

DIGITAL TWINS OF LABORATORY EXERCISES WITH DC MOTOR

IDENTIFICATION AND POSITION CONTROL OF DC MOTOR

A) Estimating parameters of DC motor or parameter identification of DC motor

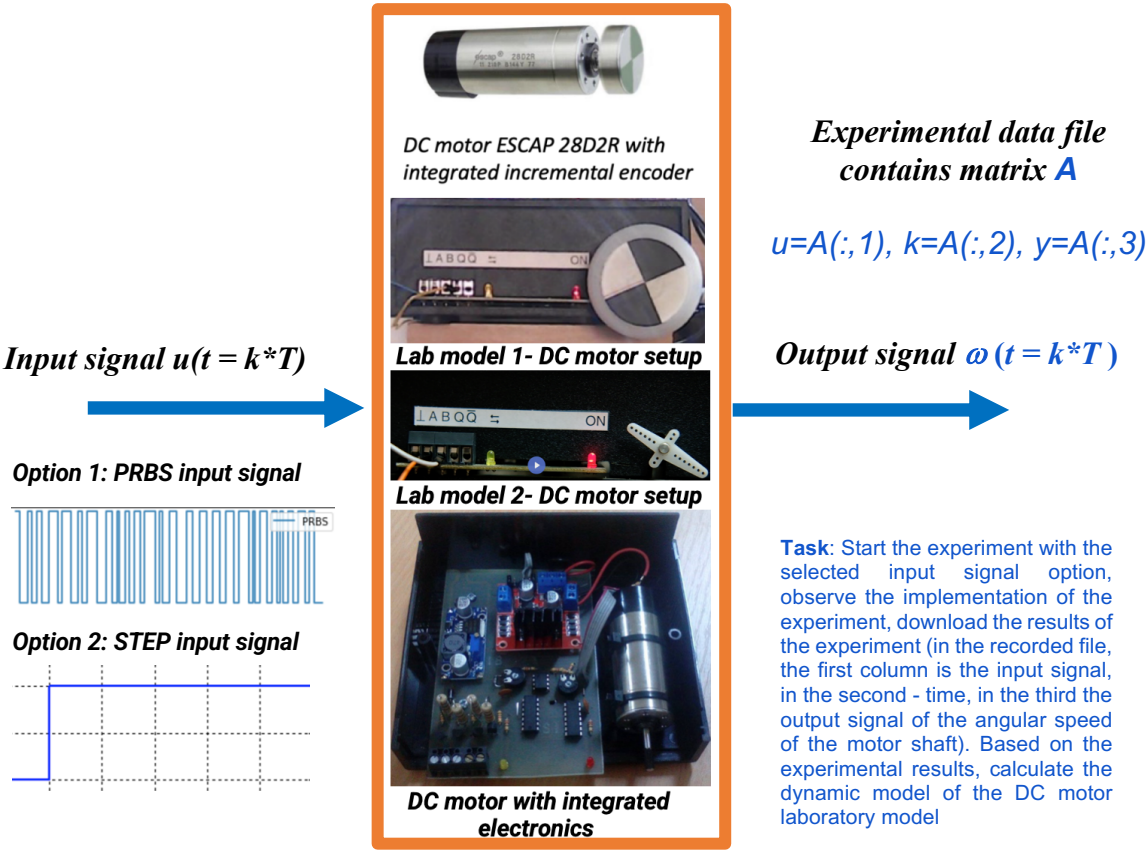
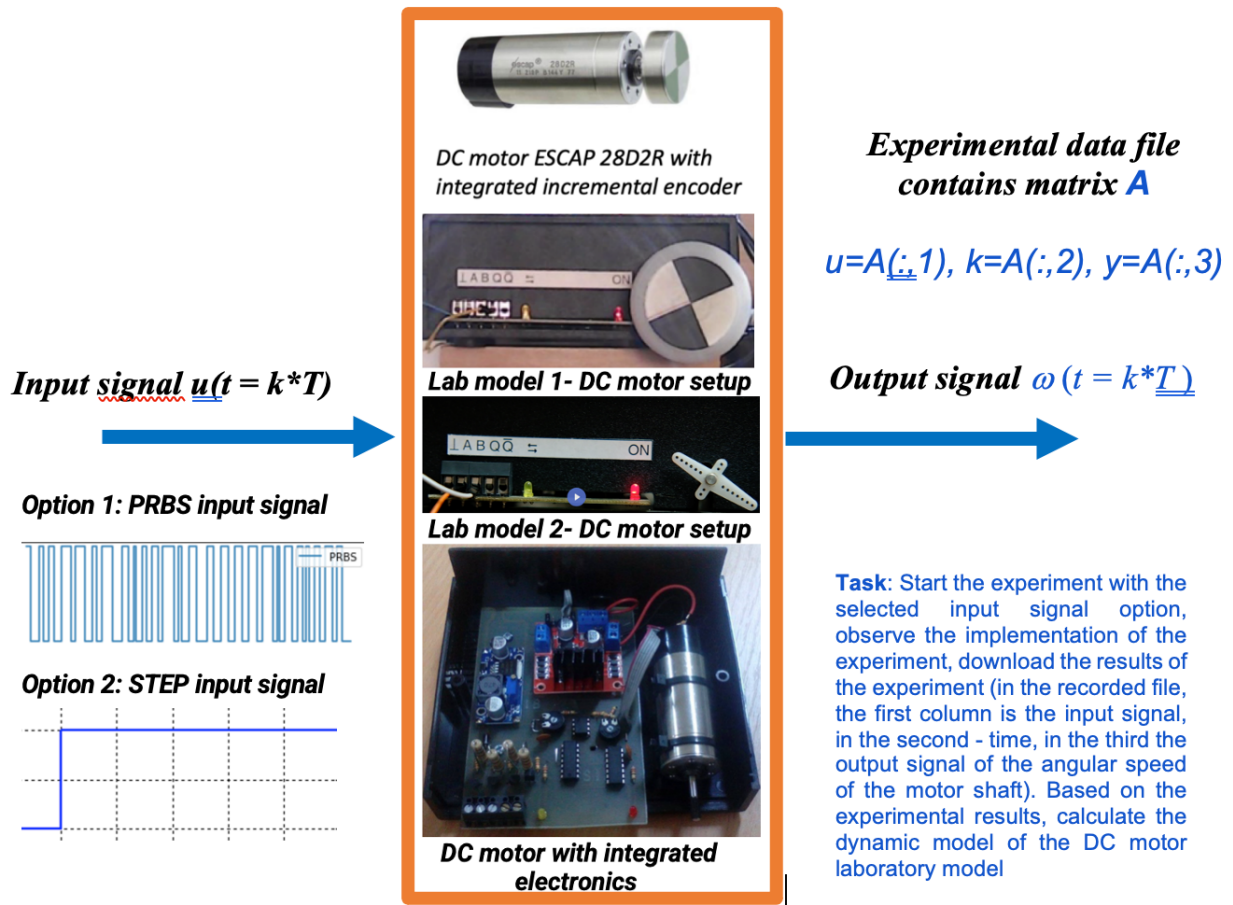
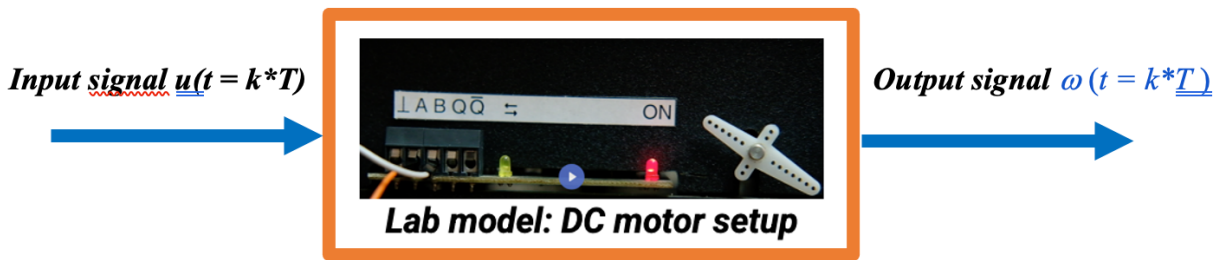


Figure1: Open loop experiment

Integrated figure 1:



## OPEN LOOP EXPERIMENT AND IDENTIFICATION OF DC MOTOR



**TASK (1):** Based on the recording of input and output data from the conducted experiment, the mathematical model of the DC motor setup (Lab model is in open loop) should be determined.

