Centurion University of Technology and Management Odisha

CHOICE BASED CREDIT SYSTEM

COURSE STRUCTURE & SYLLABUS

BASKET - III

Centurion
UNIVERSITY

School of Engineering & Technology

2022

Course Structure
Basket - III

Course Code	Course Title	Credits	Course Type T+P+PJ
CUTM1017	Industrial IOT and Automation	6	3-2-1
CUTM1018	Data Analysis and Visualisation using Python	4	0-1-3
CUTM1019	Machine Learning using Python	4	1-2-1
CUTM1020	Robotic automation with ROS and C++	4	1-2-1
CUTM1021	Basics of Design Thinking	2	0-0-2
CUTM1022	System Integration with DYMOLA	2	0-0-2
CUTM1023	Smart Engineering Project (G2M)	3	0-0-3

Industrial IoT and Automation

Code	Course Title	Credit	T-P-PJ
CUTM1017	Industrial IoT and Automation	6	3-2-1

Objective

- Students will learn the new evolution in hardware, software, and data.
- While the promise of the Industrial Internet of Things (IIoT) brings many new business prospects, it also presents significant challenges ranging from technology architectural choices to security concerns.
- Students acquire upcoming Industrial Internet of Things: Roadmap to the Connected World Course offers important insights on how to overcome these challenges and thrive in this exciting space.

Course outcome

- Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
- Explore IoT technologies, architectures, standards, and regulation
- Realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices
- Examine technological developments that will likely shape the industrial landscape in the future
- Understand how to develop and implement own IoT technologies, solutions, and applications
- At the end of the program, students will be able to understand how to develop and implement their own IoT technologies, solutions, and applications.

Course content

MODULE 1: Introduction & Architecture

Theory

What is IIoT and connected world? The difference between IoT and IIoT, Architecture of IIoT, IOT node.

Challenges of IIOT

Hands-On

1. Introduction to Arduino, ESp8266, Introduction to raspberry Pi.

MODULE2: **IIOT Components**

Theory:

Fundamentals of Control System, introductions, components, closed loop & open loop system.

Introduction to Sensors (Description and Working principle): What is sensor? Types of sensors, working principle of basic

Sensors -Ultrasonic Sensor, IR sensor, MQ2, Temperature and Humidity Sensors (DHT-11).Digital switch, Electro

Mechanical switches.
Practice:
2. Measurement of temperature & pressure values of the process using raspberry pi/node mcu.
3. Modules and Sensors Interfacing (IR sensor, ultrasonic sensors ,Soil moisture sensor) using raspberry pi/node mcu.
4. Modules and Actuators Interfacing (Relay, Motor, Buzzer) using raspberry pi/node mcu.

MODULE 3: Communication Technologies of IIoT

Theory:

Communication Protocols: IEEE 802.15.4, ZigBee, Z Wave, Bluetooth, BLE, NFC, RFID
Industry standards communication technology (LoRAWAN, OPC UA, MQTT), connecting into existing Modbus and Profibus
Technology, wireless network communication.
Practice:
5. Demonstration of MQTT communication
6. Demonstration of LoRa communication.

MODULE 4: Visualization and Data Types of IIoT

Theory:

Front end EDGE devices, enterprise data for IIoT, emerging descriptive data standards for IIoT, cloud data base, could
Computing, fog or edge computing,
Connecting an Arduino /raspberry pi to the Web: Introduction, setting up the Arduino/raspberry pi development
Environment, Options for Internet connectivity with Arduino, configuring your Arduino/raspberry pi board for the IoT.
Practice:
7. Visualization of diverse sensor data using dashboard (part of IoT's 'control panel')
8. Sending alert message to the user.

