Semester: III						
FOUNDATIONS OF CYBER PHYSICAL SYSTEMS **Category: PROFESSIONAL CORE COURSE** **(Theory and Practice)**						
Course Code	**:**	**AI234AI**		**CIE**	**:**	**100+50 Marks**
Credits: L: T: P	**:**	**3:0:1**		**SEE**	**:**	**100+ 50 Marks**
Total Hours	**:**	**45L+30P**		**SEE Duration**	**:**	**3.00 Hours**

Unit-I	**9Hrs.**
Cyber-Physical Systems-Basics and Fundamentals Introduction, CPS concept and requirements, CPS Architecture, CPS Applications: CPS for Vehicular, Environments, CPS for Agriculture, CPS for Health and Medical Sciences, CPS for the Smart Grids, Future aspects of CPS, Challenges and Opportunities.	
Unit – II	**9Hrs.**
Basics of Computer and Embedded Architecture Computer Architecture-Processors, Basic System Architecture, Interrupts, CISC and RISC, Digital Signal Processors, Memory-RAM and ROM, Input/ Output: Programmed I/O, Interrupt-driven I/O, Direct Memory Access (DMA)-Standard block transfer, Demand-mode transfers, Fly-by transfer, Data-chaining transfers. Parallel and Distributed Computers-Introduction to parallel architectures, SIMD computers, MIMD computers, Embedded Computer Architecture.	
Unit –III	**9Hrs.**
Embedded System Components Introduction, Hardware Components- Sensors, Actuators, IO Interfaces, Processor Complex or System on Chip (SoC), Processor and IO Interconnection, Bus Interconnection, High-Speed Serial Interconnection, Low-Speed Serial Interconnection, Firmware Components - Boot Code, Device Drivers, Operating System Services	
Unit –IV	**9Hrs.**
Sensors Sensor Definition, Use of Sensors, Sensor Network Definition and the Use of Sensor Networks, Traditional Sensor Networks vs. WSNs, Types of Sensors, Sensor Performance, Smart Sensors, Sensor Networks and Associated Technologies: Wireless Sensor Networks as Sensor Networks and Smart Sensor Networks	
Unit –V	**9Hrs**
Actuators Actuators, Actuator Types: Hydraulic actuators, Pneumatic actuators, Electric actuators, Thermal or magnetic actuators, Mechanical actuators, soft actuator, Shape memory polymers, Actuator Characteristics. **Robotic Application** Introduction, Robotic Arm, Sensing, Actuation, Automation and Autonomy.	

PART A	
Exp. No	**Experiment Description**
1.	Write a program with ESP8266 to calculate the distance of an obstacle. If the distance calculated is less than a certain value turns on a buzzer /beeper and display the distance in LCD / OLED.
2.	Write a program with ESP8266 to capture the temperature and relative humidity from the environment and display the same using LCD/ LED.
3.	Write a program to collect data using Temperature sensors on RaspberryPi3 and apply visualization techniques to display the processed data
4.	Write a program to collect data using RaspberryPi3 from the environment, and upload data to the any of the Cloud Platform.
5.	Write an interactive python script on RaspberryPi3 to control servo motor
6.	Write a program to capture the live image using the USB Camera on Jetson Nano and send it as notification

7.	Write a program to capture the live image using the USB Camera on Jetson Nano development kit and mark the region of interest and display using Open CV
8.	Write a program to show the communication between client and server.
PART B	
A batch of two students should develop a prototype for any one of the Sustainable Development Goals. The prototype should demonstrate the use of various sensors & actuators, and embedded modules in real-time applications.	

Course Outcomes: After completing the course, the students will be able to:-	
CO1	Understand the concept of Cyber-Physical Systems and apply it to address complex engineering problems
CO2	Analyze the various Cyber-Physical System Components used in solving the real-world problem
CO3	Design and implement data acquisition and processing techniques to extract meaningful information from CPS
CO4	Demonstrate the use of modern tools in solving day-to-day problems by exhibiting teamwork through oral presentations and reports
CO5	Collaborate in a group to design, develop, and evaluate Cyber-Physical Systems

Reference Books	
1	Cyber-Physical System Design with Sensor networking Technologies, Control, Robotics and Sensor Series, Edited by Sherali Zeadally and Nafaa Jabeur ISBN 978-1-84919-825-7
2	Designing Embedded Hardware, John Catsoulis, 2nd Edition, O'Reilly Media, 2005, ISBN: 0-596- 00755-8
3	Real-Time Embedded Components and Systems with LINUX and RTOS, S. Siewert and J. Pratt, 2016, ISBN: 978-1-942270-04-1
4	Introduction to IoT, Sudip Misra, Anandarup Mukherjee and Arijit Roy, Cambridge University Press, 1st Edition, 2020, ISBN 978-1-108-84295-2, ISBN 978-1-108-95974-2.

RUBRICFOR THE CONTINUOUS INTERNAL EVALUATION		
#	**COMPONENTS**	**MARKS**
1.	**QUIZZES:** Quizzes will be conducted in online/offline mode. **TWO QUIZZES** will be conducted & Each Quiz will be evaluated for 10 Marks. Each quiz is evaluated for 10 marks adding up to 20 MARKS	**20**
2.	**TESTS:** Students will be evaluated in test, descriptive questions with different complexity levels (Revised Bloom's Taxonomy Levels: Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating). **TWO tests will be conducted**. Each test will be evaluated for **50Marks**, adding upto 100 Marks. **FINAL TEST MARKS WILL BE REDUCED TO 40 MARKS.**	**40**
3.	**EXPERIENTIAL LEARNING:** Students will be evaluated for their creativity and practical implementation of the problem. Case study based teaching learning (10), Program specific requirements (10), Video based seminar/presentation/demonstration (10) Designing & Modeling (10) **Phase 2 will be done in the exhibition mode (Demo/Prototype/any outcome). ADDING UPTO 40 MARKS**.	**40**
4.	**LAB:** Conduction of laboratory exercises, lab report, observation, and analysis (30 Marks), lab test (10 Marks) and Innovative Experiment/ Concept Design and Implementation (10 Marks) adding up to 50 Marks. THE FINAL MARKS WILL BE 50 MARKS	**50**
	MAXIMUM MARKS FOR THE CIE(THEORY+LAB)	**150**

RUBRIC FOR SEMESTER END EXAMINATION (THEORY)		
Q.NO.	**CONTENTS**	**MARKS**
	PART A	
1	Objective type of questions covering entire syllabus	20
	PART B (Maximum of THREE Sub-divisions only)	
2	Unit 1 : (Compulsory)	16
3 & 4	Unit 2 : Question 3 or 4	16
5 & 6	Unit 3 : Question 5 or 6	16
7 & 8	Unit 4 : Question 7 or 8	16
9 & 10	Unit 5: Question 9 or 10	16
	TOTAL	**100**

RUBRIC FOR SEMESTER END EXAMINATION (LAB)		
Q.NO.	**CONTENTS**	**MARKS**
1	Write Up	10
2	Conduction of the Experiments	20
3	Viva	20
	TOTAL	**50**