

Figure 1: Home-screen of the CIT android application

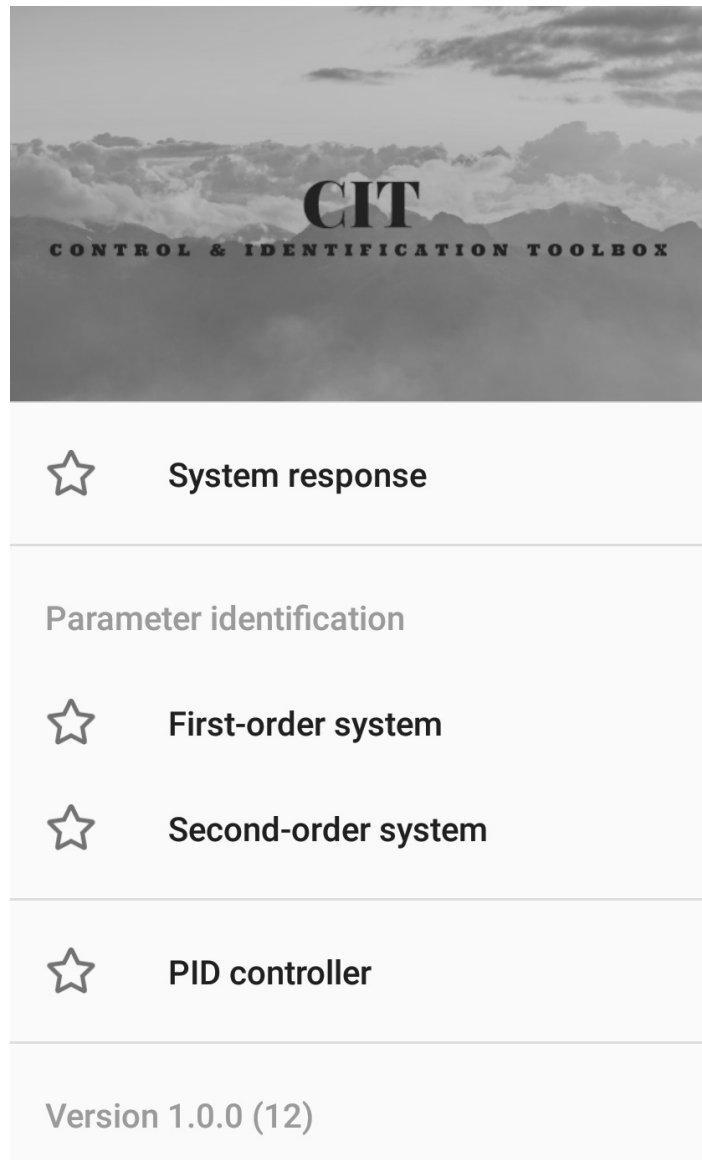


Figure 2: Drawer of the CIT android application

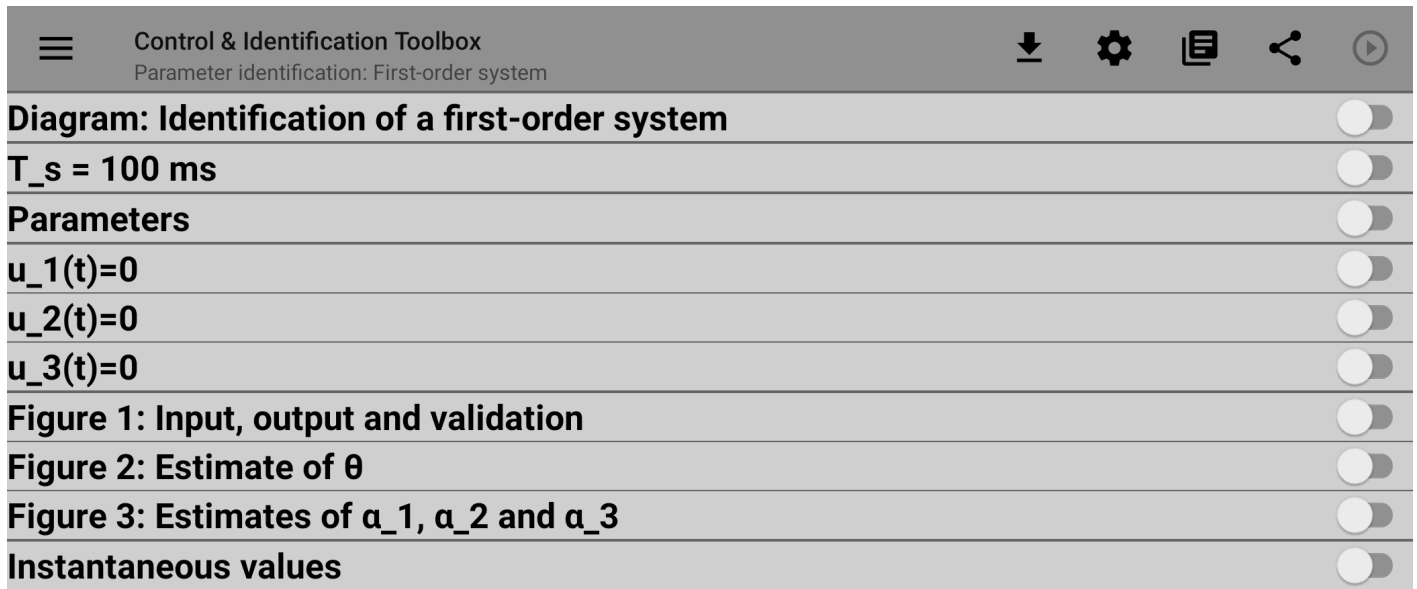


Figure 3: Experimental results screen (ERS) for first-order parameter identification

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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

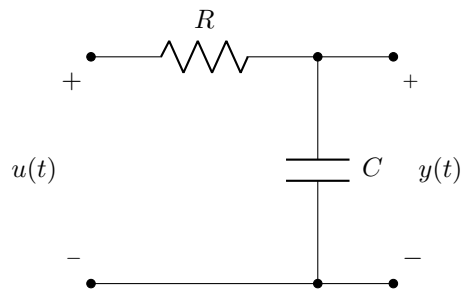


Figure 5: First order low pass filter

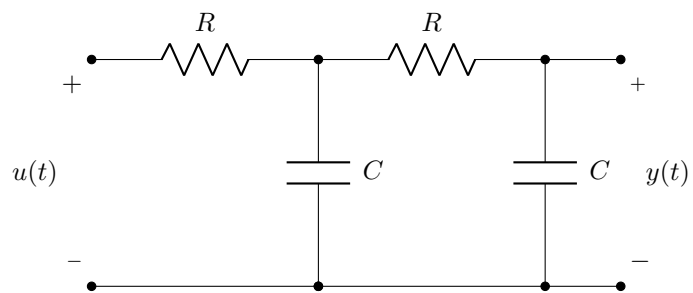


Figure 6: Second order low pass filter.