MODULE 5:

Theory
Extraction from Web: Grabbing the content from a web page, Sending data on the web, troubleshooting basic Arduino
issues, types of IoT interaction , Machine to Machine interaction (M2M).
Practice
9. Device control using mobile Apps or through Web pages.
10. Machine to Machine communication

MODULE 6: Control & Supervisory Level of Automation

Theory
Programmable logic controller (PLC), real-time control system, Supervisory Control & Data Acquisition (SCADA).
HMI in an automation process, ERP &MES
Practice
11. Digital logic gates programming using ladder diagram

12. Implementation of Boolean expression using ladder diagram
13. Simulation of PLC to understand the process control concept.

Module 7: **Application of IIOT**

Case study: Health monitoring, Iot smart city, Smart irrigation, Robot surveillance

Text Books:

1. Industrial IoT Challenges, Design Principles, Applications, and Security by Ismail Butun (editor)

2. Internet of Things with Arduino Cookbook, Marco Schwartz, ISBN 978-1-78528-658-2 2.

Reference Books:

1. The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
2. Industrial Internet of Things: Cybermanufacturing System**,** Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)
3. Internet of Things- A Hands on Approach, Arshdeep Bahga and Vijay Madisetti , Universities Press , 2015.

Data Analysis and Visualization Using Python

Code	Course Title	Credit	T-P-PJ
CUTM1018	Data Analysis and Visualisation Using Python	4	0-1-3

Objective

- How to tell a story from data
- How to marshal the data for storyline
- The ability to develop visualisation to tell the story
- The focus is on analysis of data using visualisation as a tool

Course outcome

- To create impactful visualization with good story line.

Course content

Module-I

STORY BOARD DEVELOPMENT

The objective and flow of the story to be understood through cases

Module-II

DATA READING USING PYTHON FUNCTIONS

Python libraries: Pandas, NumPy, Plotly, Matplotlib, Seaborn, Dash

Data collection from online data sources, Web scrap, and data formats such as HTML, CSV, MS Excel, data compilation, arranging and reading data, data munging

Module-III

DATA VISUALSATION USING PYTHON LIBRARIES

Different graphs such as Scatterplot, Line chart, Histogram, Bar chart, Bubble chart, Heatmaps etc.

Dashboard Basics – Layout, Reporting, Infographics, Interactive components, live updating

Projects List

1. COVID 19
2. World Development Indicators
3. ERP dashboarding
4. Details of Social/ Empowerment schemes of Govt. etc.

References:

https://www.programmer-books.com/wp-content/uploads/2019/04/Python-for-Data-Analysis-2nd-Edition.pdf

https://towardsdatascience.com/data-visualization/home

Reading materials and videos available on internet on how to use ANACONDA, JUPYTER NOTEBOOK and Python Libraries

Machine Learning using Python

Code	Course Title	Credit	T-P-PJ
CUTM1019	Machine Learning using Python	4	1-2-1

Objective

- Understand the meaning, purpose, scope, stages, applications, and effects of ML.
- Explore important packages of python, such as numpy, scipy, OpenCV and scikit-learn.

Course outcome

- Students will able to Create and incorporate ML solutions in their respective fields of study.

Course content

Module 1 – Application and Environmental-setup (12 hrs)

- Applications of Machine Learning In different fields (Medical science, Agriculture, Automobile, mining and many more).
- Supervised vs Unsupervised Learning based on problem Definition.
- Understanding the problem and its possible solutions using IRIS datasets.
- Python libraries suitable for Machine Learning(numpy, scipy, scikit-learn, opencv)
- Environmental setup and Installation of important libraries.

Module 2 - Regression (8 hrs)

- Linear Regression
- Non-linear Regression
- Model Evaluation in Regression
- Evaluation Metrics in Regression Models
- Multiple Linear Regression
- Feature Reduction using PCA
- Implementation of regression model on IRIS datasets.

Module 3 - Classification (24 hrs)

- Defining Classification Problem with IRIS datasets.
- Mathematical formulation of K-Nearest Neighbour Algorithm for binary classification.
- Implementation of K-Nearest Neighbour Algorithm using sci-kit learn.
- Classification using Decision tree.
- Construction of decision trees based on entropy.
- Implementation of Decision Trees for Iris datasets .
- Classification using Support Vector Machines.
- SVM for Binary classification
- Regulating different functional parameters of SVM using sci-kit learn.
- SVM for multi class classification.
- Implementation of SVM using Iris datasets .
- Implementation of Model Evaluation Metrics using sci-kit learn and IRIS datasets.

