(1) Determine the molecular orbital energies, the delocalization energy and the $\pi$-bond order for:

![Molecular orbital diagram](image)

(2) There are two limiting cases for the C$_4$ carbocyclic system, cyclobutadiene (I) and butadiene (II).

![Structures](image)

For each structure
(a) Construct the SALC-MO expressions for the wavefunctions.
(b) Calculate the energies of the molecular orbitals
(c) Construct the molecular orbital diagram and calculate the delocalization energy.
(d) Determine the $\pi$ bond orders.

(3) Consider the C$_8$H$_8$ molecule in a hypothetical planar form with a point group of D$_{8h}$:

![Molecular structure](image)

Table 7.1 on page 146 in Cotton summarizes the SALC-MO wavefunctions and the energies obtained from solutions of the secular determinant. Derive these results.