Faculty of Science and Technology

Savitribai Phule Pune University

Maharashtra, India

http://unipune.ac.in

Honours* in Virtual Reality and Augmented Reality

Board of Studies

(Computer Engineering)

(with effect from A.Y. 2020-21)

Savitribai Phule Pune University

Honours* in Virtual Reality and Augmented Reality

With effect from 2020-21

Year & Semester	Course Code and Course Title	Teaching Scheme Hours / Week			Examination Scheme and Marks						Credit Scheme		
		Theory	Tutorial	Practical	Mid-Semester	End-Semester	Term work	Practical	Presentation	Total Marks	Theory / Tutorial	Practical	Total Credit
TE & V	Virtual Reality	04	--	--	30	70	--	--	--	100	04	--	04
	Virtual Reality Laboratory	--	--	02	--	--	50	--	--	50	--	01	01
	Total	04	-	02	100		50	-	-	150	04	01	05
										Total Credits =		**05**	
TE & VI	Augmented Reality	04	--	--	30	70	--	--	--	100	04	--	04
	Total	04	-	-	100		-	-	-	100	04	-	04
										Total Credits =		04	
BE & VII	Virtual Reality in Game Development	04	--	--	30	70	--	--	--	100	04	--	04
	Virtual Reality Game Development Laboratory	--	--	02	--	--	50	--	--	50	--	01	01
	Total	04	-	02	100		50	-	-	150	04	01	05
										Total Credits =		05	
BE & VIII	Application Development using Augmented Reality and Virtual Reality	04	-	--	30	70	--	--	--	100	04	--	04
	Seminar	--	02	--	--	--	-	--	50	50	02	--	02
	Total	04	-	02	100		-		50	150	06	-	06
										Total Credits =06			

Total Credit for Semester V+ VI+ VII+ VIII = 20

*** <u>To be offered as Honours for Major Disciplines as–</u>**

1. Computer Engineering

2.Electronics and TelecommunicationEngineering

3.Electronics Engineering

<u>For any other Major Disciplines which is not mentioned above, it may be offered as Minor Degree.</u>

Reference: https://www.aicte-india.org/sites/default/files/APH%202020_21.pdf / page 99-100

Savitribai Phule Pune University
Honours* in Virtual Reality and Augmented Reality
Third Year of Engineering (Semester V)
Virtual Reality

Teaching Scheme:	Credit	Examination Scheme:
THEORY: 04 Hours/Week	**04**	**Mid_Semester(TH): 30 Marks** **End_Semester(TH): 70 Marks**

Companion Course, if any: Virtual Reality Lab

Course Objectives:

- This course is designed to give historical and modern overviews and perspectives on virtual reality.
- It describes the fundamentals of sensation, perception, technical and engineering aspects of virtual reality systems.

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Describe how VR systems work and list the applications of VR.
CO2: Understand the design and implementation of the hardware that enables VR systems tobe built.
CO3: Understand the system of human visionand its implication on perception and rendering.
CO4: Explain the concepts of motion and tracking in VR systems.
CO5: Describe the importance of interaction and audio in VR systems.

#Exemplar/Case Studies-Elaborated examples/Case Studies are included at the end of each unit to explore how the learned topics apply to real world situations and need to be explored so as to assist students to increase their competencies, inculcating the specific skills, building the knowledge to be applicable in any given situation along with an articulation. One or two sample exemplars or case studies are included for each unit; instructor may extend the same with more. **Exemplar/Case Studies** may be assigned as self-study by students and to be excluded from theory examinations.

Course Contents

Unit I	Introduction to Virtual Reality	(08 Hours)
Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.		
#Exemplar/Case Studies	Study the use of Virtual Reality at NASA	
Unit II	**Representing the Virtual World**	**(08 Hours)**
Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR		
#Exemplar/Case Studies	GHOST (General Haptics Open Software Toolkit) software development toolkit.	
Unit III	**The Geometry of Virtual Worlds &The Physiology of Human Vision**	**(08 Hours)**
Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.		
#Exemplar/Case Studies	Sweeping coverage of eye movements	

Unit IV	Visual Perception & Rendering	(08 Hours)
Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates		
#Exemplar/Case Studies	Automatic stitching of panoramas in Virtual Reality	
Unit V	**Motion & Tracking**	**(08 Hours)**
Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies		
#Exemplar/Case Studies	A virtual Study Use Case- NICE, An Educational Experience	
Unit VI	**Interaction & Audio**	**(08 Hours)**
Interaction - Motor Programs and Remapping, Locomotion, Manipulation, Social Interaction. Audio -The Physics of Sound, The Physiology of Human Hearing, Auditory Perception, Auditory Rendering.		
#Exemplar/Case Studies	Side effects of using VR systems/ VR sickness.	

