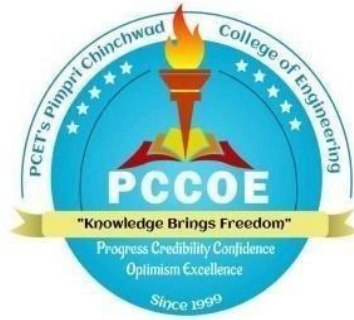


Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

(An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune)



Curriculum Structure and Syllabus

of

Multi-Disciplinary Minors (MDM) in

**Designing with Augmented and Virtual Reality
(AR/VR)**

(Regulations 2023)



Effective from Academic Year 2024-25

VISION AND MISSION OF INSTITUTE

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations.

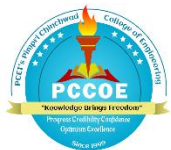
EOMS Policy

“We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute’s social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS).”



**Pimpri Chinchwad Education Trust's
Pimpri Chinchwad College of Engineering**

Course Approval Summary

Board of Studies - Department of Information Technology

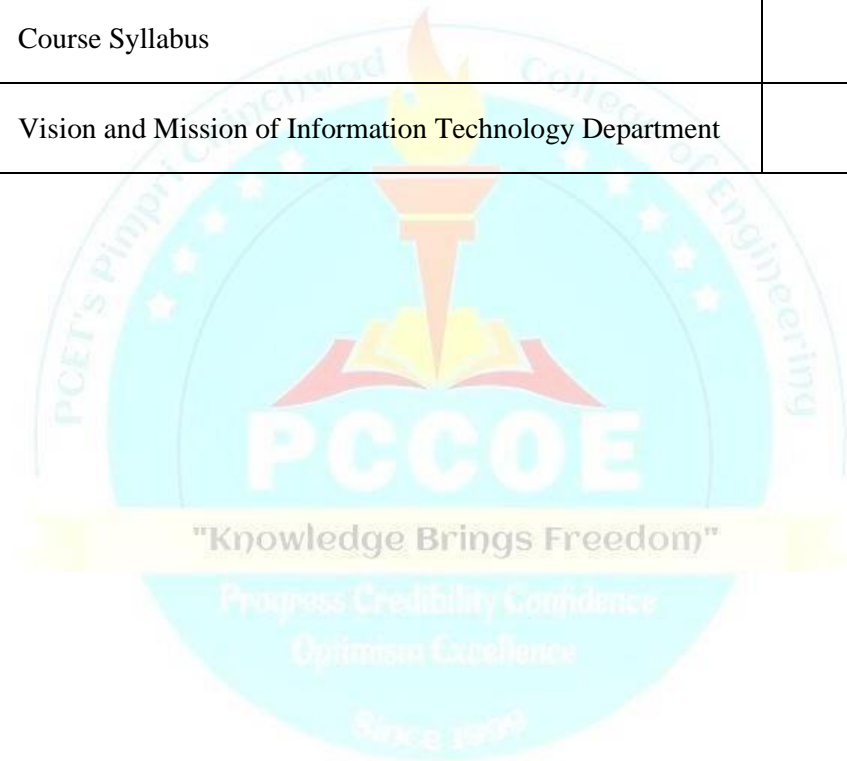
Sr. No.	Name of the Course	Course Code	Page Number	Signature and stamp of BoS chairman
1.	Virtual Reality	BIT23MD01	5	
2.	Augmented Reality	BIT24MD02	7	
3.	Experience Design in AR/VR	BIT25MD03	9	
4.	Experience Design in AR/VR Laboratory	BIT25MD04	11	
5.	X- Reality Technologies and Applications	BIT26MD05	13	
6.	Project	BIT27MD06	15	

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering

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1	Preface	1
2	Curriculum Structure	2
3	Course Syllabus	4
4	Vision and Mission of Information Technology Department	17



LIST OF ABBREVIATIONS IN CURRICULUM STRUCTURE

Sr. No.	Abbreviation	Expansion
1.	L	Lecture
2.	P	Practical
3.	T	Tutorial
4.	H	Hours
5.	FA	Formative Assessment
6.	SA	Summative Assessment
7.	TW	Term Work
8.	OR	Oral Exam
9.	PR	Practical Exam

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Preface

In today's rapidly evolving digital landscape, AR and VR are at the forefront of innovation, revolutionizing industries and reshaping human experiences. From entertainment and gaming to healthcare, education, and beyond, these immersive technologies hold immense potential to transform how we learn, work, and interact with the world around us.

This design with AR/VR Multidisciplinary minor (MDM) curriculum is the culmination of extensive research, collaboration, and expertise from educators, industry professionals, and technologists passionate about harnessing the power of AR and VR for education. With a focus on both theoretical foundations and practical applications, the goal is to empower learners at all levels to explore, create, and innovate in the exciting realm of immersive technology.

