In[38]:=

```
(*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]
borra todo
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[39]=

$$\left\{\left\{r1 \to \frac{1.\,Y1\,Y2 + 1.\,Y2^2 - 1.\,Y1\,Y3 - 1.\,Y2\,Y3 + e^{0.8\,kx}\left(1.\,Y1\,Y2 - 1.\,Y2^2 + 1.\,Y1\,Y3 - 1.\,Y2\,Y3\right)}{1.\,Y1\,Y2 - 1.\,Y2^2 - 1.\,Y1\,Y3 + 1.\,Y2\,Y3 + e^{0.8\,kx}\left(1.\,Y1\,Y2 + 1.\,Y2^2 + 1.\,Y1\,Y3 + 1.\,Y2\,Y3\right)},\right.\right.$$

$$r2 \to \frac{Y1\,(2.\,Y2 - 2.\,Y3)}{1.\,Y1\,Y2 - 1.\,Y2^2 - 1.\,Y1\,Y3 + 1.\,Y2\,Y3 + e^{0.8\,kx}\left(1.\,Y1\,Y2 + 1.\,Y2^2 + 1.\,Y1\,Y3 + 1.\,Y2\,Y3\right)},$$

$$t2 \to \frac{Y1}{0.5\,Y1 + 0.5\,Y2 + \frac{e^{-0.8\,kx}\left(0.5\,Y1\,Y2 - 0.5\,Y2^2 - 0.5\,Y1\,Y3 + 0.5\,Y2\,Y3\right)}{1.\,Y2 + 1.\,Y3}},$$

$$\left.\left.t3 \to \frac{4.\,e^{0.8\,kx}\,Y1\,Y2}{1.\,Y1\,Y2 - 1.\,Y2^2 - 1.\,Y1\,Y3 + 1.\,Y2\,Y3 + e^{0.8\,kx}\left(1.\,Y1\,Y2 + 1.\,Y2^2 + 1.\,Y1\,Y3 + 1.\,Y2\,Y3\right)}\right\}\right\}$$

In[45]:=

```
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

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

Out[49]=

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

In[50]:=
```
expr1 = Expand[
        expande factores
    (einf2 einf3 (-w^2 + wl2^2) (-w^2 + wl3^2) (-w^2 + wt2^2) + e1 einf2 (-w^2 + wl2^2) (-w^2 + wt3^2)) ];
expr2 = Expand[ (e1 einf3 (-w^2 + wl3^2) (-w^2 + wt2^2)^2 + einf2^2 (-w^2 + wl2^2)^2 (-w^2 + wt3^2)) ];
        expande factores

newexpr1 = Collect[expr1, w]
           agrupa coeficientes
newexpr2 = Collect[expr2, w]
           agrupa coeficientes
```

Out[52]=
$$-\text{einf2 einf3 } w^6 + \text{einf2 einf3 wl2}^2 \text{ wl3}^2 \text{ wt2}^2 + w^4 \left(\text{e1 einf2} + \text{einf2 einf3 wl2}^2 + \text{einf2 einf3 wl3}^2 + \text{einf2 einf3 wt2}^2\right) + \text{e1 einf2 wl2}^2 \text{ wt3}^2 + w^2 \left(-\text{e1 einf2 wl2}^2 - \text{einf2 einf3 wl2}^2 \text{ wl3}^2 - \text{einf2 einf3 wl2}^2 \text{ wt2}^2 - \text{einf2 einf3 wl3}^2 \text{ wt2}^2 - \text{e1 einf2 wt3}^2\right)$$

Out[53]=
$$\left(-\text{einf2}^2 - \text{e1 einf3}\right) w^6 + \text{e1 einf3 wl3}^2 \text{ wt2}^4 + \text{einf2}^2 \text{ wl2}^4 \text{ wt3}^2 + w^4 \left(2 \text{ einf2}^2 \text{ wl2}^2 + \text{e1 einf3 wl3}^2 + 2 \text{ e1 einf3 wt2}^2 + \text{einf2}^2 \text{ wt3}^2\right) + w^2 \left(-\text{einf2}^2 \text{ wl2}^4 - 2 \text{ e1 einf3 wl3}^2 \text{ wt2}^2 - \text{e1 einf3 wt2}^4 - 2 \text{ einf2}^2 \text{ wl2}^2 \text{ wt3}^2\right)$$

In[54]:=
```
newequation = Collect[ newexpr1 * Cosh[kx * d] + newexpr2 * Sinh[kx * d], w];
              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[55]=
$$-\text{einf2 einf3 Cosh}[\text{d kx}] + \left(-\text{einf2}^2 - \text{e1 einf3}\right) \text{Sinh}[\text{d kx}]$$

Out[56]=
$$\left(\text{e1 einf2} + \text{einf2 einf3 wl2}^2 + \text{einf2 einf3 wl3}^2 + \text{einf2 einf3 wt2}^2\right) \text{Cosh}[\text{d kx}] + \left(2 \text{ einf2}^2 \text{ wl2}^2 + \text{e1 einf3 wl3}^2 + 2 \text{ e1 einf3 wt2}^2 + \text{einf2}^2 \text{ wt3}^2\right) \text{Sinh}[\text{d kx}]$$

Out[57]=
$$\left(-\text{e1 einf2 wl2}^2 - \text{einf2 einf3 wl2}^2 \text{ wl3}^2 - \text{einf2 einf3 wl2}^2 \text{ wt2}^2 - \text{einf2 einf3 wl3}^2 \text{ wt2}^2 - \text{e1 einf2 wt3}^2\right) \text{Cosh}[\text{d kx}] + \left(-\text{einf2}^2 \text{ wl2}^4 - 2 \text{ e1 einf3 wl3}^2 \text{ wt2}^2 - \text{e1 einf3 wt2}^4 - 2 \text{ einf2}^2 \text{ wl2}^2 \text{ wt3}^2\right) \text{Sinh}[\text{d kx}]$$

Out[58]=
$$\text{einf2 einf3 wl2}^2 \text{ wl3}^2 \text{ wt2}^2 \text{ Cosh}[\text{d kx}] + \text{e1 einf2 wl2}^2 \text{ wt3}^2 \text{ Cosh}[\text{d kx}] + \text{e1 einf3 wl3}^2 \text{ wt2}^4 \text{ Sinh}[\text{d kx}] + \text{einf2}^2 \text{ wl2}^4 \text{ wt3}^2 \text{ Sinh}[\text{d kx}]$$

In[59]:=
```
(*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[67]= $-5.25\,\text{Cosh}[0.4\,kx] - 6.91\,\text{Sinh}[0.4\,kx]$

Out[68]= $6.57622 \times 10^{29}\,\text{Cosh}[0.4\,kx] + 8.51601 \times 10^{29}\,\text{Sinh}[0.4\,kx]$

Out[69]= $-2.66889 \times 10^{58}\,\text{Cosh}[0.4\,kx] - 3.34951 \times 10^{58}\,\text{Sinh}[0.4\,kx]$

Out[70]= $3.51874 \times 10^{86}\,\text{Cosh}[0.4\,kx] + 4.00991 \times 10^{86}\,\text{Sinh}[0.4\,kx]$