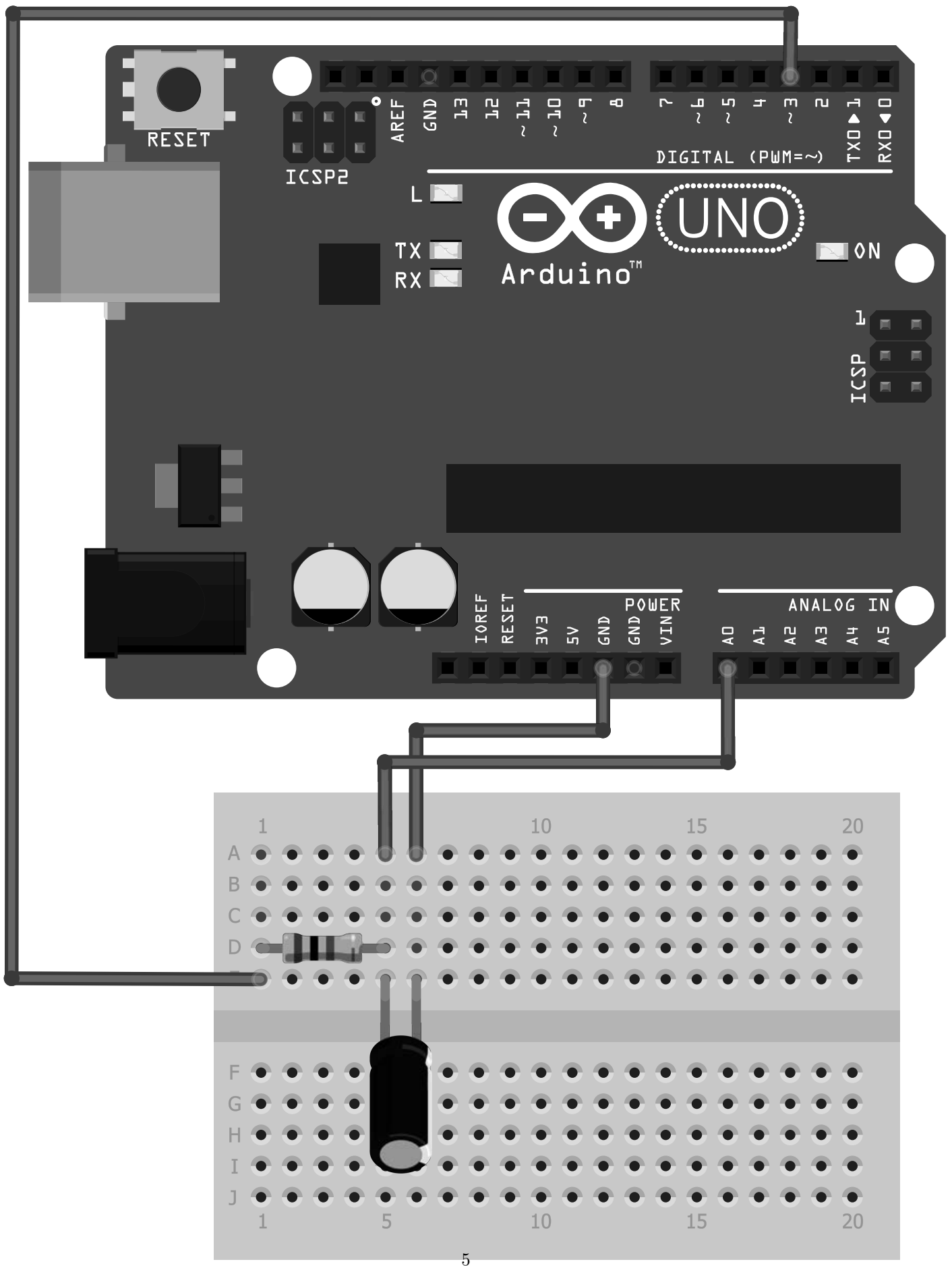


Figure 7: Bridge circuit with a first order RC low pass filter

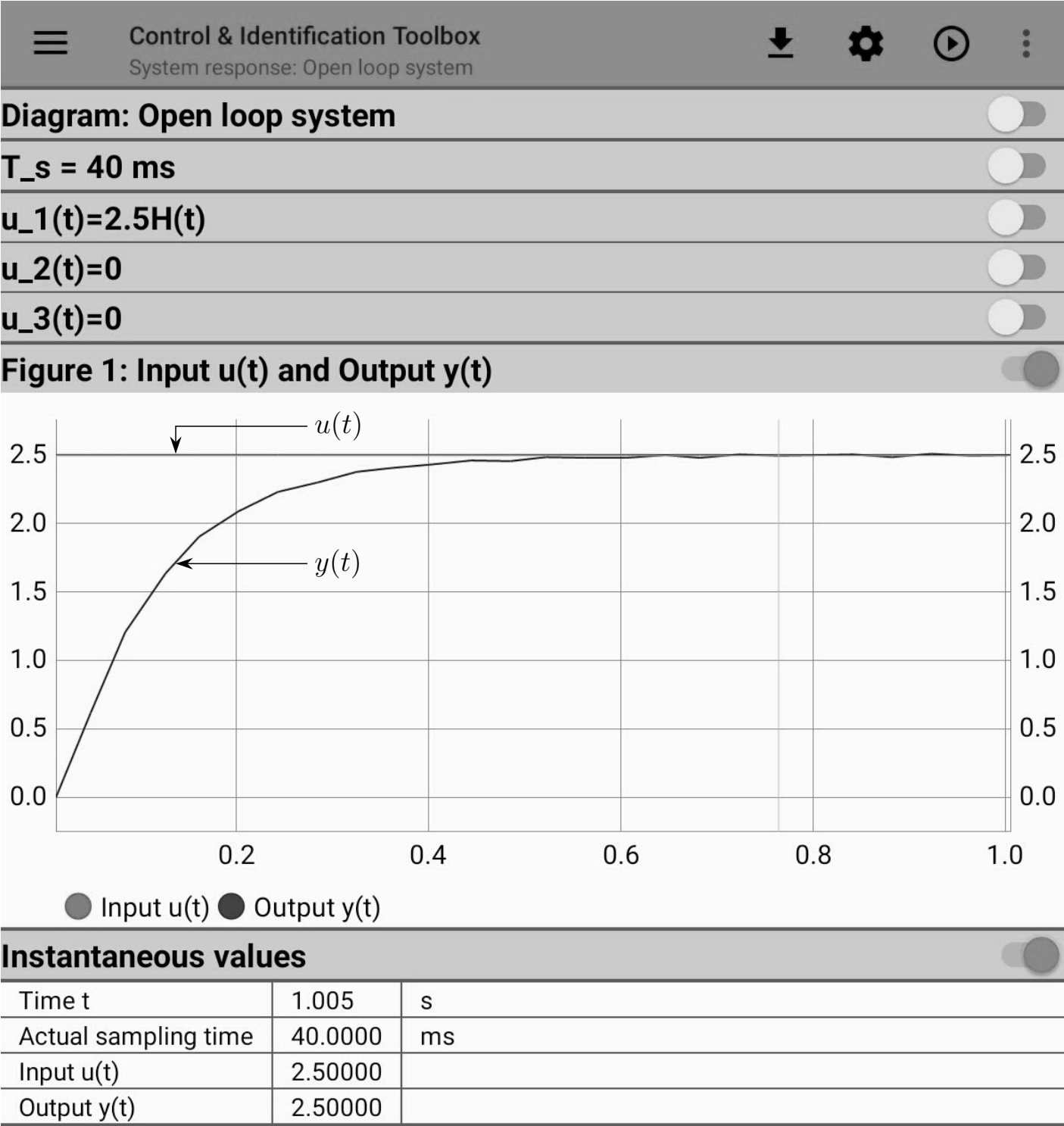


Figure 8: Step response of the first-order low pass filter.

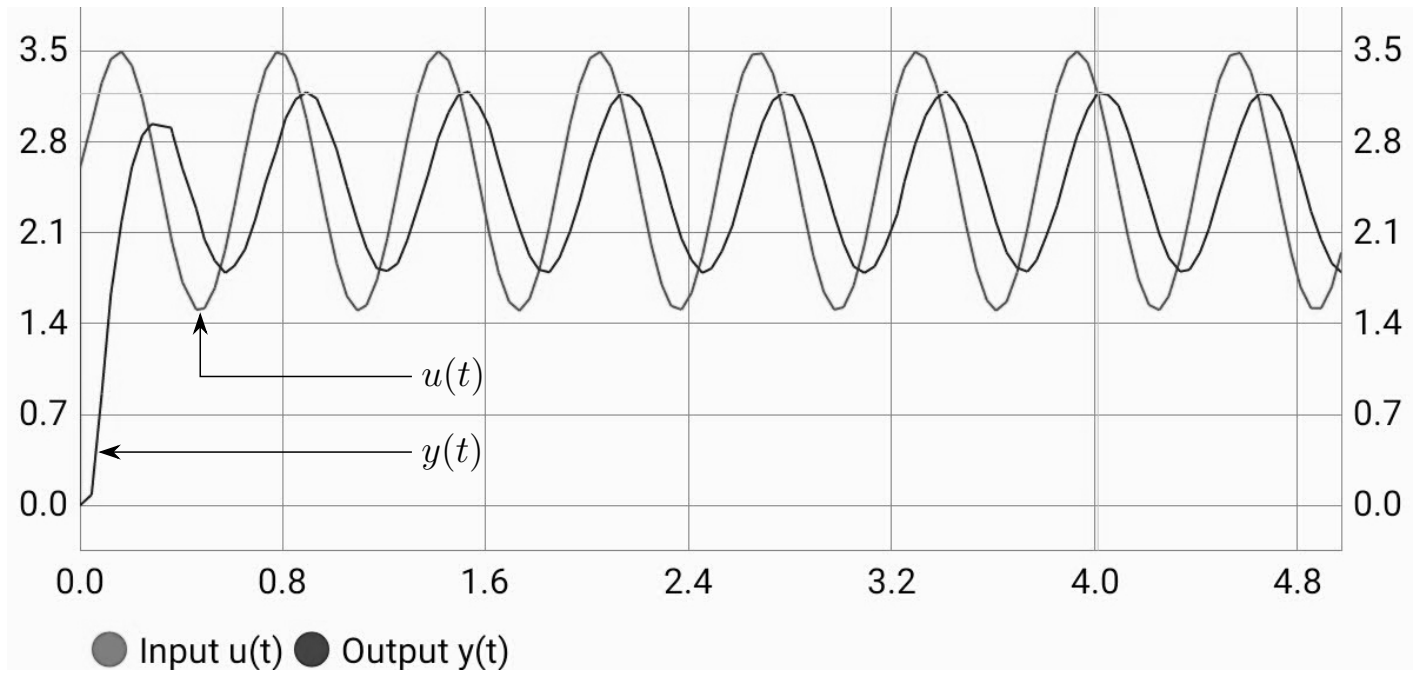


Figure 9: Sinusoidal response of the first-order low pass filter.