The curriculum encourages approaching AR and VR with curiosity, creativity, and a spirit of exploration. AR/VR helps to imagine and create the future with these transformative technologies.

Designing with Augmented and Virtual Reality (AR/VR) is offered by the Information Technology Department and applicable to all branch students at Pimpri Chinchwad College of Engineering Pune.

Curriculum Structure
MDM in
Designing with Augmented
and Virtual Reality
(AR/VR)

CURRICULUM STRUCTURE

MDM in Designing with Augmented and Virtual Reality (Regulations 2023)

(With effect from Academic Year 2024-25)

Course Code	Course Name	Credit Scheme				Teaching Scheme (Hours/Week)			Evaluation Scheme and Marks						
		L	P	T	Total	L	P	T	FA		SA	TW	PR	OR	Total
									FA1	FA2					
Semester III															
BIT23MD01	Virtual Reality	2	-	-	2	2	-	-	10	10	30	-	-	-	50
Semester IV															
BIT24MD02	Augmented Reality	2	-	-	2	2	-	-	10	10	30	-	-	-	50
Semester V															
BIT25MD03	Experience Design in AR/VR	3	-	-	3	3	-	-	20	20	60	-	-	-	100
BIT25MD04	Experience Design in AR/VR Laboratory	-	1	-	1	-	2	-	-	-	-	50	-	-	50
Semester VI															
BIT26MD05	X-Reality Technologies and Applications	2	-	-	2	2	-	-	10	10	30	-	-	-	50
Semester VII															
BIT27MD06	Project	-	4	-	4	-	8	-	-	-	-	100	-	50	150
Total		9	5	-	14	9	10	-	50	50	150	150	-	50	450

L-Lecture, P-Practical, T-Tutorial, FA-Formative Assessment, SA-Summative Assessment, TW-Term Work, OR-Oral, PR-Practical

Course Syllabus

MDM (Designing with AR/VR)	B.Tech.: CIVIL/COMP/COMP(R)/CSE-AIML/ E&TC/MECH				Semester	III	
Course	Virtual Reality				Code	BIT23MD01	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	10	10	30	50
Prior knowledge of: Computer fundamentals is essential							
Course Objectives: <ol style="list-style-type: none"> 1. Understand Virtual Reality Fundamentals 2. Examine visual, aural, and haptic representations in VR and their significance in creating immersive experiences. 3. Examine the mechanisms behind visual perception in VR, including depth, motion, and color perception. 							
Course Outcomes: After learning the course, the students will be able to: <ol style="list-style-type: none"> 1. Identify the essential components of a VR system and their respective roles in delivering immersive experiences. 2. Apply knowledge of virtual world representation to enhance user engagement and interaction. 3. Interpret the Integration of Geometry and Human Vision in Virtual Reality 4. Analyze rendering techniques used in VR, such as ray tracing and rasterization, considering their advantages and limitations. 							
Detailed Syllabus							
Unit	Description						Duration (Hrs)
1.	Introduction to Virtual Reality 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.						8
2.	Representing the Virtual World Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR						7
3.	The Geometry of Virtual Worlds & The Physiology of Human Vision Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.						7
4.	Visual Perception & Rendering 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						8
	Total						30

Text Books:

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

Reference Books:

1. Kim, G. J. (2005). *Designing Virtual Systems: The Structured Approach*.
2. Bowman, D. A., Kujiff, E., LaViola, J. J., Jr., & Poupyrev, I. (2005). *3D User Interfaces, Theory and Practice*. Addison Wesley.
3. Bimber, O., & Raskar, R. (2005). *Spatial Augmented Reality: Merging Real and Virtual Worlds*.
4. Burdea, G. C., & Coiffet, P. (2003). *Virtual Reality Technology*. Wiley Interscience

E-sources:

1. Virtual Reality Engineering , <https://nptel.ac.in/courses/121106013>
2. <https://nptel.ac.in/courses/106/106/106106138/>

MDM (Designing with AR/VR)	B.Tech.: CIVIL/COMP/COMP(R)/CSE-AIML/E&TC/MECH				Semester	IV	
Course	Augmented Reality				Code	BIT24MD02	
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	10	10	30	50
Prior knowledge of: Computer fundamentals is essential							
Course Objectives: <ol style="list-style-type: none"> Understand the concept of Augmented Reality (AR), and its essential hardware components. Demonstrate proficiency in implementing marker tracking and natural feature detection algorithms for augmented reality applications. Explain the principles of marker-based tracking and identify different types of markers used in augmented reality. 							
Course Outcomes: After learning the course, the students will be able to: <ol style="list-style-type: none"> Interpret the concept of Augmented Reality (AR) and its historical development. Examine the various hardware components essential for augmented reality displays and sensory inputs. Explore computer vision techniques used for marker tracking Examine real-world examples of marker-based and markerless augmented reality applications. 							
Detailed Syllabus							
Unit	Description						Duration (Hrs)
1.	Introduction to Augmented Reality (A.R.) Augmented Reality, history of augmented reality, The Relationship Between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum Between Real and Virtual Worlds, applications of augmented reality Augmented Reality Concepts- How Does Augmented Reality Work? Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.						7
2.	Augmented Reality Hardware Hardware Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.						8
3.	Computer Vision for Augmented Reality & A.R. Software Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for						7

	Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.	
4.	AR Techniques- Marker based & Markerless tracking Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication Marker types- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real world examples Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.	8
	Total	30
Text Books:		
<ol style="list-style-type: none"> Schmalstieg, D., & Hollerer, T. (2016). Augmented Reality: Principles and Practice. Addison-Wesley Professional. MacIntyre, B., Bolter, J. D., & Gandy, M. (2016). Introduction to Augmented Reality. CRC Press. Pesce, M. (2011). Augmented Reality: Where We Will All Live. Sutro Press. 		
Reference Books:		
<ol style="list-style-type: none"> Azuma, R. T. (2019). Augmented Reality: Principles and Practice (2nd ed.). Addison-Wesley Professional. Billinghurst, M., & Grasset, R. (Eds.). (2016). Augmented Reality: Innovative Perspectives across Art, Industry, and Academia. Springer. Pintus, R., Alletto, S., & Tistarelli, M. (2019). Augmented Reality: Principles, Technologies, and Applications. Springer. 		
E-sources:		
<ol style="list-style-type: none"> https://en.wikipedia.org/wiki/Augmented_reality https://developers.google.com/ar https://unity.com/unity/features/arfoundation 		

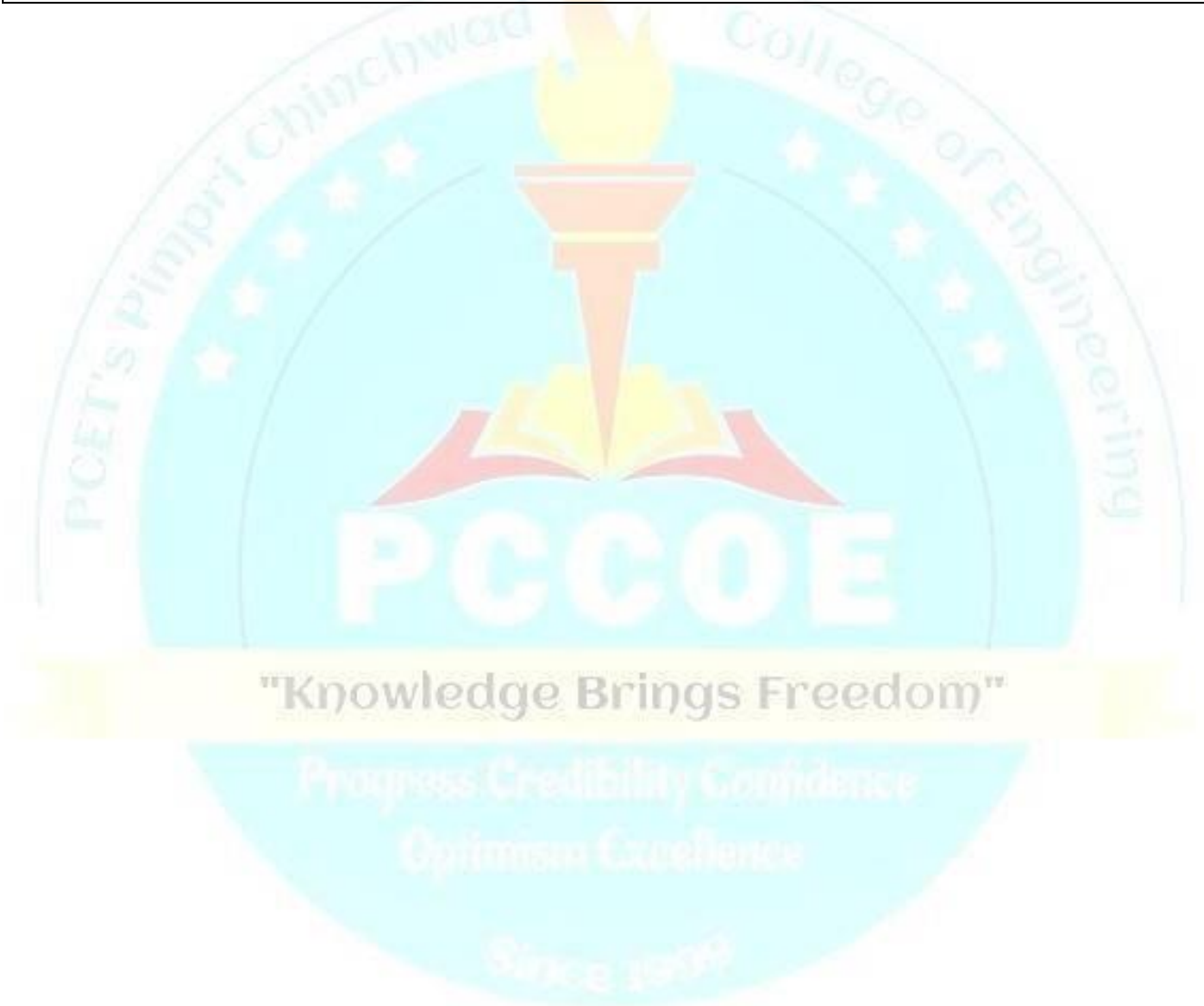
MDM (Designing with AR/VR)	B.Tech.: CIVIL/COMP/COMP(R)/CSE-AIML/E&TC/MECH			Semester	V		
Course	Experience Design for VR/AR			Code	BIT25MD03		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
3	3	-	-	20	20	60	100
Prior knowledge of: Human Computer Interaction is essential							
