NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	BTech CSE, Integrated BTech (CSE)-MBA, BTech CSE (Artificial Intelligence & Machine Learning)
Course Code:	XXXX
Course Title:	Augmented and Virtual Reality
Course Type:	Department Elective-II
Year of Introduction:	2025-26

L	T	Practical Component				C
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Course Learning Outcomes (CLO):

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

1. apply the AR/VR development approaches to build AR/VR applications (BL3)
2. differentiate between the AR/VR/MR/XR concepts (BL4)
3. evaluate the usability of AR/VR applications and critique their use of AR/VR capabilities (BL5)
4. design AR/VR applications using state-of-the-art tools and technologies. (BL6)

Unit	Contents	Teaching Hours (Total 45)
Unit-I	**Introduction to Immersive Technologies:** history of virtual reality, virtuality and immersion, a brief history of immersive technologies and their need in today's scenario, VR technology, the components of a VR system, the difference between virtual reality, augmented reality, mixed reality and XR, various AR/VR development platforms and devices	03
Unit-II	**Human Perception, Cognition, Physiology and Psychology:** the human systems: visual, auditory, and vestibular, Human physiology and psychology: adaptation, ergonomics, ethics, scientific concerns, VR health and safety issues: effects of VR simulations on users, guidelines for proper VR usage and user-centered design, user experience and an ethical code of conduct.	04
Unit-III	**Motion Trackers, Navigation Trackers, and Interfaces:** trackers: position and motion trackers, tracker performance parameters, inertial and hybrid trackers – head-mounted display trackers, magnetic trackers, optical - active and passive trackers, ultrasonic trackers, navigation and manipulation interfaces: tracker-based navigation/manipulation interfaces, three-dimensional probes and controllers, data gloves and introduction to gesture interfaces.	08
Unit-IV	**Areas for immersive reality applications and computing platforms:** entertainment, education, medical, industrial, military,	05

	training, and consumer research. Use-cases, applications, and production pipelines: from sensing to rendering, computing platforms: standalone, mobile, and high-end immersive computing platforms.	
Unit-V	**3D Rendering for Immersive Environments:** inside-out camera tracking: depth sensing, Microsoft HoloLens, Full-Body tracking: inverse & forward kinematics, Kinect, intel-real-sense, full body inertial tracking, holographic video, introduction to distributed VR architectures, rendering architecture: graphics accelerators: 3D rendering API's, OpenGL, Vulcan, DirectX	05
Unit-VI	**Modeling the Physical world:** Geometric modeling: virtual architecture, virtual object shape, virtual object appearance, procedural textures, and procedural objects; Kinematics modeling: homogeneous transformation matrices, object position, transformation invariants, object hierarchies, scale, perspective, and perception. Physical modeling: collision detection, surface deformation, force computation, force smoothing and mapping, haptic texturing, and behavior modeling.	10
Unit-VII	**Sound in Immersive Environments:** Evolution of Sound Systems: from mono sound to stereo to surround, object-based sound, ambisonics, head-related-transfer-function (HRTF). Sound design basics: sound as information, earcons, the impact of sound in objects and actions, natural v/s, real sound.	04
Unit-VIII	**Presence and Interactivity:** augmenting the sense of presence: space and architecture, the uncanny valley, dissolving the medium. Identity in Immersive Environments: change of identity, transforming the senses, extending the senses. Interactivity: interactivity within physical dimensions, interactivity beyond physical restrictions.	06

Self-Study:

The self-study contents will be declared at the commencement of the semester. Around 10% of the questions will be asked from self-study content

Suggested Readings/ References:

1. Kelly S. Hale, Kay M. Stanney, Handbook of Virtual Environments: Design, Implementation, and Applications, (Human Factors and Ergonomics), CRC Press
2. Jason Jerald, The VR Book: Human-Centered Design for Virtual Reality, Association for Computing Machinery and Morgan & Claypool Publishers
3. Philippe Fuchs, Virtual Reality Headsets - A Theoretical and Pragmatic Approach, Paperback, CRC Press
4. Tony Parisi, Learning Virtual Reality: Developing Immersive Experiences and Applications for Desktop, Web, and Mobile, O'Reilly.
5. Alva Noe, Action in Perception, MIT Press
6. Michael Madary and Thomas K. Metzinger, Real Virtuality: A Code of Ethical Conduct, Journal of Frontiers in Robotics and AI
7. Luca Turchet, Designing presence for real locomotion in immersive virtual environments: An affordance-based experiential approach, Virtual Reality, SpringerLink.

8. Corey J. Bohil, Bradly Alicea, and Frank A. Biocca, Virtual reality in neuroscience research and therapy, Nature Reviews Neuroscience, PubMed

Laboratory Work:

Laboratory work will be based on the above syllabus with a minimum of 10 experiments to be incorporated. The students in a suitable group size will design and perform one experiment as a part of Laboratory work.

Sr No	List of Experiments/Exercises	Hours
1.	Study an existing VR application and write a summary (1000 words) covering the personal view of the look and feel, especially in relation to immersion, presence, agency, and interactivity experience.	03
2	Design an immersive environment in Unity-3D or Unreal by building a simple 3D world in which an interactive player can move around. Connect the controllers and create a simple interaction loop. Measure velocity, acceleration, distances, and other motion and spatial parameters of the user and the controllers. (This will be a group experiment)	03
3	Find an existing immersive commercial application that you think violates best practices of design. Identify what doesn't work and propose a solution. Create a multisensory action that accommodates all senses: visual, auditory, and tactile. (This will be a group experiment)	03
4	Define an interactive scenario that involves a combination of visual, auditory, and rich controller integration within the context of your application area. Write and submit a proposal of your idea, a description of your prototype, and a flow chart for its design and use. (This will be a group experiment)	03
5	Develop a VR application with full body tracking support using the HTC Vive trackers and the Ikinema framework. Add moving objects into your immersive environment with behavior and collision detection features.	03
6	In continuation to practical 5, populate your immersive application with objects that have behavior or transformative properties. (This will be a group experiment)	03
7	In continuation to practical 5, introduce autonomous characters or objects into your 3D world. Extend or transform the senses and create a sense of extra power for the user.	03
8	Use a physical computing platform to rapidly prototype a custom controller, environmental sensor or biosensor in order to bridge the gap between the physical and the virtual worlds. (This will be a group experiment)	03
9	Design and implement several distinguish sounds to accommodate an interaction within your prototype environment. Create a unique event in order to direct the user's attention to a specific object solely based on sound and then do the same with visual and tactile feedback but no sound. (This will be a group experiment).	03
10	Write a short assessment of your immersive application so far, discuss the safety aspects for commercial use in reference to the target group, and explain how it will improve their intended experience. Discuss how can you improve it if you have the resources to bring it to market? (This is a group experiment)	03