

DUALITY AND ALGORITHMIC ASPECTS OF CERTAIN
INTEGER NONLINEAR PROGRAMMING PROBLEMS

by

M. CHANDRAMOHAN

Department of Mathematics
Indian Institute of Technology, Delhi

Submitted

in fulfilment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

to the

Indian Institute of Technology, Delhi

December, 1978

ACKNOWLEDGEMENTS

It gives me great pleasure to place on record my deep sense of gratitude to my supervisor Dr. Suresh Chandra, Deptt. of Mathematics, Indian Institute of Technology, Delhi, for the invaluable help I had received from him throughout my research work here. But for his keen interest he had evinced in the progress of my studies, this would not have been possible.

My thanks are due to Professor O.P. Bhutani, Head of the Department and Professor N.S. Kambo, Department of Mathematics, Indian Institute of Technology, Delhi for their encouragement and interest in my work.

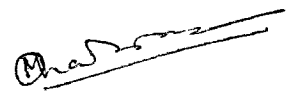
I thank the Director, I.I.T. Delhi, for providing me all the facilities for research work and also acknowledge the financial assistance I had received from the Ministry of Education, Government of India, in the form of Q.I.P. Scholarship for three years. My profound thanks go to Principal, Calicut Regional Engineering College, Calicut, for sponsoring me under Q.I.P. for Ph.D. studies.

The kindness of Mathematical community in sending me reprints and preprints has been immense, which I gratefully acknowledge.

My thanks are also due to my friends and colleagues and in particular to Sqn. Ldr. L.S. Vaidyanathan and Mr. K.J. George for all the help I had received from them.

I owe a debt of gratitude to my wife whose sacrifice and encouragement have always been a great source of strength to me. I would also like to express my deep sense of indebtedness to my parents, brothers and sisters for their tremendous patience, endurance and affection.

Finally, Mr. Ranjit Kumar and Miss Neelam Dhody deserve praise for their expert typing of this thesis.


M. CHANDRAMOHAN

ABSTRACT

This thesis entitled "Duality and Algorithmic Aspects of Certain Integer Nonlinear Programming Problems" is divided into six chapters, the contents of which are given below.

The first chapter is general introduction which contains preliminaries, review of related work and a summary of the thesis.

The second chapter is on duality in mixed integer linear and nonlinear fractional programming and integer nondifferentiable programming. This also includes a method for solving integer nondifferentiable programs based on the above duality theory.

The third chapter consists of a study of variable transformation methods for solving integer fractional programs. In this, the equivalence of integer fractional programs with certain related problems whose objective functions are no longer fractional, are established. The study also includes development of branch and bound methods for solving integer linear and nonlinear fractional programs based on these equivalence relations.

The fourth chapter is on parametric methods for solving fractional programs. Here, solvability of mixed integer linear fractional programs through a finite number

of mixed integer linear programs is established. It also contains procedures for solving integer linear fractional programs. Parametric methods for solving integer nonlinear fractional programs are also proposed.

The fifth chapter consists of a method for enforcing additional constraints to linear fractional programs and its applications in solving integer linear fractional programs by using cutting plane and branch and bound methods.

The sixth and the last chapter of the thesis consists of a finite all integer method for solving integer convex programs whose problem functions are polynomials with rational coefficients. The applicability of this in solving certain integer nonlinear fractional programs is also pointed out.

CONTENTS

	<u>Page</u>
CHAPTER I INTRODUCTION	1
1.1 Preliminaries	4
1.2 Review of Related Work	9
1.3 Summary of the Thesis	23
 CHAPTER II DUALITY IN INTEGER NONCONVEX AND NONDIFFERENTIABLE PROGRAMMING	 30
2.1 Mixed Integer Linear Fractional Programming	 32
2.2 Mixed Integer Nonlinear Fractional Programming	 40
2.3 Integer Nondifferentiable Programming	 50
2.4 Algorithmic Aspects Based on Duality	 66
 CHAPTER III VARIABLE TRANSFORMATION METHODS FOR INTEGER FRACTIONAL PROGRAMS	 72
3.1 The Equivalent Problem for an Integer Linear Fractional Program (ILFP)	 75
3.2 A Branch and Bound Method for Integer Linear Fractional Programs (ILFPs)	 79
3.3 Integer Nonlinear Fractional Programs	 95
3.4 Linear Fractional Complementary Programming Problems	 109
3.5 Sensitivity Analysis in Integer Linear Fractional Programming (ILFP)	 112
 CHAPTER IV PARAMETRIC METHODS FOR INTEGER FRACTIONAL PROGRAMS	 115
4.1 Parametric Method for Mixed Integer Linear Fractional Programs	 116

	<u>Page</u>
CHAPTER IV (Continued)	
4.2 Methods of Solution	122
4.3 Generalization	134
CHAPTER V A METHOD OF ENFORCING ADDITIONAL CONSTRAINTS TO LINEAR FRACTIONAL PROGRAMS AND ITS USES IN SOLVING INTEGER LINEAR FRACTIONAL PROGRAMS	140
5.1 Development of the Method	142
5.2 Applications in Solving Integer Linear Fractional Programs (ILFPs)	153
CHAPTER VI AN ALL INTEGER METHOD FOR INTEGER CONVEX PROGRAMS	168
6.1 Development of the Method	169
6.2 Finiteness of the Algorithm	175
6.3 Relaxing the Restrictions	178
6.4 Extension to Integer Nonlinear Fractional Programs (INLFPs)	183
REFERENCES	185