National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Investigation on Compact Planar Passive/Active Multiband Filtering Microwave System
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Venue	: EC 303 (EC Seminar room)
Date and Time	: 22 Jul 2025 (4:00 pm)

Abstract : The continuous advancement of wireless communication systems demands compact, high- performance RF and microwave components that enhance system integration and efficiency. With the expansion of 5G/6G networks, Internet of Things (IoT) applications, and next-generation microwave systems, achieving miniaturization while maintaining superior performance has become a critical research challenge. This thesis addresses this challenge by designing and implementing various planar microstrip-based passive and active filtering components to achieve system-level miniaturization without compromising performance. The research work investigates novel approach for various RF system components including filtering antennas, oscillators, and self-oscillating mixer, designed to meet the growing need for frequency agility in terms of tunability, and reconfigurability.

The first part of the research investigates the development of a novel, highly-selective filtering antenna that integrates filtering and radiation characteristics within a single structure. Next, a diplexing filtering antenna is demonstrated, offering high out-of-band rejection and fair isolation between output ports. To extend the work further, tunability and reconfigurability characteristics are incorporated into the filtering antenna, achieving multiband operation with high-selectivity and enhanced out-of-band rejection.

The second part presents a voltage-controlled oscillator (VCO) with frequency reconfigurability characteristics, realized using a tunable high-selectivity filter and an integrated tunable phase shifter. This configuration achieves wideband discrete oscillation frequencies with low phase-noise, enabling efficient spectrum utilization for reconfigurable RF front-end system.

Next, a self-oscillating mixer (SOM) is proposed, featuring tunable intermediate frequency (IF) generation employing a tunable filtering antenna. This novel approach reduces circuit size, enhances spectral purity, and improves phase-noise performance compared to conventional mixer topologies, supporting robust frequency conversion making it suitable for modern RF receivers operating across wide frequency bands.

Finally, a reconfigurable dual-band balanced oscillator employing a dual-band balanced filter is demonstrated. The balanced configuration effectively suppresses the common-mode noise and enhances frequency stability, with discrete frequency selection suitable for multiband balanced RF systems in 5G applications.

All the proposed compact designs are validated through full-wave electromagnetic simulations and circuit simulations, along with fabricated prototypes that confirm strong agreement between simulations and measurements. The results demonstrate the feasibility of highly-selective, tunable, and reconfigurable components that significantly contribute to system miniaturization and performance enhancement. This work offers new possibilities for compact multiband filtering microwave components in next-generation wireless communication systems.