Contents

Certificate of Approval **v**

Certificate **vii**

Acknowledgement **ix**

Declaration **xi**

List of Symbols and Abbreviations **xiii**

Abstract **xv**

1 Introduction **1**
1.1 Introduction 2
1.2 Literature Survey 3
1.2.1 Review of some high frequency asymptotic techniques 3
1.2.2 Review of three dimensional dyadic diffraction coefficient 6
1.2.3 Review of ray tracing techniques 7
1.2.4 Review of transmission through building 11
1.3 Objectives 12
1.4 Thesis Organisation 12

2 GTD and UTD Formulations Used in the Modeling of Propagation Channel **15**
2.1 Introduction 16
2.2 Straight Edge Diffraction: Normal Incidence 16
2.2.1 Modal solution 18
2.2.2 High frequency asymptotic solution 19
2.2.3 Singularity of cotangent term of diffraction coefficient 26
2.3 Straight Edge:Oblique Incident 30
2.3.1 Diffraction coefficient for perfect conducting (PEC) wedge 30
2.3.2 Diffraction from the edge of three-dimensional dielectric wedge . . . 32

Copyright IIT Kharagpur

3 New Heuristic Diffraction Coefficient for Modeling of Wireless Channel 37
3.1 Introduction . . . 38
3.2 Heuristic Diffraction Coefficient . . . 39
3.2.1 Holm's diffraction coefficient . . . 39
3.2.2 Daniela heuristic diffraction coefficient . . . 40
3.2.3 Novel heuristic diffraction coefficient . . . 41
3.3 Rigorous Maliuzhinets Diffraction Coefficient . . . 45
3.3.1 UTD-like form of Maliuzhinets diffraction coefficient . . . 45
3.3.2 Property of Maliuzhinets function . . . 48
3.3.3 Solution of Maliuzhinets function for arbitrary wedge angle . . . 49
3.3.4 Comparison of UTD-like Maliuzhinets diffraction coefficient with FDTD results and available measurement . . . 50
3.4 Numerical Results and Discussions . . . 52
3.4.1 Comparison of proposed coefficient with accurate rigorous Maliuzhinets diffraction coefficient . . . 52
3.4.2 Comparison of proposed coefficient with measurement . . . 55
3.4.3 Comparison of proposed coefficient with available measurement . . . 57
3.4.4 Application of proposed heuristic diffraction coefficient in microcellular urban scenario . . . 62
3.5 Conclusions . . . 64

4 Novel Three Dimensional Dyadic Diffraction Coefficient for Wireless Channel 65
4.1 Introduction . . . 66
4.2 Novel Three-dimensional Dyadic Diffraction Coefficient . . . 67
4.2.1 Two-dimensional heuristic diffraction coefficient . . . 67
4.2.2 Improved three-dimensional dyadic coefficient . . . 68
4.2.3 Rooftop model for building scenario . . . 73
4.2.4 Results and discussion . . . 77
4.3 Conclusions . . . 81

5 Fast Two-Dimensional Ray-Tracing Algorithm for the Characterization of Urban Microcellular Environments 83
5.1 Introduction . . . 84
5.2 Propagation Models . . . 84
5.3 Image-Based Method for Ray-Tracing . . . 88
5.3.1 Computation of image source . . . 88
5.3.2 Ray-tube approach . . . 89
5.3.3 Database preparation . . . 93
5.3.4 Diffraction coefficient used in our ray-tracing model . . . 94
5.4 Efficient Ray-tracing Algorithm . . . 95
5.4.1 Construction of the sub-tree from the buildings database . . . 97
5.4.2 Preparation of look-up table . . . 99
5.5 Results and Discussions . . . 103
5.5.1 Application of the proposed ray-tracing algorithm in Ottawa city . 103
5.5.2 Application of the proposed ray-tracing algorithm in Bern city . . . 106

Copyright IIT Kharagpur

5.5.3 Application of the proposed ray-tracing algorithm in Fribourg city . 108
5.6 Conclusions 111

6 Analytical Characterization of Transmission through a Building for Deterministic Microcellular Propagation Modeling 113
6.1 Introduction 114
6.2 Transmission through a Lossy Dielectric Wall 115
6.2.1 Computation of refracted angle 116
6.2.2 Determination of transmitted ray through a wall 118
6.2.3 Propagation model 120
6.3 Transmission through a Building 123
6.3.1 Propagation model for transmitted field through a building 124
6.3.2 Diffraction from an interior of a building 125
6.3.3 Application of transmission model to a single building scenario . . . 127
6.4 Application of Analytical Transmission Model to Microcellular Urban Scenario of Bern City 128
6.4.1 Propagation model 128
6.4.2 Tree modeling 131
6.4.3 Rooftop modeling 137
6.4.4 Result and discussions 138
6.5 Conclusions 141

7 Conclusions and Future Scope of Study 143
7.1 Conclusions 144
7.2 Contributions Made by the Scholar 145
7.3 Future Scope of Study 146

References 149
References 149

Publication 156

Author's Biography 159

Copyright IIT Kharagpur