# Problem 1

In[ ]:=
```
P = 1 mW; A = 1 mm^2;

μ = e a_0; UnitConvert[μ, "Debyes"]
```

Out[ ]=

2.541746473 D

In[ ]:=

$$E_0 = \sqrt{\frac{2\,P}{c\ \varepsilon_0\ A}};\ \texttt{UnitConvert}[E_0,\ \texttt{"V/m"}]$$

Out[ ]=

868.021098 V/m

In[ ]:=

$$\Omega_0 = \frac{\mu\, E_0}{\hbar};\ \texttt{UnitConvert}[\Omega_0,\ \texttt{"MHz"}]$$

Out[ ]=

69.7855727 MHz

# Problem 2

In[9]:=

$$c_1 = 1 - \frac{i\,\Omega_0{}^2}{4\,\delta}\left(t - \frac{1}{i\,\delta}\left(e^{i\,\delta\,t} - 1\right)\right);$$

$$c_1\, c_1{}^* \ \texttt{// ComplexExpand // FullSimplify}$$

Out[10]=

$$1 + \frac{8\,\delta^2\,(-1 + \text{Cos}[t\,\delta])\,\Omega_0^2 + \left(2 + t^2\,\delta^2 - 2\,\text{Cos}[t\,\delta] - 2\,t\,\delta\,\text{Sin}[t\,\delta]\right)\,\Omega_0^4}{16\,\delta^4}$$

# Problem 3

In[23]:=
```
σx = PauliMatrix[1]; σz = PauliMatrix[3];
σ- = (PauliMatrix[1] + i PauliMatrix[2]) / 2;
σ+ = (PauliMatrix[1] - i PauliMatrix[2]) / 2;
```

In[80]:=

$$H_0 = -\frac{\hbar\,\omega_0}{2}\,\sigma_z;$$

$$V = \hbar\Omega_0\,\text{Cos}[\omega\,t - \phi]\,\sigma_x;$$

$$U = \text{MatrixExp}[-i\,H_0\,t\,/\,\hbar];$$

In[78]:=
```
V_I = U†.V.U // ComplexExpand // TrigToExp // FullSimplify;
V_I // MatrixForm
```

Out[79]//MatrixForm=

$$\begin{pmatrix} 0 & e^{-i\,t\,\omega_0}\,\text{Cos}[\phi - t\,\omega]\,\hbar\Omega_0 \\ e^{i\,t\,\omega_0}\,\text{Cos}[\phi - t\,\omega]\,\hbar\Omega_0 & 0 \end{pmatrix}$$