Experiment realization:



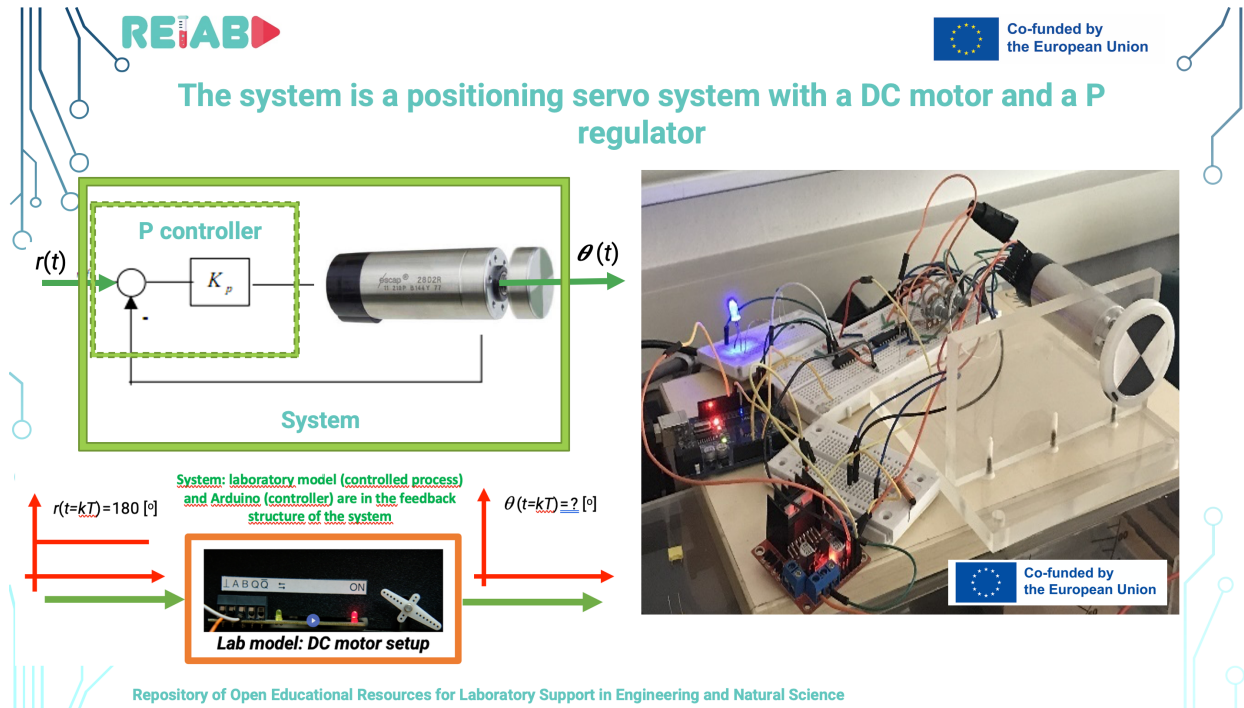
DTW SW should use data

FROM <https://unicloud.kg.ac.rs/index.php/s/p3fLSpztqFjSDk4> = >>>

Option of input signal $u(t)$	EXP VIDEO	EXP FILE	Experimental data within EXP FILE
PRBS (Option 1)	PRBS.MOV	PRBS_1	$a = \text{load}(\text{"PRBS\_1"})$ or $a = \text{load}(\text{"STEP\_1"})$  1 <sup>st</sup> column Control or input signal: $u\_k\text{vant} = a(:, 1);$
STEP (Option 2)  <i>The control variable of the DC motor is in "quants", and refers to a PWM signal with an amplitude of 12V, a resolution of 10 bits and a PWM cycle frequency of 20 KHz.</i>	2STEP.MOV	STEP_1	$u\_v = a(:, 1) * 0.0117; \text{ [V]}$ $u\_p = a(:, 1) * 0.0978; \text{ [%]}$  2 <sup>nd</sup> column Time [s] $t = a(:, 2) * 0.005; \text{ \% t[s]}$  3 <sup>rd</sup> column Output (angular velocity) $y = a(:, 3);$

