# ACCURATE RATIONAL TWO-PORT MODELING OF PASSIVE AND ACTIVE DISTRIBUTED PARAMETER STRUCTURES

A dissertation

submitted for the degree of

DOCTOR OF PHILOSOPHY

in Electrical Engineering

by

UMESH KUMAR

Department of Electrical Engineering,

INDIAN INSTITUTE OF TECHNOLOGY, DELHI

1978

# CERTIFICATE

This is to certify that the dissertation, 'Accurate rational two-port modeling of passive and active distributed parameter structures', which is being submitted by Umesh Kumar for the award of the degree of Doctor of Philosophy to the Indian Institute of Technology, New Delhi, is a record of bonafide research work, carried out under our guidance and supervision.

This dissertation has reached the standard fulfilling the requirements of the regulations relating to the degree. The results obtained in this dissertation have not been submitted to any other University or Institute for the award of any degree or diploma.

(A.B.Bhattacharyya)
Professor and Head,
Centre for Applied Research in Electronics,
Indian Institute of Technology,
New Delhi-110029, India.

( S.C.Dutta Roy )
Professor,
Department of Electrical Engg.
Indian Institute of Technology,
New Delhi-110029., India.

## ACKNOWLEDGEMENT

The author wishes to express his profound gratitude to his supervisors, Professors S.C. Dutta Roy and A.B. Bhattacharyya for their valuable guidance and constant encouragement during the entire course of this dissertation.

Thanks are due to the authorities of I.I.T. Delhi for providing research facilities. Appreciation is extended to the Council of Scientific and Industrial Research, India, for the award of a Senior Research Fellowship.

Affectionate appreciations are also due to the friends for their help and for their good wishes.

UMESH KUMAR

## ABSTRACT

The thesis is concerned with the synthesis of lumped, single section, accurate and rational two-port circuit models for passive and active distributed parameter networks.

In this dissertation, the passive distributed parameter structures considered are the uniformly distributed RC($\overline{URC}$) structure, a special class of tapered distributed structures and the distributed RC($\overline{RC}$) notch filter. The active distributed paramter structure considered is the Metal Oxide Semiconductor Field Effect Transistor (MOSFET).

A generalized modeling technique through a new approximation method for transcendental functions viz. the continued fraction expansion (CFE) and truncation scheme, is presented. The utility and applicability of the technique is established through several illustrative examples.

Modeling of the $\overline{URC}$ structure is presented in the first instance. Rational and precise approximations to the y-parameters, which are complex irrational functions of the complex frequency variable $s$, are developed through the postulated technique wherefrom an accurate, two-port model is obtained. For computer aided design (CAD) purposes, a controlled source equivalent of the model is also given. The technique is extended to model a special class of nonuniform distributed lossless

and RC transmission lines characterized by a similar set of immittance parameters. Also modeling of distributed RC ($\overline{RC}$) notch filters including the important effect of parasitics is achieved in the same fashion.

MOSFET modeling in the unsaturated mode is carried out by regarding its channel as a cascade of four equal length $\overline{URC}$ sections. Also the dynamic response of MOSFET charge control model is improved considerably by modifying the charge control equations through inclusion of the intrinsic associated time delays during channel formation.

# TABLE OF CONTENTS