Dr. Rakesh Sinha

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NIT Rourkela

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Lab: Circuit-EM Co-Design Lab

EDUCATION

Doctor of Philosophy, Electronics & Electrical Communication Engineering — August 2016
Area of Specialization: RF Microwave Engineering
THESIS - Synthesis of Asymmetric Multiport Network
Indian Institute of Technology Kharagpur, Kharagpur, India
Date of PhD Viva-Voce Exam: 19th August 2016

Master of Technology, Electronics & Electrical Communication Engineering — June 2011
CGPA: 8.28
Area of Specialization: RF Microwave Engineering
THESIS - Analysis of impulse response and UWB antenna for time domain measurement
Indian Institute of Technology Kharagpur, Kharagpur, India

Bachelor of Technology, Electronics & Communication Engineering — June 2008
CGPA: 7.54
THESIS - Prepaid Electricity Meter
Kalyani Government Engineering College, Kalyani, India
West Bengal University of Technology, Kolkata, India

PUBLICATIONS

Full Paper

[J1] **R. Sinha**, A. De, and S. Sanyal, "A Theorem on Asymmetric Structure based Rat-Race Coupler," *IEEE Microw. Wireless Compon. Lett.*, vol. 25, no. 3, pp. 145-147, Mar. 2015. (https://doi.org/10.1109/LMWC.2014.2382661)

[J2] **R. Sinha** and A. De, "Synthesis of Multiport Networks using Port Decomposition Technique and its Applications,"*IEEE Trans. Microw. Theory Techn.*, vol. 64, no. 4, pp. 1228 – 1244, Apr. 2016. (https://doi.org/10.1109/TMTT.2016.2532868)

[J3] **R. Sinha** and A. De, "Theory on Matching Network in Viewpoint of Transmission Phase-Shift," *IEEE Trans. Microw. Theory Techn.*,vol. 64, no. 6, pp. 1704 – 1716, June 2016. (https://doi.org/10.1109/TMTT.2016.2558645)

[J4] S. Ghosal* , **R. Sinha***, A. De, A. Chakrabarty and H. Son, "Theory of Coupled Characteristic Mode," *IEEE Trans. Antennas & Propagation*, vol. 68, no. 6, pp. 4677 - 4687, June 2020.(https://doi.org/10.1109/TAP.2020.2969852)

*equal contribution

[J5] **R. Sinha**, "Design of Multi-Port With Desired Reference Impedances Using Y-Matrix and Matching Networks," *IEEE Trans. Circuits Syst. I, Reg. Papers*, vol. 68, no. 5, pp. 2096-2106, May. 2021. (https://doi.org/10.1109/TCSI.2021.3061773)

[J6] S. Ghosal , **R. Sinha**, A. De, and A. Chakrabarty, "Characteristic Mode Analysis of Mutual Coupling," *IEEE Trans. Antennas & Propagation*,vol. 70, no. 2, pp. 1008 - 1019, Feb. 2022.(https://doi.org/10.1109/TAP.2021.3119117)

[J7] **R. Sinha**, "Design of Multi-Port With Desired Reference Impedances Using Y-Matrix and Matching Networks," *IEEE Trans. Circuits Syst. II, Express Briefs,* (Accepted). (https://doi.org/10.1109/TCSII.2022.3201114)

Comments & Corrections

[J8] **R. Sinha** and A. De,"Correction to Synthesis of Multiport Networks using Port Decomposition Technique and its Applications,"*IEEE Trans. Microw. Theory Techn.*, vol. 64, no. 6, pp. 1954, June 2016. (https://doi.org/10.1109/TMTT.2016.2558647)

[J9] **R. Sinha** and A. De, "Comments on Design of a Microstrip Dual-Band Crossover with Asymmetrical Π-Shaped Transmission Lines," *IEEE Microw. Wireless Compon. Lett.*, vol. 26, no. 7, pp. 496 – 497, July 2016. (https://doi.org/10.1109/LMWC.2016.2574827)

[J10] **R. Sinha** and A. De, "Comments on An Analytical Design Method for a Novel Dual-Band Unequal Coupler With Four Arbitrary Terminated Resistances," *IEEE Trans. Ind. Electron.*, vol. 64, no. 5, pp. 4068-4069, May 2017. (https://doi.org/10.1109/TIE.2017.2652371).

[J11] **R. Sinha**, "Comments on Design of a Planar Dual-Band Power Divider With Arbitrary Power Division and a Wide Isolated Frequency Band," *IEEE Trans. Microw. Theory Techn.*, vol. 65, no. 6, pp. 2211 – 2211, June 2017. (https://doi.org/10.1109/TMTT.2016.2647245).

