# MANIFOLDS: FALL 2014
# EXERCISE 9

DMITRY NOVIKOV

Abstract. 2.3 Guillemin and Pollack, Thom's transversality theorems from Golubitsky and Guillemin

**Problem 1.** *2.3.3, 2.3.4, 2.3.11, 2.3.20*

**Problem 2.** *Describe the normal bundle* $N(\mathbb{R}P^1, \mathbb{R}P^2)$.

**Problem 3.** *Show that a generic smooth map* $f : \mathbb{R}^2 \to \mathbb{R}^2$ *is a local diffeomorphism at a generic point, and the points where the Jacobian degenerates form a union of smooth curves. Draw these lines for* $(x, t) \to (x^3 - tx, t)$. Hint: *Let* $\Sigma \subset J^1(\mathbb{R}^2, \mathbb{R}^2)$ *be the set of all 1-jets with degenerate Jacobian. Locally it is defined by* $\det \begin{pmatrix} a & b \\ c & d \end{pmatrix} = 0$*, i.e. of codimension* 1*. The set* $\Sigma' = \Sigma \cap \{\nabla \det = 0\} = \{a = b = c = d = 0\}$ *of singular points of* $\Sigma$ *is a submanifold of codimension 4. Apply Thom transversality theorem first to* $\Sigma'$ *and then to the submanifold* $\Sigma \setminus \Sigma'$.

*Date*: December 30, 2014.