One Week MATLAB Project Course on
5G Wireless Technologies: Massive MIMO, mmWave, NOMA, Full Duplex, OFDM/FBMC, NB-IoT
July 8th to 14th, 2019

Organized by Prof. Aditya K. Jagannatham, EE Department, IIT Kanpur in association with E & C Dept., Ramaiah Institute of Technology, Bengaluru

IMPORTANT INFORMATION FOR THE SHORT COURSE AT RIT, Bangalore

Note:

1. Campus map of RIT are given at the end of the document.
2. Please bring a scientific calculator along with you to participate in problem solving during lectures and tutorial sessions. If possible, please also bring laptop with MATLAB installed and fully charged during all regular course days also. In addition, MATLAB project participants are required to bring Laptop with MATLAB preferably R13 or later to participate in the MATLAB projects to be conducted on 13th(02:00 PM onwards) and 14th July, 2019.

Contact Info

Note: Please contact only in case of **emergency**

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How to reach RIT, Bangalore

Bangalore is connected by rail and road with the major cities in India. RIT campus is located in Mathikere area. RIT is located at a distance of about 7 kilometers from the KSR Railway Station (Majestic), 3 Kilometers from Yeswanthpur railway station and 8 kilometers from Cantonment railway station. **Taxis are available from the KSR Railway Station (Majestic) (from Platform number 1 side).** There is a pre-paid auto and taxi booth. **The rates are about Rs. 200/- to 250/- for a taxi and Rs. 50/- for an auto-rickshaw.** Sometimes you may be able to negotiate a few rupees less with the driver, if you don't go to the pre-paid booth. For taxi services you can also call the following taxi agencies.

Sunil Travels	9739438108/ 9980934666

Important Note: Please note visitor can through gate 10.

Please note that transportation has to be arranged by the participant and the associated charges have to be borne by the participant. These are not covered in the registration fees.

Air connectivity

Visitors coming over to Bangalore have to get down at Kempegowda Airport, Bangalore is capital of the state of Karnataka, India. One can avail the taxis at the airport taxi-stand, but they can ask for any arbitrary amount. You can use the taxi service numbers listed above to book a taxi in advance. **Depending on the type of vehicle, these taxis will charge between Rs 1200/- and Rs. 1600/-. (Charge for Air-conditioned taxi is only Rs. 100/- to 200/- extra.)**

Accommodation Information

Accommodation for the participants is NOT provided, but assistance is provided. You can book the rooms, details is mention below.

Accommodation Details:

1. **Grand**
   Boys PG and Lodge, 1st Cross, Near Ramaiah Engg College bus stop, Mathikere, Bangalore – 54. Contact No. (080) 41101338, (+91) 9972381338. (Approx. Rs 650/- per 2 persons and Rs 800/- per 3 persons)

2. **Maurya Pardise Inn**
   #7/1, MSREC Road, Mathikere, (Near Ramaiah Engg College bus stop), Bangalore – 54. Ph: 080-41279589. (Approx. Rs 850/- per single, Rs 1000/- per 2 persons and Rs 1300/- per 3 persons)

3. **Royal Residency**
   #8/1, 2nd Cross, RIT College Road, Mathikere (Near Ramaiah Engg College bus stop), Bangalore – 54. Ph: 080 – 42086870, 09886537666. (Approx. Rs 1000/- per 2 persons and Rs 1300/- per 3 persons)

4. **Visitors Comfort**
   #4, Sai Shamik Plaza, 3rd Cross, Opposite to M. S. Ramaiah College gate, Mathikere, Bangalore – 54. Ph: 080 – 40933635, 9743858076. (Approx. Rs 1100/- per 2 persons and Rs 1300/- per 3 persons).

5. **Paris Residency Bangalore**
   No.43, Market Road, Near Yashwantpur Railway Station, Yashwanthpur, Bazaar St, Bengaluru, Karnataka 560022. Ph: 070650 67404 (Approx. Rs 731/- per person)

Also note accommodation is NOT included in the registration fees.

Breakfast/ Meals Information

Participants have to bear food expenses. Participants can have breakfast, lunch and dinner in RIT Canteen. Timings are as follows.

Breakfast: 8:30 AM to 11:00 AM

Lunch: 12:30 PM to 2:00 PM

In addition there are a variety of food outlets in and around RIT. Their location, timing details with contact information are given below.

