Shirpur Education Society's

R. C. Patel Institute of Technology, Shirpur

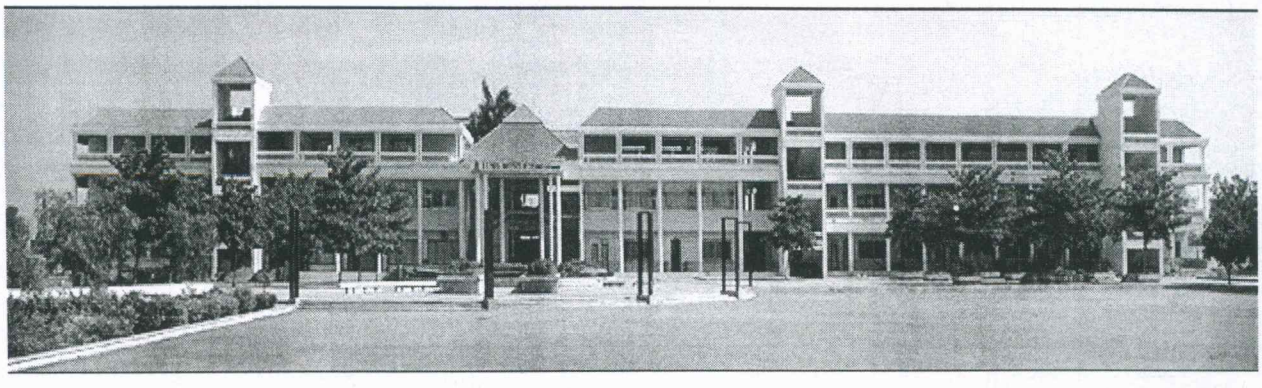
(An Autonomous Institute)

Course Structure and Syllabus

Honors Degree Program in Immersive Technologies

Artificial Intelligence and Machine Learning

With effect from Year 2024-25



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Honors Degree Program in Immersive Technologies (w.e.f. 2024-25)

Sr	Course Category	Course Code	Course Title	Teaching Scheme			Evaluation Scheme					Total	Credit	
							Continuous Assessment (CA)							
							TA	Term Test 1 (TT1)	Term Test 2 (TT2)	Average of (TT1 & TT2)	ESE			
				L	T	P	[A]			[B]	[C]	[A+B+C]		
Sem-III														
1	H1	RCP23ACH1301	Computer Graphics and Virtual Reality	4			25	15	15	15	60	100	4	4
Sem-IV														
2	H1	RCP23ALH1401	C# Programming Laboratory			4	25				25	50	2	2
Sem-V														
3	H1	RCP23ACH1501	Augmented Reality and Mixed Reality	3			25	15	15	15	60	100	3	4
	H1	RCP23ALH1501	Augmented Reality and Mixed Reality Laboratory			2	25				25	50	1	
Sem-VI														
4	H1	RCP23ACH1601	Game Design and Gamification	3			25	15	15	15	60	100	3	4
	H1	RCP23ALH1601	Game Design and Gamification Laboratory			2	25				25	50	1	
Sem-VIII														
5	H1	RCP23ACH1801	Metaverse	4			25	15	15	15	60	100	4	4
			Total	14		8	175			60	315	550	18	

Prepared by: Ms. S. P. Salunkhe

Prof. Dr. U. M. Patil
BOS Chairman

Prof. Dr. P. J. Deore
Dean Academics/Dy. Director

Checked by: Dr. P. S. Sanjekar

Prof. S. P. Shukla
C.O.E.

Prof. Dr. J. B. Patil
Director

R. C. Patel Institute of Technology, Shirpur Autonomous

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Sem-III														
1	H1	RCP23ACH1301	Computer Graphics and Virtual Reality	4			25	15	15	15	60	100	4	4

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Sem-IV														
1	H1	RCP23ALH1401	C# Programming Laboratory			4	25				25	50	2	2

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Auto

Semester - III

Computer Graphics and Virtual Reality (RCP23ACH1301)

Teaching Scheme
Lectures : 04 Hrs./week
Credits : 04

Examination Scheme
Term Test : 15 Marks
Teacher Assessment : 25 Marks
End Sem Exam : 60 Marks
Total Marks : 100 Marks

Prerequisite: Basic Mathematics, C Programming

Course Objectives:

1. The course intends to introduce the students to fundamental knowledge and basic technical-competence in the field of computer graphics.
2. The course will introduce the basic concepts of Computer graphics.
3. The course will also acquaint the student with algorithms for generating and rendering graphical models, mathematics for geometrical transformations.
4. The course will also enable students to apply various techniques of projections, shading, illumination and lighting to graphical models.