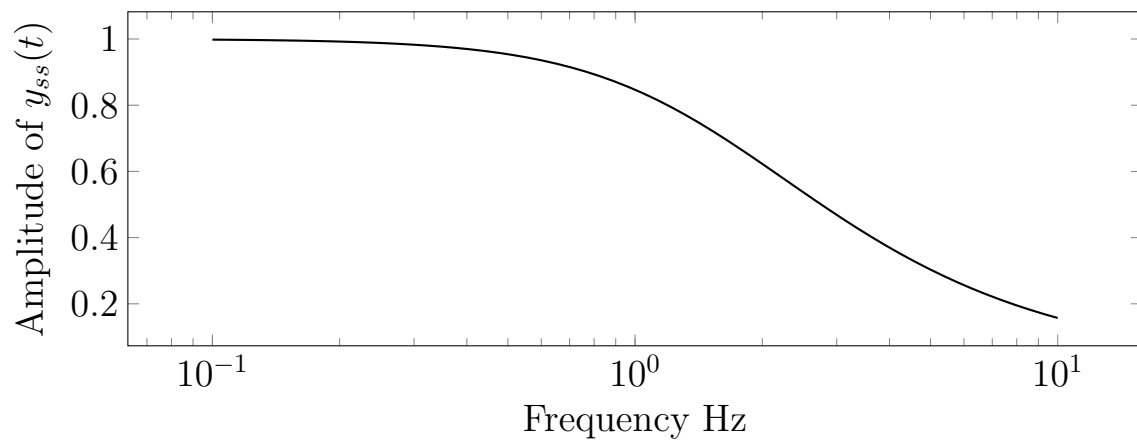


Figure 10: Magnitude of the frequency response of the first-order low pass filter.

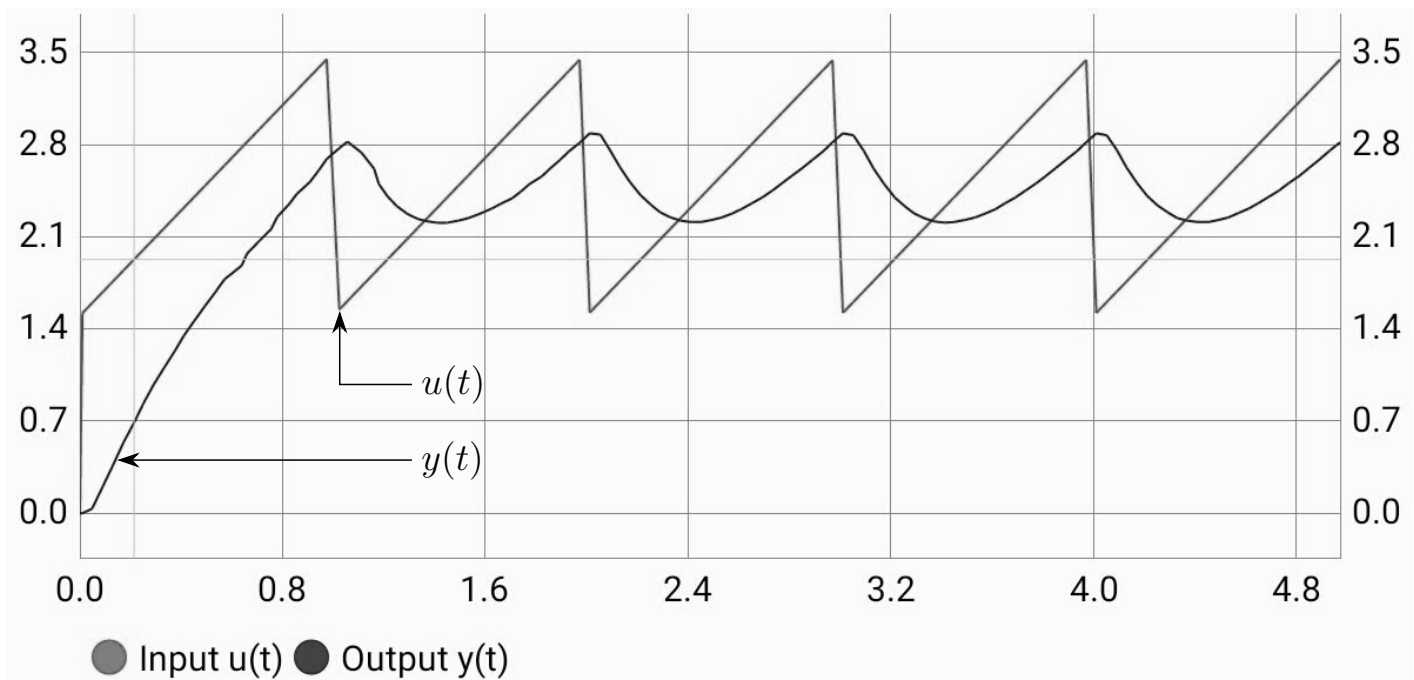


Figure 11: Response of the second-order filter to a sawtooth wave input.

