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Mandatory Course Topic: Industrial Metaverse
Type: Hybrid Course

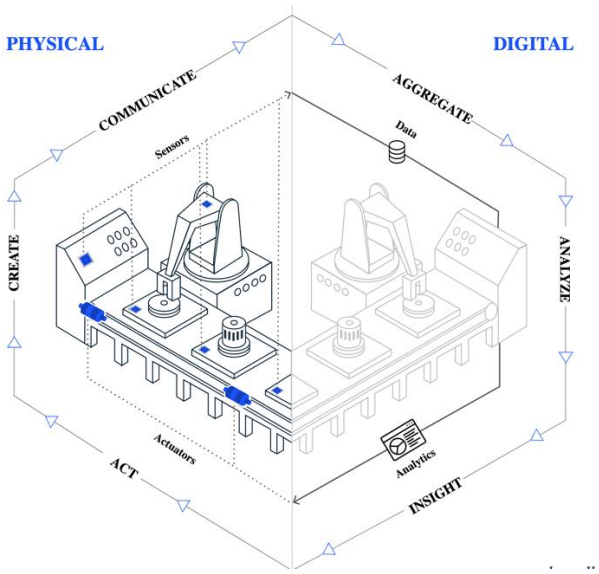
Target Group	**Polytechnic students – CS & IT**

Subject	Industrial Metaverse for CS & IT	**Total duration of the training in Hours**	60 hours (2 credits)
Theory Class Training in Hrs	15 hours (1 credit)	**Practical class Training in Hrs**	45 hours (1 credit)
Theory class focus area	Basic introduction, 3d models, AR VR, Industrial IoT platforms, data modeling, digital twins, simulation, business cases, use models	**Practical class focus area**	IoT integration to data modeling & simulating 3d (digital twin) equipments in metaverse
Total credits	2 credits	**Type of training**	**Hybrid**

Introduction to Industrial metaverse :

What is Digital Twin?

A digital twin is a virtual representation of an object or system in the digital world of the Metaverse. It is updated from real-time data and uses simulation, machine learning and reasoning to help decision making. In simple words, creating a complex virtual model is the counterpart or twin of the physical object in the real world. With sensors that relay information and two-way internet of things (IoT) object connections, this technology can synchronize the digital environment with the physical world and vice versa. Any changes or movement in the material world is reflected in the digital representation of the twin.

