

Figure 1: Home-screen of the CIT android application



★ **System response**

Parameter identification

★ **First-order system**

★ **Second-order system**

★ **PID controller**

Version 1.0.0 (12)

Figure 2: Drawer of the CIT android application

☰ Control & Identification Toolbox
Parameter identification: First-order system

Diagram: Identification of a first-order system

T_s = 100 ms

Parameters

u_1(t)=0

u_2(t)=0

u_3(t)=0

Figure 1: Input, output and validation

Figure 2: Estimate of θ

Figure 3: Estimates of α_1, α_2 and α_3

Instantaneous values

Figure 3: Experimental results screen (ERS) for first-order parameter identification

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1: Initialize USB CDC to the boudrate = 115 200 bit s-1
2: while 1 do
3:   Receive from USB and store in A
4:   if A[0] == 0x34 then
5:     Set the value of A[2] as PWM out to the Analog
output port # A[1]- 0x60
6:   end if
7:   if A[0] == 0x33 then
8:     Read analog value from the Analog input # A[1]-
0x60 and send the value to USB
9:   end if
10: end while

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Figure 4: Bridge device's firmware

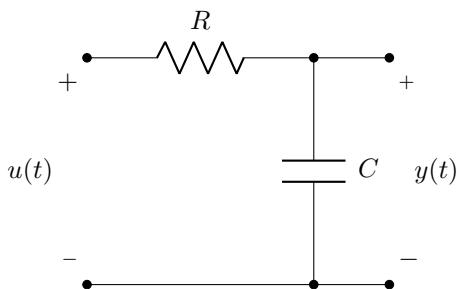


Figure 5: First order low pass filter

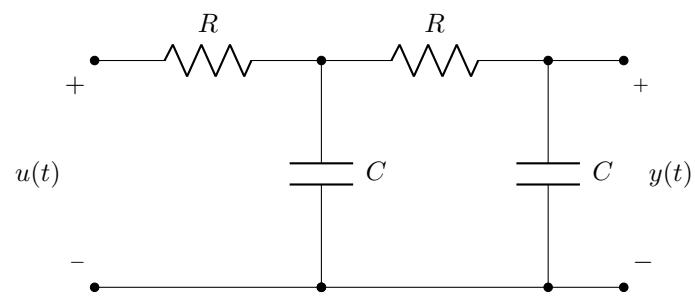


Figure 6: Second order low pass filter.

