

**NIRMA UNIVERSITY**

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| <b>Institute:</b>            | Institute of Technology                            |
| <b>Name of Programme:</b>    | Master of Computer Application (2-Years Programme) |
| <b>Course Code:</b>          | 3MCAD364   |
| <b>Course Title:</b>         | Augmented and Virtual Reality                      |
| <b>Course Type:</b>          | Departmental Elective                              |
| <b>Year of Introduction:</b> | 2021-22  |

**Credit Scheme**

| L | T | Practical Component |    |   |   | C |
|---|---|---------------------|----|---|---|---|
|   |   | LPW                 | PW | W | S |   |
| 3 | 0 | 2                   | -  | - | - | 4 |

**Course Learning Outcomes (CLO):**

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

1. understand the differences in AR/VR concepts and technologies
2. evaluate usability of AR/VR applications and critique their use of AR/VR capabilities
3. design AR/VR applications using state-of-the-art tools
4. apply the AR/VR development approaches to build AR/VR applications

**Syllabus:**

**Total Teaching hours: 45**

| Unit     | Syllabus  | Teaching hours |
|----------|---|----------------|
| Unit-I   | <b>Introduction to Immersive Technologies:</b> history of virtual reality, reality, virtuality and immersion, a brief history of immersive technologies and its need in today scenario, VR technology, the components of a VR system, difference between virtual reality, augmented reality, mixed reality and XR, various AR/VR development platforms and devices.   | 03             |
| Unit-II  | <b>Human Perception, Cognition, Physiology and Psychology:</b> 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 | <b>Motion Trackers, Navigation Trackers and Interfaces:</b> trackers: position and motion trackers, tracker performance parameters, inertial and hybrid trackers - hmd 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  | <b>Areas for immersive reality applications and computing platforms:</b> entertainment, education, medical, industrial, military, training and consumer research. Use-cases, applications and production pipelines: from sensing to rendering, computing platforms: standalone, mobile and high- end immersive computing platforms.   | 05             |



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|-----------|--|----|
| Unit-V    | <b>3D Rendering for Immersive Environments:</b> 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, Vulkan, DirectX.   | 05 |
| Unit-VI   | <b>Modeling the Physical world:</b> 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, behavior modeling. | 10 |
| Unit-VII  | <b>Sound in Immersive Environments: Evolution of Sound Systems:</b> from mono sound to stereo to surround, object-based sound, ambisonics, HRTF. Sound design basics: sound as information, earcons, impact of sound in objects and actions, natural v/s real sound.   | 04 |
| Unit-VIII | <b>Presence and Interactivity:</b> 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 semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/References:

1. Kelly S. Hale, Kay M. Stanney. 2014. Handbook of Virtual Environments: Design, Implementation, and Applications, (Human Factors and Ergonomics) ISBN-13: 978-1466511842. Amazon
2. Michael Madary and Thomas K. Metzinger. 2016. Real Virtuality: A Code of Ethical Conduct. Recommendations for Good Scientific Practice and the Consumers of VR-Technology. *Frontiers in Robotics and AI* 3, February: 1–23. <http://doi.org/10.3389/frobt.2016.00003>
3. Jason Jerald. 2015. The VR Book: Human-Centered Design for Virtual Reality. Association for Computing Machinery and Morgan & Claypool Publishers. <http://doi.org/10.1145/2792790>
4. Philippe Fuchs - Appropriate use of VR headsets <http://worldvrforum.com/product/appropriate-use-virtual-reality-head/>
5. Luca Turchet. 2015. Designing presence for real locomotion in immersive virtual environments: An affordance-based experiential approach. *Virtual Reality* 19, 3–4: 277–290. <http://doi.org/10.1007/s10055-015-0267-3>
6. Tony Parisi. 2015. Learning Virtual Reality ISBN: 9781491922828
7. Alva Noe. 2004. Action in Perception. ISBN: 9780262640633

8. Corey J. Bohil, Bradly Alicea, and Frank A. Biocca. 2011. Virtual reality in neuroscience research and therapy. *Nature Reviews Neuroscience* 12, 12: 752–62. <http://doi.org/10.1038/nrn3122>

| Suggested List of Experiments: | Sr. No. | Title   | Hours |
|--------------------------------|---------|---|-------|
|                                | 1.      | To study an existing VR application and write a summary (1000 words) covering the personal view on the look and feel especially in relation to immersion, presence, agency and interactivity experience.  | 03    |
|                                | 2       | To design an immersive environment in Unity-3D or Unreal by building a simple 3D world that an interactive player can move around in. 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       | To find an existing immersive commercial application that you think it 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       | To define an interactive scenario that involves 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       | To 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       | To populate your immersive application with objects that have behavior or transformative properties. (This will be group experiment)  | 03    |
|                                | 7       | To 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    |
|                                |         | OR  |       |
|                                |         | To 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)  |       |
|                                | 8       | To design and implement several distinguish sounds to accommodate an interaction within your prototype environment. Create a unique event in order to direct user's attention to a specific object solely based on  | 03    |

- sound and then do the same with visual and tactile feedback but no sound. (This will be group experiment).
- 9 To add a training component to your existing prototype and define the mechanics that will progressively improve user's performance to mastery through an interaction loop using the dual concept of challenge / reinforcing. (This will be a group experiment) 03
- 10 To write a short assessment of your immersive application so far and discuss the safety aspects for commercial use in reference to the target group and explain how will it improve their intended experience? How can you improve it if you had the resources to bring it to market? (This is a group experiment) 03

Suggested Case List: -NA-