BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, Pilani

Hyderabad Campus

First Semester 2019-2020
Course Handout (Part II)

Date: 24/07/2019

In addition to Part I (General Handout for all courses appended to the Time Table), this portion gives further specific details regarding the course.

Course No.   **: CS G541**
Course Title   **: Pervasive Computing**
Instructor In-charge   **: Suvadip Batabyal**

1. Course Description

The course is about the emerging discipline of Pervasive Computing, which is also known as ubiquitous computing. The key element here is the omnipresence of information devices. These devices can be embedded into cars, airplanes, ships, bikes, posters, signboards, walls and even clothes. This course focuses on the understanding elements involved in designing and building Internet of Things / Cyber Physical Systems / Ambient Intelligence based Environments. It, thus covers independent information devices including but not limited to wearable computers, mobile phones, smart phones, smart-cards, wireless sensor-compute nodes etc. and the services made available by them in typical Ubiquitous/ Pervasive / Everywhere Computing environment. It includes select aspects of human-computer interaction using several types of elements including sensing, text, speech, handwriting and vision.

2. Scope and Objectives
- Provide a sound conceptual foundation in the area of Pervasive Computing aspects.
- Understand the effects of Human-Computer Interaction and its Applications.
- Understand the concepts of Smart Devices, Smart Environment and Smart Interaction.
- Create awareness about the concepts, architecture and applications of Context-Aware Systems and Intelligent Systems.
- Understand the core concepts of networking and communication in Pervasive Computing systems.
- Conceptualize, analyze and design select classes of pervasive computing systems.

After completing this course, the students will be able to
- Design and implement case-studies of applications related to one or more aspect of Pervasive Computing.
- Understand the relationship between the Smart Devices, Environment and Interaction towards creating a ubiquitous system.
- Identify the core architectural as well as operational aspects of Context-Aware Systems, Intelligent Systems and Autonomous Systems.
- Develop in-depth research insight into the future aspects of Pervasive Computing.

3. Prescribed Text Book

T1.   Stefen Poslad: <u>Ubiquitous Computing: Smart Devices, Environments and Interactions</u>, Wiley, London, 2009, Indian reprint, 2014.

4. Reference Books

R1.   Mohammad S. Obaidat, Mieso Denko, Isaac Woungang (Editors): Pervasive Computing and Networking, Wiley, 2012.

In addition, course will refer to 4-6 selected papers to provide context of recent trends in Pervasive and Ubiquitous Computing.

5. Course Plan

Lec. #	Topics to be covered	Learning Outcome	Chap. in Text book
1-3.	Introduction of Pervasive Computing aspects including properties and applications	Introduction to Pervasive Computing. Understanding UbiCom from the perspective of core internal properties of UbiCom. Viewing UbiCom from the external interaction of the system across core system environments (virtual, physical and human). Understanding the holistic Smart DEI Framework.	T 1.1-1.2
	Core properties of Ubiquitous Systems, Ubiquitous System Environment Interaction		T 1.3
	Smart DEI Model, Basics of Smart Devices, Smart Environment and Smart Interaction		T1.4-1.5
4-5.	Select Case Studies in Past, Contemporary and In-research Pervasive Computing Systems and related products / applications	How has Pervasive Computing evolved? Case Studies highlighting the evolution of Pervasive Computing. Understanding the Current Status and Emerging Trends in Pervasive/Ubiquitous/Everywhere/ Invisible Computing	T 2.1-2.2
	UbiCom Applications, Design Challenges and Evaluation Framework for UbiCom systems		T 2.3-2.4
6-9.	Pervasive Computing Device Technologies and Service Architectures: Device types, Device Characteristics, Abstraction and Virtualization, Distributed Service Viewpoints	Smart Devices and Services. 1Main characteristics of smart devices as a means to provide an embodiment for smart services and viewpoints. Effect of Abstraction and virtualization. Architectural models for UbiCom systems. Understanding the service	T 3.1
	Service Architectural Models, Middleware, Service Oriented Computing, Grid		T 3.2