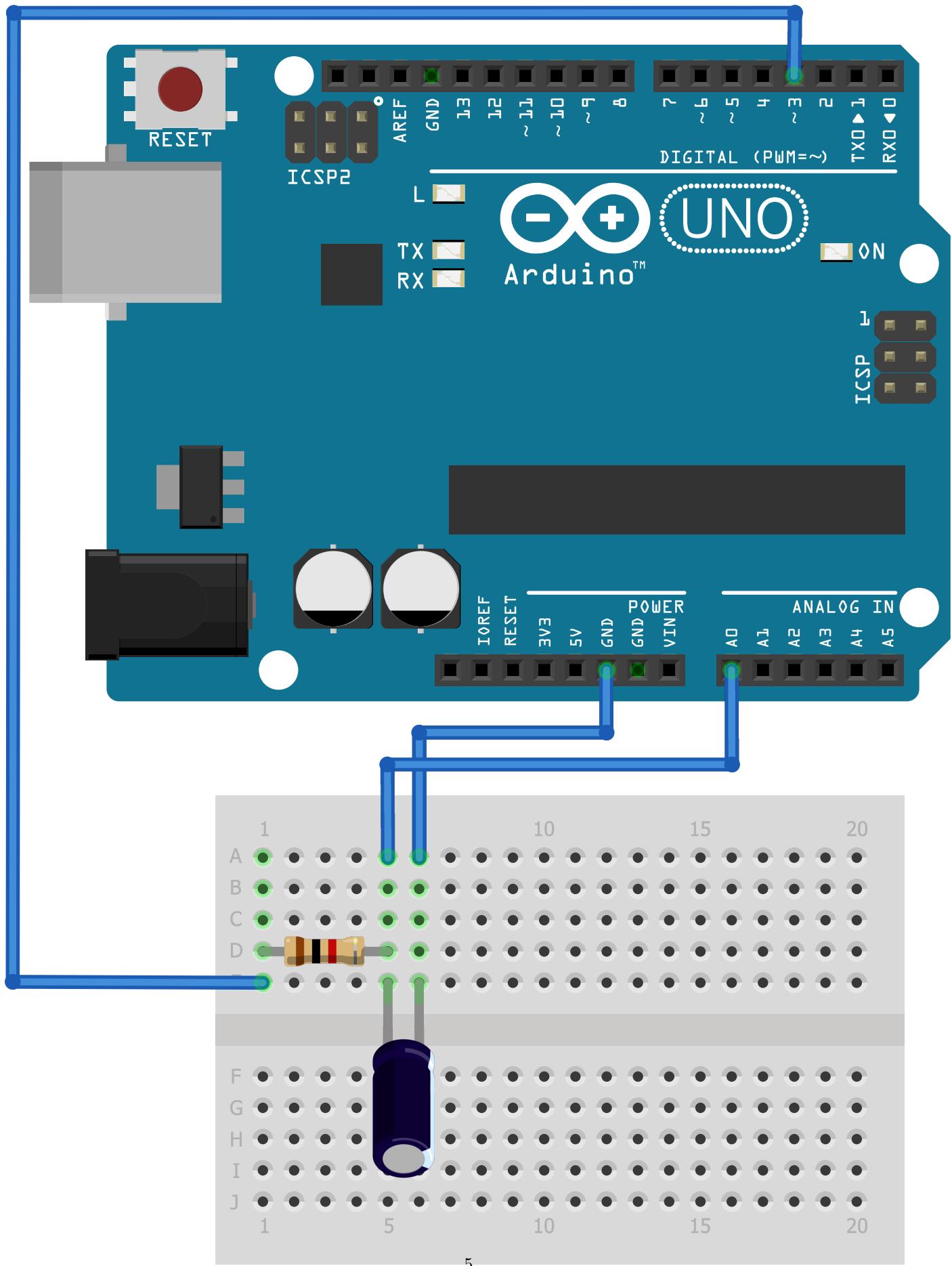


Figure 7: Bridge circuit with a first order RC low pass filter

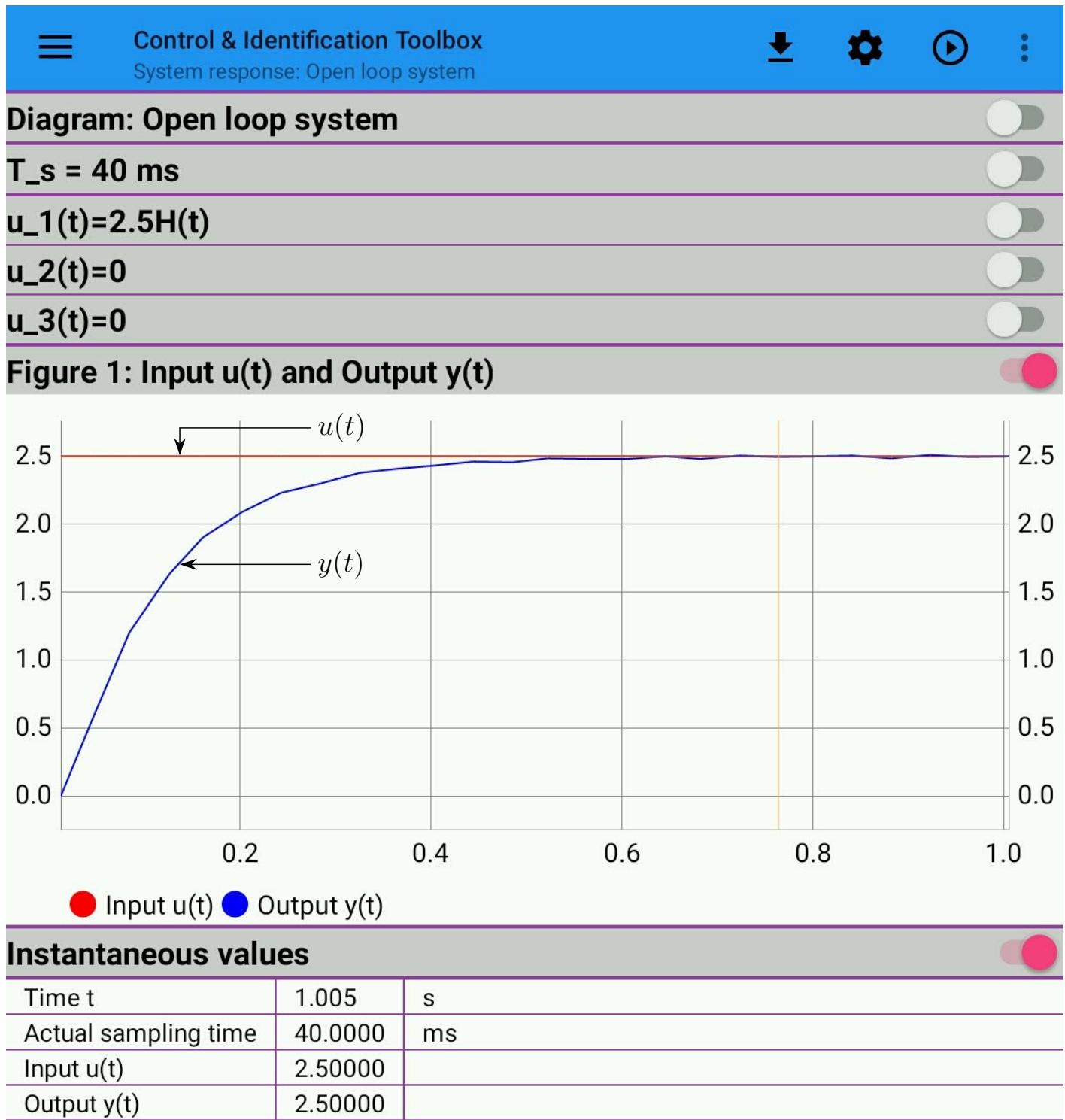


Figure 8: Step response of the first-order low pass filter.

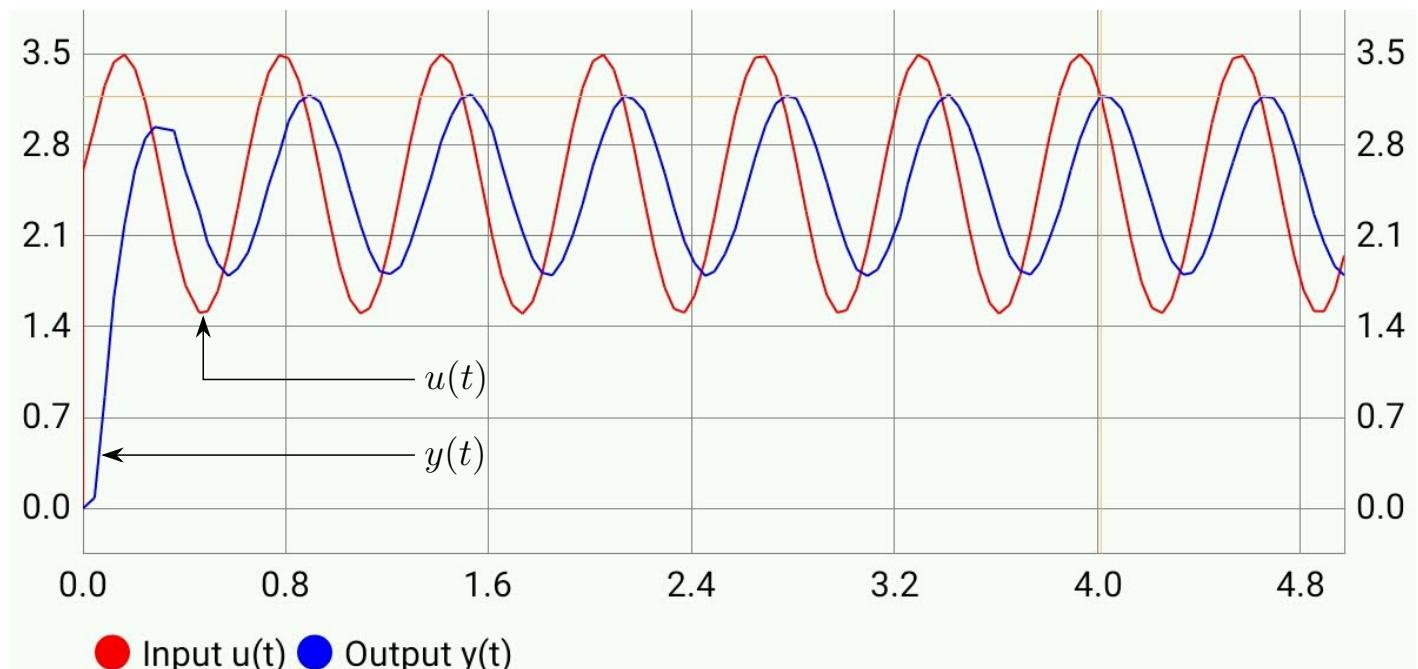


Figure 9: Sinusoidal response of the fist-order low pass filter.

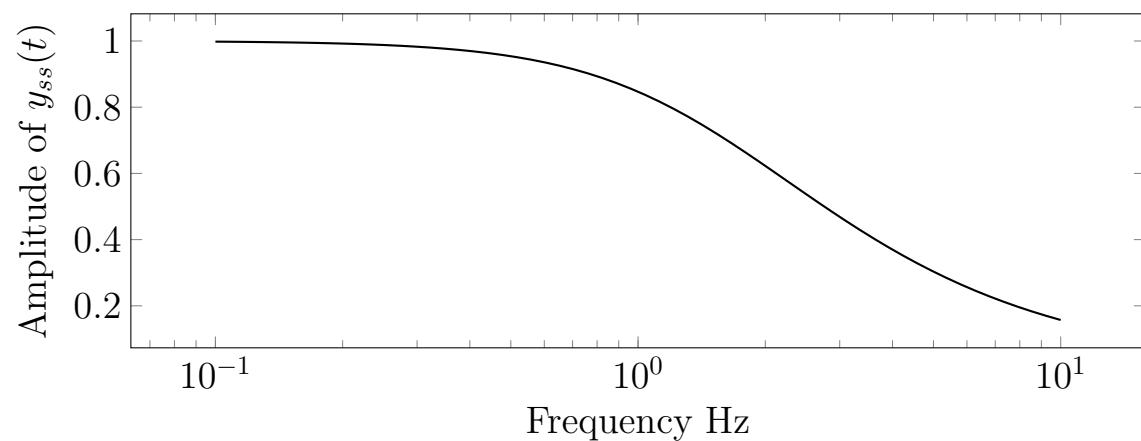


Figure 10: Magnitude of the frequency response of the first-order low pass filter.