CO	Course Outcomes	Blooms Level	Blooms Description
CO1	Implement various algorithms to generate lines, circles, curves, fractals, and polygons and colour them.	L3	Apply
CO2	Apply 2D and 3D Transformations, viewing, and projections on a given object	L3	Apply
CO3	Understand the concept of colour models, lighting, shading, and hidden surface elimination.	L2	Understand
CO4	Understand the fundamentals of Animation, Virtual reality, the related technologies, and describe applications of Virtual Reality.	L2	Understand

Course Contents

Unit-I — 10 Hrs.

Introduction to Computer graphics and Output Primitives:

Graphics primitives-pixel, resolution, aspect ratio, frame buffer, refresh rates, DisplayDevices, Bitmap and Vector based graphics, Overview of Coordinate system.Scan Conversion of - point, line using Digital differential analyser & Bresenham's algorithm, circle using midpoint approach and Bresenham.

Polygons: Concave, Convex, Inside/Outside Test Area Filling: Scan line Polygon Fill Algorithm, Boundary Fill and Flood Fillalgorithm

Unit-II — 10 Hrs.

Two Dimensional and 3D Transformations and Projections: 2D: Basic Geometrical 2D transformations- Translation, Rotation, Scaling, Reflection, Shear, their homogeneous Matrix representation, Viewing Pipeline, View Coordinate reference frame, Window to Viewport Transformation, Point Clipping, Line clipping: Cohen Sutherland Algorithm,Liang Barsky Algorithms, Polygon Clipping: Sutherland Hodgeman PolygonClipping and Weiler Atherton, Text Clipping. 3D: Three Dimensional Transformations: Translation, Rotation, Scaling, Rotation about an arbitrary axis Three-Dimensional Viewing Pipeline, Viewing Transformation, Projections: Parallel (Oblique and Orthographic), Perspective

Unit-III — 10 Hrs.

Light, Color, Shading and Hidden Surfaces: Properties of Light, Color Models - CIE chromaticity diagram, RGB, HSV, CMY Illumination Models, Phong Model, combined diffuse and specular reflections with multiple light sources, Warn Model Shading Algorithms: Introduction to Rendering, Halftone, Gouraud and Phong Shading Hidden Surfaces: Introduction, Back face detection and removal, Algorithms: z buffer, Painter's algorithm, Area Subdivision (Warnock).

Unit-IV — 08 Hrs.

Curves: Introduction to curves, interpolation and approximation, BlendingFunction, Bezier and B-spline curves

Fractals: Introduction, Classification, Fractal Generation- Snowflake, Sierpinski Gasket, Koch Curve, Cantor Middle-Thirds Set, Hilbert Curve,Applications of Fractals.

Unit-V — 08 Hrs.

Animation: Animation Sequence, Animation Motion Control Methods, Morphing, Warping (only Mesh Warping).

Virtual Reality: Basic Concepts, Classical Components of VR System,Types of VR Systems, Three-

Dimensional Position Trackers, Navigation andManipulation Interfaces, Gesture Interfaces, Graphical Display, Sound displays, and Haptic Feedback. Input Devices, Graphical Rendering Pipeline,Haptic Rendering Pipeline, Open GL rendering pipeline. Applications of Virtual Reality.

Unit-VI 06 Hrs.

Geometric Modeling: Virtual Object Shape, Object Visual Appearance. Kinematics Modeling: Object Position, Transformation Invariants, Object Hierarchies, Physical Modeling: Collision Detection, Surface Deformation, Force Computation. Behavior Modeling.

