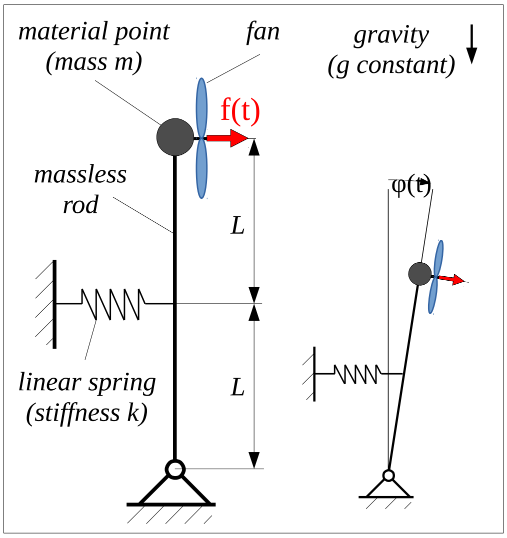
Theory of Machines and Automatic Control - project class

The Faculty of Automotive and Construction Machinery Engineering

Winter 2018/2019; **http://myinventions.pl/lectures/**



<u>Project no. 3</u>

1. MODELING

a) Obtain equation of motion of the presented system using Lagrange equations of the second kind. Choose $\varphi(t)$ angle as a generalized coordinate. Assume, that the $\varphi(t)$ is very small.

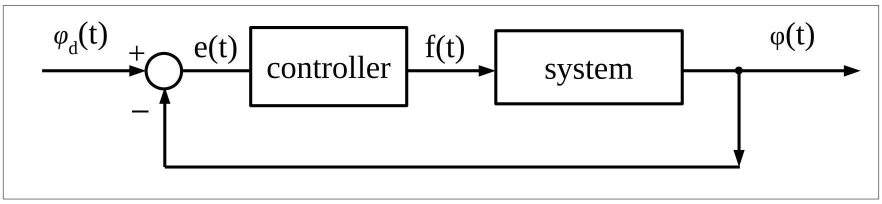
b) Obtain transfer function of the system with Laplace transform. Force $F(t)$ is an input, angle $\varphi(t)$ is an output.

c) Draw step response, Nyquist Plot and Bode Plot of the system using parameters from the table below.

Teacher: S. Korczak			
Student number	L [m]	m [kg]	k [N/m]
295654	0,2	1	50
295229	0,25	2	40
290030	0,15	2,2	44
290032	0,19	1,2	80
K-5055	0,22	1,5	72
K-5234	0,21	1,1	60
290045	0,18	1,3	55
290048	0,19	1,8	70
290050	0,2	1,5	75
295513	0,22	1,9	49
K-5216	0,21	1,1	68
281108	0,25	1,5	38

Teacher: P. Wawrzyniak			
Student number	L [m]	m [kg]	k [N/m]
288480	0,19	1	100
295511	0,22	0,9	80
290057	0,21	2	150
290058	0,18	2	120
295515	0,19	3	140
286495	0,21	2	110
295227	0,22	1,5	90
290062	0,21	2	150
K-5235	0,2	1,8	120
	0,22	1,7	130
	0,21	1,6	80
	0,25	2	90

2. CONTROL



For system's transfer function obtained in 1b, calculate reduced transfer function of control system, where input $\varphi_d(t)$ is a desired angle (setpoint) and output $\varphi(t)$ is a real pendulum angle, for: a) P controller, b) PD controller

3. STABILITY

a) Check stability of the system described <u>in point 1b</u> using general stability criterion.

b) Find out values of proportional and derivative constants that give us stability of the control systems from <u>points 2a and 2b</u>. Use Hurwitz criterion.

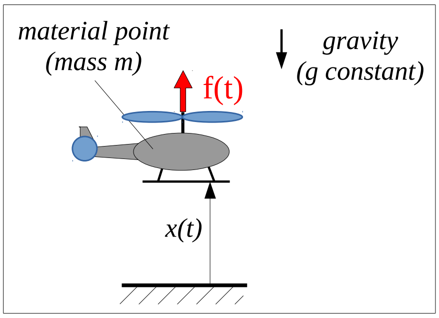
c) Draw step responses and Bode Plots for exemplary proportional and derivative constants that satisfies stability criterion from point 3b.

Theory of Machines and Automatic Control - project class

The Faculty of Automotive and Construction Machinery Engineering

Winter 2018/2019; **http://myinventions.pl/lectures/**

Project no. 3



1. MODELING

a) Obtain equation ,of motion of the presented system using Lagrange equations of the second kind. Choose copter altitude $x(t)$ as a generalized coordinate. Assume vertical movement with air resistance linearly dependent to velocity with c constant.

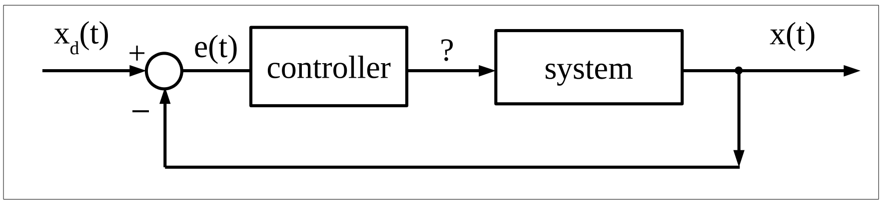
b) Obtain transfer function of the system where $x(t)$ is an output. Can we use rotor force $f(t)$ as an input?

c) Draw step response, Nyquist Plot and Bode Plot of the system using values:

Teacher: S. Korczak		
Student number	m [kg]	c [Ns/m]
295516	1000	20
290028	2000	18
293690	1800	22
K-5218	1600	26
K-5052	500	10
295528	300	7
295514	450	11
290049	1300	13
290051	1500	15
295512	1900	19
K-5209	1400	14
275221	1100	12

Teacher: P. Wawrzyniak		
Student number	m [kg]	c [Ns/m]
295510	1000	11
	2000	13
	1800	15
	1600	19
K-5235	700	9
	900	7
	1300	12
282640	1500	16
	1900	12
	1400	15
	1100	10
	1300	12

2. CONTROL



For system's transfer function obtained in 1b, calculate reduced transfer function of control system, where input $x_d(t)$ is a desired copter altitude and output $x(t)$ is a real altitude, for: a) P controller, b) PI controller

3. STABILITY

a) Check stability of the system described <u>in point 1b</u> using general stability criterion.

b) Find out values of proportional and derivative constants that give us stability of the control systems from <u>points 2a and 2b</u>. Use Hurwitz criterion.

c) Draw step responses and Bode Plots for exemplary proportional and derivative constants that satisfies stability criterion from point 3b.