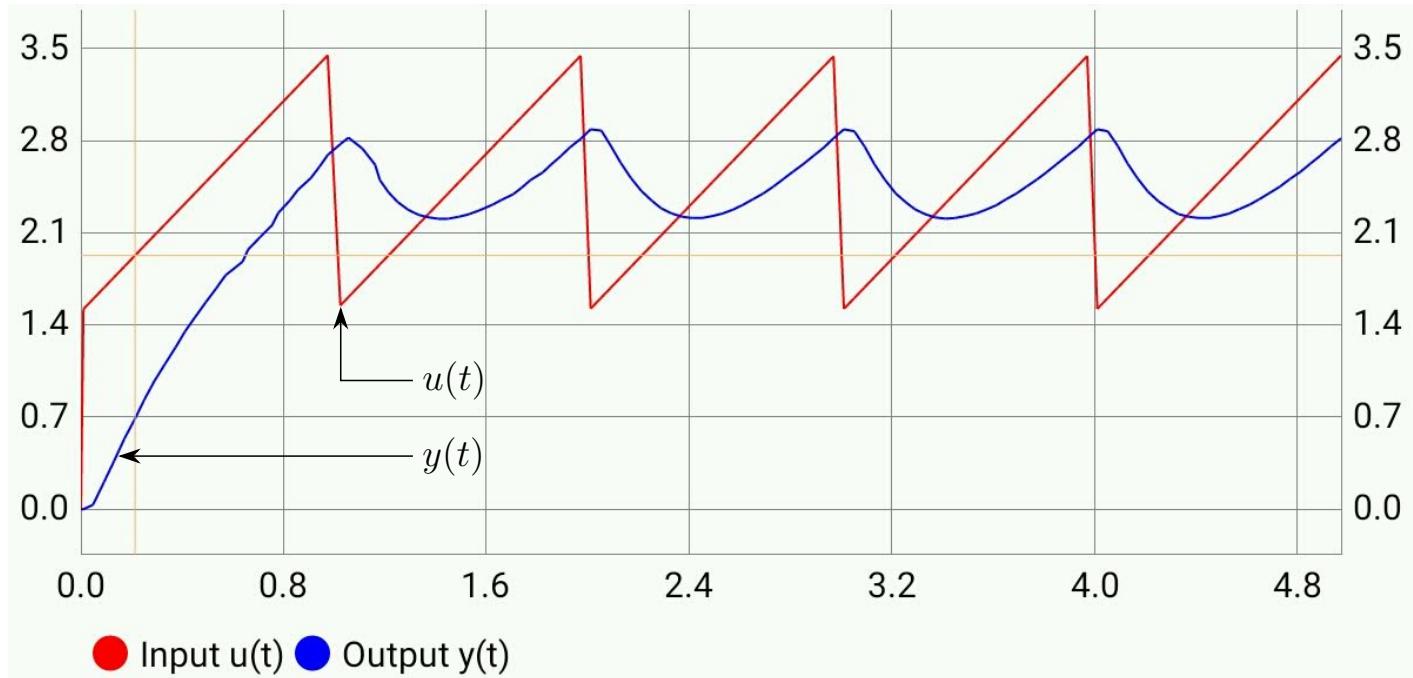


Figure 11: Response of the second-order filter to a sawtooth wave input.

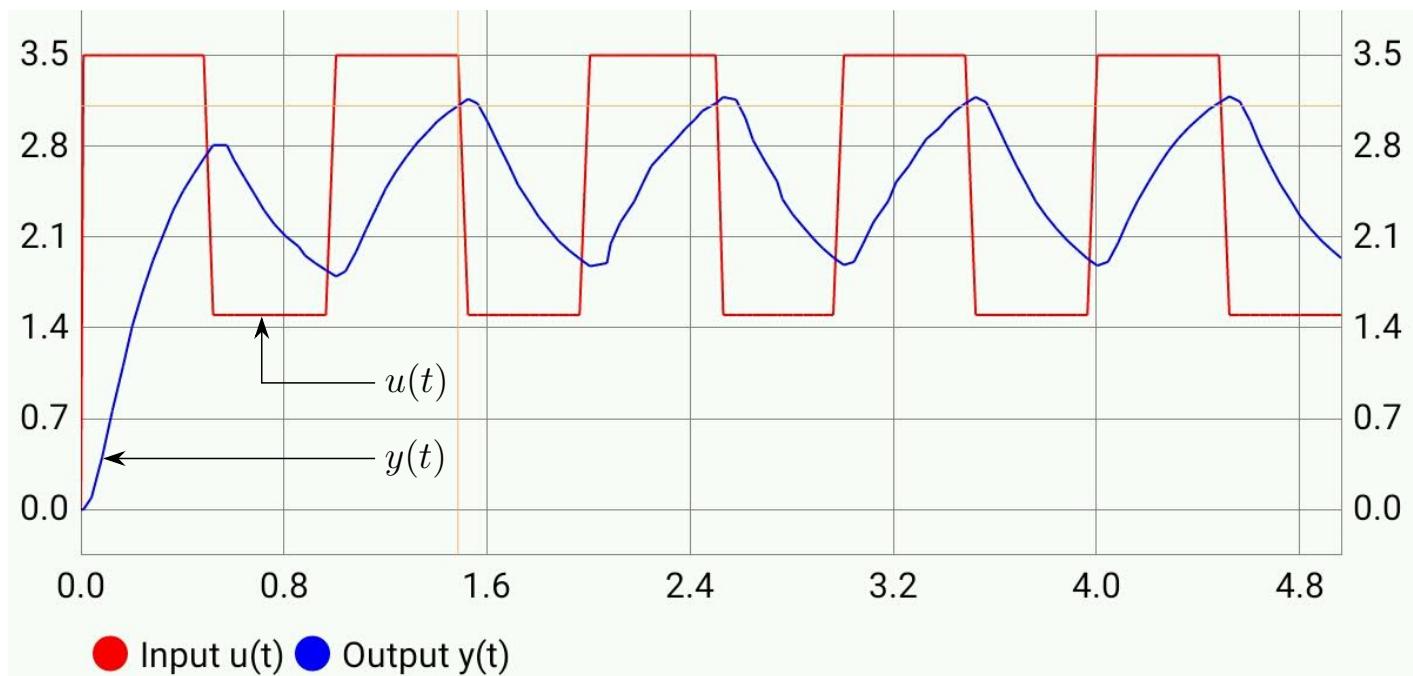


Figure 12: Response of the second-order filter to a square wave input.

