Virtual Reality Nanodegree Syllabus

Join the Creative Revolution

Before You Start

Thank you for your interest in the Virtual Reality Nanodegree program! In order to succeed in this program, we recommend having some advanced computer skills, such as with a graphics editor or similar tools. Be prepared to write code, think like a designer, and work in teams.

TERM 1

Project 0: What's the Code?

This project lets you experience multiple 3D environments from the Udacity VR program. You'll download the Udacity VR app and run it inside of your Cardboard headset. When you put on the headset, you'll walk around an apartment and island from the VR Nanodegree and see demonstrations of various VR techniques you'll soon learn. By trying this app, you will:

- ➔ See a demonstration of the VR techniques you'll learn in the VR Nanondegree program.
- ➔ Experience completed future projects you will learn how to build from scratch.
- ➔ Hunt for a secret code hidden in the VR world.

Project 1: Udacity Carnival

Customize and build a VR carnival game! When you begin, you'll have three carnival games that are out of order. It's your job to fix them. Using Unity, you'll fix each game by correctly wiring up the event system. After that, you'll customize each game with your own images and text. When you finish, you'll play the three games and send us your score. You'll win points, have fun, and learn a lot about event-based programming and art customization inside of Unity.

Supporting Module Content: Introduction to Virtual Reality

Lesson Title	Learning Outcomes
WHAT IS VR?	➔ Differentiate the components that make up Virtual Reality hardware and software such as specialized optics and trackers ➔ Differentiate types of Virtual Reality experiences you find on mobile and desktop devices ➔ Understand the tracking and optical technology behind a VR headset
PLATFORMS AND PARADIGMS	➔ Differentiate between VR platforms based on their sensor and performance capabilities ➔ Analyze the technical differences between various VR headsets like optical properties, tracking capabilities, ergonomics, and price-point ➔ Understand VR development paradigms for each headset
HELLO WORLD	➔ Download and Install all software for VR development ➔ Create your first VR application ➔ Modify an existing VR Unity project

Project 2: Build an Apartment

Become a VR architect and design an apartment! Start off by creating some walls. Next, add some couches, chairs, tables, and rugs. Don't forget to add a kitchen! Once you've finished decorating, be sure to add some nice mood lighting. Then, deploy it to your Cardboard headset.

Supporting Module Content: VR Scenes and Objects

Lesson Title	Learning Outcomes
GAME OBJECTS	➔ Create your first virtual game objects and add them to your scene ➔ Edit an object's transform property ➔ Navigate the Unity Interface
MATERIALS	➔ Creating materials ➔ Modifying properties of a material ➔ Using a texture on a material ➔ Creating a custom material with shaders
ANIMATIONS	➔ Using Unity's Mecanim system to animate objects ➔ Creating keyframes and using interpolation between keyframes ➔ Transitioning between Animations
CAMERAS	➔ Using the Camera component

	➔ Creating a VR Camera in Unity ➔ Implementing Head Tracking
LIGHTS	➔ Create a performant well-lit Unity scene ➔ Differentiate between various types of lighting ➔ Using Global Illumination (GI)

Project 3: A Maze

Place the walls, add lights and materials, and then code a fully functional VR maze game using Unity and the Google VR SDK, where the user explores a maze environment to demonstrate working knowledge of 2D and 3D UI, waypoint based navigation, procedural animation, interactive objects, spatial audio, particle effects, and persistent storage of session data. Players will navigate the maze, collect coins along the way, then find a key that opens a gate to secret treasure.

Supporting Module Content: VR Software Development

Lesson Title	Learning Outcomes
CREATING SCRIPTS	➔ Link 3D models with C# code. ➔ Use code to move cubes ➔ Create your C# methods
CONTROLLING OBJECTS USING CODE	➔ Use the Unity documentation ➔ Creating references ➔ Create 100s of objects in a loop
VR INTERACTION	➔ Using multiple scenes and switching between them ➔ Create UI interfaces for VR ➔ Register for your code to activate on a condition
PROGRAMMING ANIMATIONS	➔ Use code to trigger animations ➔ Trigger animation parameters ➔ Start and Stop Animations
PHYSICS & AUDIO	➔ Code raycasts ➔ Detect collisions between objects ➔ Enable gravity on objects ➔ Play an audio clip
ADVANCED VR SCRIPTING	➔ Read existing code ➔ Modify existing complex scripts

TERM 2

Project 4: Puzzler

You will apply design techniques to iterate, document, and write a public write-up for a well-designed and user-tested mobile VR application that asks users to solve a familiar Simon-says-like puzzle in a new way. This writeup will be graded as your course project.

