





# Dr. Anirban Bhowal

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## Education

Degree/Certificate	Institute/Board	CGPA/Percentage	Year
PhD (Communication Engineering)	Indian Institute of Technology, Guwahati	9.75	2015-2020
MTech (Communication Engineering)	Indian Institute of Information Technology, Allahabad	8.88	2013-2015
BTech (Electronics and Communication Engineering)	Heritage Institute of Technology, Kolkata	9	2008-2012
Senior Secondary	C.I.S.C.E. Board	95.75%	2008
Secondary	C.I.S.C.E. Board	94.8%	2006

## Experience

- **Assistant Professor at NIT Rourkela, India** **May 2023-**  
Research: RIS and spatial modulation
- **Assistant Professor at IIIT Naya Raipur, India** **Oct. 2022-May 2023**  
Courses taught: Signals and Systems, Telecommunication Switches and Networks, Sensors and Actuators, Software Development, Communication Systems  
Research: RIS and spatial modulation
- **Postdoctoral fellow under Prof. Sonia Aïssa at INRS Montreal** **March 2021-Sept. 2022**  
Worked in the field of RIS, spatial modulation, short packet communication, and energy harvesting
- **Teaching assistant during PhD in IIT Guwahati** **July 2015-July 2020**  
Assisted my supervisor in microwave lab course and other theoretical courses like MIMO Wireless Communication
- **Mentoring of EE-101 (Basic Electronics) course for SAB, IIT Guwahati** **Oct-Nov 2018**  
Mentored EE-101 (Basic Electronics) students and taught several topics like op-amps, transistors, diodes etc.
- **Teaching assistant during MTech in IIIT Allahabad** **Aug 2013-July 2015**  
Assisted the faculties in various lab courses like antenna simulation, analog communication, microwave, wireless communication.

## Projects

- **Performance Analysis of RIS-Based Applications** **Postdoctoral project**  
*Prof. Sonia Aïssa, EMT-INRS Montreal*
  - Investigating realistic channel models for RIS.
  - Performance analysis of different configurations of RIS considering realistic channel and physical environment characteristics.
  - Performance analysis of spatial modulation-assisted RIS.
  - Introducing ambient backscattering in RIS-assisted communication for energy harvesting.
  - Performance analysis of RIS for short packet communications.
  - Coverage probability analysis for different coordinated multi-point WPT configurations.
- **Advanced Spatial Modulation Schemes: Performance Analysis and Applications** **PhD thesis**  
*Prof. Rakesh Singh Kshetrimayum, Dept. of EEE, IIT Guwahati*
  - The thesis proposes advanced spatial modulation (ASM) techniques for various applications and performance analysis is carried out in terms of bit error rate (BER) and outage probability (OP).
  - Spatial Modulation (SM) along with physical layer network coding (PLNC) is proposed for radio frequency (RF) device-to-device (D2D) bidirectional cooperative systems.
  - ASM techniques like enhanced spatial modulation (ESM) and spatial media based modulation (SMBM) are proposed for sporting activities in body area network (BAN) communication.

- ASM techniques like optical SM-PLNC, transmit laser selection (TLS), TLS-OSM, optical ESM (OESM), optical generalized spatial modulation (OGSM) and optical improved quadrature spatial modulation (OIQSM) are proposed for free-space optical (FSO) systems.
- ASM techniques like TLS, TLS-OSM and OIQSM are also proposed for underwater optical wireless communication (UOWC).
- ASM techniques like hybrid spatial modulation (HSM), transmit source selection (TSS) and TSS-HSM are proposed for hybrid FSO/RF cooperative systems that can be applied in future generation cellular communication networks.

- **Efficient Broadcasting over a Single Frequency Network**

**MTech Thesis**

*Dr. Neetesh Purohit, Dept. of Communication Engineering, IIIT Allahabad*

- For improving the performance of single frequency network (SFN) in 4G LTE, ultra-extended cyclic prefix (CP) duration is proposed in this thesis to account for the larger delay spread especially in rural and hilly areas.
- The performance of SFN for both extended and ultra-extended CP are compared in terms of spectral efficiency.

