

Quantum Physics 141

Problem Set 2

National Institute of Physics

(Dated: March 13, 2020)

Deadline: 25 March 2020

Submission: PDF file via Google Submission form. The link is posted on the course website sand.nip.upd.edu.ph/physics141.

I. GRIFFITHS 3.48 EXPANDING WELL [30 pts]

A particle of mass m is in the ground state of an infinite square well with width a . At time $t = 0^+$ the well instantly expands to twice its original width: from a to $2a$.

20 pts What is the expectation value of the energy immediately after this expansion?

10 pts Will this expectation value change over time or remain constant?

II. GRIFFITHS 3.57 SPECTRAL DECOMPOSITION [20 pts]

Let the observable \hat{Q} have a complete set of eigenkets $\{|n\rangle\}$ with corresponding eigenvalues $\{q_n\}$. Prove that \hat{Q} can be decomposed as

$$\hat{Q} = \sum_n q_n |n\rangle \langle n|. \quad (1)$$

III. GRIFFITHS 3.58 TWO-LEVEL SYSTEM [50 pts]

Let $|1\rangle$ and $|2\rangle$ be the orthonormal basis states for a two-level system. The Hamiltonian for this system is

$$\hat{H} = h(|1\rangle \langle 1| + |2\rangle \langle 2|) + g(|1\rangle \langle 2| + |2\rangle \langle 1|), \quad (2)$$

with h and g real constants.

10 pts Obtain the matrix elements $H_{ij} = \langle i | H | j \rangle$ of the Hamiltonian and arrange them in matrix form.

20 pts Obtain the eigenkets of the Hamiltonian (stationary states) and the corresponding energy eigenvalues.

20 pts Derive the time dependence of the state $|\psi(t=0)\rangle = |1\rangle$ at times $t > 0$.