Supporting Module Content: VR Design

Lesson Title	Learning Outcomes
INTRO TO VR DESIGN	➔ Understand basic VR design principles such as iteration, user testing, and documentation ➔ Analyze the Udacity VR app and deconstruct its design methodology
DESIGN FOUNDATIONS, ERGONOMICS, AND THE PUZZLER PROJECT	➔ Create a VR User Persona ➔ Design an ergonomic VR experience ➔ Create comfortable VR Text
SET THE SCENE, AND YOUR FIRST USER TEST!	➔ Create a VR Testing Scene ➔ Create your first User Test ➔ Document your first VR experience
GRAPHICAL USER INTERFACES	➔ Rapidly prototype VR interfaces ➔ Practice the Design loop
LET'S GET MOVING!	➔ Understand Simulator Sickness ➔ Experiment with various VR locomotion schemes ➔ Implement a teleportation locomotion
AUDIO GOODNESS, GAME MECHANICS, AND FEEDBACK!	➔ Understand the importance of audio in VR ➔ Implement 3D audio ➔ Use Google VR Spatial Audio
PRESENTING THE WORK	➔ Document your thought process ➔ Share your design process with others

Project 5: Night at the Museum

For this project, you'll construct a virtual reality exhibit about a cutting-edge VR company or technology of your choice. After conducting your research, you will create a mobile virtual reality experience with "information booths" that include both visual and audio feedback for users. These booths will need to showcase your findings—the goal here is to inform other people about the topic at hand in a fun and creative way through a series of (at least five) display points. Users should be able to travel back and forth between display areas inside the space. Note: This is not a VR slideshow, it is a VR space which contains information about your research. This project showcases locomotion, VR scene design, interactivity, as well as an informed understanding of the industry.

Supporting Module Content: VR Platforms and Applications

Lesson Title	Learning Outcomes
PLATFORMS AND FOCUS PATHS	➔ Explore pros and cons of the major VR headsets on the market including Cardboard, Rift, Vive, Gear VR, PSVR, and more ➔ Decide what headset is the most exciting option, personally, to develop for
THE HORIZON	➔ Discover future technology that will impact VR development such SLAM and eye tracking by examining VR prototypes and studies
MAJOR INDUSTRIES	➔ Understand the major professional industries that VR is impacting such as healthcare, architecture, gaming, and entertainment by reviewing projects in these spaces

TERM 3

Mobile Performance & 360 Media

Project 6: Tic-Tac-Toe

In this project, you'll play detective and put your optimization skills to use by speeding up a poorly optimized VR game. The game is Tic-Tac-Toe, played against a friendly AI Robot. While fun and attractive, the only problem is that the experience is completely unoptimized for mobile VR. Your task is to use what you've learned to optimize this project to run at 60 frames per second on your phone.

Supporting Module Content: Mobile Performance

Lesson Title	Learning Outcomes
PERFORMANCE METRICS	➔ Experience a poorly performing VR application and understand how to diagnose different types of problems like low framerate due to GPU performance vs CPU performance ➔ Reading and interpreting the FPS display ➔ Measure power usage on mobile devices ➔ Mitigate heat management issues
GRAPHICS PIPELINE	➔ Track which parts of a 3D scene tax the CPU, GPU, and battery ➔ Use the Frame Debugger to analyze how a scene is rasterized ➔ Use the Stats window to get a high-level overview of the local scene performance ➔ Implement SetPass reduction strategies
THE PROFILER	➔ Measure the performance of a VR application running on a mobile device using Remote Profiling ➔ Identify poorly performing scripts using the Profiler and Debugger
SCRIPT PERFORMANCE	➔ Analyze code for inefficient algorithms, object lookups, and unnecessary overhead
OPTIMIZATIONS	➔ Implement an object pooling strategy ➔ Optimize poorly performing shaders ➔ Optimize game physics ➔ Optimize inefficient game art

Project 7: The Protagonist's Journey

In this project, you'll do everything you need to prepare for a 360 shoot. You'll write the script, produce the storyboard, and then finally plan the logistics surrounding the shoot. By the end, you'll be prepared to make a great 360 film.

