

# Microwave Antennas

**Course Code:** EC742

**Course Title :** Microwave Antennas

**Credit Hours:** 3

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## ***I. Course Description:***

Fundamentals of antenna and planar transmission lines - Uniform/Non-uniform feed Linear/Planar array antennas - Uniform/Non-uniform illuminated aperture antennas - Horn antennas - Reflector Antennas - Microstrip antennas - Wideband antennas - Antenna synthesis Approach

## ***II. Course Objectives:***

1. After completion of this course, the student should be able to analyze and design the following antenna types:
  - Aperture Antennas (Horn-Reflector-Slot)
  - Planar Antennas (MS-CPW-SL)
  - Array antennas (Linear/Planner)
  - Ultra Wideband Antennas
  - Mobile handset and Base station Antennas
  - Chip Filtenna Module
  - Multi-port Antennas and MIMO Antennas
  - Planar Rectennas
  - Flexible Antennas
2. To use antenna synthesis methods to design an arbitrary antenna configuration having the required characteristic
3. To learn how to use one of the current electromagnetic simulator (CST simulator)

## ***III. Student participation***

### **(a) Student Seminar:**

- Mobile Handset Antennas
- Mobile Base Station Antennas
- Planar UWB Antennas
- Planar (filter-antenna) Filtennas
- Flexible Antennas
- Planar Rectennas
- MIMO Antennas
- Reconfigurable Planar Antennas

**(b) Student Project:**

Design, Simulation and Implementation one of the following antenna modules using MW simulator tool (CST\_Studio):

- Planar Wideband Antennas
- Planar Multiband Antennas
- Planar UWB Antennas
- Planar Filtennas (Multi-resonance antennas)
- Planar multi-port Antennas
- Planar MIMO Antennas
- Planar reconfigurable antennas

**VI. Background:**

- Basics of engineering mathematic
- Basics of Electromagnetic
- Basics of antenna
- Basics of transmission line

**Reference**

- [1] Constantine A. Balanis, "Antenna Theory: Analysis and Design", John Wiley & Sons Inc., 3<sup>rd</sup> Edition, 2005
- [2] Ben Allen and el., "Ultra-Wideband Antennas and Propagation for Communications, Radar and Imaging", John Wiley & Sons Inc., 2007
- [3] Zhi Ning Chen and Kwai-Man Luk, "Antennas for Base Stations in Wireless Communications", McGraw-Hill, New York, 2009
- [4] Zhi Ning Chen, "Antennas for Portable Devices", John Wiley & Sons, Ltd, May.2007
- [5] David M. Pozar, "Microwave Engineering", John Wiley & Sons, Inc., 3<sup>rd</sup> Edition, 2005

## *Course Topics*

### **1. Array Antennas: Ch. 6**

- Uniform feed Linear/Planner Array Antennas
- Non-Uniform feed Linear/Planar Array Antennas (Binomial/Dolph-Tschebyscheff)

### **2. Aperture Antennas: Uniform/Non-uniform illumination**

- Rectangular and Circular Apertures **Ch.12**
- Horn Antennas **Ch.13**
- Microstrip Antennas **Ch.14**
- Reflector Antennas **Ch.15**

### **3. Wideband Antennas: Ch.10**

- Traveling wave antennas (Long Wires)
- Broadband antennas (Helical )
- Biconical antennas

### **4. Antenna Synthesis Ch.7**

- Schelkunoff method
- Beam Shaping FT

## Course Plan

<i>Week No.</i>	<i>Topics Per Week</i>	<i>Task Due Date</i>
<b>W1</b>	Planar Transmission Lines and Antennas Fundamentals	
<b>W 2 - 5</b>	Linear/Planar Array Antennas Uniform Feed	<b>Assignment #1 (W-8)</b>
	Linear/Planar Array Antennas Non-Uniform Feed	
<b>W 6 - 7</b>	Aperture Antennas Uniform/Non-Uniform illuminated Rectangular and Circular	
<b>W 7 - 8</b>	Microstrip Antennas Horn Antennas	
<b>W 9</b>	<b>Midterm Exam</b>	<b>Assignment #2 (W-12)</b>
<b>W 10</b>	Reflector Antennas	
<b>W 11</b>	Wideband Antennas	
<b>W12</b>	Antenna Synthesis	
<b>W 13</b>	<b>Final Lecture + Take Home Exam</b>	
<b>W 14 - 15</b>	<b>Seminars/W-14/15</b>	<b>Take Home Exam (W-14) Project (W-15)</b>
<b>W 16</b>	<b>Final Exam</b>	<b>Final Grade By W-17</b>

***Project (submitted: W. # 15)******Design and Implementation of Planar Antenna Module******Project Objectives***

1. Understand concept and design of the planar Antenna
2. Applications of planar antenna
3. To learn how to simulate planar antenna using Microwave simulator (CST\_Studio)
4. To get experience of how to implement planar antenna using planner circuit technology (Thin Film)

***Project Group***

Student Number per one project: **Two Students**

***Project Task***

1. Select a current published paper of planar antenna (**only 2014-2015**)
2. Using the Circuit simulator to compute the S-parameters, VSWR, radiation efficiency, Gain, and the radiation pattern of the selected planar antenna
3. Implement the planar antenna on FR-4 substrate (or other)
4. Measurement the S-parameters and VSWR of the planar antenna

***Project Report***

1. Introduction
2. A good summary of the selected planar antenna and its applications
3. Simulation and implantation of the selected planar antenna
4. A discussion paragraph about the simulated and the measured results

## *Seminar (Power Point presented: W. # 14 & W. #15)*

### *Seminar Objectives*

1. Understand the concept of different planar antennas/filtennas/rectennas /reconfigurable antennas /MIMO antennas configurations
2. To be acquainted with the current planar antennas/filtennas/ rectennas /reconfigurable antennas/MIMO antennas applications and specifications

### *Seminar Group*

Student Number per one project: **Three Students**

### *Final Grade Evaluation*

Activities	Grade	Final Evaluation
<b>Midterm exam</b> (3-Questions each one 10 Mark)	<b>15 %</b>	<b>7<sup>th</sup> Exam out of 30%</b>
<b>Take home exam</b> (3-Questions each one -10 Mark)	<b>15 %</b>	
<b>Assignments</b> (2-Assignmets 20-Mark for each)	<b>10 %</b>	<b>12<sup>th</sup> Exam out of 20 %</b>
<b>Seminar</b> (power point presentation -30 Mark)	<b>10%</b>	
<b>Attendance</b>	<b>10%</b>	<b>10 %</b>
<b>Project</b> Simulation: 20 Mark, Implementation: 20 Mark Report: 20 Mark	<b>20 %</b>	<b>Final Exam out of 40 %</b>
<b>Final exam (Comprehensive)</b> (4-Questions each one 20 Mark)	<b>20 %</b>	