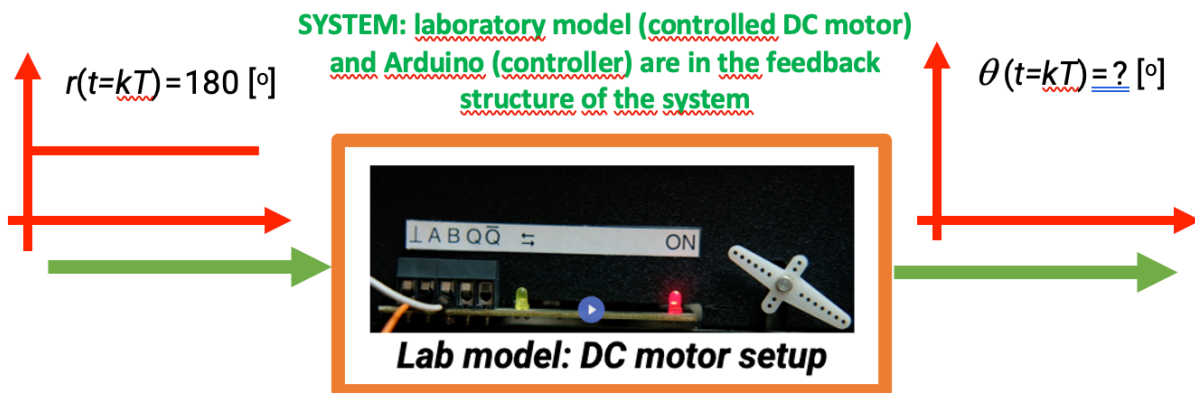
## B) Position control of DC motor

On the following picture is depicted an illustration of the system structure for positioning of DC motor shaft



By changing the gain of the P regulator, the quality of the transient process of the output variable is affected.

### EXPERIMENT:



The system is a positioning servo system with a DC motor and a P regulator

**TASK (2):** Students can check whether the simulation and experiment results match. Then, students can calculate for which gain  $K$  of the  $P$  controller, the system becomes unstable. Is it possible to calculate the  $P$  regulator gain for which the system achieves the fastest possible aperiodic response?

DTW SW should use data

FROM <https://unicloud.kg.ac.rs/index.php/s/p3fLSpztqFjSDk4> = >>>

P Controller and its parameter: <b>gain K</b>	EXP VIDEO	EXP FILE	Experimental data within EXP FILE:
K=0.75	K_0_75.mp4	K_0_7_SA_KOMP	<b>REFERENCE SIGNAL</b> $r(t)=180^\circ$ Sample time: $T=0.005$ [s] $a=\text{load}(\text{"name of the EXP FILE"})$ 1 <sup>st</sup> column Control signal: $u=a(:,1);$ $u_v= a(:,1)*0.0117; \text{ [V]}$ $u_p= a(:,1)*0.0978; \text{ [%]}$ 2 <sup>nd</sup> column Time [s] $t=a(:,2)*0.005; \text{ % t[s]}$ 3 <sup>rd</sup> column Output (angle in $^\circ$ ) $y=a(:,3);$
K=1.5	K_1_5.mp4	K_1_5_SA_KOMP	
K=3	K_3.mp4	K_3_SA_KOMP	
K=4.5	K_4_5.mp4	K_4_5_SA_KOMP	

Literature

Lab exercise (O5): <https://unicloud.kg.ac.rs/index.php/s/9Wf4oQpwYMEpS5F>