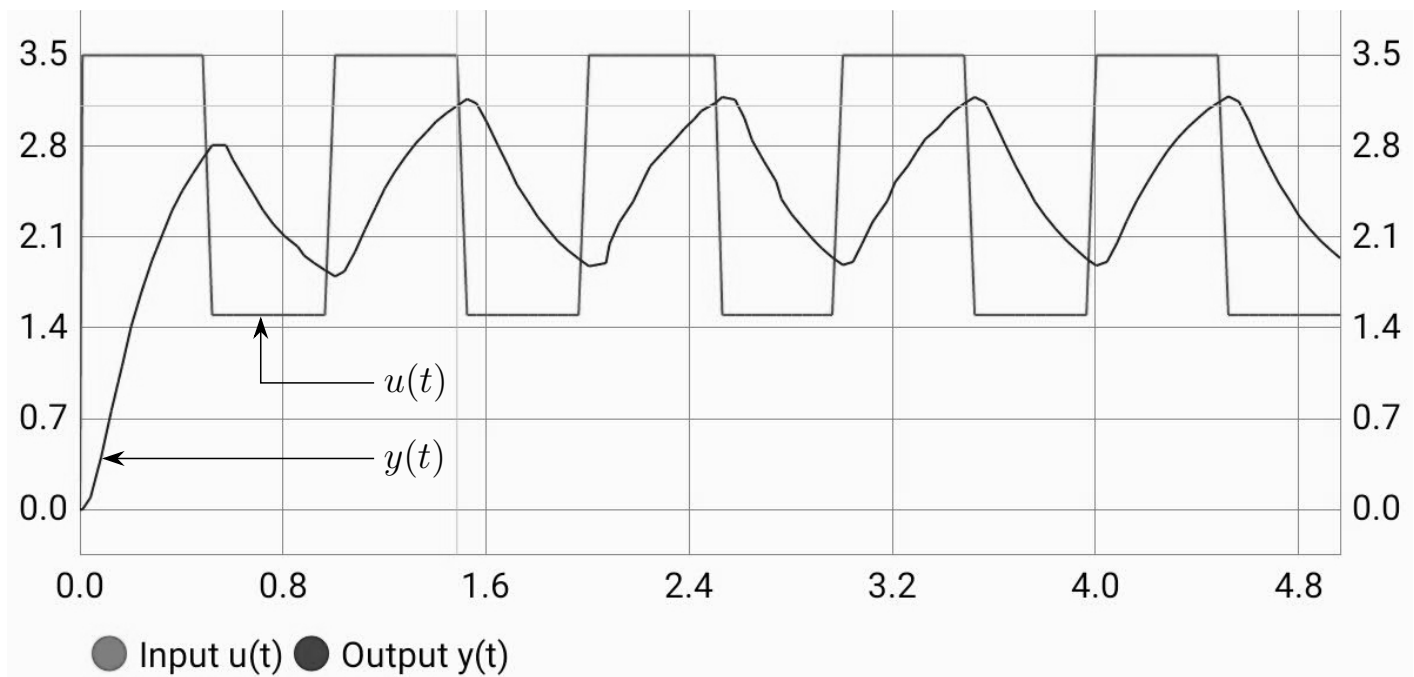
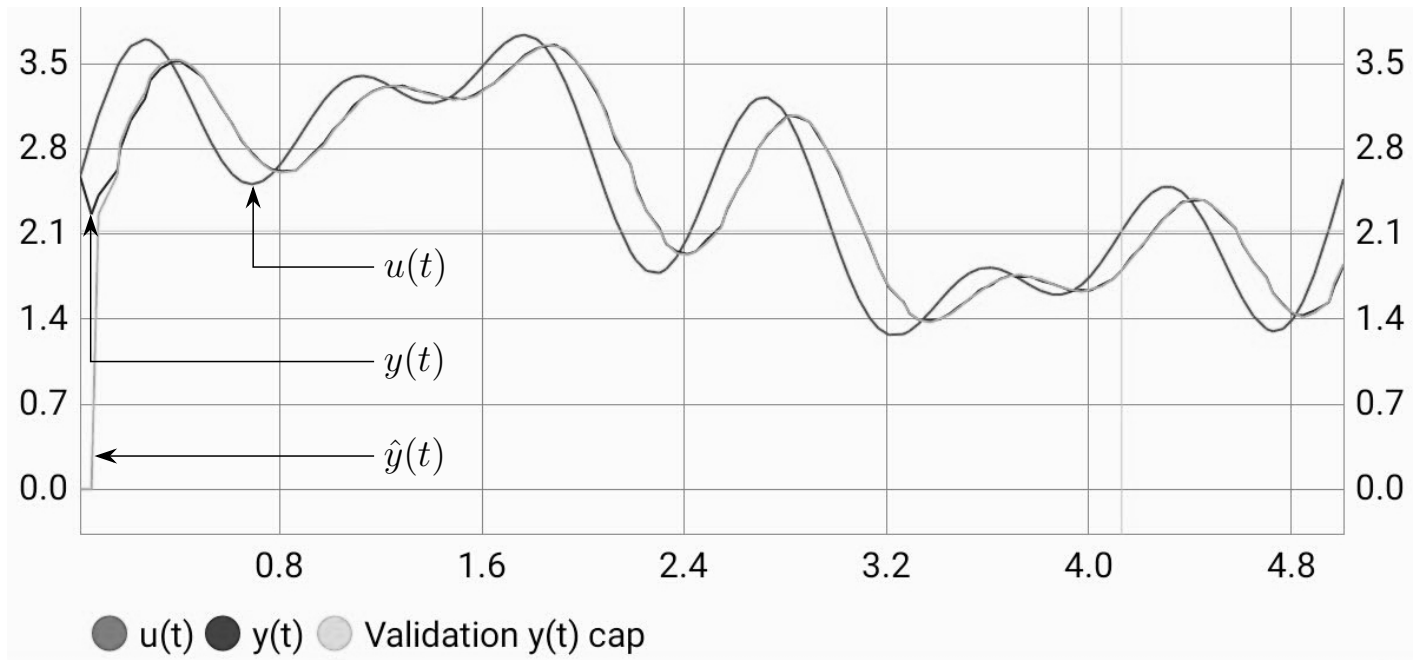


Figure 12: Response of the second-order filter to a square wave input.





**Figure 2: Estimate of  $\theta$**

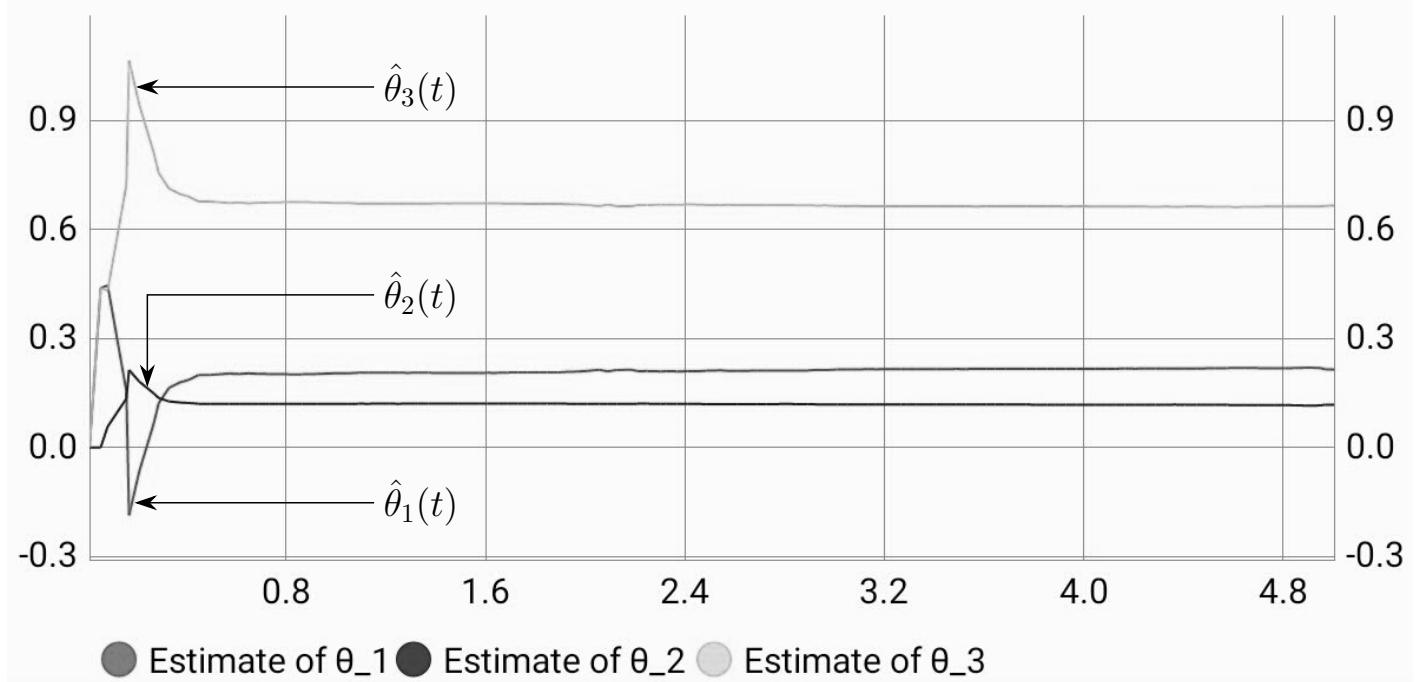
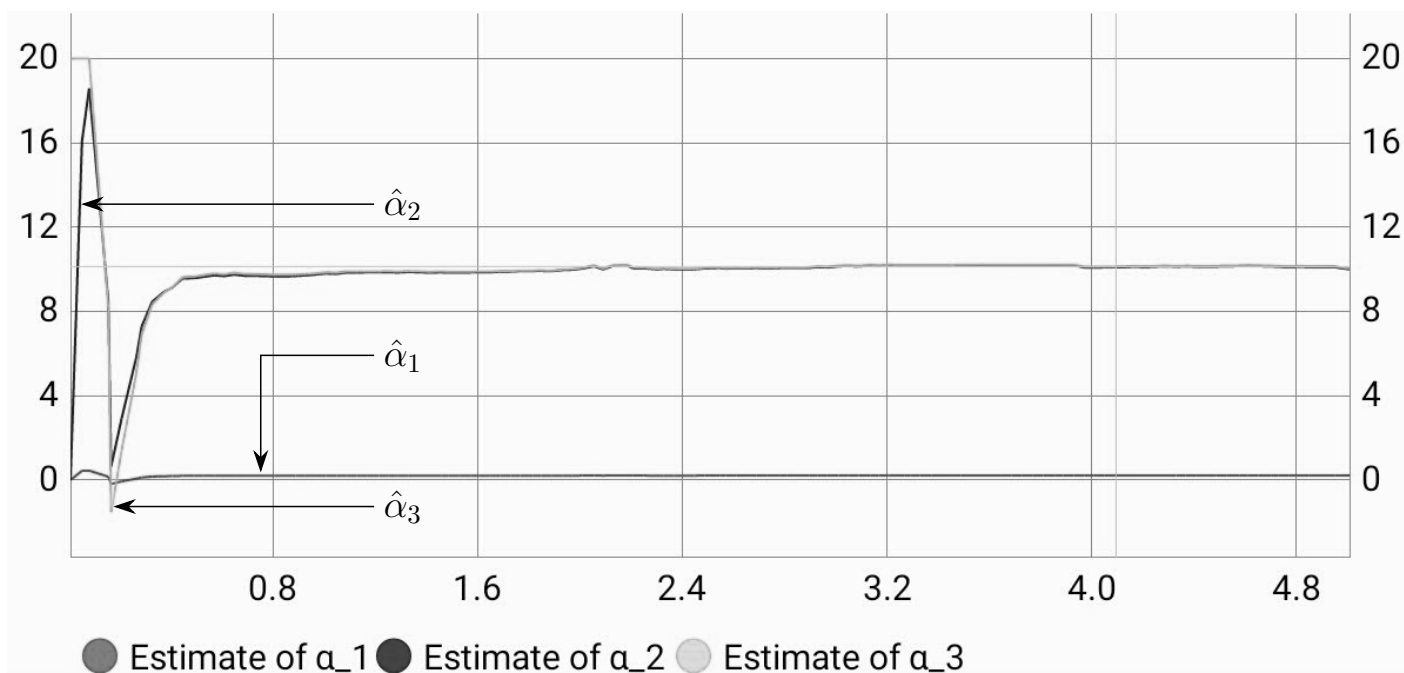