Supporting Module Content: 360 Media Pre-Production

Lesson Title	Learning Outcomes
INTRODUCTION TO IMMERSIVE MEDIA	➔ Understand the principles of immersive 360 media such as spherical projection by critically reviewing professional 360 content ➔ Understand the basic workflow of creating 360 Video ➔ Applying Metadata to 360 video and publishing that content
DEVELOPING A CRITICAL EYE	➔ Analyze a variety of existing 360 video content ➔ Analyze footage for the various techniques, tips, and tricks other film makers may use to direct attention in 360
SCRIPTING AND PLANNING	➔ Create a script for 360 content ➔ Plan a 360 shoot ➔ Edit scripts to match equipment and budget
360 STORYBOARDING	➔ Storyboard using a variety of methods ➔ Differences between storyboarding for 360 and regular video
360 CAMERAS	➔ Exploration of existing 360 cameras ➔ Differentiate between monoscopic and stereoscopic capture ➔ Place cameras appropriately for 360 imaging
MICROPHONES AND LIGHTING	➔ Explore different equipment and techniques used for audio capture ➔ Explore lighting techniques for 360 video

Project 8: The Storyteller’s Revenge

In this project, you’ll stitch together your own footage (or footage provided). Then, you’ll correct the color and edit the raw footage into a story. Finally, you’ll build a custom 360 video player in Unity and add controls, particles, titles, credits, and at least one interaction (like a button and trigger pull, or a gaze-based interaction). The interaction should trigger a different video, branch the story, or allow for replayability.

Supporting Module Content: 360 Media Production

Lesson Title	Learning Outcomes
STITCHING	➔ Stitch 360 video using Autopano Video Pro

	➔ Blend, weight, synchronize, and stabilize footage
EDITING BASICS	➔ Edit footage in Adobe Premiere ➔ Create transitions in 360 video
ADVANCED EDITING	➔ Color correct 360 footage ➔ Add title screens to your video ➔ Add points of interest using GoPro's plugin
ADVANCED STITCHING	➔ Use Autopano Giga to edit and refine stitching using control points and masks ➔ Gain a deeper understanding of how blending works
SPATIAL AUDIO	➔ Cut spatialized audio ➔ Place sound in 3D space using Google audio spatializer
INTERACTIVITY WITH UNITY	➔ Create an interactive 360 experience using Unity's video player ➔ Create player controls and branching storylines using a custom 360 video player

HIGH IMMERSION, UNITY

Project 9: Rube Goldberg Challenge

This project is a chance for you to create your first fully-functional high-immersion VR game. You'll create a Rube Goldberg game that challenges players to create contraptions that solve physics puzzles. First you'll import SteamVR and set up your scene environment. Then you'll add locomotion, grabbing physics, and a menu system. With the core components built, you'll create Oculus versions of your code.

Supporting Module Content: High Immersion

Lesson Title	Learning Outcomes
DESKTOP VR BENEFITS AND CONSTRAINTS	➔ Understand the benefits and constraints of the Vive and Oculus Rift ➔ Differentiate "modes" of high immersion development ➔ Understand design techniques of existing VR experiences
HIGH-IMMERSION ENGINEERING	➔ Import SteamVR and use it for input handling ➔ Create several locomotion mechanics ➔ Create hand interaction via grabbing and throwing of objects ➔ Create a swipeable object spawning menu
CROSS-PLATFORM DEVELOPMENT	➔ Use the Oculus SDK ➔ Translate our SteamVR functionality to use the Oculus SDK ➔ Manage two separate SDKs in one project for a cross-platform VR experience.

