# Contents

1 Introduction

1.1 Topological fluid mechanics 1
1.2 Use of space-time manifold 7
1.3 Calculus of Differential forms 9
1.4 Invariance of geometrical objects 16
1.5 Summary of the thesis 21

2 Vorticity Related Invariants in Hydrodynamics

2.1 Introduction 23
2.2 Invariants in inviscid flows 24
2.3 Invariance of geometrical objects in $E^4$ 27
2.4 Vorticity two form in $E^4$ 32
2.5 Invariant transport of vorticity related fields 33
2.6 Discussion 40

3 Topological invariants in hydrodynamics

3.1 Introduction 42
3.2 Invariants associated with vector fields 43
3.3 Geometry of flux conserving fields 49
3.4 Closed two forms and related invariants in $E^4$ 52
3.5 Examples 58
CONTENTS

3.6 Comparison between hydrodynamics and MHD 64
3.7 Discussion .................................................. 66

4 Surface invariants 69

4.1 Introduction .................................................. 69
4.2 Differential forms, vector fields and their invariance 70
4.3 Sequence of Lie derivatives ................................ 71
4.4 Surface invariants related to one forms .................... 76
4.5 Line and surface preservation of vector fields .......... 78
4.6 Invariant surfaces related to two forms ................. 81
4.7 Some illustrative examples .................................. 85
4.8 Discussion .................................................. 92

5 Conclusion 94

Bibliography 97