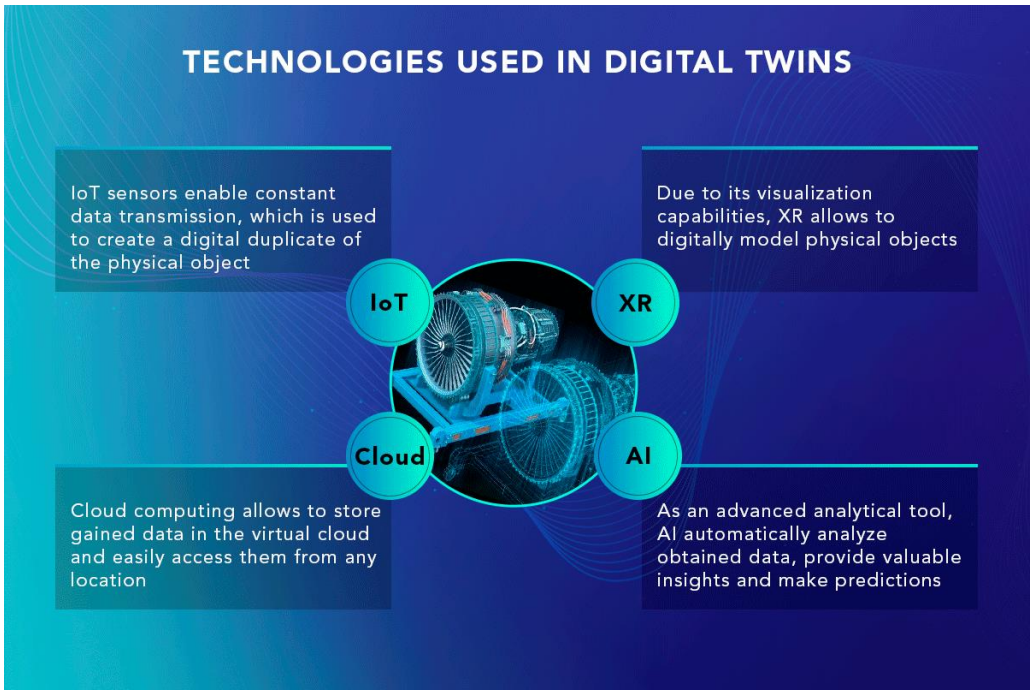


What are the essential building blocks of Metaverse?

The Metaverse and the Digital twin technology can bring realism into the virtual world and experiences beyond our imagination, creating exact replications of reality. Just imagine entering a virtual store of a fashion e-commerce company to try the clothes before buying them. It would be best suited for you to let your digital twin avatar try the clothes first to match your real measurements.

Similarly, a technical training program led by Metaverse will add value to the training if technicians can operate 3D representations of complex systems. Digital twin technology can drive all these ideas into reality and help build a metaverse that is more interviewed into reality. Digital twin and simulation technology will empower Metaverse to support remote

maintenance workshops of machines that need to be serviced and potentially connected with or mapped onto a real workshop.



Technologies used in Digital Twin: AR VR, IoT, Cloud computing & AI

How does Industrial Metaverse work ?

So to understand how Digital Twin works in the Metaverse, let's take a look at how can incorporate digital twins into the Metaverse:

- **Product:**
  Digital twins used to design products
- **Production:**
  Digital twins are used to validate process manufacturing or production
- **Performance:**
  The performance digital twin captures the data from products in operation and analyses it to provide actionable insight for informed decision-making.

What are the use cases of Industrial Metaverse?

There are several sectors where the application of digital twins in the Metaverse can turn out to be beneficial; let's look at some of those sectors as follows :

- **Manufacturing:** Digital twin technology is widely implemented in the manufacturing industry. Virtual copies of entire factories and plants ensure transparent production processes. Digital twins significantly impact how the products are designed, manufactured,

and maintained, making them more efficient and optimized while reducing the throughout time

- **Automobile:** Digital Twins in the automobile sector can create a virtual model of a physically connected vehicle. It captures the behavioural and functional data of the vehicle and helps in analysing the overall performance and connected features of the vehicle. Digital twin helps in delivering truly personalized customer service for the customers.
- **Retail:** Appealing customers has become the key in the retail sector. Digital twin applied in Metaverse can play a key role in mounting the retail customer experience by creating 3D virtual models of showrooms and products, delivering customers a real-like experience. The digital twin also helps with better in-store planning, security implementation, and energy management in an optimized manner.
- **Healthcare:** The medical sector has benefitted from digital twins in organ donation, surgery training, and making other medical procedures less risky. Digital twins with data from IoT can play a vital role in healthcare by improving patient monitoring. It can provide preventive measures for the patients with personalized health care.
- **Smart Cities:** 3D digital twins of whole cities already exist, such as Virtual Singapore. Hence, smart city planning and implementation with digital twins in the Metaverse can help enhance economic development, effective management of human resources, and reduction of ecological footprint to increase the overall quality of life of a citizen in both the physical and virtual world.
- **Industrial IoT:** Industrial firms can monitor, track and control industrial systems digitally by implementing digital twins in the Metaverse. The digital twin records operational data and is handy in catching environment data such as location, configuration, financial models, etc., helping predict future operations of the industries.

COURSE OBJECTIVE:

- Create a Digital twin
- Create build the network and messaging infrastructure for digital twin.
- Build a metaverse for hosting digital twin component
- Digital component Presentation using Virtual reality.