Course Objectives: <ol style="list-style-type: none"> To introduce user perspective To conceptualize Ideas To collaborate through prototyping and evaluation guidelines 							
Course Outcomes: After learning the course, the students will be able to: <ol style="list-style-type: none"> Apply the method of design thinking Build ideation models with critical thinking Develop physical and digital prototypes from idea concepts Evaluate the user interface with a standard guideline Evaluate User Satisfaction and measure it through Feedback 							
Detailed Syllabus							
Unit	Description						Duration (Hrs)
1.	Introduction to the Design Thinking Process Empathy, Human- and life-centered approach, Problem statement, Ideation, Prototyping, Testing, and Design critiques. Need finding: Problem context; User personas; Observation of context; Talking to users; Constraints; Problem statement.						9
2.	Ideation and storyboarding Mind maps; Thinking visually; Collaborative ideation–whiteboards, digital whiteboard tools (Google Jamboard, Mural, Miro, etc.), Synthesis of ideas, Evaluating ideas from the perspective of the medium; Use cases, Summarizing the idea into key use cases.						9
3.	Prototyping Introduction to prototypes–low to high fidelity; Importance of prototyping, Making prototypes–paper, physical, digital; Prototype key use cases.						9
4.	Evaluation of interaction and experience Usability; Usefulness; Guidelines for interaction development; Evaluating usability against the currently known guidelines						9
5.	User feedback Taking user feedback on the prototype for key use cases; the Think-Aloud protocol.						9
	Total						45