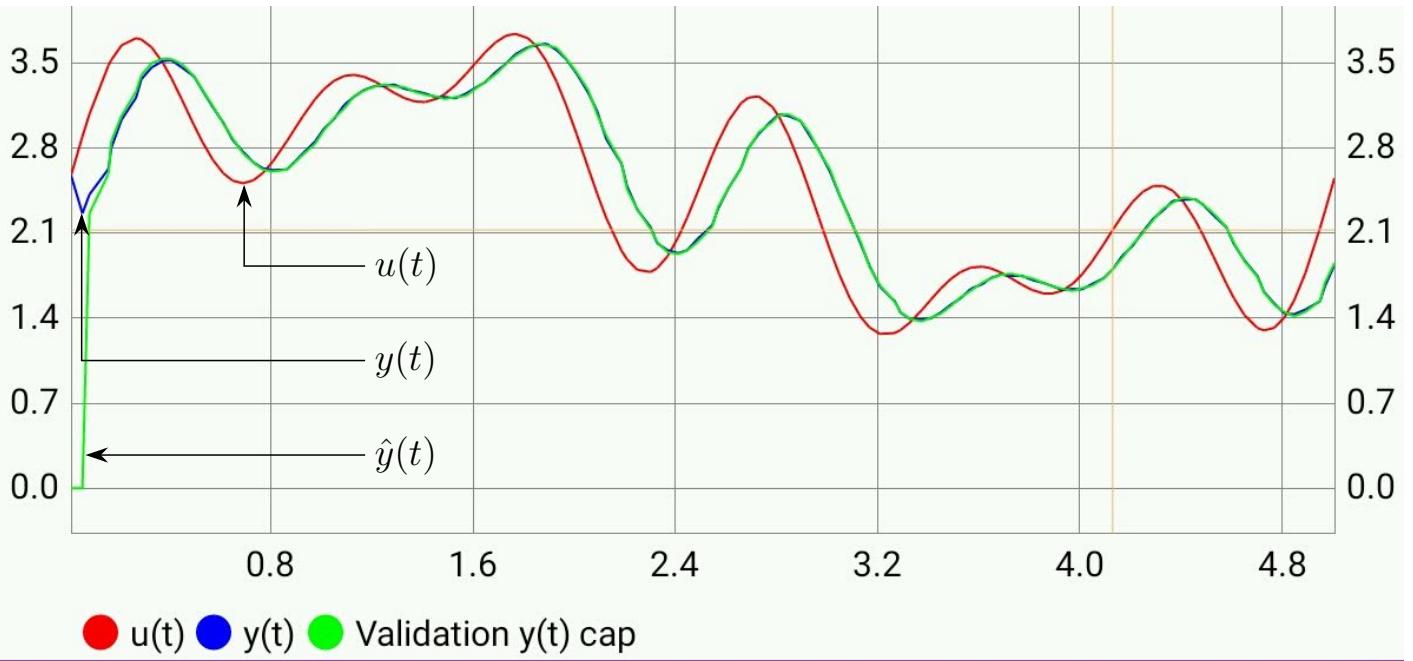


Figure 2: Estimate of θ

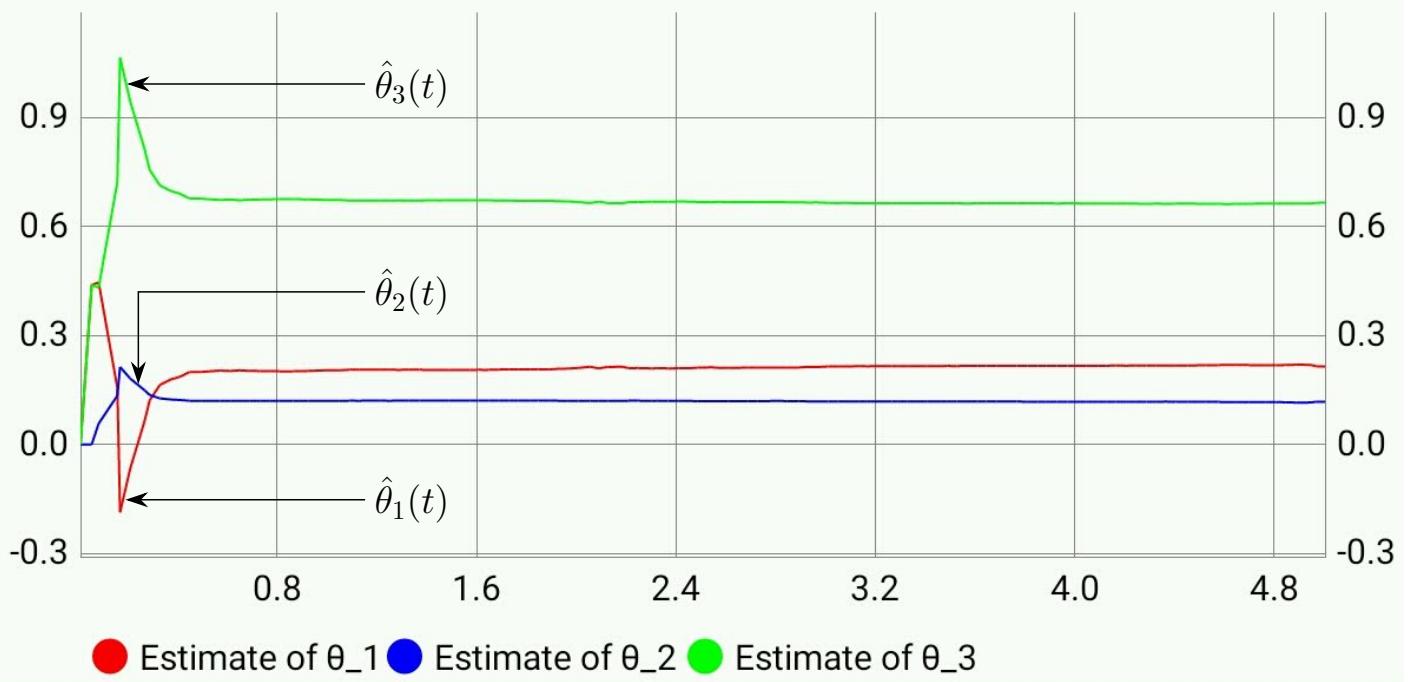


Figure 13: Signals $u(k)$, $y(k)$, $\hat{y}(k)$ and parameters $\hat{\theta}_1$, $\hat{\theta}_2$, $\hat{\theta}_3$.



Instantaneous values

Time t	5.007	s
Actual sampling time	40.4023	ms
$u(t)$	2.55100	
$y(t)$	1.83594	
Validation $y(t)$ cap	1.85209	
Estimate of θ_1	0.214658	
Estimate of θ_2	0.117516	
Estimate of θ_3	0.666384	
Estimate of α_1	0.214658	
Estimate of $\hat{\alpha}_2$	10.0028	
Estimate of $\hat{\alpha}_3$	10.0462	

Figure 14: Estimates $\hat{\alpha}_1(t)$, $\hat{\alpha}_2(t)$, $\hat{\alpha}_3(t)$, .and instantaneous values of signals and parameters.

