INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

REAL TIME SYSTEMS								
VI Semester: IT								
Course Code	**Category**	**Hours / Week**			**Credits**	**Maximum Marks**		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AITD15	**Elective**	3	0	0	3	40	60	100
Contact Classes: 48	**Tutorial Classes: Nil**	**Practical Classes: Nil**				**Total Classes: 48**		
Prerequisite: Operating Systems								

I. COURSE OVERVIEW:

This course provides a comprehensive introduction to the design, development, and analysis of real-time systems, which are critical in applications where correctness depends not only on logical results but also on their timeliness. The course explores scheduling algorithms, system architectures, real-time operating systems (RTOS), fault tolerance, and practical implementation techniques. Students will gain theoretical insights and practical skills to design and analyze real-time systems in various domains, such as automotive, aerospace, robotics, and healthcare.

II. COURSES OBJECTIVES:

The students will try to learn

I. The concepts, characteristics, and modeling of real-time systems using task classifications and timing behavior of periodic, aperiodic, and sporadic workloads.

II. The real-time task scheduling, synchronization challenges (priority inversion) and algorithmic frameworks such as static RMS and dynamic EDF for feasibility and schedulability decisions.

III. The real-time operating system architecture, task and memory management, and inter-process communication mechanisms supported by industrial RTOS platforms.

IV. The communication behavior in social/connected environments and system-level fault tolerance, trust-reputation reasoning, security attack spectrums, and counter-measure principles for intelligent real-time applications.

III. COURSE OUTCOMES:

At the end of the course students should be able to

CO1 Define real-time system properties, differentiate hard and soft categories, and model systems as periodic or event-driven tasks for domains such as embedded automation and safety-critical computing.

CO2 Apply schedulability tests using utilization and response-time analysis and evaluate feasibility for independent and dependent task systems.

CO3 Explain and handle priority inversion using protocols like FreeRTOS scheduling constructs and synchronization methods.

CO4 Illustrate RTOS architecture, manage task life-cycle, and use IPC mechanisms including semaphores, mutexes, and message queues.

CO5 Interpret trust and reputation reasoning for networked agents using analysis approaches inspired by the Priority Ceiling Protocol and trust transitivity principles.

CO6 Summarize emerging real-time trends applied in Internet of Things, cyber-physical, and edge/AI-enabled real-time systems with a security-aware perspective.

IV. COURSE CONTENT:

MODULE I: INTRODUCTION TO REAL-TIME SYSTEMS (10)

Real-Time Systems Basics: Definition and importance of real-time systems. Characteristics: Timeliness, reliability, predictability, Comparison: Hard vs. soft real-time systems. Examples of real-time systems: Automotive systems, healthcare, avionics, and industrial automation. System Modeling: Real-time system models: Periodic and aperiodic tasks.

MODULE II: REAL TIME TASK SCHEDULING (09)

Types and Characteristics: Periodic, aperiodic, and sporadic tasks. Independent and dependent systems. Real-Time Scheduling Algorithms: Static scheduling: Rate Monotonic Scheduling (RMS). Dynamic scheduling: Earliest Deadline First (EDF). Priority-driven preemptive and non-preemptive scheduling. Schedulability Analysis: Utilization-based tests. Response time analysis and feasibility studies. Task Synchronization: Priority inversion and solutions: Priority Inheritance, Priority Ceiling Protocol.

MODULE III: REAL TIME OPERATING SYSTEMS (09)

RTOS Fundamentals: Architecture and key components of an RTOS. Task management: Creation, scheduling, and termination. IPC mechanisms: Semaphores, mutexes, message queues, and event flags. Memory Management in RTOS

RTOS Examples and Case Studies**:** Overview of popular RTOS: FreeRTOS, VxWorks, QNX. Case studies: RTOS implementations in real-world applications.

MODULE IV: REALTIME COMMUNICATION AND FAULT TOLERANCE (09)

Understanding and predicting human behaviour for social communities User data management - Inference and Distribution Enabling new human experiences Reality mining Context Awareness Privacy in online social networks Trust in online environment Trust models based on subjective logic Trust network analysis, Trust transitivity analysis Combining trust and reputation - Trust derivation based on trust comparisons Attack spectrum and countermeasures.

MODULE V: ADVANCED TOPICS AND APPLICATIONS (10)

Resource Management: Resource sharing protocols and contention resolution. Energy-aware scheduling and optimization techniques. Modeling and Verification: Timed automata and Petri nets. Formal methods for verification and testing of real-time systems. Emerging Trends in Real-Time Systems: Real-time applications in IoT, cyber-physical systems, and edge computing. Real-time AI/ML for intelligent systems.

V. TEXT BOOKS:

1. I.W. S. Liu, “Real-Time Systems”, Pearson Education Publisher, A comprehensive guide to real- time system concepts, scheduling algorithms, and real-world applications.
2. BorkoFurht, “Handbook of Social Network Technologies and Applications”, 3rdEdition, Springer, 2015.

VI. REFERENCE BOOKS:

1. Phillip A. Laplante, “Real-Time Systems Design and Analysis: Tools for the Practitioner", Willey Publisher, Provides a practitioner’s perspective with a balance of theory and practical tools for real- time system design.
2. Hermann Kopetz, “Real-Time Systems: Design Principles for Distributed Embedded Applications" Springer Publisher, covers the principles of distributed real-time systems, including communication and fault tolerance.

VII. ELECTRONICS RESOURCES:

1. https://nptel.ac.in, Video lectures and assignments by leading professors from IITs and IISc
2. edX and Coursera, Real-Time Embedded Systems Specialization" by University of California, Irvine
3. Udemy, Courses on real-time operating systems (FreeRTOS, VxWorks) and embedded systems

4. https://www.freertos.org, Comprehensive documentation, tutorials, and example projects for FreeRTOS

VIII. MATERIALS ONLINE

1. Course template
2. Tutorial question bank
3. Tech-talk topics
4. Open-ended experiments
5. Definitions and terminology
6. Assignments
7. Model question paper – I
8. Model question paper – II
9. Lecture notes
10. PowerPoint presentation
11. 11.E-Learning Readiness Videos (ELRV)