(*Cálculo de los coeficientes de la ecuación de sexto grado
para "Hibridación de polaritones fonónicos superficiales I"*)
número i

ClearAll[e1, e2, wl1, wl2, wt1, wt2, eq1, sols, Omega1, Omega2, params, e1, wl1, wl2, wt1,
borra todo
 wt2, eq1, sols, Omega1, Omega2, params, einf2, einf3, wl3, wt3, c, kx, w, d, arraysol]
eq1 = FullSimplify[Solve[{1 + r1 == r2 + t2,
      simplifica compl·· resuelve
    Y1 (1 - r1) == Y2 (t2 - r2), t2 * Exp[-d * kx] + r2 * Exp[d * kx] == t3 * Exp[-d * kx],
                                     exponencial   exponencial   exponencial
    Y2 (t2 * Exp[-d * kx] - r2 * Exp[d * kx]) == Y3 * t3 * Exp[-d * kx]}, {r1, r2, t2, t3}]]
              exponencial   exponencial   exponencial

Out[2]=
$$\left\{\left\{ r1 \rightarrow \frac{(Y1 + Y2)\ (Y2 - Y3) + \mathbb{e}^{2\,d\,kx}\ (Y1 - Y2)\ (Y2 + Y3)}{(Y1 - Y2)\ (Y2 - Y3) + \mathbb{e}^{2\,d\,kx}\ (Y1 + Y2)\ (Y2 + Y3)}, \right.\right.$$

$$r2 \rightarrow \frac{2\ Y1\ (Y2 - Y3)}{(Y1 - Y2)\ (Y2 - Y3) + \mathbb{e}^{2\,d\,kx}\ (Y1 + Y2)\ (Y2 + Y3)},$$

$$t2 \rightarrow \frac{2\ \mathbb{e}^{2\,d\,kx}\ Y1\ (Y2 + Y3)}{(Y1 - Y2)\ (Y2 - Y3) + \mathbb{e}^{2\,d\,kx}\ (Y1 + Y2)\ (Y2 + Y3)},$$

$$\left.\left. t3 \rightarrow \frac{4\ \mathbb{e}^{2\,d\,kx}\ Y1\ Y2}{(Y1 - Y2)\ (Y2 - Y3) + \mathbb{e}^{2\,d\,kx}\ (Y1 + Y2)\ (Y2 + Y3)} \right\}\right\}$$

ClearAll[e1, wl1, wl2, wt1, wt2, eq1, sols, Omega1,
borra todo
  Omega2, params, einf2, einf3, wl3, wt3, c, kx, w, d, arraysol]

(*Funciones dieléctricas*)
e2 = einf2 * (wl2^2 - w^2) / (wt2^2 - w^2);
e3 = einf3 * (wl3^2 - w^2) / (wt3^2 - w^2);

(*Ecuación de dispersión*)
eq = Sinh[kx * d] * (e1 * e3 + e2^2) + Cosh[kx * d] * (e1 * e2 + e2 * e3) == 0;
     seno hiperbólico   coseno hiperbólico

$$\left(einf2\ einf3\ (-w^2 + wl2^2)\ (-w^2 + wl3^2)\ (-w^2 + wt2^2) + e1\ einf2\ (-w^2 + wl2^2)\ (-w^2 + wt3^2)\right)$$
    Cosh[d kx] +
    coseno hiperbólico
$$\left(e1\ einf3\ (-w^2 + wl3^2)\ (-w^2 + wt2^2)^2 + einf2^2\ (-w^2 + wl2^2)^2\ (-w^2 + wt3^2)\right) Sinh[d kx] == 0$$
                                                                                    seno hiperbólico

Out[·]=
$$\left(einf2\ einf3\ (-w^2 + wl2^2)\ (-w^2 + wl3^2)\ (-w^2 + wt2^2) + e1\ einf2\ (-w^2 + wl2^2)\ (-w^2 + wt3^2)\right)$$
    Cosh[d kx] +
$$\left(e1\ einf3\ (-w^2 + wl3^2)\ (-w^2 + wt2^2)^2 + einf2^2\ (-w^2 + wl2^2)^2\ (-w^2 + wt3^2)\right) Sinh[d kx] == 0$$

```
In[ ]:= expr1 = Expand[
```
expande factores
$$\left(\text{einf2 einf3} \left(-w^2 + wl2^2\right) \left(-w^2 + wl3^2\right) \left(-w^2 + wt2^2\right) + \text{e1 einf2} \left(-w^2 + wl2^2\right) \left(-w^2 + wt3^2\right)\right)\ ];$$

```
expr2 = Expand[
```
expande factores
$$\left(\text{e1 einf3} \left(-w^2 + wl3^2\right) \left(-w^2 + wt2^2\right)^2 + \text{einf2}^2 \left(-w^2 + wl2^2\right)^2 \left(-w^2 + wt3^2\right)\right)\ ];$$

```
newexpr1 = Collect[expr1, w]
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agrupa coeficientes