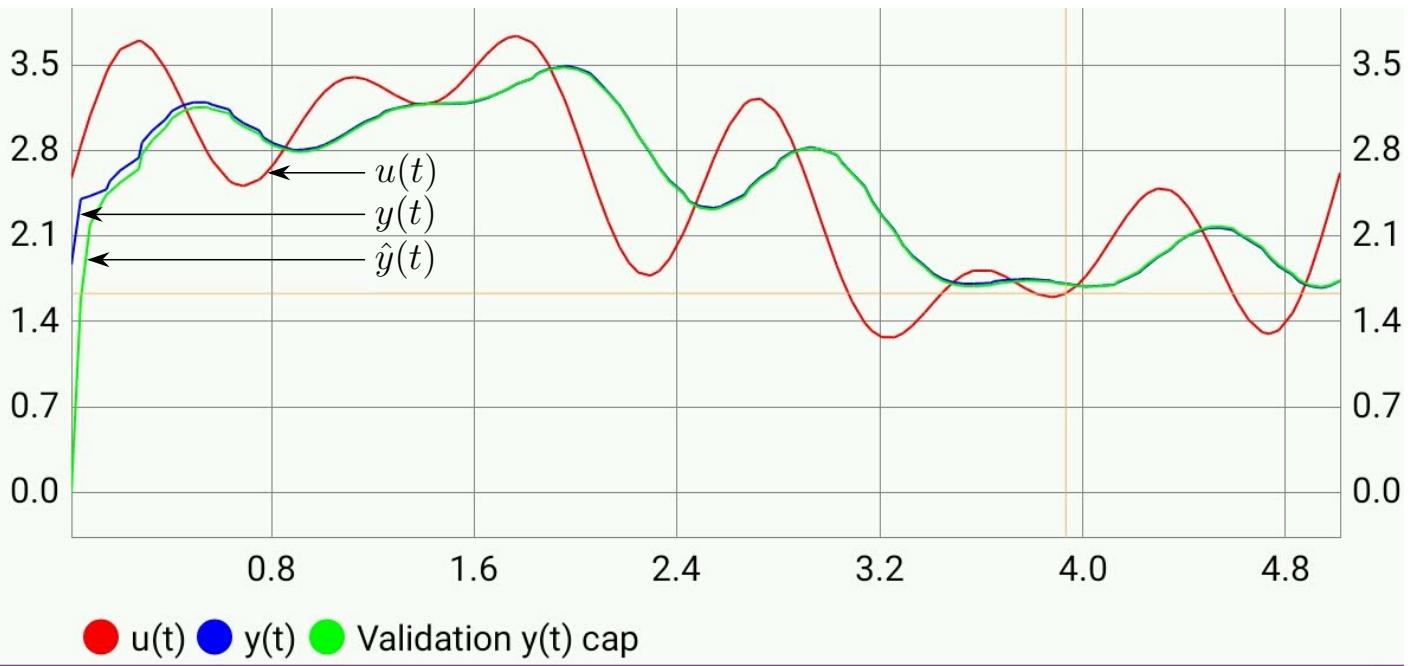


Figure 2: Estimate of Θ

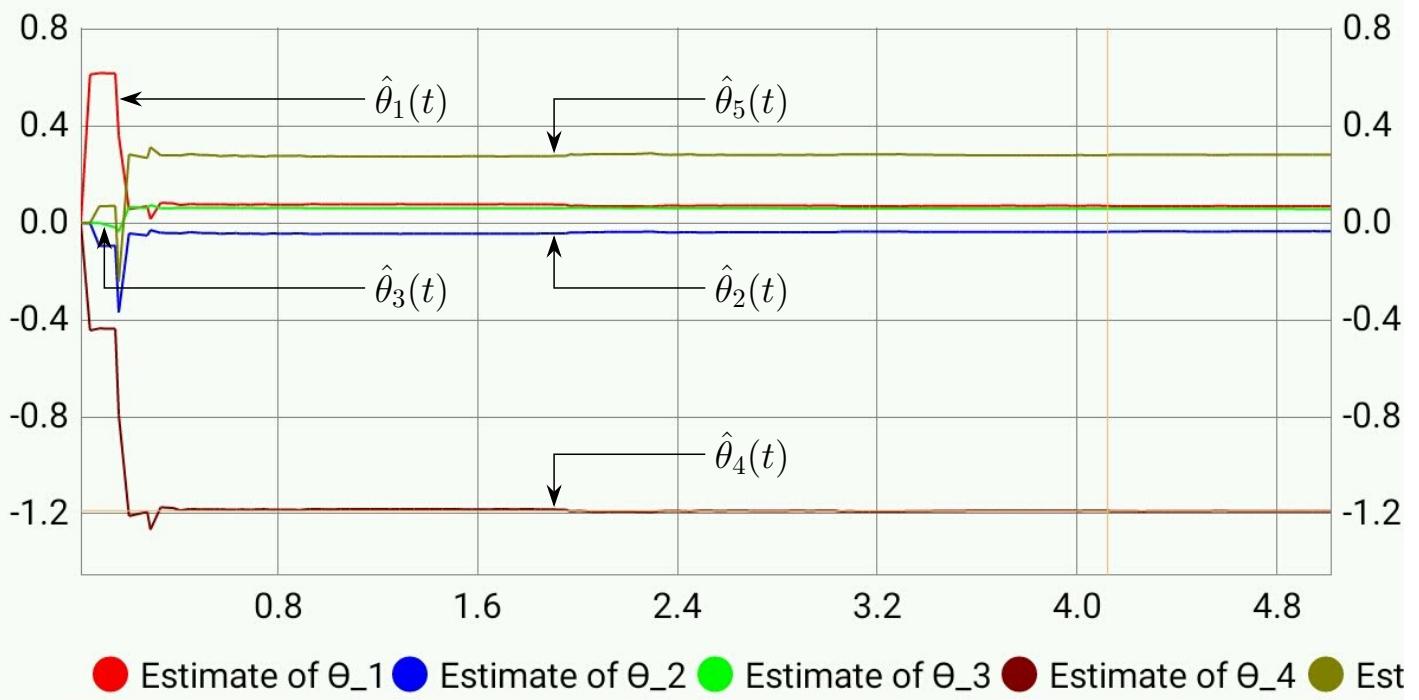
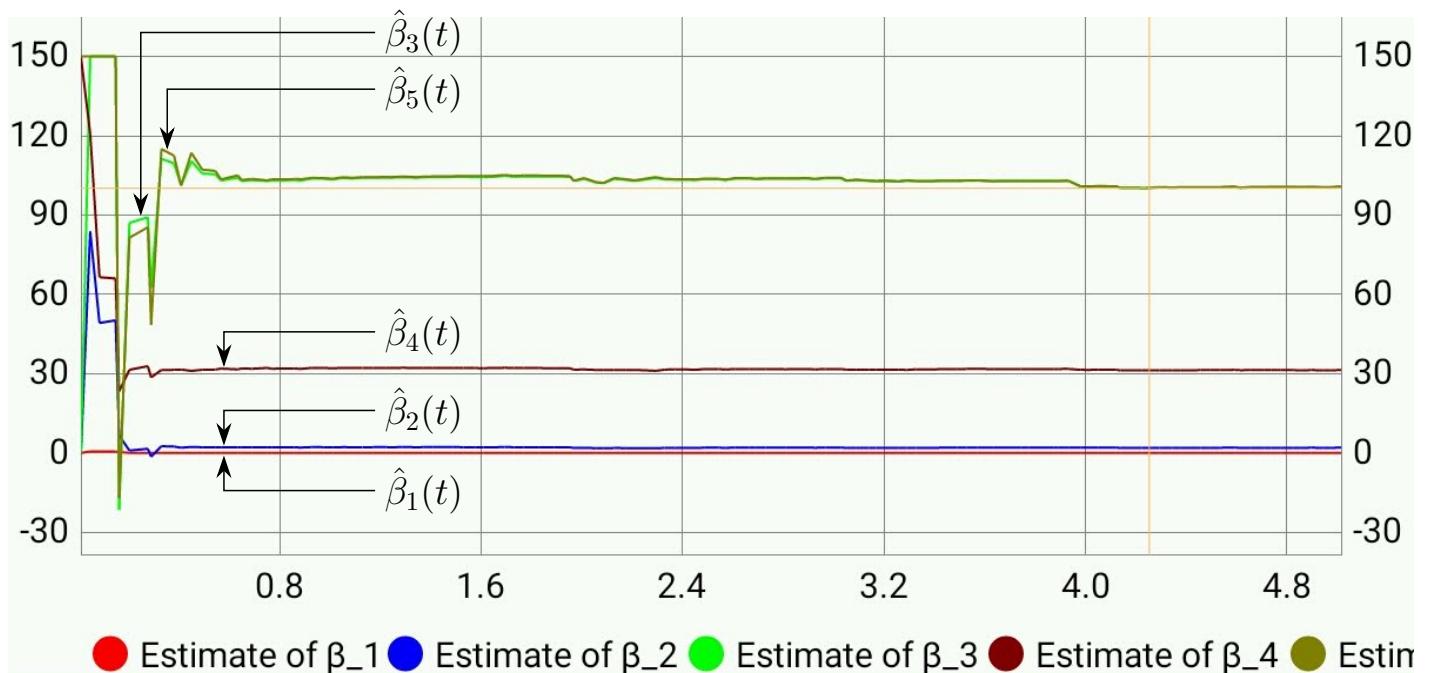


Figure 15: Signals $u(k)$, $y(k)$, $\hat{y}(k)$ and parameters $\hat{\theta}_1$, $\hat{\theta}_2$, $\hat{\theta}_3$, $\hat{\theta}_4$ and $\hat{\theta}_5$.