Text Books:

1. Thomas Lockwood Design Thinking: Integrating Innovation, Customer Experience, and Brand, Allworth Press, ISBN-13 978-1581156683
2. Don Norman, THE DESIGN OF EVERYDAY THINGS, BASIC BOOKS, 1st Edition, ISBN 978-0465055715

Reference Books:

1. Gershenfeld, N., Gershenfeld, A., & Cutcher-Gershenfeld, J. (2017). Designing reality: How to survive and thrive in the third digital revolution. Basic Books.
2. Bartle, R. (2003). Designing virtual worlds. New Riders.
3. Nite, S. (2016). Virtual reality insider: Guidebook for the VR industry. Sky Nite.
4. Jerald, J. (2015). The VR book: Human-centered design for virtual reality. Morgan & Claypool.

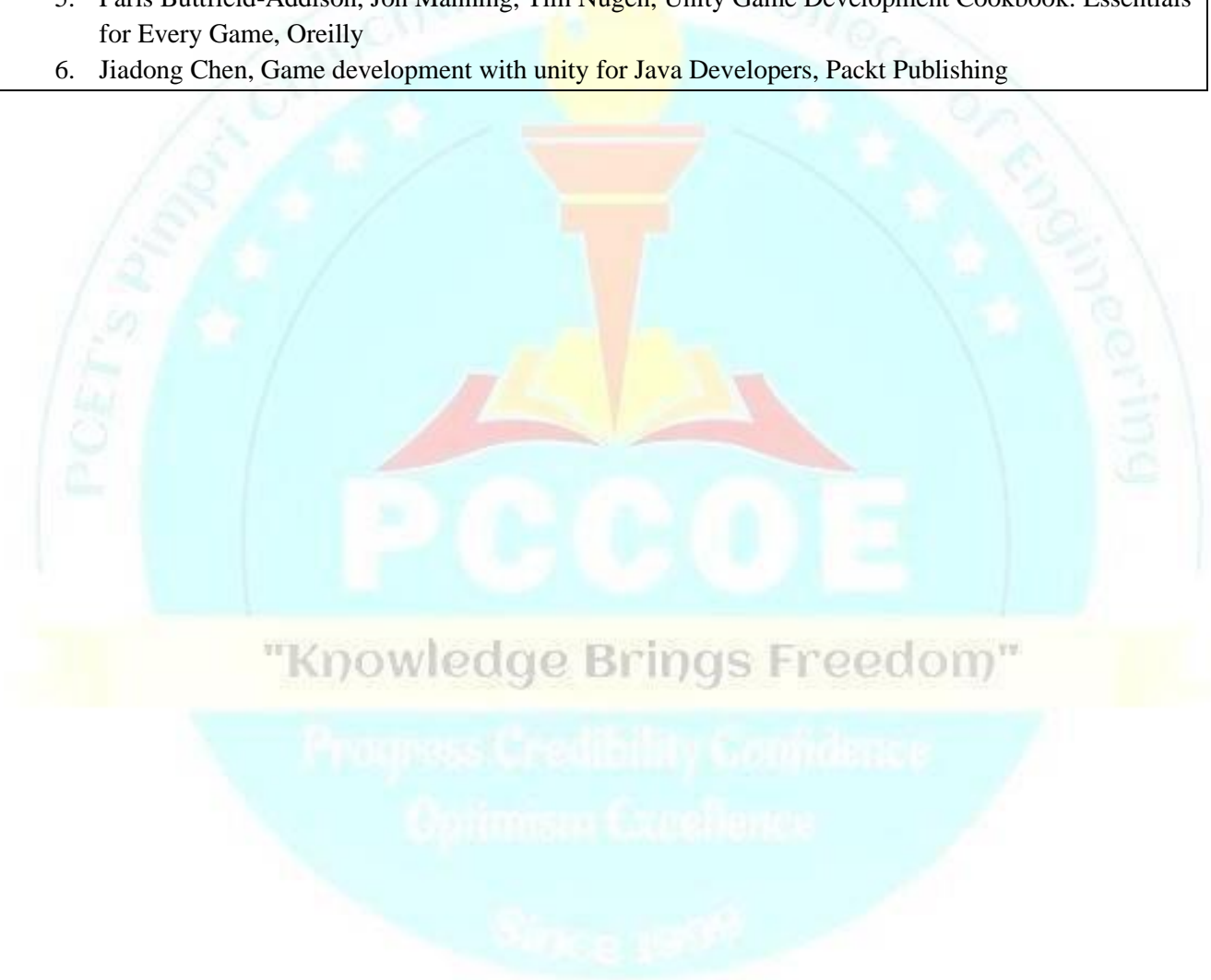


MDM (Designing with AR/VR)	B.Tech.: CIVIL/COMP/COMP(R)/CSE-AIML/E&TC/MECH			Semester	V
Course	Experience Design for VR/AR Laboratory			Code	BIT25MD04
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme	
	Lecture	Practical	Tutorial	TW	PR/OR
1	-	2	-	50	50
Prior knowledge of: Problem Solving Skills is essential					
Course Objectives: <ol style="list-style-type: none"> To practice AR/VR tools To apply the AR/VR concepts for Building Applications 					
Course Outcomes: After learning the course, the students will be able to: <ol style="list-style-type: none"> Create 3D scenes with Unity and experiment with various user interface (UI) techniques that are used in VR applications Create a 2D game in Unity. Choose designs for VR experiences 					
Guidelines for Laboratory /TW Assessment Continuous assessment of laboratory work should be based on the overall performance of Laboratory assignments of a student. Each Laboratory assignment assessment will assign grades/marks based on parameters, such as timely completion, performance, innovation, efficient codes, punctuality, and neatness.					
Guidelines for Laboratory Conduction The instructor is expected to frame the assignments by understanding the prerequisites, technological aspects, utility, and recent trends related to the topic. The assignment framing policy needs to address the average students and be inclusive of an element to attract and promote intelligent students. The use of open-source software is encouraged. Based on the concepts learned. The instructor may also set one assignment or mini-project that is suitable to the respective branch beyond the scope of the syllabus. Students should apply the concepts of Experience Design in AR/VR and design thinking techniques					
Detailed Syllabus					
Assignment No.	Suggested List of Assignments				
1.	Install and configure Unity software for designing applications.				
2.	Develop a VR game in Unity such that on each gun trigger click, destroy the cubes placed on the plane and gain a score point. Make a score UI and display it on the screen.				
3.	Develop a VR Golf Game. The scene should contain a play area (golf course), which consists of a series of cups/holes each having different scores. Display the scorecard				
4.	Develop a VR Basketball Game. The scene should contain a basketball court. The developed game should be a single-player game. The objective of the game is to let the player put the ball in the basket a maximum number of times. Display the scorecard.				