[J12] **R. Sinha**, "Comments on Miniaturization of a 90° Hybrid Coupler with Improved Bandwidth Performance," *IEEE Microw. Wireless Compon. Lett.*, vol. 27, no. 9, pp. 857 – 858, September 2017. (https://doi.org/10.1109/LMWC.2017.2724004)

[J13] **R. Sinha**, R. Chatterjee and H. Son "Comments on Microstrip T-Junction Power Divider With Exponentially Tapered Transmission Lines," *IEEE Microw. Wireless Compon. Lett.*, vol. 27, no. 11, pp. 1037 - 1038, November 2017. (https://doi.org/10.1109/LMWC.2017.2751305)

[J14] **R. Sinha** and A. De,"Correction to Theory on Matching Network in Viewpoint of Transmission Phase Shift,"*IEEE Trans. Microw. Theory Techn.*, vol. 65, no. 12, pp. 5077 – 5077, December 2017. (https://doi.org/10.1109/TMTT.2017.2715332)

[J15] **R. Sinha** and H. Son "Comments on Dual-Band Design Theory for Dual Transmission-Line Transformer," *IEEE Microw. Wireless Compon. Lett.*, vol. 28, no. 12, pp. 1155 - 1157, December 2018. (https://doi.org/10.1109/LMWC.2018.2869295)

[J16] **R. Sinha** "Comments on A Dual-Band Port-Extended Branch-Line Coupler and Mitigation of the Band-Ratio and Power Division Limitations," *IEEE Trans. Compon. Packag. Manuf. Technol.*, vol. 9, no. 6, pp. 1203 - 1205, June 2019. (https://doi.org/10.1109/TCPMT.2019.2912987)

[J17] **R. Sinha** , A. De, and S. Sanyal, "Reply to Comments on A Theorem on Asymmetric Structure based Rat-Race Coupler," *IEEE Microw. Wireless Compon. Lett.*,, vol. 29, no. 10, pp. 699 - 701, October 2019. (https://doi.org/10.1109/LMWC.2019.2933363)

[J18] **R. Sinha**, "Comments on A Three-Section Dual-Band Transformer for Frequency-Dependent Complex Load Impedance," *IEEE Microw. Wireless Compon. Lett.*, vol. 29, no. 12, pp. 783 - 785, December 2019. (https://doi.org/10.1109/LMWC.2019.2928485)

[J19] **R. Sinha**, "Comments on Two Novel Reconfigurable PDs Based on Cascaded Transmission Lines," *IEEE Microw. Wireless Compon. Lett.*, vol. 30, no. 3, pp. 316-318, March 2020 (https://doi.org/10.1109/LMWC.2019.2961677)

Research Profile: Google Scholar, ResearchGate, LinkedIn, ORCiD: 0000-0003-0592-8505, ResearcherID: B-7784-2017, Scopus ID: 56453860100 IEEE

EXPERIENCE

Assistant Professor — February 2020 – Present
Circuit-EM Co-Design Lab
Department of Electrical Engineering
National Institute of Technology (NIT), Rourkela, India

Postdoctoral Research Associate — August 2018 – July 2019
Applied Electromagnetics Lab at CNU
Chungnam National University (CNU), Daejeon, South Korea

Postdoctoral Research Associate — July 2017 – July 2018
Electromechanical Systems & Control Lab (ESCL)
Ulsan National Institute of Science and Technology, Ulsan, South Korea

Assistant Professor — October 2016 – June 2017
JIS College of Engineering, Kalyani, India

Research Scholar — July 2011 – August 2016
Indian Institute of Technology Kharagpur, Kharagpur, India

Master of Technology — July 2009 – June 2011
Indian Institute of Technology Kharagpur, Kharagpur, India

SIGNIFICANT RESEARCH CONTRIBUTIONS

- **General Asymmetric Structure-Based Rat-Race and Branch-Line Coupler**: Conventionally rat-race and branch-line Coupler (RRC & BLC) consist of quarter wavelength transmission lines (TL) or their equivalent symmetric two-port network (TPN). It has been shown that RRC & BLC can be designed using asymmetric-TPN blocks and the design equations have been derived for the same. The use of asymmetric structure provides more flexibility in the design of microwave components.
- **Multiport Networks Synthesis using Port Decomposition Technique and its Applications**: A multiport network synthesis algorithm has been proposed based on port decomposition (by short-circuiting the port) and reduce-multiport scattering parameter technique. Design equations of four couplers using asymmetric-TPN blocks have been derived using the algorithm. The port-decomposition technique provides physical insight into the working of microwave components.
- **Impedance Matching Network (Interconnect) with Desired Transmission Phase**: The impedance matching network (IMN) is used to connect two ports having a different (or same) impedance. Conventionally design equations of IMN were derived using reflection property, no attention has been paid to the transmission (Phase) property. It has been shown that the transmission phase is crucial in

the design of IMN. A general design equation of IMN has been derived incorporating the transmission phase. The concept of transmission phase in the design of matching networks may play an important role in the future Phased Array Antenna Technology.