Instantaneous values

Time t	5.016	s
Actual sampling time	40.4788	ms
u(t)	2.61643	
y(t)	1.73340	
Validation y(t) cap	1.73523	
Estimate of θ_1	0.0692599	
Estimate of θ_2	-0.0343029	
Estimate of θ_3	0.0572122	
Estimate of θ_4	-1.18859	
Estimate of θ_5	0.280906	
Estimate of β_1	0.0692599	
Estimate of β_2	2.00433	
Estimate of β_3	100.661	
Estimate of β_4	31.3661	
Estimate of β_5	100.821	

Figure 16: Estimates $\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \hat{\beta}_4, \hat{\beta}_5$, and instantaneous values of signals and parameters.

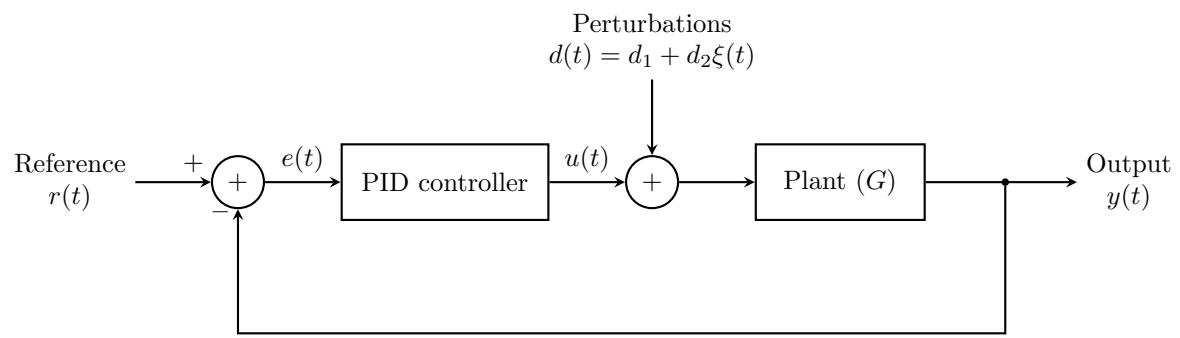