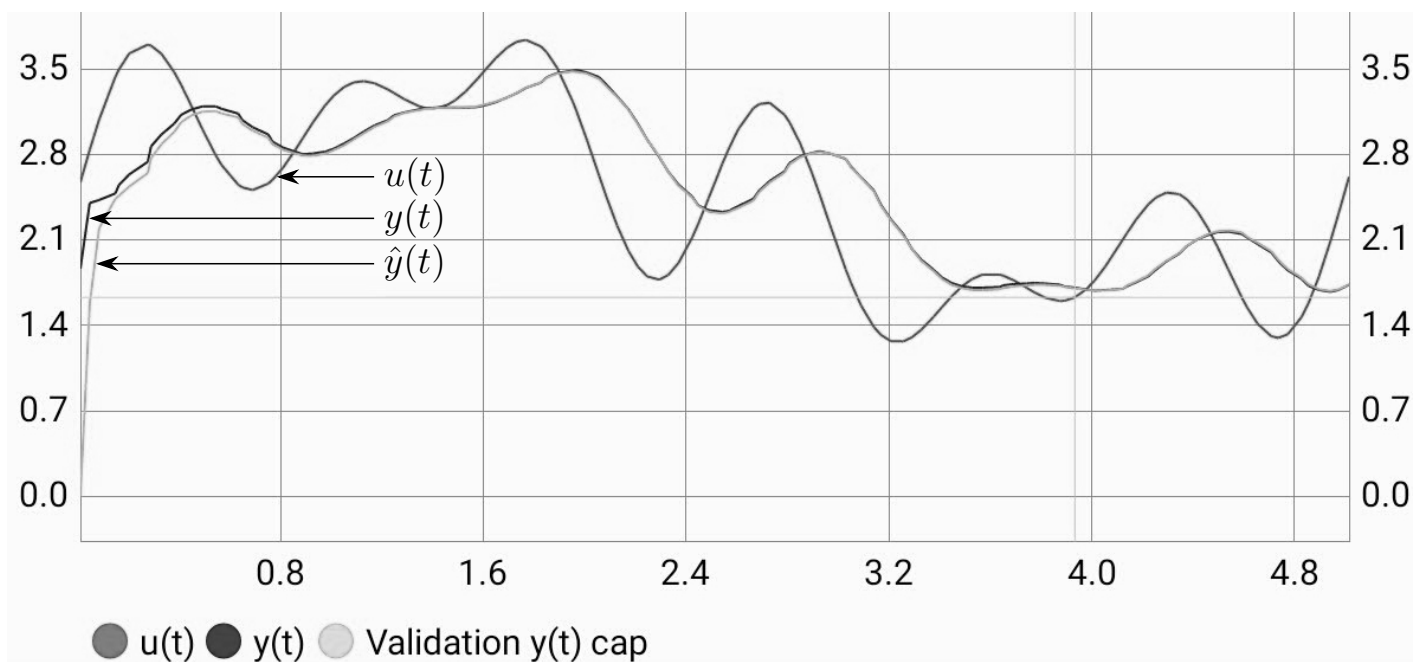
Figure 13: Signals  $u(k)$ ,  $y(k)$ ,  $\hat{y}(k)$  and parameters  $\hat{\theta}_1$ ,  $\hat{\theta}_2$ ,  $\hat{\theta}_3$ .



### 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 $\theta_1$	0.214658	
Estimate of $\theta_2$	0.117516	
Estimate of $\theta_3$	0.666384	
Estimate of $\alpha_1$	0.214658	
Estimate of $\alpha_2$	10.0028	
Estimate of $\alpha_3$	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  $\Theta$**

