Indian Institute of Technology,

Kanpur Proposal for a New Course

1. **Course No:** EE698Q (Old Course No)

2. **Course Title:** 5G Wireless Technologies

3. **Per Week Lectures:** 3 (L), Tutorial: (T), Laboratory: ___(P), Additional Hours[0-2]: (A), Credits (3*L+2*T+P+A): 9 **Duration of Course:** Full Semester

4. **Proposing Department/IDP:** EE

5. **Proposing Instructor(s): Aditya Jagannatham (adityaj@iitk.ac.in)**
   Other faculty members interested in teaching the proposed course:
   Swamy Peruru (swamyp@iitk.ac.in), Rohit Budhiraja (rohitbr@iitk.ac.in)

6. **Course Description:**

Objectives: The course will present an in-depth analysis of several key 5G wireless technologies such as Massive MIMO, mmWave MIMO, Filter Bank Multi-Carrier (FBMC), Non-Orthogonal Multiple Access (NOMA), Full-Duplex (FD) etc. It is also intended to cover other advanced wireless technologies such as Cooperative Communication, Cognitive Radio, Multi-User MIMO and more**.** Finally, students working in groups of two are expected to prepare a term paper that will focus on an in-depth study and analysis of any cutting edge 5G wireless technology of their choice.

Contents (*preferably in the form of 5 to 10 broad titles)*:

S. No.	Broad Title	Topics	No. of Lectures (1.5 hours each)
1.	**Evolution of Wireless Cellular Technology**	Evolution of Wireless Cellular Technologies - 2G/ 3G/ 4G. Introduction to 5G Wireless Networks and Technologies	1
2.	**MIMO Wireless Systems**	**MIMO Wireless Systems**. Performance of Multi-Antenna and MIMO Wireless Systems. Optimal Precoding and Power Allocation for Multi-User MIMO Systems	2
3.	**Massive MIMO Systems, Processing and Performance**	Introduction to massive MIMO Systems – Key Features. Signal Processing for massive MIMO with Perfect Channel State Information – Rate Scaling. Channel Estimation for massive MIMO Systems and Rate scaling in massive MIMO systems with CSI Uncertainty	4

4.	**New Modulation for 5G**	Spatial Modulation of Massive MIMO Systems	1
5.	**mmWave Wireless Systems**	Introduction to mmWave MIMO Wireless Systems, Properties and Modeling of mmWave Wireless Channels, Analog, Digital and Hybrid Processing for mmWave MIMO Wireless Systems	2
6.	**Transceiver Design for mmWave**	Channel Estimation in mmWave Wireless Systems and Introduction to Sparse Processing, Design of Optimal RF/ Baseband Precoders and Combiners for mmWave MIMO Wireless Systems	3
7.	**Filter Bank Multi-Carrier Systems**	Introduction to Filter Bank Multi-Carrier Systems – Key Properties and Advantages, FBMC System Model – Intrinsic Interference, Signal Transmission and Decoding in FBMC Systems, Performance Analysis of FBMC Systems and Comparison with OFDM Systems	3
8.	**Non-Orthogonal Multiple-Access (NOMA)**	Introduction to NOMA Wireless Systems, System Model and Decoding for NOMA Systems, Performance Analysis of NOMA Networks – Outage Probability, Optimal Performance of NOMA Systems and Average Rate	3
	Full-Duplex Wireless Technology	Introduction to FD Wireless Technology, Self Interference in FD System and Resulting Performance, Optimal Signal Processing for FD Systems, Optimal Power Allocation and Performance of FD Systems	2
	Cooperative Wireless Communication	Introduction and Protocols for Cooperative Wireless Communication, Decode-and-Forward (DF) for Wireless Relaying Systems, Performance Analysis of DF for Multi-antenna and MIMO Wireless Systems, DF Relaying for Multi-Relay Wireless Systems	3
	Cognitive Radio Systems	Introduction to Cognitive Radio Concept and Software Defined Radio (SDR), Spectrum-Sensing for Cognitive Radio Systems, Optimal Power Allocation and Interference Suppression for MIMO Cognitive Radio Systems	2
		Total Lectures (1.5 hours each)	26

A) **Pre-requisites:** EE320 (Principles of Communication Systems)

B) **Short summary for including in the Courses of Study Booklet:** The course will present an in-depth analysis of several key 5G wireless technologies such as Massive MIMO, mmWave MIMO, Filter Bank Multi-Carrier (FBMC), Non-Orthogonal Multiple Access (NOMA), Full-Duplex (FD) etc. It is also intended to cover other advanced wireless technologies such as Cooperative Communication, Cognitive Radio, Multi-User MIMO and more**.**

7. **Recommended reference:**
    - Fundamentals of Massive MIMO By Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo
    - Millimeter wave wireless communications By Theodore S. Rappaport, Robert W. Heath, Robert. C. Daniels, James N. Murdock

8. **Evaluation Policy:** Assignments: 10%, Mid-sem: 25%, Endsem: 35%, Quizzes 20% Term paper 10%

9. **Course strength last three times:**

    2024-2025 Semester II: 60;
    2019-2020 Semester II: 41;
    2018-2019 Semester II: 51;

Dated: 11/09/2025 Proposer: Aditya Jagannatham

Dated: DUGC/DPGC Convener:

The course is approved / not approved

Chairman, SUGC/SPGC

Dated:_____