	Computing	provision life cycle. Operating system support for service execution.	
	Service Provisioning Lifecycle, Dynamic Service Discovery, Service Invocation and Composition		T 3.3
	Overview, Types of OS, CPU Scheduling, Kernels, Case Studies		T3.4
10	Research/product Presentation	Introduction to recent advances in pervasive computing	Class Notes
11-12	Concept of Mobility, Mobile Service Design, Select Case Studies.	Smart Mobiles, Cards and Device Networks.	T 4.1-4.2
	Power Management for Mobile Devices, Smart Card Devices, Device Networks, Overview of OSGi approach	Understanding the different notions of mobility. Issues in Smart Mobile Design. Power Management in resource constrained ICT devices. Overview of different smart card type devices and the device networks.	T 4.4-4.5
13-17	Overview of Human Computer Interaction, Types of HCI: Explicit HCI, Implicit HCI (iHCI), User Interfaces	Human Computer Interaction. Understanding the diversity of ICT device interfaces and interaction. Studies of several designs include types of natural interaction such as gesture input, voice input, etc. Effect of types of interaction and interfaces in a wider range of computer devices that support much more natural human computer interaction. Understanding the fundamentals of HCD and iHCI design. Design challenges and case studies in Affective Computing	T 5.1-5.2
	Interfaces for Mobile Hand-held devices and Game Consoles, Hidden User Interfaces using Smart Devices		T 5.3
	Hidden UIs via Wearable and Implanted Devices, Brain Computer Interface, Sense of presence and Telepresence, Case Studies		T 5.4
	Human Centred Design (HCD), Mental models and Conceptual models, Knowledge acquisition and Representation		T 5.5-5.6
	iHCI design heuristics and patterns, Framework, Interaction paradigms, Trajectories, Affective Computing		T 5.7

18	Research Presentation	Discuss and analyze recent advances in pervasive computing	Class Notes
19-24.	Tagging fundamentals and applications, Physical Annotations, Tags, Automatic Identification Systems, Performance Comparison.	Tagging, Sensing and Controlling

Passive, Active and Semi-Active Tagging fundamentals and applications. Understanding the RFID approach and role of the RFID tags. Introduction to sensors, sensor-compute nodes, sensor networks and wireless sensor networks (WSNs).
Fundamentals of robots, applications of relevance and human-robot interactions. Overview of real-time embedded systems. | T 6.1-6.2 |
	Fundamentals of RFID, components, overview of operations, selection criteria, deployment, applications		T 6.2.4
	Overview of Sensors, types, Architecture, Sensor characteristics, challenges		T 6.3
	Basics of Wireless Sensor Networks, Architecture, Quality of Service, Energy Issues, Design and Development		T 6.3
	Applications of Wireless Sensor Networks (WSN), Study of Protocols, Comparison with Mobile Ad-Hoc Networks (MANET)		T 6.3, T6.3.4.1
	Embedded systems and Real-time Systems, Robots, Human Robot Interaction, Case Studies		T 6.5, 6.7
25-26.	Overview of Context-Aware Systems, Types of such systems, Modeling concepts, Multi-dimensional Framework	Context-Aware Systems.

Understanding the Fundamentals of Context-Aware Computing, Context Modelling, Mobility aspects of awareness and its implications. Studies of Spatial aspects of awareness and its implications, Temporal aspects of awareness and its implications, etc. Select Case Studies | T 7.1-7.2 |
| | Architecture of Context-Aware Systems, Types of Awareness, Context Broker as a Case Study | | T 7.3-7.6 |
| 27-29. | Elements of intelligent / smart pervasive computing systems, Environments and Architectures of relevance, brief discussion on major types / classes of Intelligent Systems (ISes) and their relevance to | Intelligent Systems.