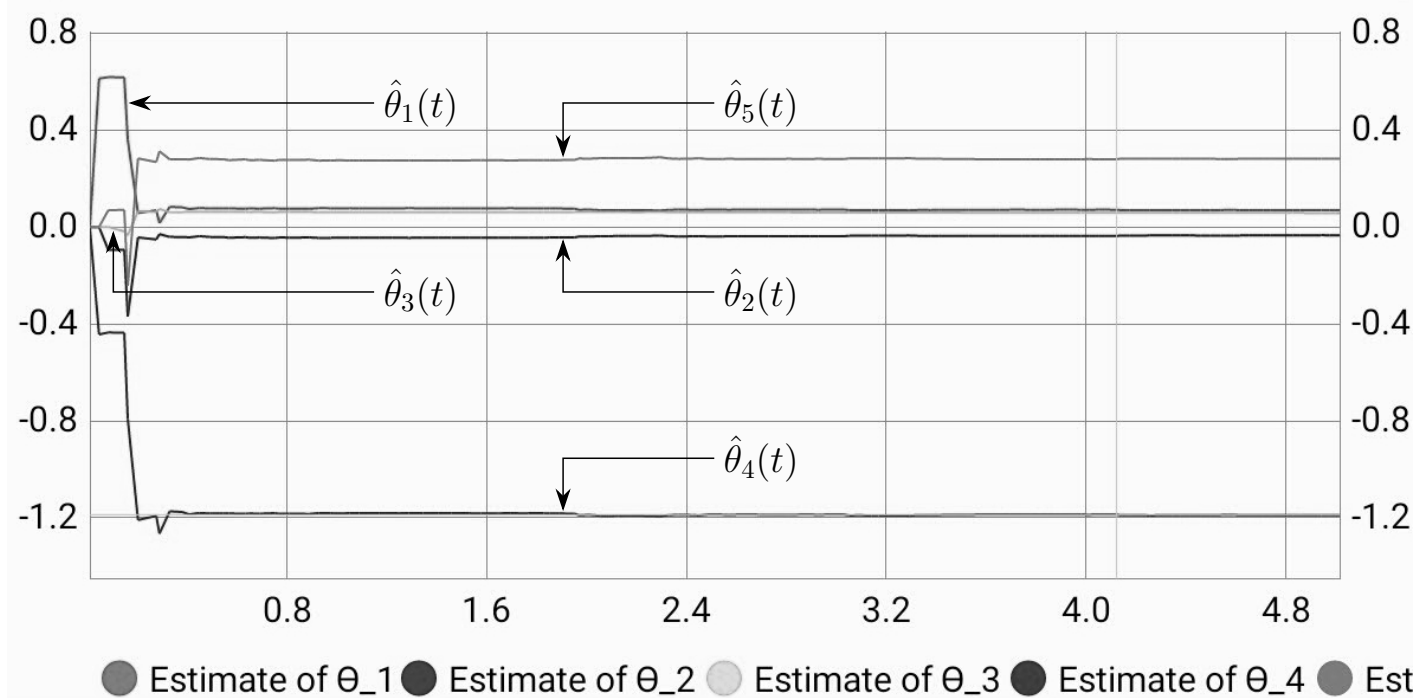
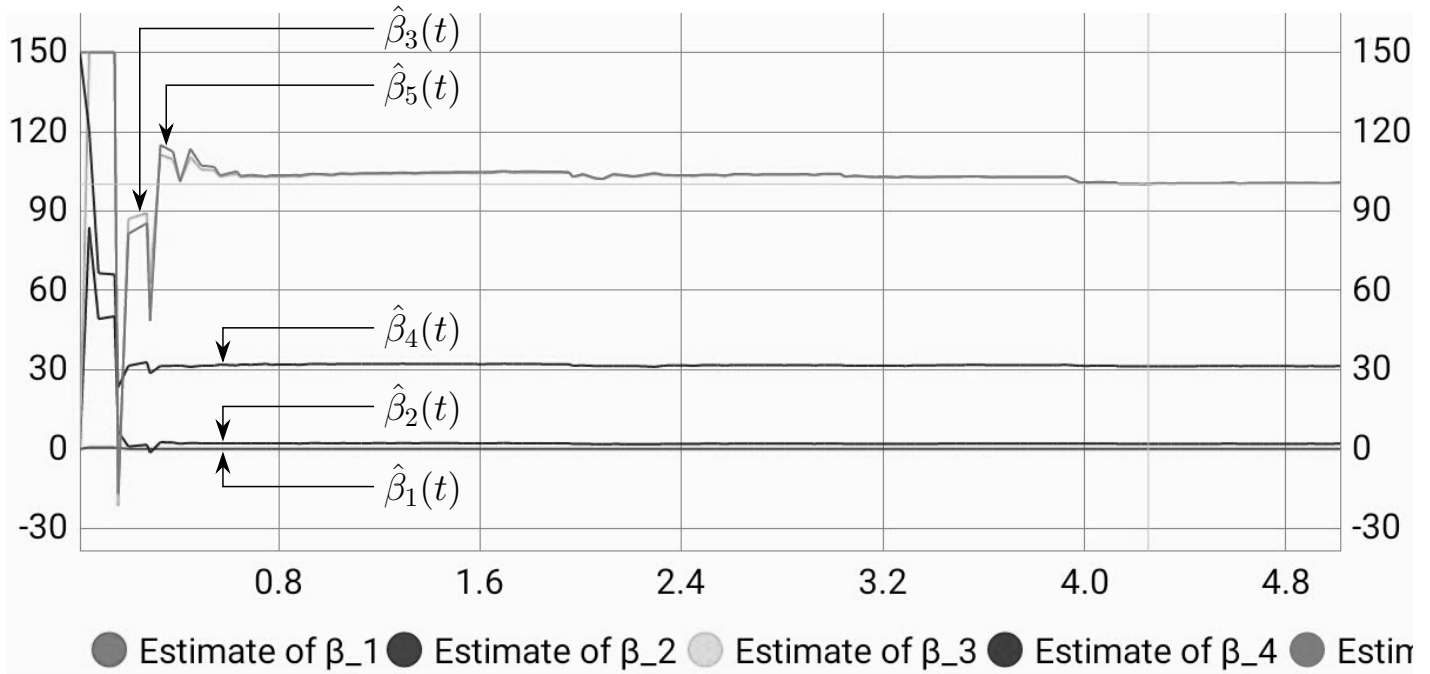


Figure 15: Signals  $u(k)$ ,  $y(k)$ ,  $\hat{y}(k)$  and parameters  $\hat{\theta}_1$ ,  $\hat{\theta}_2$ ,  $\hat{\theta}_3$ ,  $\hat{\theta}_4$  and  $\hat{\theta}_5$ .



### 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 $\theta_1$	0.0692599	
Estimate of $\theta_2$	-0.0343029	
Estimate of $\theta_3$	0.0572122	
Estimate of $\theta_4$	-1.18859	
Estimate of $\theta_5$	0.280906	
Estimate of $\beta_1$	0.0692599	
Estimate of $\beta_2$	2.00433	
Estimate of $\beta_3$	100.661	
Estimate of $\beta_4$	31.3661	
Estimate of $\beta_5$	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.

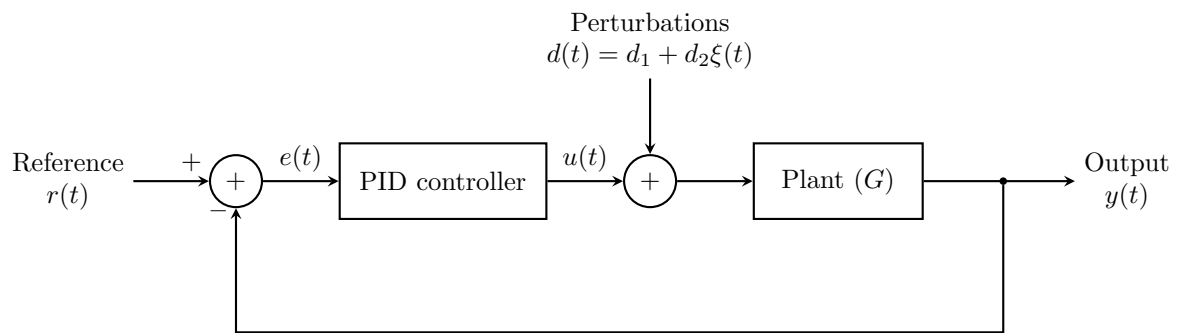
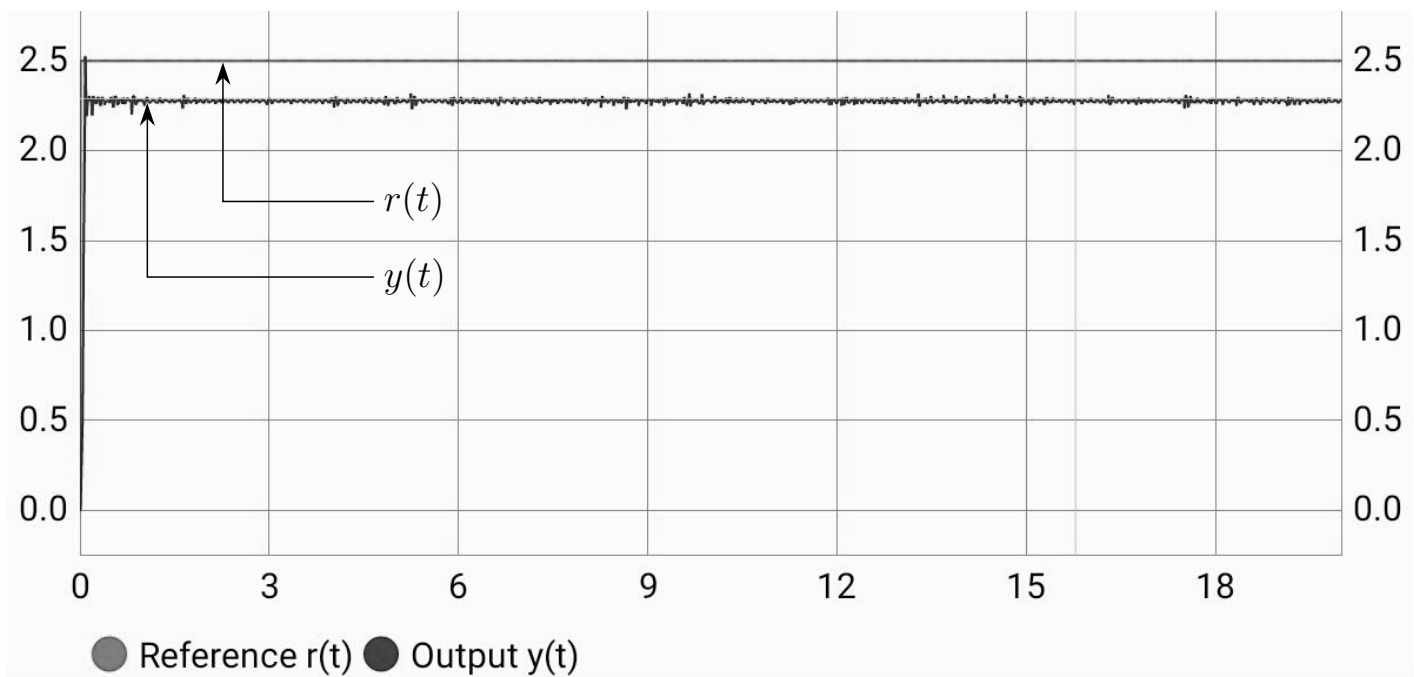


