PREFACE

The work of the present thesis focus on the beam-wave interaction study of the gyro-twystron amplifier. The thesis aims to develop studies on the most unexplored gyrotron variant of vacuum electron device (VED), i.e. gyro-twystron, to create a solid theoretical background for future experimental studies. In addition to VEDs, the historical developments of gyro-twystron is scrutinised to bring out the research gap and problems. The Identification of oscillations and its suppression have been done, in a series of works on the gyro-twystron amplifier, and the part of these works has been published in *IEEE Transaction on Electron Devices*. Further, the aim, introduction and scope of the thesis are briefly discussed below.

As compared to solid state devices, VEDs generates high RF power to serve the various applications from space exploration to nuclear researches. At higher frequencies, the fabrication difficulties and operational limitation of conventional microwave tubes push the research and development activities towards Gyrotron devices. With high power generation/ amplification and handling capabilities, gyrotron devices find applications in plasma heating, ceramic sintering, RADAR and particle accelerator application. Gyrotron oscillator finds application in plasma heating in popularly known thermonuclear fusion reactors while its amplifier counterparts are found suitable for RADAR and particle accelerator applications.

Gyro-twystron amplifier derived from the gyrokl***ystron*** and gyro-***TW***T amplifier (***TWystron***) and combines the advantages of both amplifiers thereby possess high power-bandwidth product and gain-bandwidth product. A slow-wave counterpart of Gyro-twystron have a successful services history in the US AN/TPS RADAR system and renders as a veteran tube. Despite these aspects, the gyro-twystron is the most unexplored device in gyrotron family. These advantages and applications attract authors to extend the study of gyro-twystron to answer the challenges of vacuum electronics.

For the megawatt-class operation, the stability of gyro-twystron is an issue as the output waveguide section is vulnerable to parasitic instabilities and backward wave oscillations. A nonlinear multimode code has been developed to investigate the growth of operating as well as competing modes in RF interaction structure of X-band gyro-twystron and predicted the second harmonic TE_{02} is most troublesome mode. To suppress the second TE_{02}, the periodic dielectric rings are introduced in the output waveguide section of gyro-twystron, and the design and stability study of PDL waveguide has been made. A multimode study of PDL gyro-twystron has been made to investigate the suppression of parasitic modes in addition to the growth of operating mode. A study has also been made for the performance improvement of the gyro-twystron amplifier by introducing an intermediate cavity. The particle emitter and collector is designed/optimized to improve the electron beam quality for beam-wave interaction and improve the energy extraction at collector electrode, respectively. The work of author is supported by UGC, Government of India, New Delhi through the UGC-NET JRF Fellowship under Grant 3956/NET-JUNE 2013.