Food outlet	**Location/ Timing**
Food Village	Near gate 10, RIT Campus, 11:00 am - 11:00 pm
Nandini Deluxe	New BEL Road, 11:00 am - 11:00 pm

The venue for the lecture part of the short course is in LHC Seminar Hall-II, RIT Campus

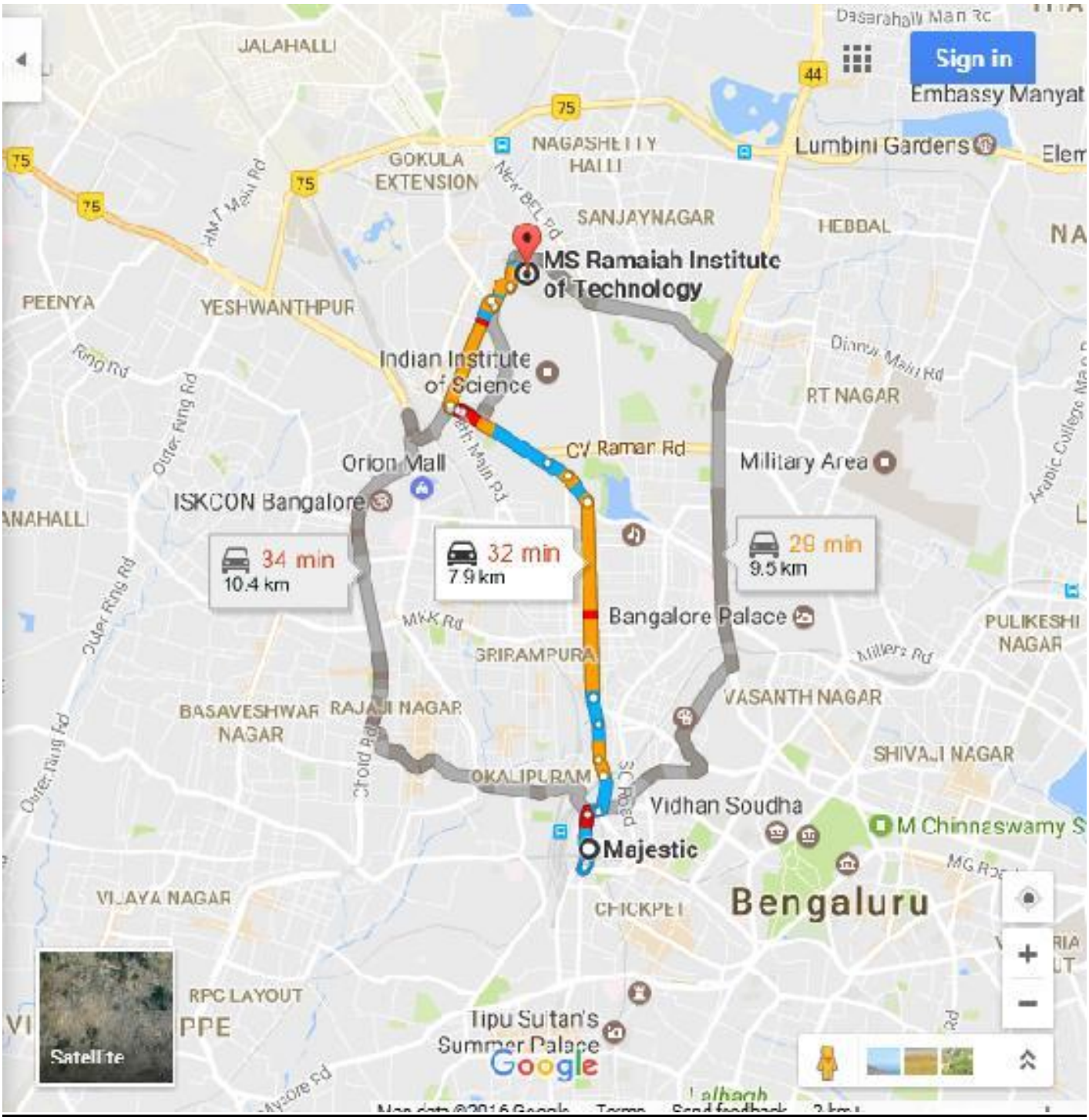
Course folder, stationary and printed course material will be provided on 8th July morning during the registration session starting at 8:30 AM. Course certificate and receipt for the short course registration will be given only to those who attend all modules of the course and after all the payment dues are cleared.

Please bring a scientific calculator along with you to participate in problem solving during lectures and tutorial sessions.

Group Photograph

A group photo session will be held for all short course participants on July 13, 2019 (SATURDAY) from 10:15 AM to 10:30 AM

[Map Showing Route From Majestic Gate to RIT Campus]



Tentative Schedule

The tentative schedule for the duration of the short course from 8th to 14th July. It is also available online at:

