ES360 Exam 1

Practice Exam

Permitted Materials:

You are permitted to use the following to take this exam:

- Your calculator
- Both sides of a single 8.5" x 11" sheet of paper with anything you want on it

Exchanging or sharing of any material during the actual exam is prohibited.

SHOW ALL WORK. For short answer and calculating problems show all appropriate work and clearly indicate your answer by drawing a box around it. Partial credit may be awarded at the instructor's discretion, but only if you have shown your work.

This exam is 8 pages long (including this cover sheet). Ensure you have all 8 pages.

Comments on the Practice Exam:

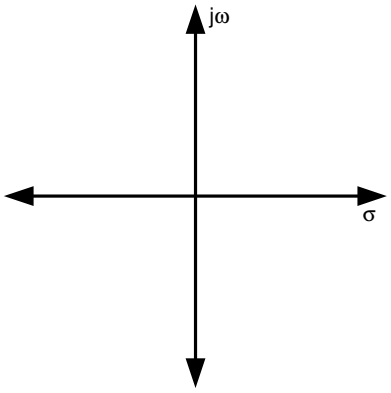
This practice exam shows the types questions on Exam 1. On the actual exam, there may be more or less of any particular question type.

R.S. Cortesi
LT, USN

Practice Exam #1

For questions 1 and 2 find the numerical answers in both rectangular and polar form. Additionally plot the answer on the complex plane

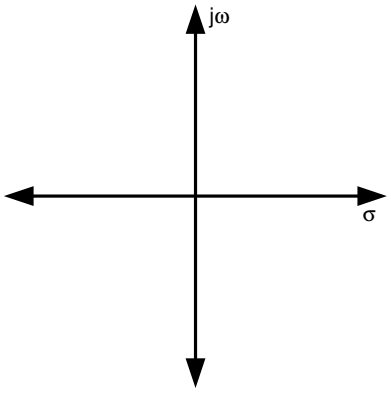
1) $(2\angle 90°)\cdot(2\angle 180°)$



Polar

Rectangular

2) $(6+7j)+(4+3j)$

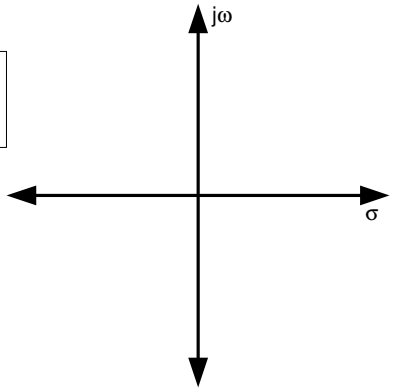


Polar

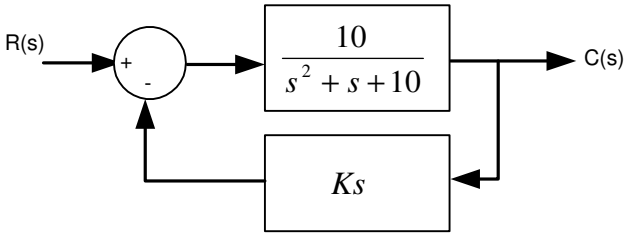
Rectangular

3) Solve $2s^2+6s+14=0$ and plot the solution on the complex plane.

s=

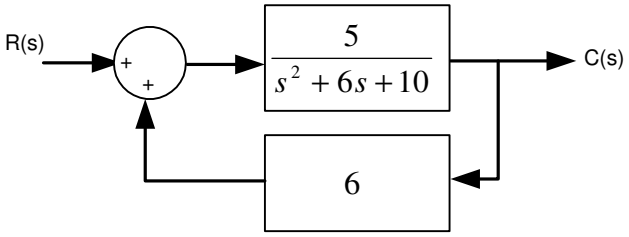


4) Simplify the block diagram. Your answer must be in the form $\frac{polynomial_1}{polynomial_2}$.



