Course Outline for “CT537: Advanced Wireless Communications”

1. **Title**: Advanced Wireless Communications

2. **Credit Structure (L-T-P-Cr)**: 3 0 0 3

3. **Course Code**: CT537

4. **Semester**: SEM 3

5. **Category**: M. Tech specialization Core

6. **Prerequisites**: none

7. **Foundation for**: This is an advanced level course

8. **Abstract Content**:

Primary: The aim of the course is to introduce the students to some of the latest advances in wireless communications. The course focuses its attention on the physical layer design aspects. The course will cover wireless channel models, wireless standards (viz., GSM, 3G, IEEE 802.11 and IEEE 802.16 ), latest wireless technologies and information theoretic aspects of wireless channels. The course aims to keep a right balance between theory and practice. A good background in basic probability theory and random processes is required.

(Note: Final year B. Tech students with CGPA > 7.4/10 may also take it).

The detailed course outline is as follows:

**Module 1: Introduction to Wireless Channel Models and Standards**
- Wireless Channel Models (namely, frequency flat, frequency selective, fast fading and slow fading channels)
- Overview of GSM and 3G standards.
- Overview of IEEE 802.11 standard (Wi-Fi)
- Overview of IEEE 802.16 standard (WiMax)

**Module 2: Orthogonal Frequency Division Multiplexing (OFDM)**
- Motivation for OFDM
- Why cyclic prefix in OFDM Systems??
- Common problems (namely inter-carrier interference, high peak to average power ratio (PAPR)) in OFDM Systems.

**Module 3: Information theory basics**
- Basics of convex optimization (namely, convex sets, convex functions, duality, etc.)
- Basic information theoretic definitions (such as entropy, mutual information, etc.) and their properties.
- Differential entropy.
- Relation between information theory and estimation theory (Data Processing Inequality)
Module 4: Capacity of Scalar Wireless Channels
- Introduction to the notion of channel capacity.
- Capacity of time-invariant channels.
- Capacity of time varying (or fading) channels.

Module 5: Capacity of Vector (MISO, SIMO and MIMO) Channels and Spatial Multiplexing
- Capacity of MISO, SIMO Channels (for both time-invariant and time varying cases).
- Capacity of MIMO Systems (Telatar's paper).
- V-BLAST and D-BLAST.
- Space Time Block Codes (STBC) and Space Time Trellis Codes (STTC).

9. Suggested Texts:

Main Text Book:
- Fundamentals of Wireless Communications by David Tse and Pramod Viswanath.

References:
- Fundamentals of Digital Communication by Upamanyu Madhow
- Wireless Communications by Andrea Goldsmith
- Elements of Information Theory by Thomas Cover and Joy Thomas.
- Digital Communications by John G. Proakis
- Introduction to space-time wireless communications by Arogyaswami Paulraj, Rohit Nabar and Dhananjay Gore.

10. Detailed Contents:

<table>
<thead>
<tr>
<th>Topic Name</th>
<th>Content</th>
<th>No. of Lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wireless channel models and standards</td>
<td>See Module 1 above</td>
<td>6</td>
</tr>
<tr>
<td>OFDM</td>
<td>See Module 2 above</td>
<td>8</td>
</tr>
<tr>
<td>Information and optimization theory</td>
<td>See Module 3 above</td>
<td>10</td>
</tr>
<tr>
<td>Capacity of scalar wireless channels</td>
<td>See Module 4 above</td>
<td>6</td>
</tr>
<tr>
<td>Capacity of Vector channels</td>
<td>See Module 5 above</td>
<td>10</td>
</tr>
</tbody>
</table>

11. Outcomes and Objectives:
- At the end of the course the student would have solid understanding of latest wireless technologies and standards.
- The course also prepares students for industry related jobs in the area of wireless communications.
12. **Grading policy:** The final grade would be computed as the weighted sum of the marks obtained in the following four components:

- 1 – Insem examination
- 2 – Insem examination
- Final examination
- Homeworks/quizzes