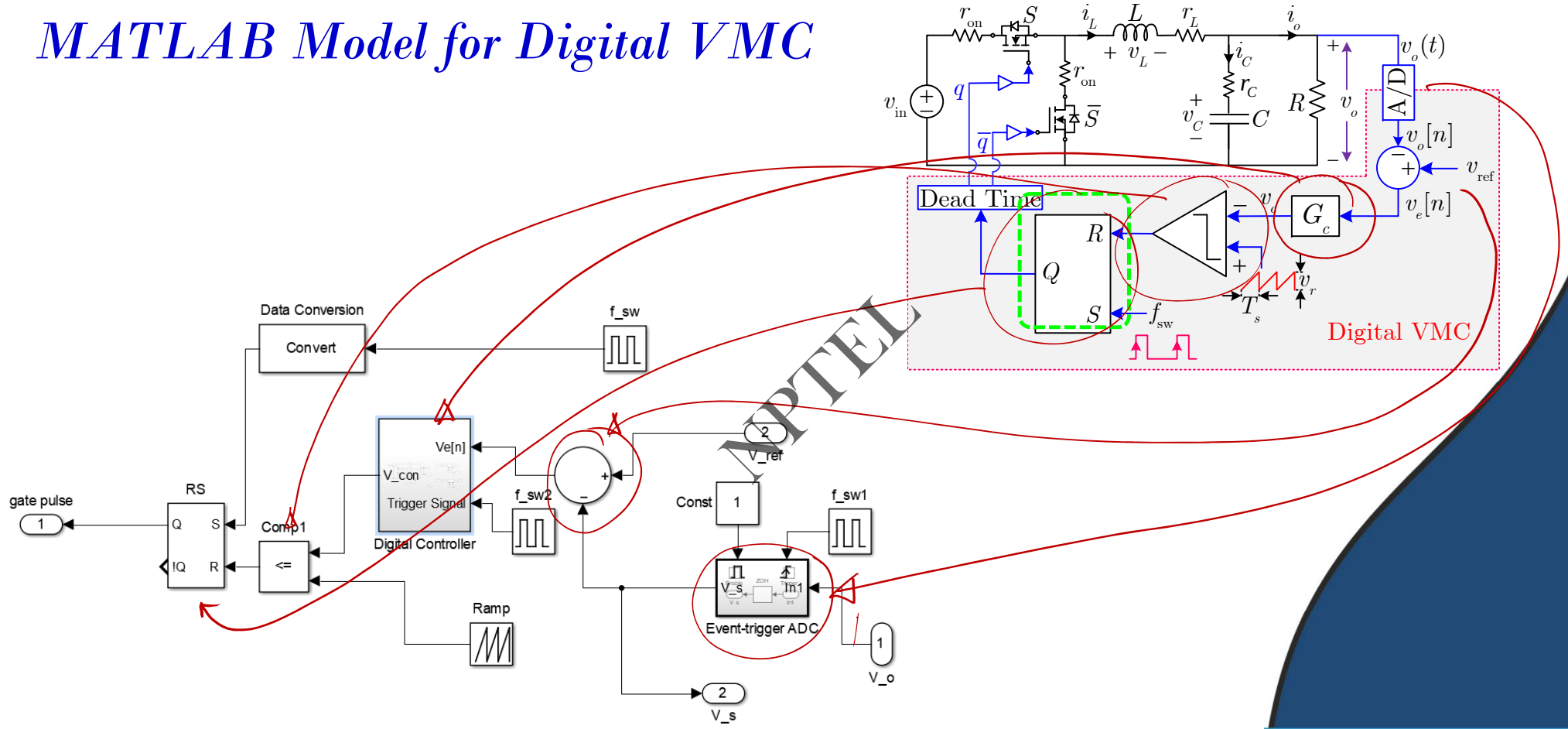



# MATLAB Model for Digital VMC

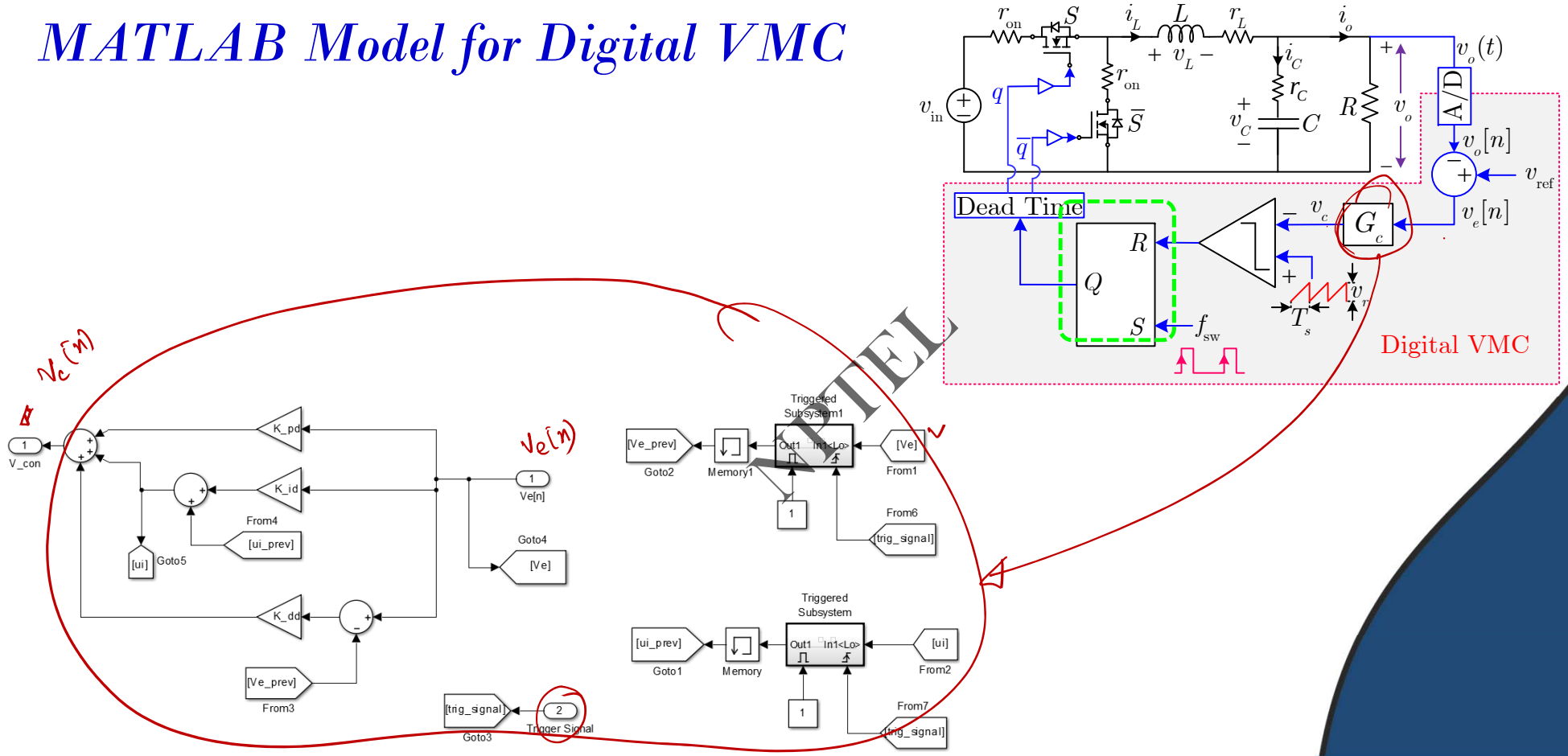


# MATLAB Model for Digital VMC



# MATLAB Model for Digital VMC



# CONCLUSION

- Custom MATLAB model development for digital voltage mode control
- MATLAB simulation case studies



# THANK YOU !