Figure 17: Closed loop system with a PID Controller

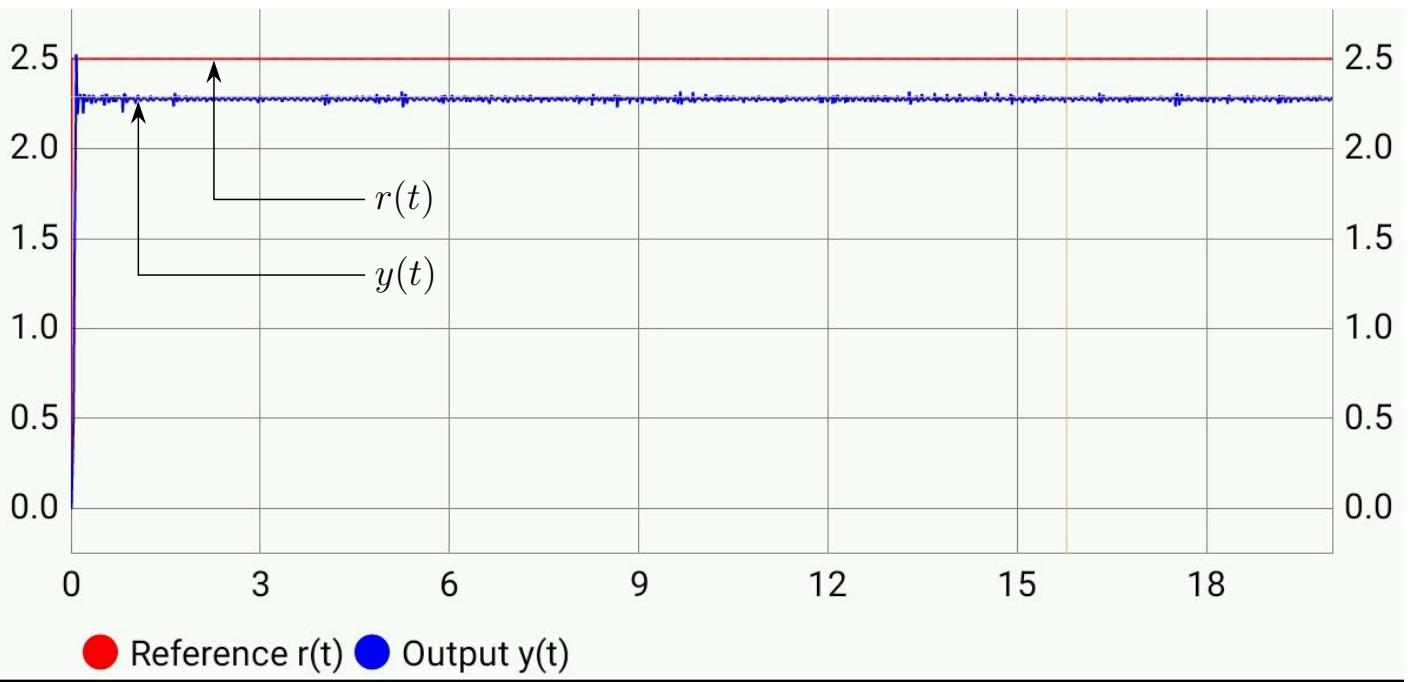


Figure 2: Error $e(t)$ and Control $u(t)$

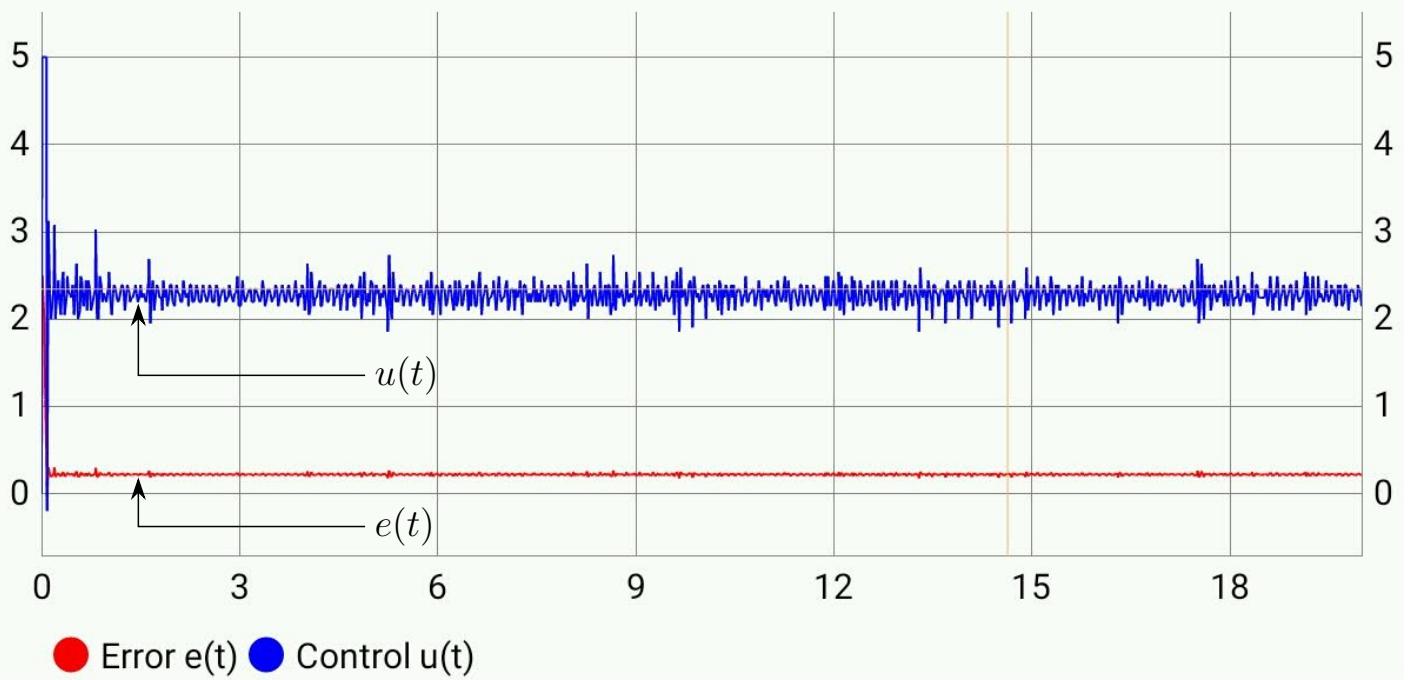


Figure 18: Signals $r(k)$, $y(k)$, $e(k)$ and $u(k)$ of the closed-loop system with $K_P = 10$, $K_I = 0$, and $K_D = 0$.

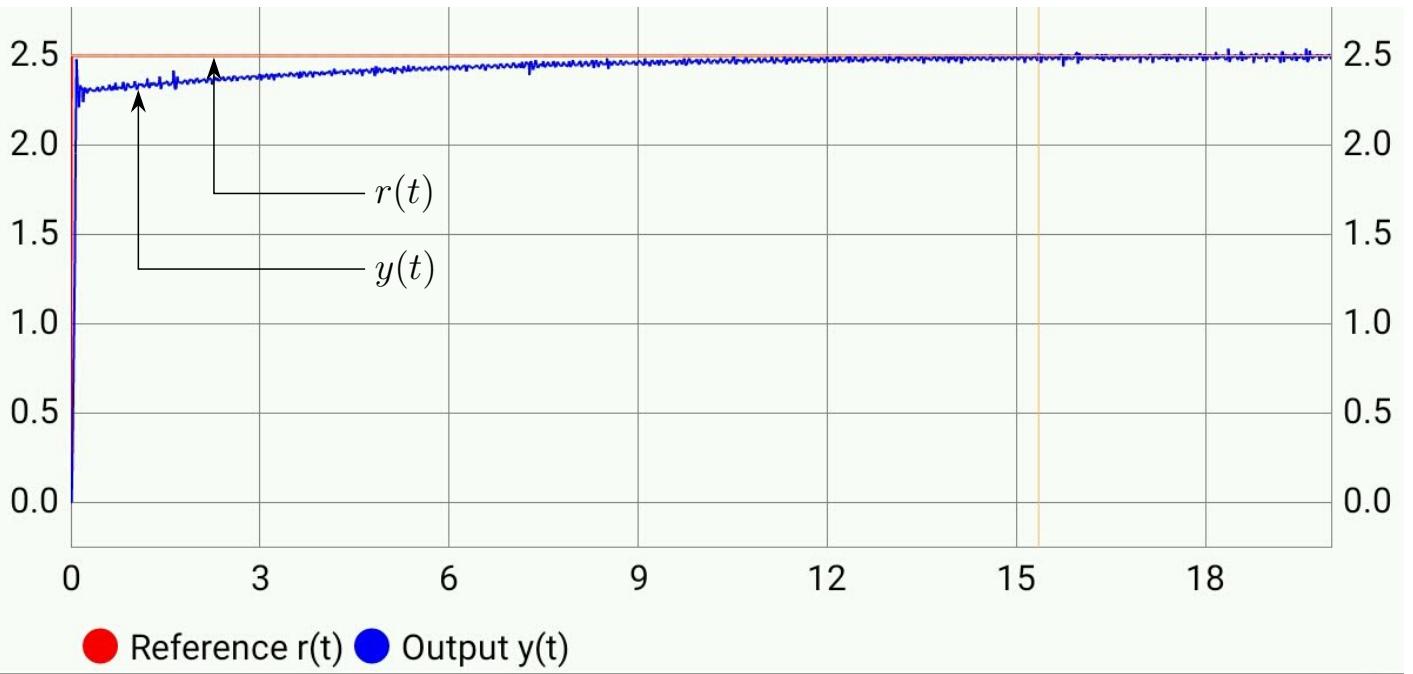


Figure 2: Error $e(t)$ and Control $u(t)$

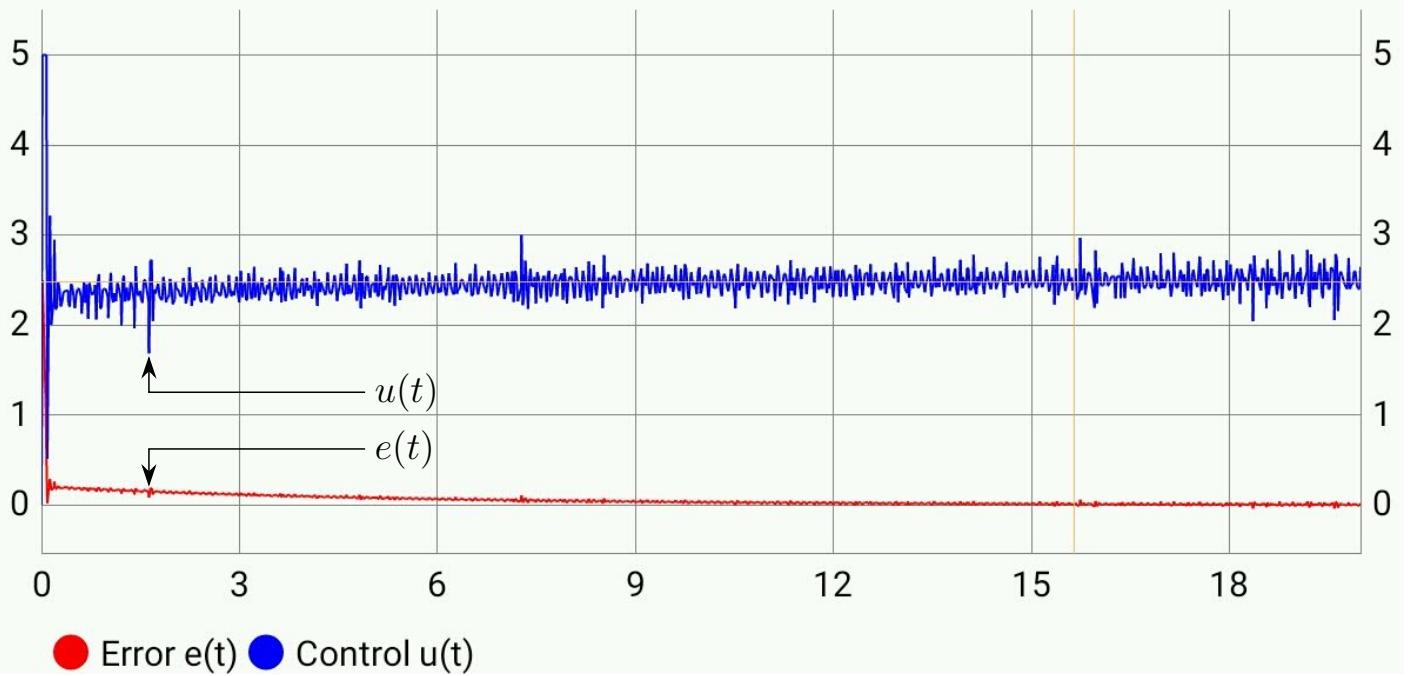


Figure 19: Signals $r(k)$, $y(k)$, $e(k)$ and $u(k)$ of the closed-loop system with $K_P = 10$, $K_I = 2$, and $K_D = 0$.