Text Books:

1. "Reality+: Virtual Worlds and the Problems of Philosophy", WW Norton, ISBN 13- 978-1324050346, 2023.
2. "Virtual and Augmented Reality", Khanna Book Publishing, ISBN 13 978-9390779000, 2021.
3. Donald Hearn and M. Pauline Baker, "Computer Graphics C Version" , 2nd Edition, Pearson Education 2018.
4. Rajesh K. Maurya, "Computer Graphics", Wiley India Publication, 2018.
5. "Foundations of 3D Computer Graphics", MIT Press, ISBN 9780262017350 (ISBN10:0262017350), 2012.

Reference Books:

1. "Multimedia Computing Systems and Virtual Reality (Innovations in Multimedia, Virtual Reality and Augmentation)", Taylor & Francis Ltd, ISBN: 978-1032048239, 2022.
2. Samit Bhattacharya, "Computer Graphics", Oxford Publication, 2018.
3. "Virtual & Augmented Reality For Dummies", Wiley, 2018
4. "Computer Graphics", Steven Harrington,McGraw Hill, 2017.
5. F.S. Hill, Stephen M. Kelley, "Computer Graphics using Open GL", Prentice Hall, 2008.

Online Resources:

1. Computer Graphics - Course (nptel.ac.in)
2. Interactive Computer Graphics — Coursera
3. Introduction to Computer Graphics - Open Textbook Library (umn.edu)
4. https://ocw.mit.edu/courses/6-837-computer-graphics-fall-2012
5. Free Graphics Tutorial - Computer Graphics — Udemy

6. No Slide Title (stonybrook.edu)

Evaluation Scheme:

Theory :

Continuous Assessment (A):

Subject teacher will declare Teacher Assessment criteria at the start of semester.

Continuous Assessment (B):

1. Two term tests of 15 marks each will be conducted during the semester.
2. Average of the marks scored in both the tests will be considered for final grading.

End Semester Examination (C):

1. Question paper based on the entire syllabus, summing up to 60 marks.
2. Total duration allotted for writing the paper is 2 hrs.

Semester - IV

C# Programming Laboratory (RCP23ALH1401)

Practical Scheme
Practical : 04 Hrs./week
Credit : 02

Examination Scheme
Teacher Assessment : 25 Marks
End Sem Exam : 25 Marks
Total : 50 Marks

Prerequisite: Object-oriented programming.

Course Objectives:

1. Understand the C# fundamentals tc build robust VR applications.
2. Discover the proficiency in Unity Engine to create interactive VR experiences.
3. Understand VR concepts and technologies to design immersive virtual environments.
4. Develop practical VR projects to apply learned skills and showcase expertise.

COs	Course Outcomes	Blooms Level	Blooms Description
CO1	Understand the foundation in C# programming for VR development.	L2	Understand
CO2	Discover Unity Engine and its VR tools.	L3	Apply
CO3	Analyze complex problems and break them into manageable tasks for immersive VR experiences.	L4	Analyze
CO4	Apply optimization in VR applications for performance and user experience.	L3	Apply

Course Contents

Unit-I Introduction to C# and .NET Framework — 08 Hrs.

Variables, data types, and operators, Control flow statements (if-else, switch-case, loops), Arrays and collections (lists, dictionaries), Object-Oriented Programming (OOP): Classes, objects, and inheritance, Encapsulation, polymorphism, and abstraction, Interfaces and abstract classes, Methods and Functions: Defining, calling, and overloading methods Parameters and return values, Exception Handling: Try-catch-finally blocks, Custom exceptions.

Unit-II Unity Engine Basics — 10 Hrs.

Unity Editor: Navigating the Unity interface, Creating and managing projects, Importing assets (models, textures, scripts), Game Objects and Hierarchy: Creating and organizing game objects, Parent-child relationships Components: Transform, Renderer, Collider, Rigid body, and other components Scripting in Unity: Writing C# scripts for Unity, Interacting with Unity objects and components, Using Unity's built-in APIs (e.g., Input, Physics).

Unit-III Unity for Virtual Reality — 10 Hrs.

VR & Types of VR devices (HMDs), Use cases and applications of VR Unity and VR: Setting up a VR project in Unity, Configuring player settings for VR platforms, Using VR input devices (controllers, hand tracking), XR Interaction Toolkit: Understanding the XR Interaction Toolkit. Creating interactive experiences using the toolkit, Implementing locomotion, object manipulation, and other interactions.