- **Design of Radio Frequency Transmitter**

**BTech Project**

*Dr. Asima Adak, Dept. of ECE, Heritage Institute of Technology, Kolkata*

- Designed a four stage FM (frequency modulation) radio transmitter on a PCB (printed circuit board).

## Professional Activities

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- Referee of several reputed journals including IEEE Communication Letters, IEEE Transactions on Vehicular Technology, IEEE Internet of Things, IEEE Transactions on Communications, IEEE Wireless Communications Letters, IEEE Journal of Lightwave Technology, IET Radar, Sonar and Navigation, Electronics Letters, IET Journal of Engineering, Journal of Physical Communication Elsevier, AEU-International Journal of Electronics and Communication, OSA Applied Optics.
- Referee of International Conference on Communications (ICC) 2021, 2022, 2023, National Conference on Communications (NCC) 2021, 2023, International Conference on Signal Processing and Communications (SPCOM) 2020.
- Served as external reviewer, on behalf of Glasgow University, EPSRC UK, 2021.
- TPC member in IEEE ICC 2022, 2023, and NCC 2023.
- Invited talk on “Underwater Optical Wireless Communication”, at IIT Guwahati, India (part of NCC 2023), Feb. 2023, and at NIT Rourkela, India, July 2023.
- Delivered webinar lecture on “Advanced Spatial Modulation in Optical Wireless Communications (ASMOC)” at Nirma Institute of Technology, India, Aug. 2021.
- Delivered webinar lecture on “Advanced Spatial Modulation in Emerging Wireless Communications (ASMEC)” at Raghu Institute of Technology, India organized by IEEE Student Branch, Visakhapatnam, May 2021, and at Bapatla Engineering College, Andhra Pradesh, India, Nov. 2021.
- Member of the executive committee of IIIT Allahabad USA alumni chapter (2021-2022) and Sangam Chapter (Aug. 2021-Present).
- Mess Management Committee, Dibang Hostel, IIT Guwahati, 2019-2020.
- PG Senator, SGC, IIT Guwahati, 2018-19.
- Volunteer in Research Conclave, IIT Guwahati, 2017 and 2018.
- Treasurer, RSF-EEE, IIT Guwahati, 2017-18 and Student Adviser, RSF-EEE, IIT Guwahati, 2018-19.
- Sports Secretary, Dibang Hostel, IIT Guwahati, 2016-17 and 2017-18.
- Placement Coordinator, IIIT Allahabad, 2014-15.

## Research Interests

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|---------------------------------------------|-----------------------------------|
| ● RIS Assisted Communication                | ● Hybrid FSO/RF Communication     |
| ● Short Packet Communications               | ● Body Area Network Communication |
| ● Optical Wireless Communication            | ● Device-to-Device Communication  |
| ● Underwater Optical Wireless Communication | ● Spatial Modulation              |

## Courses Taught

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|-------------------------------------------|-----------------------------------|
| ● Communication Systems                   | ● Sensors and Actuators           |
| ● Telecommunication Switches and Networks | ● Software Development via Python |
| ● Signals and Systems                     | ● Semiconductor Devices           |

## Awards and Fellowships

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- 2020- Recipient of Best PhD thesis award by EEE department, IIT Guwahati
- 2020- International Travel Grant by Science and Engineering Research Board (SERB), Department of Science and Technology, India (Not availed)
- 2020- IEEE ComSoc International Student Travel Grant for WCNC 2020
- 2017- COMSNETS Domestic Student Travel Grant for COMSNETS 2017
- 2015-2020- Institute Fellowship (during PhD) by MHRD, Government of India
- 2013-2015- Institute Fellowship (during MTech) by MHRD, Government of India

