Problem 1
Compute homology and cohomology with various coefficients of the following pairs of spaces and show that they are not homotopy equivalent:
(a) $\mathbb{R}P^2 \vee S^3, \mathbb{R}P^3$
(b) $\mathbb{C}P^3, S^4 \times S^2$

Problem 2
Show that any continuous map $f: S^{k+\ell} \to S^k \times S^\ell$ induces a trivial map $f_*: H_{k+\ell}(S^{k+\ell}) \to H_k(S^k \times S^\ell)$ as long as $k, \ell > 0$. Is the same true for all continuous maps $g: S^k \times S^\ell \to S^{k+\ell}$?

Problem 3
Let $d \in \mathbb{N}$. $d > 0$. For the map $f_d: \mathbb{C}P^n \to \mathbb{C}P^n$ given by $f_d([z_0 : \ldots : z_n]) := [z_d^0 : \ldots : z_d^n]$ compute $f_d^*: H^*(\mathbb{C}P^n; \mathbb{Z}) \to H^*(\mathbb{C}P^n; \mathbb{Z})$.

Problem 4
(a) Repeat the statement of Seifert and van Kampens Theorem as formulated in Hatcher's book (several open sets covering $X$).
(b) Hatcher pg. 52,53: problems 2.,3.,4.,9
(c) Compute fundamental groups of a surface of genus $g = 1, 2, \ldots, \mathbb{R}P^2$, Klein bottle, finite connected sums of $\mathbb{R}P^2$.
(d) Hatcher pg. 54,55: problems 17.,20.
(e) Fundamental groups of knot complements: Hatcher pg. 55, problem 22.