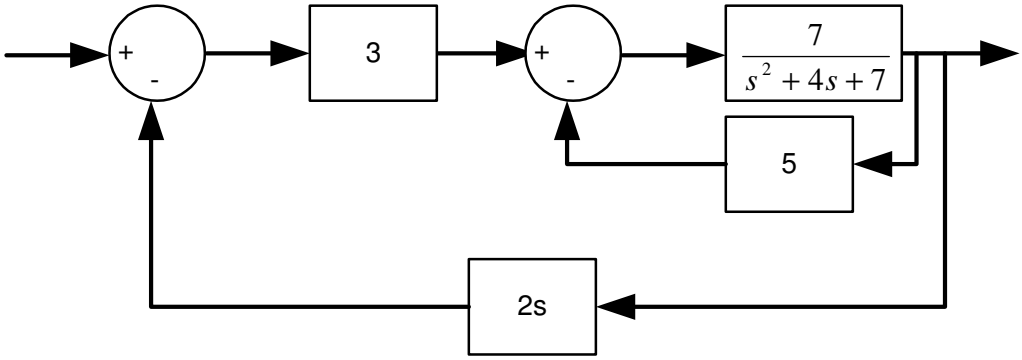
Answer

5) Simplify the block diagram. Your answer must be in the form $\frac{polynomial_1}{polynomial_2}$. Watch the signs in the feedback loop!!!



Answer

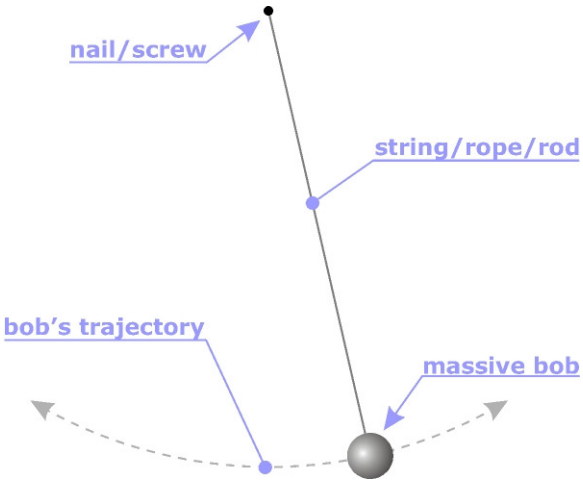
6) Reduce the following block diagram to a rational function. Sketching the intermediate block diagrams will be helpful. Your answer must be in the form $\frac{polynomial_1}{polynomial_2}$.



Answer

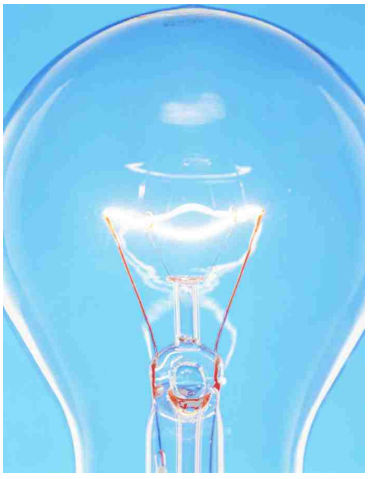
In the systems pictured below label the kinetic and potential energy storage elements and the dissipative elements. Additionally label any devices which convert energy from one domain to another (Translational to Thermal, electric to rotational, etc.).

7)

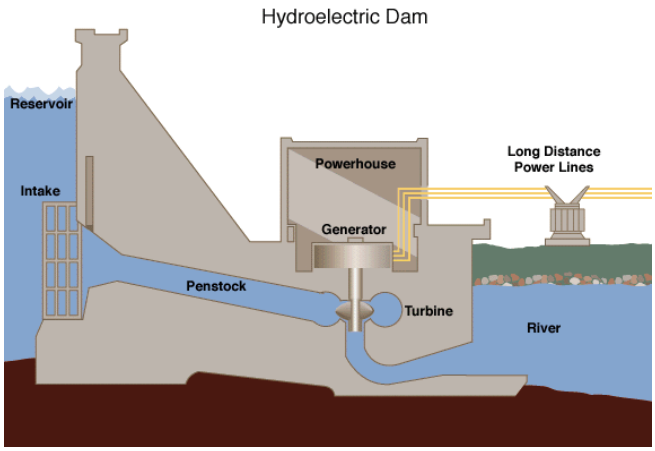


8)

9)



10)



