

Savitribai Phule Pune University
Board of Studies – Mechanical and Automobile Engineering
Undergraduate Program – Final Year Automation and Robotics (2019 pattern)

402045E: Augmented Reality and Virtual Reality					
Teaching Scheme		Credits		Examination Scheme	
Theory	3 Hrs./Week	Theory	3	In-Semester	30 Marks
				End-Semester	70 Marks
Prerequisites: Mathematics, Physics, Programming and Problem Solving, Engineering Graphics, Solid Modeling and Drafting, Numerical & Statistical Methods, Mechatronics, Artificial Intelligence & Machine Learning, Computer Aided Engineering					
Course Objectives: 1. Learn the fundamental Computer Vision, Computer Graphics and Human-Computer interaction Techniques related to VR/AR 2. Review the Geometric Modeling Techniques 3. Review the Virtual Environment 4. Discuss and Examine VR/AR Technologies 5. Use of various types of Hardware and Software in Virtual Reality systems 6. Simulate and Apply Virtual/Augmented Reality to varieties of Applications					
Course Outcomes: On completion of the course the learner will be able to; CO1. UNDERSTAND fundamental Computer Vision, Computer Graphics and Human-Computer Interaction Techniques related to VR/AR CO2. UNDERSTAND Geometric Modeling Techniques CO3. UNDERSTAND the Virtual Environment CO4. ANALYZE and EVALUATE VR/AR Technologies CO5. APPLY various types of Hardware and Software in Virtual Reality systems CO6. DESIGN and FORMULATE Virtual/Augmented Reality Applications					
Course Contents					
Unit 1	Introduction to Virtual Reality (VR)				
Virtual Reality and Virtual Environment, Computer graphics, Real time computer graphics, Flight Simulation, Virtual environment requirement, benefits of virtual reality, Historical development of VR, Scientific Landmark					
Unit 2	Computer Graphics and Geometric Modelling				
The Virtual world space, positioning the virtual observer, the perspective projection, human vision, stereo perspective projection, Color theory, Conversion From 2D to 3D, 3D space curves, 3D boundary representation, Simple 3D modelling, 3D clipping, Illumination models, Reflection models, Shading algorithms, Geometrical Transformations: Introduction, Frames of reference,					

Modelling transformations, Instances, Picking, Flying, Scaling the VE, Collision detection	
Unit 3	Virtual Environment
Input/Output Devices: Input (Tracker, Sensor, Digital Gloves, Movement Capture, Video-based Input, 3D Menus & 3D Scanner, etc.), Output (Visual/Auditory/Haptic Devices) Generic VR system: Introduction, Virtual environment, Computer environment, VR technology, Model of interaction, VR Systems, Animating the Virtual Environment: Introduction, The dynamics of numbers, Linear and Nonlinear interpolation, the animation of objects, linear and non-linear translation, shape & object in between, free from deformation, particle system Physical Simulation: Introduction, Objects falling in a gravitational field, Rotating wheels, Elastic collisions, projectiles, simple pendulum, springs, Flight dynamics of an aircraft	
Unit 4	Augmented Reality (AR)
Taxonomy, Technology and Features of Augmented Reality, AR Vs VR, Challenges with AR, AR systems and functionality, Augmented Reality Methods, Visualization Techniques for Augmented Reality, Enhancing interactivity in AR Environments, Evaluating AR systems	
Unit 5	Development Tools and Frameworks
Human factors: Introduction, the eye, the ear, the somatic senses Hardware: Introduction, sensor hardware, Head-coupled displays, Acoustic hardware, Integrated VR systems Software: Introduction, Modelling virtual world, Physical simulation, VR toolkits, Introduction to VRML	
Unit 6	AR / VR Applications
Introduction, Engineering, Entertainment, Science, Training, Game Development	
Books and other resources	
Text Books: <ol style="list-style-type: none"> 1. Coiffet, P., Burdea, G. C., (2003), "Virtual Reality Technology," Wiley-IEEE Press, ISBN: 9780471360896 2. Schmalstieg, D., Höllerer, T., (2016), "Augmented Reality: Principles & Practice," Pearson, ISBN: 9789332578494 3. Norman, K., Kirakowski, J., (2018), "Wiley Handbook of Human Computer Interaction," Wiley-Blackwell, ISBN: 9781118976135 4. LaViola Jr., J. J., Kruijff, E., McMahan, R. P., Bowman, D. A., Poupyrev, I., (2017), "3D User Interfaces: Theory and Practice," Pearson, ISBN: 9780134034324 5. Fowler, A., (2019), "Beginning iOS AR Game Development: Developing Augmented Reality Apps with Unity and C#," Apress, ISBN: 9781484246672 6. Hassanien, A. E., Gupta, D., Khanna, A., Slowik, A., (2022), "Virtual and Augmented Reality for Automobile Industry: Innovation Vision and Applications," Springer, ISBN: 9783030941017 	

References Books:

1. Craig, A. B., (2013), "Understanding Augmented Reality, Concepts and Applications," Morgan Kaufmann, ISBN: 9780240824086
2. Craig, A. B., Sherman, W. R., Will, J. D., (2009), "Developing Virtual Reality Applications, Foundations of Effective Design," Morgan Kaufmann, ISBN: 9780123749437
3. John Vince, J., (2002), "Virtual Reality Systems," Pearson, ISBN: 9788131708446
4. Anand, R., "Augmented and Virtual Reality," Khanna Publishing House
5. Kim, G. J., (2005), "Designing Virtual Systems: The Structured Approach", ISBN: 9781852339586
6. Bimber, O., Raskar, R., (2005), "Spatial Augmented Reality: Merging Real and Virtual Worlds," CRC Press, ISBN: 9781568812304
7. O'Connell, K., (2019), "Designing for Mixed Reality: Blending Data, AR, and the Physical World," O'Reilly, ISBN: 9789352138371
8. Sanni Siltanen, S., (2012), "Theory and applications of marker-based augmented reality," Julkaisija –Utgivare Publisher, ISBN: 9789513874490

Web References:

1. Manivannan, M., (2018), "Virtual Reality Engineering," IIT Madras, <https://nptel.ac.in/courses/121106013>
2. Misra, S., (2019), "Industry 4.0: Augmented Reality and Virtual Reality," IIT Kharagpur, <https://www.youtube.com/watch?v=zLMgdYI82IE>
3. Dube, A., (2020), "Augmented Reality – Fundamentals and Development," NPTEL Special Lecture Series, <https://www.youtube.com/watch?v=MGuSTAqlZ9Q>
4. <http://cambum.net/course-2.htm>