FACULTY OF TECHNOLOGY & ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING

CS378: VIRTUAL & AUGMENTED REALITY (PE-II)

Credits and Hours:

Teaching Scheme	Theory	Practical	Tutorial	Total	Credit
Hours/week	3	2	-	5	4
Marks	100	50	-	150	

Pre-requisite courses:

- Introduction to Computer Programming

Outline of the Course:

Sr No.	Title of the unit	Minimum number of Hours
1.	Introduction of Virtual Reality (VR) and Augmented Reality (AR)	4
2.	Multiple Modals of Input and Output Interface in Augmented Reality	4
3.	Geometry of Virtual Worlds	4
4.	Light and Optics	4
5.	Visual Physiology and Perception	5
6.	Tracking System	4
7.	Interactive Techniques in Augmented Reality	4
8.	Introduction of Immersive VR Hardware	4
9.	Development Tools and Frameworks in Virtual Reality	4
10.	Application of AR/VR	4
11.	Discussion over research paper in Area of VR/AR	4

Total Hours (Theory): 45

Total Hours (Lab): 30

Total Hours: 75

Detailed Syllabus:

1	**Introduction of Augmented reality**	**04 hours**	**09%**
1.1	Fundamental Concept and Components of AR/VR		
1.2	Primary Features and Present Development on AR/VR		
1.3	Birds-eye view (general), Birds-eye view (hardware)		
1.4	Birds-eye view (software), Birds-eye view (sensation and perception)		
2	**Multiple Modals of Input and Output Interface in Augmented Reality**	**04 hours**	**09%**
2.1	Input -- Tracker, Sensor, Digital Glove, Movement Capture		
2.2	Input --Video-based Input, 3D Menus & 3DScanner		
2.3	Output -- Visual / Auditory / Haptic Devices		
3	**Geometry of Virtual Worlds**	**04 hours**	**09%**
3.1	Geometric modeling, Transforming models		
3.2	Matrix algebra and 2D rotations		
3.3	3D rotations and yaw, pitch, and roll		
3.4	Axis-angle representations, Quaternions		
3.5	Converting and multiplying rotations, Homogeneous transforms		
3.6	The chain of viewing transforms, Eye transforms		
4	**Light and Optics**	**04 hours**	**09%**
4.1	Three interpretations of light		
4.2	Refraction, Simple lenses		
4.3	Diopters, Imaging properties of lenses		
4.4	Lens aberrations		
4.5	Optical system of eyes		
5	**Visual Physiology and Perception**	**5 hours**	**12%**
5.1	Photoreceptors, Sufficient resolution for VR		
5.2	Light intensity, Eye movements		
5.3	Neuroscience of vision		
5.4	Depth perception, Motion perception		
5.5	Frame rates and displays		
6	Tracking System	04 Hour	**08%**
6.1	Orientation Tracking, Tilt and Yaw drift Correction		
6.2	Tracking with Camera, Filtering		

7	**Interactive Techniques in Virtual Reality**	**04 hours**	**09%**
7.1	Body Track, Hand Gesture		
7.2	3D Manus		
7.3	Object Grasp		
8	Introduction of Immersive VR Hardware	**04 hours**	**09%**
8.1	VR Box, HMD		
8.2	CAVE		
8.3	**Data Gloves, Controller.**		
9	**Development Tools and Frameworks in Virtual Reality**	**04 hours**	**09%**
9.1	Frameworks of Software Development Tools in VR		
9.2	Unreal Engine, Unity3D		
9.3	Blender, A-Frame		
10	**Application of AR/VR in D**	**04 hours**	**09%**
10.1	VR Technology in Film & TV Production, In health Care		
10.2	VR Technology in Physical Exercises, Games, Education		
10.3	Demonstration of VR applications		
11	**Discussion over research paper in Area VR/AR**	**04 hours**	**08%**

Course Outcome:

After completion of the course students will be able to

CO1	Describe how AR/VR systems work and list the applications of AR/VR.
CO2	Understand the design and implementation of the hardware that enables AR/VR systems to be built.
CO3	Understand the system of human vision and its implication on perception and rendering
CO4	Explain the concepts of motion and tracking in VR system
CO5	Describe the importance of interaction and audio in VR systems.
CO6	Develop the creativity and designing skill in 3D development.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	-	3		3	-	-	-	-	-	3	-
CO2	-	-	-	-	-	3	-	-	-	-	2	-	3	-
CO3		3	-	2	-	-	-	1	-	3	-	-		-
CO4	3		1	-	-	-	-		-	-	-	-	2	-
CO5	-	-	-	-	-	-	-	-	2		3	-	1	-
CO6	-	-	-	-	-	3	-	-	-	-	-	2	-	-

Recommended Study Material:

❖ **Text Books:**

1. Virtual Reality (The MIT Press Essential Knowledge series) by Samuel Greengard.
2. VIRTUAL REALITY By Steven M. LaValle Cambridge University Press.

