# SARVAJANIK UNIVERSITY
## Sarvajanik College of Engineering and Technology
**Bachelor of Technology**

**B. Tech. Semester VII**

**Subject Name:** **Cyber Physical Systems** **Subject Code: BTEC14701**
**Type of course:** PEC
**Prerequisite:** Microcontrollers, Digital Logic
**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 areas and challenges.

**Teaching and Examination Scheme:**

| Teaching Scheme | | | | Theory Marks | | | Practical Marks | | Total |
|---|---|---|---|---|---|---|---|---|---|
| L | T | P | C | TEE | CA1 | CA2 | TEP | CA3 | 150 |
| 3 | 0 | 2 | 4 | 60 | 25 | 15 | 30 | 20 | |

**CA1:** Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

**Content:**

| Sr. no. | Topics | Teaching Hrs. | Module % Weightage |
|---|---|---|---|
| 1. | **Introduction:** Cyber-Physical Systems (CPS) in the real world, Design principles and validation of CPS, Industry 4.0, AutoSAR, IIOT implications, Building Automation, Medical CPS. | 5 | 10 |
| 2. | **Platform components and principles of dynamic systems:** CPS HW platforms - Processors, Sensors, Actuators, CPS Network – Wireless Hart, CAN, Automotive Ethernet, Scheduling Real Time CPS tasks, Dynamical Systems and Stability, Controller Design Techniques, Performance under Packet drop and Noise. | 12 | 25 |
| 3. | **Intelligent CPS:** Safe Reinforcement Learning, Robot motion control, Autonomous Vehicle control, Gaussian Process Learning, Smart Grid Demand Response, Building Automation. | 10 | 20 |
| 4. | **CPS implementation issues:** From features to automotive software components, Mapping software components to ECUs, CPS Performance Analysis - effect of scheduling, bus latency, sense and actuation faults on control performance, network congestion, Building real-time | 10 | 25 |

| | | | |
|---|---|---|---|
| | networks for CPS, network congestion. | | |
| **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, secure Task mapping and Partitioning, State estimation for attack detection. | 8 | 20 |

**Suggested Specification table with Marks (Theory/Practical):**

| % Distribution of Marks | | | | | |
|---|---|---|---|---|---|
| **R Level** | **U Level** | **A Level** | **N Level** | **E Level** | **C Level** |
| 10 | 20 | 25 | 20 | 15 | 10 |

**Legends: R:** Remembrance, **U:** Understanding; **A:** Application, **N:** Analyze, **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 Text Books:**

| Sr. No. | Title of book /article | Author(s) | Publisher and details like ISBN | Year of publication | Publication Edition |
|---|---|---|---|---|---|
| **1.** | Introduction to Embedded Systems: A Cyber-Physical Systems Approach | E.A.Lee, Sanjit Seshia | MIT Press | 2017 | 2nd |
| **2.** | Principles of Cyber-Physical Systems | Rajeev Alur | MIT Press | 2015 | Latest |

**Course Outcome:**

| Sr. No. | CO Statement<br>After learning this subject students will be able to | Marks % weightage |
|---|---|---|
| **CO-1** | Narrate challenges in implementing a cyber-physical system from a computational perspective | 15 |
| **CO-2** | Analyze sensing, communication, control, and computing elements in a typical Cyber-physical system | 25 |
| **CO-3** | Identify and explain the requirements of control applications and Cyber-Physical Systems | 25 |
| **CO-4** | Analyze model base techniques in security issues. | 20 |
| **CO-5** | Analyze and Implement Cyber physical systems | 15 |

**Mapping with POs:**

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| | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO 1 | PSO 2 | PSO 3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO-1** | 3 | 2 | 1 | 2 | 3 | - | - | - | - | - | 2 | 1 | 2 | 3 | 1 |
| **CO-2** | 3 | 2 | 1 | 2 | 3 | - | - | - | - | - | 2 | 1 | 2 | 3 | 1 |
| **CO-3** | 3 | - | 3 | 3 | - | 1 | 1 | - | - | - | 2 | - | - | - | - |
| **CO-4** | 3 | 2 | | 2 | 3 | - | - | - | - | - | 2 | - | - | - | - |
| **CO-5** | 3 | 2 | 1 | 2 | 3 | - | - | - | - | - | 2 | 1 | 2 | 3 | 1 |

**List of Practical:**

1. (a) Differentiate Embedded System and Cyber Physical System (CPS)
   (b) Features of ESP8266 Node MCU
   (c) Steps of adding esp8266 Node MCU library in Arduino IDE . Follow:: https://www.instructables.com/Steps-to-Setup-Arduino-IDE-for-NODEMCU-ESP8266-WiF/
   (d) Create your own channel with your name on Thingspeak and show necessary steps to observe various fields in the channel. Use https://thingspeak.com/
2. Write a program to transfer an analog sensor connected on esp8266 Node MCU to an IoT channel created in Thingspeak. Observe the necessary graphs.
3. Write a Program to read data from an IoT thingspeak channel and display the same at serial monitor of esp8266 NodeMCU.
4. Write a code (a) To transfer the distance measured by ultrasonic sensor to the IoT channel created on thingspeak (b) Read the distance value of the ultrasonic sensor from the IoT channel and if the measured distance is greater than the threshold distance activate an alarm connected to esp8266 nodemcu.
5. An LM35 temperature sensor is interfaced with esp8266 nodeMCU. Write a code to transfer the temperature measured by LM35 to thinkspeak channel.
6. An LM35 temperature sensor is interfaced with esp8266 nodeMCU. The data of LM35 is uploaded onto thingspeak channel. Write a code to read the temperature value from the cloud and operate the device..
7. An analog sensor LM35 is connected with ESP8266 Node MCU number 1 and a LDR is connected with an analog channel of ESP8266 Node MCU number 2. Write a program to transfer content of both ESP 8266 on a single channel on Thingspeak. Observe the output.
8. Write a script to read content of thingspeak channel and visualize the result.
9. Write a code to operate AC appliances using the HTML page created on mobile phones. The AC appliances are interfaced with esp8266 node MCU.
10. Write a code to use GSM modem to send data of analog / digital sensor connected with node MCU on cloud channel.
11. Write a code to establish communication between two different microcontrollers and transfer data using a Zigbee device.

**Major Equipment:**

- ESP8266, Arduino UNO Board, Ultrasonic sensor, LDR, IR Sensor, LCD, Zigbee

**List of Open Source/learning website:**

- https://nptel.ac.in/courses/106105241-Foundations of Cyber Physical Systems

**List of Open Source Software:**

- https://www.arduino.cc/en/software