

TABLE OF CONTENTS

| | |
|----------------|----|
| Foreword | ix |
|----------------|----|

CHAPTER I

The Differential Geometry of Higher Order Jets and Tangent Bundles.

| | |
|---|----|
| I.1 - Introduction | 1 |
| I.2 - Jet manifolds | 2 |
| 2.1 - Jets of sections | 2 |
| 2.2 - Jets of mappings | 4 |
| 2.3 - The k-jet prolongation | 5 |
| 2.4 - A particular situation | 6 |
| 2.5 - Local coordinates for jets | 8 |
| 2.6 - Holonomic, semi-holonomic and non-holonomic prolongations | 9 |
| I.3 - Exterior differential geometry of higher order tangent bundles | 13 |
| 3.1 - The tangent bundle of higher order | 13 |
| 3.2 - The Liouville vector field of higher order .. | 21 |
| 3.3 - The almost tangent structure of higher order. | 24 |
| 3.4 - Vertical derivations | 32 |
| 3.5 - Vertical differentiation | 37 |
| 3.6 - Semibasic forms | 43 |
| 3.7 - Homogeneous vector fields and forms | 49 |
| 3.8 - Semisprays and sprays of higher order | 54 |
| 3.9 - Connections of higher order | 60 |
| I.4 - Exercises | 69 |

CHAPTER II

Generalized Classical Mechanics

| | |
|---|-----|
| II.1 - Introduction | 73 |
| II.2 - Generalized Lagrangian formalisms | 79 |
| 2.1 - Tulczyjew's formalism | 79 |
| 2.2 - Horizontal presymplectic structures | 88 |
| 2.3 - Generalized Klein's formalism | 91 |
| 2.4 - Homogeneous Lagrangians | 103 |
| II.3 - Generalized Hamiltonian formalism | 108 |
| 3.1 - Jacobi-Ostrogradsky coordinates and Legendre transformation | 108 |
| 3.2 - Hamilton equations | 113 |
| 3.3 - Variational approach | 116 |
| 3.4 - Poisson brackets, canonical transfor- mations and Hamilton-Jacobi equation | 119 |
| II.4 - Exercises | 124 |

CHAPTER III

Generalized Field Theory

| | |
|---|-----|
| III.1 - Introduction | 127 |
| III.2 - Traditional method formalism | 131 |
| 2.1 - Higher order Lagrangian densities | 131 |
| 2.2 - Higher order Euler-Lagrange field equations | 134 |
| 2.3 - Functionals defined on a variable domain .. | 137 |
| 2.4 - An extension of Jacobi-Ostrogradsky's approach | 139 |
| 2.5 - The generalized electrodynamics of Bopp-Podolsky | 145 |
| 2.6 - The de Donder-Hamilton field equations | 152 |
| 2.7 - Canonical transformations and Poisson brackets | 154 |

| | |
|--|-----|
| III.3 - The formalism on Jet manifolds | 159 |
| 3.1 - Preliminaries | 159 |
| 3.2 - The canonical (or structure) one-form on $J^k M$ | 165 |
| 3.3 - Higher order variational problems and exterior differential systems | 170 |
| 3.4 - Two attempts for the Hamiltonization of the field equations | 186 |
| 3.5 - A possible relation between two Hamiltonian formalisms | 198 |
| 3.6 - Some comments on Noether's theorem in the generalized formalism | 205 |
| III.4 - Further considerations and some examples | 211 |
| 4.1 - Lagrangians with higher partial derivatives of different orders | 211 |
| 4.2 - Perturbation theory: an example | 214 |
| 4.3 - An acceleration dependent Lagrangian for relativistic mechanics | 217 |
| 4.4 - Quantization of higher order field the- ories | 221 |
| 4.5 - Bornea's quantization for linear momenta.. | 224 |
| 4.6 - Difficulties with the higher order the- ories | 228 |
| III.5 - Exercises | 230 |
| APPENDIX A - Vector bundles | 235 |
| APPENDIX B - Constrained systems | 243 |
| B.1 - Introduction | 243 |
| B.2 - Presymplectic systems | 247 |
| 2.1 - Singular sets | 247 |
| 2.2 - Conditions to solve the algorithm.. | 251 |
| B.3 - Generic constraints | 259 |
| 3.1 - Preliminaries | 259 |
| 3.2 - Generic embeddings and consistent Hamiltonians | 261 |
| REFERENCES | 267 |
| SUBJECT INDEX | 285 |