INDUSTRY SCOPE:

- Chemical plant design and control
- Agriculture automation
- Home water automation
- Landscape Maintenance automation
- Green building planning and simulation
- Facility Management and Visualisation
- Warehouse Design and Simulation
- Component Prototyping for Automotives
- Smart Building planning

COURSE CONTENT:

Problem statement: Industrial Metaverse control for reservoir automation, management, and tracking

Unit 1: Build physical infrastructure using microprocessor and sensors

Content learnt:

- Introduction to Metaverse and Phygital environments
- Introduction to microcontroller and sensors
- What is analogue and digital data?
- Getting started with programming for microcontroller
- How to Interface Sensors with a microcontroller?

Activity performed

- Initialise Microprocessor on simulator
- Setup sensors with microprocessors on simulator
- Upload code to microprocessor on simulator
- Process sensor data on simulator

Unit 2 : Build the transport layer for metaverse using Cloud computing services

Content learnt:

- Introduction to IoT and Cloud
- Features of cloud and its initialization
- How to read and write data to cloud

- Integration of microcontroller and sensors from simulator with cloud

Activity performed

- Initialise cloud
- Setup databases for platform deployment
- Upload sensor data to cloud

Unit 3: Create digital assets required for XR interaction by using a 3D modelling tool

Content learnt:

- Introduction to Blender
- 3d modelling Structure
- 3D assets and Textures
- Creating a model for dam reservoir
- Creating various farm states

Activity performed

- Build 3D Models
- Texture 3D models
- Animate 3D Models
- Setup state machines
- Bake and prepare environment for sensor data

Unit 4: Integrate digital and physical assets to create a Digital Twin in Metaverse

Content learnt:

- Introduction to Unity and packages
- Optimization of 3d model
- Introduction to REST API
- Interfacing cloud data with unity
- Testing Hardware and cloud with unity

Activity performed

- Download the plugin and interface with microprocessor
- Bring optimised 3D models for Integration
- Use REST API and match sensor data across cloud

Unit 5: Build Industrial Metaverse

Content learnt:

- Introduction to Oculus quest2
- How to integrate oculus quest2 with unity
- Deploying project to oculus quest2

Activity performed

- Build Final Metaverse Digital twin
- Demonstrate metaverse twin with VR
- Create a portfolio of all products using metaverse

Final Project Showcase:

Phygital world creation for Industrial Metaverse using IoT, CAD and Edge computing. Interface in a Digital world and control real world twins for multiple industries.

A complete component twin within a working metaverse for controlling and promoting collaborative features in the virtual reality.

Final Project Outcome:

A complete Industrial metaverse stack designed for Visualization of the Industrial Project with its real-world twin will be created by the student. The following will be submitted as part of the report

a) Portfolio of other projects made by student
b) Realtime control and feedback from the water tank

COURSE OUTCOME:

1. Create a physical hardware on simulator that reads and controls real world data.
2. Digitize and build a cloud framework to build a digital twin.
3. Design virtual world with multiple asset files
4. Build the Phygital Model using Virtual reality and control simulated actions in realtime.

Job Roles:

- IoT Developer
- Automation solution architect
- Embedded Developer
- IoT Analyst
- Metaverse Achitect
- Metaverse Product Manager

- XR Interaction Designer
- Digital twin specilaist
- Digital twin engineer
- Digital enginner
- BI Developer
- Simulation engineer

FOR FURTHER READING:

Digital twins – Visualisation and simulation using VR – Omniverse Digital twin platform – Industrial metaverse – Digital native

REFERENCES:

1. SketchUp for Site Design: A Guide to Modelling Site Plans, Terrain, and Architecture 2nd Edition by Daniel Tal.
2. SketchUp for Builders: A Comprehensive Guide for Creating 3D Building Models Using SketchUp by John Brock.
3. SketchUp for Interior Design: 3D Visualizing, Designing, and Space Planning.
4. The SketchUp Workflow for Architecture: Modelling Buildings, Visualizing Design, and Creating Construction Documents with SketchUp Pro and Layout.