5.	Develop a VR environment for flying helicopter/moving car simulation.
6.	Develop a mini project in Unity for Town Planning, Home Automation, etc using AR/VR concepts

Reference Books:

1. Gershenfeld, N., Gershenfeld, A., & Cutcher-Gershenfeld, J. (2017). Designing reality: How to survive and thrive in the third digital revolution. Basic Books.
2. Bartle, R. (2003). Designing virtual worlds. New Riders.
3. Nite, S. (2016). Virtual reality insider: Guidebook for the VR industry. Sky Nite.
4. Jerald, J. (2015). The VR book: Human-centered design for virtual reality. Morgan & Claypool.
5. Paris Buttfield-Addison, Jon Manning, Tim Nugen, Unity Game Development Cookbook: Essentials for Every Game, Oreilly
6. Jiadong Chen, Game development with unity for Java Developers, Packt Publishing



MDM (Designing with AR/VR)	B.Tech.: CIVIL/COMP/COMP(R)/CSE-AIML/E&TC/MECH			Semester	VI		
Course	X-Reality Technologies and Applications			Code	BIT26MD05		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme			
	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
2	2	-	-	10	10	30	50
Course Objectives:							
<ol style="list-style-type: none"> To understand AR/VR hardware To understand navigation through trackers To define rendering and modelling for user experiences 							
Course Outcomes:							
After learning the course, the students will be able to:							
<ol style="list-style-type: none"> Demonstrate AR/VR Head Mounted Hardware Choose Motion Trackers Bring together real world and digital elements. Use next-generation sensing and imaging technologies. 							
Detailed Syllabus							
Unit	Description						Duration (Hrs)
1.	Head Mounted Display Hardware Introduction to Head-mounted display optics, Image formation, stereo rendering for HMDs, Field of View and Visual Field, Lens Distortion Correction, Overview of Micro displays, focus cues & the vergence-accommodation conflict, Focus Cue based Displays, Optical See-through AR Displays, Optical See-through AR Displays						8
2.	Tracking, Navigation And Manipulation Position and Motion Trackers, Inside Out/Outside, Tracker Performance Parameters, Optical - Active and Passive Trackers, Inertial and Hybrid Trackers - HMD Trackers, Other trackers, Inside-Out Camera tracking, Depth Sensing, commercially available systems - Specifications study						7
3.	Rendering And Modeling Graphics Accelerators, 3D Rendering API's, Best practices and Optimization techniques, Common Development pipelines in VR/AR/MR, Distributed XR Architectures, Multi-pipeline Synchronization, Co-located Rendering Pipelines, Distributed Virtual Environments, Audio rendering, Combining other senses						7
4.	Interaction And Experience Engineering Design considerations in XR interaction, motor programs, remapping, Locomotion, Implementations, Challenges to be addressed, Manipulation, Holograms, Social interaction, Storytelling, User interface design, User-experience design, Evaluation of human-computer interaction						8
	Total						30

Text Books:

