GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering (Part Time)
Subject Code: 2961104
Semester –VI
Subject Name:Cyber Physical systems

Type of course: ProgrammeElective Course

Prerequisite: Knowledge of microprocessor/microcontroller hardware, programming concept in assembly and C.

Rationale: Cyber Physical Systems plays crucial role in today's industry, where automation is generally achieved by interdisciplinary mode involving various branches of engineering to solve real life problems. IT improves the standard of living of human life. It provides challenges to implement next generation systems leading to solutions showing future trends, application area and challenges

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	2	3	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	**Introduction to Cyber-Physical Systems** Cyber-Physical Systems **(CPS)** in the real world , Basic principles of design and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS	4
2	**CPS – Environment** Human and CPS , Human Computer Interface (HCI), Hardware and Software Co-Design CPS HW platforms - Processors, Sensors, Actuators, CPS Network – Wireless Hart, CAN, Automotive Ethernet, CPS Sw stack - RTOS , Scheduling Real Time control tasks	7
3	**CPS Engineering** CPS Models, Low level Control, Mid High Level Control and Automation, From features to software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, Sense and actuation faults on control performance, network congestion. Architecture and Design Language	6
4	**CPS Analysis and Verification** Advanced Automata based modeling and analysis, Basic introduction and examples, Timed and Hybrid Automata Formal Analysis: Flowpipe construction, reachability analysis, Analysis of CPS Software, Weakest Pre-conditions, Hybrid Automata Modeling : Flowpipe construction using SpaceX and Phaver tools, CPS SW Verification: Frama-C	**6**
5	**CPS Security** Information and Cyber Security basics, Privacy in CPS, Threats to CPS in various domains such as Automotive, Medical , Industrial control etc. , CPS Attack models	**5**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
5	**15**	**25**	**10**	**10**	**5**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Rajeev Alur , Principles of Cyber-Physical Systems, MIT Press
2. A. Lee, Sanjit Seshia, Introduction to Embedded Systems – A Cyber–Physical Systems Approach , MIT Press
3. P. Tabuada, "Verification and control of hybrid systems: a symbolic approach", Springer-Verlag

Course Outcomes:

After learning the course, the students should be able to

Sr. No.	**CO statement**	**Marks % weightage**
CO-1	Address challenges in implementing a cyber-physical system from a computational perspective	30%
CO-2	Design of Cyber Physical Systems using formal methods, safety assurance and security aspects	30%
CO-3	Analyze and Implement CPS systems	40%

List of Experiments:

(General guidelines. Institute may change list of experiments based on laboratory set up available)

1. Study of HCI for CPS

2. Study of Communication Technologies in CPS
3. Modeling of CPS
4. Simulation of CPS
5. Analysis of CPS
6. Design of CPS for Hardware/Software Co-Design
7. Hybrid Model Analysis of CPS
8. CPS Performance Analysis
9. Study of CPS Security Attacks
10. Implementation of mechanism to mitigate security attacks of CPS