Project 10: Performance Bounceback

Performance optimization is one of the most important skillsets for a VR developer, since apps running below the target framerate are essentially unplayable, causing nausea and discomfort. This project simulates a real-world scenario in which a VR game has been hastily built with a focus on functionality rather than performance. You've been hired to take the game and make it a performant app ready for release!

Supporting Module Content: Performance and Publishing

Lesson Title	Learning Outcomes
DESKTOP VR OPTIMIZATION	➔ Understand Unity's most common performance bottlenecks ➔ Identify and fix them with Unity's performance tools
ADVANCED LIGHTING	➔ Use Unity's lighting system to maximize performance ➔ Understand the pros and cons of Forward vs Deferred Rendering ➔ Balance real-time and baked lighting for optimal performance, ➔ Use optimal shadow settings ➔ Use lightprobes
PUBLISHING FOR DESKTOP VR	➔ Understand how to host your app on Steam, Viveport, and the Oculus Store

HIGH IMMERSION, UNREAL

Project 11: Kitchen Cleanup

This project is your first chance to make a game within Unreal Engine 4 for either standing or roomscale VR. You'll need to utilize motion controllers to build a kitchen-themed interaction game, and you'll use functions, physics, blueprint communication, and audio to create an immersive experience. Spawn messy dishes and get them into the sink as quickly as possible!

Supporting Module Content: High Immersion

Lesson Title	Learning Outcomes
THE DIFFERENCES BETWEEN UNREAL AND UNITY	➔ Compare the differences between Unreal Engine and Unity such as programming style, target audience, and ease-of-use so you can choose the engine most appropriate for your VR projects ➔ Learn the basics of the UI of the Unreal Engine, and its major features

DESKTOP VR	➔ Apply design theory for roomscale and standing scale VR ➔ Build a basic VR-ready playable character ➔ Create and launch a working Unreal Engine Project
INTERACTING WITH MOTION CONTROLLERS	➔ Implement motion controllers ➔ Simulate basic physics interactions ➔ Create input events for use in Blueprints ➔ Create basic blueprint coding ➔ Use line traces to identify objects
AUDIO AND AMBIENCE	➔ Create sound cues ➔ Modify the properties of an audio cue ➔ Implement audio and use it within blueprints
BLUEPRINT COMMUNICATION	➔ Learn how to directly communicate with blueprints ➔ Learn how to communicate with a specific class of blueprints ➔ Learn how to communicate with any number of any class of blueprints ➔ How to use and implement and call custom events
HANDY INTERACTIONS	➔ Implementing blueprint interfaces ➔ Use blueprint functions. ➔ Additional physics interactions

Project 12: Hide and Seek

This is your first chance to build an Unreal VR experience based around locomotion. You'll create a find-the-object style of game, create a set of blueprints that randomly hides an object, and develop a locomotion method that allows you to move around the apartment so you can find the object.

Supporting Module Content: High Immersion

Lesson Title	Learning Outcomes
PERFORMANCE ANALYSIS	➔ Use Unreal Engine 4's built in tools for analyzing performance ➔ Look at examples of proper art asset optimization ➔ Analyze an unoptimized scene in Unreal Engine 4
LOCOMOTION DESIGN	➔ Look at examples of different types of locomotion in VR ➔ Look at the causes of motion sickness with locomotion methods ➔ Create a projectile-based locomotion method ➔ Generate more advanced physics simulations ➔ Build a spline mesh
ANIMATION	➔ Create a time-based animation using a timeline ➔ Use the Unreal Engine 4 animation Pipeline ➔ Create an animated motion controller that responds to input ➔ Use Enumerators to store the state of a player's interaction

LIGHTING	➔ Create different types of lights in a scene ➔ Use the forward renderer ➔ Examine the different types of shadows in UE4 ➔ Use different types of lighting, to create an optimized lighting scene ➔ Use a lightmass importance volume

Project 13: VR Nanodegree Capstone

For your final project, you will work to complete a series of VR challenges, winning points as you progress. You will create a VR project of your choosing, using any hardware. But, it must meet certain criteria in order to “win.” You can choose from a wide range of achievements like “app store submission,” “use of speech recognition,” or “mixed reality trailer.” Each achievement then wins you a different number of points. To successfully complete the project, you need to reach the required points level.