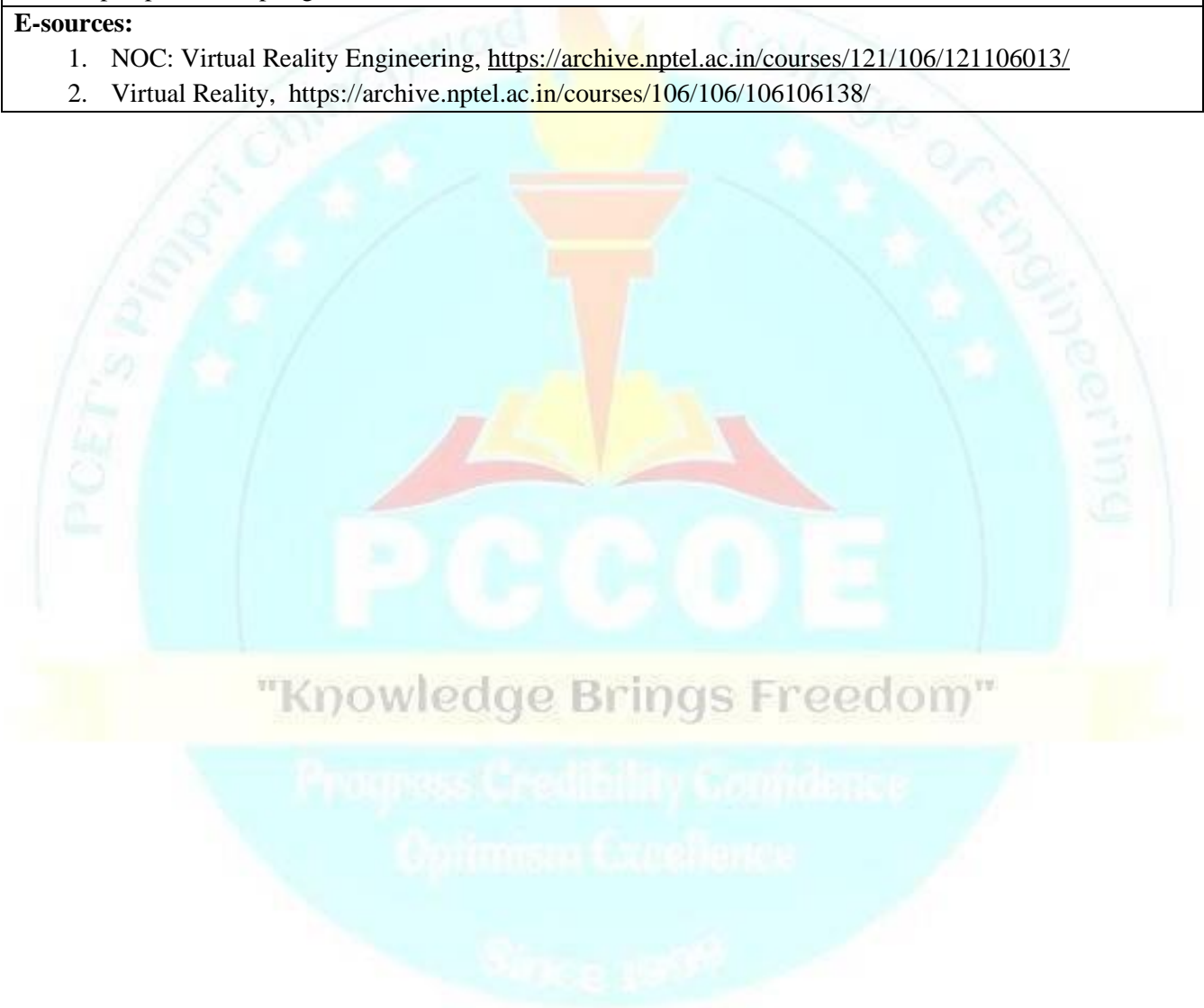
1. Dieter Schmalstieg , Tobias Hollerer, Augmented Reality: Principles and Practice (Usability), 1st Edition, Addison-Wesley Professional
2. Sherman, William R. and Alan B. Craig. Understanding Virtual Reality – Interface, Application, and Design, Morgan Kaufmann, Morgan Kaufmann Publishers.

Reference Books:

1. Dunleavy, M., & Dede, C. (2014). Augmented reality teaching and learning. Springer.
2. Furht, B., & Kaplantzis, S. (Eds.). (2019). Handbook of augmented reality. Springer.
3. Kam, H. J., Mirza, F., & Li, J. (Eds.). (2020). Extended reality in education: Synthesis and perspectives. Springer.

E-sources:

1. NOC: Virtual Reality Engineering, <https://archive.nptel.ac.in/courses/121/106/121106013/>
2. Virtual Reality, <https://archive.nptel.ac.in/courses/106/106/106106138/>



MDM (Designing with AR/VR)	B.Tech.: CIVIL/COMP/COMP(R)/CSE-AIML/ E&TC/MECH			Semester	VII		
Course	Project			Code	BIT27MD06		
Credits	Teaching Scheme (Hrs./Week)			Evaluation Scheme and Marks			
	Lecture	Practical	Tutorial	TW	OR	PR	Total
4	-	8	-	100	50	-	150
Prior knowledge of: 1. Development tool for AR/VR is essential							
Course Objectives: This course will enable students 1. To develop the miniproject using AR/VR.							
Course Outcomes: After learning the course, the students will be able to: 1. Develop the application using the AR/VR Tool 2. Analyze the AR/VR application to meet the objectives. 3. Evaluate the AR/VR knowledge to solve the specific problem. 4. Write report based on evaluation and analysis undertaken							
Guidelines: 1. Identify a problem statement and find the feasible solution using AR/VR. 2. Detail the steps taken to implement your proposed solution. This may involve software development, prototype construction or simulation in AR/VR etc. 3. Interpret the results of your research in MDM selected in the context of existing literature and theoretical frameworks. 4. Student can choose any of the problem statement and apply AR/VR techniques learnt through Multidisciplinary Minor Course.							