Figure 17: Closed loop system with a PID Controller



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

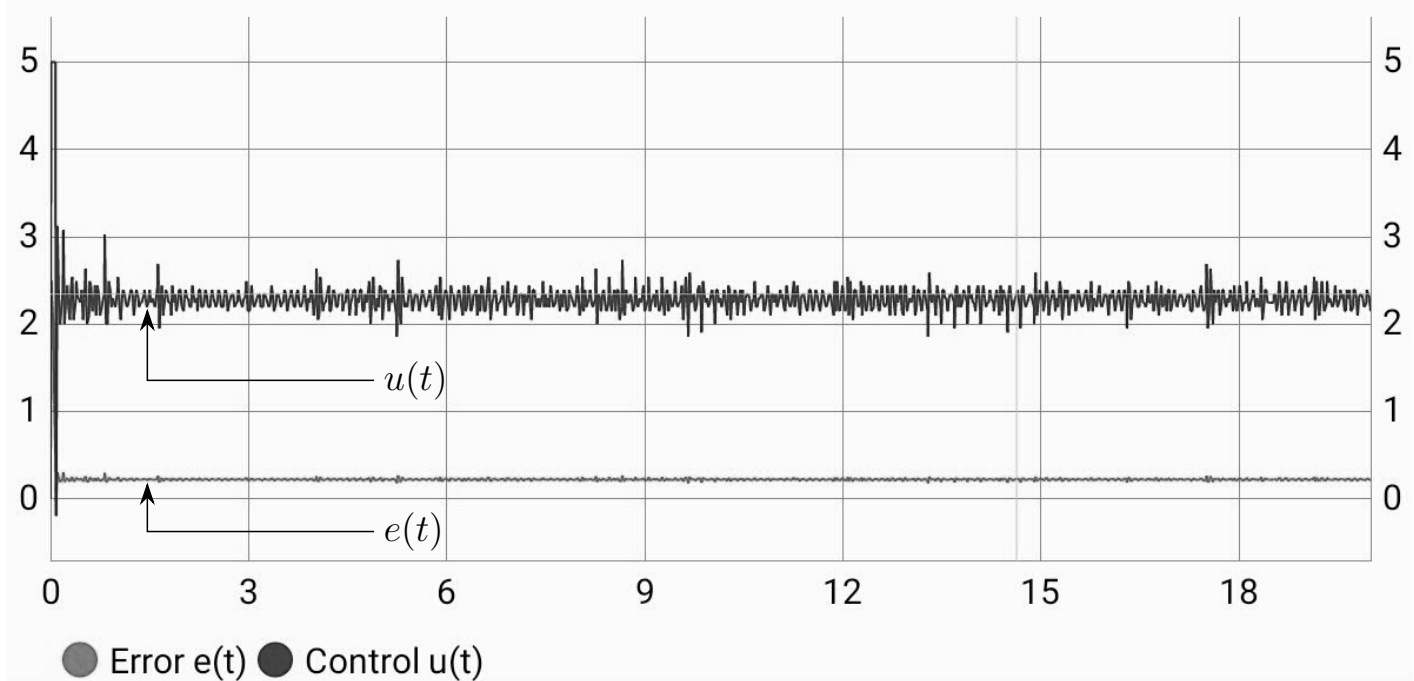
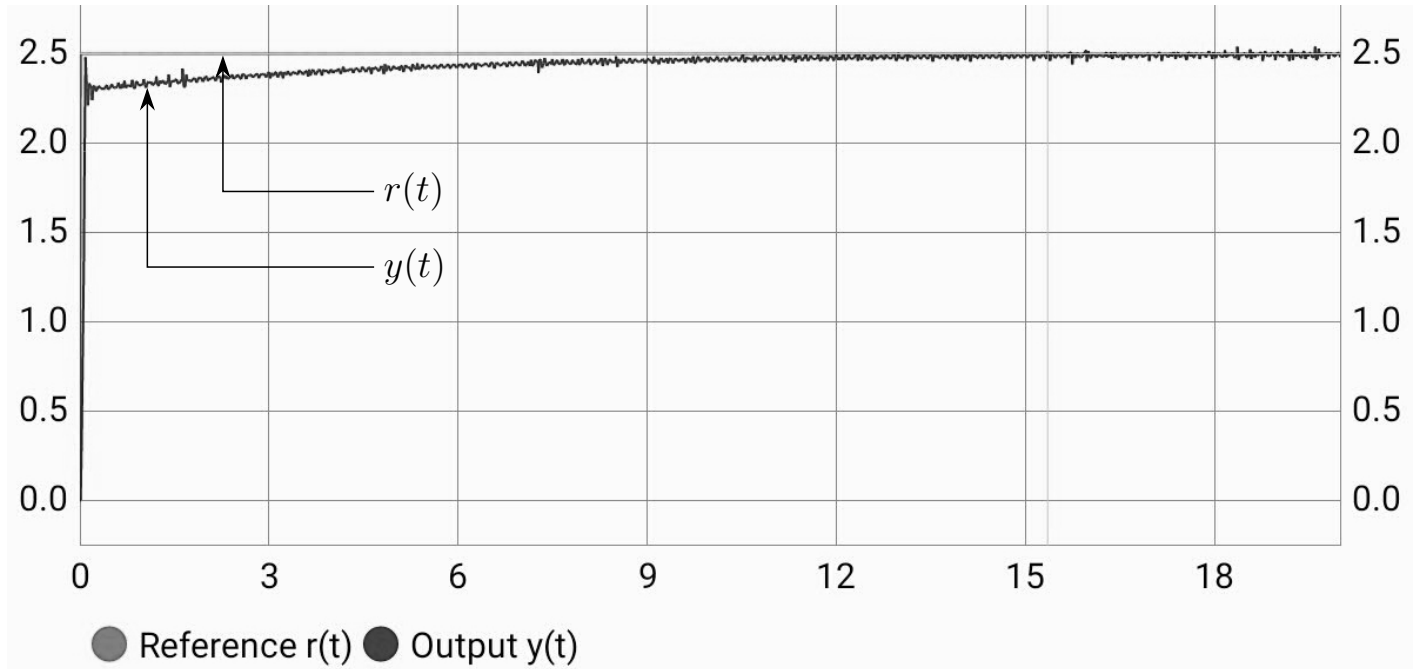


Figure 18: Signals  $r(k)$ ,  $y(k)$ ,  $e(k)$  and  $u(k)$  of the closed-loop system with  $K_P = 10$ ,  $K_I = 0$ , and  $K_D = 0$ .



