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

COURSE CONTENT

HARDWARE SOFTWARE CO-DESIGN								
I Semester: ES								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
BESE04	**Elective**	3	-	-	3	40	60	100
Contact Classes: 45	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 45**		
Prerequisite: Basic principles of physics.								

I. COURSE OVERVIEW:
This course intended to provide combined effort of hardware and software concurrent design in order to meet embedded system level objectives. It focuses on the hardware architectures, languages for systems design, system partitioning and design challenges. It gives the platform for designing applications in the area of aircraft, industrial automation, robotics, wireless communication and automobiles.

II. COURSES OBJECTIVES:
The students will try to learn

I. Providing adequate knowledge in the modeling of heterogeneous embedded systems based on design constraint and provide alternate solution exploring trade-off.
II. Explore the various wireless communication technologies that enable IoT devices to connect and communicate, such as Wi-Fi, Bluetooth, Zigbee, LoRa WAN, and cellular networks.
III. Introducing the importance of estimating the cost analysis in terms of hardware and software parameters.
IV. Introducing various co-synthesis and co-simulation tools for the effective design of embedded systems with better communication between different modules.

III. COURSE OUTCOMES:
At the end of the course students should be able to:

CO1 Demonstrate the principles and strategies involved in mapping software components onto hardware platforms in embedded systems.
CO2 Identify and differentiate between various types of partitioning techniques used in embedded systems, such as hardware/software partitioning and task/data partitioning, and recognize when to apply each type.
CO3 Identify the principles of hardware synthesis, which involve the automatic generation of hardware components from high-level design descriptions, and how it contributes to the integration of hardware and software in embedded systems.
CO4 Examine the importance of interface synthesis in creating efficient communication and interaction between hardware and software components within embedded systems, and learn to design and implement effective interfaces.
CO5 Analyze the execution timing and power consumption of hardware components within embedded systems, with the ability to optimize timing and power efficiency for specific applications.
CO6 Interpret the concept of virtual prototyping and how co-simulation plays a crucial role in creating virtual prototypes for embedded systems, allowing for early system evaluation and validation

IV. COURSE CONTENT:

MODULE – I: HW/SW PARTITIONING CONSTRAINTS & TRADEOFFS (9)

Cost modeling, Principle of hardware/software mapping – Real time scheduling – design specification & constraints on Embedded systems – Tradeoffs. Introducing Hardware/Software Co-design, The Quest for

Energy Efficiency, The Driving Factors in Hardware/Software Co-design, The Dualism of Hardware Design and Software Design.

MODULE –II: HW/SW PARTITIONING METHODOLOGIES (9)

Partitioning-Types of partitioning-Partitioning granularity - Kernigan-Lin Algorithm –Extended Partitioning – Binary Partitioning: GCLP Algorithm

MODULE –III: CO-SYNTHESIS (9)

Software synthesis – Hardware Synthesis – Interface Synthesis – Co-synthesis Approaches: Vulcan, Cosyma, Cosmos, Polis and COOL.

Single processor – coprocessor architecture, mixed-signal architectures, multiprocessor architectures, reconfigurable architectures, Systems on Chip.

MODULE –IV: ESTIMATION: HARDWARE & SOFTWARE (9)

Hardware area, execution timing and power, Software memory and execution timing, Worst Case Execution Time, Case studies.

MODULE –V: CO-SIMULATION & CO-VERIFICATION (9)

Principles of Co-simulation – Abstract Level; Detailed Level – Co-simulation as Partitioning support – Co-simulation using Ptolemy approach, Virtual Prototyping, Rapid Prototyping.

V. TEXT BOOKS:

1. Soonhoi Ha, Jürgen Teich, “Handbook of Hardware/Software Codesign”, Springer, 2017. ,2014

VI. REFERENCE BOOKS:

1. Schaumont, Patrick, A,” A Practical Introduction to Hardware/Software Codesign”, 2013, reprint, Springer, India.N. Ida, Sensors, Actuators and Their Interfaces, Scitech Publishers, 2014.
2. Felice Balarin, Massimiliano Chiodo, Paolo Giusto, Harry Hsieh, Attila Jurecska, Luciano Lavagno, Claudio.
3. Passerone, Alberto Sangiovanni-Vincentelli, Ellen Sentovich, Kei Suzuki, Bassam Tabbara, “Hardware- Software Co-Design of Embedded Systems: The POLIS Approach”, Springer, 2012.

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