Module 4 - Unsupervised Learning (12 hrs)

- Defining clustering and its application in ML .
- Mathematical formulation of K-Means Clustering.
- Defining K value and its importance in K-Means Clustering.
- Finding appropriate K value using elbow technique for a particular problem.
- Implementation of K-Means clustering for IRIS datasets

Projects

- To be defined based on respective study area of student.

References:

Text Book:

1. EthemAlpaydin, Introduction to Machine Learning, Second Edition, http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012.

Web Resource:

1. https://towardsdatascience.com/beginners-guide-to-machine-learning-with-python-b9ff35bc9c51

Robotic automation with ROS and C++

Code	Course Title	Credit	T-P-PJ
CUTM1020	Robotic automation with ROS and C++	4	1-2-1

Course Content:

1. Robotic Automation Introduction
2. Sensors & Controllers
3. Sequential robot control
4. ROS & C++
5. Project

Course Objectives

- To upgrade knowledge levels of robotic application in modern industries
- Project based training

Course Outcomes

- Advanced knowledge on robotic automation
- Understand different types of devices to which robotic modules are connected
- Provide the knowledge about understand various types of robotic applications.
- Industry based project & advanced learning.

Course Syllabus

Module – 1

Robotic Automation Introduction

1.1 Basic's of automation

1.2 Use of robots in industry.

Module - 2

Sensor's requirement in robots.

2.1 Selecting sensors as per the project.

2.2 Specification checking of sensors.

2.3 Interfacing of sensor to controllers.

Practice

P2.1 TILT, PROXIMITY, TEMPERATURE, HUMIDITY, SMOKE, FINGERPRINT

P2.2 BLUETOOTH, ESP8266, GPS, GSM

Module - 3

Controllers and output port handling.

3.1 Concept of 8951 controller

3.2 Concept of Arduino and concept of Raspberry Pi.

Practice
P3.1 Port handling of 8951
P3.2 Port handling of Arduino
P3.3 Port handling of Raspberry Pi

Module- 4
Sequential robot control
4.1 Designing of sequential robot control system.
4.2 Writing of programs in different programming languages.
4.3 Controlling of input/output devices.
Practice
P4.1 Programming of controllers with different programming languages
P4.2 Designing of sequential control robot.

Module- 5
ROS & C++
5.1 What is Ubuntu & ROS?
5.2 Requirement and application of ROS.
5.3 ROS based simulation of Turtlbot.
5.4 Adding of robot with wheel & sensor. Placing robot inside Gazebo.
Practice:
P5.1 Ubuntu basic command.
P5.2 Installation of Ubuntu, ROS & Gazebo
P5.3 Turtlbot control application
P5.4 Gazebo based robot control and simulation.
P5.5 Python and C++ based programming to control robot.
Virtual LAB : Using ROBOMASTER (AWS)
Projects

1. Mobile controlled robot
2. Autonomous operated robot.
3. 3. Location targeted robot

Basics of Design Thinking

Code	Course Title	Credit	T-P-PJ
CUTM1021	Basics of Design Thinking	2	0-0-2

Course Rationale:

Steve Jobs famously said "Design is just not what is looks or feels like. Design it how it works". Design Thinking is described as a discipline where designer's sensibility and methods match with the needs of users. It draws on logic, imagination, intuition and systemic reasoning to explore the possibilities of a solution to a challenge and to create desired outcomes that benefit the end user. So, if you are among the one who is constantly thinking of solving a problem of business or society, it is ideal for you. This course will help you with the basics of design thinking and through an action centric learning approach, lead to creatively explore the challenges and by using the design thinking tool propose innovative solutions.