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

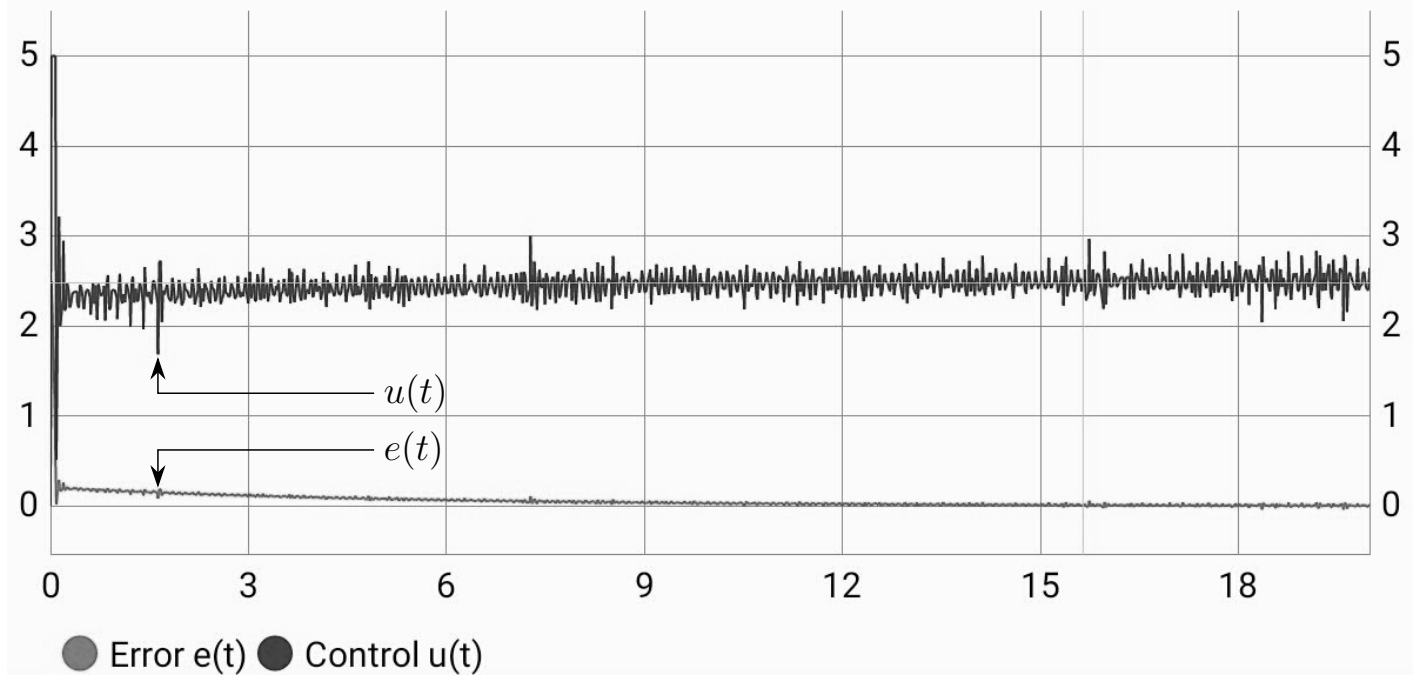
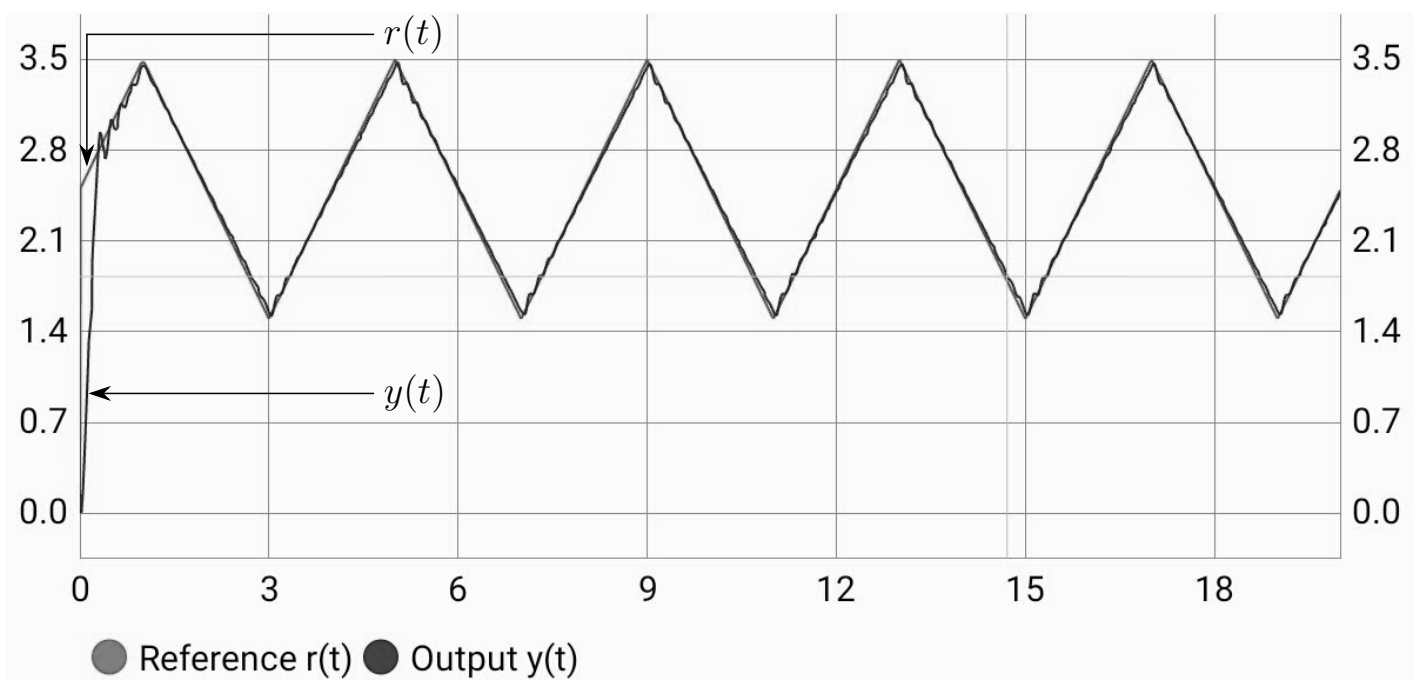


Figure 19: Signals  $r(k)$ ,  $y(k)$ ,  $e(k)$  and  $u(k)$  of the closed-loop system with  $K_P = 10$ ,  $K_I = 2$ , and  $K_D = 0$ .



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

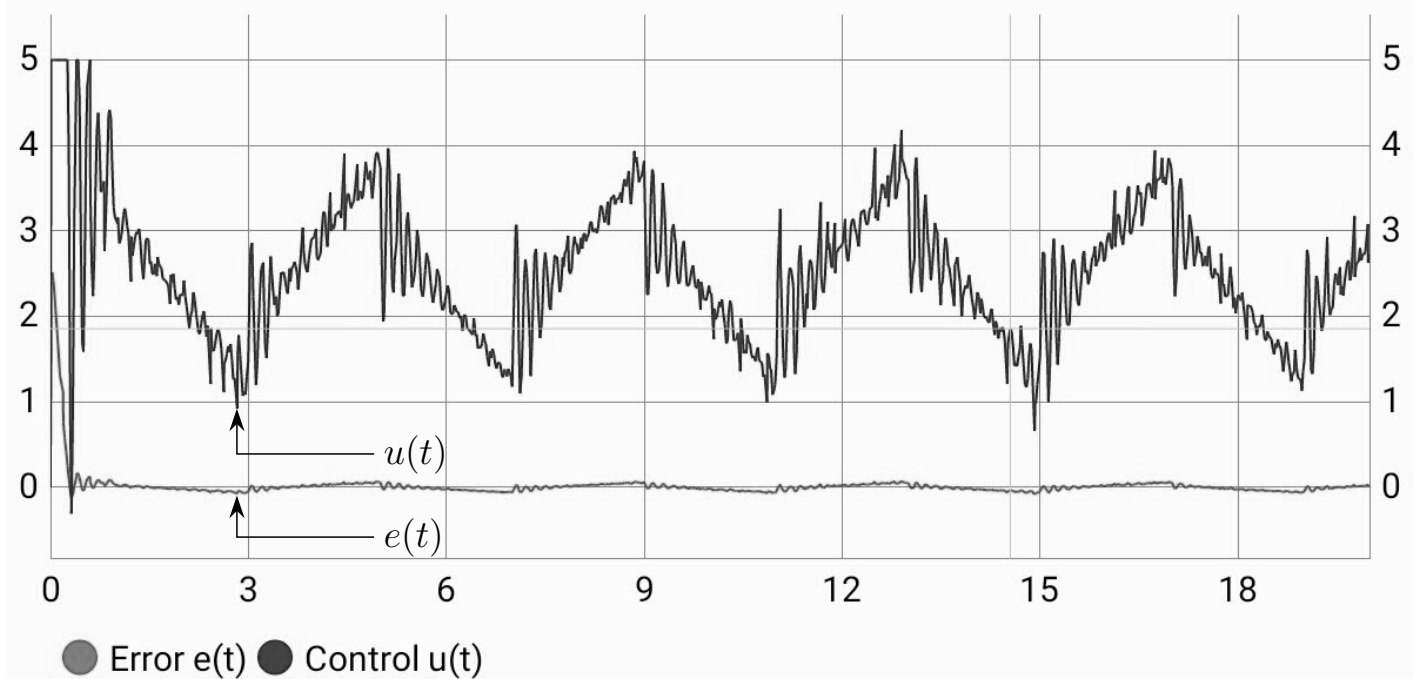


Figure 20: Signals  $r(k)$ ,  $y(k)$ ,  $e(k)$  and  $u(k)$  of the closed-loop system with  $K_P = 20$ ,  $K_I = 5$ , and  $K_D = 0.1$ .