

# Lección 4. Sistemas de control dinámico

18 de febrero de 2015

## 1 Transformada de Laplace (TL)

Sea  $x(t)$  tal que  $|x(t)| < Me^{mt}$ ,  $M > 0$  y  $m > 0$ , entonces

$$X(s) = \mathcal{L}\{x(t)\} = \int_{-\infty}^{\infty} x(t)e^{-st}dt; \text{ ecuación de análisis} \quad (1)$$

y

$$x(t) = \mathcal{L}^{-1}\{X(s)\} = \frac{1}{2\pi j} \int_{\sigma-j\infty}^{\sigma+j\infty} X(s)e^{st}ds; \text{ ecuación de síntesis} \quad (2)$$

Las propiedades siguientes de la TL se emplean en el presente capítulo:

1. Linealidad

$$\mathcal{L}\{\alpha x_1(t) + \beta x_2(t)\} = \alpha X_1(s) + \beta X_2(s) \quad (3)$$

2. Desplazamiento temporal

$$\mathcal{L}\{x(t - t_0)\} = e^{-st_0} X(s) \quad (4)$$

3. Convolución<sup>1</sup>

$$\mathcal{L}\{x_1(t) * x_2(t)\} = X_1(s)X_2(s) \quad (5)$$

4. Diferenciación en el dominio del tiempo

$$\mathcal{L}\left\{\frac{dx(t)}{dt}\right\} = sX(s) \quad (6)$$

5. Integración en el dominio del tiempo

$$\mathcal{L}\left\{\int_{-\infty}^t x(\tau)d\tau\right\} = \frac{1}{s}X(s) \quad (7)$$

6. Teorema del valor final

$$\lim_{t \rightarrow \infty} x(t) = \lim_{s \rightarrow 0} sX(s) \quad (8)$$

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<sup>1</sup> $x_1(t) * x_2(t) = \int_{-\infty}^{\infty} x_1(\tau)x_2(t - \tau)d\tau$

## 2 Package Ada.Calendar

```
1package Ada.Calendar is
2  type Time is private;
3  subtype Year_Number is Integer range 1901 .. 2099;
4  subtype Month_Number is Integer range 1 .. 12;
5  subtype Day_Number is Integer range 1 .. 31;
6  subtype Day_Duration is Duration range 0.0 .. 86_400.0;
7  function Clock return Time;
8  function Year (Date : Time) return Year_Number;
9  function Month (Date : Time) return Month_Number;
10 function Day (Date : Time) return Day_Number;
11 function Seconds(Date : Time) return Day_Duration;
12
13 procedure Split (Date : in Time;
14                 Year : out Year_Number;
15                 Month : out Month_Number;
16                 Day : out Day_Number;
17                 Seconds : out Day_Duration);
18 function Time_Of(Year : Year_Number;
19                 Month : Month_Number;
20                 Day : Day_Number;
21                 Seconds : Day_Duration := 0.0)
22 return Time;
23
24 function "+" (Left : Time; Right : Duration) return Time;
25 function "+" (Left : Duration; Right : Time) return Time;
26 function "-" (Left : Time; Right : Duration) return Time;
27 function "-" (Left : Time; Right : Time) return Duration;
28 function "<" (Left, Right : Time) return Boolean;
29 function "<=" (Left, Right : Time) return Boolean;
30 function ">" (Left, Right : Time) return Boolean;
31 function ">=" (Left, Right : Time) return Boolean;
32
33 Time_Error : exception;
34 private
35 ... -- not specified by the language
36end Ada.Calendar;
```

### 3 Package Ada.Real\_Time

```
1package Ada.Real_Time is
2  type Time is private;
3  Time_First : constant Time;
4  Time_Last : constant Time;
5  Time_Unit : constant := implementation-defined-real-number;
6
7  type Time_Span is private;
8  Time_Span_First : constant Time_Span;
9  Time_Span_Last : constant Time_Span;
10 Time_Span_Zero : constant Time_Span;
11 Time_Span_Unit : constant Time_Span;
12
13 Tick : constant Time_Span;
14 function Clock return Time;
15 function "+" (Left : Time; Right : Time_Span) return Time;
16 function "+" (Left : Time_Span; Right : Time) return Time;
17 function "-" (Left : Time; Right : Time_Span) return Time;
18 function "-" (Left : Time; Right : Time) return Time_Span;
19 function "<" (Left, Right : Time) return Boolean;
20 function "<=" (Left, Right : Time) return Boolean;
21 function ">" (Left, Right : Time) return Boolean;
22 function ">=" (Left, Right : Time) return Boolean;
23
24 function "+" (Left, Right : Time_Span) return Time_Span;
25 function "-" (Left, Right : Time_Span) return Time_Span;
26 function "-" (Right : Time_Span) return Time_Span;
27 function "*" (Left : Time_Span; Right : Integer) return Time_Span;
28 function "*" (Left : Integer; Right : Time_Span) return Time_Span;
29 function "/" (Left, Right : Time_Span) return Integer;
30 function "/" (Left : Time_Span; Right : Integer) return Time_Span;
31
32 function "abs"(Right : Time_Span) return Time_Span;
33 function "<" (Left, Right : Time_Span) return Boolean;
34 function "<=" (Left, Right : Time_Span) return Boolean;
35 function ">" (Left, Right : Time_Span) return Boolean;
36 function ">=" (Left, Right : Time_Span) return Boolean;
37 function To_Duration (TS : Time_Span) return Duration;
38 function To_Time_Span (D : Duration) return Time_Span;
39
40 function Nanoseconds (NS : Integer) return Time_Span;
41 function Microseconds (US : Integer) return Time_Span;
42 function Milliseconds (MS : Integer) return Time_Span;
43 type Seconds_Count is range implementation-defined;
44 procedure Split(T : in Time; SC : out Seconds_Count; TS : out Time_Span);
45 function Time_Of(SC : Seconds_Count; TS : Time_Span) return Time;
46
47private
48  ... -- not specified by the language
49end Ada.Real_Time;
```

## 4 Diagrama de componentes de la aplicación de control de un horno