Learning Resources

Text Books:

1. M. LaValle, " Virtual Reality, Steven", Cambridge University Press, 2016
2. William R Sherman and Alan B Craig, " Understanding Virtual Reality", Interface, Application and Design, , (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Alan B Craig, William R Sherman and Jeffrey D Will, "Developing Virtual Reality Applications: Foundations of Effective Design", Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Inter science, India, 2003.

e-Books:

- http://lavalle.pl/vr/book.html

MOOC Courses:

- https://nptel.ac.in/courses/106/106/106106138/
- https://www.coursera.org/learn/introduction-virtual-reality

Savitribai Phule Pune University
Honours* in Virtual Reality and Augmented Reality
Third Year of Engineering (Semester V)
Virtual Reality Laboratory

Teaching Scheme	Credit	Examination Scheme
Practical: 02 Hours/Week	**01**	**Term Work: 50 Marks**

Companion Course, if any: **Virtual Reality**

Course Objectives:

The objective of this course is to explore the concepts of Virtual reality and develop 3D virtual environment.

Course Outcomes:

On completion of the course, learner will be able to–

CO1: Create and deploy a VR application.
CO2: understand the physical principles of VR
CO3: Create a comfortable, high-performance VR application using Unity.
CO4: Identify, examine and develop software that reflects fundamental techniques for the design and deployment of VR experiences.

Guidelines for Laboratory Conduction

- **Lab Assignments:** Following is list of suggested laboratory assignments for reference. Laboratory Instructors may design suitable set of assignments for respective course at their level. Beyond curriculum assignments and mini-project may be included as a part of laboratory work. The instructor may set multiple sets of assignments and distribute among batches of students. It is appreciated if the assignments are based on real world problems/applications. The Inclusion of few optional assignments that are intricate and/or beyond the scope of curriculum will surely be the value addition for the students and it will satisfy the intellectuals within the group of the learners and will add to the perspective of the learners. For each laboratory assignment, it is essential for students to draw/write/generate flowchart, algorithm, test cases, mathematical model, Test data set and comparative/complexity analysis (as applicable). Batch size for practical and tutorial may be as per guidelines of authority.
- **Term Work**–Term work is continuous assessment that evaluates a student's progress throughout the semester. Term work assessment criteria specify the standards that must be met and the evidence that will be gathered to demonstrate the achievement of course outcomes. Categorical assessment criteria for the term work should establish unambiguous standards of achievement for each course outcome. They should describe what the learner is expected to perform in the laboratories or on the fields to show that the course outcomes have been achieved. It is recommended to conduct internal monthly practical examination as part of continuous assessment.
- **Assessment:** Students' work will be evaluated typically based on the criteria like attentiveness, proficiency in execution of the task, regularity, punctuality, use of referencing, accuracy of language, use of supporting evidence in drawing conclusions, quality of critical thinking and similar performance measuring criteria.
- **Laboratory Journal-** Program codes with sample output of all performed assignments are to be submitted as softcopy. Use of DVD or similar media containing students programs maintained by Laboratory In-charge is highly encouraged. For reference one or two journals may be maintained with program prints in the Laboratory. As a conscious effort and little contribution towards Green IT and environment awareness, attaching printed papers as part of write-ups and program listing to journal may be avoided. Submission of journal/ term work in the form of softcopy is desirable and appreciated.

Suggested List of Laboratory Experiments/Assignments (Implementation of each problem statement is mandatory.) (Use suitable programming language/Tool for implementation)	
Sr. No.	**Group A**
1.	Installation of Unity and Visual Studio, setting up Unity for VR development, understanding documentation of the same.
2.	Demonstration of the working of HTC Vive, Google Cardboard, Google Daydream and Samsung gear VR.
3.	Develop a scene in Unity that includes: i. A cube, plane and sphere, apply transformations on the 3 game objects. ii. Add a video and audio source.
4.	Develop a scene in Unity that includes a cube, plane and sphere. Create a new material and texture separately for three Game objects. Change the colour, material and texture of each Game object separately in the scene. Write a C# program in visual studio to change the colour and material/texture of the game objects dynamically on button click.
5.	Develop a scene in Unity that includes a sphere and plane. Apply Rigid body component, material and Box collider to the game Objects. Write a C# program to grab and throw the sphere using vr controller.
6.	Develop a simple UI (User interface) menu with images, canvas, sprites and button. Write a C# program to interact with UI menu through VR trigger button such that on each successful trigger interaction display a score on scene.
7.	Create an immersive environment (living room/ battlefield/ tennis court) with only static game objects. 3D game objects can be created using Blender or use available 3D models.
8.	Include animation and interaction in the immersive environment created in Assignment 7.
	Mini-Projects/ Case Study
9.	Create a virtual environment for any use case. The application must include at least 4 scenes which can be changed dynamically, a good UI, animation and interaction with game objects. (e.g. VR application to visit a zoo)