Alexandria University
Faculty of Engineering
Electrical Engineering Department
Mid-term Exam, April 2013

جامعة الإسكندرية
كلية الهندسة
قسم الهندسة الكهربية
امتحان الفصل الدراسي الثاني (ابريل ٢٠١٣)

Course Title and Code Number:
Control Systems and Components (EE391)
Third Year (Communications and Electronics)
Time Allowed: 45 Mins

اسم المقرر والرقم الكودي له:
أنظمة التحكم ومكوناتها (EE391)
السنة الدراسية الثالثة (اتصالات و الكترونيات)
الزمن: ٤٥ دقيقة

Answer All Questions: **(15 marks)**

Laplace transform table is provided in page 2:

1. The following block diagram represents a generic closed-loop linear system consisting of a reference input *R(s)*, a disturbance *D(s)*, and sensor noise *N(s)* and output *C(s)*. **(5 marks)**

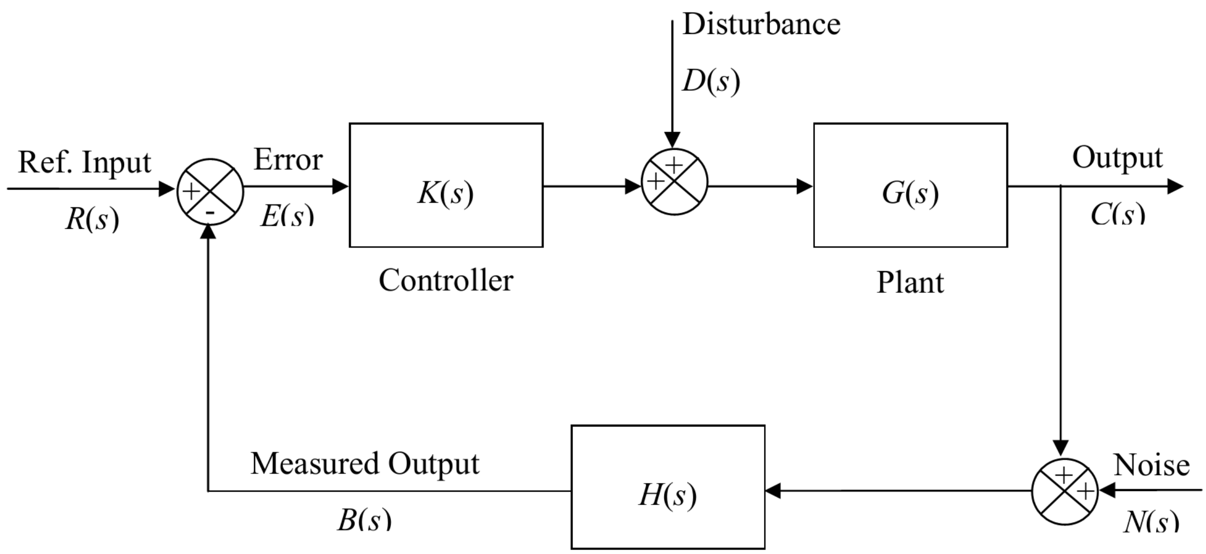

Figure 1

a. Evaluate the output *C(s)* in terms of the inputs *R(s)*, *D(s)*, and *N(s)*.

b. Assume that *H(s) = 1* (i.e. unity feedback) and *K(s) = K* (proportional controller). Assume also that there is no noise or disturbance (i.e. *N(s) = 0* and *D(s) = 0*).
Derive a simple expression for the error *E(s) = R(s)-B(s)*, in terms of *R(s)*, *G(s)*, and *K*.

c. Consider the following transfer function of the plant:

$$G(s) = \frac{1}{2 + s^2}$$

Assume *H(s) = 1*, *K(s) = K*, *N(s) = 0*, and *D(s) = 0*. Find the steady state error e_{ss} for a unit-step reference input *R(s)*, (i.e. *e(t)* as t goes to infinity).

2. Simplify the block diagram shown in Figure 2 and obtain the closed-loop transfer function *C(s)/R(s)*. **(4 marks)**

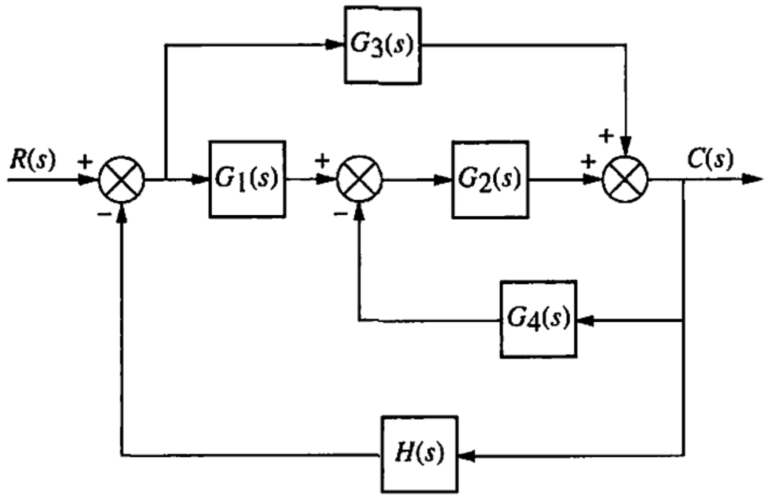

Figure 2

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3. For the second-order system shown in Figure 3 **(6 marks)**

a. **Derive** an expression of the output *C(s)* for a unit step input *R(s)*.

b. **Derive** an expression for the peak time, and maximum overshot for the underdamped system.

c. Determine the values of *K* and *B* of the closed-loop system so that the maximum overshoot in unit-step response is *25%* and the peak time is *2* sec. Assume that $J = 1 kg\text{-}m^2$.

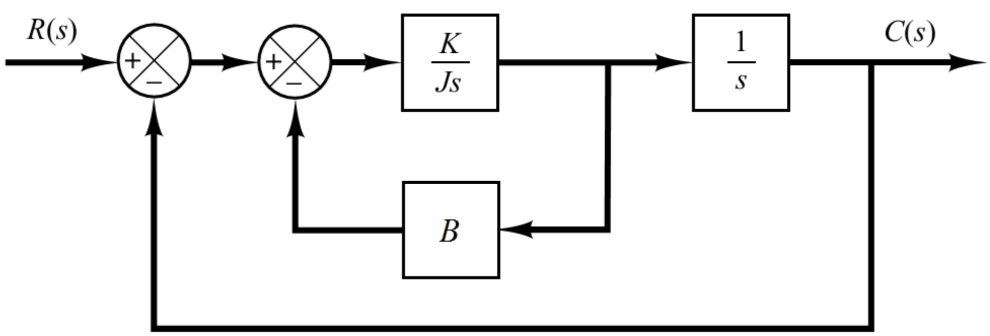

Figure 3

Table1 : Laplace Transform Pairs

L[f(t)]→F(s)	L[sin (ωt)]→ $\frac{\omega}{s^2+\omega^2}$	L[unit step 1(t)]→$\frac{1}{s}$	L($\frac{t^{n-1}}{(n-1)!}$)→ $\frac{1}{s^n}$
L[δ(t)]→1	L[cos(ωt)]→ $\frac{s}{s^2+\omega^2}$	L(t)→ $\frac{1}{s^2}$	L[e^{-at}.f(t)]→F(s+a)

Good Luck

Examiner: ***Dr. Mohammed Morsy***