INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

SOFTWARE DEFINED RADIO								
II Semester: ES								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BESE10	**Elective**	3	0	0	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: **Internet of Thins, Embedded Systems.**								

I. COURSE OVERVIEW:

This course offers a foundational understanding of Software Defined Radio (SDR), a transformative technology in modern wireless communication systems. It introduces the essential radio frequency (RF) components and demonstrates how they can be implemented and controlled through software. Students will learn about the software architectures that enable flexibility and configurability in SDR platforms. The course also emphasizes hands-on experience in building and analyzing SDR systems, highlighting their adaptability and relevance in evolving communication standards and protocols. By the end of the course, students will be prepared to design, simulate, and evaluate SDR systems for current and next-generation wireless applications.

II. COURSES OBJECTIVES:

The students will try to learn

I. Gain foundational knowledge of software-defined radio (SDR) and its characteristics and benefits over traditional hardware-based radio systems.
II. Master multirate signal processing techniques and their application in digital receivers.
III. Examine real-world applications and case studies of SDR technology.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1	Describe the components and implementation issues of the RF front-end, including challenges like dynamic range, noise, and distortion.
CO2	Apply multirate signal processing techniques, such as sample rate conversion and digital filter banks.
CO3	Analyze and implement digital signal generation methods, including Direct Digital Synthesis (DDS), and understand their performance characteristics.
CO4	valuate and select appropriate digital hardware platforms (DSPs, FPGAs, ASICs) for specific SDR applications based on performance trade-offs.
CO5	Analyze and apply concepts of synchronization, channel coding, and digital modulation in SDR systems.
CO6	Identify and apply SDR technology in various real-world applications such as military communications, wireless network testing, and spectrum monitoring

IV. COURSE CONTENT:

MODULE - I: INTRODUCTION TO SOFTWARE DEFINED RADIO (9)

The Need for Software Radios, What is Software Radio, Characteristics and Benefits of Software Radio-Design

Principles of Software Radio, RF Implementation Issues, The Purpose of RF Front, End, Dynamic Range- The Principal Challenge of Receiver Design, RF Receiver Front, End Topologies, Enhanced Flexibility of the RF Chain with Software Radios- Importance of the Components to Overall Performance-Transmitter Architectures and Their Issues, Noise and Distortion in the RF Chain, ADC and DAC Distortion.

MODULE –II: MULTI RATE SIGNAL PROCESSING (9)

Introduction, Sample Rate Conversion Principles, Polyphase Filters, Digital Filter Banks, Timing Recovery in Digital Receivers using Multirate Digital Filters. Digital Generation of Signals: Introduction, Comparison of Direct Digital Synthesis with Analog Signal Synthesis, Approaches to Direct Digital Synthesis, Analysis of Spurious Signals, Spurious Components due to Periodic Jitter- Band Pass Signal Generation, Performance of Direct Digital

Synthesis Systems, Hybrid DDS-PLL Systems, Applications of Direct Digital Synthesis- Generation of Random Sequences, ROM Compression Techniques.

MODULE –III: ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERSION (9)

Parameters of Ideal Data Converters, Parameters of Practical Data Converters- Analog to Digital and Digital to Analog Conversion, Techniques to Improve Data Converter Performance- Common ADC and DAC Architectures

MODULE –IV: DIGITAL HARDWARE CHOICES (9)

Introduction, Key Hardware Elements, DSP Processors, Field Programmable Gate Arrays, Trade-Offs in Using DSPs, FPGAs, and ASICs, Power Management Issues using a Combination of DSPs, FPGAs, and ASICs

MODULE–V: OBJECT–ORIENTED REPRESENTATION OF RADIOS AND NETWORK RESOURCES (9)

Programming- Object Brokers- Mobile Application Environments- Joint Tactical Radio System. Case Studies in Software Radio Design: Introduction and Historical Perspective, SPEAK Easy, JTRS, Wireless Information Transfer System, SDR-3000 Digital Transceiver Subsystem, Spectrum Ware, CHARIOT.

V. TEXT BOOKS:

1. Software Radio: A Modern Approach to Radio Engineering, Jeffrey H. Reed, PEA Publication, 2002.
2. Software Defined Radio: Enabling Technologies, Walter Tuttle Bee, Wiley Publications, 2002.

VI. REFERENCE BOOKS:

1. Software Defined Radio for 3G, Paul Burns, Artech House, 2002.
2. Software Defined Radio: Architectures, Systems and Functions, Markus Dillinger, Kambiz Madani and Nancy Alonistioti, Wiley, 2003.
3. Software Radio Architecture: Object Oriented Approaches to Wireless System Engineering, Joseph Mitola III, John Wiley & Sons, 2000.

VII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Assignments
4. Model question paper – I
5. Model question paper – II
6. Lecture notes
7. Power point presentations
8. Early Lecture Readiness Videos