## Publications

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- **Books**

1. A. Bhowal and R. S. Kshetrimayum, “Advanced Spatial Modulation Systems”, *Springer Nature*, Singapore, Jan 2021.

- **Journals**

1. A. Bhowal and S. Aïssa, “RIS Selection-Based Cooperative RIS-Assisted MIMO D2D Communication”, Revised version to be submitted in *IEEE Transactions on Communications*, July 2023.
2. A. Bhowal and S. Aïssa, “Polarization-Enabled MIMO Bidirectional Device-to-Device Communications via RIS”, *IEEE Transactions on Communications*, vol. 71, no. 1, pp. 427-440, Jan. 2023.
3. A. Bhowal and S. Aïssa, “MIMO Device-to-Device Communications via Cooperative Dual-Polarized Intelligent Surfaces”, *IEEE Wireless Communications Letters*, vol. 12, no. 2, pp. 202-206, Feb. 2023.
4. M. Abolpour, S. Aïssa, L. Musavian, and A. Bhowal, ”Rate Splitting in the Presence of Untrusted Users: Outage and Secrecy Outage Performances”, *IEEE Open Journal of the Communications Society*, vol. 3, pp. 921-935, May 2022.
5. Z. Mohammed, A. Bhowal, and S. Aïssa, “Distance Distributions and Coverage Probabilities in Poisson-Delaunay Triangular Cells with Application to Coordinated Multi-Point Wireless Power Transfer”, *IEEE Transactions on Wireless Communications*, vol. 21, no. 11, pp. 9143-9154, Nov. 2022.
6. A. Bhowal and S. Aïssa, “RIS-Aided Communications in Indoor and Outdoor Environments: Performance Analysis with a Realistic Channel Model”, *IEEE Transactions on Vehicular Technology*, vol. 71, no. 12, pp. 13356-13360, Dec. 2022.
7. A. Bhowal, S. Aïssa, and R. S. Kshetrimayum, “RIS-Assisted Advanced Spatial Modulation Techniques for Ambient Backscattering Communications”, *IEEE Transactions on Green Communications and Networking*, vol. 5, no. 4, pp. 1684-1696, Dec. 2021.
8. A. Bhowal and R. S. Kshetrimayum, “Advanced Optical Spatial Modulation techniques for FSO communication”, *IEEE Transactions on Communications*, vol. 69, no. 2, pp. 1163-1174, Feb. 2021.
9. A. Bhowal and R. S. Kshetrimayum, “Relay based Hybrid FSO/RF communication with Hybrid Spatial Modulation and Transmit Source Selection”, *IEEE Transactions on Communications*, vol. 68, no. 8, pp. 5018-5027, Aug. 2020.
10. A. Bhowal and R. S. Kshetrimayum, “Optical Improved Quadrature Spatial Modulation for Cooperative Underwater Wireless Communication under Weak Oceanic Turbulence Conditions”, *IET Optoelectronics*, vol. 14, no. 6, pp. 434-439, December 2020, doi: 10.1049/iet-opt.2020.001.
11. A. Bhowal, A. S. Sapre, R. Lalani, and R. S. Kshetrimayum, “Advanced Spatial modulation for efficient MIMO based B2B communications in Sporting Activities”, *IET Communications*, vol. 13, no. 20, pp. 3529-3536, December 2019.
12. A. Bhowal and R. S. Kshetrimayum, “Transmit laser selection for two hop decode and forward FSO communication with pointing errors”, *IEEE Communication Letters*, vol. 23, no. 12, pp. 2301-2305, December 2019.
13. A. Bhowal and R. S. Kshetrimayum, “Performance analysis of B2B communication for different sporting activities”, *IEEE Sensors Letters*, vol. 3, no. 7, July 2019.
14. A. Bhowal and R. S. Kshetrimayum, “Outage probability bound of decode and forward two way relay employing optical spatial modulation over Gamma-Gamma channels”, *IET Optoelectronics*, vol. 13, no. 4, pp. 183-190, July 2019.
15. A. Bhowal and R. S. Kshetrimayum, “Outage probability bound of decode and forward two-way full-duplex relay employing spatial modulation over cascaded  $\alpha - \mu$  channels”, *International Journal of Communication Systems*, Wiley, vol. 32, no. 3, e3876, February 2019.
16. A. Bhowal and R. S. Kshetrimayum, “Performance Analysis of One-way and Two-way relay for Underwater Optical Wireless Communications”, *OSA Continuum*, vol. 1, no. 4, pp. 1400-1413, November 2018.

