

CALIFORNIA INSTITUTE OF TECHNOLOGY
Control and Dynamical Systems

CDS 202

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Winter 2009

Problem Set #3

Issued: 22 Jan 09
Due: 29 Jan 09

Reading: Abraham, Marsden, and Ratiu (MTA), sections 2.5 and 3.5

Problems:

1. MTA 2.5-3 (i), (ii) and (iv): exponential maps. You can assume (iii), which is a bit tricky to prove.
2. MTA 2.5-4: Equivalence of implicit and inverse function theorems.
3. MTA 2.5-12: Roots of polynomials are smooth functions of polynomial coefficients.
4. MTA 3.5-1 (i)–(ii): matrix manifolds. For (ii), you focus on showing that $O(n)$ is a matrix of dimension $n(n-1)/2$ (you already showed it has two components in HW #1).
5. [Guillemin and Pollack, page 18, #6; MTA 3.5-5]
 - (a) If f and g are submersions/immersions, show that $f \times g$ is.
 - (b) If f and g are submersions/immersions, show that $g \circ f$ is.
 - (c) If f is an immersion, show that its restriction to any submanifold of its domain is an immersion.
 - (d) When $\dim M = \dim N$, show that submersions/immersions $f : M \rightarrow N$ are the same as local diffeomorphisms.
6. MTA 3.5-11: covering maps.