SEMESTER 5

REAL TIME SYSTEMS

Course Code	**PBAIT504**	**CIE Marks**	**60**
Teaching Hours/Week (L: T:P: R)	**3:0:0:1**	**ESE Marks**	**40**
Credits	**4**	**Exam Hours**	**2 Hrs 30 Mns**
Prerequisites (if any)	**PCCST403**	**Course Type**	**Theory**

Course Objectives:

1. To introduce the core principles of real-time systems, scheduling architectures, and fault tolerance.
2. To equip students with the methodologies for requirements engineering and data management in real-time environments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	**REAL TIME SYSTEM AND SCHEDULING** Introduction– Structure of a Real Time System –Task classes – Performance Measures for Real Time Systems – Estimating Program Run Times – Issues in Real Time Computing – Task Assignment and Scheduling – Classical uniprocessor scheduling algorithms –Fault Tolerant Scheduling.	**9**
2	**SOFTWARE REQUIREMENTS ENGINEERING** Requirements engineering process –Types of requirements – Requirements specification for real time systems – Formal methods in software specification – Structured Analysis and Design – Object oriented analysis and design and unified modelling language – Organizing the requirements document – Organizing and writing documents – Requirements validation and revision	**9**
3	**REAL TIME DATABASES** Basic Definition, Real time Vs General purpose databases, Main Memory Databases, Transaction priorities, Transaction Aborts, Concurrency control issues, Disk Scheduling Algorithms, Databases for Hard Real Time System.	**8**
4	**CLOCK SYNCHRONIZATION AND CASE STUDIES** **Clock Synchronization**–Clock, A Non fault– Tolerant Synchronization Algorithm – Impact of faults – Fault Tolerant Synchronization in Hardware – Fault Tolerant Synchronization in software. **CASE STUDIES**- Air traffic controller system.	**10**

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Suggestion on Project Topics

1. Real-Time Operating Systems (RTOS) for Embedded Systems

- **Project Idea**: Develop and implement an embedded system using an RTOS (e.g., FreeRTOS, VxWorks). Focus on real-time task scheduling, inter-process communication, and managing time constraints for the system.
- **Key Concepts**: Task scheduling, time partitioning, inter-process communication (IPC), system initialization.
- **Applications**: Robotics, automotive systems, medical devices, IoT.

2. Design of a Real-Time Scheduling Algorithm

- **Project Idea**: Design and implement a custom real-time scheduling algorithm, such as Rate Monotonic Scheduling (RMS) or Earliest Deadline First (EDF). Test it with different system loads and provide performance comparisons.
- **Key Concepts**: Scheduling algorithms, real-time constraints, task prioritization, deadlines.
- **Applications**: Multitasking systems, real-time control systems, aerospace systems.

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3. Real-Time Traffic Management System

- **Project Idea**: Create a traffic management system that dynamically adjusts traffic lights based on real-time traffic data (e.g., using sensors or cameras). Ensure the system meets real-time constraints for managing traffic flow.
- **Key Concepts**: Real-time data acquisition, event-driven programming, traffic light scheduling, sensor integration.
- **Applications**: Smart cities, intelligent transportation systems, automated traffic management.

4. Real-Time Data Acquisition and Monitoring System

- **Project Idea**: Develop a system for real-time data acquisition, such as monitoring temperature, humidity, or pressure, with data logging, visualization, and alerting features. Implement real-time constraints to ensure timely data capture and processing.
- **Key Concepts**: Real-time data collection, sensor interfacing, event-driven architecture, time-critical data processing.
- **Applications**: Industrial automation, environmental monitoring, IoT-based monitoring systems.

5. Real-Time Video Streaming System

- **Project Idea**: Design a real-time video streaming system that supports live video feeds with low latency. Implement real-time constraints to handle video encoding, transmission, and display.
- **Key Concepts**: Video compression, network protocols, latency optimization, real-time streaming.
- **Applications**: Live broadcasting, video surveillance, remote collaboration tools.

6. Real-Time Embedded System for Automotive Control

- **Project Idea**: Develop an embedded control system for an automotive application (e.g., braking, engine control). Implement a real-time operating system (RTOS) to handle critical tasks with time constraints.
- **Key Concepts**: Embedded systems, real-time control, safety-critical systems, CAN bus.
- **Applications**: Autonomous vehicles, automotive safety systems, driver assistance systems.

7. Real-Time Multi-Agent System for Cooperative Robots

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- **Project Idea**: Design a real-time system where multiple robots (agents) work together to complete a task, such as exploration or assembly. Focus on communication protocols and real-time decision-making for task allocation.
- **Key Concepts**: Multi-agent systems, distributed computing, task coordination, real-time communication.
- **Applications**: Industrial automation, robotics, cooperative drone systems.

8. Real-Time Control System for Industrial Automation

- **Project Idea**: Implement a real-time control system for an industrial process (e.g., temperature control, robotic arm control, or conveyor belt systems). Ensure that the system responds within strict timing constraints.
- **Key Concepts**: Control loops, feedback systems, real-time scheduling, process monitoring.
- **Applications**: Manufacturing, process control, robotics.

9. Real-Time Communication System in Ad-Hoc Networks

- **Project Idea**: Develop a communication protocol for real-time data transmission in an ad-hoc network, where the network topology is dynamic and nodes join and leave unpredictably. Ensure that the communication is reliable and meets real-time constraints.
- **Key Concepts**: Ad-hoc networks, communication protocols, network routing, real-time data transmission.
- **Applications**: Military communications, disaster recovery systems, vehicle-to-vehicle communication.