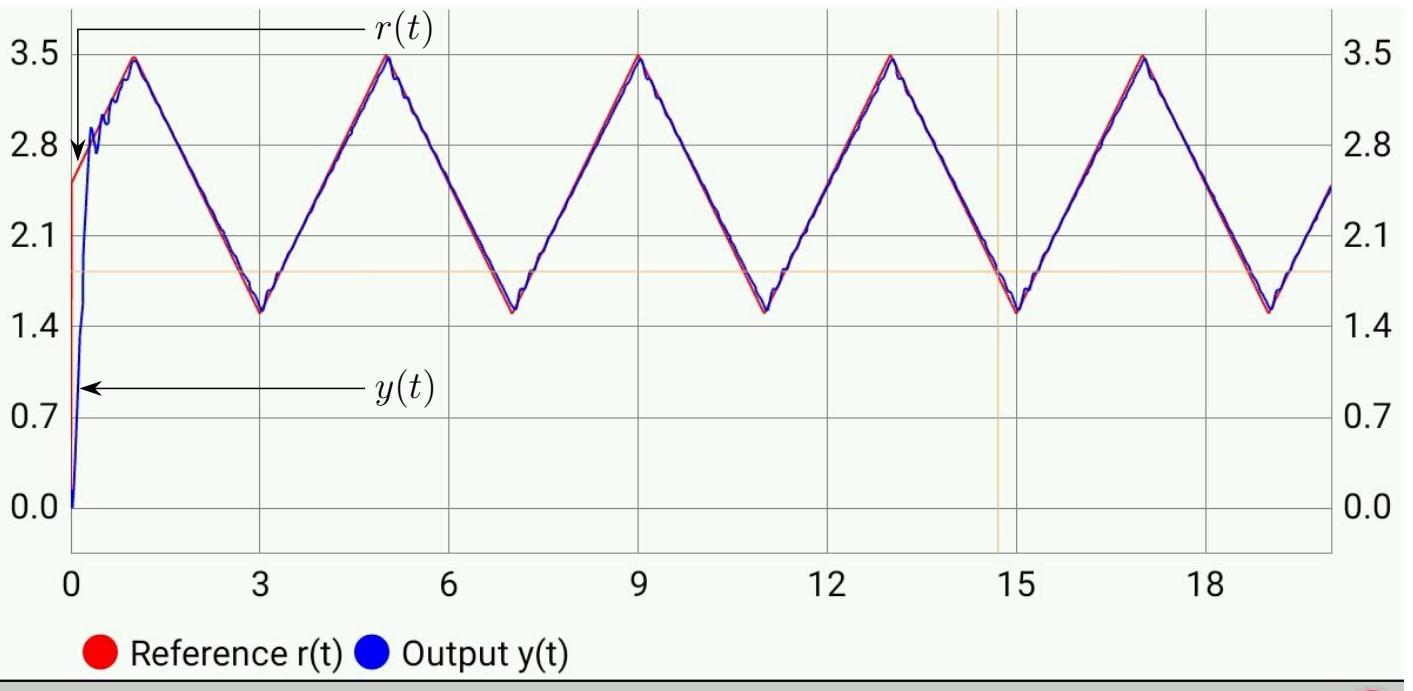


Figure 2: Error $e(t)$ and Control $u(t)$

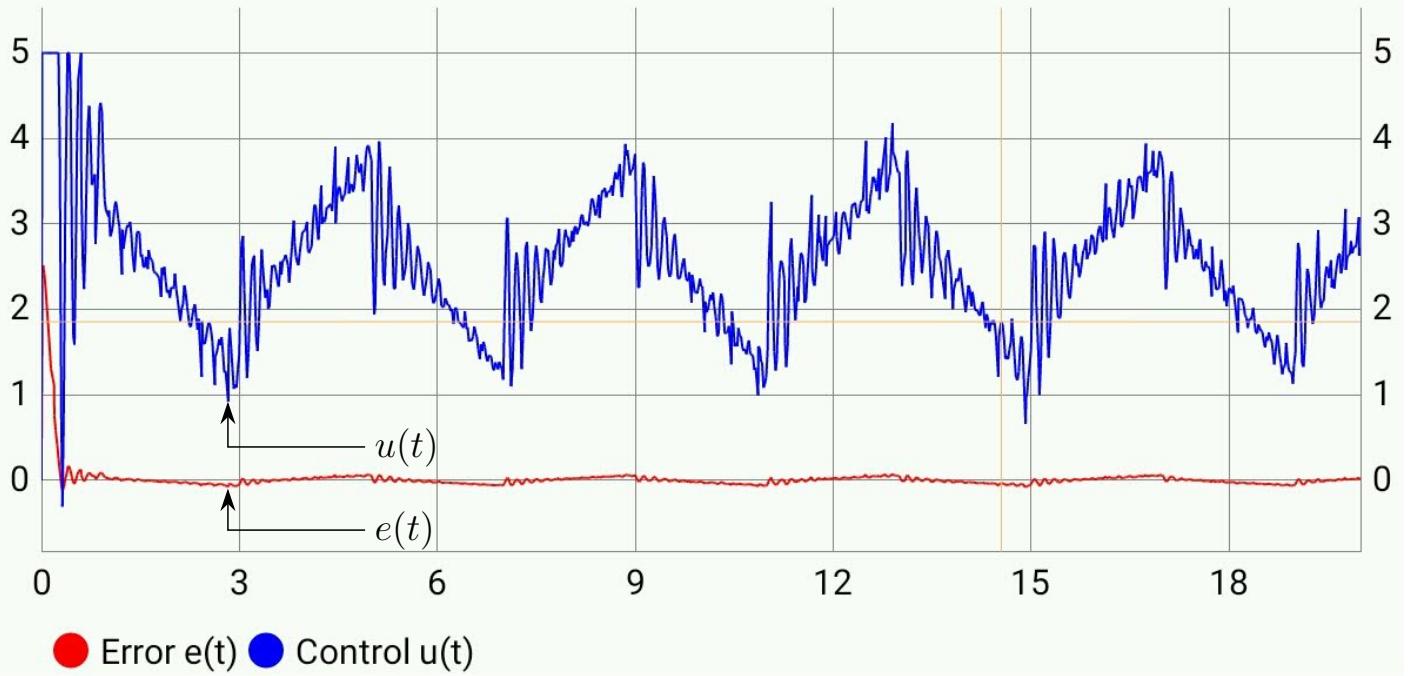


Figure 20: Signals $r(k)$, $y(k)$, $e(k)$ and $u(k)$ of the closed-loop system with $K_P = 20$, $K_I = 5$, and $K_D = 0.1$.