❖ **Reference Books:**

1. Virtual Reality with VRTK4: Create Immersive VR Experiences Leveraging Unity3D and Virtual Reality Toolkit By Rakesh Baruah.
2. Virtual Reality (The MIT Press Essential Knowledge series) by Samuel Greengard
3. George Mather, Foundations of Sensation and Perception: Psychology Press; 2 edition, 2009.
4. Peter Shirley, Michael Ashikhmin, and Steve Marschner, Fundamentals of Computer Graphics, A K Peters/CRC Press; 3 edition, 2009.
5. Burdea G. C., Coiffet P., “Virtual Reality Technology”, J. Wiley & Sons, Second Ed., 2003.
6. Watt A., Policarpo F., “3D Games. Real-time Rendering and Software Technology". Addison-Wesley, 2001.

❖ **Web Materials:**

1. http://nptel.ac.in
2. http://msl.cs.uiuc.edu/vr/
3. www.coursera.com
4. http://cgis.utcluj.ro/teaching/

FACULTY OF TECHNOLOGY & ENGINEERING
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CS379: WIRELESS COMMUNICATION AND MOBILE COMPUTING (PE-II)

Credit and Hours:

Teaching Scheme	Theory	Practical	Total	Credit
Hours/week	3	2	5	4
Marks	100	50	150	

Pre-requisite courses:

- Computer Networks
- Modern Networks

Outline of the course:

Sr. No.	Title of the unit	Minimum number of hours
1.	Wireless Communication Fundamentals	03
2.	Telecommunication Systems	12
3.	Wireless LAN	18
4.	Mobile Network Layer	12
5.	Mobile Transport Layer	12
6.	Advanced Mobile Technologies	03

Total hours (Theory): 45 Hrs.

Total hours (Lab): 30 Hrs.

Total hours: 75 Hrs.

Detailed Syllabus:

1.	**Wireless Communication Fundamentals**	**03 hours**	**05%**
1.1	Applications		
1.2	A short history of wireless communication.		
1.3	A market for mobile communications		
1.4	Some open research topics		
1.5	A simplified reference model		
2.	**Telecommunication Systems**	**12 hours**	**21%**
2.1	GSM: Mobile services, System architecture, Radio interface, Protocols, Localization and Calling, Handover, Security, New data services		
2.2	DECT: System architecture, Protocol architecture		
2.3	TETRA, UMTS and IMT–2000		
3.	**Wireless LAN**	**18 Hours**	**28 %**
3.1	Infrared vs radio transmission		
3.2	Infrastructure and ad-hoc network		
3.3	IEEE 802.11: System architecture, Protocol architecture, Physical layer, medium access control layer, MAC management, 802.11a, 802.11b, Newer developments		
3.4	HiperLAN: HiperLAN 1, HiperLAN2		
3.5	Bluetooth: Architecture, Radio layer, Baseband layer, Link Manager Protocol, L2CAP, Security, SDP, Profiles, IEEE 802.15		
4.	**Mobile Network Layer**	**12hours**	**21%**
4.1	Mobile IP		
4.2	Dynamic Host Configuration Protocol		
4.3	Mobile ad–hoc networks: Routing, Destination sequencedistance vector, Dynamic source routing		
5.	**Mobile Transport Layer**	**12 hours**	**21%**
5.1	Traditional TCP: Congestion control, Slow start, Fast retransmit/fast recovery, Implications of mobility		
5.2	Classical TCP improvements: Indirect TCP, Snooping TCP, Mobile TCP, Fast retransmit/fast recovery, Transmission/time- out freezing, Selective retransmission, Transaction-oriented TCP		
5.3	TCP over 2.5/3G wireless networks		
6.	**Advanced Mobile Technologies**	**03 hours**	**04%**

6.1	Introduction of 4G, 5G and other advanced mobile technologies	
6.2	The architecture of future networks	

Course Outcome:

After completion of the course, Students will be able to:

CO1	Demonstrate the principles and theories of mobile computing technology
CO2	Characterize the infrastructure and technology of mobile computing technologies
CO3	List applications in various domains offered to the public, employees and businesses through mobile computing technology
CO4	Describes the current technologies to build potential future of mobile computing technologies and applications
CO5	Identify the potential future of mobile computing technologies and applications

Course Articulation Matrix:

	PO01	PO02	PO03	PO04	PO05	PO06	PO07	PO08	PO09	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	1	2	1	-	-	-	-	-	-	-	-	-
CO3	1	2	2	-	2	-	-	-	-	-	1	-
CO4	-	3	1	1	-	-	1	-	-	-	-	-
CO5	-	3	1	1	-	-	1	-	-	-	-	-

