**I)** Study Section 10.1.2 on pages 362-363 of the textbook (Auletta, Fortunato & Parisi, Cambridge University Press, 2009).

**II)** Solve the following problems.

1. Give the details of the derivation of Equation 10.21 on page 361 of the textbook (Auletta, Fortunato & Parisi, Cambridge University Press, 2009.)

2. Consider a particle of mass $m$ that moves on the real line and interacts with the potential

$$v(x) := \begin{cases} \zeta\, e^{-x} & \text{for} \quad x \in [0,a], \\ \infty & \text{for} \quad x \notin [0,a], \end{cases}$$

where $a$ and $\zeta$ are real numbers and $a$ is positive. Use perturbation theory to obtain the energy eigenvalues of the particle up to and including second order terms in $\zeta$.

3. Use first-order perturbation theory to find eigenvalues and a set of orthonormal eigenvectors of the following matrices

$$\mathbf{M} := \begin{bmatrix} 1+\zeta & \zeta & 0 & -\zeta \\ \zeta & 2 & 2\zeta & -\zeta \\ 0 & 2\zeta & 3 & -i\zeta \\ -\zeta & -\zeta & i\zeta & 4 \end{bmatrix}, \qquad \mathbf{N} := \begin{bmatrix} 2+\zeta & \zeta & 0 & -\zeta \\ \zeta & 2 & 2\zeta & -\zeta \\ 0 & 2\zeta & 3 & -i\zeta \\ -\zeta & -\zeta & i\zeta & 4 \end{bmatrix}.$$

4. Consider the system described in Problem 2. Suppose that at time $t = 0$ it is in the state defined by the position wave function:

$$\psi_0(x) := \begin{cases} \sin(\pi x/a) & \text{for} \quad x \in [0,a], \\ 0 & \text{for} \quad x \notin [0,a]. \end{cases}$$

Use first-order time-dependent perturbation theory to compute the probability of finding this system in its initial state at time $t > 0$.

**Note:** You may put your homework papers in my mailbox in the photocopy room in the second floor of the Science Building.