http://www.iitk.ac.in/mwn/BANG5G/index.html

DAY 1: July 8, 2019 (MONDAY)	
08:30 AM	Registration
09:00 AM- 10:15 AM	5G Technology Roadmap – Key Specifications and Technologies
10:15 AM- 10:45 AM	Tea Break
10:45 AM- 12:15 PM	Overview of Massive MIMO Technology – Signal Processing, Precoding, Combining
12:15 PM- 02:00 PM	Lunch Break
02:00 PM- 03:15 PM	Problem Solving – 5G Technologies, MIMO Techniques and Massive MIMO
03:15 PM- 03:45 PM	Tea Break
03:45 PM- 05:15 PM	Sub 6 GHz Wireless Technology, Beamforming, MIMO, MU-MIMO Design, Diversity
DAY 2: July 9, 2019 (TUESDAY)	
09:00 AM- 10:15 AM	Massive MIMO Channel Modeling, Receiver Design, Signal Processing and Performance
10:15 AM- 10:45 AM	Tea Break
10:45 AM- 12:15 PM	Massive MIMO Channel Estimation, Effect of Imperfect CSI, Multi-Cell Massive MIMO and Pilot Contamination, Spatial Modulation, SSK and GSM
12:15 PM- 2:00 PM	Lunch Break
02:00 PM- 03:15 PM	Problem Solving – Massive MIMO, Performance and Optimization
03:15 PM- 03:45 PM	Tea Break
03:45 PM- 05:15 PM	Overview of mmWave MIMO, Hybrid Signal Processing, Analog Beamforming, Transceiver Architecture
DAY 3: July 10, 2019 (WEDNESDAY)	
09:00 AM- 10:15 AM	mmWave MIMO Channel Modeling, Channel Estimation for mmWave MIMO Systems
10:15 AM- 10:45 AM	Tea Break
10:30 AM - 11:30 AM	Invited expert lecture on Technology Trends and Real World Applicability by Mr Akshay Aggarwal Director of Technology for MediaTek

11:30 AM - 12:15 PM	Optimal Transceiver Design for mmWave MIMO
12:15 PM - 2:00 PM	Lunch Break
02:00 PM- 03:15 PM	Problem Solving - Hybrid Signal Processing Techniques, Architectures for mmWave MIMO
03:15 PM - 03:45 PM	Tea Break
03:45 PM - 05:15 PM	mmWave MIMO Transceiver Design (Contd.), RF/ BB Precoder Optimization, RF/ BB Combiner Optimization
DAY 4: July 11, 2019 (THURSDAY)	
09:00 AM - 10:15 AM	Overview of NOMA – Challenges, Performance Comparison with Orthogonal Multiple Access (OMA)
10:15 AM - 10:45 AM	Tea Break
10:45 AM - 12:15 PM	Performance Analysis of fixed NOMA, DL/ UL Models, Outage Probability and Optimal Power Allocation
12:15 PM - 2:00 PM	Lunch Break
02:00 PM - 03:15 PM	Problem Solving – NOMA, Performance Analysis for DL/ UL
03:15 PM - 03:45 PM	Tea Break
03:45 PM - 05:15 PM	Performance Analysis of Ordered NOMA, Probability of Outage, MIMO NOMA
DAY 5: July 12, 2019 (FRIDAY)	
09:00 AM - 10:15 AM	Overview of Filter Bank Multicarrier (FBMC) Technology, FBMC OQAM Systems, Advantages over OFDM
10:15 AM - 10:30 AM	Tea Break
10:30 AM - 11:30 AM	Invited expert lecture on Making 5G NR a reality by Dr. Tanumay Datta, working in Wireless R&D, Qualcomm Bangalore
11:30 AM – 12:15 PM	Overview of Filter Bank Multicarrier (FBMC) (Contd.)
12:15 PM - 2:00 PM	Lunch Break
02:00 PM - 03:15 PM	Problem Solving: OFDM, FBMC Systems, MIMO-FBMC
03:15 PM - 03:45 PM	Tea Break
03:45 PM - 05:15 PM	MIMO-FBMC Architecture, Transmitter and Receiver Techniques for MIMO-FBMC
05:15 PM Onwards	High Tea

DAY 6: July 13, 2019 (SATURDAY)	
09:00 AM - 10:15 AM	Full - Duplex Technology, Self-Interference, Analog/ Digital Cancellation
10:15 AM - 10:30 AM	Group Photo Session of Course Participants
10:30 AM - 10:45 AM	Tea Break
10:45 AM - 12:15 PM	Introduction to 5G NB-IoT, 5G New Radio (NR) standards
12:15 PM - 2:00 PM	Lunch Break
02:00 PM - 03:15 PM	MATLAB Project on Massive MIMO, Receiver Techniques, Channel Estimation
03:15 PM - 03:45 PM	Tea Break
03:45 PM - 05:15 PM	MATLAB Project on New Modulation Techniques for 5G - Spatial Modulation, Space-Shift Keying and Generalized Spatial Modulation
DAY 7: July 14, 2019 (SUNDAY)	
09:00 AM- 10:15 AM	MATLAB Project in mmWave MIMO Channel Modeling, mmWave MIMO Channel Estimation
10:15 AM- 10:45 AM	Tea Break
10:45 AM- 12:15 PM	MATLAB Project in Optimal Precoder/ Combiner Design for mmWave MIMO Systems, Hybrid Signal Processing
12:15 PM- 2:00 PM	Lunch Break
02:00 PM- 03:15 PM	MATLAB Project on NOMA Systems, UL/ DL Analysis for Fixed and Ordered NOMA Systems
03:15 PM- 03:45 PM	Tea Break
03:45 PM- 05:15 PM	MATLAB Project on FBMC and OFDM Implementation, Transmitter/ Receiver for FBMC, MIMO-FBMC Systems