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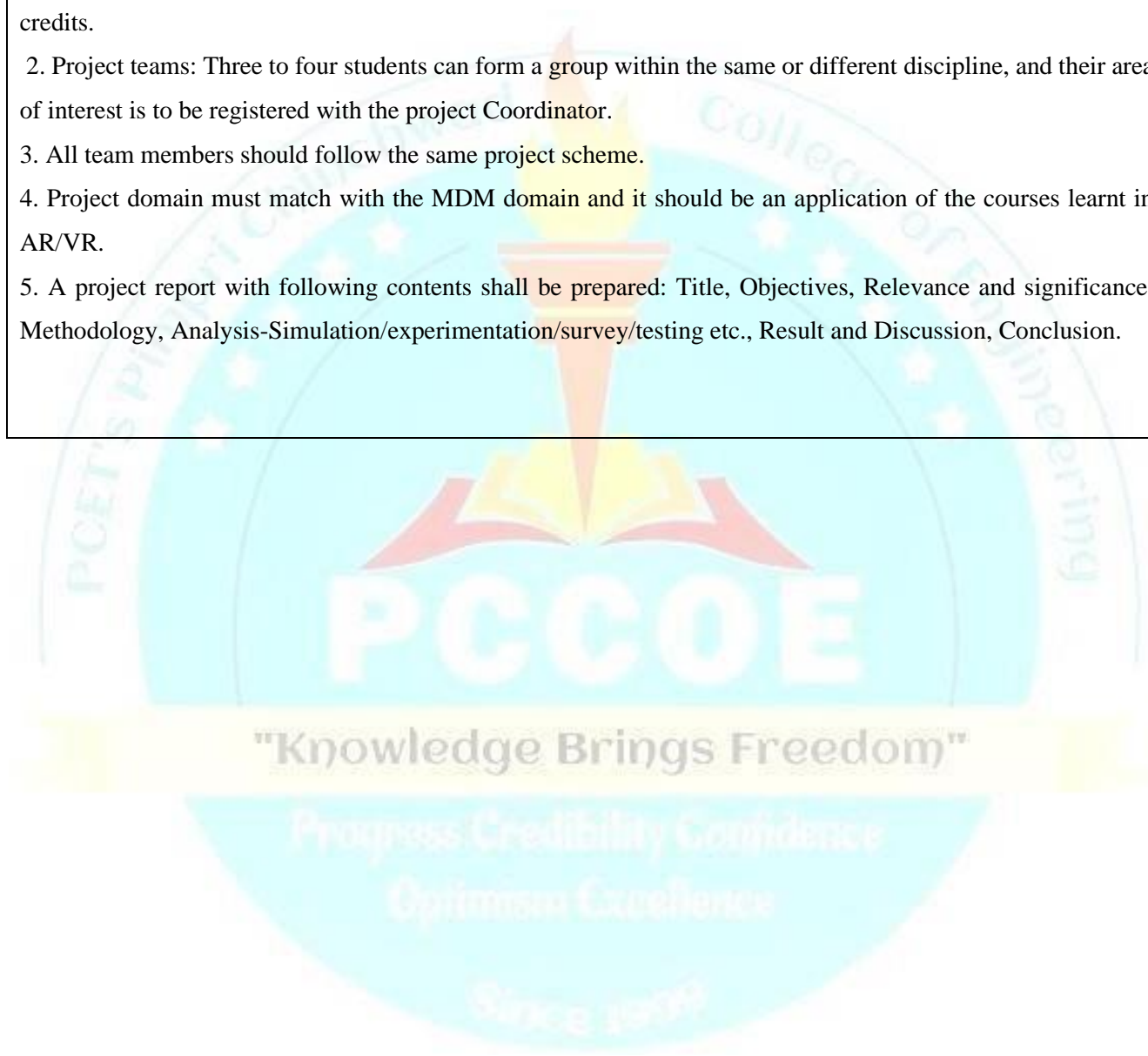
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Project Work: Project work intends to conceive an idea and to implement it systematically by using knowledge derived during the course of education mainly to innovate or facilitate. A group of Under Graduate students in the Final Year will undertake this mini project in AR/VR.

General Guidelines for Project Work:

1. Project is one of the essential contributory teamwork that has to be completed for the required number of credits.
2. Project teams: Three to four students can form a group within the same or different discipline, and their area of interest is to be registered with the project Coordinator.
3. All team members should follow the same project scheme.
4. Project domain must match with the MDM domain and it should be an application of the courses learnt in AR/VR.
5. A project report with following contents shall be prepared: Title, Objectives, Relevance and significance, Methodology, Analysis-Simulation/experimentation/survey/testing etc., Result and Discussion, Conclusion.



Vision and Mission of Information Technology Department

Department Vision

To become a front-runner in the western region in preparing Information Technology engineers with academic excellence and research skills empowering their roles in technology and society.

Department Mission

1. To equip students with the skills and knowledge through a dynamic learning environment
2. To collaborate with industries to nurture proficient Information Technology Engineers
3. To cultivate a spirit of research, innovation, and entrepreneurship to address community and business challenges.
4. To imbibe work ethics and leadership skills through co-curricular and extracurricular activities.

"Knowledge Brings Freedom"

Progress Credibility Confidence
Optimism Excellence

Since 1979