Course Objectives: The course aims to

- To orient the participants with the basics of the design thinking process
- To familiarize participants with the elements of Design thinking

Course Outcome: After completion of the course the students

- will be able to apply the design thinking process to innovative problem solving

Course contents:

Module: I

Basics of Design Thinking, Why Design Thinking, Design Thinking Mindset (Inspiration, Ideation and Implementation) Design thinking process, (Empathy, Define, Ideate, Prototype, Test). Cases of application of Design thinking approach (Intuit, IDEO, Infosys, IBM, Google, Apple, Jubilant Foods)

Module: II

Executing a Design Thinking Project- Apply Interviewing and empathy building technique, Drawing inferences from the observations, Defining a point of view, Ideation process, developing and testing prototypes and writing a story of a minimum viable solution.

Projects-

- Develop a customer friendly insulin pump design
- Develop a new customer experience for buying a diamond ring online
- Develop a new disease monitoring device for health workers working in remote areas.
- Designing an integrated machinery for end to end farm activities for small and marginal farmers.
- Design a Fund raising campaign

Recommended References:

Books: Tom Kelly & Jonathan Littman (2001). "The Art of Innovation" Broadway Publication.

System Integration with DYMOLA

Code	Course Title	Credit	T-P-PJ
CUTM1022	**System Integration with DYMOLA**	2	0-0-2

Course Objectives

- To provide powerful multi-disciplinary systems engineering through compatible model libraries for a large number of engineering domains.
- To design high-fidelity modeling of complex integrated systems.
- To design intuitive modeling i.e. advanced, formally defined object-oriented modeling language.
- To enable users to easily build their own components or adapt existing ones to match their unique needs.
- To provide hardware-in-the-loop simulations (HILS) i.e. real-time simulation with AurdinoUno, Python, Matlab, 3D real-time animation, CAD files import capability.
- To increase the ability to integrate with complex 3D geometry for integrated simulation.
- To increase powerful model management, calibration & optimization capabilities.

Course Outcomes

- The use of open standards such as DYMOLA (Modelica and FMI) is a key enabler to better understand the behavior of systems and to work and communicate accurately with partners and suppliers.
- DYMOLA is not only capable to support an ad-hoc modeling level, such as functional behavior or detailed design, but is also able to convert these predictive models into real-time models.
- The user can able to create new elements in an easy and intuitive way, to answer to its own modeling requirements.
- Future Centurions are ready for operating in many industries including automotive, aerospace, architecture, Motorsport, energy, and high tech.

Course Syllabus

Module 1 - Introduction Dymola and Modelica library

Package Browser, Component Browser, Parameter and Variable Editor Simulation Window,

Modeling, and Simulation.

The Modeling window is used to compose models and model components.

The Simulation experiment on the model, plot results and animate the behavior.

Creating user-defined models and scripting using Modelica language.

Role Play – Explore the pre-defined libraries and Models, Creating a Package

Practice Project - Preparation of animated projects

https://www.youtube.com/watch?v=39xyI0k

https://www.youtube.com/watch?v=FN8LlnTwzVE&t=314s

Module 2 – Physical Modeling using DYMOLA

Import of user-defined libraries and packages, interfacing with physical models using ArduinoUno.

The Simulation experiment on the model using multi-domain libraries such as mechanical, electrical, control, thermal, pneumatic, hydraulic, powertrain, thermodynamics, vehicle dynamics, air-conditioning domains

Dymola interface that is stored in the Python package

Role Play – Explore the pre-defined libraries and Models, Creating a Package

Practice Project - Preparation of projects using user-defined packages,

Systems Physics with Modelica/Dymola

https://www.youtube.com/watch?v=xlpHwX-W3Ns

Module 3 – Animation and 3D view Using DYMOLA

MultiBody Frame Connector, Building a Mechanical Model, Concept of Furuta

Role Play - Practical session by students for students

Practice Project - Modeling of animated projects using the MultiBody library.

https://www.youtube.com/watch?v=c9Ar2b4X5rQ

https://www.youtube.com/watch?v=k7lLBASaEJg

Session Plan

Session 1

Project 1

Simulating a model – Modeling of Integrated circuits

Description: Use of Electrical and Electronics components.