Unit-IV Advanced VR Techniques, Spatial Mapping, and World Tracking — 10 Hrs.

Understanding spatial mapping and world-tracking concepts Using a Foundation for spatial mapping and object placement, Implementing persistent experiences, and Advanced Rendering Techniques: Shader programming for VR, Post-processing effects (bloom, depth of field, motion blur), Optimizing rendering performance for VR, User Experience Design for VR: Designing intuitive and immersive user interfaces, Considering user comfort and fatigue, Testing and iterating on VR experiences

Unit-V VR Project Development, Project Planning, and Design — 08 Hrs.

Defining project scope and goals, Creating a project timeline and milestones. Designing user experiences and interactions, Prototyping and Iteration: Rapid prototyping and testing, Iterative development process, Deployment and Distribution: Packaging and distributing VR applications, Deploying to VR platforms (SteamVR, Oculus Store)

Unit-VI VR Networking and Multiplayer Network Programming Basics 08 Hrs.

Client-server architecture, Networking protocols (TCP/IP, UDP), Unity Networking and Mirror, Multiplayer VR Game Development: Synchronizing player movement and actions, Handling input and output latency, Optimizing network performance.

Suggested List of Experiments:

1. Case Study- on any one topic
    - The rhythm-based game where players swing lightsabers to match the rhythm of the music.
    - Story-driven, single-player adventure game set in the Half-Life universe.
    - Game that allows players to catch Pokémon in the real world.
2. Create a console application that generates a random number and prompts the user to guess it. Provide feedback on each guess.
3. Develop a text-based adventure game with multiple choices and outcomes.
4. Create a class hierarchy for shapes (e.g., Circle, Rectangle, Triangle) and implement methods to calculate area and perimeter
5. Write a program to read a text file and count the number of words, lines, and characters.
6. Create a 2D platformer game with a player character, platforms, and enemies. Implement player movement, jumping, and collision detection.
7. Develop a 3D first-person shooter with player movement, weapon mechanics, and enemy AI.
8. Create a simple VR scene with a 3D object that the user can interact with using VR controllers.
9. Implement teleportation locomotion in a VR scene, allowing the user to move around by selecting destination points.
10. Create an AR application that allows users to place virtual objects on real-world surfaces using spatial mapping.
11. Develop a multiplayer VR game where multiple players can interact with each other in a shared virtual environment.
12. Mini Project

Any other experiment based on syllabus will be included, which would help the learner to apply the concept learnt.

Text Books:

1. Dr. Richa Handa, "C# .NET Framework Programming Book For Student — Coding Language", Richa Handa Publisher, 2023.
2. Mark J. Price, "C# 10 and .NET 6 - Modern Cross-Platform Development", Packt Publication, 2022.
3. Harrison Ferrone, "Learning C# by Developing Games with Unity", 7^{th} Edition, Packt Publication, 2022.

Reference Books:

1. Mohamed Essam, "Mastering Unity Game Development with C#: Harness the full potential of Unity 2022 game development using C#", Packet Publications, 2024.
2. Sebastiano M. Cossu, "Beginning Game AI with Unity: Programming Artificial Intelligence with C# Perfect", Springer Publication, 2022.
3. David Baron, "Game Development Patterns with Unity 2021", 2^{nd} Edition, Packet Publications, 2021.
4. Jonathan Linowes, "Unity Virtual Reality Projects: Explore the World of Virtual Reality by Building Immersive and Fun VR Projects Using Unity", 3^{rd} Edition, Packt Publications, 2015.

Online References:

1. https://www.w3schools.com/cs/index.php
2. https://www.codecademy.com/learn/learn-c-sharp
3. https://www.udemy.com/course/unityrpg/?couponCode=DIWALIMT102824
4. https://www.udemy.com/course/the-ultimate-guide-to-game-development-with-unity/?couponCode=DIWALIMT102824

Evaluation Scheme:

Laboratory:

Continuous Assessment (A):

Laboratory work will be based on RCP23ALH1401. The distribution of marks for term work shall be as follows:

1. Performance in Experiments: 05 Marks
2. Journal Submission: 05 Marks
3. Viva-voce: 05 Marks
4. Subject Specific Lab Assignment/Case Study: 10 Marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

End Semester Examination (C):

Oral/ Practical examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.