Recommended Study Material:

- **Text Books:**
  1. Jochen Schiller, “Mobile Communications”, PHI/Pearson Education, Second Edition, 2003
  2. “Mobile Computing: Technology, Applications and Service Creation” by Asoke K Talukder and Roopa R Yavagal, TMH,ISBM: 0-07-058807-4

- **Reference Books:**

1. William Stallings, “Wireless Communications and Networks”, PHI/Pearson Education, 2002.
2. Kaveh Pahlavan, Prasanth Krishnamoorthy, “Principles of Wireless Networks”,
3. PHI/Pearson Education, 2003.
4. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, “Principles of

5. Mobile Computing", Springer, New York, 2003.
6. Hazysztof Wesolowshi, "Mobile Communication Systems", John Wiley and Sons Ltd, 2002
7. Research papers from IEEE, Springer etc.

❖ **Reference Links/ e-content:**

1. www.ietf.org – For drafts
2. www.ieee.org – For standards and technical research papers

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CS374: MODERN NETWORKS (PE-II)

Credits and Hours:

Teaching Scheme	Theory	Practical	Tutorial	Total	Credit
Hours/week	3	2	0	5	4
Marks	100	50	0	150	

Pre-requisite courses:

- Data Communication

Outline of the course:

Sr. No.	Title of the unit	Minimum number of hours
1	Elements of Modern Networking	07
2	Requirements and Technology	10
3	SDN: Background and Motivation	10
4	SDN Data Plane and OpenFlow	05
5	SDN Control Plane&SDN Application Plane	13

Total hours (Theory): 45

Total hours (Lab): 30

Total hours: 75

Detailed Syllabus:

1.	Elements of Modern Networking	**07 Hours**	**16%**
	The Networking Ecosystem, Example Network Architectures, Ethernet, Wi-Fi, 4G/5G Cellular, Network Convergence, Unified Communications		
2.	Requirements and Technology	**10 Hours**	**22%**
	Types of Network and Internet Traffic, Demand: Big Data, Cloud Computing, and Mobile Traffic, Requirements: QoS and QoE, Routing, Congestion Control, SDN and NFV, Modern Networking Elements		
3.	SDN: Background and Motivation	**10 Hours**	**22%**
	Evolving Network Requirements, The SDN Approach, SDN- and NFV-Related Standards		
4.	SDN Data Plane and OpenFlow	**05 Hours**	**11%**
	SDN Data Plane, OpenFlow Logical Network Device, OpenFlow Protocol		
5.	SDN Control Plane&SDN Application Plane	**13 Hours**	**29%**
	SDN Control Plane Architecture, ITU-T Model, OpenDaylight, REST, Cooperation and Coordination Among Controllers, SDN ApplicationPlane Architecture, Network Services Abstraction Layer, Traffic Engineering, Measurement and Monitoring, Security, Data Center Networking, Mobility and Wireless, Information-Centric Networking		

Course Outcome (COs):

At the end of the course, the students will be able to

CO1	Measure and Analyse different network parameters.
CO2	Understand working of application layer protocols.
CO3	Understand and Analyse transport layer services and its impacts on data rate.
CO4	Understand basic functionality of network layer devices.
CO5	Understand functionality of multiple access protocol.
CO6	Analyse traditional network and get familiar with Software defined networking.

Course Articulation Matrix:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	3	1	-	-	-	-	-	-	-	2	-
CO2	3	3	1	3	1	-	-	-	-	-	-	-	1	-
CO3	3	3	1	3	1	-	-	-	-	-	-	-	1	-
CO4	3	3	1	3	1	-	-	-	-	-	-	-	1	-
CO5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	3	-	-	-	-	-	-	-	-	-

Enter correlation levels 1, 2 or 3 as defined below:

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)If

there is no correlation, put "-"

Recommended Study Material:

- **Text Books:**
  1. William Stallings, Florence Agboma, Sofiene Jelassi "Foundations of Modern Networking, SDN, NFV, QoE, IoT, and Cloud"; Pearson Publisher, ISBN-13: 978-0-13-417539-3
  2. Behrouz A. Forouzan, "TCP/IP Protocol Suite.", Fourth Reprint, 2003;Tata McGraw Hill ISBN: 0-07-049551-3
- **Reference Books:**
  1. Douglas E. Comer and David L. Stevens, "Internetworking with TCP/IP Volume- 2, Design, Implementation and Internals ", Prentice Hall
- **Web Materials:**

1. https://www.sdxcentral.com/
2. https://sdn.ieee.org/standardization
3. https://trac.ietf.org/trac/irtf/wiki/sdnrg
4. https://www.opennetworking.org/sdn-resources/openflow
5. https://www.opendaylight.org/
6. https://www.opennetworking.org/