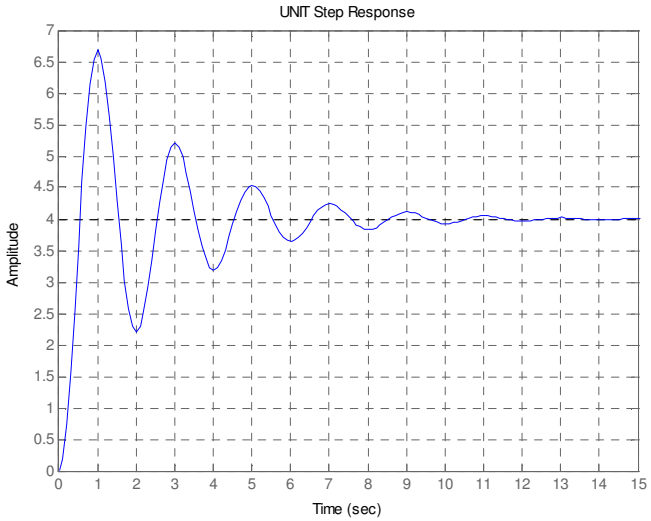
11) For the unit step applied to the transfer function $G(s) = \dfrac{10}{s^2 + 3s + 10}$ find the following:

Characteristic Equation	
Roots of the Characteristic Equation	
System Response Type: (Over Damped, Critically Damped, Under Damped, Unstable)	
ϖ_n	
$\zeta\varpi_n$	
ζ	
ϖ_d	
Ts	
Tp	
%OS	
DC Gain	

12) For the unit step applied to the transfer function $G(s) = \dfrac{6}{s^2 + 10s + 10}$ find the following:

Characteristic Equation	
Roots of the Characteristic Equation	
System Response Type: (Over Damped, Critically Damped, Under Damped, Unstable)	
ϖ_n	
$\zeta\varpi_n$	
ζ	
ϖ_d	
Ts	
Tp	
%OS	
DC Gain	

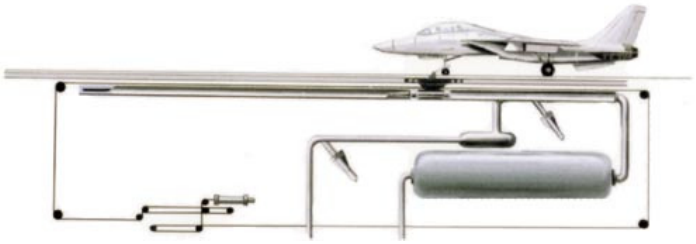
13) A **unit step** applied to a system generates the following response. Use the plot to find the values for: ϖ_d, Ts, Tp, %OS, DC Gain, and the second order transfer function.



ω_d	
T_s	
T_p	
%OS	
DC Gain	

G(s) =

14) The translational motion of an aircraft carrier's catapult shot can be modeled by a first order transfer function.



The first order transfer function which models this system is:

$$G(s) = \frac{\frac{1}{M}}{s + \frac{B}{M}}.$$

a) For a given force applied by the catapult, which variable(s) in the <u>transfer function</u> determines the systems steady state speed? Why?

b) If the take-off weight of the aircraft increases due to mission requirements, how will the time to reach the final steady state speed change? Use the transfer function to explain. Also, describe two ways to decrease the settling time to reach the steady state velocity.

Practice Exam #1 Solutions

1) $4\angle 270°$ and $-4i$

2) $14.14\angle 45°$ and $10+10i$

3) $-1.5 \pm 2.18i$

4) $\dfrac{10}{s^2+(1+10K)s+10}$

5) $\dfrac{5}{s^2+6s-20}$

6) $\dfrac{21}{s^2+46s+42}$

See Lesson 3b for ideas on questions 7 through 10.

	11)	12)
Characteristic Equation	$s^2+3s+10=0$	$s^2+10s+10=0$
Roots of the Characteristic Equation	$s=-1.5\pm 2.78i$	$s=-1.12$ and $s=-8.87$
System Response Type: (Over Damped, Critically Damped, Under Damped, Unstable)	Under Damped	Over Damped
ϖ_n	3.16	3.16
$\zeta\varpi_n$	1.5	5
ζ	0.47	1.58
ϖ_d	2.78	0
Ts	2.7 sec	3.6 sec
Tp	1.1 sec	∞
%OS	19.6%	0
DC Gain	1	0.6

13) $\varpi_d = \pi \frac{rad}{\sec}$, Ts = 10 sec, Tp = 1 sec, %OS = 68.8%, DC Gain = 4

$$G(s)=\frac{40}{s^2+0.8\cdot s+10}$$

14)

a) The magnitude of B determines the system's steady state speed because it is the only term which appears in the transfer function's DC gain, $DC_{gain}=\dfrac{1}{B}$. The mass term M cancels out.

b) For this transfer function the settling time is given by $Ts=\dfrac{4M}{B}$. As the mass of the aircraft increases so does the settling time. The two ways of decreasing settling time are **decreasing the mass** and **increasing the friction**.