ONLINE REFERNCES:

- Digital Twin: A Complete Guide For The Complete Beginner, a book by Vijay Raghunathan & Santanu Deb Barma
- Digital Twin – Fundamental Concepts to Applications in Advanced Manufacturing, a book by Surjya Kanta Pal , Debasish Mishra , Arpan Pal , Samik Dutta , Debashish Chakravarty , & Srikanta Pal
- Learning in Metaverses: Co-Existing in Real Virtuality, a book by Eliane Schlemmer
- https://docs.arduino.cc/software/ide-v1/tutorials/Windows
- https://www.circuitstoday.com/nodemcu
- https://nodemcu.readthedocs.io/en/release/

SOFTWARE REQUIREMENTS

1. VS Code

2. Rest API
3. Blender
4. Unity3D
5. Think speak
6. Woakwi

HARDWARE REQUIREMENTS

1. PC – Minimum requirements
    a) 16 – GB RAM
    b) 4GB - Dedicated GPU
    c) 500 GB HDD

2. Oculus (VR Presentation)

Industry Use cases/ Problem statements:

Each of following 10 use cases will be 2 or 3 variation in terms of the configuration of the physical space to make it 20 to 30 industrial use cases.

1. **Poultry Farming:** Develop an industrial metaverse project where we would be creating a digital twin of "Poultry Farming". Poultry Farming is a domestic or commercial breeding of birds primarily for their meat, eggs, and feathers. In this instance, it is necessary to continuously monitor the real-time data in order to automate the feeding and temperature.
2. **GreenHouse:** Constructing a digital twin for a GreenHouse in which the environment is continuously monitored based on variables such as temperature, soil, humidity, and distance.
3. **Automatic shutdown system:** Building an automatic shutdown system in an industrial metaverse scenario like a large commercial structure. With the help of this digital twin system, all electrical equipment would switch off, if there were no people present.
4. **Smart home technology:** Creating a digital twin based on smart home technology in a large residential space where an automatic shutdown system is installed. Here the sensor receives the physical world data to find whether any human presence is around and would cause all electrical equipment to turn off.

5. **Factory robot:** Developing a digital twin that controls a factory robot to perform any pick-and-place tasks. These industrial metaverse robots are monitored to implement automated solutions like lifting or moving objects which do not require a lot of thought processes.
6. **Gantry crane machine:** A gantry crane machine can be used to carry objects horizontally as well as lift and lower them. The majority of its applications involve lifting big objects and moving them to new locations. We are developing a digital twin for monitoring and controlling the Gantry crane based on real-time data.
7. **Supply chain system:** A supply chain system plays a vital role in the production pipeline from raw goods to finished products. Conveyors are employed in these situations to facilitate simple and quick supply chain support. In order to incorporate industrial metaverse in supply chain management, a digital twin is deployed to control and observe the conveyor system.
8. **Smart home energy monitor:** Build a digital twin to implement a smart home energy monitor in order to measure numerous factors that affect the power flow, such as voltage dips and load current. In this system, the physical data is collected and sent to the virtual twin in order to boost the energy performance of the residential spaces using an industrial metaverse platform.
9. **Milling:** Milling is one of the most important steps in the production of rice. It is generally performed post the production of rice. There are a variety of operations that have to be performed during milling in order to make rice fit for the process. We are deploying a digital twin that can control the speed of the rice mill in order to achieve the best quality with smart technology.
10. **Cement Mixer:** Developing a digital twin that can be used for setting up the optimal ratio of a cement mixer by controlling the speed of the motor. This speed data of the physical machine is extracted and tweaked using the virtual twin.
11. Industrial Metaverse control for **reservoir automation,** management, and tracking

Mode of Delivery: Hybrid

Financials:

- Our cost for Naan Mudhalvan Initiative (Hybrid) : Rs 2000 per student + GST
- Cost includes only a 5 day Faculty Development Program in 1 location.