Workbench Use: Behavior Modelling, Functional and Logical Design.

Session 2

Project 2

Simulating a model -Creating a model for Electric DC Motor

Description: Design a DC Motor Model, Test, and Simulation, Creating a library for components, Creating a model for motor drive, Scripting.

Workbench Use: Behavior Modelling, Modelica Standard Library.

Session 3

Project 3

Simulating a model -Simple Pendulum with Frictionless joint Using Multi-Body Library

Description: Design the Simple pendulum and the Furuta joint using Dymola and Modelica language. Friction joint for the Mechanical equipment.

Workbench Use: Behavior Modelling.

Session 4

Project 4

Simulating a model – Pick and Place Robot

Description: 5 Axis Pick and Place Robot Design, Validation, and Optimization in the 3DS platform.

Workbench Use: Behavior Modelling, Functional and Logical Design. Part design and Assembly Design.

https://www.youtube.com/watch?v=9RgdZUvEjPw

Session 5

Project 5

Simulating a model – 3D Printer Design

Description: Design All System and Sub System of the 3D Printer, Validation and Simulation using 3Ds Platform.

Workbench Use: Behavior Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 6

Project 6

Simulating a model – Bicycle Behavior Modeling

Description: Design Power Train, Driving Cycle, part design, and Simulation.

Workbench Use: Behavior Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 7

Project 7

Simulating a model – Refrigerator Compartment Door Design using Thermal Library

Description: This component model the airflow through the door of a refrigerator or freezer compartment.

Workbench Use: Behavior Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 8

Project 8

Simulating a Model – Engine Analytic Using MultBody Library.

Description: Engine analytic, an engine with 6 cylinders, 6 planar loops, 1 degree of freedom, and analytic handling of kinematic loops.

Workbench Use: Behavior Modeling.

Session 9

Project 9

Simulating a model – Control the real and Digital servo motor ArduinoUno Library

Description: Control the Real and Digital Servo motor with simulation.

Workbench Use: Behavior Modelling, Arduino based System Design, and Functional and logical design.

Session 10

Project 10

Simulating a model – Virtual Universes with Poppy Humanoid Using ArduinoUno Library

Description: Virtual universes with a human assistant robot with simulation.

Workbench Use: Behavior Modelling, Arduino based System Design, Functional, and logical design.

Session 11

Project 11

Simulating a model – Implementation of Model using Python Library

Description: Modeling using python library, validation and optimization in the 3Ds platform.

Workbench Use: Behavior Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 12

Project 12

Simulating a model – Industrial Robot Design

Description: 6 Axis industrial robot design, validation, and optimization in the 3Ds platform.

Workbench Use: Behavior Modelling, Functional and Logical Design. Part design and Assembly Design.

Session 13

Project 13

simulating a model – Temperature Control System Using State Graph

Description: The model contains an electric circuit with a heating resistor and a switch.

Workbench Use: Behavior Modelling.

https://www.youtube.com/watch?v=zz-_crJOGo0&t=26s

https://www.youtube.com/watch?v=Zl592ARjnpU

Session 14

Project 14

Simulating a model – Magnetic Ball System using Magnetic Library

Description: The electronic circuit consists of a voltage source, a resistor, and an inductor in the form of a tightly wound coil. An iron ball beneath the inductor experiences a gravitational force as well as an induced magnetic force (from the inductor) that opposes the gravitational force.

Workbench Use: Behavior Modelling.

Session 15

Project 15

Simulating a Model – Design of Water to Steam Converter Using Fluid Library

Description: Create a package under Fluid_Package called Water_To_Steam using temperature sensors.

Workbench Use: Behavior Modelling.

Session 16

Project 16

Simulating a Model – Design of Liquid Valve Control Using Fluid Library

Description: Building a simple circuit with two valves and a volume block.

Workbench Use: Behavior Modelling.

https://www.youtube.com/watch?v=P_YI3RiTI14