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This is to certify that the thesis entitled "**Reconfigurable Intelligent Surface Assisted NOMA for Next-Generation Wireless Communications**" being submitted by **M Hemanta Kumar (19091006)** to the Indian Institute of Technology (Banaras Hindu University) Varanasi, for the award of the Degree of Doctor of Philosophy in the Department of Electronics Engineering is a record of bonafide research work carried out absolutely by him under our supervision and guidance. The thesis has reached the standard; fulfilling the requirements of the regulations relating to the nature of the degree. The results embodied in this thesis have not been submitted to any other university or institute for the award of any degree or diploma.

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CANDIDATE'S DECLARATION

I, **M Hemanta Kumar**, certify that the work embodied in this thesis is my own bonafide work and carried out by me under the supervision of **Dr. M.Thottappan** and **Dr. Sanjeev Sharma** from **29/07/2019** to **19/07/2022**, at the Department of Electronics Engineering, Indian Institute of Technology (Banaras Hindu University), Varanasi. The matter embodied in this thesis has not been submitted for the award of any other degree/diploma. I declare that I have faithfully acknowledged and given credits to the research workers wherever their works have been cited in my work in this thesis. I further declare that I have not willfully copied any other's work, paragraphs, text, data, results, etc., reported in journals, books, magazines, reports dissertations, theses, etc., or available at websites and have not included them in this thesis and have not cited as my own work.

Date: 19/07/2022
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CERTIFICATE BY THE SUPERVISOR

It is certified that the above statement made by the student is correct to the best of our knowledge.

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M Hemanta Kumar

Dedicated to My Supervisors

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Abbreviations

AWGN	**A**dditive **W**hite **G**aussian **N**oise
BEP	**B**it **E**rror **P**robability
BER	**B**it **E**rror **R**ate
BS	**B**ase **S**tation
CDF	**C**umulative **D**istribution **F**unction
CDMA	**C**ode **D**ivision **M**ultiple **A**ccess
CR	**C**ognitive **R**adio
CSI	**C**hannel **S**tate **I**nformation
D2D	**D**evice-to-**D**evice
DF	**D**ecode-and-**F**orward
FD	**F**ull-**D**uplex
FDMA	**F**requency **D**ivision **M**ultiple **A**ccess
i.i.d.	**I**ndependent and **I**dentically **D**istributed
IoT	**I**nternet of **T**hings
LTE	**L**ong **T**erm **E**volution
MA	**M**ultiple **A**ccess
MI	**M**utual **I**nformation
MIMO	**M**ulti-**I**nput and **M**ulti-**O**utput
MISO	**M**ultiple-**I**nput **S**ingle-**O**utput
MMSE	**M**inimum **M**ean **S**quare **E**rror
mmWave	**M**illimeter **W**ave
MRC	**M**aximal **R**atio **C**ombining

NOMA	**N**on-**O**rthogonal **M**ultiple **A**ccess
OFDMA	**O**rthogonal **F**requency **d**ivision **M**ultiple **A**ccess
OMA	**O**rthogonal **M**ultiple **A**ccess
PDF	**P**robability **D**ensity **F**unction
QoS	**Q**uality of **S**ervice
RF	**R**adio **F**requency
SC	**S**uperposition **C**oding
SER	**S**ymbol **E**rror **R**ate
SIC	**S**uccessive **I**nterference **C**ancellation
SISO	**S**ingle **I**nput **S**ingle **O**utput
SINR	**S**ignal-to-**I**nterference-**P**lus-**N**oise **R**atio
SNR	**S**ignal-to-**N**oise **R**atio
SWIPT	**S**imultaneous **W**ireless **I**nformation and **P**ower **T**ransfer
TDMA	**T**ime **D**ivision **M**ultiple **A**ccess
ZF	**Z**ero-**F**orcing
ZFBF	**Z**ero-**F**orcing **B**eam**F**orming
1G	**F**irst **G**eneration
2G	**S**econd **G**eneration
3G	**T**hird **G**eneration
3GPP	**T**hird **G**eneration **P**artnership **P**roject
4G	**F**ourth **G**eneration
5G	**F**ifth **G**eneration
6G	**S**ixth **G**eneration

PREFACE

Next-generation wireless communication systems are expected for high spectral and energy efficiency, colossal data rate, low latency, and massive connectivity. This is because of an exponential increase in mobile traffic, mobile devices, and new disruptive services and applications. Recently, reconfigurable intelligent surface (RIS) and nonorthogonal multiple access (NOMA) methods have been explored to enhance spectral and energy efficiencies. A RIS, also known as intelligent reflecting surfaces (IRS), has equipped a large number of low-cost passive reflective elements. Each reflecting element smartly tunes the phase of the incident signals according to the channel environment and the reflected signals can be constructively added to enhance the signal-to-noise (SNR) towards receivers. On the other hand, NOMA is the latest member of the multiple access technique, which supports more users at the same time/frequency/code with different power levels assigned according to their channel gains. Further, NOMA yields an effective achievable rate over the conventional orthogonal multiple access (OMA).

Hence, the mutual benefits of RIS and NOMA can satisfy the demand for massive connectivity, low latency with higher energy, and spectral efficiency for next-generation wireless networks. Moreover, in downlink RIS-assisted index modulation-NOMA (R-INOMA), the BS transmits the information through RIS to three users. The first user (cell-edge user) is assigned in the spatial domain, and the remaining two users are multiplexed with power domain NOMA (PD-NOMA). Further, the investigated upper-bound bit error probability (BEP) of INOMA users, is achieved that at low transmit power, higher received SNR under the Rayleigh fading channels and enhanced the cell-edge performance.

Furthermore, multiple RISs can be created a virtual line-of-sight (LoS) channel between the base station (BS) and users to improve the network coverage and received SNR, especially in high frequencies and severe path attenuation scenarios. Since millimeter-wave (mmWave) and terahertz (THz) frequencies suffer higher path loss due to molecular absorption and the LoS path is blocked. Additionally, the implemented joint optimization of transmit antennas beamforming and reflecting elements phase beamforming at BS and RIS, respectively, enhance the performance of more users which are distributed at the cell edge than in the cell center scenario.

Next, the author has reported the present work in a timely in reputed journals, namely, IEEE Communication Letters, Transactions on Emerging Telecommunications Technologies, and International Journal of Communication Systems.

The author will consider his modest effort as a success if it would be useful to the community of wireless communications designers and researcher.