Understanding individual intelligent systems of different types. Studies of intelligent systems consisting of multiple | T 8.1-8.3 |

	Ubiquitous Computing Environments	interaction intelligent entities. Applications of IS in different paradigms.	
	Knowledge representation in Intelligent Systems, Soft computing models, IS System Operations and interactions, Case Studies		T 8.4 - 8.7
	Applications: Generic, / social networking / media-exchange / recommender and referral systems and associated work flow aspects in pervasive computing		T 9
30-31.	Basics of Autonomous Systems and Intelligent Life paradigm of computing, Types of Autonomous Systems, Properties and Limitations	Autonomous Systems. Understanding the main types of autonomous system and the properties of a more general type of autonomous system model called the self-star model. Studies of reflective type self-aware systems. Autonomic or self-management system models.	T 10.1-10.3
	Self-Management, Autonomic Computing, Evolutionary Computing, Select Case Studies		T 10.4-10.6
32-36.	Audio and Data Networks, Overview of WLAN, WiMAX, Bluetooth, Zigbee	Ubiquitous Communication. Understanding each of the major kinds of network prevailing in UbiCom paradigm. Studies of Internetworking technologies and QoS issues. Overview of cellular networks with design challenges and case studies in UbiCom systems. Discussions on upcoming networking concepts based on 5G networks and Cognitive Radio Networks.	T 11.1-11.4
	Basics of Ubiquitous Networks, Combining voice and data networks, Quality of Service issues, Case study of VoIP applications, Research Issues		T 11.5-11.5
	Cellular Networks in Pervasive Computing, Architecture, Challenges, Case Studies, Upcoming 5G networks, Mobile Ad-hoc Networks		Online Lecture Notes
	Controlling Network aspects, Service oriented networks, Mesh Networks, Internetworking aspects and design challenges, Mesh networks, Personal Area Networks, Body Area Networks		T 11.6-11.7
	Next-generation networks; Understanding the concepts of Cognitive Radio Networks,		Online Lecture

			Notes
	properties, design issues, Case-Studies		
37-38.	Managing smart devices in virtual environments, Requirements, Functions, Overview of Protocols. Fault Management	Management of Smart Devices. Understanding the management of UbiCom systems in terms of the three core designs of smart devices, smart environments and smart interaction. Studies of fault management issues in UbiCom Systems. Overview of the security aspects and their solutions for UbiCom applications.	T 12.1-12.2
	Smart Devices Management in Human-Centred and Physical Environments, Security and Privacy issues, Case Studies.		T12.3-T12.4
39-40.	Overview of Key Challenges in UbiCom design, Challenges involved in Smart Devices, interaction patterns and Smart Physical Environment Device interactions	Ubiquitous System: Challenges and Outlook Overview of the challenges of UbiCom systems in terms of the support for the five core properties of UbiCom systems i.e. distributed, iHCI, Context Awareness, Autonomy, Artificial Intelligence.	T13.1-13.5
	Issues in Smart Human Device Interaction, Human Intelligence vs Machine Intelligence, Social Issues		T13.6-13.8
41-42	Research presentations	Recent trends in Ubiquitous Computing	Class Notes
43	Course wrap up	Revise the salient points of the course	Class Notes

6. Evaluation Scheme:

EC No.	Evaluation Component	Duration (Min)	Weightage (%)	Date & Time	Nature of Component
1	Mid Semester Test	90	20	28/09/2019, 1.30 -- 3.00 PM	Closed Book
2	Research Presentation	-----	15		Open Book/Take home
3	Case Study	-----	15		Open Book/Take home
4	Quiz		10		Closed Book
5	Comprehensive	180	40 (10+30)	03/12/2019 FN	10%Open book + 30% Closed Book

- Quiz: 2 quiz each of 5 marks.

- Research presentation: 1 research presentation on individual basis. The topics and related papers to be selected by the students in consultation with the instructor. Presentation dates will be announced in CMS.

- Case study: Team of 2/3. Problem statement to be given by the instructor. Three meetings/presentations will be conducted during the entire semester. Weightage: 5% - Problem understanding and preliminary investigation, 5%- Problem formulation and data collection, 5% - Outcomes.

Notices: All notices shall be displayed electronically in CMS.

Makeup Policy: No makeup exam allowed without prior permission.

Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

Instructor In-Charge
CS G541