Transitions in continuous spectrum

Problem 8.33

A charged linear oscillator is under the effect of an homogeneous electric field that changes in time by the law:

a) $\mathcal{E}(t) = \mathcal{E}_0 \exp\{-t^2/\tau^2\}$;

b) $\mathcal{E}(t) = \mathcal{E}_0 (1 + t^2/\tau^2)^{-1}$;

c) $\mathcal{E}(t) = \mathcal{E}_0 \exp\{-t^2/\tau^2\} \cos \omega_0 t$.

Assuming the oscillator was in the nth quantum state before the field was turned on (for $t \to -\infty$), find the transition probabilities into different states for $t \to +\infty$ in the first order of perturbation theory. For $n = 0$, compare the result obtained to the exact one.

Problem 8.34

An homogeneous electric field that changes in time as $\boldsymbol{\mathcal{E}}(t) = \mathcal{E}(t)\mathbf{n}_0$ is applied to a two-dimensional rotor with the dipole moment d. Before the field is applied, the rotor has a definite value of energy and a definite projection of the angular momentum, m. Calculate the probabilities of different values of the projection of the angular momentum and rotor energies for $t \to +\infty$ in the first order of perturbation theory. Consider in particular the forms of $\mathcal{E}(t)$ given in the previous problem.

Problem 8-45

Find the probability of “ionization” per unit of time for a particle in the ground state of a one-dimensional δ -well up to first order in perturbation theory,

if the particle is under the influence of a uniform, periodic-in-time field, $V(x,t) = -xF_0 \cdot \cos(\omega_0 t)$

Solve the problem both neglecting the interaction in the final state and taking it into account.