- **Sub-network Inequality Theory**: A network can be represented as interconnections of multiple sub-networks. The schematic of the interconnections of multiple sub-networks is called topology. Two networks are said to be functionally equivalent to each other if and only if their network matrices are equal, even if they are topologically different from each other. If sub-networks (with identical orientation and position) of two networks with identical topology are equivalent, then the whole networks are also equivalent to each other. However, if two networks with identical topology are equivalent to each other, then it is not necessary that the sub-networks are also equivalent to each other. In other words, if the sub-networks of two topologically identical networks are not equivalent to each other, then it does not provide a guarantee that the whole networks are also not equivalent.
- **Phase Shift and Electrical Length are not the same**: It is a common belief among microwave engineers that phase shift due to transmission line (TL) is equal to the electrical length of the TL. That is true only for matched TL and TL with an electrical length of multiple of 90 deg. However, if the termination impedance or port impedance is different from the characteristic impedance of the TL, then phase shift is different from the electrical length. This difference is due to the multiple reflections of waves at terminations.
- **Theory of Coupled Characteristic Mode**: The coupled characteristic modes are linear combinations of uncoupled characteristic modes. The uncoupled characteristic modes are higher dimensional projection isolated modes. Therefore coupled characteristic modes can be represented as a linear combination of higher dimensional projection of isolated modes. Such mode coupling can be approximated as "one to one" or "two to two" or "many to many" mode coupling. An analytical method has been developed to calculate the coefficients and eigenvalues of "one to one" mode coupling. The Eigen data of "two to two" and "many to many or n to n" mode coupling can be obtained by solving lower order (i.e., 4 and 2n) eigenvalue problems.
- **S-matrix Synthesis with Unequal Complex Terminations using Y-matrix and Desired Phased IMN**: If we consider a multiport as interconnections of multiple two-port-network (TPN) with common ground, then the topology of the multiport network can be predicted using the non-diagonal non-zero entries of Y-matrix of the network. The port impedance of a network can be controlled using external matching networks with identical phase shifts. Utilizing these concepts two algorithms have been proposed to design multiport networks with unequal complex port impedances.

COMPETITIVE EXAM QUALIFIED

Graduate Aptitude Test in Engineering Rank: 279, Percentile: 99.33	2009
Graduate Aptitude Test in Engineering Rank: 1790, Percentile: 93.57	2008
West Bengal Joint Entrance Exam. Rank: 623	2004

HARDWARE & SOFTWARE SKILLS

- **Language** : Python and C
- **Package** : MATLAB, SCILAB, GNU Octave, Mathematica, Latex, MS Office 2013
- **RF Simulation Tools** : Agilent ADS, IE3D, HFSS, CST Microwave Studio, Ansoft Designer.
- **Hardware Skill**: Vector Network Analyzer, Spectrum Analyzer, Signal Generator, Oscilloscope, VSWR Meter, Power Meter.
- **Operating systems** : Windows 10, Ubuntu 20.04 LTS

HONORS

Junior Research Fellowship, February 2009 – May 2009
Robotics and Automation Division
Central Mechanical Engineering Research Institute, Durgapur, India

MHRD Fellowship for M. Tech, July 2009 – June 2011
Dept. of Electronics & Electrical Communication Engineering
Indian Institute of Technology Kharagpur, Kharagpur, India

MHRD Fellowship for PhD, July 2011 – June 2016
Dept. of Electronics & Electrical Communication Engineering
Indian Institute of Technology Kharagpur, Kharagpur, India

PERSONAL DETAILS

- **Father Name**: Nibhas Chandra Sinha
- **Date of Birth**: 19th April 1986
- **Gender**: Male
- **Marital Status**: Married
- **Children**: One son

REFERENCE

Dr. Ick-Jae Yoon (Post-Doctoral Supervisor)
Associate Professor, Department of Electrical Engineering,
Chungnam National University (CNU),
Daejeon - 305-764, Republic of Korea.
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Dr. Hungsun Son (Post-Doctoral Supervisor)
Associate Professor, School of Mechanical, Aerospace and Nuclear Engineering,
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Dr. Arijit De (PhD Supervisor)
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Date: October 26, 2022
Place: Rourkela

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