BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani
Pilani Campus
AUGS/ AGSR Division

FIRST SEMESTER 2020-21
COURSE HANDOUT

Date: 18.08.2020

In addition to part I (General Handout for all courses appended to the Time table) this portion gives further specific details regarding the course.

Course No : **EEE F474**
Course Title : **Antenna Theory and Design**
Instructor-in-Charge : **NAVNEET GUPTA**
Instructor(s) : **-**
Practical Instructor : **Ritish Kumar**

1. Course Description (as per Bulletin):
Introduction into antenna theory and practice, Radiation integrals and auxiliary potential functions; basic EM theorems in antenna problems, Antenna characteristics, Infinitesimal dipole; wire and loop radiating elements, Wire antennas – dipoles, monopoles, Arrays – analysis and design, Reflector antennas, Broadband antennas, Micro-strip patch antennas , Smith Chart Review in line with antenna theory and Design , Antenna measurements, Antenna design using commercial software, study of radiation pattern of various antennas

2. Scope and Objective of the Course:
To provide the fundamental knowledge about the antenna design which is the key subject of radar, wireless communication and mobile communication. The main objective of this course is to introduce theory, analysis, design and measurements of antennas. First, the electromagnetic theory is introduced and the fundamental antenna parameters are explained. Classical radiating elements; dipoles/monopoles, loops, apertures, horns, reflectors and modern antennas like microstrip patch antennas (MPAs) and fractal antennas are included to meet the cutting-edge requirement of this field. Considerable special attention is also planned to antennas popular in mobile telecommunications. Antenna simulations through professional software will be taken through seminars.

3. Text Books:
C.A. Balanis, *Antenna Theory, Analysis and Design*, 3rd ed., John Wiley and Sons.

4. Reference Books:
J. D. Kraus and R. J. Marhefka, *Antennas*, 3rd ed. McGraw-Hill.

5. Course Plan:

Module No. & Lec.	Topics	Reference	Learning Objectives
1. Introduction to antenna Theory Lec: 1-3	Introduction to antenna theory, review of Maxwell's equations and electromagnetic wave theory, Smith Chart and impedance matching	Chapter-1	To recall the basics of EM theory useful to discuss antenna theory and impedance matching tech.
2. Fundamental Parameters of Antennas Lec: 4-8	Radiation pattern, power density, radiation intensity, beamwidth, Directivity, Antenna Efficiency and Gain etc.	2.1-2.11	To describe parameters used to evaluate the properties of antenna and understand the importance of polarization and Friis transmission equation
	Types of Antenna polarization, Axial ratio, PLF, Polarization efficiency, Antenna Equivalent circuit, Friis transmission and Radar range equation	2.12-2.17	

3. Potential Functions Lec:9	Radiation integrals and auxiliary potential functions	3.1-3.6	To derive potential functions
4. Basic Radiators Lec: 10-12	Short dipoles, half wave dipoles, loop antennas	4.1-4.3, 4.6 & 5.2	To understand the importance of basic radiators
5. Antenna Arrays Lec: 13-17	Two element array, Linear array, planar array, *N*-Element Linear Array, Hansen-Woodyard array, Binomial & DT array	6.1-6.5, 6.8	To describe the various linear antenna arrays
6. Traveling wave and Broadband antennas Lec: 25-26	Design and analysis of long wire and helical antenna	10.2-10.3	To discuss important broadband antennas
7. Frequency Independent Antennas Lec: 27-28	Design and analysis of Log periodic antenna and Fractal antenna	11.4-11.6	To learn some important types of FIA
8. Aperture Antenna Theory Lec: 18-20	Huygen's principle, Image theory, rectangular apertures; Babinet's Principle and slot antennas.	12.2-12.5, 12.8	To explain the Huygen's principle for aperture antennas
9. Horn Antennas Lec: 21-24	E-Plane, H-Plane, sectorial and Pyramidal antennas: Design and concept	Chapter 13	To analyze the performances of horn antennas
10. Microstrip Patch Antenna Lec; 29-33	General characteristics, radiation mechanism feeding techniques, rectangular patch, Transmission line and cavity model and design steps	14.1-14.2	To explain the theory and radiation mechanism of patch antennas
11. Special Antennas Lec: 34-35	Reflector antenna, EMC antenna, Satellite antenna and mobile base station antenna	15.4, 4.7.4 and lecture notes	To learn the antennas used in advanced wireless technology
12. Commercial software tools Lec: 36-40	Design of advanced antennas using commercial software tools: CST and HFSS	Research papers	To learn the commercial software tools.

Laboratory Experiment: Design and analysis of different types of antennas using MATLAB Antenna tool.

Learning outcomes of this course:

After completing this course student shall be able to:

1. Understand important and fundamental antenna engineering parameters and terminology,
2. Learn the basic concepts of electromagnetic wave radiation and reception,
3. Develop the basic skills necessary for designing a wide variety of practical antennas and antenna arrays.
4. Learn and analyze design issues and the necessary trade-offs that are required in complex systems with antenna design as a significant aspect of the overall system design and development.
5. Work on commercial software tools for designing antennas

6. Evaluation Scheme:

Component	Duration	Marks (Total:200)	Date & Time	Nature of component (Close Book/ Open Book)
Test-1	30 Min.	25	Sep.10–Sep.20 (During scheduled class hour)	Open Book
Test-2	30 Min.	25	Oct.09–Oct.20 (During scheduled class hour)	Open Book
Test-3	30 Min.	25	Nov 10–Nov 20 (During scheduled class hour)	Open Book
Quizzes	10 min	10	During Lecture Hour	Open Book
Seminars	15 min	15	During November	
Experiments (Lab)	--	25	Lab Hour	-
Comprehensive Examination	120 Min.	75	01/12/2020 FN	Closed Book

6. Chamber Consultation Hour: Thursday: 5:00 PM to 5:50 PM

7. Mid-Semester Grading: Mid-semester grading will be announced just after Test 2 in the fourth week of October.

8. Notices: All notices will be put up on NALANDA (LMS-e portal).

9. Make-up Policy: Depending on **urgency** and situation. IC in consultation with AUGSD will decide to provide make-up.

Instructor-in-charge
Course No. EEE F474