```
newexpr2 = Collect[expr2, w]
```
agrupa coeficientes

$$Out[ ]= -\text{einf2 einf3}\ w^6 + \text{einf2 einf3}\ wl2^2\ wl3^2\ wt2^2 +$$
$$w^4 \left(\text{e1 einf2} + \text{einf2 einf3}\ wl2^2 + \text{einf2 einf3}\ wl3^2 + \text{einf2 einf3}\ wt2^2\right) +$$
$$\text{e1 einf2}\ wl2^2\ wt3^2 + w^2 \left(-\text{e1 einf2}\ wl2^2 - \text{einf2 einf3}\ wl2^2\ wl3^2 -\right.$$
$$\left.\text{einf2 einf3}\ wl2^2\ wt2^2 - \text{einf2 einf3}\ wl3^2\ wt2^2 - \text{e1 einf2}\ wt3^2\right)$$

$$Out[ ]= \left(-\text{einf2}^2 - \text{e1 einf3}\right) w^6 + \text{e1 einf3}\ wl3^2\ wt2^4 + \text{einf2}^2\ wl2^4\ wt3^2 +$$
$$w^4 \left(2\ \text{einf2}^2\ wl2^2 + \text{e1 einf3}\ wl3^2 + 2\ \text{e1 einf3}\ wt2^2 + \text{einf2}^2\ wt3^2\right) +$$
$$w^2 \left(-\text{einf2}^2\ wl2^4 - 2\ \text{e1 einf3}\ wl3^2\ wt2^2 - \text{e1 einf3}\ wt2^4 - 2\ \text{einf2}^2\ wl2^2\ wt3^2\right)$$

```
In[ ]:= newequation = Collect[ newexpr1 * Cosh[kx * d] + newexpr2 * Sinh[kx * d], w];
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agrupa coeficientes · coseno hiperbólico · seno hiperbólico

```
(*Coeficientes analíticos*)
Coefficient[newequation, w, 6]
```
coefficiente

```
Coefficient[newequation, w, 4]
```
coefficiente

```
Coefficient[newequation, w, 2]
```
coefficiente

```
Coefficient[newequation, w, 0]
```
coefficiente

$$Out[ ]= -\text{einf2 einf3}\ \text{Cosh}[d\ kx] + \left(-\text{einf2}^2 - \text{e1 einf3}\right)\ \text{Sinh}[d\ kx]$$

$$Out[ ]= \left(\text{e1 einf2} + \text{einf2 einf3}\ wl2^2 + \text{einf2 einf3}\ wl3^2 + \text{einf2 einf3}\ wt2^2\right)\ \text{Cosh}[d\ kx] +$$
$$\left(2\ \text{einf2}^2\ wl2^2 + \text{e1 einf3}\ wl3^2 + 2\ \text{e1 einf3}\ wt2^2 + \text{einf2}^2\ wt3^2\right)\ \text{Sinh}[d\ kx]$$

$$Out[ ]= \left(-\text{e1 einf2}\ wl2^2 - \text{einf2 einf3}\ wl2^2\ wl3^2 -\right.$$
$$\text{einf2 einf3}\ wl2^2\ wt2^2 - \text{einf2 einf3}\ wl3^2\ wt2^2 - \text{e1 einf2}\ wt3^2\big)\ \text{Cosh}[d\ kx] +$$
$$\left(-\text{einf2}^2\ wl2^4 - 2\ \text{e1 einf3}\ wl3^2\ wt2^2 - \text{e1 einf3}\ wt2^4 - 2\ \text{einf2}^2\ wl2^2\ wt3^2\right)\ \text{Sinh}[d\ kx]$$

$$Out[ ]= \text{einf2 einf3}\ wl2^2\ wl3^2\ wt2^2\ \text{Cosh}[d\ kx] + \text{e1 einf2}\ wl2^2\ wt3^2\ \text{Cosh}[d\ kx] +$$
$$\text{e1 einf3}\ wl3^2\ wt2^4\ \text{Sinh}[d\ kx] + \text{einf2}^2\ wl2^4\ wt3^2\ \text{Sinh}[d\ kx]$$

In[ ]:= (*Constantes para coeficientes numéricos*)
einf2 = 2.1;
einf3 = 2.5;
wl2 = 2.343262549732213*^14;
wt2 = 1.9816014488089134*^14;
wl3 = 1.7630978670010866*^14;
wt3 = 1.4541790099624347*^14;
e1 = 1;
d = 0.4;
Coefficient[newequation, w, 6]
⌊coefficiente
Coefficient[newequation, w, 4]
⌊coefficiente
Coefficient[newequation, w, 2]
⌊coefficiente
Coefficient[newequation, w, 0]
⌊coefficiente

Out[ ]= $-5.25\,\text{Cosh}[0.4\,kx] - 6.91\,\text{Sinh}[0.4\,kx]$

Out[ ]= $6.57622 \times 10^{29}\,\text{Cosh}[0.4\,kx] + 8.51601 \times 10^{29}\,\text{Sinh}[0.4\,kx]$

Out[ ]= $-2.66889 \times 10^{58}\,\text{Cosh}[0.4\,kx] - 3.34951 \times 10^{58}\,\text{Sinh}[0.4\,kx]$

Out[ ]= $3.51874 \times 10^{86}\,\text{Cosh}[0.4\,kx] + 4.00991 \times 10^{86}\,\text{Sinh}[0.4\,kx]$