10. Real-Time Video Surveillance System with Object Detection

- **Project Idea**: Develop a real-time video surveillance system that uses computer vision techniques for object detection (e.g., people, vehicles) and triggers real-time alerts based on specific actions or conditions.
- **Key Concepts**: Computer vision, object detection algorithms, real-time image processing, alerting systems.
- **Applications**: Security surveillance, smart cities, automated monitoring systems.

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11. Real-Time Audio Processing for Speech Recognition

- **Project Idea**: Implement a real-time speech recognition system where audio input is processed and transcribed to text in real-time. Focus on reducing latency and ensuring reliable recognition under varying conditions.
- **Key Concepts**: Signal processing, real-time audio capture, speech recognition, machine learning.
- **Applications**: Voice assistants, transcription services, hands-free control systems.

12. Real-Time Health Monitoring System

- **Project Idea**: Develop a health monitoring system that captures real-time data from wearable devices (e.g., heart rate, ECG) and sends alerts to healthcare professionals if critical thresholds are breached.
- **Key Concepts**: Wearable sensors, data transmission, real-time alert systems, healthcare applications.
- **Applications**: Telemedicine, wearable health devices, elderly care.

13. Real-Time Distributed Database for Financial Transactions

- **Project Idea**: Implement a distributed database system that supports real-time transaction processing. Focus on ensuring consistency, availability, and low-latency response times.
- **Key Concepts**: Distributed systems, transaction processing, database management, consistency models.
- **Applications**: Online banking, e-commerce, real-time financial analysis.

14. Fault-Tolerant Real-Time System

- **Project Idea**: Develop a fault-tolerant real-time system that ensures high availability and correct behavior even in the presence of hardware or software failures. Implement redundancy techniques to guarantee system uptime.
- **Key Concepts**: Fault tolerance, redundancy, error handling, real-time recovery techniques.
- **Applications**: Critical systems, aerospace, military applications, automotive safety.

15. Real-Time Voice over IP (VoIP) System

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- **Project Idea**: Design a real-time VoIP system that ensures high-quality voice communication with low latency, even under network congestion or packet loss.
- **Key Concepts**: Real-time voice encoding/decoding, network protocols (e.g., SIP, RTP), QoS (Quality of Service), latency optimization.
- **Applications**: Communication systems, video conferencing, remote collaboration.

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 2 marks **(8x2 =16 marks)**	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 6 marks. **(4x6 = 24 marks)**	**40**

Course Outcomes (COs)

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

	Course Outcome	Bloom's Knowledge Level (KL)
CO1	Apply principles of real-time system design techniques to develop real-time applications	K3
CO2	Make use of the database in real-time applications.	K2
CO3	Make use of the architectures and behaviour of real-time operating systems.	K2
CO4	Evaluate the synchronization techniques present in a real-time system.	K5
CO5	Analyse case studies and real-time project systems	K4

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Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	-	-	-	-	-	-	-	✓
CO2	✓	✓	✓	✓	-	-	-	-	-	-	-	✓
CO3	✓	✓	✓	✓	-	-	-	-	-	-	-	✓
CO4	✓	✓	✓	✓	✓	✓	-	-	-	-	-	✓
CO5	✓	✓	✓	✓	✓	✓	-	-	-	-	-	✓

Text Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	"Real Time Systems"	C.M. Krishna, Kang G. Shin	Tata McGraw - Hil	2010
2	Real-time systems: theory and practice‖	Rajib Mall	Pearson Education,	2009
3	Real-Time System Design and Analysis	Philip.A.Laplante	Prentice Hall of India	3rd Edition, 2004

Reference Books				
Sl. No	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
1	Hard real-time computing systems: predictable scheduling algorithms and applications	Giorgio C. Buttazzo	Springer	2008
2	Resource management in real-time systems and networks	C. Siva Ram Murthy, G. Manimaran	PHI	2009
3	Real-Time Systems	C.M. Krishna, ang G. Shin	McGraw-Hill International Editions	1997

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Video Links (NPTEL, SWAYAM…)	
Module No.	**Link ID**
1	http://nptel.ac.in/courses/106105036/
2	http://www.cse.unsw.edu.au
3	http://www.cse.unsw.edu.au/~cs9242/08/lectures/09- realtimex2.pdf
4	http://ppedreiras.av.it.pt/resources/str1112/apresentacoes_pesquis_a/Real-time-CS.pdf

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	**Practical**	**Presentation**
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		**30**

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1. **Project Planning and Proposal (5 Marks)**

   - Clarity and feasibility of the project plan
   - Research and background understanding
   - Defined objectives and methodology

2. **Contribution in Progress Presentation and Question Answer Sessions (4 Marks)**

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. **Involvement in the Project Work and Team Work (3 Marks)**

    - Active participation and individual contribution
    - Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

    - Adherence to the project timeline and milestones
    - Application of theoretical knowledge and problem-solving
    - Final Result

5. **Final Presentation (5 Marks)**

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    - Quality and clarity of the overall presentation
    - Individual contribution to the presentation
    - Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**

    - Overall quality and technical excellence of the project
    - Innovation and originality in the project

Creativity in solutions and approaches