- **Conferences**

1. S. Mondal, A. Bhowal, S. Kashyap, R. S. Kshetrimayum, and M. Patra, "Performance Analysis of a Mixed RF-FSO Aided Cognitive Radio Network", in Proc. *International Conference on Microwave, Optical, and Communication Engineering (ICMOCE)*, Bhubaneswar, India, May 2023.
2. S. Mondal, A. Bhowal, S. Kashyap, R. S. Kshetrimayum, and M. Patra, "Outage Probability Analysis of Hard-Switching Based Mixed FSO/IRS-Aided RF Communication", in Proc. *National Conference on Communications (NCC)*, Guwahati, India, Feb. 2023.
3. A. Bhowal, S. Aïssa, and M. Naseri, "RIS Enabled Multi-User SWIPT for URLLC", in Proc. *IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC)*, Sept. 2022.
4. A. Bhowal and S. Aïssa, "Performance Evaluation of RIS-Assisted Full-Duplex MIMO Bidirectional Communications with a Realistic Channel Model", Invited Paper in Proc. *International Wireless Communications and Mobile Computing Conference (IWCMC)*, Dubrovnik, Croatia, June 2022.
5. A. Bhowal, S. Aïssa, and R. S. Kshetrimayum, "RIS-Assisted Spatial Modulation and Space Shift Keying for Ambient Backscattering Communications", in Proc. *IEEE International Conference on Communications (ICC)*, Montreal, Canada, June 2021.
6. A. Bhowal and R. S. Kshetrimayum, "Transmit laser selection for dual hop decode and forward UOWC cooperative communication", in Proc. *IEEE Wireless Communications and Networking Conference (WCNC)*, Seoul, South Korea, pp. 1-6, May 2020.
7. A. Bhowal and R. S. Kshetrimayum, "Large scale MIMO performance analysis over cascaded - MIMO channel for M2M communication", in Proc. *IEEE International Conference on COMMunication Systems NETWORKS (COMSNETS)*, Bangalore, India, pp.405-406, January 2017.
8. A. Bhowal and R. S. Kshetrimayum, "End to end performance analysis of M2M cooperative communication over cascaded - channels", in Proc. *IEEE International Conference on COMMunication Systems NETWORKS (COMSNETS)*, Bangalore, India, pp. 116-122, 2017.
9. A. Bhowal, T. Paradkar, and N. Purohit, "Evaluation of extended CP and ultra-extended CP in MBSFN", in Proc. *IEEE UP Section Conference on Electrical Computer and Electronics (UPCON)*, Allahabad, India, pp. 1-6, December 2015.
10. A. Bhowal, N. Verma, and R. Singh, "Design and Evaluation of a New Compact CPW Fed Slot Textile Antenna for UWB applications", in Proc. *IEEE International Conference on Communications and Signal Processing (ICCSP)*, Melmaruvathur, India, pp. 314-317, April 2015.
11. S. Choudhury and A. Bhowal, "Comparative Analysis of machine learning algorithms along with classifiers for network intrusion detection", in Proc. *IEEE International Conference on Smart Technologies and Management for Computing, Communication, Controls, Energy and Materials (ICSTM)*, Chennai, India, pp. 89-95, May 2015.

## Students Supervised

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- Himanshu Tiwari, MTech (NIT Rourkela, Ongoing)
- Sahil Tembhurkar, *Perceiving Sentiments from Speech using Deep Neural Networks*, BTech (IIIT Naya Raipur), Jul. 2023.
- Satyapal Singh Kanwar, *Face Mask Detection using Deep Learning Techniques*, BTech (IIIT Naya Raipur), Jul. 2023
- Ajay Kumar Sori, *Human Posture Estimation*, BTech (IIIT Naya Raipur), Jul. 2023

## Other Details

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- Google Scholar: <https://scholar.google.com/citations?user=CKudYGYAAAAJhl=th>(<https://scholar.google.com/citations?user=CKudYGYAAAAJhl=th>)

## References

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- Prof. Sonia Aïssa, Professor, INRS-EMT, Montreal, Canada, [sonia.aissa@inrs.ca](mailto:sonia.aissa@inrs.ca)
- Prof. Rakesh Singh Kshetrimayum, Professor, IIT Guwahati, India, [krs@iitg.ac.in](mailto:krs@iitg.ac.in)
- Dr. Neetesh Purohit, Associate Professor, IIIT Allahabad, India, [np@iiita.ac.in](mailto:np@iiita.ac.in)